Technical Memorandum

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Subject: **Dual Site Groundwater Operable Unit; Montrose Chemical and Del Amo Superfund Sites; Groundwater Remedial System, Basis of Design for Planned Extraction and Injection Wells**

The Dual Site Groundwater Operable Unit remedial system will utilize a total of 15 extraction wells and seven injection wells (Figure 1). Six extraction wells and four injection wells were installed as part of the pilot testing program (Hargis + Associates, Inc. [H+A], 2008a). With one exception, the locations of the remaining wells have been established by the U.S. Environmental Protection Agency (EPA) modeling effort (CH2M HILL, 2008); one injection well location was specified as part of a separate evaluation of injection well capacities which will be provided as part of the Preliminary Basis of Design Report for the groundwater remedy Remedial Design (RD) (H+A, in press). The basis of design for the remaining extraction and injection wells is presented (Figure 1).

The design of a number of components of the groundwater remedial system such as the well vaults, down well equipment, and conveyance pipelines, are dependent upon the design of the remaining extraction and injection wells. To facilitate design of the groundwater remedial system, the proposed well designs have been summarized (Table 1). In support of the proposed design, the remainder of this document presents the rationale for the following:

- The configuration of the wellfield;
- Recommended drilling technology and drilling fluid properties;
- Pilot boring design, logging, and sampling;
- Extraction and injection well designs including:

  - Conductor casing set depths, diameters, and material specifications, and
  - Well construction specifics such as well diameters, screen intervals, material specifications, screen slot size, filter pack intervals, and annulus materials.

- Well development procedures

Wellfield Evaluation

The need for one of the model-specified extraction wells, G-EW-6, is currently being evaluated. Additional field investigations were conducted to assess the need for extraction well G-EW-6 (H+A, 2008b and H+A, in press). The results of the field investigation indicate that the chlorobenzene concentration in the Gage aquifer (Gage) at the proposed location for G-EW-6 is less than 5 micrograms per liter (µg/l) (H+A, in press). That is, chlorobenzene is not present at a concentration above the Maximum Contaminant Level of 70 µg/l in the Gage at the proposed location for well G-EW-6. As further detailed in a technical memorandum presenting the results of an evaluation of the need for extraction well G-EW-6 (H+A, in press), it is recommended that proposed extraction well G-EW-6 not be included in the final wellfield for the Dual Site Groundwater Operable Unit. Instead, the pumping allocated to proposed extraction well G-EW-6, i.e., about 30 gallons per minute (gpm), would be allocated to existing extraction well G-EW-2 for a total maximum pumping rate at extraction well G-EW-2 of about 60 gpm, such that the overall system still operates at 700 gpm. However, pending finalization of the wellfield, extraction well G-EW-6 is included in this document as a contingency well. Additionally, it was confirmed that existing extraction well G-EW-2 is adequately sized to operate at a higher pumping rate (i.e., 60 gpm) that may result from the redistribution of flow from well G-EW-6.

In addition, an assessment of injection well capacities indicated that an additional injection well, referred to herein as G-IW-3, is warranted (H+A, in press). This well has therefore been included in the basis of design.

Recommended Drilling Technology

A number of drilling technologies, including hollow stem auger, roto-sonic, and mud rotary, were considered for this work. Of the considered drilling technologies, mud rotary is recommended for several reasons including:

- Successful completion of a similar drilling program (i.e., pilot borings and temporary, observation, and full-scale extraction and injection wells) at the Montrose Site (H+A, 2008a);

- Ability to drill to depths greater than 200 feet;

- Ability to drill large diameter boreholes (up to 27 inches);
- Isolation of overlying units; and
- Borehole stability.

During the pilot test well installation drilling program (H+A, 2008a) a Speed Star 50K mud rotary drill rig was used to drill a majority of the exploratory borings and all of the existing extraction and injection wells. Part of the success of the previous drilling program is attributed to the use of an adequately sized drill rig and a competent driller.

Pilot Borings

The first pilot boring will be drilled at each of the well sites to the anticipated completion depth of the deepest well at that location (Figure 1; Table 2). For instance, if a Gage well and a Bellflower well are to be installed at a location, the first pilot boring will be completed through the Gage and into the top of the Gage-Lynwood aquitard. If no Gage well is to be installed adjacent to a Bellflower well, the boring will be completed to the lower Bellflower aquitard. At each location, these borings will serve as the pilot hole for the deepest well. The purpose of the pilot boring is to collect data to aid in the design of the extraction or injection well(s). Continuous core samples will be collected from near the target depth for the base of the conductor casing and 10 feet above the target zone throughout the anticipated well screen interval for the planned extraction and injection wells for lithologic logging. Additionally, at the location of BF-IW-3 and G-IW-3, geophysical logs including gamma ray, spontaneous potential, single point resistance, short normal and long normal resistivity, and focused resistivity will be obtained from the pilot boring. This location is not adjacent to any existing deep lithologic control points, and geophysical logs have proven to be useful during past field investigations at the site for assessing variations in lithology, identification of hydrostratigraphic units, and selection of appropriate screened intervals for monitor, extraction, and injection wells.

In combination with the field prepared lithologic log, the geophysical data will assist in determining the depth and thickness of key lithologic features including the Bellflower sand (BFS), the lower Bellflower aquitard, and the Gage. Identifying these units is crucial to properly selecting the conductor casing set depths, the well screen interval, the total depth of the well, and other key well specifications.

Additionally, soil samples for grain size distribution analysis will be collected at each exploratory boring location from the hydrogeologic unit to be screened. The grain size distribution data will be used to determine the final well screen slot size and the filter pack size.

Full-Scale Well Design

The following sections discuss the basis for sizing and material specifications for the full-scale extraction and injection wells.

Conductor Casing and Screen Intervals

Lithologic data from borings and wells installed in the vicinity of the planned well sites were evaluated to develop preliminary well designs (Figure 1). The table below indicates the boring(s) and/or well(s) evaluated for each planned extraction and injection well.

Table 3. Lithologic Basis For Proposed Full-Scale Well Construction

Hydrogeologic Unit	Well Identifier	Evaluated Borings and Wells
EXTRACTION WELLS		
Upper Bellflower Aquitard	UBA-EW-1	EB-27
	UBA-EW-2	EB-27
Bellflower Sand	BF-EW-3	BF-15, EB-23
	BF-EW-4	BF-11
	BF-EW-5	EB-2, EB-27
	BF-EW-6	EB-4, EB-27
Gage Aquifer	G-EW-4	EB-11
	G-EW-5	EB-23
	G-EW-6	Cross-Section A-A' Near Borings EB-13, EB-32, & EB-36
INJECTION WELLS		
Bellflower Sand	BF-IW-3	EB-26
Gage Aquifer	G-IW-3	EB-26
	G-IW-4	SBL0081[a]

(a) = Boring installed by Del Amo (Dames & Moore, 1998).

The following general criteria were considered when specifying the conductor casing and screen intervals:

Table 4. Criteria for Conductor Casing and Screen Intervals

Hydrogeologic Unit	Conductor Casing Depth[a]	Screened Interval[a]
UBA, Hydraulic Containment Wells	Minimum conductor casing depth per California Well Standards (California Department of Water Resources, 1991)	From the base of the conductor casing into the upper coarse-grained portion of the UBA[b]
BFS, Hydraulic Containment Wells	Terminates in the fine-grained layer overlying the screen interval	From the coarse-grained material below the UBA screen to the base of the BFS
BFS, Downgradient Extraction Wells		The entirety of the middle Bellflower B and C sands through any significant sands in the lower Bellflower aquitard (LBA)
BFS, Injection Wells		The entirety of the BFS terminating above the LBA
Gage, Extraction and Injection Wells	Terminates in the fine-grained LBA, overlying the Gage	From the top of the Gage through the coarser, upper portion of the Gage

(a) = The proposed conductor casing depth and screen interval for each planned extraction and injection well are provided in Table 1.
(b) = Screen interval will be specified such that the UBA is isolated from the lower sands to mitigate the potential for vertical migration of benzene.

The proposed casing and screen intervals have been posted to the relevant log(s) for comparison (Appendix A). Preliminary well designs will be adjusted, as appropriate, upon the completion of the exploratory boring at each well site. The lead hydrogeologist will finalize well designs based upon an evaluation of information collected from the exploratory boring installed at each well site including the lithologic log, geophysical data, and grain size data.

Full-Scale Well Diameters

A number of factors were considered when selecting extraction and injection well casing diameters including:

1. Pump sizing:

- Extraction well pumps were sized based on the maximum design pumping rate specified by EPA in the RD Model Report (CH2M HILL, 2008).
- It is anticipated that injection wells may need to be back flushed on a regular basis to recover lost capacity due to plugging. In order to minimize disruption to injection operations, injection wells may be fitted with permanent pumps to allow periodic back flushing for short periods. Injection well pumps were sized based on the estimated maximum short-term extraction rate of the wells (Appendix B).
- Per Grundfos®, a leading submersible pump manufacturer, 4-inch diameter pumps are more efficient for flowrates below 60 gpm; 6-inch diameter pumps are efficient at flows between 60 and 300 gpm.

2. Downwell Piping and Cable:

- Two 1-inch diameter, Schedule 40, flush-threaded polyvinyl chloride (PVC) drop pipes will be required in each well; one for manual water level measurement and the other for installation of a pressure transducer for automated water level monitoring.
- For extraction and injection wells, an extraction pump riser pipe was sized to match the pump discharge size or to maintain fluid velocities less than 10 feet per second flow velocity to minimize friction losses and pipe erosion at the maximum design pumping rates specified by EPA, will be installed from the top of the pump, through the well seal.
- For injection wells, a drop pipe, sized based on the EPA-specified design injection rates (Table 5), will be installed for injection of treated groundwater. To minimize entrainment of air during injection, the drop pipe will terminate below the water level anticipated during active injection.
- For the extraction pump riser pipes and injection drop pipes, the outer diameter of the corresponding pipe couplings were utilized to determine space requirements in each well.
- A submersible power cable for the submersible pumps will be installed through the well seals; while this is a minimal space requirement, it was considered.

3. Additional considerations

- Based on anticipated motor sizes, pumping rates, and pump set depths, it is anticipated that shrouds may be needed in some wells to promote pump motor cooling; the additional space required for installation of shrouds was considered, when appropriate. When a shroud is needed, the shroud outer diameter was assumed to be next largest standard nominal pipe size than the nominal pump and motor size.
- Generally, it was assumed that the minimum external clearance between the pump (or pump shroud) and other well components was 0.5 inches. This clearance minimizes potential mechanical interferences between the pump and the well components.
- Generally, it was assumed that a minimum of 0.5 inch of clearance should be maintained between pipe couplings on top of the well seal penetrations to allow clearance for pipe installation.

The anticipated flowrates, casing diameters, and pump and motor sizes for each of the planned wells are presented below in Table 5. Additionally, Figure 2 provides schematics of the well layouts based on the above-described criteria, the inner diameter of Schedule 80 PVC based on the specified nominal diameters, and the flowrates specified in the RD Model Report (CH2M HILL, 2008). The smallest well diameter was selected that still allowed installation of equipment and piping per the above criteria. Since the combination of the above-considerations determines the well casing diameters and since the considerations for injection and extraction wells are different, well diameters for a given flow rate and pump combination may vary. For example, 4-inch diameter pumps are specified for extraction wells UBA-EW-1 and BF-EW-5. However, the UBA well is specified as 6-inch diameter while the BFS well is specified as 8-inch diameter. In this case, this variance is due to a larger diameter riser pipe from the pump that is required in the higher flow BFS extraction well as compared to the lower flow UBA extraction well. Similar rationales apply to other such differences in the specified well diameters.

Table 5. Planned Well Construction Information

Hydrogeologic Unit	Well Identifier	Flowrate[a,b] (gpm)	Well Casing Diameter (inches)	Pump and Motor Nominal Diameter[c] (inches)
EXTRACTION WELLS				
Upper Bellflower Aquitard	UBA-EW-1	6	6	4
	UBA-EW-2	12	6	4
Bellflower Sand	BF-EW-3	76	8	6

Hydrogeologic Unit	Well Identifier	Flowrate[a,b] (gpm)	Well Casing Diameter (inches)	Pump and Motor Nominal Diameter[c] (inches)
	BF-EW-4	134	8	4
	BF-EW-5	35	8	4
	BF-EW-6	35	8	4
Gage Aquifer	G-EW-4	68	8	6
	G-EW-5	57	8	4[f]
	G-EW-6[d]	30	8	4
INJECTION WELLS				
Bellflower Sand	BF-IW-3	57	10	6
Gage Aquifer	G-IW-3	156[e]	12	6
	G-IW-4	125	12	6

(a) = For some extraction wells, the design rate changes over time as the plume is contained and the area targeted by the wellfield is adjusted. The indicated value is the maximum design rate specified in the RD Model Report (CH2M HILL, 2008).

(b) = For injection wells, the indicated rate is the design injection rate. However, pump sizes were based on the estimated short-term extraction rate of the wells (Appendix B).

(c) = Grundfos® submersible pump nominal diameters.

(d) = Extraction well G-EW-6 is not recommended as part of the final wellfield. It is recommended that the pumping allocated to well G-EW-6 be redistributed to existing extraction well G-EW-2 (H+A, in press).

(e) = The flowrate for injection well G-IW-3 of 156 gpm is approximately half of the design injection rate for existing well G-IW-1 (H+A, 2008b). The well will be installed to supplement injection into the Gage in the vicinity of injection well G-IW-1. The design rate for injection well G-IW-1 will be split with injection well G-IW-3.

(f) = It is possible a 6-inch pump may be required in extraction well G-EW-5 since the model-specified pumping rate is near the maximum recommended rate for a 4-inch pump. The well diameter is adequate for a 6-inch diameter pump.

gpm = gallons per minute

Conductor Casings

Conductor casings will be installed for all UBA, BFS, and Gage extraction wells in accordance with California Well Standards (California Department of Water Resources, 1991). The conductor casings are intended to support the borehole and prevent caving of unconsolidated sediments during drilling operations and placement of well casing and annular materials as well as to provide a long-term surface seal to prevent the entry of surface water or contaminants into the well. An additional objective of the conductor casings in the BFS and Gage wells is to isolate the overlying units, which are typically more impacted, from the hydrogeologic unit to be pumped.

Conductor casings shall be constructed of low carbon steel; this is the lowest cost material that provides adequate strength to resist collapse during initial grouting operations (Table 6). Long-term corrosion resistance is not necessary for the conductor casing since the grout envelope provides the seal once emplaced. Shallower conductor casings will consist of 0.25-inch thick low carbon steel (Table 6). In order to provide adequate collapse strength for deeper wells, including G-IW-3 and G-IW-4, the bottom portions of the conductor casings will consist of 0.3125-inch thick low carbon steel and the upper portions of the conductor casings will be 0.25-inch thick low carbon steel (Table 6).

The well design requires that four-arm, steel centralizers be welded to the casings every 20 feet. The centralizers will center the casing in the borehole, ensuring the cement seal is evenly emplaced around the casing.

The diameters of the casings were selected such that there would be a minimum 2.5-inch annulus between the conductor casing and the well casing. A 2-inch annulus is required by California Well Standards (California Department of Water Resources, 1991) and is considered the minimum space required to install the well filter pack, grout filter seal, fine sand, bentonite, and the grout seal via a tremie pipe.

Full-Scale Well Construction

Pursuant to the RD Model Report (CH2M HILL, 2008), the anticipated operational life of downgradient extraction wells will be on the order of 30 years; additionally the Record of Decision (EPA, 1999) indicates that the remedy duration may be as long as 50 years. Hydraulic containment wells will need to operate substantially beyond this timeframe. Thus, well longevity is considered a primary design objective.

Materials considered for the blank casing and screen intervals of the wells are: Schedule 40 PVC, Schedule 80 PVC, 304 stainless steel, and 316 stainless steel. Since wire-wrapped screen is not a solid piece of material like blank casing, its properties are different than that of blank casing and the two were considered separately.

Blank Casing

Stainless steel, Schedule 40 PVC, and Schedule 80 PVC were considered for the blank casing. Material properties considered include collapse strength, chemical compatibility, and corrosion resistance.

The collapse strength of the materials were considered to determine if the blank casing offers adequate strength to hold up to both internal and external forces exerted during the installation of the well. For the materials considered for the blank casing, an assessment of collapse strength shows that Schedule 40 PVC is adequate for the UBA extraction wells while Schedule 80 PVC is the minimum material that offers adequate collapse strength for the BFS and Gage extraction and injection wells. Due to the anticipated duration of system operation, all extraction wells will be constructed with Schedule 80 PVC. A comparison of the well pressures and collapse strengths for Schedule 80 PVC is provided in Table 7.

Both 304 and 316 stainless steels are chemically compatible with chlorobenzene (Cole Parmer, 2008). Additionally, research regarding Schedule 40 PVC degradation in the presence of chlorinated solvents indicates that Schedule 40 PVC is not subject to observable degradation in the presence of chlorobenzene at concentrations less than 10 percent of the aqueous solubility for periods as long as 18 months (U.S. Army Corps of Engineers, 1996). While not explicitly stated in this study, it is expected that the chemical resistance of Schedule 80 PVC would be greater than that of Schedule 40 PVC due to the greater thickness of Schedule 80 PVC.

As indicated in the RD Model Report (CH2M Hill, 2008), the initial concentration of chlorobenzene in the planned extraction wells is expected to be no higher than 30,000 µg/l which is about 6 percent of the aqueous solubility, or 500,000 µg/l. Additionally, the chlorobenzene concentrations decrease with time due to the cleanup of the chlorobenzene plume. This suggests minimal risk of PVC degradation over time. At injection well locations, chlorobenzene concentrations are expected to be negligible such that chemical compatibility is not a concern. Furthermore, for the planned UBA extraction wells, the blank casing will terminate above the current water table, such that chemical compatibility is not a current concern.

Corrosion potential is also a principal consideration in selecting screen and casing materials. PVC is inherently immune to corrosion whereas stainless steel is susceptible to corrosion depending on the type of stainless and the water quality. For assessment of the corrosion requirements for stainless steel, the Ryznar Stability Index (RSI) was calculated for each of the extraction wells. This is a method for evaluating the tendency of metallic casing materials to corrode in a given aqueous environment. RSI values, of less than 7.0, generally indicate low corrosion potential (Sterret, 2007). RSI values from 7.0 to 7.5 indicate corrosion potential is significant. RSI values from 7.5 to 7.9 indicate heavy corrosion potential. Different types of steel are compatible with varying ranges of RSI values. An RSI value was calculated for each extraction well location based on existing groundwater quality data. Based on these calculations, the RSI of the groundwater which will be extracted by the treatment system ranges from about 6.0 to 8.0. The upper limit RSI for 304 stainless steel is 12.0 and for 316 stainless steel the upper limit is 18.0 (Moog, 1972). This indicates that both materials are sufficiently corrosion resistant given the quality of groundwater in the vicinity of the extraction wells. However, an additional consideration is the fact that the wells may be idle for a period of years prior to beginning operation.

Since both PVC and stainless steel offer chemical resistance and adequate corrosion resistance, material costs were also considered. Per list pricing provided in October 2008 by Johnson Screen, the cost difference between Schedule 80 PVC and Schedule 10 304 stainless steel ranges from about $150 per foot for 6-inch diameter pipe, up to about $800 per foot for 12-inch diameter pipe. The differential increases as the thickness and quality of the steel is increased, up to about $2,000 per foot if Schedule 80 PVC and Schedule 40 316 stainless steel are compared.

