



CONSULTING ENGINEERS & GEOLOGISTS, INC.

335 S. Main St., Willits, CA 95490-3977 • 707-459-4518 • FAX: 707-459-1884 • willitsinfo@shn-engr.com

Reference: 417034.200

March 28, 2018

Mr. Mark Erickson
SCS Engineers
3843 Brickway Blvd. Suite 208
Santa Rosa, CA 95403

Subject: Hydrogeologic and Hydrologic Assessment for the Proposed Eastlake Sanitary Landfill Expansion, Lake County, California

1.0 Introduction

The following report summarizes and hydrogeologic (groundwater) and hydrologic (surface water) conditions at the Eastlake Sanitary Landfill (ESL) pertaining to compliance with regulatory requirements for the proposed ESL expansion and future cell construction. The existing landfill property encompasses five (5) separate parcels owned by the County of Lake totaling 80 acres of which 34.7 acres are currently permitted for Class III waste disposal (Figure 1).

The proposed landfill expansion and future waste cell construction will include a new Subtitle D-compliant waste disposal cell. Areas being considered for development as part of the landfill expansion primarily include the previously disturbed borrow area as well as currently undeveloped land to the south of the borrow area, and land abutting the north edge of the currently permitted refuse area.

1.1 Waste Disposal Cell Siting Criteria

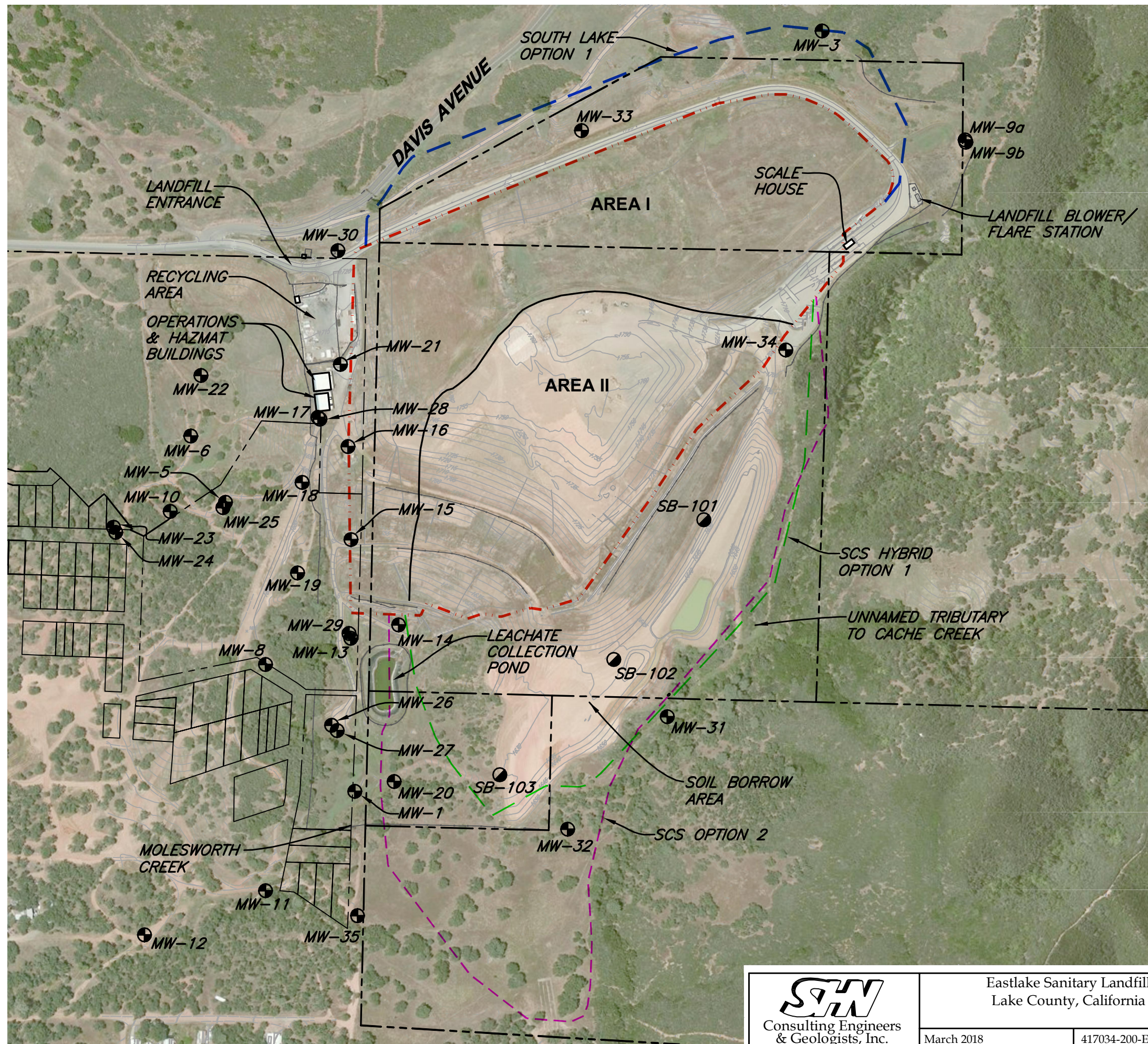
The new cell proposed for the landfill expansion is a planned Class III waste disposal cell. Pursuant to the regulations specified in Section 20260 Title 27, they are subject to siting criteria to ensure no impairment of beneficial uses of surface water or groundwater occur, and factors that need to be evaluated are outlined below and addressed in this report:

- Hydraulic conductivity and transmissivity of underlying soils
- Depth-to-groundwater and variations in depth-to-groundwater
- Background quality of groundwater and surface water
- Current and anticipated use of the groundwater
- Annual precipitation and flooding

1.2 Scope of Hydrogeologic and Hydrologic Assessment

The primary purpose of SHN's desktop and field investigation was to review available hydrogeologic and hydrologic data for the site and evaluate the proposed new waste cell locations with respect to Class III landfill siting criteria as specified in Title 27. The primary focus of this report is water quality and water movement (groundwater and surface water) at the site pertaining to effects at the proposed expansion areas.

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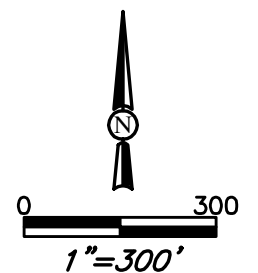


NOTE:

1. BASE MAP A COMBINATION OF PARCEL LINES FROM LAKE COUNTY, AERIAL SURVEY FROM SCS ENGINEERS, "SITE PLAN," DATED 09-26-17, AND SURVEY DONE BY SHN ENGINEERS, 2017

EXPLANATION

- PARCEL LINE
- MONITORING WELL LOCATION AND DESIGNATION
- GEOTECHNICAL BORING LOCATION AND DESIGNATION
- APPROXIMATE PERMITTED REFUSE LIMIT
- SCS HYBRID OPTION 1 (EXTENT OF FILL)
- SOUTH LAKE OPTION 1 (EXTENT OF FILL)
- SCS OPTION 2 (EXTENT OF FILL)
- 1700- EXISTING TOPOGRAPHIC CONTOUR IN FEET



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Lake County, California

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417034-200-EXST-SITE

Existing Site Conditions with
Proposed Expansion Areas
SHN 417034.200

Figure 1

greater degree of consolidation and cementation compared to that of the overlying Cache formation. Groundwater movement through planar discontinuities in the basement rock is evidenced by the presence of translocated clay within fractures (SHN, 1994). This suggests that groundwater in the Cache formation and the top of the underlying bedrock is hydraulically connected across a majority of the ESL.

For the purposes of this report, the "upper water bearing zone" is considered to be the Cache formation and the upper weathered portion of the basement rock. Groundwater elevations measured in site wells appear to reflect the presence of an open and unconfined aquifer, further indicating that the Cache formation and upper weathered bedrock section are hydraulically connected. Transmissivity in this water bearing zone is very low as demonstrated from recharge rates observed during well sampling activities. Poor recharge rates for most wells in this upper water bearing zone have required implementation of low-flow sampling methodologies in site wells.

