

THIRD FIVE-YEAR REVIEW REPORT

Bainbridge Island Landfill

Prepared for: City of Bainbridge Island

Project No. 120097-003 • May 1, 2018



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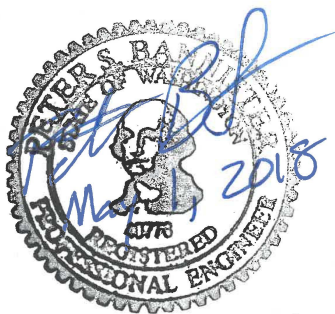


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Aspect Consulting, LLC



Meilani Lanier-Kamaha'o

Peter Bannister, PE
Associate Engineer
pbannister@aspectconsulting.com

Meilani Lanier-Kamaha'o, LG
Project Geologist
mlkamahao@aspectconsulting.com

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Acronyms

Aspect	Aspect Consulting, LLC
CAP	Cleanup Action Plan
COCs	Contaminants of Concern
CUL	Cleanup level
Ecology	Washington Department of Ecology
EPA	Environmental Protection Agency
ft/ft	feet per foot
KCHD	Kitsap County Health District
mg/L	milligrams per liter
µg/L	micrograms per liter
MTCA	Model Toxics Control Act
NAVD-88	North American Vertical Datum
NFA	No Further Action
SAP	Sampling Analysis Plan
VOC	volatile organic compound
WAC	Washington Administrative Code
1,1-DCE	1,1-dichloroethene

Executive Summary

The purpose of the five-year review of the Bainbridge Island Landfill Site (Site)--located on a parcel in the middle west portion of Bainbridge Island, west of Eagle Harbor in Kitsap County, Washington--is to determine if the final removal action in 2001 has been effective in protecting human health and the environment as defined in the Cleanup Action Plan (CAP). The final removal action involved the excavation of solid waste from the former Bainbridge Island Landfill (BIL) and disposal of that waste at a permitted solid waste facility. This five-year review report is the third five-year review report since the completion of the remedial action, and documents compliance monitoring results from 2012 through 2017.

Since the removal action was completed in 2001, concentrations of most contaminants of concern have decreased to less than Site-specific cleanup levels (CULs). Long-term compliance monitoring has demonstrated natural attenuation of VOCs in groundwater. Concentrations of vinyl chloride were detected above CULs in three downgradient monitoring wells; however, since December 2016 concentrations were non-detect and below CULs. Manganese increased at two downgradient groundwater monitoring locations during the five-year monitoring period. Since 2014, reporting limits for dissolved copper concentrations were above the Site-specific CUL for surface water, and an alternative laboratory method is warranted for future sampling efforts. Groundwater results from the Stetson Acres supply well met State and Federal drinking water standards for all events during the monitoring period.

Results of the past 16 years of monitoring indicate that the final removal action will be fully protective of human health and the environment within a reasonable restoration timeframe. The CAP indicated that 30 years of monitoring may be required to achieve cleanup objectives.

We recommend that compliance groundwater and surface water monitoring continue until contaminant levels are below CULs, and that sampling resources be devoted to those constituents listed in the Sampling and Analysis Plan (SAP) for confirmation monitoring (CH2M Hill, 2001). There are discrepancies between the list of constituents with cleanup levels in the CAP, and the list of those constituents to be sampled in the SAP. We propose changes to the future sampling scope to improve consistency and establish Site cleanup standards.

Finally, as per Ecology's request (Ching-Pi Wang, pers. comm.), we recommend that the next five-year review cycle and reporting align with a 20-year period from the 2001 removal action. To meet this schedule, the next review cycle would be based on a shortened monitoring period, between January 2018 and June 2021, and that report would be submitted at the end of 2021. We recommend the next five-year review evaluate possible causes for increasing manganese concentrations to determine if the cleanup action will be effective in mitigating the elevated manganese.

1 Introduction

The purpose of this third five-year review is to document the post-cleanup conditions and monitoring data at the Bainbridge Island Landfill Site (Site) to ensure that human health and the environment are being protected following the 2001 removal action. The Site is located east of Gazzam Lake Nature Preserve in the City of Bainbridge Island, Kitsap County, Washington, as shown on Figures 1-1 and 1-2 at various scales. Figure 1-3 shows the extents of former waste areas at the Site, prior to the 2001 removal action (BJC Group, 2002), relative to the landfill Property boundary. Figure 1-4 shows the extent of the final retained materials and soil cover following the 2001 removal action. The retained materials are described below in Section 2.3.

Cleanup at this Site is being implemented under the Model Toxics Control Act (MTCA) regulations, Chapter 173-340 Washington Administrative Code (WAC). Cleanup activities at the Site were completed under a Consent Decree between Kitsap County (County) and Washington State Department of Ecology (Ecology; Ecology, 2001a), and in accordance with the Cleanup Action Plan (CAP; Ecology, 2001b). The City of Bainbridge Island (City) acquired the Property from the County in 2002, after the removal action.