Since Schedule 80 PVC is considerably less expensive than stainless steel, is not subject to corrosion, has minimal risk of chemical attack based on the current water quality conditions, and offers sufficient collapse strength (Table 7), it is recommended for the blank casing material. For the UBA extraction wells, it could be argued that Schedule 40 PVC is adequate for the blank casing since it offers adequate collapse strength at, based on current water levels, it would not be in contact with the groundwater. However, the static water levels in the vicinity of the site have been rising an average of 1 foot per year for approximately the last 10 years. Since the UBA extraction wells are located in areas with some of the highest concentrations of chlorobenzene in groundwater, and since groundwater may eventually rise sufficiently that it could be in contact with the blank casing it is recommended that Schedule 80 PVC also be used for the UBA extraction wells. Additional rationale for the thicker PVC is that it offers additional durability to the two hydraulic containments wells which are expected to operate for many years beyond even the 32 years specified for the groundwater remediation system. A schematic construction diagram of the extraction and injection wells is included as Figure 3.

Well Screen

Wire-wrap well screens were selected over factory-slotted or louvered well screen. Per communication with Roscoe Moss Company, a leading supplier of stainless steel screens, wire-wrap screen is generally recommended over louvered screen for fine-grained aquifers where slot sizes of less than 0.050-inches are required. This is because the process for manufacturing louvered screen does not allow for precise slot sizes less than 0.050-inches. However, wire-wrap screen is manufactured to closer tolerances such that very small slot sizes can be reliably achieved. In addition, wire-wrap screen provides increased open area. The greater open area will enhance long-term productivity by reducing the impact of incrustation related plugging thus maintaining water flow into the well. Additionally, the triangular wire shape of wire-wrap screen provides superior retention of filter pack sand while allowing finer formation material to be removed during development. This facilitates well development and reduces well losses associated with the screen.

While PVC and stainless steel have comparable corrosion resistance, the chemical compatibility of PVC wire-wrap screen may not be adequate for the full-scale wells. Though studies have been conducted related to the chemical compatibility of blank PVC casing with aqueous solutions of chlorobenzene (U.S. Army Corps of Engineers, 1996), the PVC wire-wrap is composed of a thin plastic wire which is not as strong Schedule 40 or 80 PVC blank casing or as strong as steel and may be more susceptible to mechanical damage and chemical attack.

As indicated for the blank casing, stainless steel is chemically compatible with chlorobenzene. Thus, unlike PVC, there is little to no risk that the screen would be damaged or weakened due to chemical attack. Furthermore, as described above for blank casing, stainless steel offers more than adequate corrosion resistance. Since the slot size of the wire-wrap screen needs to be maintained in order to sustain well integrity and prevent entry of filter pack material, it is critical to minimize the potential for corrosion to increase the slot openings. In light of this, stainless steel is recommended for the screen interval.

Based on the above, either 304 or 316 stainless steel would be adequate for these wells. However, per Johnson Screens, a leading supplier of stainless steel screens, 316 stainless steel is recommended in cases when wells may be inactive for extended periods of time, such as post-installation but pre-system operation. Also, 316 stainless steel is more resistant to damage from acidic remediation and well treatment chemicals which may be necessary to maintain well yield. Thus, 316 stainless steel wire-wrap screen is specified.

The screen slot sizes presented in Table 1 represent an approximate slot size based on the screen specified for nearby extraction and monitor wells in the vicinity of the planned wells. The slot size used for the existing injection and extraction wells ranged from a minimum of 0.010-inch to a maximum of 0.040-inch, depending on the gradation of the formation to be screened as determined by the nearby exploratory boring (H+A, 2008a). The final screen slot size and filter pack size for the planned wells will be determined based on formation grain size analysis data to be collected from exploratory borings at each well site, as described above. A filter pack will be selected that is 4 to 6 times coarser than the formation material to be screened and a screen slot size will be selected which will retain approximately 90 percent of the filter pack material. A schematic construction diagram of the extraction and injection wells is included as Figure 3.

Operations and Maintenance Appurtenance

The extraction and injection wells associated with the groundwater remediation system will require periodic maintenance throughout the operational life of the system. As part of the operation and maintenance (O&M) program, the wells will be periodically treated with chemical additives to minimize the effect of biofouling on the formation adjacent to the well screen and the well screen to maximize the efficacy of the well. In order to reduce disruption to extraction and injection operations during this treatment process, a 1-inch diameter Schedule 80 PVC O&M access pipe will be installed within the well annulus adjacent to the well casing (Figure 3). This access pipe will be used to facilitate the introduction of the treatment solution to the bottom of the well bore without disrupting operation of the system.

Full-Scale Well Annular Materials

Colorado silica sand was selected for the filter pack. This sand is ideal for filter pack applications as it is available in a wide range of sizes, composed of hard inert grains, is uniform in grain size, and is well rounded. These properties result in a filter pack with high porosity and permeability which facilitates well development and maximizes well capacity.

A transition seal consisting of a fine sand layer and bentonite seal will be installed in each well above the filter pack. The purpose of the transition seal is to protect the filter pack and screen from the infiltration of the annular seal material. The fine sand interval will consist of #60 silica sand and the bentonite seal will consist of bentonite pellets.

The annular seal material will consist of high-solids bentonite grout containing 30% solids. Bentonite grout was selected as the annular seal because it:

- Provides an adequate seal;
- Complies with State of California Well Standards; and
- Does not generate heat during setup, as neat cement does, which could weaken the PVC well casing.

Drilling Fluid Properties

Drilling fluid used during borehole advancement will possess such characteristics as are required to adequately maintain the integrity of the borehole wall and prevent caving as drilling progresses and to permit recovery of cuttings. The drilling fluid will possess such characteristics that it will minimize formation damage from mud invasion/water loss and can be readily removed from the borehole during placement of gravel pack and development of the well.

Only potable water with <50 parts per million (ppm) hardness and pH of 8.5 – 9.5 will be used in drilling fluid composition. The drilling mud will consist of a commercial quality high grade bentonite clay system with a polymer supplement such as Drispack® or an equal additive.

All drilling fluid will be prepared onsite and the reuse or recycling of drilling fluids between boring locations will not be allowed. During borehole advancement every effort will be made to ensure that fluid conditions will prevent swelling of clay layers during well construction and create a wall cake that can be removed from the screened interval during well development. To maximize performance of the well, proper drilling fluid will be maintained to restrict mud invasion/water loss from the borehole into the aquifer and minimize damage to the formation.

Proper control of the drilling fluid during both the pilot and reaming operations will be maintained to the specified parameters or as approved by the hydrogeologist. During drilling operations the drilling contractor will measure and record properties of the drilling fluid entering the borehole at least every hour or as dictated by lithologic/hydrogeologic conditions at the Site. The following parameters will be measured and maintained at the indicated levels:

Weight (lbs/gal)	**Viscosity** (seconds/quart)	**Sand Content** (%)	**Water Loss** (mL)	**Wall Cake** (in)
10-11	35-45	<5	< 15	4/32

Notes: lbs/gal: pounds per gallon; mL: milliliters; in: inches

Once target depth is reached, the borehole will be conditioned for a minimum of 30 minutes by circulating clean mud. Following conditioning, the drilling fluid will be gradually thinned out by adding clean water while continually filtering the fluid with sand cones and shaker table. The sand content will be continually checked during fluid thinning to maintain <1% sand content. The following mud parameters will be reached prior to well construction:

Weight (lbs/gal)	**Viscosity** (seconds/quart)	**Sand Content** (%)	**Water Loss** (mL)	**Wall Cake** (in)
9 – 10	<30	<1	NA	NA

Notes: lbs/gal: pounds per gallon; mL: milliliters; in: inches; NA: Not Applicable

If at any time during drilling activities the drilling fluid properties are outside the specified parameters, drilling will be suspended and the drilling fluid will be brought into compliance with the specified properties. If the fluid cannot be reconditioned to the parameters indicated above, it will be replaced with a new mixture that complies with the specified fluid parameters. Any addition or variation in the amount of approved chemical products or water required during drilling will be recorded in the drilling log.

Well Development Procedures

To maximize efficiency of the newly installed wells, development will consists of chemical, mechanical, and hydraulic methods to remove drilling fluids from the gravel pack and aquifer.

Chemical Development

The wells will be treated with 1,500 microgram per liter (mg/l) chlorine that will be swabbed into the well screen and annulus and allowed to remain idle for a period of eight to 12 hours to breakdown polymers remaining from the bentonite drilling fluid. Following chlorination, the wells will be treated with a commercial quality clay dispersant such as NuWell-220® or an equal product approved by the hydrogeologist. The clay dispersant will be swabbed in and allowed to remain idle for a period of eight to 12 hours prior to mechanical development.

Mechanical Development

Mechanical development of the well will include surging and bailing. The screened interval will be surged with a vented surge block and bailing will be conducted to remove fines introduced into the well screen during surging and residual drilling fluid removed during the chemical and mechanical processes. The surge/bail process is anticipated to require active surging for a minimum of 1-hour for each 10 foot screened interval.

After completion of swab/bail activities, the well will be actively airlifted using procedures to prevent air introduction into the formation and to remove debris loosened by the swab and bail portion of development. Airlifting will progress from the bottom of the screened interval to the top to minimize the settling of solids at the bottom of the well casing. Airlifting is anticipated to require approximately 1-hour for each 10 foot section of screen.

Hydraulic Development

At the completion of chemical and mechanical development activities, hydraulic development will commence by intermittently pumping the well at 50% of the anticipated flowrate (Table 5) until the water clear (<5 NTU). The pump will then be stopped to allow water to flow back into the well through the screened perforations. The pump will then be started at the initial rate and stopped several times and then pumped again at 50% of the anticipated flowrate (Table 5) until the water is clear. This procedure will be repeated at each 10 ft interval while increasing the pumping rate to 125% of the anticipated flowrate (Table 5) in 25% intervals or as dictated by Site conditions.

Well development will be considered complete when the change in specific capacity becomes asymptotic, or as directed by the hydrogeologist.

References

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<u>List of Attachments</u>

* * * * *

TABLES

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TABLE 1
CONSTRUCTION DETAILS FOR EXTRACTION AND INJECTION WELLS

WELL IDENTIFIER	TOTAL BOREHOLE DEPTH (feet bgs)	BOREHOLE DIAMETER / INTERVAL (inches / feet bgs)	STEEL CONDUCTOR CASING INTERVAL (feet bgs)	BLANK CASING INTERVAL (feet bgs)	BLANK CASING AND SCREEN DIAMETER	SCREEN INTERVAL (feet bgs)	SCREEN SLOT SIZE (inches)	FILTER PACK INTERVAL (feet bgs)	FINE SAND SEAL INTERVAL (feet bgs)[a]	BENTONITE SEAL INTERVAL (feet bgs)[b]	GROUT SEAL INTERVAL (feet bgs)[c]
EXTRACTION WELLS											
UBA-EW-1	79	21 / 0-50 12 / 50-79	0-50[d] (12-inch)	0-53[e]	6	53-78[f]	0.020	40-79	38-40	35-38	3-35
UBA-EW-2	79	21 / 0-50 12 / 50-79	0-50[d] (12-inch)	0-53[e]	6	53-78[f]	0.020	40-79	38-40	35-38	3-35
BF-EW-3	139	22 / 0-75 13.25 / 75-139	0-75[d] (14-inch)	0-80[e]	8	80-138	0.020	65-139	63-65	60-63	3-60
BF-EW-4	131	22 / 0-65 13.25 / 65-131	0-65[d] (14-inch)	0-70[e]	8	70-130[f]	0.020	55-131	53-55	50-53	3-50
BF-EW-5	126	22 / 0-80 13.25 / 80-126	0-80[d] (14-inch)	0-83[e]	8	83-125[f]	0.020	65-126	63-65	60-63	3-60
BF-EW-6	139	22 / 0-80 13.25 / 80-139	0-80[d] (14-inch)	0-85[e]	8	85-138[f]	0.020	70-139	68-70	65-68	3-65
G-EW-4	201	22 / 0-147 13.25 / 147-201	0-147[d] (14-inch)	0-153[e]	8	153-200[f]	0.020	137-201	138-140	135-138	3-135
G-EW-5	185	22 / 0-133 13.25 / 133-185	0-133[d] (14-inch)	0-134[e]	8	134-184[f]	0.020	118-185	115-118	112-115	3-112
INJECTION WELLS											
BF-IW-3	126	24 / 0-105 16 / 105-126	0-105[d] (17-inch)	0-107[e]	10	107-125[f]	0.040	92-126	90-92	87-90	3-87
G-IW-3[k]	164	26 / 0-134 18 / 134-164	0-134[d] (19-inch)	0-138[e]	12	138-163[f]	0.040	123-164	121-123	118-121	3-118
G-IW-4[l]	211	26 / 0-165 18 / 170-211	0-165[d] (19-inch)	0-170[e]	12	170-210[f]	0.020	155-211	153-155	150-153	3-150
OBSERVATION WELLS											
BF-OW-5	126	10 / 0-126[i]	NA	0-110[g]	2	110-125[g]	0.020	108-126	106-108	103-106	3-103
G-OW-5	164	10 / 0-164[i]	NA	0-138[g]	2	138-163[g]	0.020	135-164	133-135	126-133	See BF-OW-5
TEMPORARY WELLS											
EB-45-BFS	126[m]	5 / 0-126	NA	0-110[h]	2	110-125[h]	0.020	108-126	107-108	97-107	NA[j]
EB-45-G	195[m]	5 / 0-195	NA	0-138[h]	2	138-163[h]	0.040	136-164	135-136	125-135 164-195	NA[j]
CONTINGENCY WELL											
G-EW-6	191	22 / 0-146 13.25 / 146-191	0-146[d] (14-inch)	0-150[e]	8	150-190[f]	0.020	135-191	133-135	130-133	3-130

FOOTNOTES

(a) #60 silica sand
(b) Bentonite pellets
(c) High solids (30%) bentonite grout
(d) Stainless steel centralizers will be installed every 20 feet in the annulus between the steel casing and the borehole.
(e) Schedule 80 flush-threaded polyvinyl chloride (PVC). PVC blank casing will be connected to the screen using a stainless steel adaptor.
(f) Screen will be Johnson Free Flow™ or equivalent 316 stainless steel wire-wrap with welded joints. Blank casing will be flush-threaded Schedule 80 PVC. Stainless steel centralizers will be installed at a minimum of 20-foot intervals along the well screen and the blank well casing.
(g) Schedule 40 flush-threaded PVC.
(h) Schedule 80 flush-threaded PVC.
(i) Dual-cased observation well will be installed in a single 10-inch diameter borehole and the total borehole depth will be the depth of the Gage observation well, or 164 feet bls.
(j) Exploratory borehole will be grouted as describe in Table 2.
(k) For injection well G-IW-3, the conductor casing will be 0.25-inch thick from land surface to 94 feet bls and 0.3125-inch thick from 94 feet bls to 134 feet bls.
(l) For injection well G-IW-4, the conductor casing will be 0.25-inch thick from land surface to 85 feet bls and 0.3125-inch thick from 85 feet bls to 165 feet bls.
(m) Exploratory boring EB-45 will first be drilled to the anticipated depth of the shallower temporary well, EB-45-BFS, or 126 feet bls. Upon the completion of sampling of the shallower temporary well, the well will be removed, and the exploratory boring will be advanced to approximately 195 feet bls and the deeper temporary well, EB-45-G, will be installed, developed, sampled, and removed, and the borehole will be grouted to land surface.

ABBREVIATIONS

bgs = Below ground surface
NA = Not applicable

Note: Construction details including final well depths, screen intervals, and screen slot size presented in this table are estimated. Final well design will be determined based on geophysical data and soil physical parameter data obtained from nearby exploratory borings.

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TABLE 2

PROPOSED PILOT BOREHOLE DRILLING

PILOT BOREHOLE / ASSOCIATED WELL(S)	TOTAL BOREHOLE DEPTH (feet bgs)	CONTINOUS CORING INTERVAL[1] (feet bgs)
UBA-EW-1 and BF-EW-5	135	50-135
UBA-EW-2 and BF-EW-6	145	50-145
BF-EW-3	145	60-145
BF-EW-4	140	45-140
G-EW-4	205	140-205
G-EW-5	190	115-190
BF-IW-3 and G-IW-3	195	95-195
G-IW-4	210	110-210

FOOTNOTES

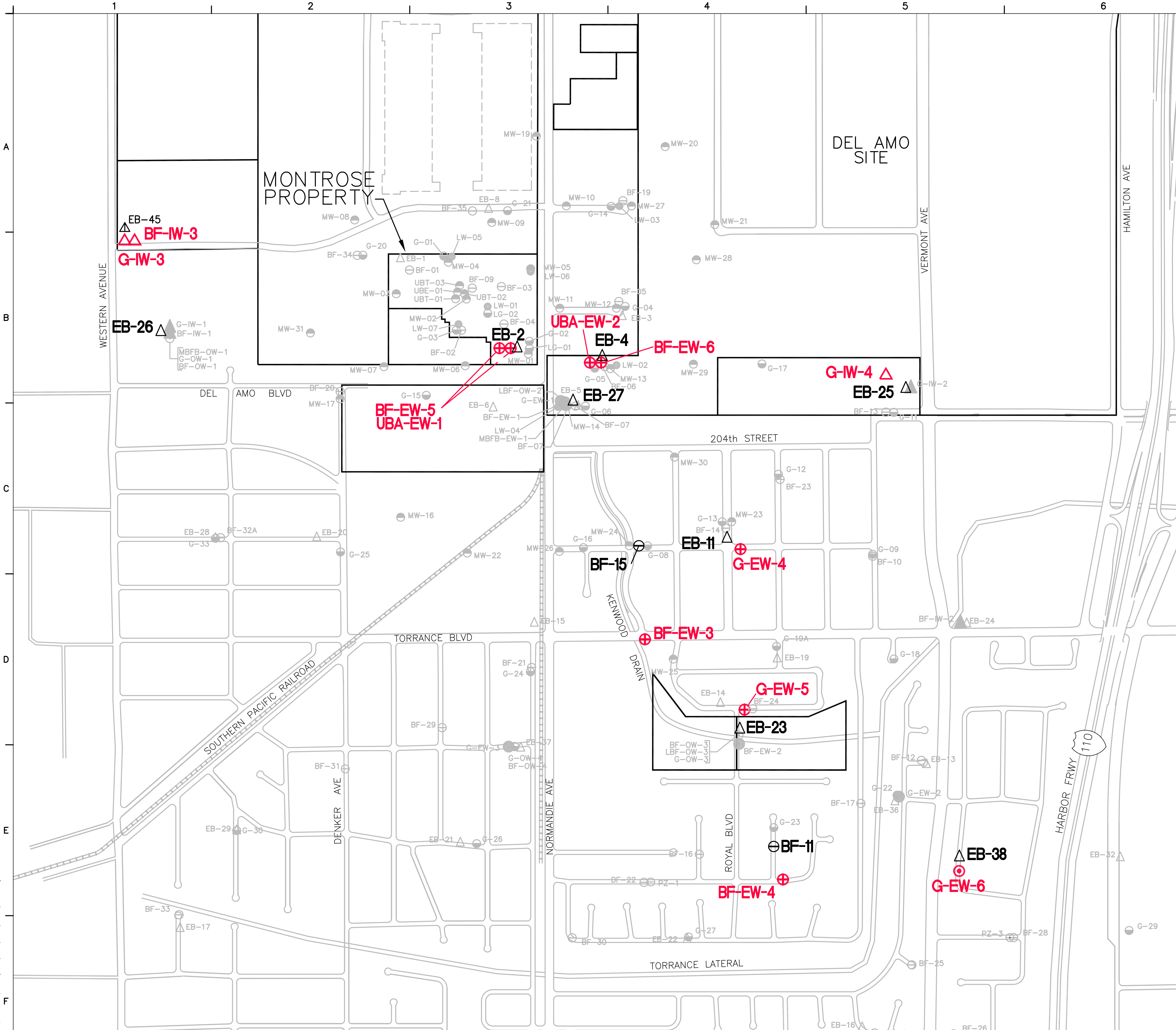
(1) Depth intervals presented in this table are estimated. Additional coring may be conducted based on conditions encountered in the field.