A fracture flow analysis study was performed in January 2016 along the western boundary of ESL in open boreholes for monitoring wells MW-25 and MW-27 (Norcal, 2016). Borehole geophysical logging of MW-25 extended to a depth of 140 feet below ground surface (BGS) and to a depth of 91 feet BGS in boring location MW-27. Each of these boring locations was placed adjacent to existing wells with the intent of having a deeper screen interval for a comparison of groundwater quality and depth-to-water. Well MW-25 is screened in the underlying bedrock 50 feet below the adjacent well MW-5, which is screened in the upper Cache formation. A comparison of water quality and depth-to-groundwater in these two wells shows a distinct difference, indicating separation and that the wells in this area are not hydraulically connected.

A fracture and flow analysis was completed for well MW-27 directly adjacent to well MW-26 (screened in upper zone). A comparison of water quality and depth-to-water in these two wells shows that this nested well pair is hydraulically connected at depths within the upper formation and the underlying fractured bedrock. Borehole geophysical logging identified a significant fracture zone at the 89 to 91 foot BGS depth in MW-27, which exhibited a high rate of transmissivity. This is the only boring location at ESL that has shown a high rate of groundwater flow.

The movement of groundwater through the native material is directed to the south-southwest with a gradient range from approximately 0.04 to 0.07 feet per foot (ft/ft). Most of the wells at the facility have been monitored for more than 20 years with historical depth-to-groundwater in wells ranging from 15 to 100 feet BGS. Groundwater depth is significantly greater on the ridges based on historical site monitoring observations. Seasonal variations in groundwater elevation beneath the site have been observed to vary up to 15 feet in some wells. Groundwater movement across the site has remained relatively consistent over historical site monitoring. Groundwater contour maps for two monitoring events completed in 2018 as part of the field investigation are provided in Appendix 2.

The scope of work completed to address the quality and movement of water at the ESL included the following:

- A desktop review of existing site data, including published hydrogeologic and hydrologic monitoring and mapping
- Subsurface investigation, including the installation of three monitoring wells to assess conditions within the areas of potential expansion
- Site-wide depth-to-water measurements in monitoring wells (two events)
- Preparation of this report with findings and conclusions pertaining to groundwater and surface water quality and movement

2.0 Site Information

2.1 Description

The ESL is a canyon-fill disposal site located at the head of Molesworth Creek with surface elevations that range from approximately 1,550 feet above mean sea level (MSL) to approximately 1,800 feet above MSL. The maximum thickness of municipal solid waste is approximately 200 feet, at an elevation range of approximately 1,600 feet to 1,800 above MSL. Land uses within a 1-mile radius of the facility are zoned residential, commercial, agricultural, and open space.

Former and current waste emplacement occurs within a south-southwest trending canyon. Cover material for the existing refuse areas is generated onsite from a borrow area located to the south of the permitted refuse area. The 34.7-acre facility accepts Class III landfill material, including municipal waste, construction debris, and treated woodwaste. The facility began operations in 1972 and receives approximately 50,000 tons of refuse per year. The ESL consists of landfill units Area I (22.4 acres unlined) and Area II (12.3 acres lined).

Existing facilities at the site include a scale house, operation and hazmat buildings, leachate collection pond, landfill gas capture and control system, a gas blower and flare station, and surface water impoundment (Figure 1).

2.2 Monitoring Programs

Groundwater monitoring at the ESL is conducted in accordance with Waste Discharge Requirements (WDR) and Monitoring and Reporting Program (MRP) No. R5-2006-0108, issued by the Central Valley Regional Water Quality Control Board (RWQCB). The well network is comprised of 33 monitoring wells that include background wells MW-3, MW-9a, and MW-9b; and detection wells MW-1, MW-5, MW-6, MW-8, and MW-10 through MW-35. Wells are monitored for depth-to-water on a quarterly basis and sampled for water quality semiannually.

Surface water monitoring at the ESL is conducted in general accordance with MRP No. R5-2006-0108 and the Industrial General Permit (IGP) stormwater pollution prevention plan (SWPPP). The MRP surface-water monitoring is performed at a sample location in Molesworth Creek just below the leachate storage pond, a downstream location in the unnamed tributary to Cache Creek, and upstream in the unnamed tributary that is considered representative of background surface water quality. In accordance with the SWPPP for the site, surface water that originates outside ESL is routed around the landfill footprint. Stormwater that falls within the landfill footprint is routed through rock culverts and downdrains to Molesworth Creek. Stormwater that infiltrates into the landfill is captured and routed to the leachate collection pond for proper disposal. Monitoring for the SWPPP is conducted at discharge locations (DLs) where surface water leaves the site.

2.3 Geology and Hydrogeology

SHN's review of the available reports and maps, coupled with recent site investigation observations, provides the basis for the following discussions on site geology and hydrogeology. Published geologic mapping and reports in the immediate vicinity of the project site compiled by SHN and others (Cooper, 1987; Emcon, 1971; SHN, 2011; SHN, 2016) indicates that the local basement rock consists of unnamed upper Cretaceous age sandstone. North of the project site, Franciscan Complex bedrock composed of pervasively sheared and fractured metamorphosed sandstone, chert, and basalt is present. Bedrock encountered during drilling activities consists of predominantly fractured and weathered sandstone, with interbedded shale. These materials are consistent with the type of material found in the Great Valley sequence.

Late Tertiary age Cache formation is overlying the basement rocks and is visible in localized outcrops at the site. The Cache formation consists of freshwater sediments comprised of coarse gravel, sand, silt, and clay, and basal strata of poorly sorted gravel with sand and silt, deposited in an alluvial environment. The slope of the contact between the Cache formation and the basement rock is toward the south at a moderately steep angle based on drill data. A southward dipping contact is consistent with the topography and a south-southwest groundwater gradient determined for the site. Geologic cross-sections for the ESL using monitoring well and borehole drilling logs are provided in Appendix 1.

In the ESL site area, the primary aquifer unit is the permeable Cache formation and an upper fracture zone of the basement rock. Surface water infiltrates the weakly cemented and poorly consolidated sediments of the relatively permeable Cache formation, and migrates downward until encountering the less permeable basement rock. Due to weathering and fracturing in the upper sections of the basement rock, a small percentage of the groundwater infiltrates into fractures in the bedrock. However, the contact between the Cache formation and underlying basement rock appears to act largely as a perching layer, which results in flow parallel to the contact beneath site.

The permeability of the Cache formation is estimated to range between 1×10^{-4} centimeters per second (cm/sec) and 1×10^{-5} cm/sec (SHN, 1994). The permeability of the underlying basement rock has not been determined by laboratory testing, but is expected to be much less permeable due to its greater age, and

2.4 Release to Groundwater

Groundwater at the ESL has been impacted by volatile organic compounds (VOCs) based on analytical results from monitoring wells primarily located along the western and southern boundary of the waste unit (MW-5, MW-10, MW-13, MW-14, MW-15, MW-16, and MW-17). A review of historical groundwater VOC data collected at the site indicates the presence of VOCs consisting of:

Chlorinated Solvents: 1,1-dichloroethane (1,1-DCA), cis 1,2-dichloroethene (cis 1,2-DCE), chloroethane, chloromethane, vinyl chloride (VC), trichloroethene (TCE), dichlorofluoromethane, and trichlorofluoromethane

Petroleum Constituents: benzene, toluene, methyl tertiary-butyl ether (MTBE), tertiary-butyl alcohol (TBA), and diisopropyl ether (DIPE)