WAC 173-340-420 (2) requires that Ecology conduct a periodic review of this Site every five years because the cleanup action was approved by Ecology under the Consent Decree; institutional controls (access restrictions and restrictive covenants) are required as part of the cleanup. The first and second periodic review reports were provided to Ecology in 2006 and 2011, respectively (CH2M Hill, 2006; CH2M Hill, 2011). Aspect Consulting, LLC (Aspect) prepared this third periodic review report--which focuses on compliance monitoring for the period from January 2012 through December 2017--on behalf of the City of Bainbridge Island. The locations of the on-Property groundwater monitoring wells and surface water compliance monitoring locations are shown on Figures 1-4. The one off-Property groundwater observation well (Stetson Acres; BOW37) is shown on Figure 1-5.

Kitsap County Health District (KCHD) is the local regulatory agency that oversees the operation, closure, and post closure of solid waste landfills in the County. A copy of the five-year review report will be submitted to both Ecology and KCHD for review. A copy of the five-year review report is provided to the County, at their request, based on their past ownership of the landfill. Ecology will publish a notice of this periodic review report for this Site in the Site Register and provide an opportunity for public comment.

This third periodic review report is organized to provide a summary of Site conditions and monitoring results (Section 2), periodic review of the effectiveness of the Site remedy (Section 3), and conclusions and recommendations (Section 4).

2 Summary of Site Conditions

This section provides a summary of the Bainbridge Island Landfill Site conditions. Additional detail is presented with the CAP (Ecology, 2001b) and the First and Second Five-Year Review Reports (CH2MHill, 2006; 2011).

2.1 Physical Setting

The Site is located on a parcel in the middle west portion of Bainbridge Island, west of Eagle Harbor on Bainbridge Island, Washington (see Figure 1-1). The island has a marine climate including warm, dry summers and cool, wet winters. The average total annual precipitation is approximately 54 inches, of which 85 percent falls between October and April.

Topography varies significantly in the vicinity of the Site (see Figure 1-2). A steep, narrow, east-sloping ravine was reshaped and largely filled in by landfilling activities between 1947 and 1975 (CH2MHill, 2001). The main landfill was located at an elevation of approximately 200 to 270 feet North American Vertical Datum (NAVD-88), as shown in Figure 1-3. An unnamed stream flows across the Site from west to east. The north, southeast, and southwest portions of the Property are covered with second-growth forest and remain relatively undisturbed.

2.2 Hydrogeology

Three aquifers were delineated during the RI investigation (CH2M HILL, 2000a), the perched aquifer, an upper aquifer, and a lower aquifer. Figure 1-6 shows the transect of one geologic cross section (B-B') from the RI investigation (CH2MHill, 2000a), and Figure 1-7 presents the geologic cross section which depicts the aquifers, water table, and corresponding geologic descriptions. The upper aquifer is also referred to as the “Semi-Perched” aquifer, while the lower aquifer is also referred to as the “Sea Level Aquifer” (USGS, 2005; Aspect, 2015).

The perched aquifer consists of permeable sand and gravel and is underlain by lower permeability materials. It is located primarily northwest of the Site and is considered hydraulically isolated from the upper aquifer (CH2M HILL, 2000a). The upper aquifer consists of saturated glacial advance outwash sand and is locally unconfined. A silt and clay aquitard separates the upper and lower aquifers. The lower aquifer consists of a saturated sand unit but is much thinner than the upper aquifer and is confined. The lower aquifer has been described as virtually hydraulically isolated from the upper aquifer (CH2MHill, 2000a) by the 150-foot-thick aquitard. The Sampling and Analysis Plan (SAP) requires only sampling the upper aquifer because the perched aquifer and lower aquifer are hydraulically isolated (CH2M HILL, 2001).

Table 1-1 lists the depths to groundwater for the four on-Property groundwater monitoring wells (including MW-12, MW-13, MW-14, and MW-15), which were measured semiannually from December 2013 through December 2017. Depending on location, the depth to groundwater at the Site was between approximately 120 to 150 feet

below ground surface (bgs), which represents a relatively thick unsaturated zone between ground surface and the water table. The difference between high and low groundwater levels at all monitoring well locations was approximately 4 feet. Table 1-1 also lists the corresponding groundwater elevations for the four monitoring wells, which ranged from approximately 127 to 138 feet NAVD-88. Groundwater elevation contour maps for the upper aquifer are presented in Figures 1-8 through 1-16. Groundwater flow is from the south-southwest to north-northeast, and consistent with flow direction observed during the RI, except for June 2016 and June 2017 where groundwater elevations suggest a slightly northwest flow direction.