(2) Each borehole will be abandoned using neat cement upon the completion of drilling activities.

ABBREVIATIONS

bgs = below ground surface

FIGURES



EXPLANATION

PLANNED EXTRACTION WELL	EXISTING EXPLORATORY BORING
PLANNED INJECTION WELL	UPPER BELLFLOWER AQUITARD WELL
PLANNED EXPLORATORY BORING	MIDDLE BELLFLOWER B SAND WELL
CONTINGENCY EXTRACTION WELL	BELLFLOWER SAND WELL
EXISTING EXTRACTION WELL	LOWER BELLFLOWER AQUITARD OR GAGE WELL
EXISTING INJECTION WELL	LYNWOOD AQUIFER WELL
	OBSERVATION WELL

WELL IDENTIFIERS:

MW = MONITOR WELL	PZ = PIEZOMETER
EW, UBE = EXTRACTION WELL	LBF = LOWER BELLFLOWER AQUITARD
BF = BELLFLOWER SAND	G = GAGE
MBFB = MIDDLE BELLFLOWER B SAND	LW = LYNWOOD
IW = INJECTION WELL	EB = EXPLORATORY BORING
OW = OBSERVATION WELL	

NOTES:

1. AN EXPLORATORY BORING WILL BE INSTALLED AT EACH PLANNED WELL SITE.
2. LITHOLOGIC DATA FROM EXPLORATORY BORINGS AND MONITOR WELLS SHOWN IN **BOLD** FONT WAS USED TO DETERMINE THE PROPOSED WELL DESIGN FOR EXTRACTION AND INJECTION WELL. (APPENDIX A).

0 700 1,400

FEET

REV	DATE	DESCRIPTION	DRN	APP

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2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA USA
PHONE: 714.969.0800

HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering
2365 NORTHSIDE DRIVE, SUITE C-100
SAN DIEGO, CALIFORNIA 92108 USA
PHONE: 619.521.0165

TITLE: **PLANNED EXTRACTION AND INJECTION WELL LOCATIONS**

PROJECT: **MONTROSE CHEMICAL CORPORATION OF CALIFORNIA**

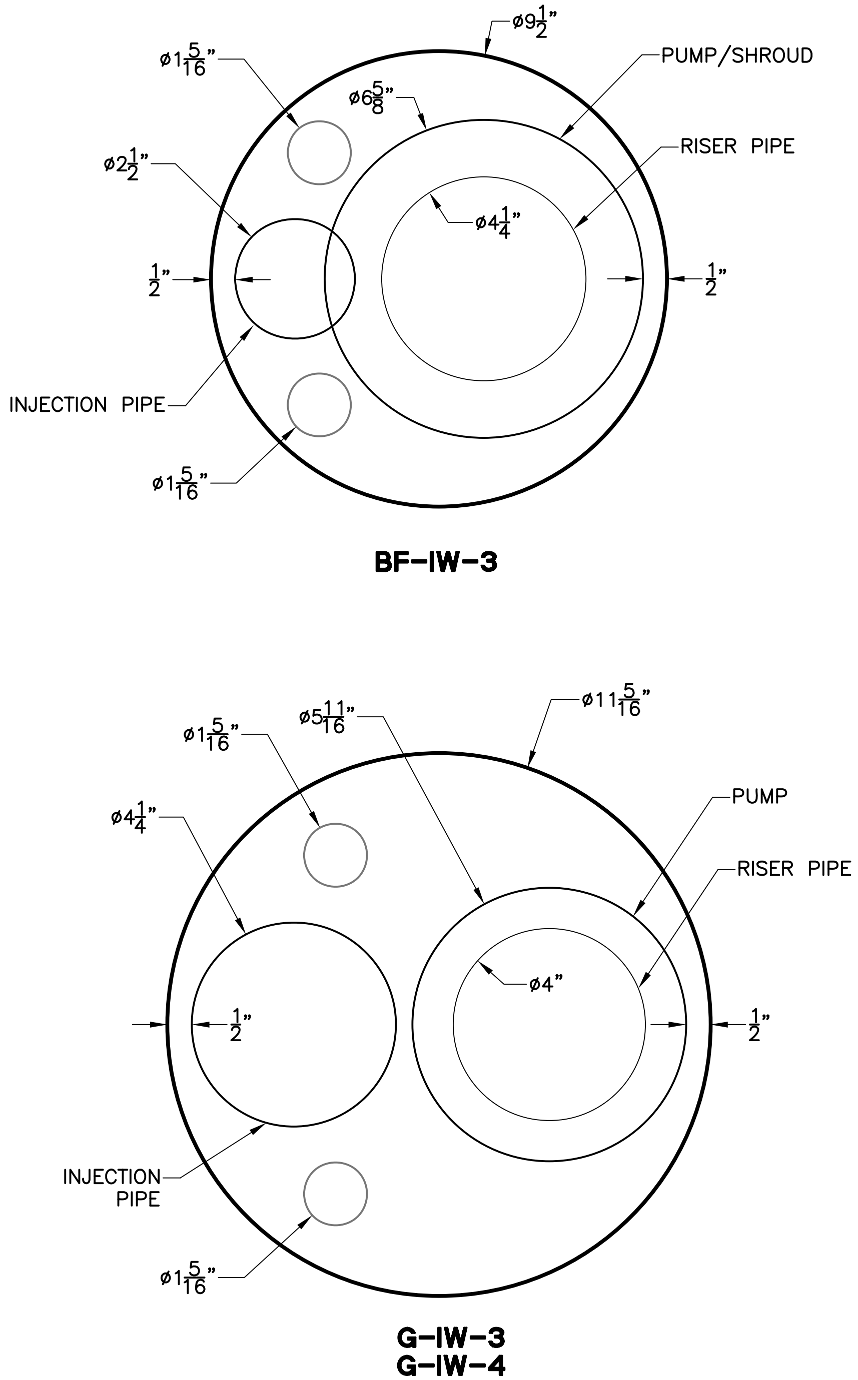
SITE: **DUAL SITE GROUNDWATER OPERABLE UNIT MONTROSE CHEMICAL AND DEL AMO SUPERFUND SITES**

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

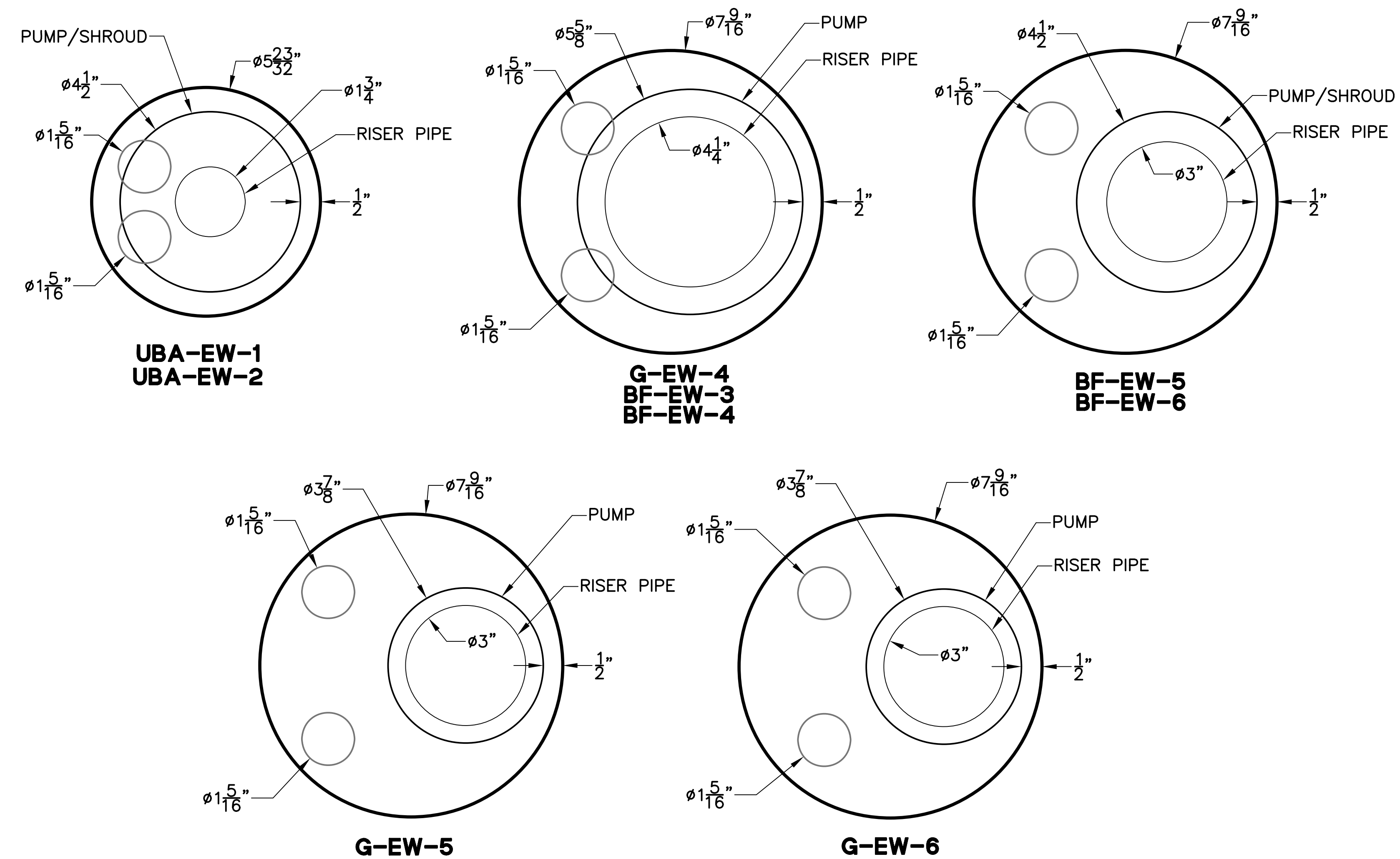
DATE

DESIGN BY:	GLW	DATE:	April 30, 2009
DRAWN BY:	GTH	PROJECT NO.:	SB0450
CHECKED BY:	DMO	FILE:	410-7180.dwg
FIGURE NO.:	1	SHEET NO.:	1 OF 2



INJECTION WELL DIAGRAMS

SCALE: 1" = 4"



EXTRACTION WELL DIAGRAMS

SCALE: 1" = 4"

NOTES:

1. TWO 1-INCH DIAMETER, SCHEDULE 40 PVC DROP PIPES WILL BE REQUIRED IN EACH WELL; ONE FOR MANUAL WATER LEVEL MEASUREMENT AND THE OTHER FOR INSTALLATION OF A PRESSURE TRANSDUCER FOR AUTOMATED WATER LEVEL MONITORING.
2. RISER PIPE AND INJECTION PIPE DIAMETERS INDICATED ARE THE OUTER DIAMETERS OF STEEL COUPLINGS FOR REQUIRED PIPE SIZE.
3. WHEN A SHROUD IS INDICATED, THE INDICATED DIAMETER IS THE OUTER DIAMETER OF THE SCHEDULE 40 PVC PUMP SHROUD.
4. FOR WELLS, THE INNER DIAMETER OF THE WELL CASING IS INDICATED.
5. INJECTION PIPE AND THE 1-INCH PVC DROP PIPES WILL TERMINATE ABOVE THE TOP OF THE DEVELOPMENT PUMPS.

REV	DATE	DESCRIPTION	DRN	APP

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HARGIS + ASSOCIATES, INC
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PHONE: 619.521.0165

TITLE: SCHEMATIC DIAGRAMS FOR PLANNED EXTRACTION AND INJECTION WELLS

PROJECT: MONTROSE CHEMICAL CORPORATION OF CALIFORNIA

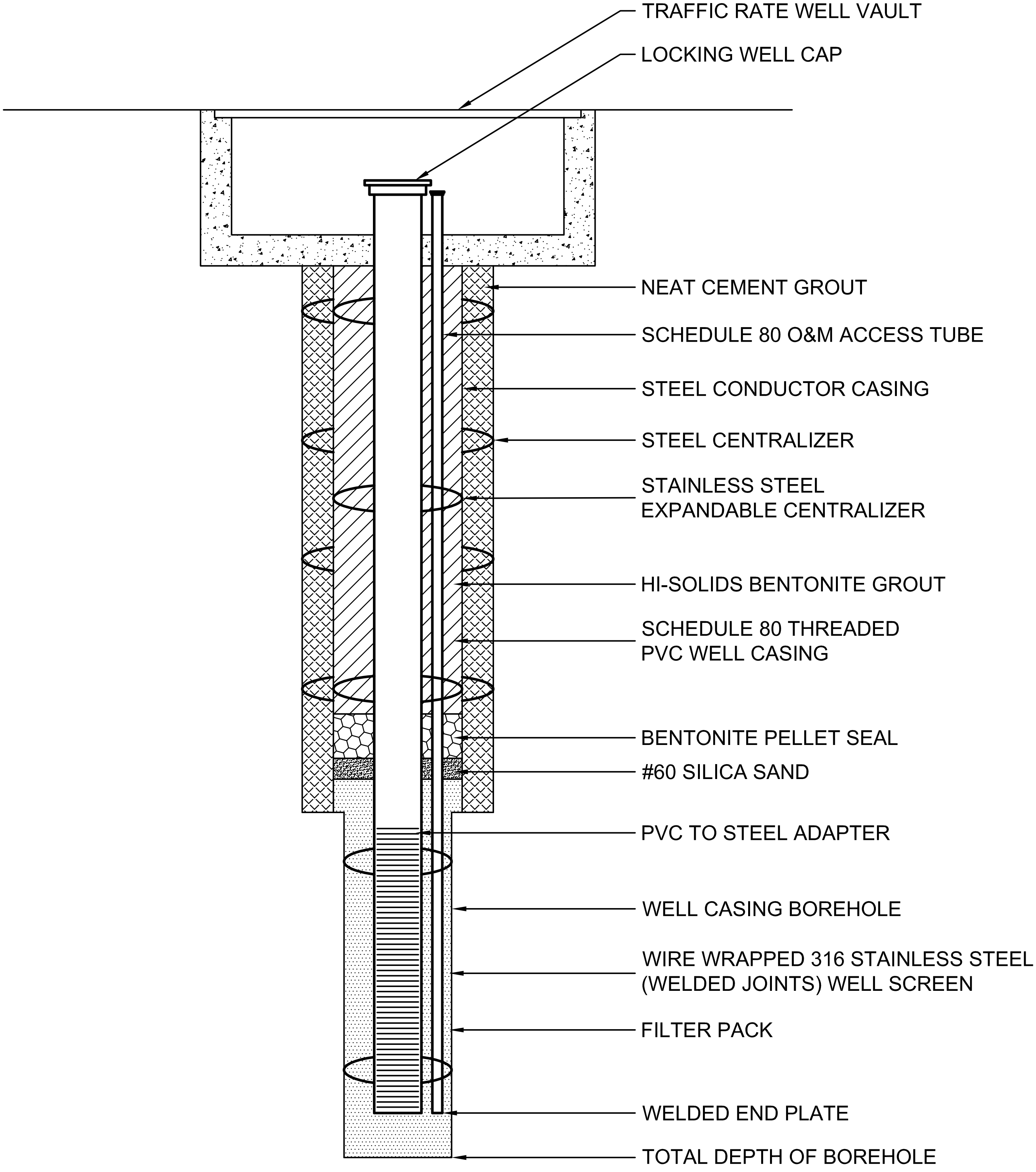
SITE: DUAL SITE GROUNDWATER OPERABLE UNIT MONTROSE CHEMICAL AND DEL AMO SUPERFUND SITES

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	GLW	DATE:	April 30, 2009
DRAWN BY:	GTH	PROJECT NO.:	SB0450
CHECKED BY:	DMO	FILE:	710-0617.dwg
FIGURE NO.:	2	SHEET NO.:	2 OF 2



NOT TO SCALE

Geosyntec consultants

HARGIS + ASSOCIATES, HYDROGEOLOGY • ENGINEERING

SCHEMATIC CONSTRUCTION DIAGRAM EXTRACTION–INJECTION WELL
DUAL SITE GROUNDWATER OPERABLE UNIT
MONTROSE CHEMICAL AND DEL AMO SUPERFUND SITES

DATE:	MAY 2009	FILE NO.	0450F001
PROJECT NO.	SB0450A-01*20	FIGURE NO.	3

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APPENDIX A

Partial Lithologic Logs Indicating Conductor Casing and Screen Interval Depths

APPENDIX A

PARTIAL LITHOLOGIC LOGS INDICATING CONDUCTOR CASING AND SCREEN INTERVAL DEPTHS

TABLE OF CONTENTS

REFERENCES

Hargis + Associates, Inc., 2009, Technical Memorandum re: Torrance Groundwater Remedial System, Basis of Design for Planned Extraction and Injection Wells, Montrose Site, Torrance, California. March 18, 2009.