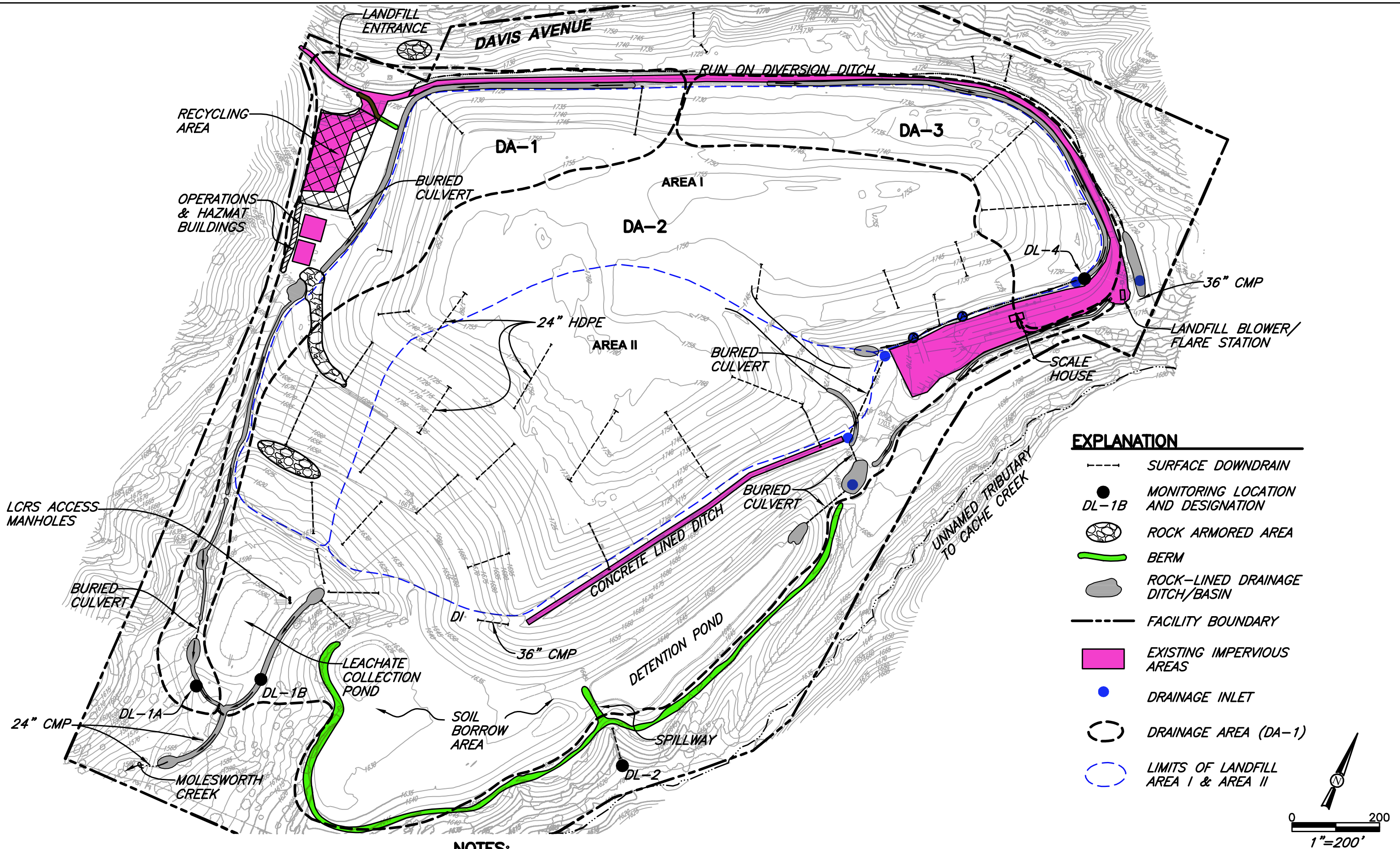
Most VOC concentrations recorded for groundwater samples collected from site wells are relatively stable, follow decreasing trends, or fall below standard laboratory detection limits. However, cis 1,2-DCE and benzene concentrations recorded for monitoring wells MW-5 and MW-16 are interpreted to be following increasing trends. Due to the VOC release to groundwater, the RWQCB issued Cleanup and Abatement Order (CAO) No. R5-2015-0713 for the ESL on July 30, 2015. Through implementation of the CAO program, the vertical and horizontal delineation of the VOC plume has been completed. Corrective action to address the VOC release to groundwater has yet to be implemented at ESL. Isoconcentration maps completed for delineation of VOCs in groundwater at ESL are presented in Appendix 3.

2.5 Surface Water

The ESL facility is situated within a pre-existing canyon in the headwaters of Molesworth Creek. The drainage area associated with the landfill is approximately 58 acres, including the waste cell area, the borrow area, access roads, and storage areas (Figure 2). Specific drainage areas for the facility have been mapped into separate zones based on surface water flow, which include the proposed expansion areas abutting the north edge of the currently permitted refuse area and the disturbed borrow area. A majority of the drainage from the site discharges to Molesworth Creek to the west. The northeast area of the facility drains to the unnamed tributary to Cache Creek to the south. Both creeks are ephemeral streams that primarily carry surface water in the winter and early spring months. Molesworth Creek drains into Clear Lake, near the southwestern limit of the City of Clearlake and the unnamed tributary to Cache Creek eventually reaches the Sacramento delta.

The existing drainage system consists of high density polyethylene (HDPE) and corrugated metal pipes (CMP) that route stormwater to lined and unlined ditches at the perimeter of the waste cell (Figure 2). The ESL is an active facility with alterations and improvements to the drainage system made as necessary. Large areas of the site consist of bare earth and repair of erosion is regularly required. These repairs are generally accomplished by earth moving, hydroseeding of eroded areas, and the addition of rock slope protection as needed. Containment berms direct runoff from the active face to the leachate collection and storage pond is effective in keeping stormwater that comes in contact with the active face from draining offsite. Collected

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417034-200-SITE-DRNG

Site Drainage

SHN 417034.200

Figure 2

leachate is designed to gravity drain into the 600,000-gallon leachate collection pond before being discharged into the local sanitary sewer system. The primary concern for the facility runoff continues to be elevated levels of suspended sediment.

3.0 Waste Disposal Cell Siting Criteria

Pursuant to the regulations specified in Section 20260 Title 27, siting criteria for the new waste cell to ensure that no impairment of beneficial uses of surface water or of groundwater occurs are outlined in the following sections.

3.1 Underlying Soils

As described in the geology and hydrogeology section of this report, the ESL area is comprised of late Tertiary age Cache formation overlying Cretaceous age basement rocks. The Cache formation consists of coarse gravel, sand, silt, and clay, and basal strata of poorly sorted gravel with sand and silt. The underlying bedrock of the Great Valley sequence is comprised predominantly of fractured and weathered sandstone, with interbedded shale. The permeability of the Cache formation is estimated to range between 1×10^{-4} cm/sec and 1×10^{-5} cm/sec and the underlying basement rock is expected to be much less due to its greater age and greater degree of consolidation.

3.2 Groundwater Depth

Depth-to-groundwater in potential expansion areas was assessed using existing site wells and newly installed wells completed as part of the recent field investigation. In the area north of the currently permitted refuse area, depth-to-water was observed to range from 20 to 25 feet BGS in well MW-33, and 15 feet BGS in well MW-3. Depth-to-groundwater in the borrow area was obtained from peripheral wells (MW-31, MW-32, MW-34 and MW-35) and a static water level reading in soil boring SB-103. Groundwater was observed to be present at a depth range of 45 to 55 feet BGS in this area. South of the borrow area, monitoring well MW-32 exhibits a depth-to-groundwater of 50 to 55 feet BGS.

As previously stated, seasonal fluctuations in depth-to-groundwater are observed in site wells and can reach as much as 15 feet. Not all wells exhibit this much fluctuation, with most wells ranging below 10 feet in seasonal variations. Water level measurements collected as part of this field investigation were conducted in January and March 2018, during which time, the groundwater elevations are anticipated to be at or near their seasonal highest.

3.3 Background Water Quality

Background water quality has been established at ESL through implementation of MRP No. R5-2006-0108, issued by the RWQCB. The MRP contains groundwater and surface water sampling locations that are considered background and are sampled during site monitoring events. Constituent concentration limits are established from results of background sample locations and used for comparison purposes to evaluate results from downgradient and downstream sample locations.

3.4 Groundwater Use

Groundwater use in the area of the ESL is not known to occur. There is agriculture land use within 1/2-mile of the facility (upgradient) and residences in proximity to ESL are on domestic potable water provided by the city.