Groundwater is used as a drinking water source by residents living in the vicinity of the Site, as illustrated by Figures 1-6 and 1-7 showing selected domestic wells. One off-Property water supply well, the Stetson Acres well (BOW-37), and four on-Property groundwater monitoring wells are Site compliance points.

2.3 Site History

This section provides a historical summary of the Bainbridge Island Landfill, before and after it was identified as a Site by Ecology, based on available records on Ecology's website and previous Site reports, where indicated.

- **In 1942**, Kitsap County acquired the property (Property) that was later to become the Bainbridge Island Landfill. The Property was acquired as part of a tax foreclosure process.
- **In approximately 1946**, the County opened the Bainbridge Island Landfill facility (Facility) at the Property to alleviate indiscriminate dumping on the island. The Facility was initially operated and maintained by the County, and refuse was deposited in a ravine that bisected the Property. The Facility served the residents of the island, military installations, and the operator of the local refuse collection service.
- **Between 1951 and 1975**, the Facility was operated by the local refuse collection service under a lease from the County. Approximately 7 acres of the Facility were used for disposing various types in different areas (see Figure 1-3). The main landfill and west end area accepted primarily domestic refuse and a small amount of commercial waste. As was the practice at the time, some refuse was burned at the Facility until 1968. The five septage pits received liquid-solid sludge from domestic septic system haulers. The largest of the five pits was the south septage pit, located southwest of the main landfill. Trench 3, located just north of the south septage pit, was an excavation in native soil where liquid wood-preserving waste from the Wyckoff Company was disposed until 1973.
- **In 1974**, a neighboring resident brought a lawsuit against the County which expedited closure of the Bainbridge Island Landfill.
- **Between 1975 and 1978**, Ecology sampled the leachate and surface water to investigate potential contamination.

- **In 1977**, the Bainbridge Island Landfill closure was completed, and a refuse transfer station was opened on the property by Bainbridge Disposal Company. The transfer station continues to operate today on a portion of the property transferred to BDI Vincent Road LLC, according to the County assessor's office.
- **In 1986**, the U.S. Environmental Protection Agency (EPA) conducted a site investigation in which surface and subsurface soil, surface water, and domestic water wells were sampled (Ecology & Environment, 1986). The investigation identified organic contaminants in leachate and surface water, and organic and inorganic contaminants in Trench 3, septage pits, and the main landfill. No evidence of contamination was detected in domestic water wells.
- **Between 1988 and 1994**, the Bremerton-Kitsap County Health District sampled surface water, leachate, and septage pit sludge from the closed landfill, and collected samples from the domestic wells near the property. The samples from the surface water, leachate, and drinking water wells complied with state primary drinking water standards. Viral assays were negative for sludge samples. The metal content in sludge was similar to typical septage (Ecology, 2001a).
- **In 1990**, Ecology became the lead regulatory agency for Site management.
- **In 1992**, Ecology ranked the Site as a level 1 hazardous waste site under MTCA, based primarily on the disposal of listed wastes from the nearby Wyckoff wood treatment facility in Trench 3. On a scale of 1 to 5, level 1 sites represent the highest level of risk to human health and the environment.
- **Also in 1992**, Kitsap County performed an independent remedial action in Trench 3. Approximately 475 tons of contaminated sludge from Trench 3 was removed, stabilized, and disposed at a hazardous waste landfill. An additional 930 tons of contaminated soil were removed and disposed (Golder & Associates, 1993).
- **In 1996**, Kitsap County began the Remedial Investigation (RI) and Feasibility Study (FS) for the cleanup of the landfill under the enforcement order from Ecology. The data and interpretations of the RI are recorded in three documents: the RI report and the RI Supplements 1 & 2 (CH2M HILL, 2000a). The FS was completed in May 2000 (CH2M HILL, 2000b).

2.3.1 Removal Action

In 2001, Kitsap County implemented the Ecology-selected cleanup action for the Site, including waste reclamation with a soil cover, monitoring, institutional controls, and monitored natural attenuation. The septage pit wastes were excavated and disposed at a permitted facility without screening or sorting. The wastes in the main landfill and west end area were excavated and sorted by size. Approximately 18,100 tons of waste materials larger than 1.5 inches in diameter were disposed at a permitted facility (CH2MHill, 2006). The remaining fraction (less than 1.5 inches) of waste materials excavated from the main landfill and the west end area contained mostly soil, gravel, and

ash, with small fragments of metal, glass, and plastic. This material was retained on Site and capped (CH2MHill, 2006).

A 2-foot-minimum soil cap was placed on top of the retained material to prevent exposures (direct contact and ingestion), and to allow precipitation infiltration. Infiltration was expected to provide oxygen and other trace nutrients to enhance biodegradation. Erosion protection included re-vegetation of the soil cap, and placement of erosion mats and large gravel at the center of a constructed drainage channel. As certified in the Landfill Reclamation Report (BJC, 2002), the work was completed in accordance with the CAP.