EXPLORATORY BORING EB-27

DATE DRILLED: *7/26/05*	SURFACE ELEVATION: *42 feet msl*
BOREHOLE DIA.: *5 inches*	TOTAL DEPTH OF BORING: *200 feet bls*
DRILLING COMPANY: *WDC Exploration & Wells*	METHOD: *Mud Rotary*
DRILLER'S NAME: *A. Vega*	DRILL RIG: *Speedstar 50K*
LOGGED BY: *G.Waggle/J.Januszciewicz*	CHECKED BY

PROJECT NAME: *Montrose*

PROJECT NUMBER: *857.39*

LOCATION *Northeast corner of intersection of Del Amo Blvd and Normandie Ave, Los Angeles, CA*

COMMENTS *Continuous Core Sampling. Backfilled with neat cement once coring completed.*

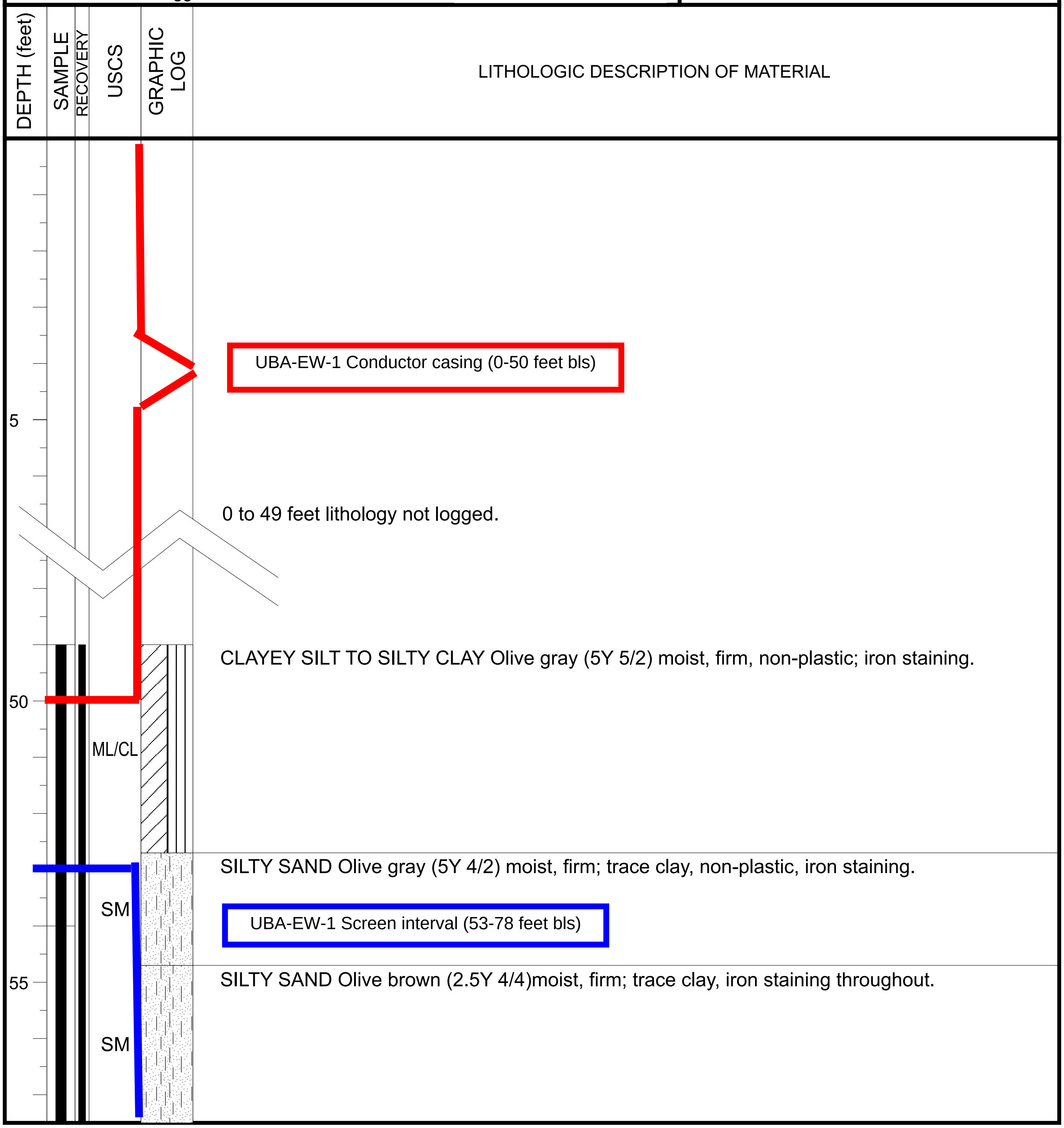


FIGURE A-1: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-1

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

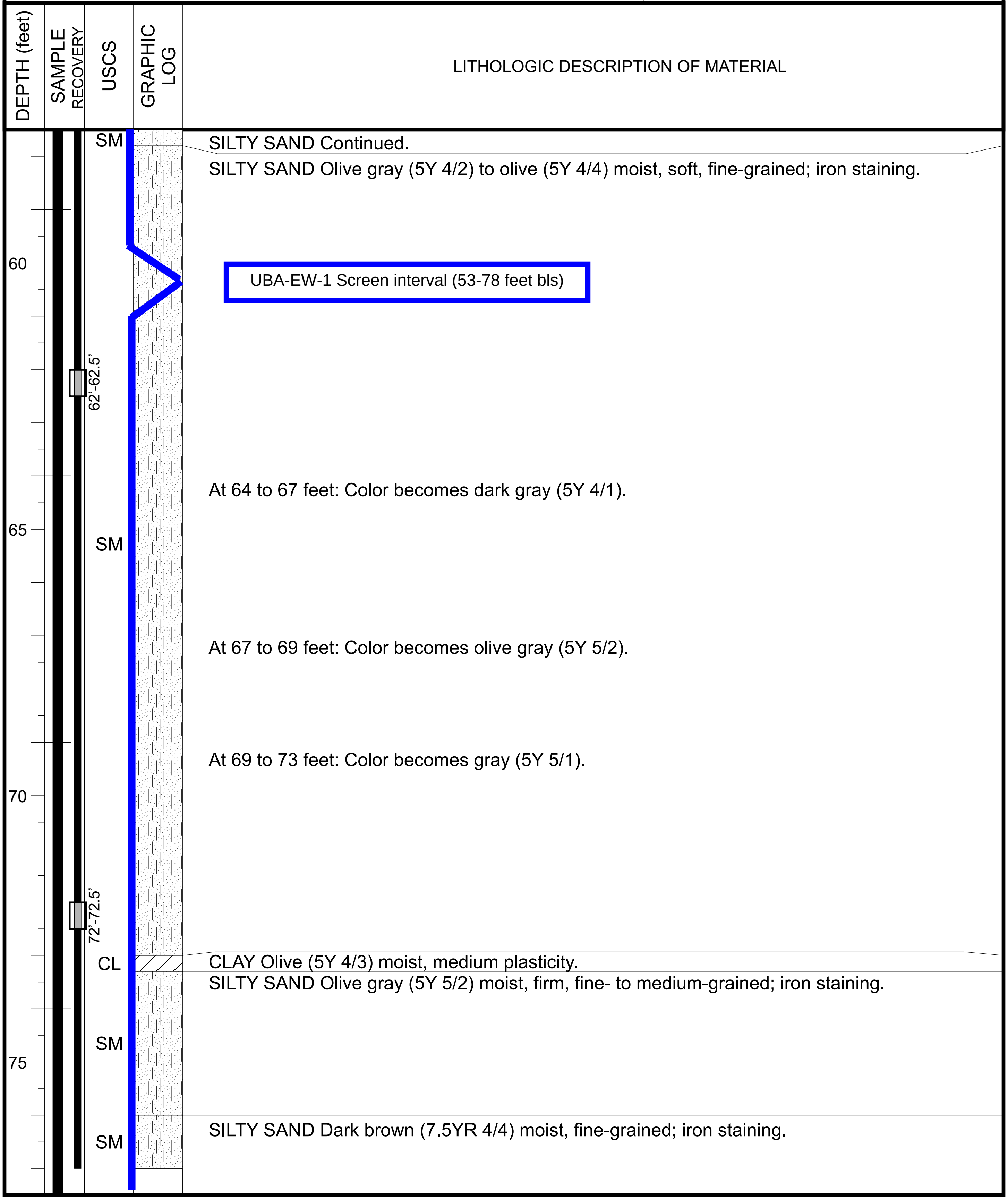


FIGURE A-1: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-1

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

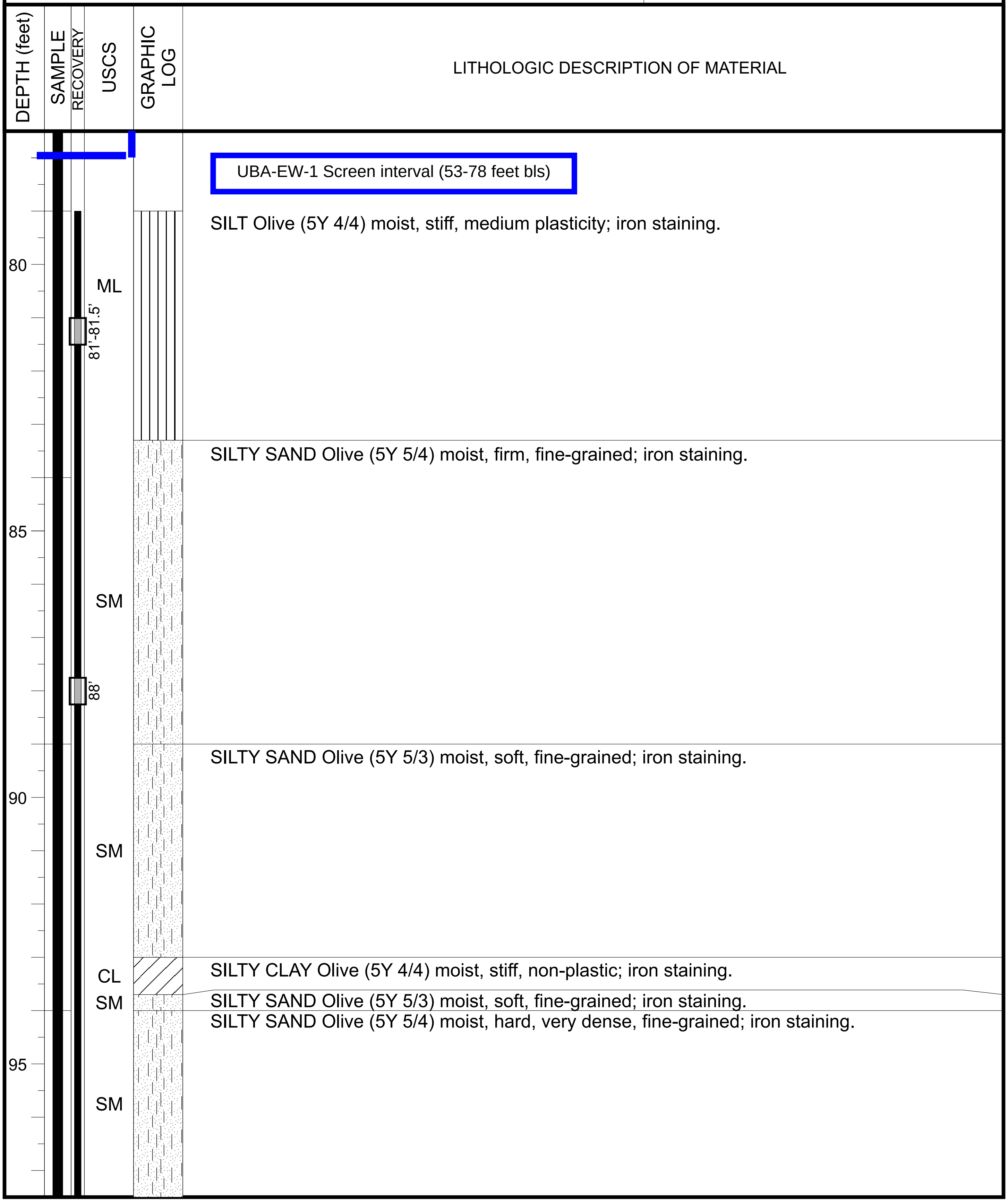


FIGURE A-1: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-1

EXPLORATORY BORING EB-27

DATE DRILLED: *7/26/05*	SURFACE ELEVATION: *42 feet msl*
BOREHOLE DIA.: *5 inches*	TOTAL DEPTH OF BORING: *200 feet bls*
DRILLING COMPANY: *WDC Exploration & Wells*	METHOD: *Mud Rotary*
DRILLER'S NAME: *A. Vega*	DRILL RIG: *Speedstar 50K*
LOGGED BY: *G.Waggle/J.Januszziewicz*	CHECKED BY:

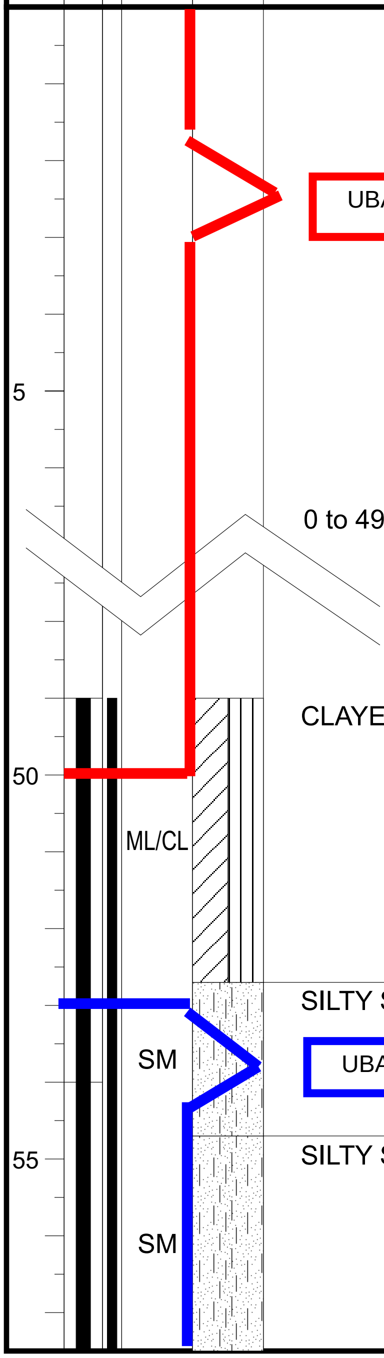
PROJECT NAME: *Montrose*

PROJECT NUMBER: *857.39*

LOCATION *Northeast corner of intersection of Del Amo Blvd and Normandie Ave, Los Angeles, CA*

COMMENTS *Continuous Core Sampling. Backfilled with neat cement once coring completed.*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL



UBA-EW-2 Conductor casing (0-50 feet bls)

0 to 49 feet lithology not logged.

CLAYEY SILT TO SILTY CLAY Olive gray (5Y 5/2) moist, firm, non-plastic; iron staining.

SILTY SAND Olive gray (5Y 4/2) moist, firm; trace clay, non-plastic, iron staining.

UBA-EW-2 Screen interval (53-78 feet bls)

SILTY SAND Olive brown (2.5Y 4/4)moist, firm; trace clay, iron staining throughout.

FIGURE A-2: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-2

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

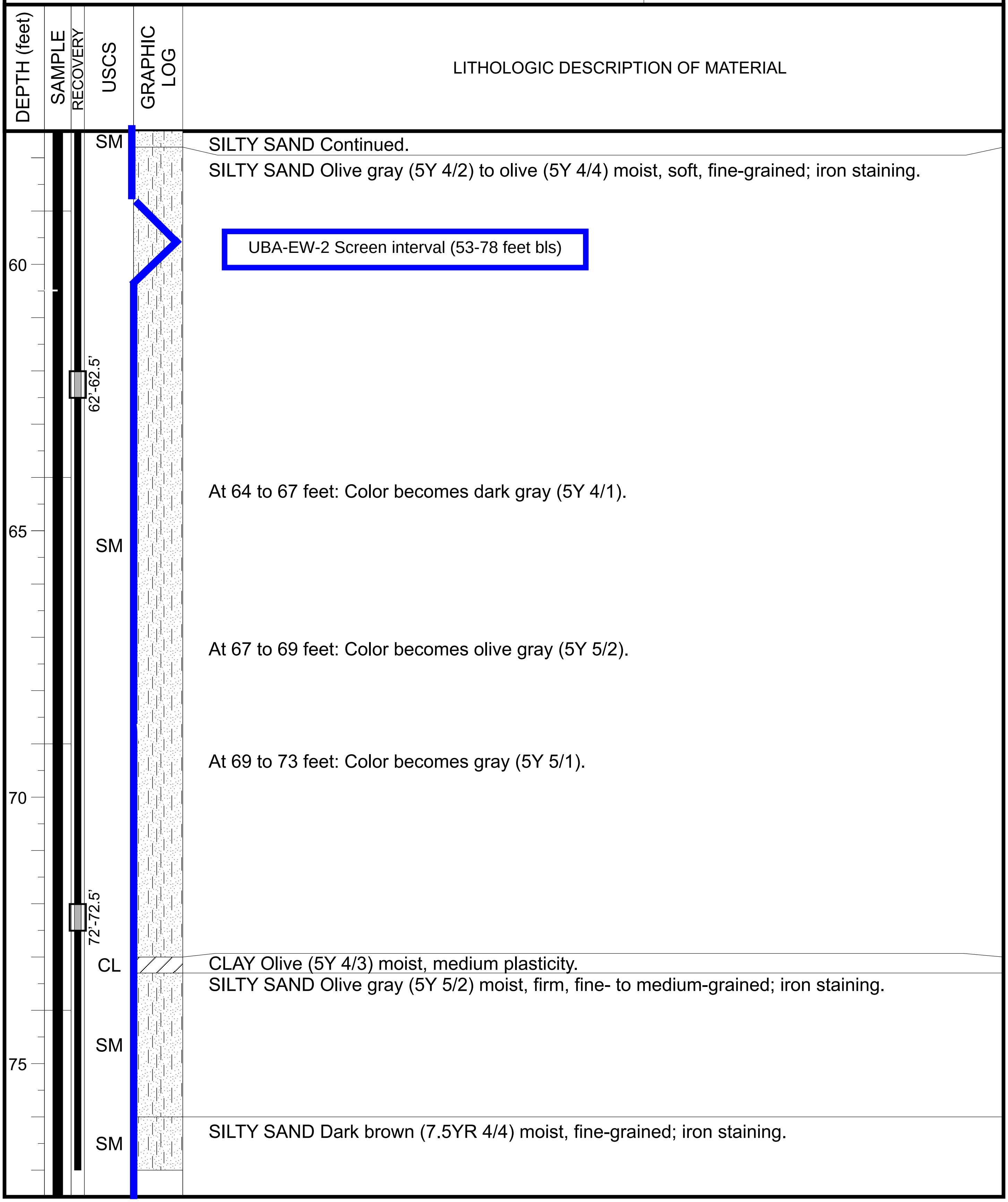


FIGURE A-2: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-2

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

UBA-EW-2 Screen interval (53-78 feet bls)

Samples: 81'-81.5'; 88'

Depth (feet): 80, 85, 90, 95

USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
ML	SILT Olive (5Y 4/4) moist, stiff, medium plasticity; iron staining.
SM	SILTY SAND Olive (5Y 5/4) moist, firm, fine-grained; iron staining.
SM	SILTY SAND Olive (5Y 5/3) moist, soft, fine-grained; iron staining.
CL	SILTY CLAY Olive (5Y 4/4) moist, stiff, non-plastic; iron staining.
SM	SILTY SAND Olive (5Y 5/3) moist, soft, fine-grained; iron staining.
SM	SILTY SAND Olive (5Y 5/4) moist, hard, very dense, fine-grained; iron staining.

FIGURE A-2: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL UBA-EW-2

FIGURE A-3A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-15

Dates: October 10, 1989
Weather: Overcast, warm
Drill Rig: Gardner Denver 1000
Sample Method: Mud rotary cuttings
Location: Milton Street, east of Kenwood Avenue

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Drilling 0 - 68 feet	NA	NA	0 - 68	No samples collected for lithologic logging. Refer to lithologic log for monitor well MW-24.
Mud Rotary Cuttings collected at 5-foot intervals 68 - 113 feet			68 - 73	INTERBEDDED SILT (ML) AND SANDY SILT (ML): Silt is olive, 5Y 5/3, firm; trace clay, nonplastic; sandy silt is blue-gray, firm to stiff, nonplastic; sand is fine-grained, well sorted; trace rust-orange staining. At 71 feet, sand lens, less than .05 feet thick.
			73 - 75	SANDY SILT (ML): Blue-gray, firm to stiff, nonplastic.
			75 - 76	INTERBEDDED SILTY SAND (SM) AND SAND (SP): Olive, 5Y 5/6, medium dense to dense, fine-grained, moderately sorted; some medium-grained sand.

BF-EW-3 Conductor casing (0-75 feet bls)

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

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FIGURE A-3A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-15

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 68 - 113 feet	NA	NA	76 - 78	SILTY SAND (SM): Blue-gray, very dense, fine-grained, well sorted; some sandy silt inter beds, very stiff, nonplastic.
			78 - 79	SILTY SAND (SM): Same as 76 - 78 except no sandy silt interbeds.
			79 - 79.5	SILT (ML): Blue-gray, very stiff to hard, nonplastic.
			79.5 - 80	FOSSILIFEROUS SAND (SP): Olive-gray, 5Y 5/2, to olive, 5Y 5/4, very dense, fine-grained, well sorted, subangular; fossils are bivalves, white and brown, nonweathered to slightly weathered; some olive silt.
			80 - 85	FOSSILIFEROUS SAND (SP): Olive, 5Y 5/3, very dense to cemented, fine-grained, well sorted; fossils comprised of bivalve shells, moderately to slightly weathered. At 82 feet, clayey silt interbeds, less than 0.5 feet thick, blue-gray, firm, slightly plastic; occasional clay lenses, olive, 5Y 5/3; soft, moderately plastic.