3.5 Precipitation and Flooding

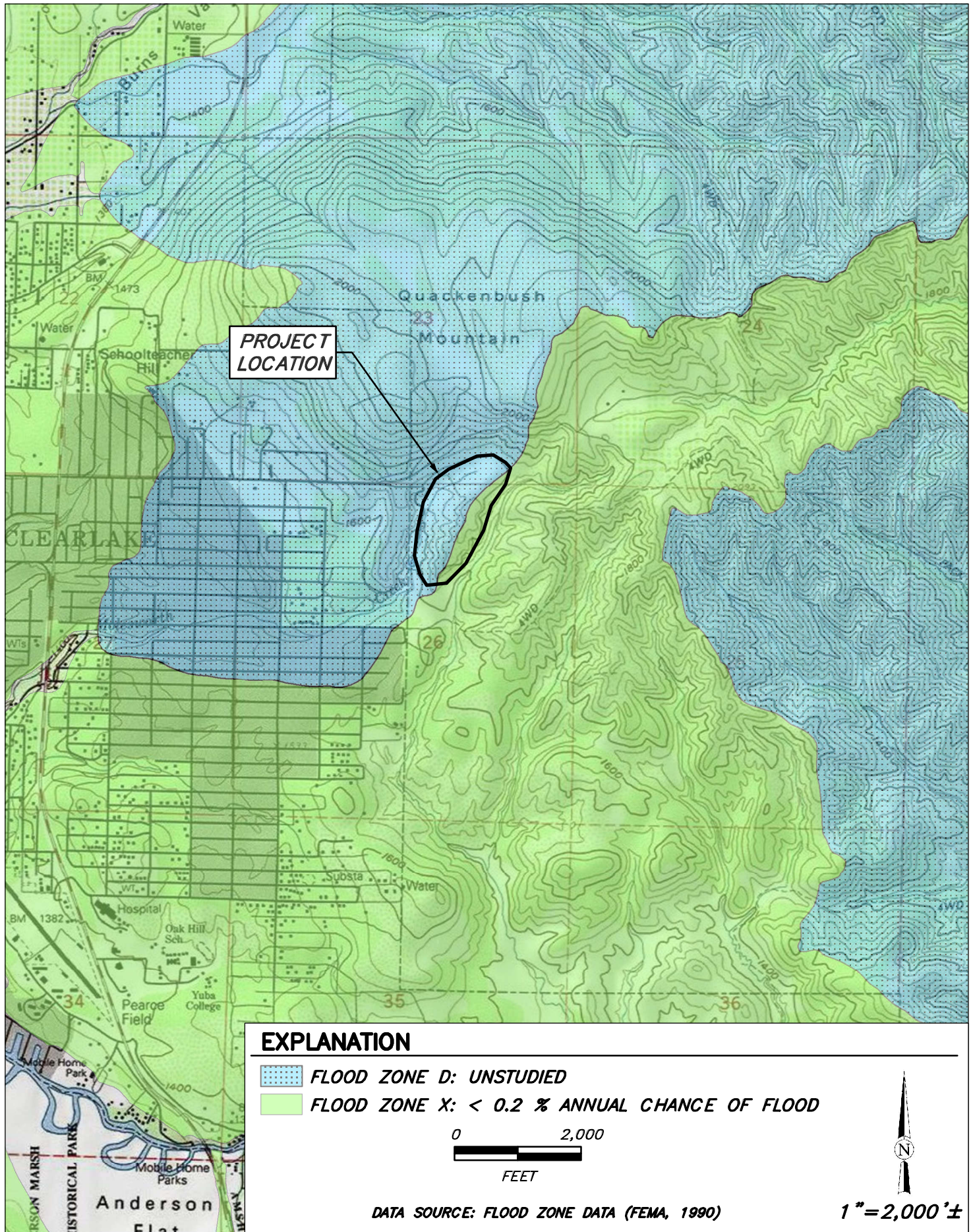
The annual average rainfall for the city of Clearlake is 31.5 inches (US Climate Data, 2018) and the ESL is not located in the 500-year flood zone (Figure 3). Evaluation of a 100-year 24-hour storm event for ESL is estimated as 6.98 inches of rain, with a 90% confidence interval (NOAA, 2018). The total quantity of stormwater generated by this storm over the approximately 58-acre drainage area is estimated at 1,472,000 cubic feet (ft³) of water during a 24-hour period. The existing drainage system shown in Figure 2 is not adequate to handle anticipated stormwater volume or peak flow from a 100-year, 24-hour storm event, namely the 24-inch culvert to Molesworth Creek. Erosion and damage to drainage features may occur resulting from localized flooding at slope benches and sediment would be deposited in drainage pipes and stormwater collection ditches.

Due to the site predominantly having sloped surfaces that can limit infiltration, increased flow during storm events may have unintended impacts to the two tributaries at ESL. Current SWPPP monitoring at discharge locations from the site show elevated levels of iron and aluminum, which are consistent with naturally occurring metals in areas of volcanic deposits. Use of the sedimentation basin located at the site borrow area is essential for controlling suspended sediment in stormwater runoff prior to discharging from the site. Removal of this site feature will result in additional flow volume to Molesworth Creek with increased levels of suspended sediment leaving ESL. The affect can also increase erosion along discharge paths to Molesworth Creek and the unnamed tributary to Cache creek.

4.0 Conclusions

As described in this report, the results of our assessment indicate that the areas proposed for landfill expansion can meet the Title 27 siting criteria and are determined to be suitable for future development as Class III waste disposal areas. Engineering controls implemented during design and construction should be able to ensure that protection of water quality is maintained. Surface drainage design should take into account features that can accommodate the 100-year 24-hour event, in accordance with Title 27

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SCS Engineers

Hydrogeologic and Hydrologic Assessment—Proposed Eastlake Sanitary Landfill Expansion

March 28, 2018

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Respectfully submitted,

SHN Engineers & Geologists



Erik J. Nielsen, PG, CHG, QSP
Project Hydrogeologist

EJN:lms

- Appendices:
1. Geologic Cross-Sections
 2. Groundwater Contour Maps
 3. Isoconcentration Maps

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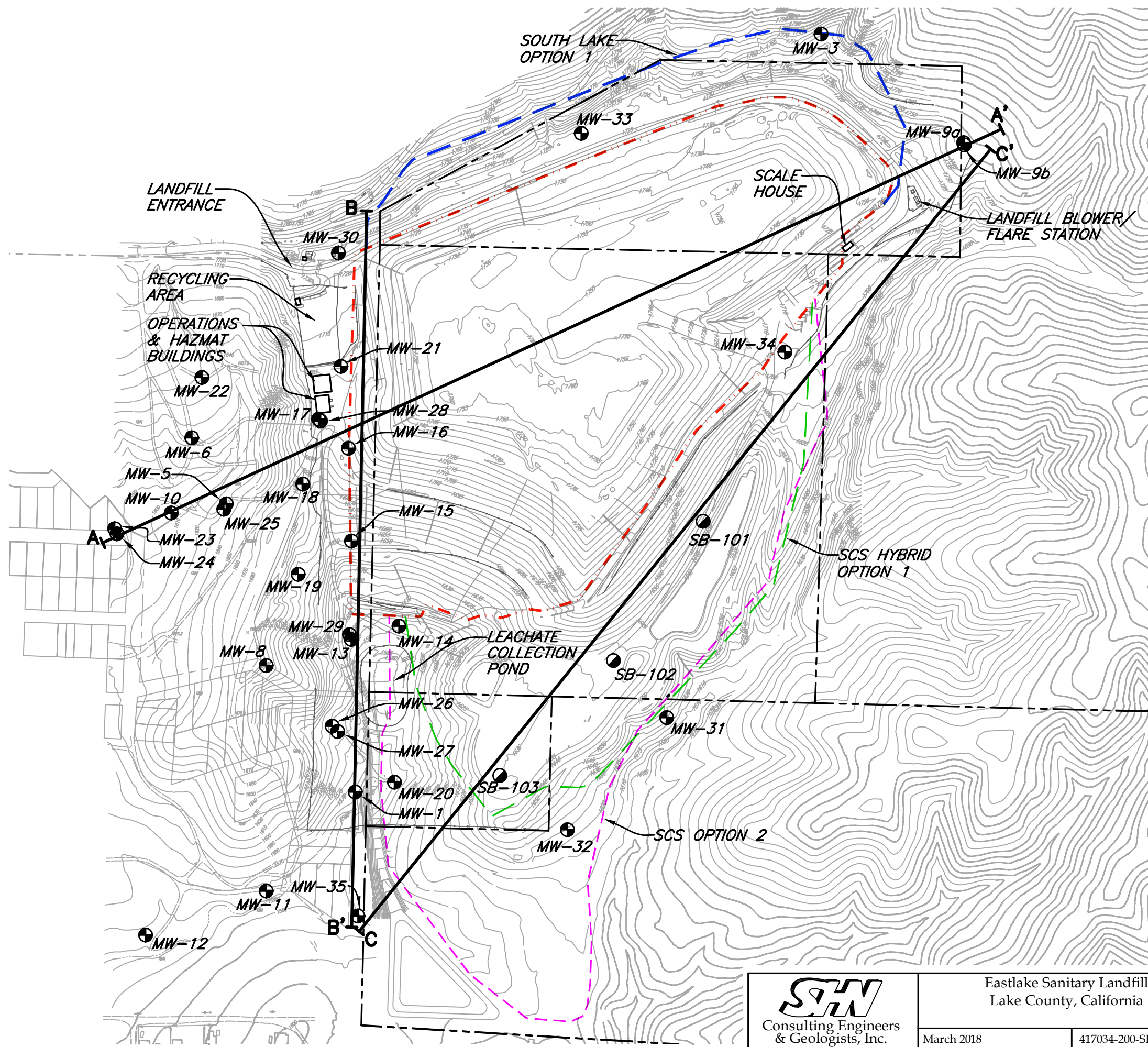
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Geologic Cross-Sections 1