2.3.2 Post-Removal Conditions

Stormwater drainage originating on the western portion of the Site was directed into a diversion pipe, which conveys water for discharge to the east of the Site (Figure 1-4).

In 2002, the Property ownership transferred from Kitsap County to the City. The official Quit Claim Deed, dated April 22, 2002, documents the property ownership transfer. Ecology was informed about all stages of the land transfer process (CH2M Hill, 2011).

On January 29, 2004, the slope above surface water monitoring location SWD failed, and approximately 1,500 cubic yards of the retained materials and soil cap slid up to 500 feet down the ravine (CH2M Hill, 2006). To address the slope failure, the City made temporary repairs in 2004, and completed repairs in 2007. In 2008, the slide area was further repaired by armoring the entire slope with large rock and installing a new drainage pipe to channel water from the landfill (CH2M Hill, 2011). The former slope failure (slide area) and drainage pipe are shown on Figure 1-4. No slope failure occurred during the 2012 to 2017 monitoring period.

In 2005, the Street and Stormwater Maintenance Materials Decant Facility (Decant Facility) was constructed on the Site. Spoils from roadway shoulders, street cleaning, ditches, and catch basins from maintenance activities have been brought to the Decant Facility for dewatering. The solid portion spoils are hauled to a permitted landfill for disposal. The surface water treatment system includes an oil-water separator, a sand filter, a bioswale, and a settling pond. The detention pond discharges to the drainage east of the Site (Figure 1-4). This batch treatment process has occurred on a quarterly basis (CH2M Hill, 2011).

2.4 Cleanup Levels

Table 1-2 summarizes the contaminants of concern (COCs) and cleanup levels (CULs) for groundwater and surface water presented in the CAP (Ecology, 2001a). The SAP included a modified list of COCs and CULs (CH2M Hill, 2001). Minor adjustments in CULs for vinyl chloride in groundwater and dissolved copper in surface water were proposed in the first and second periodic review reports (CH2M Hill, 2006; CH2M Hill, 2011) based on new state and federal laws for COCs. For the purposes of this report, both the original and proposed CULs are referenced.

Groundwater CULs were determined for protection of groundwater as drinking water, and discharge to surface water. The COCs with CULs for groundwater include: vinyl chloride, 1,1-dichloroethene (1,1-DCE), manganese (total and dissolved fractions), nitrate, sulfate, chloride, conductivity, and pH. Groundwater samples have also historically been collected for laboratory analysis of carbonate alkalinity (including bicarbonate, carbonate, and hydroxide). CULs for groundwater COCs are listed in Table 1-2.

Surface water CULs were determined for protection of freshwater aquatic organisms. The COCs with CULs for surface water include: copper (dissolved fraction), iron (total and dissolved fractions), zinc (dissolved fraction), and lead (dissolved fraction). Surface water samples have also historically been collected for laboratory analysis of carbonate alkalinity, coliforms (total and fecal), and *E. coli*. CULs for surface water COCs are listed in Table 1-2.

2.5 Institutional Controls

Institutional controls include access restrictions and restrictive covenants to prevent exposure to retained materials on Property.

Vehicular access to the Property is limited by a gate at the entrance off Vincent Road. The boundary of the active transfer station is fenced, and signage is posted, to prevent trespass to other portions of the Property.

The restrictive covenants text is included in the Consent Decree (Ecology, 2001a), and elements of the restrictive covenants for the Site include:

- 1) Prohibition of the beneficial use or withdrawal of Site groundwater,
- 2) Prohibition on installing wells other than those required under the CAP, and
- 3) Prohibition on activities that would damage the integrity of the soil cover placed over the inert waste material.

The City conducts visual inspections of the Site, access restrictions, cover system, and monitoring network during sampling events (at a minimum). The City periodically mows the vegetated cover and removes brush as needed for safe access to sampling locations.

Kitsap County Public Health conducts annual inspections of the former Bainbridge Island Landfill, as summarized in the email provided as Appendix A.

2.5.1 Future Property Development

The City is evaluating possibilities for Property redevelopment as a composting facility and/or other possible uses. Aveterra Corporation is looking to build a composting facility near the existing transfer station which may include redevelopment of a portion of the Site. The City will coordinate with Ecology to ensure potential future Property development is consistent with restrictive covenants, and an engineering analysis and report will be developed and submitted to Ecology for approval.

2.6 Compliance Monitoring

This section includes discussions of monitoring locations, data quality review, and monitoring results.