BF-EW-3 Screen interval (80-138 feet bls)

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

FIGURE A-3A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-15

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 68 - 113 feet	NA	NA	80 - 85	FOSSILIFEROUS SAND (SP): (continued) At 83 feet, fewer shells.
			85 - 91	SAND (SP): Olive, 5Y 5/3, very dense, fine-grained, well sorted, angular to subangular, some muscovite flakes; trace shells.
			91.5 - 99	SAND (SW): Light brownish gray, 2.5Y 6/2, fine-grained, well sorted; most of the returns go through 1/16-inch sieve.
	BF-EW-3 Screen interval (80-138 feet bls)		99 - 102.5	SAND (SP): Light olive-brown, 2.5Y 5/6, cemented, very fine- to medium-grained, well graded, cemented, subrounded, predominantly quartz, multicolored grains.
			102.5 - 105	FOSSILIFEROUS SAND: Yellow, 2.5Y 7/6, fine-grained, moderately cemented, fine- to medium-grained, coarse grains are shell fragments, medium sand is well rounded; fossils comprise white bivalve shell fragments, slightly weathered; cuttings include dark bands of well-cemented, fine-grained sand.

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

FIGURE A-3A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-15

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 68 - 113 feet	NA	NA	105 - 111.5	SAND (SP): Light brownish gray, 2.5Y 6/2, very dense, fine- to medium-grained, poorly sorted; medium sand subrounded to well rounded; minor light gray cemented sand fragments; trace shell fragments.
			111.5 - 113	SANDY SILT/CLAYEY SILT WITH SAND (SM): Olive-yellow, 5Y 6/6, slightly plastic; sand loose, fine-grained.

BF-EW-3 Screen interval (80-138 feet bls)

TOTAL DEPTH OF BOREHOLE: 113 FEET

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

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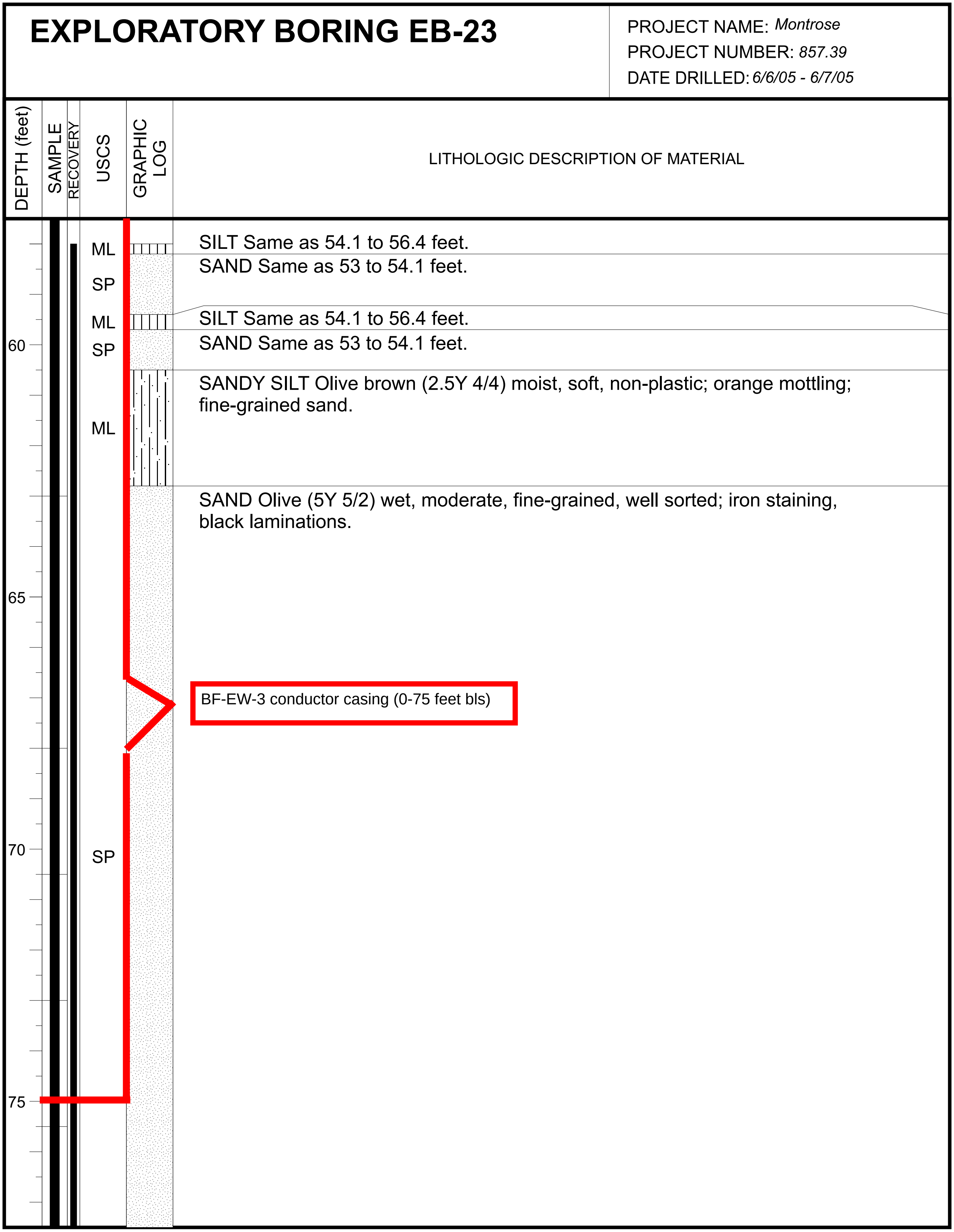

FIGURE A-3B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL

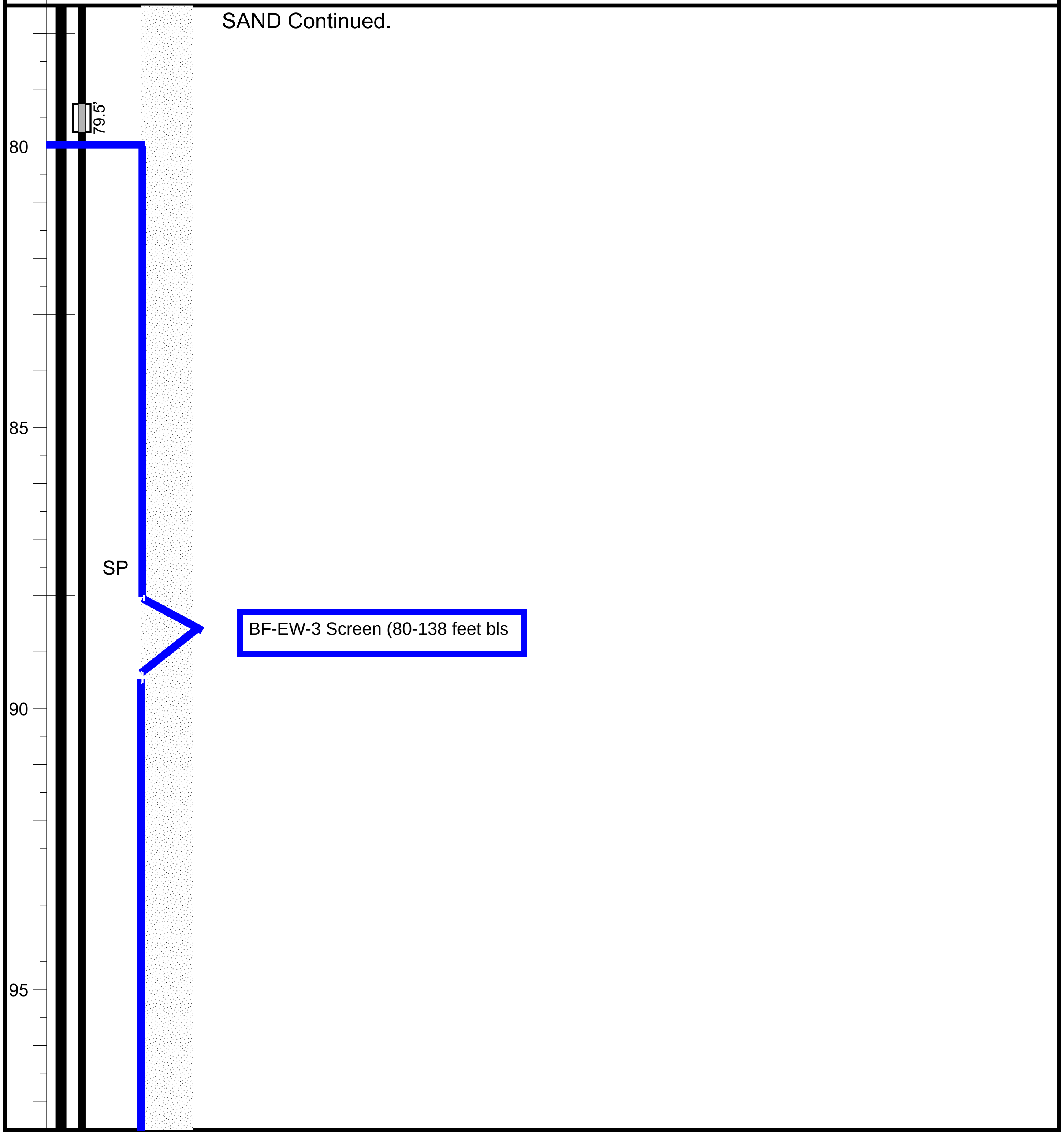

FIGURE A-3B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
100			SP		SAND Continued.
			SP		SAND Wet, moderate, fine- to coarse-grained, predominantly medium, well sorted.
105			SP-SM		SAND WITH SILT Wet, moderate to weak, fine- to coarse-grained, predominantly fine, poorly sorted; abundant shells.
110			SP		SAND same as 62.8 to 103.1 feet. BF-EW-3 Screen (80-138 feet bls
115			SP		SAND Wet, fine-grained, well sorted; abundant shells.

FIGURE A-3B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
			SP		SAND Continued.
					SAND Dark greenish grey (5G 4/1) wet, moderate, fine- to medium-grained, predominantly medium, well sorted.
120		122'	SP		
125			SM		SILTY SAND Greenish grey (5BG 5/1) wet, fine- to medium-grained, predominantly fine; abundant shells.
					BF-EW-3 Screen (80-138 feet bls
130			ML		SILT Dark greenish gray (5G 4/1) moist, firm, non-plastic; trace sand.
135			SP		SAND Dark greenish grey (5GY 4/1) wet, moderate, fine-grained, well sorted.

FIGURE A-3B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
					BF-EW-3 Screen (80-138 feet bls
			SP		SAND Continued.
	138.5 / 139'		CL		CLAY Dark greenish grey (5GY 4/1) moist, firm to hard, moderate to high plasticity; no sand.
140			SP		SAND Same as 133.8 to 138.1 feet.
145					
150	150'				
155					

FIGURE A-3B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-3

FIGURE A-4: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-4

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-11

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 0 - 126 feet	NA	NA	45 - 57	CLAYEY SANDY SILT (ML): (continued) At 50 feet, multibanded colors of rust brown, olive-yellow, 5Y 6/6, olive-gray, 5Y 5/2, and yellowish brown, 10YR 5/6, very stiff, some cemented zones. At 55 feet, grades to clayey silt.
			57 - 65	SILTY SAND (SM): Olive, 5Y 5/3, to olive-gray, 5Y 5/2, loose to medium dense, fine-grained, well sorted. At 60 feet, less silt content; occasional silt lenses, olive, 5Y 4/4, firm.
			65 - 103.5	SAND (SP): Olive, 5Y 4/4, medium dense, fine-grained, well sorted; gradational contact above. At 75 - 80 feet, trace silt lenses, dark yellowish brown, 10YR 4/6, and olive-yellow, 5Y 6/6, stiff. At 80 - 85 feet, occasional silty sand zones.

BF-EW-4 Conductor casing (0-65 feet bls)

BF-EW-4 Screen interval (70-130 feet bls)

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

FIGURE A-4: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-4

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-11

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 0 - 126 feet	NA	NA	65 - 103.5	SAND (SP): (continued) At 85 - 90 feet, trace gravel; fine- to coarse-grained, angular. At 90 - 95 feet, trace cemented zones. At 95 feet, no silt; grades olive, 5Y 4/4, medium dense, fine-grained, well sorted, angular to subangular; trace cemented zones.
BF-EW-4 Screen interval (70-130 feet bls)			103.5 - 113	FOSSILIFEROUS SAND (SP/SW): Olive, 5Y 5/3, to light olive-brown, 2.5Y 5/4, cemented, medium to coarse-grained, poor to moderately sorted; fossils comprised of bivalves, oyster shells, cream, brown and white colored, fragmented and whole, moderately weathered; grades with depth to olive, 5Y 5/6, to olive-yellow, 2.5Y 6/6, with some yellowish brown, 10YR 6/6. At 109 feet, some fine sand and some fine gravel.

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

FIGURE A-4: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-4

FROM LITHOLOGIC LOG FOR MONITOR WELL BF-11

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 0 - 126 feet	NA	NA	113 - 114.5	SANDY SILT (ML) AND SILTY SAND (SM): Olive, 5Y 5/3, firm to stiff, slightly plastic; silty sand is very dense, fine- to coarse-grained; some shells and some clay.
			114.5 - 124.5	FOSSILIFEROUS SAND (SP/SW): Olive, 5Y 5/3 to 5Y 5/4, slightly cemented, fine- to medium-grained, moderately to poorly sorted, angular; fossils comprised of fragmented shells, moderately weathered. At 119 feet, fine- to coarse-grained, poorly sorted; predominantly fine, moderately cemented; some clayey silt (ML), dark gray, 5Y 4/1, very stiff, moderately plastic.
			124.5 - 126	FOSSILIFEROUS SANDY SILT: Olive, 5Y 5/3, stiff to hard; some dark gray clayey silt.

BF-EW-4 Screen interval (70-130 feet bls)

NOTE: While this log terminates at 126 feet bls, the surface elevation at this boring is approximately 5 feet lower than at BF-EW-4. Thus, a depth of 125 feet bls at the exploratory boring is equivalent to the total screen depth at BF-EW-4 of 130 feet bls.

TOTAL DEPTH OF BOREHOLE: 126 FEET

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

FIGURE A-5A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

FROM LITHOLOGIC LOG OF EXPLORATORY BORING EB-2

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL
67-70.5	FOSSILIFEROUS SILTY SAND	SM	Pale olive, fine-grained sand, well cemented shell fragments.
70.5-79	INTERBEDDED SAND/ SILTY SAND/ SILT	SP/SM/ML	Sand is olive gray, fine-grained, trace mica; silty sand is olive gray, medium dense to dense, fine-grained, well sorted; silt is very stiff, light olive brown, thinly laminated, slightly plastic; interbeds are about 1 to 3 inches thick, some orange oxidation stains.
79-82	CLAYEY SILT	ML	Olive gray to medium bluish gray, firm to stiff, shaley partings, orange oxide stain on parting surface, some mica and shell fragments, sweet odor.
82-86.5	SAND	SP	Olive to olive gray, fine- to medium-grained, grains are discoidal to subprismoidal, subangular to subround, some orange oxide stains, trace mica, predominantly quartz.
86.5-95	INTERBEDDED SAND AND SANDY SILT	SP/ML	Olive sand is fine-grained, some mica; sandy silt is slightly to moderately plastic, trace clay.
95-99	SAND	SP	Olive gray, dense, fine-grained, grains are subdiscoidal to subprismoidal, subangular to subrounded, trace of mica, predominantly quartz.
			At 97 feet, silt interbed, olive with orange oxide staining.
99-102.5	SANDY SILT WITH CLAY	ML	Medium bluish gray, firm to stiff, some mica, trace of shell fragments.

BF-EW-5 Conductor casing (0-80 feet bls)

BF-EW-5 Screen interval (83-125 feet bls)

*Unified Soil Classification System
ASTM D-2487

FIGURE A-5A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

FROM LITHOLOGIC LOG OF EXPLORATORY BORING EB-2

BF-EW-5 Screen interval (83-125 feet bls)

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL
102.5-103.5	FOSSILIFEROUS SILTY SAND	SM	Grayish green, fine-grained sand, abundant shell fragments.
103.5-105	FOSSILIFEROUS SANDY SILT	ML	Grayish green, dense, fine-grained sand, abundant shell fragments, trace clay, strong sweet odor.
105-107	FOSSILIFEROUS CLAYEY SAND	SC	Dark greenish gray, dense, fine-grained sand, very abundant shell fragments up to one inch in diameter.
107-113	SAND	SP	Pale olive to brownish yellow, fine- to medium-grained, mottled, dense, grains are discoidal to subprismoidal, subangular to subrounded, trace silt, shell fragments, moderately well cemented, crumbles to hard nodules 0.25-0.5 inch in diameter, orange oxide stains throughout. At 110-113 feet, sand is well graded fine to coarse, some shell fragments.
113-124	SAND	SP	Yellowish brown, fine- to medium-grained, distinctive multicolored grains including: black, white, clear, yellow, maroon, orange, red, pink, green; well-cemented sand nodules with shell nucleus. At 119-120 feet becoming less cemented. At 120-124 feet light brownish gray, no cementation.

*Unified Soil Classification System
ASTM D-2487

FIGURE A-5A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

FROM LITHOLOGIC LOG OF EXPLORATORY BORING EB-2

BF-EW-5 Screen interval (83-125 feet bls)

DEPTH INTERVAL (FEET BELOW LAND SURFACE)		GROUP SYMBOL*	DESCRIPTION OF MATERIAL
124-131.5	SILT	ML	Olive with medium bluish gray interbeds, firm, some orange oxide stain. At 130-131.5 feet, predominantly bluish gray, silvery micaceous luster; some sand, fine- to medium-grained.
131.5-132.5	SILTY SAND	SM	Medium bluish gray, fine- to medium-grained.
132.5-137.5	SILT	ML	Medium bluish gray to gray to dark greenish gray, firm to hard, some fine sand, non to slightly plastic, some mica.
137.5-138	CLAY	CL	Marbled olive, dark gray and grayish green, soft to firm, plastic.
138-142.5	SAND	SP	Dark greenish gray, fine-grained sand, grains are angular to subangular, subprismoidal to subdiscoidal, abundant biotite flakes, trace silt. At 140-142.5 feet, some silt.
142.5-147	INTERBEDDED SAND/ SANDY SILT/ CLAYEY SILT	SP/ML	Dark greenish gray, some orange oxide stains, sand as above.

*Unified Soil Classification System
ASTM D-2487

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
					BF-EW-5 Conductor casing (0-80 feet bls)
80	81'-81.5'		ML		SILT Olive (5Y 4/4) moist, stiff, medium plasticity; iron staining.
85	88'		SM		SILTY SAND Olive (5Y 5/4) moist, firm, fine-grained; iron staining.
					BF-EW-5 Screen interval (83-125 feet bls)
90			SM		SILTY SAND Olive (5Y 5/3) moist, soft, fine-grained; iron staining.
			CL		SILTY CLAY Olive (5Y 4/4) moist, stiff, non-plastic; iron staining.
			SM		SILTY SAND Olive (5Y 5/3) moist, soft, fine-grained; iron staining.
95			SM		SILTY SAND Olive (5Y 5/4) moist, hard, very dense, fine-grained; iron staining.