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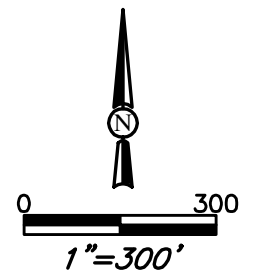


NOTE:

1. BASE MAP A COMBINATION OF PARCEL LINES FROM LAKE COUNTY, AERIAL SURVEY FROM SCS ENGINEERS, "SITE PLAN," DATED 09-26-17, AND SURVEY DONE BY SHN ENGINEERS, 2017

EXPLANATION

- PARCEL LINE
- MW-31 MONITORING WELL LOCATION AND DESIGNATION
- SB-102 GEOTECHNICAL BORING LOCATION AND DESIGNATION
- - - - APPROXIMATE PERMITTED REFUSE LIMIT
- - - - SCS HYBRID OPTION 1 (EXTENT OF FILL)
- - - - SOUTH LAKE OPTION 1 (EXTENT OF FILL)
- - - - SCS OPTION 2 (EXTENT OF FILL)
- 1700- EXISTING TOPOGRAPHIC CONTOUR IN FEET
- A A' GEOLOGIC CROSS SECTION LOCATION



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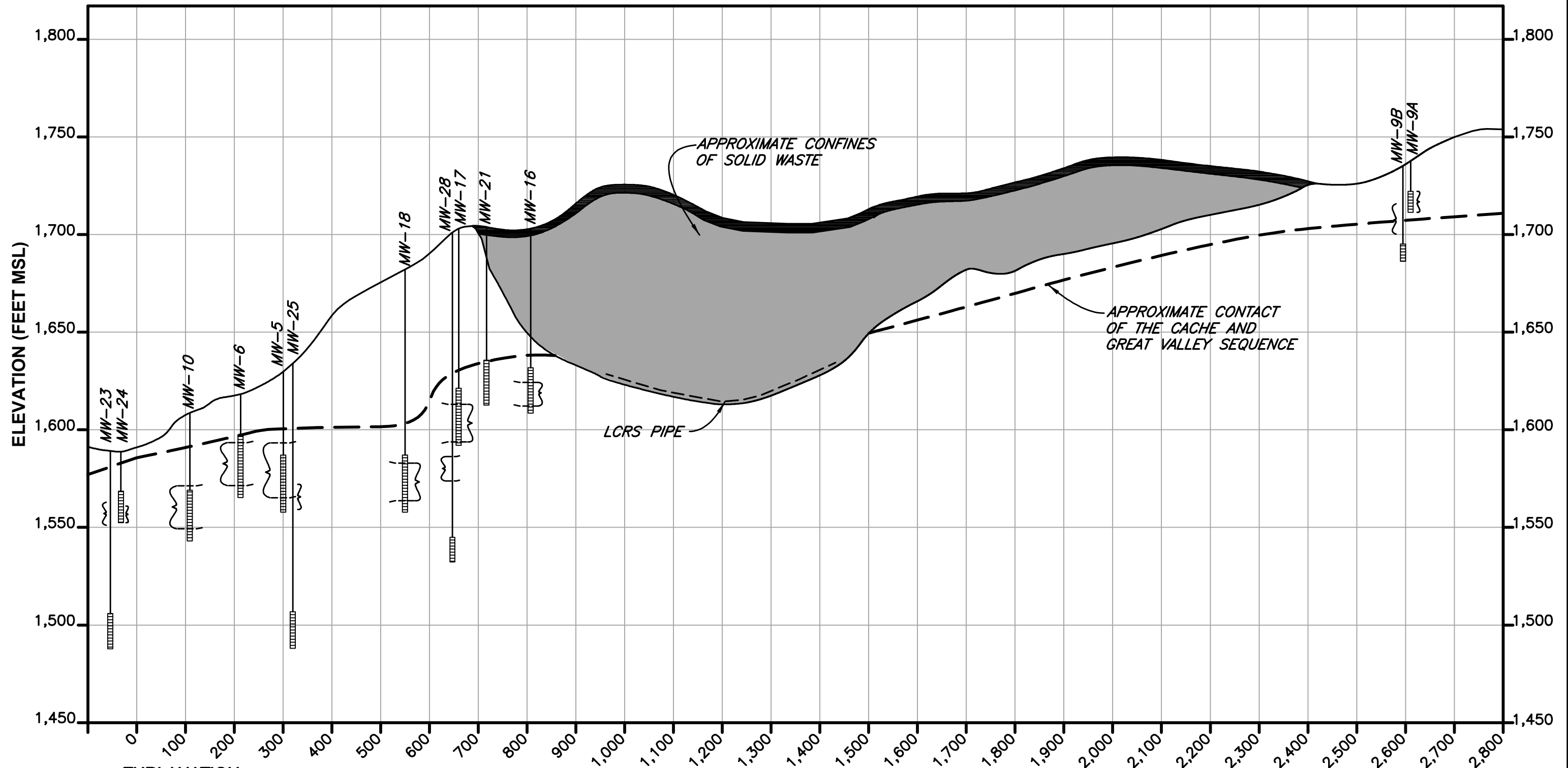
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Site Plan with
Cross Section Locations
SHN 417034.200

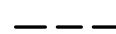
Figure A-1

A (SOUTHWEST)

(NORTHEAST) A'



EXPLANATION

-  APPROXIMATE DEPTH OF GROUNDWATER RANGE
-  LCRS - LEACHATE COLLECTION AND RECOVERY SYSTEM

SECTION A-A'

SCALE: H 1"=200'
V 1"=50'