2.6.1 Monitoring Locations

The groundwater monitoring network consists of four on-Property monitoring wells¹ (MW-12, MW-13, MW-14, and MW-15) and one off-Property domestic water well (the Stetson Acres well [BOW-37]). All groundwater monitoring locations are shown on Figure 1-5. Monitoring well MW-12 is upgradient of the contained materials and provides background concentrations for comparison with results from downgradient wells. In accordance with the CAP (Ecology, 2001a), the upper aquifer groundwater monitoring wells have been sampled semiannually, during dry season and wet season conditions (typically June and December), by City personnel.

Surface water has been monitored at two locations on the Site. The upstream station is near the western property boundary and the downstream location is on the eastern property boundary, downstream of the Decant Facility settling pond outlet structure (Figure 1-4). The sampling stations were not disturbed by the 2001 remedial actions, as a result of post-closure construction, or by the slope failures and repairs of 2004, 2007, and 2008. Both surface water stations have been sampled once per year in conjunction with the wet season groundwater monitoring event (typically December).

2.6.2 Monitoring Data Quality Review

Laboratory results and field parameter measurements were found to be usable for assessment of the Site cleanup effectiveness, based on a review of data quality and validity—with exceptions noted below.

Water samples were collected under chain-of-custody procedures and transported for laboratory analysis by Pace Analytical Services, Inc. of Minneapolis, Minnesota and Freemont Analytical, Inc. of Seattle, Washington. Laboratory results were provided in standard report format. Field parameters were measured using calibrated field sensors and recorded manually on sampling sheets.

¹ Other on-Property groundwater monitoring wells (and soil gas probes) installed during the RI were decommissioned in 2001 in accordance with resource well regulations (Chapter 173-160 WAC).

For this report, the City provided the following data:

- Laboratory results² and field parameters³ for groundwater sampling events from June 2012 through December 2017
- Laboratory results⁴ and field parameters⁵ for surface water sampling events from December 2012 through December 2017

Data quality was evaluated as part of the monitoring and review process. Some laboratory results were qualified by the laboratory as “estimated between the practical quantitation limit and the method detection limit” (J-flagged), and/or “below the test detection limit” (U-flagged). No samples or results were rejected by the laboratory. Data quality evaluation confirmed that all samples were analyzed for the requested parameters.

Field parameter data should be interpreted cautiously. During several monitoring events, recorded measurements were outside the normal range of values. The cause of out-of-range field parameters could have been due to inconsistent instrument operation or setup, transposition while recording values, or inconsistent units. Laboratory results were not influenced by field parameter measurements. See section 4 regarding future monitoring of field parameters.

2.6.3 Groundwater Results and Trends

Groundwater quality data from June 2012 through December 2017 are discussed below, first by compliance point location, then in the context of detected COC concentrations over time. A rigorous statistical analysis to demonstrate compliance (WAC 173-340-720 (9)) will be provided in the next periodic review report.

Monitoring Well MW-12 is located upgradient of the contaminant source as shown in Figures 1-4 and 1-5. Table 3-1 presents groundwater field parameters and laboratory results for MW-12, using the well alias “BMW-12” typically provided on chain-of-custody forms. All groundwater results from June 2012 through December 2017 were below CULs. These results are consistent with the previous periodic review reports (CH2MHill, 2006, 2011). Results from MW-12 provide background conditions for comparison with observations at downgradient monitoring locations. Background groundwater conditions include elevated dissolved oxygen (greater than 10 milligrams per liter (mg/L)), relatively low alkalinity, no detected manganese (total and dissolved fractions), and no detected VOCs.

Monitoring well MW-13 is the eastern-most on-Property compliance point downgradient of contained materials as shown in Figures 1-4 and 1-5. Table 3-2 presents groundwater data from MW-13, using the well alias “BMW-13” typically provided on chain-of-custody forms. During 8 of the 12 sampling events, vinyl chloride

² The groundwater sampling event scheduled for June 2013 was postponed until October 2013.

³ Field parameters for groundwater sampling were not available for the June 2012, December 2012, or June 2013 events.

⁴ The surface water sampling event scheduled for December 2013 was postponed until January 2014.

⁵ Field parameters for surface water sampling were not available for January 2014.

concentrations were not detected at MW-13 and were below the CUL of 0.023 µg/L⁶. During all monitoring events, 1,1-DCE, chloride, nitrate, and sulfate were reported at concentrations less than the respective CULs. Low dissolved oxygen (less than 2 mg/L), relatively high alkalinity, and relatively high manganese concentrations (greater than the CUL of 0.05 mg/L) at MW-13 may indicate the effects of contained materials.