FIGURE A-5B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
		SM	SILTY SAND continued.
		CL	SILTY CLAY Olive (5Y 5/6) moist, very stiff, medium plasticity; iron staining.
100	102'-102.5'	CL	SILTY CLAY Dark gray (5Y 4/1) otherwise same as above.
105	107'-107.5'	SM	SILTY SAND Olive (5Y 5/3) moist, fine-grained; iron staining.
		SP	SAND Olive (5Y 4/4) moist, soft, fine- to medium-grained; iron staining, with shell fragments.
110	112'-112.5'	SP	SAND Olive (5Y 5/4) moist, medium- to coarse-grained, subrounded to subangular; some silt, iron staining. At 113 to 114 feet: shell fragments.
		SM	SILTY SAND Gray (5Y 6/1) moist, fine-grained; iron staining.
115		SM	SILTY SAND Olive (5Y 5/3), increased sand content, otherwise same as above.

BF-EW-5 Screen interval (83-125 feet bls)

FIGURE A-5B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
		SM		SILTY SAND continued.
120		SM		SILTY SAND Gray (5Y 6/1) moist, hard, fine-grained; iron staining.
				BF-EW-5 Screen interval (83-125 feet bls)
		SM		SILTY SAND Olive (5Y 4/4) moist, dense, fine- to medium-grained; iron staining.
125		SM		SILTY SAND Olive (5Y 4/4) dense, fine- to medium-grained; iron staining.
				At 126 to 128 feet: Color becomes dark gray (5Y 4/1).
		SM		
		SP		SAND Olive gray (5Y 5/2) wet, fine-grained, well sorted.
130	131'-131.5'; 131.5'-132'	CL		CLAY Olive gray (5Y 4/2) moist, hard, non-plastic.
		ML		SANDY SILT Dark greenish gray (5GY 4/1) moist, firm, non-plastic; sand: fine-grained.
135		SM		SILTY SAND Greenish gray (5GY 5/1) wet, fine-grained, well sorted.

FIGURE A-5B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-5

FIGURE A-6A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

FROM LITHOLOGIC LOG FOR EXPLORATORY
BORING EB-4

DRILLING/SAMPLING METHOD	BLOW COUNTS; RECOVERY[1]	OVA[2] (ft/ppm)	DEPTH INTERVAL (feet)	AND DESCRIPTION
Mud Rotary Cuttings	NA	NA	68-75	SAND (SP): Light olive gray, 5Y 6/2, dense, fine-grained, some silt.
			75-86	SANDY SILT (ML): Light yellowish brown, 2.5Y 6/4, stiff, fine-grained sand, slightly plastic, trace mica.
			86-90	SAND (SP): Olive brown, 2.5Y 4/4, dense, fine-grained, trace mica, trace shell fragments.
			90-100	SANDY SILT (ML): Light olive brown, 2.5Y 5/4, firm, fine-grained, nonplastic.
			100-113	CLAYEY SILT (ML): Olive brown, 2.5Y 4/3, firm, trace fine-grained sand, moderately plastic, trace mica.

BF-EW-6 Conductor casing (0-80 feet bls)

BF-EW-6 Screen interval (85-138 feet bls)

1 Blow counts per 0.5 foot interval using a California modified drive sampler and a 140-pound hammer with a 30-inch drop. Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.

2 Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated. OVA background readings deducted when reported values are below 50 ppm.

NA Not available

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FIGURE A-6A: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

FROM LITHOLOGIC LOG FOR EXPLORATORY
BORING EB-4

DRILLING/SAMPLING METHOD	BLOW COUNTS; RECOVERY[1]	OVA[2] (ft/ppm)	DEPTH INTERVAL (feet)	AND DESCRIPTION
Mud Rotary Cuttings	NA	NA	113-115	FOSSILIFEROUS SAND AND SILTY SAND (SP/SM): Fossiliferous sand contains multicolored well cemented sand grains, fine to medium, abundant shell fragments. Silty sand is olive, 5Y 5/4, fine-grained.
BF-EW-6 Screen interval (85-138 feet bls)			115-125	FOSSILIFEROUS SAND AND SAND (SP): Fossiliferous sand same as 113-115; sand is olive, 5Y 5/4, fine-grained, trace mica, trace shell fragements.
			125-133	SANDY CLAYEY SILT (ML): Olive, 5Y 4/3, stiff, predominantly fine-grained sand, trace mica, trace shell fragments, iron oxide stains.
			133-139	SAND (SP): Blue gray, dense, fine-grained, some silt, trace mica.
			139-149	CLAYEY SILT (ML): Blue gray, stiff, trace fine-grained sand, moderately plastic.

1 Blow counts per 0.5 foot interval using a California modified drive sampler and a 140-pound hammer with a 30-inch drop. Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.

2 Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated. OVA background readings deducted when reported values are below 50 ppm.

NA Not available

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

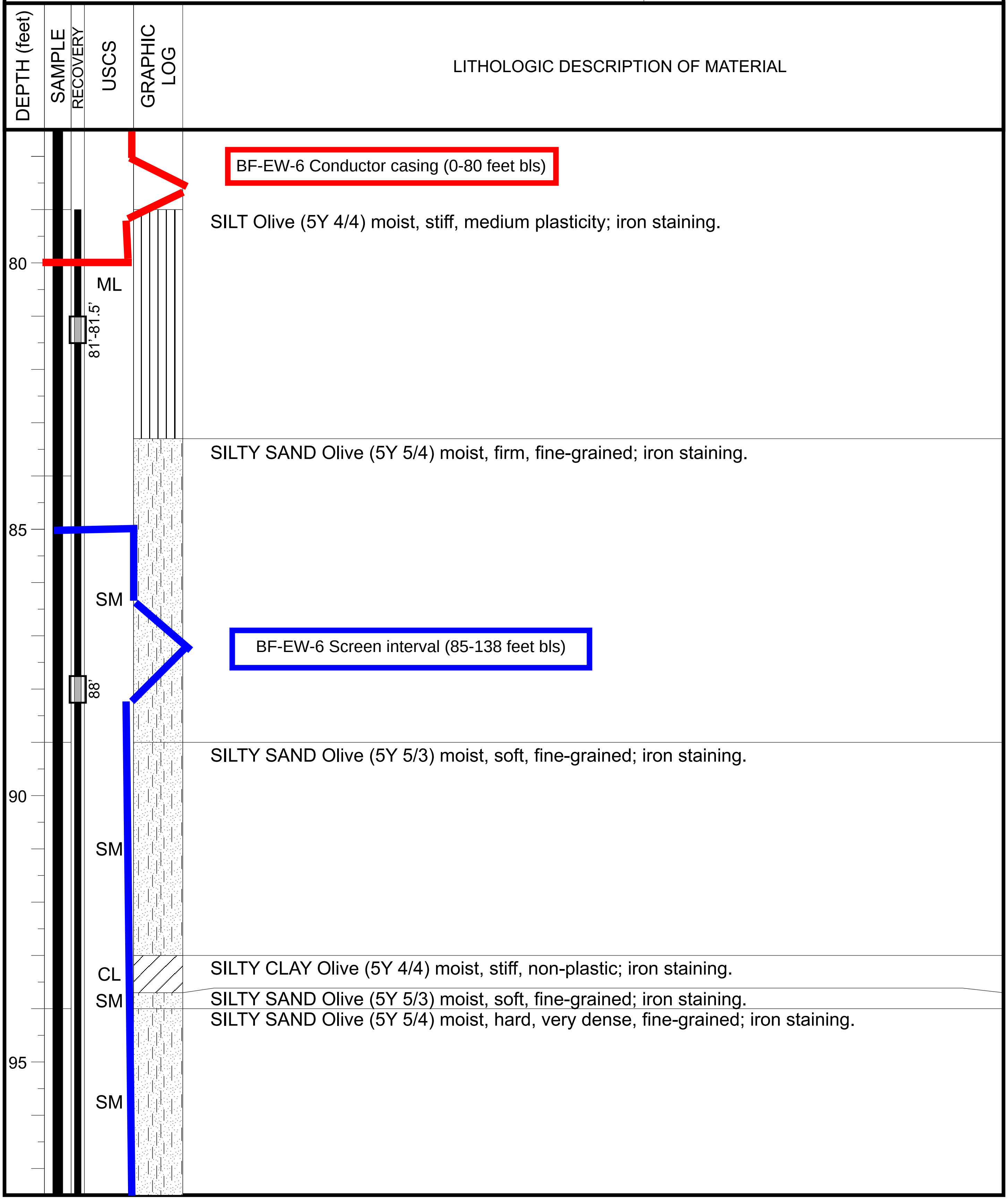

FIGURE A-6B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
		SM		SILTY SAND continued.
		CL		SILTY CLAY Olive (5Y 5/6) moist, very stiff, medium plasticity; iron staining.
100	102'-102.5'	CL		SILTY CLAY Dark gray (5Y 4/1) otherwise same as above.
105				
	107'-107.5'	SM		SILTY SAND Olive (5Y 5/3) moist, fine-grained; iron staining.
		SP		SAND Olive (5Y 4/4) moist, soft, fine- to medium-grained; iron staining, with shell fragments.
110	112'-112.5'	SP		SAND Olive (5Y 5/4) moist, medium- to coarse-grained, subrounded to subangular; some silt, iron staining. At 113 to 114 feet: shell fragments.
		SM		SILTY SAND Gray (5Y 6/1) moist, fine-grained; iron staining.
115		SM		SILTY SAND Olive (5Y 5/3), increased sand content, otherwise same as above.

BF-EW-6 Screen interval (85-138 feet bls)

FIGURE A-6B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
		SM		SILTY SAND continued.
120		SM		SILTY SAND Gray (5Y 6/1) moist, hard, fine-grained; iron staining. BF-EW-6 Screen interval (85-138 feet bls)
		SM		SILTY SAND Olive (5Y 4/4) moist, dense, fine- to medium-grained; iron staining.
125		SM		SILTY SAND Olive (5Y 4/4) dense, fine- to medium-grained; iron staining. At 126 to 128 feet: Color becomes dark gray (5Y 4/1).
		SM		
		SP		SAND Olive gray (5Y 5/2) wet, fine-grained, well sorted.
130	131'-131.5' 131.5'-132'	CL		CLAY Olive gray (5Y 4/2) moist, hard, non-plastic.
135		ML		SANDY SILT Dark greenish gray (5GY 4/1) moist, firm, non-plastic; sand: fine-grained.
		SM		SILTY SAND Greenish gray (5GY 5/1) wet, fine-grained, well sorted.

FIGURE A-6B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

EXPLORATORY BORING EB-27

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/26/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
			SM		SILTY SAND continued. BF-EW-6 Screen interval (85-138 feet bls)
140			CL		CLAY Dark greenish gray (5GY 4/1) moist, firm, medium plasticity.
			SM		SILTY SAND Same as 135.4 to 138.4 feet.
145			SP		SAND Greenish gray (5G 5/1) wet, fine-grained, well sorted.
150			SP		SAND Greenish gray (5G 5/1) wet, fine-grained, well sorted.
			CL		CLAY Dark greenish gray (5GY 4/1) moist, firm, medium plasticity.
155			SP		SAND Greenish gray (5G 5/1) wet, fine-grained, well sorted.

FIGURE A-6B: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL BF-EW-6

FIGURE A-7: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-4

FROM LITHOLOGIC LOG FOR EXPLORATORY BORING
EB-11

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 130 - 150 feet	NA	NA	130 - 140.5	SAND (SP): Olive-gray, 5Y 4/2, dense to slightly indurated, fine- to medium-grained moderately sorted; some shell fragments; trace silt. At 134 feet, no shells. At 137 - 139 feet, silt lens, black, 5Y 2.5/1; some clay, soft to stiff.
G-EW-4 Conductor Casing (0-147 feet bls)			140.5 - 147	CLAY (CH) WITH SAND (SP) INTERBEDS: Blue-gray, 2.5Y 4/0, soft, moderately plastic; sand is fine-grained, well sorted. At 141 feet, black lens; thickness uncertain. At 145.5 - 147 feet, sand lens, blue-gray, very dense, fine-grained, well sorted.
			147 - 149	CLAYEY FOSSILS: Fragmented and complete shells to 1-1/2-inch diameter, white bivalves and blue-gray oysters; little weathering.
			149 - 150	CLAY (CH): Blue-gray, soft, moderately plastic; white bivalve shell fragments and blue-gray shell fragments to 1-inch diameter.

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

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FIGURE A-7: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-4

FROM LITHOLOGIC LOG FOR EXPLORATORY
BORING EB-11

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Wireline Core 150 - 151 feet	R = 1.0/1.0		150 - 150.5	CLAY (CH): Same as 149 - 150.
Wireline Core 151 - 155 feet	R = 4.0/4.0		150.5 - 155	SAND (SP): Bluish gray to dark gray, 2.5Y 4/0, loose to slightly dense, fine-grained, well sorted, subrounded to subangular; trace silt.
Mud Rotary Cuttings collected at 5-foot intevals 155 - 209 feet	NA	NA	155 - 183	SAND (SP): Same as 150.5 - 155 except with occasional silty sand interbeds. At 160 - 162 feet, occasional sandy silt and silty sand interbeds. At 169 feet, some medium-grained sand. At 174 feet, increase in medium-grained sand; moderately sorted; brown bivalve shell fragments, weathered; black silty sand pieces. At 176 feet, trace medium sand grains and some shell fragments.

G-EW-4 Screen interval (153-200 feet bls)

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

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FIGURE A-7: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-4

FROM LITHOLOGIC LOG FOR EXPLORATORY
BORING EB-11

G-EW-4 Screen interval (153-200 feet bls)

DRILLING/SAMPLING METHOD	RECOVERY*	OVA** (ft/ppm)	DEPTH INTERVAL (feet)	DESCRIPTION
Mud Rotary Cuttings collected at 5-foot intervals 155 - 209 feet	NA	NA	155 - 183	SAND (SP): (continued)
				At 179 feet, clayey silt lens, less than 1 foot thick.
				At 181 feet, some silty sand interbeds, soft.
			183 - 187	SAND (SP): Bluish gray to very dark gray, 2.5Y 3/0, medium dense, fine- to medium-grained, moderately sorted, subangular to subrounded; some silt interbeds alternating firm and hard.
			187 - 194	SILTY SAND (SM): Very dark gray, 2.5Y 3/0, to bluish gray, loose, fine-grained, well sorted, subangular; some sandy silt, soft.
				At 189 feet, grades dense to slightly cemented.
			194 - 196	SHELL FRAGMENTS: White; some silty sand.
			196 - 202.5	SAND (SP): Very dark gray, 2.5Y 3/0, to bluish gray, very dense, fine-grained, well sorted.

OVA = Organic vapor analyzer
ft/ppm = Feet; parts per million
NA = Not applicable

*Recovery = length of sample in sampler/length of sampler driven or cored, measured in feet.
**Organic vapor analyzer (OVA) readings in parts per million (ppm) of soil collected at depth indicated, in feet. OVA background readings deducted when reported values are below 50 ppm.

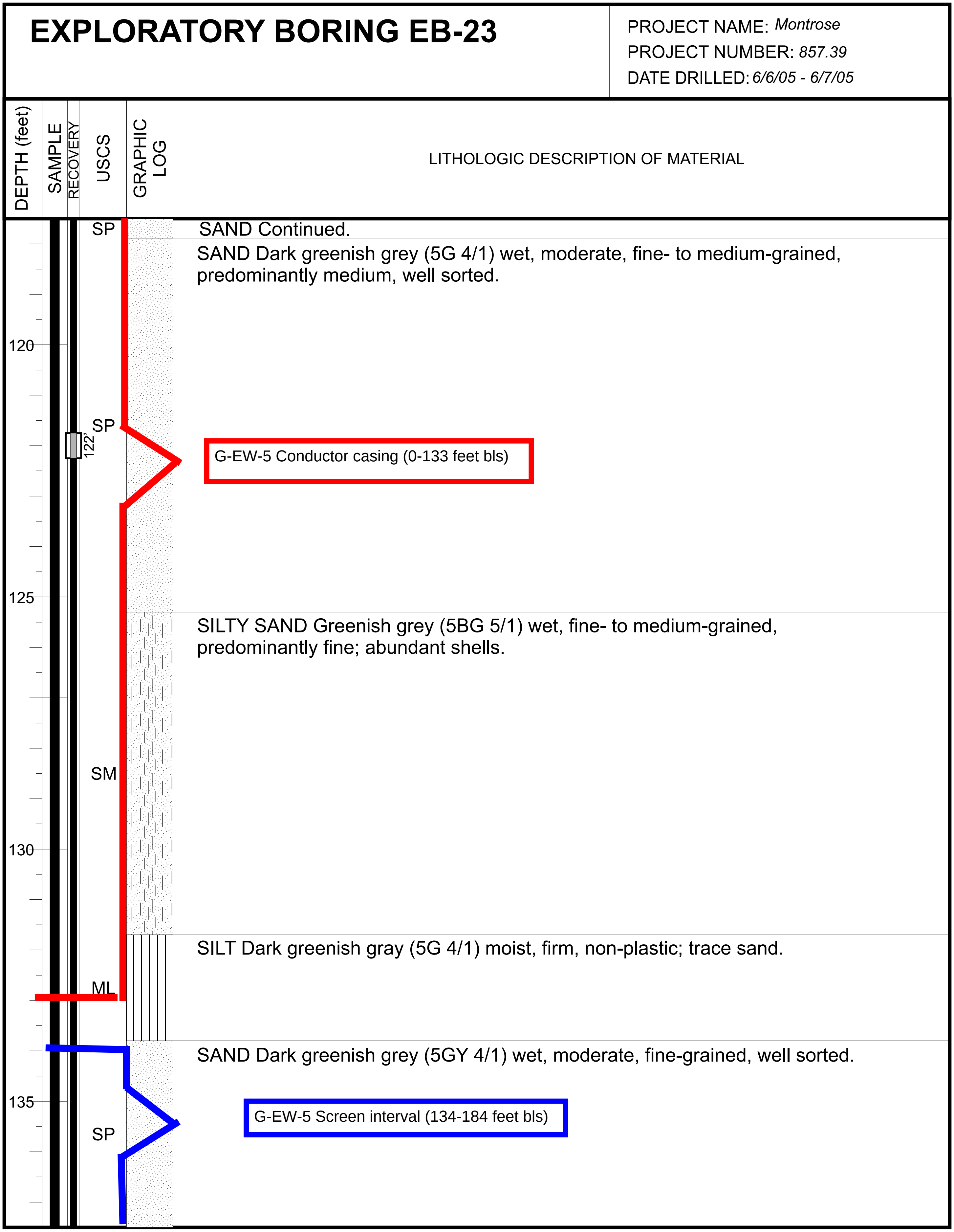


FIGURE A-8: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-5

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

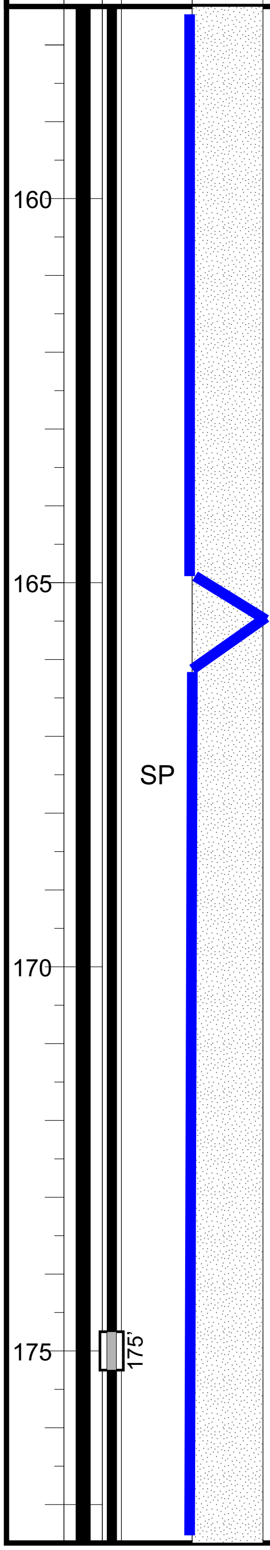
DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
			SP		SAND Continued.
	139' 138.5'		CL		CLAY Dark greenish grey (5GY 4/1) moist, firm to hard, moderate to high plasticity; no sand.
140			SP		SAND Same as 133.8 to 138.1 feet.
145					
					G-EW-5 Screen interval (134-184 feet bls)
150	150'				
155					

FIGURE A-8: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-5

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet) | SAMPLE | RECOVERY | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION OF MATERIAL



SAND Continued.