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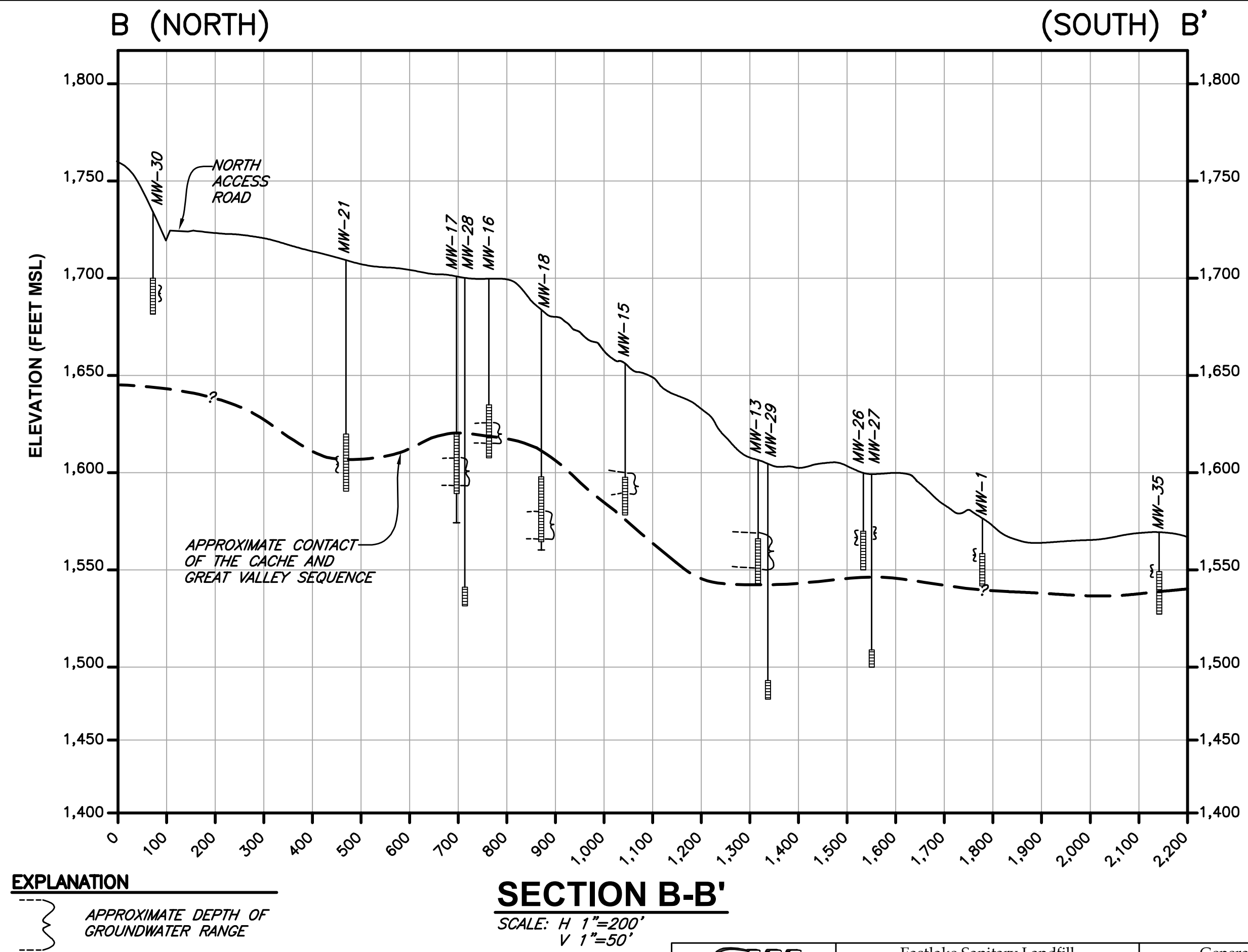
Generalized Geological
Cross Section A-A'
SHN 417034.200

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Figure A-2

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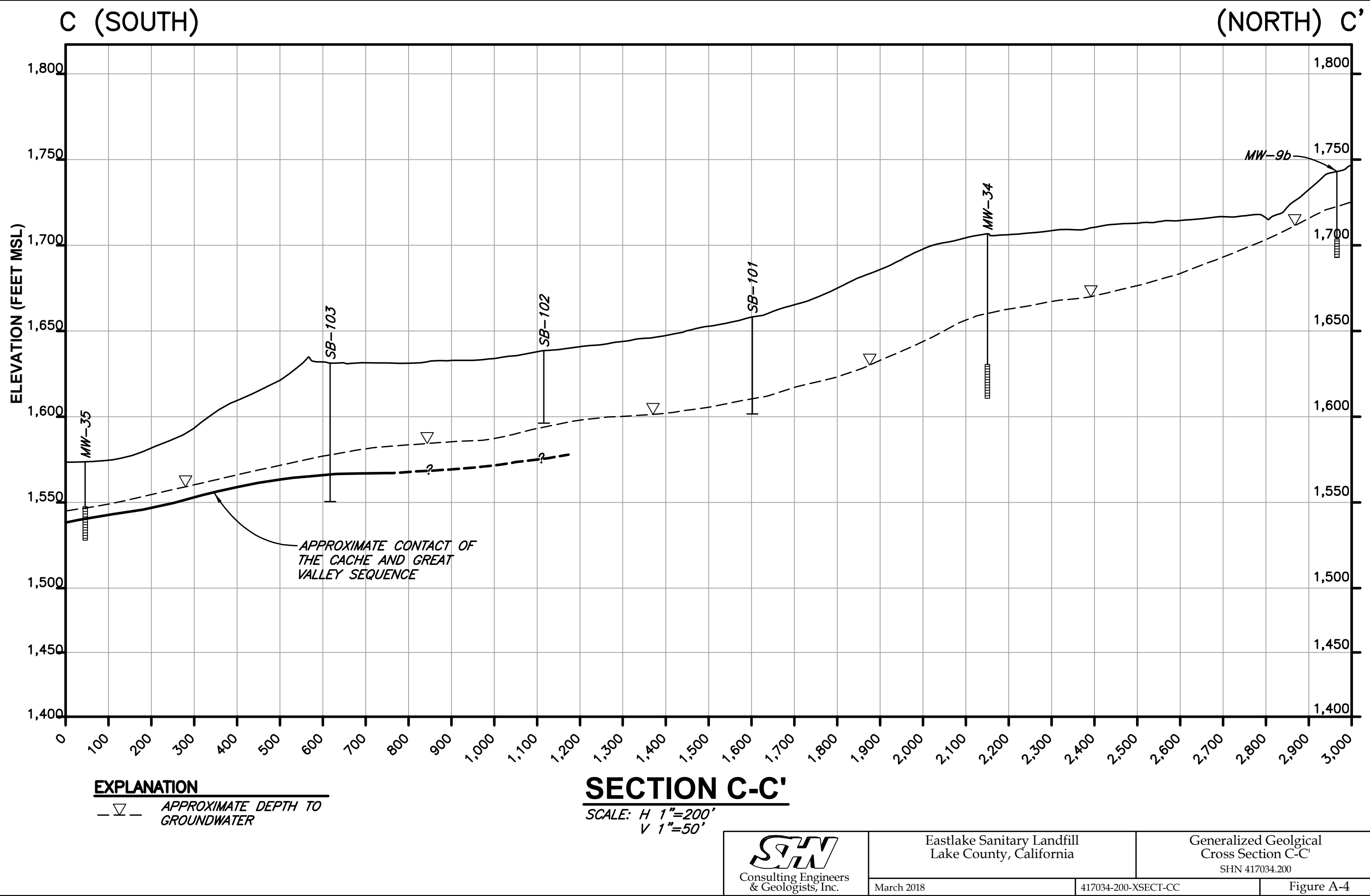


SECTION B-B'

SCALE: H 1"=200'
V 1"=50'