Monitoring well MW 14 is the central on-Property compliance point downgradient of contained materials as shown in Figures 1-4 and 1-5. Groundwater data for MW-14 is presented on Table 3-3, using the well alias “BMW-14” typically provided on chain-of-custody forms. During 6 of the 12 sampling events, vinyl chloride concentrations were not detected, and were below the CUL of 0.023 µg/L. During all monitoring events, 1,1-DCE, chloride, nitrate, sulfate, and manganese (dissolved and total fractions) were reported at concentrations less than the respective CULs. Low dissolved oxygen (less than 2 mg/L), relatively high alkalinity, and increasing manganese concentrations (less than the CUL of 0.05 mg/L) at MW-14 may indicate the effects of contained materials.

Monitoring well MW-15 is the western-most on-Property compliance point downgradient of contained materials as shown in Figures 1-4 and 1-5. Table 3-4 presents groundwater data from MW-15, using the well alias “BMW-15” typically provided on chain-of-custody forms. All concentrations of COCs in groundwater during the 2012 through 2017 monitoring period were below CULs. Compared to background, dissolved oxygen was lower, alkalinity was elevated, there was little to no detected manganese, and no detected VOCs.

Observation Well BOW-37 (Stetson Acres well) is located approximately 800 feet downgradient of the northwest corner of the Property, and is the farthest downgradient compliance point as shown in Figure 1-5. Groundwater data for BOW-37 are presented in Table 3-5, using the well alias “BOW-37” typically provided on chain-of-custody forms⁷. Results from compliance point BOW-37 met State and Federal drinking water standards for all events during the monitoring period. State and federal drinking water standards, also called maximum contaminant levels (MCLs), were equal to the Site CULs, except for vinyl chloride, which has a MCL of 2 µg/L, and 1,1-DCE, which has a MCL of 7 µg/L. Vinyl chloride concentrations were below the MCL of 2 µg/L during all sampling events, and below the CUL of 0.023 µg/L during 10 of the 12 sampling events. During all monitoring events, 1,1-DCE, chloride, nitrate, sulfate, and manganese (dissolved and total fractions) were reported at concentrations less than the respective CULs and MCLs.

Vinyl chloride concentrations in groundwater at MW-13 and BOW-37 continued decreasing during the reporting period, compared with previously observed concentrations (CH2M 2006; CH2M 2011). When vinyl chloride was detected at MW-14 during the reporting period, concentrations were similar to those observed from mid-2009

⁶ The 2001 Consent Decree adopted a CUL of 0.023 µg/L. In 2011, a revised CUL of 0.029 µg/L was proposed (CH2MHill, 2011).

⁷ From the June 2014 through December 2017 sampling events samples collected from the Stetson Acres well were documented with sample identification of BMW-37 rather than BOW-37.

through 2011 (CH2M 2011). Figure 3-1 presents a time-series plot of vinyl chloride concentrations from 2012 through 2017 at groundwater compliance wells.

Chloride concentrations in groundwater were below the CUL of 250 mg/L, as shown in Figure 3-2 presenting a time-series plot from 2012 through 2017 at groundwater compliance wells.

Nitrate concentrations in groundwater were below the CUL of 10 mg/L as nitrogen, as shown in Figure 3-3 presenting a time-series plot from 2012 through 2017 at groundwater compliance wells.

Manganese concentrations were stable or increasing, based on groundwater sampling results. Figure 3-4 and 3-5 present time-series plots of total and dissolved manganese concentrations from 2012 through 2017, for all groundwater compliance wells. Manganese is a naturally occurring element and can be mobilized under reducing (anoxic) conditions.

1,1-DCE concentrations in groundwater were below the CUL of 0.073 mg/L, as shown in Figure 3-6 presenting a time-series plot from 2012 through 2017 at groundwater compliance wells.

2.6.4 Surface Water Results and Trends

Surface water data from December 2012 through December 2017 are discussed in this section, first by compliance point location, then in the context of detected COC concentrations over time. A rigorous statistical analysis to demonstrate compliance (WAC 173-340-730 (7)) will be provided in future periodic review reports.

Upstream surface water location SWU is located on the west end of the Property, as shown in Figure 1-4. Table 3-6 presents surface water field parameters and laboratory results for SWU. During one of six sampling events, total iron exceeded the CUL of 1,000 µg/L.

During the last four of six sampling events, dissolved copper was not detected at a reporting limit of 10 µg/L, above the CUL of 1.8 µg/L. An alternative analytical method for determining the dissolved copper concentration with reporting limits below the CUL is proposed in Section 3.6.

During the first two of six sampling events, dissolved lead exceeded the CUL of 0.3 µg/L. Samples were not collected for analysis of dissolved lead during the last four sampling events, or during the period from 2001 through 2011 based on previous periodic review reports (CH2M Hill, 2006; CH2M Hill, 2011). Results from SWU provide background conditions, including relatively high dissolved oxygen (greater than 7 mg/L), relatively low alkalinity, and relatively low bacterial count.