G-EW-5 Screen interval (134-184 feet bls)

At 172.5 feet: becomes very fine-grained; trace silt.

At 176.5 to 177.5 feet: trace fossils.

FIGURE A-8: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-5

EXPLORATORY BORING EB-23

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *6/6/05 - 6/7/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
180			SP		SAND Continued. At 178.5 feet: strong cementation. G-EW-5 Screen interval (134-184 feet bls) At 182.8 feet: trace fossils. At 184 feet: trace fossils.
185			SM		SILTY SAND Dark greenish grey (5GY 4/1) wet, firm, non-plastic;very fine-grained sand.
190			SP		SAND Dark green grey (5B 4/1) wet, moderate, fine-grained, well sorted; abundant shells, trace silt (<5%).
195			SP		SAND Dark greenish grey (5B 4/1) wet, moderate, fine-grained, well sorted.
			ML		SILT Dark green grey (5B 4/1) moist, hard, non-plastic; no sand.
					TOTAL DEPTH OF BORING = 196.5 FEET BELOW LAND SURFACE

FIGURE A-8: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-5

EXPLORATORY BORING EB-38 AND MONITOR WELL G-35

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.50D*
DATE DRILLED: *11/17/08-11/20/08*

DEPTH (feet)	USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
	SM	SILTY SAND continued.
	ML	SILT, Same as 134.5 to 134.9 feet.
	SM	SILTY SAND, Same as 134.9 - 138 feet.
140	ML	SILT, Same as 134.5 to 134.9 feet.
	SM	SILTY SAND (0/85/15) Very dark greenish gray (3/N), very fine- to fine-grained, well sorted.
		G-EW-6 Conductor casing (0-146 feet bls)
145	ML	SILT WITH SAND (0/15/85) Dark gray (5Y 4/1), firm, moderate plasticity; sand: very fine- to fine-grained.
	SM	SILTY SAND (0/85/15) dark gray (5Y 4/1), very fine- to fine-grained, well sorted.
	SP-SM	SAND WITH SILT (0/90/10) Dark gray (5Y 4/1), very fine- to fine-grained, trace medium; abundant shell fragments(10%). At 148 to 148.2 feet: Silt lense. At 148.5 to 148.7 feet: Silt lense. At 149 to 149.3 feet: Silt lense.
150	SP	SAND (0/95/5) Olive gray (5Y 4/2), fine- to medium-grained, trace gravel up to ¼-inch; abundant shell fragments (10%).
		G-EW-6 Screen interval (150-190 feet bls)
155		
	SP-SM	SAND WITH SILT, See below.

WELL CONSTRUCTION DIAGRAM

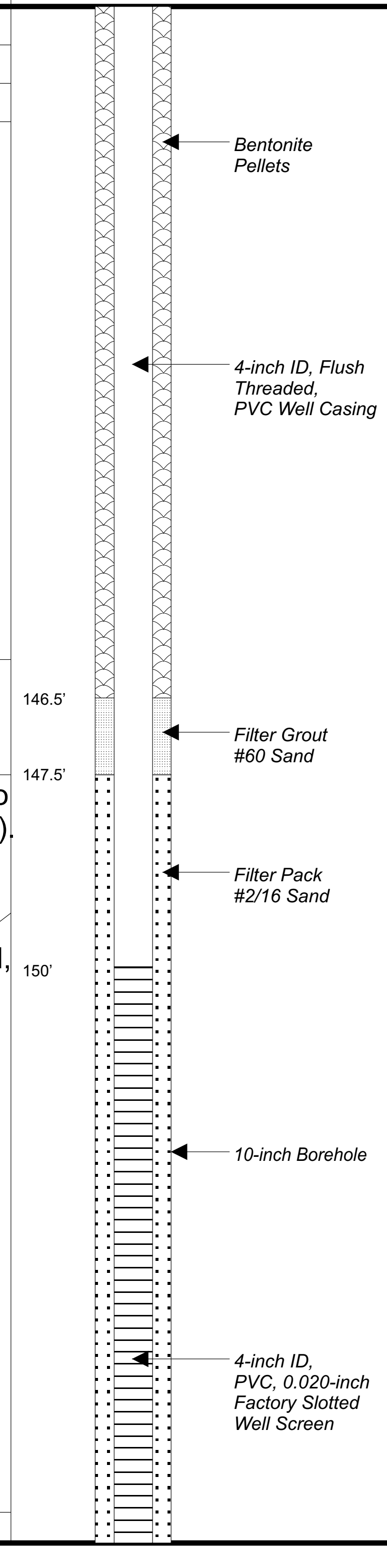


FIGURE A-9: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-6

EXPLORATORY BORING EB-38 AND MONITOR WELL G-35

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.50D*
DATE DRILLED: *11/17/08-11/20/08*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL	WELL CONSTRUCTION DIAGRAM
			SP-SM		SAND WITH SILT Olive gray (5Y 4/2), fine-grained, well sorted; silt: firm, non-plastic.	
160			SP		SAND (0/95/5) olive gray (5Y 4/2), fine-grained, trace medium, well sorted, medium dense; fines increase with depth.	
165					G-EW-6 Screen interval (150-190 feet bls)	
					At 168 feet: color becomes Olive (5Y 4/3).	
170						
175						

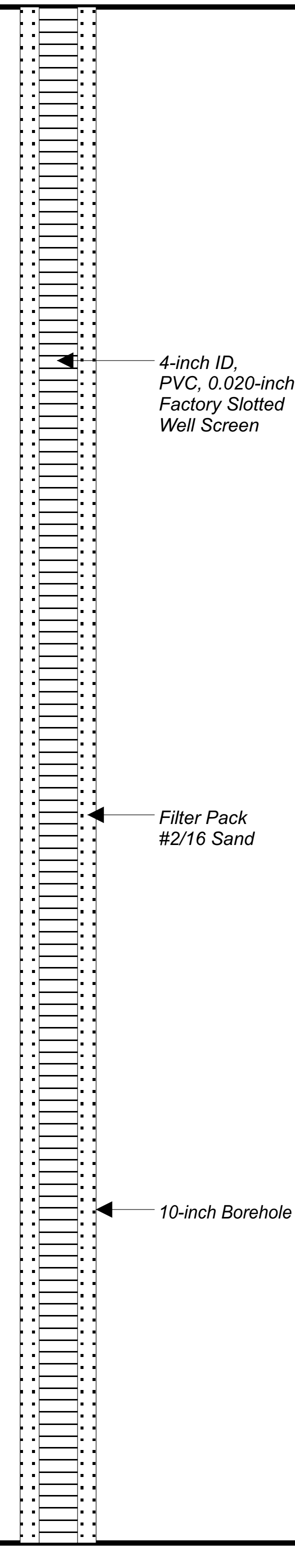


FIGURE A-9: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-6

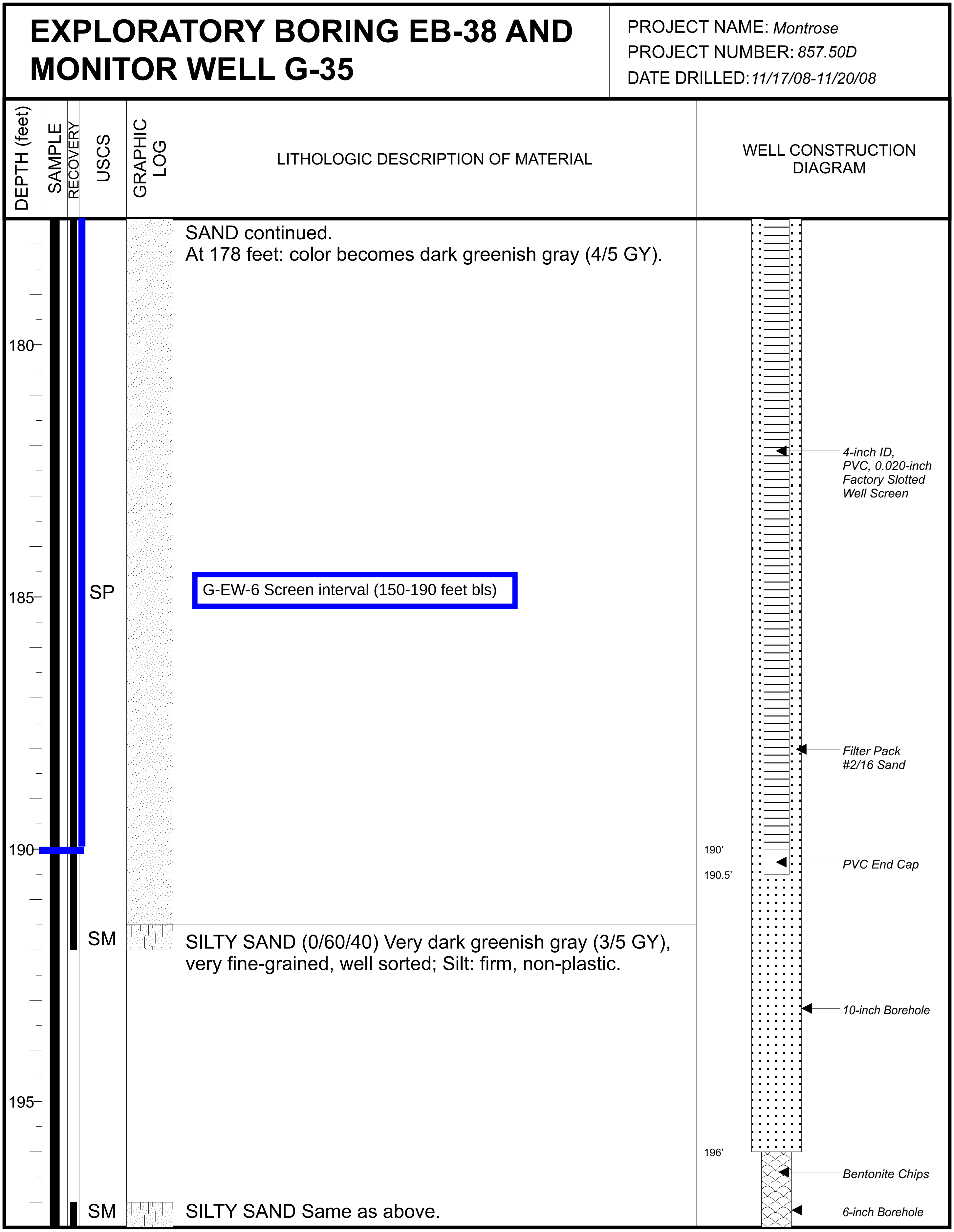
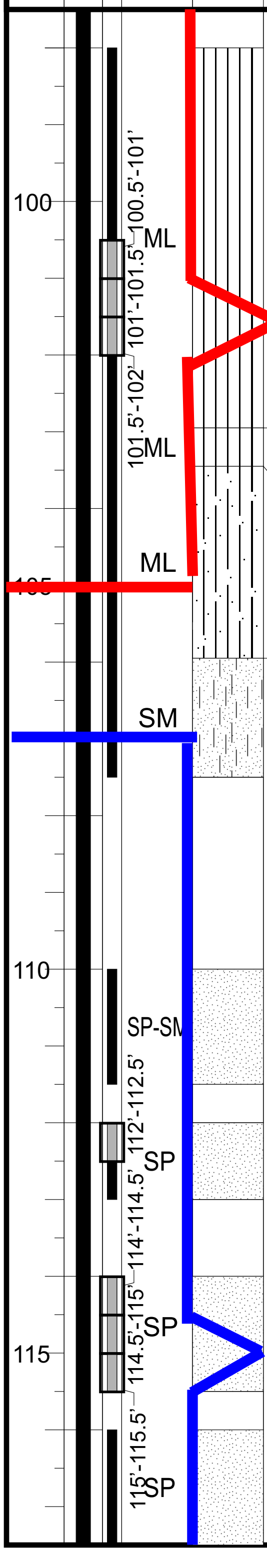


FIGURE A-9: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR EXTRACTION WELL G-EW-6

EXPLORATORY BORING AND TEMPORARY WELL EB-26

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *2/21/06 - 2/28/06*

DEPTH (feet) | SAMPLE | RECOVERY | USCS | GRAPHIC LOG | LITHOLOGIC DESCRIPTION OF MATERIAL | TEMPORARY WELL CONSTRUCTION DIAGRAM



SILT (0,0,100) Light olive brown (2.5Y 5/4) moist, stiff; orange mottling.
At 99 feet: becomes 5GY 4/1.

At 100 feet: becomes dark bluish gray (5B 4/1) hard; with trace very fine-grained sand.

BF-IW-3 conductor casing (0-105 ft bls)

SILT WITH SAND (0,20,80) Dark greenish gray (5GY 4/1) moist, hard; sand: very fine-grained.

SANDY SILT (0,50,50) Dark greenish gray (5GY 4/1) moist, stiff; sand: fine- to medium-grained.

SILTY SAND (0,60,40) Olive gray (5Y 5/2) moist, dense, fine- to medium-grained, well sorted; sand content increases to 80% with depth and medium-grained sand content increases with depth.

SAND WITH SILT (0,90,10) Olive (5Y 5/4) wet, loose, sub-rounded, fine- to medium-grained.

SAND (0,95,5) Olive (5Y 5/4) wet, loose, sub-rounded, fine- to medium-grained.

SAND Same as above.

BF-IW-3 screened interval(107-125 ft bls)

SAND (0,95,5) Olive (5Y 5/4) wet, loose, sub-rounded, fine- to medium-grained.

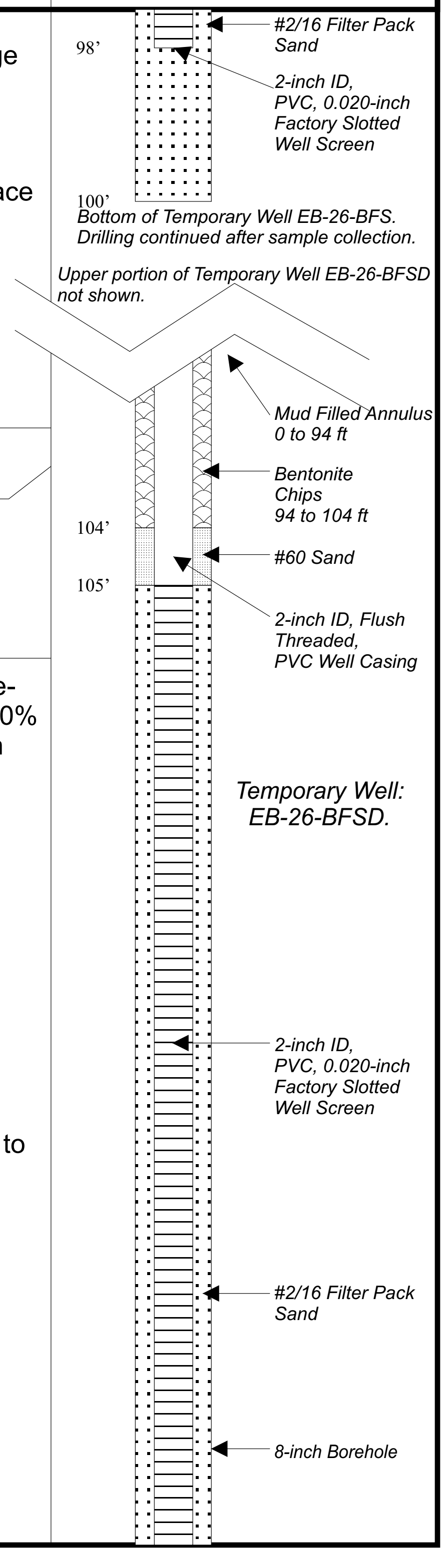


FIGURE A-10: PROPOSED CONDUCTOR CASING AND SCREEN INTERVALS FOR BF-IW-3

EXPLORATORY BORING AND TEMPORARY WELL EB-26

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *2/21/06 - 2/28/06*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
	118'-118.5'	SP	SAND continued.
120		SP	SAND (0,100,0) Olive (5Y 4/3) wet, loose, fine- to medium-grained; trace silt.
			BF-IW-3 screened interval (107-125 ft bls)
		SP	SAND Same as above
125		SM	SILTY SAND (0,60,40) to SANDY SILT (0,45,55) Olive (5Y 4/3) moist, dense to hard, very fine-to fine-grained; orange mottling.
	126'-126.5'	ML	SILT WITH SAND (0,30,70) Gray (5Y 5/1) moist, hard, fine-grained. At 127 feet: 6 inch thick sand interbed.
		ML	CLAYEY SILT (0,0,100) Dark gray (N4) moist, firm.
130		ML	SANDY SILT (0,40,60) Dark gray (N4) moist, firm; sand: fine-grained.
		SP	SAND (0,95,5) Dark gray (N4) moist, medium dense, very fine- to fine-grained.
	134'-134.5'	ML	SILT WITH SAND (0,25,75) Dark gray (N4) wet, stiff; sand: fine-grained, sand content decreases with depth.
135		SP	SAND (0,95,5) Dark gray (N4) moist to wet, loose to dense, fine-grained.