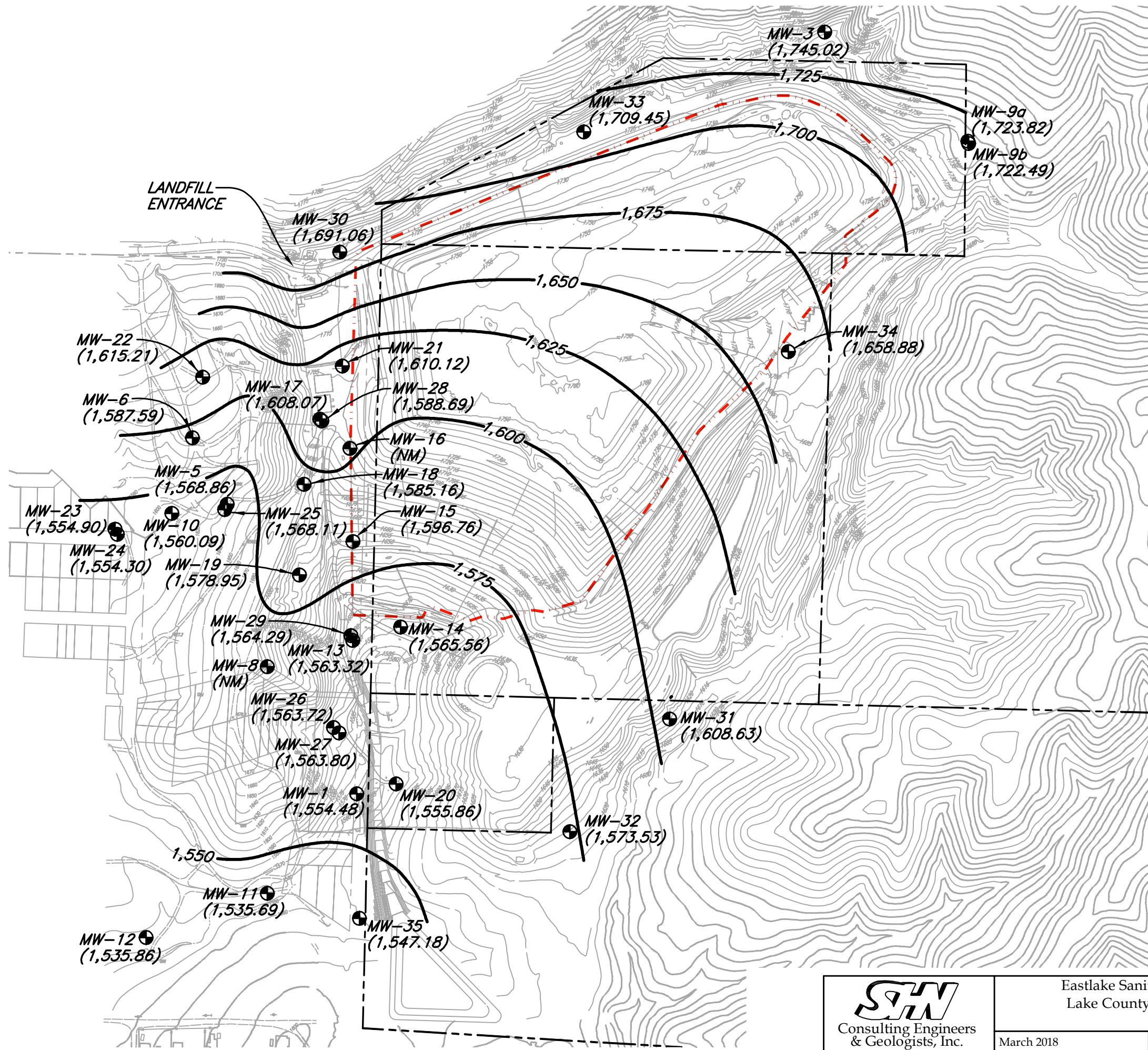
 Consulting Engineers & Geologists, Inc.	Eastlake Sanitary Landfill Lake County, California		Generalized Geological Cross Section B-B' SHN 417034.200	
	March 2018	417034-200-XSECT-BB	Figure A-3	

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Groundwater Contour Maps 2

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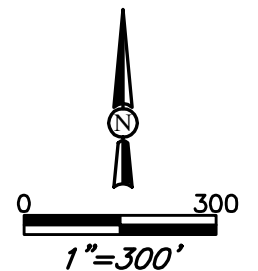


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2. DATA FROM WELL MW-25 AND MW-28 NOT USED TO GENERATE GROUNDWATER CONTOURS.

EXPLANATION

- MW-31 MONITORING WELL LOCATION AND DESIGNATION
- (1,562.28) GROUNDWATER ELEVATION (FEET NAVD88)
- 1,725— GROUNDWATER CONTOUR (FEET NAVD88)
- (NM) NOT MEASURED
- APPROXIMATE PERMITTED REFUSE LIMIT
- 1700— EXISTING TOPOGRAPHIC CONTOUR IN FEET



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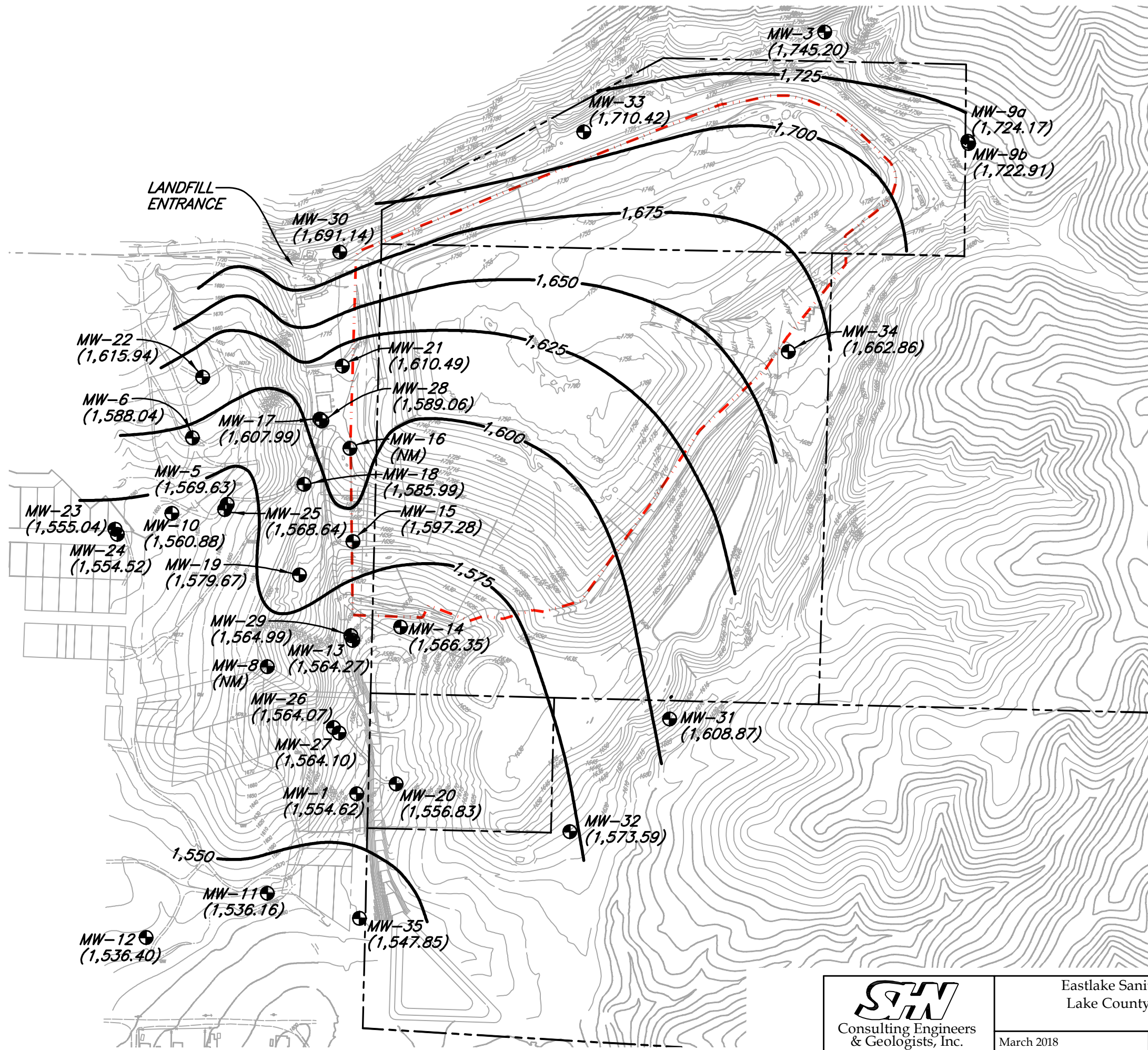
Approximate Groundwater Contours
January 23, 2018
SHN 417034.200