Downstream surface water location SWD is located on the eastern property boundary as shown in Figure 1-4. Table 3-7 presents surface water field parameters and laboratory results for SWD. During two of six sampling events, total iron concentrations exceeded

the CUL of 1,000 µg/L but were below the CUL for the other four events. During the first two sampling events, dissolved copper concentrations were near or above the CUL of 2.2 µg/L, and dissolved lead concentrations were above the CUL of 0.3 µg/L. During all monitoring events, dissolved iron and dissolved zinc were reported at concentrations below the respective CULs. By comparison with background surface water conditions, dissolved oxygen increased, alkalinity remained relatively stable, and bacterial counts increased.

Total iron concentrations in surface water appeared relatively stable, based on sampling results during the reporting period. Figure 3-7 presents a time-series plot of total iron concentrations from 2012 through 2017 at surface water compliance locations. Recent concentrations at SWD are much improved compared to concentrations of greater than 10 mg/L observed in 2004 and 2005.

Dissolved iron concentrations in surface water were below the CUL of 1,000 mg/L, as shown in Figure 3-8 presenting a time-series plot of dissolved iron concentrations from 2012 through 2017 at groundwater compliance wells.

Dissolved copper concentrations in surface water were reported not detected at concentrations above the CUL of 1.8 mg/L, as shown in Figure 3-9 presenting a time-series plot of dissolved copper concentrations from 2012 through 2017 at groundwater compliance wells.

3 Periodic Review

Based on WAC 173-340-420(4), when evaluating whether human health and the environment are being protected at this Site, the periodic review criteria include:

- a) The effectiveness of the 2001 removal action, including the effectiveness of engineered controls and institutional controls in limiting exposure to hazardous substances remaining at the Site.
- b) New scientific information for individual hazardous substances present at the Site.
- c) New applicable state and federal laws for individual hazardous substances present at the Site.
- d) Current and projected Site and resource use.
- e) Availability and practicability of more permanent remedies.
- f) The availability of improved analytical techniques to evaluate compliance with CULs.

3.1 Effectiveness of Completed Remedial Actions

Based on Site inspections by the City and Kitsap County Public Health, the institutional controls and soil cover continue to eliminate the exposure pathways (direct contact and ingestion) of retained materials. No repairs or alterations to the fencing or soil cover were necessary for the monitoring period from 2012 through 2017.

3.1.1 Effectiveness for Groundwater

Table 4-1 presents a statistical summary of the analytical data by well, showing the frequency of detections, minimum and maximum values detected, and the number of cleanup level exceedances from 2012 through 2017. Exceedances discussed throughout this report were determined based on the 2001 CULs. Table 4-1 include CULs from the 2001 CAP and Consent Decree, proposed CULs from 2011, and most stringent MTCA Method B values.

During the 2012 to 2017 reporting period, all COCs remained below CULs, except for vinyl chloride, and total and dissolved manganese. Vinyl chloride concentrations have been decreasing since 2001 and fell below CULs for all wells during 5 of the 12 monitoring events. In addition, 1,1-DCE concentrations in groundwater at all compliance points were less than the CUL. This suggests the removal action was effective for VOCs in groundwater.

Concentrations of manganese (total and dissolved) in groundwater from MW-13 have been above CULs and show a slight increasing trend. Concentrations of manganese (total and dissolved) in MW-14 show an increasing trend, though they remain below CULs.

The presence of increasing manganese levels may be due to geochemical changes. This suggests the removal action was not yet effective for manganese in groundwater.

During the reporting period, nitrate, sulfate, chloride, conductivity, and pH concentrations in groundwater at all compliance points were less than the respective CULs or cleanup standards. This suggests the removal action was effective for these COCs.

3.1.2 Effectiveness for Surface Water

Table 4-2 presents a statistical summary of the analytical data by surface water location, showing the frequency of detections, minimum and maximum values detected, and the number of cleanup level exceedances from 2012 through 2017. Table 4-2 include CULs from the 2001 CAP and Consent Decree, proposed CULs from 2011, and most stringent MTCA Method B values. Exceedances were determined based on the 2001 CULs.

Concentrations of total iron in surface water from SWU and SWD were detected above CULs. Dissolved iron concentrations in SWD dropped below the levels in SWU in four out of six years. This suggests the removal action was effective for iron in surface water.

During the reporting period, dissolved copper concentrations in surface water were reported “not detected” at concentrations greater than the CUL of 2.2 µg/L during four out of six years. No conclusion regarding the effectiveness of the removal action can be made for dissolved copper in surface water.

During the reporting period, dissolved zinc concentrations were not detected above the CUL. This suggests the removal action was effective for dissolved zinc in surface water.

3.2 New Scientific Information for COCs

CULs at the Site were based on regulatory standards for COCs rather than calculated risk for chemicals and/or media.