TEMPORARY WELL CONSTRUCTION DIAGRAM

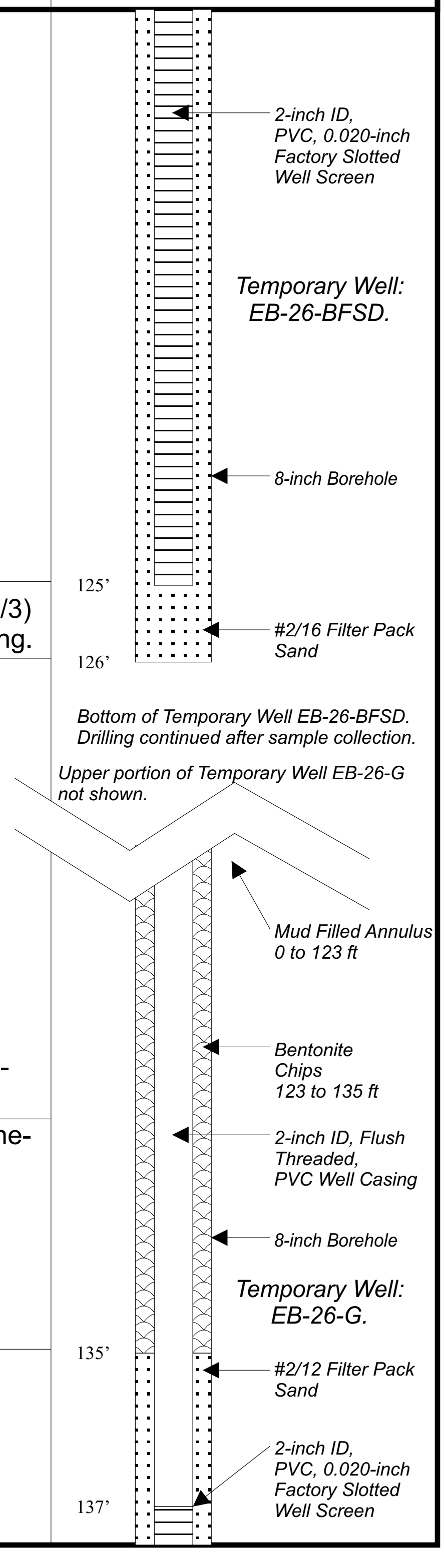


FIGURE A-10: PROPOSED CONDUCTOR CASING AND SCREEN INTERVALS FOR BF-IW-3

EXPLORATORY BORING AND TEMPORARY WELL EB-26

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *2/21/06 - 2/28/06*

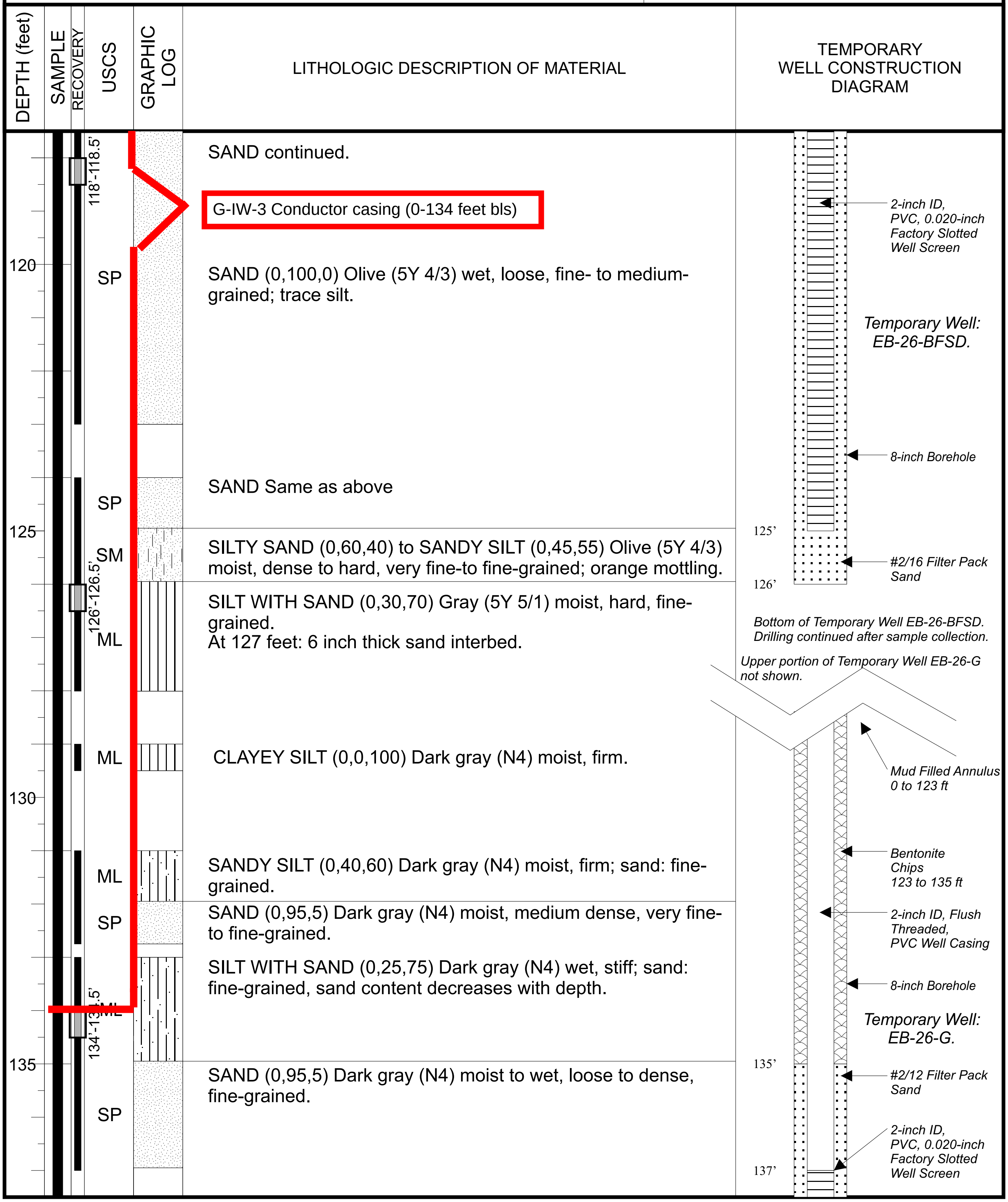


FIGURE A-11: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-3

EXPLORATORY BORING AND TEMPORARY WELL EB-26

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *2/21/06 - 2/28/06*

G-IW-3 Screen interval (138-163 feet bls)

DEPTH (feet)	SAMPLE / RECOVERY	USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
140	140'-140.5'	SP	SAND (0,95,5) Greenish gray (5GY 5/1) wet, loose, fine- to medium-grained. At 141.5 feet: becomes medium dense, fine-grained; faint black laminations.
145		SP	SAND (0,100,0) Dark greenish gray (5GY 4/1) wet, dense, very fine- to fine-grained, well sorted; trace silt.
		SP-SM	SAND WITH SILT (0,90,10) Dark greenish gray (5GY 4/1) wet loose, fine- to medium-grained, well sorted.
150	150'-150.5' 150.5'-151' 151'-151.5'	SW	SAND (0,95,5) Dark greenish gray (5GY 4/1) wet, loose, sub-angular to sub-rounded, fine- to medium-grained, well sorted.
155		SP	SAND (0,100,0) Dark greenish gray (5GY 4/1) wet, loose, fine- to medium-grained, predominantly fine, well sorted, trace silt.
		SW	SAND (0,100,0) Dark greenish gray (5GY 4/1) wet, loose, fine- to coarse-grained, poorly sorted, trace silt.
		SW	SAND Same as above.

TEMPORARY WELL CONSTRUCTION DIAGRAM

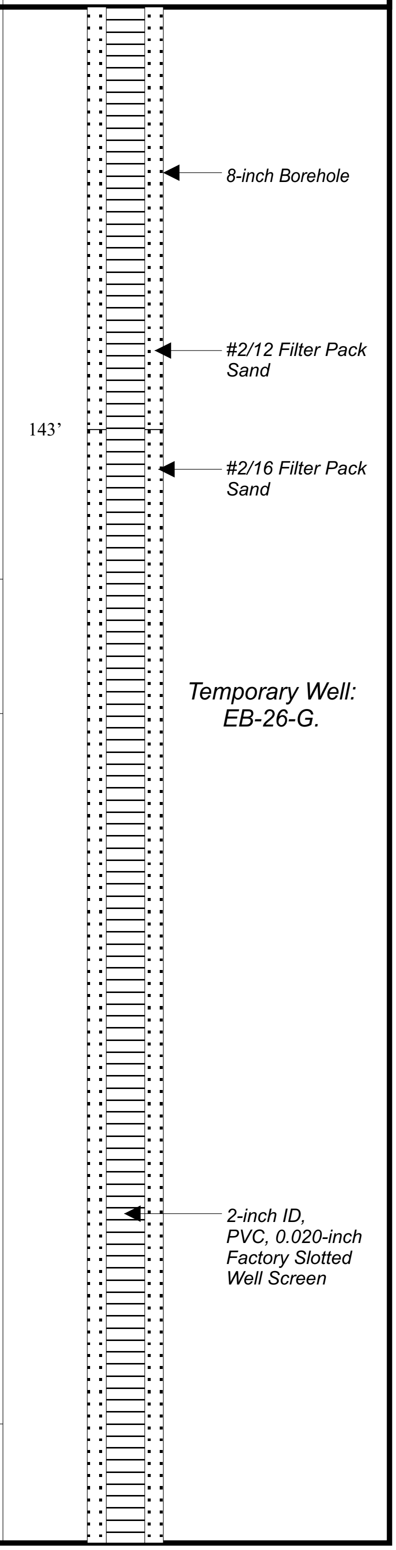


FIGURE A-11: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-3

EXPLORATORY BORING AND TEMPORARY WELL EB-26

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *2/21/06 - 2/28/06*

DEPTH (feet)	SAMPLE / RECOVERY	USCS	LITHOLOGIC DESCRIPTION OF MATERIAL
		SW/ SM	SAND (0,95,5) TO SILTY SAND (0,80,20) Greenish gray (5GY 6/1) moist, medium dense,1-inch to 2-inch interbeds sub-rounded to sub-angular, fine-grained and fine- to coarse-grained, poorly sorted.
160		SW/ SM	SAND TO SILTY SAND Same as above. At 160 feet: Thickness of interbeds increase to 2-inches to 6-inches.
			G-IW-3 Screen interval (138-163 feet bls)
	164'-164.5'	SW/ SM	SAND TO SILTY SAND Same as above. At 164.5 feet: Black laminations within interbed of fine-grained sand.
165		SP	SAND (0,100,0) Greenish gray (5GY 5/1) dry to moist, dense, very fine- to fine-grained,well sorted.
	169'-169.5'	SM	SILTY SAND (0,70,30) Dark greenish gray (5GY 4/1) wet, loose, very fine-grained, well sorted.
170		SP	SAND (0,100,0) Dark greenish gray (5GY 4/1) wet, medium dense, fine-grained, well sorted. AT 171 to 173.5 feet: Minor black laminations.
175		SP	SAND (0,100,0) Dark gray (N4) wet, medium dense, fine-grained.

TEMPORARY WELL CONSTRUCTION DIAGRAM

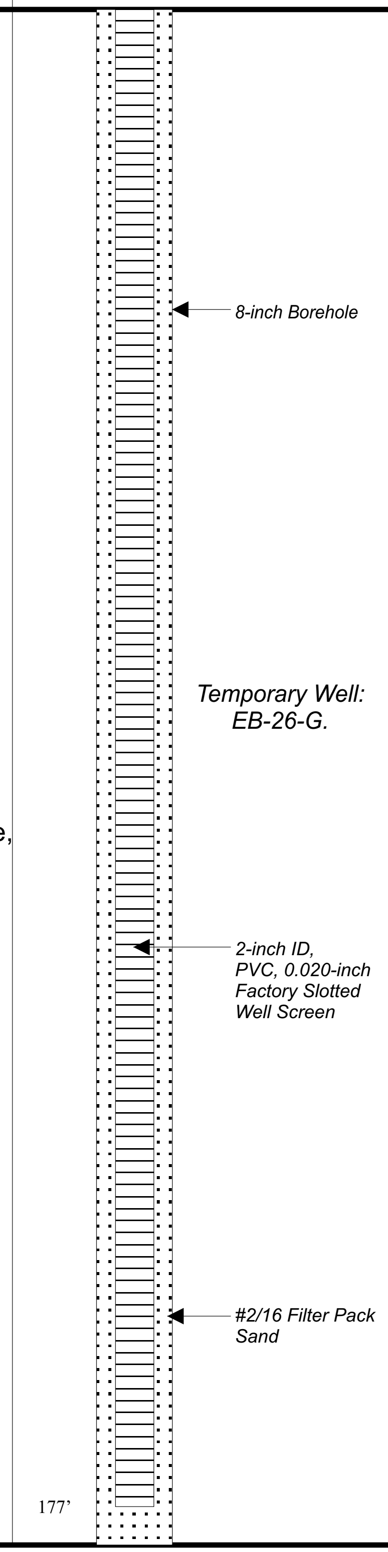


FIGURE A-11: PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-3

EXPLORATORY BORING EB-25

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/18/05*

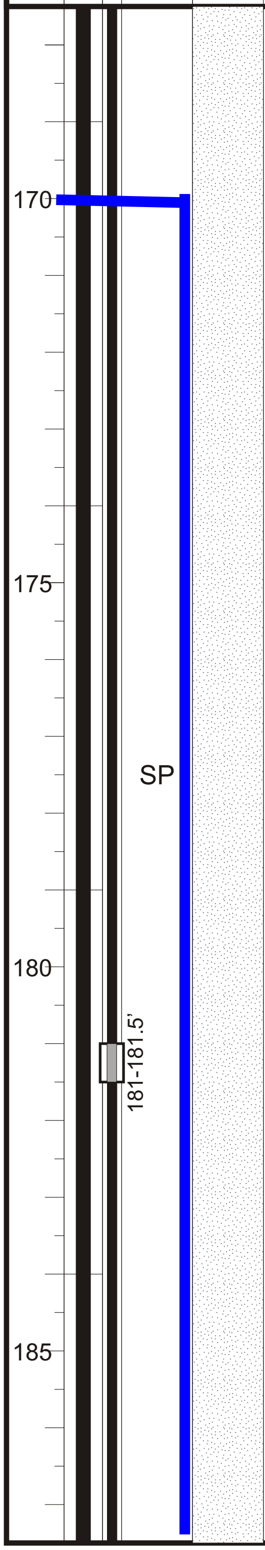
DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
150			SM		SILTY SAND continued. At 149.6 to 150.2 feet: Abundant shells.
			CL		CLAY Same as 142.2 to 147.4 feet.
155			SM/ ML		SILTY SAND to SANDY SILT Light olive gray (5Y 6/2) moist, SAND: fine- to coarse-grained, predominantly fine, poorly sorted; abundant shells. At 155.8 feet: Color changes to Dark greenish gray (5G 4/1).
			ML		SILT Dark greenish gray (5G 4/1) moist, firm, non-plastic.
160			SP		SAND Dark greenish gray (5G 4/1) wet, fine-grained, well sorted.
			ML		SILT Dark greenish gray (5G 4/1) moist, firm, non-plastic.
			SM		SILTY SAND Dark greenish gray (5G 4/1) wet, fine-grained, well sorted. G-IW-4 Conductor casing (0-165 feet bls)
165			ML		SILT Same as 161.4 to 162.1 feet.
			SP		SAND Dark greenish gray (5G 4/1) wet, fine-grained, well sorted.

FIGURE A-12 PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-4

EXPLORATORY BORING EB-25

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/18/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
					SAND continued.



G-IW-4 Screen interval (170-210 feet bls)

FIGURE A-12 PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-4

EXPLORATORY BORING EB-25

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/18/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
			SP		SAND continued.
			SP		SAND Dark greenish gray (5G 4/1) wet, fine- to coarse-grained, predominantly medium, subangular coarse-grained sand; trace clay.
			SP		SAND Same as 166.1 to 188.3 feet.
190					
195	195.1-195.5				At 195.1 to 195.5 feet: Coarse-grained sand stringer
	195.9-196.2'				At 195.9 to 196.2 feet: Coarse-grained sand stringer
	199-199.5'				G-IW-4 Screen interval (170-210 feet bls)
200					
205					

FIGURE A-12 PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-4

EXPLORATORY BORING EB-25

PROJECT NAME: *Montrose*
PROJECT NUMBER: *857.39*
DATE DRILLED: *7/18/05*

DEPTH (feet)	SAMPLE	RECOVERY	USCS	GRAPHIC LOG	LITHOLOGIC DESCRIPTION OF MATERIAL
					SAND continued.
					G-IW-4 Screen interval (170-210 feet bls)
210					
					At 211.7 feet: Trace shells.
			SP		At 214 feet: Becomes very fine-grained.
215	215-215.5				
220					
			ML		SILT Dark greenish gray (5G 4/1) moist, firm, nonplastic; trace fine-grained sand.
225					
			SP		SAND Same as 166.1 to 188.3 feet.

FIGURE A-12 PROPOSED CONDUCTOR CASING AND SCREEN INTERVAL FOR INJECTION WELL G-IW-4

APPENDIX B

Short-Term Extraction Rates of Existing and Planned Injection Well

APPENDIX B

**SHORT-TERM EXTRACTION RATES OF
EXISTING AND PLANNED INJECTION WELLS**

It is anticipated that injection wells may need to be back flushed on a regular basis to recover lost capacity due to plugging. During back-flushing, the injection wells would be pumped at the maximum short-term extraction rate of the injection wells. The short-term extraction rate of the injection wells was calculated by multiplying the estimated short-term specific capacity by the estimated available drawdown at each well. The methodology used to estimate specific capacity and available drawdown is provided below.

Available Drawdown

Available drawdown was estimated for each injection well based on the following equation:

Available Drawdown = Maximum Pumping Water Level – Depth to Static Water Level

Maximum pumping water levels were estimated for each injection well based primarily on the existing or proposed screen intervals. It was assumed that the maximum drawdown for Bellflower sand (BFS) injection wells was equal to one third of the screen interval such that the lower, more productive portion of the BFS remained saturated (Table 1). It was assumed that the maximum drawdown for the Gage aquifer (Gage) injection wells was the top of the screen (Table 1).

Table 1. Maximum Pumping Water Level

Unit	Well Identifier	Depth To Screen (feet bls)		Maximum Pumping Water Level (feet bls)
		Top	Bottom	
BFS	BF-IW-1	107	125	113
	BF-IW-2	61.5	144	89
	BF-IW-3	107	125	113
Gage	G-IW-1	138	163.5	138
	G-IW-2	173	214	173
	G-IW-3	138	163	138
	G-IW-4	170	210	170

bls = Below land surface

Static water levels were measured in existing injection wells in October 2006 (Table 2) (H+A, 2007). The depth to the static water level for the planned injection wells was estimated by subtracting the land surface elevation from the approximate water level elevation for the unit screened by the injection well (Table 2). The land surface elevation at each planned well was estimated from U.S. Geological Survey topographic maps. The water level elevation at each planned well was interpolated from water level contour maps prepared from the 2006 monitoring round (H+A, 2007).

Table 2. Depth to Static Water Level

Unit	Well Identifier	Elevation (feet msl)		Depth to Static Water Level (feet bls)
		Land Surface	Static Water Level	
BFS	BF-IW-1	55	-12	67
	BF-IW-2	23	-15	38
	BF-IW-3	56	-12	68
Gage	G-IW-1	55	-12	67
	G-IW-2	35	-15	49
	G-IW-3	56	-11	67
	G-IW-4	35	-15	49

msl = Mean sea level
bls = Below land surface

Based on the foregoing, the available drawdowns are as follows.

Table 3. Available Drawdown

Unit	Well Identifier	Maximum Pumping Water Level (feet bgs)	Depth to Static Water Level (feet bgs)	Available Drawdown (feet bgs)
BFS	BF-IW-1	113	67	46
	BF-IW-2	89	38	51
	BF-IW-3	113	68	46
Gage	G-IW-1	138	67	71
	G-IW-2	173	49	124
	G-IW-3	138	67	71
	G-IW-4	170	49	121

bgs = Below ground surface

Specific Capacity

For existing injection wells, data from the pilot tests were used to estimate the short-term specific capacity (Table 4). The short-term specific capacity was estimated to be the well capacity observed at the end of the pilot injection tests, adjusted to account for observed plugging. For the planned injection wells, where pilot test data were not available, specific capacity was estimated to be the same as the nearest injection well screened in the same aquifer (Table 4).

Short-Term Injection Well Extraction Rates

The back flushing rate should exceed the injection rate in order to sufficiently remove particulates from the screen and surrounding formation that may be the cause of plugging of the injection wells. Based on the well specific capacities without plugging and the estimates of available drawdown, the short-term injection well extraction rates are as follows:

Table 4. Short-term Injection Well Extraction Rates

Well Identifier	Estimated Specific Capacity Without Plugging (gpm/ft)	Available Drawdown (feet bgs)	Short-Term Extraction Rate (gpm)	Design Injection Rate (gpm)
BF-IW-1	1.3	46	60	40
BF-IW-2	2.4	51	122	40
BF-IW-3	1.3	46	60	57
G-IW-1	4.3	71	305	157
G-IW-2	2.2	124	273	125
G-IW-3	4.3	71	305	157
G-IW-4	2.2	121	266	125

gpm/ft = Gallons per minute per foot
bgs = Below ground surface

Based on the above evaluation, the short-term extraction rates of the injection wells exceed the design for all of the existing and planned injection wells.

Geosyntec consultants

REFERENCES

Hargis + Associates, Inc., 2007, 2006 Groundwater Monitoring Results Report, Montrose Site, Torrance, California. February 28, 2007.