March 2018

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Figure B-1

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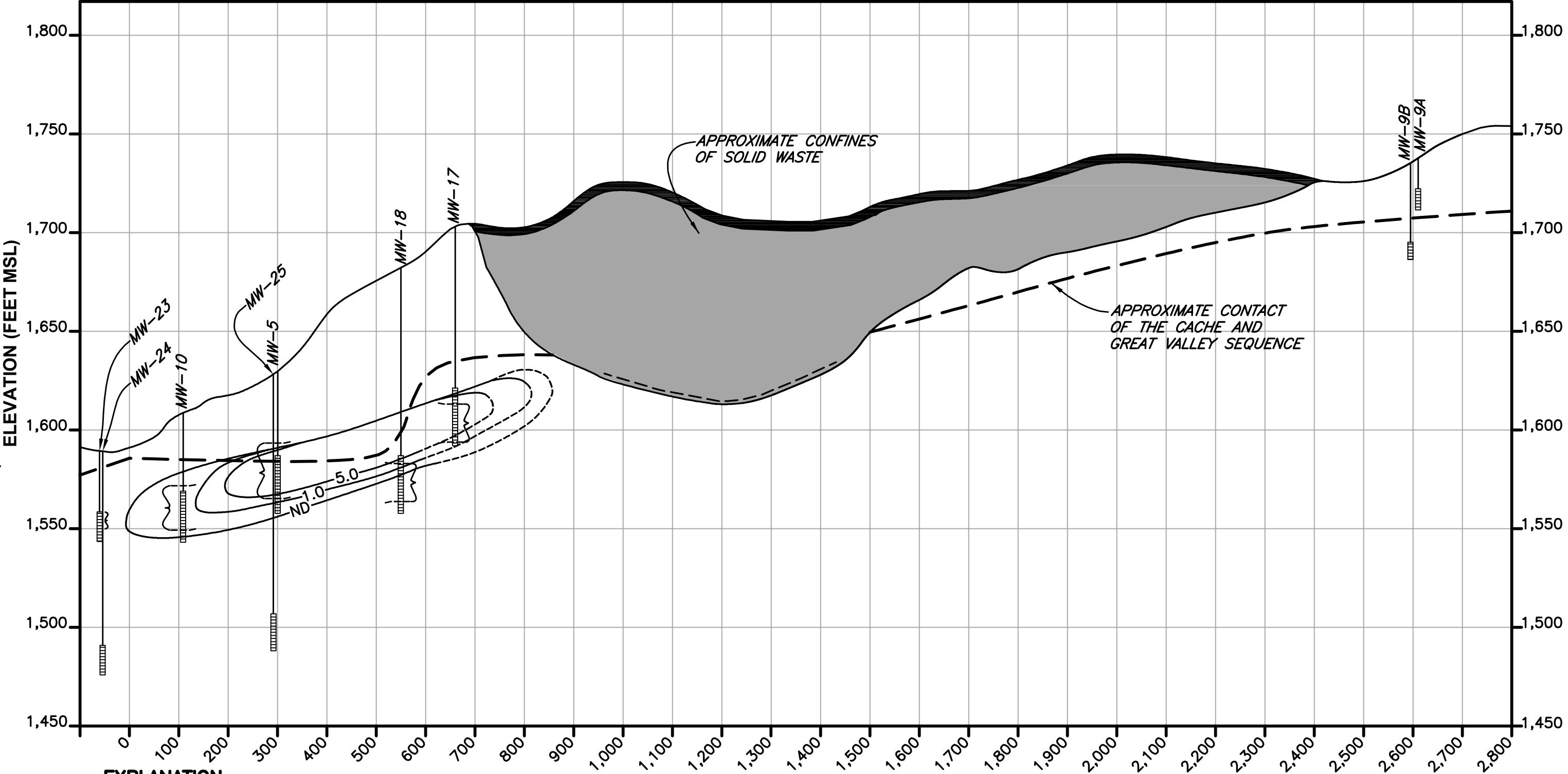
Approximate Groundwater Contours
March 8, 2018
SHN 417034.200

Figure B-2

Isoconcentration Maps **3**

A (SOUTHWEST)

(NORTHEAST) A'



EXPLANATION

-  APPROXIMATE DEPTH OF GROUNDWATER RANGE
-  TOTAL VOC CONCENTRATION (ug/L) MAY 2016
-  DASHED WHERE APPROXIMATE

SECTION A-A'

SCALE: H 1"=200'
V 1"=50'



Eastlake Sanitary Landfill
Lake County, California

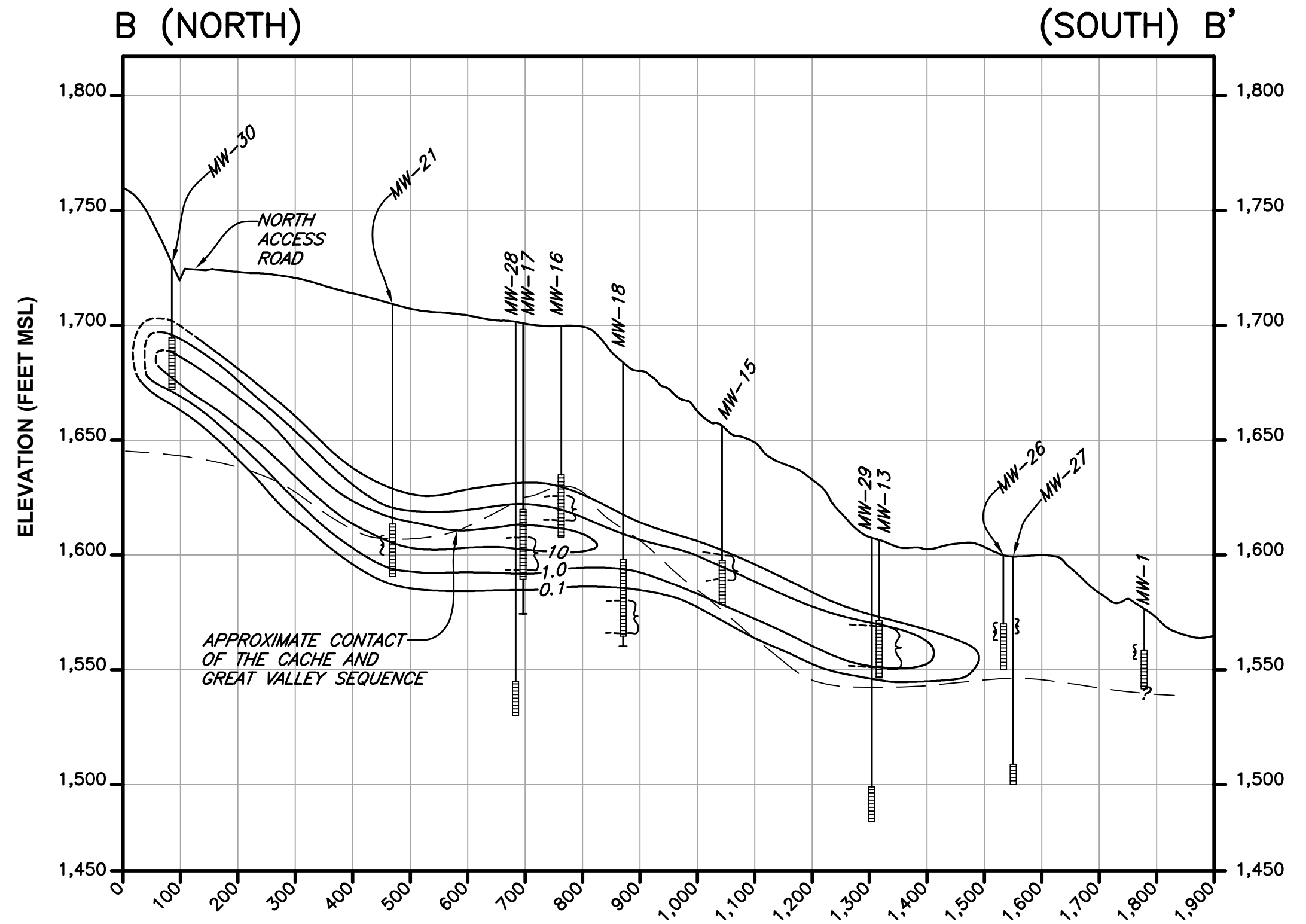
VOC Concetrations
Cross Section A-A'
SHN 417034.200

November 2016

417034-200-XSECT-AA-VOC-CONC

Figure C-1

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EXPLANATION

- 1.0— TOTAL VOC CONCENTRATION (ug/L) 2017
DASHED WHERE APPROXIMATE
- 1.0—

SECTION B-B'

SCALE: H 1"=200'
V 1"=50'

SH
Consulting Engineers
& Geologists, Inc.

Eastlake Sanitary Landfill
Lake County, California

VOC Concentrations
Cross Section B-B'
SHN 417034.200

September 2017

417034-200-XSECT-BB-VOC-CONC

Figure C-2