The manganese CUL of 0.05 mg/L is based on federal water quality criteria under the Clean Water Act, with the following note: “The Human Health for the consumption of Water + Organism criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.” The MTCA Method B noncancer formula value for manganese is 2.24 mg/L.

No other new scientific information was identified that affect existing CULs.

3.3 New State and Federal Laws for COCs

Regulatory standards used to establish CULs for groundwater and surface water were reviewed. This review consisted of a survey of updates to relevant state and federal standards since the time the CULs were developed. Updates are listed below:

For vinyl chloride, a new CUL of 0.02 µg/L is based on a 2016 update to WAC 173-201A-240, human health criteria based on consumption of water and organisms.

As noted in the second periodic review report (CH2MHill, 2011), the toxicity value for 1,1-DCE used to calculate the carcinogenic MTCA Method B CUL of 0.073 µg/L was removed from CLARC. The lowest current cleanup standard for 1,1-DCE is the state MCL of 7 µg/L.

The CULs for hardness-dependent metals in surface water (copper, lead, and zinc) were recalculated for the first periodic review report (CH2M Hill, 2006) using methods described in Water Quality Standards for the State of Washington (Chapter 173-201A WAC). A hardness of 15 mg/L was assumed based on findings from the RI/FS. Calculated chronic water quality standards for lead and zinc matched the Consent Decree CULs. However, the chronic water quality standard for copper was calculated at 2.2 µg/L, slightly higher than the CUL in the consent decree of 1.8 µg/L. The December 2012 dissolved copper concentrations at SWD were below the higher CUL of 2.2 µg/L. The January 2014 results exceeded the CUL. From December 2014 through 2017, the laboratory reporting limit for non-detect results were greater than the CUL of 2.2 µg/L. Discussion of the reporting limit for dissolved copper is described above in Section 3.1.2.

3.4 Current and Projected Site and Resource Use

The Property contains a City stormwater waste decant facility and a transfer and recycling station. The Site is currently fenced to restrict access and has an engineered soil cap. There are no plans for future changes in land use.

Land use within a three-mile radius of the Site consists primarily of single-family residential houses, with a small number of commercial and industrial operations. The Site is surrounded by low-density residential property, undeveloped and recently logged private property, and rural residential land.

3.5 Availability and Practicability of More Permanent Remedies

The remedy implemented included covering retained materials with a soil cap, which continues to be protective of human health and the environment. While higher preference cleanup technologies may be available, they are not practicable at this Site.

3.6 Availability of Improved Analytical Techniques

Surface water samples collected for laboratory analysis of dissolved copper should be processed using EPA Method 6020 to provide test detection limits below the updated CUL of 2.2 µg/L. The City should verify this approach with the laboratory and ensure all laboratory methods are capable of detection below respective cleanup levels.

No other changes in analytical techniques were identified.

4 Conclusions and Recommendations

- The cleanup actions completed at the Site appear to be protective of human health and the environment.
- The Site includes retained materials capped by a soil cover. Under WAC 173-340-740(6) (f) and based on current and historical Site monitoring data, the cleanup action will comply with cleanup standards within a reasonable restoration timeframe; however, additional actions to mitigate manganese may be necessary in the future as described below.
- The restrictive covenants for the Site are in place and will be effective in protecting public health from exposure to hazardous substances and protecting the integrity of the cleanup action.

Long-term compliance monitoring has demonstrated natural attenuation of VOCs in groundwater. From December 2016 through December 2017, vinyl chloride concentrations were non-detect and below CULs at all groundwater compliance points. Groundwater results from the Stetson Acres supply well (BOW-37) met State and Federal drinking water standards for all events during the monitoring period.

Increasing concentrations of manganese (total and dissolved fractions) have been observed. Control of geochemical processes resulting in elevated manganese in groundwater may be warranted in the future. While increasing manganese trends above CUL have been detected at well MW-13, manganese concentrations have been non-detect or below the CUL in the off-property and downgradient Stetson Acres well (Table 3-5). The project is currently at the mid-point of the 30-year restoration time frame.

We recommend that, if manganese concentrations continue to increase in the next 5-year review, a plan be developed to investigate conditions within the containment area that may be contributing to the dissolution of manganese. Carbon dioxide in soil gas is commonly associated with reducing oxygen concentrations in groundwater and mobilizing naturally occurring manganese in groundwater. The plan could include soil gas probe installations to monitor carbon dioxide and oxygen concentrations beneath the cover material. Based on the investigation, corrective actions would be considered to mitigate the identified conditions. This may include installation of passive vents to permit more atmospheric air exchange within the soil gas beneath the soil cover.

4.1 Recommended Sampling Scope Adjustment

The CAP proposed that 30 years of monitoring could be required to achieve groundwater and surface water quality objectives. Continued groundwater and surface water monitoring will be required until CULs have been achieved. We propose that future sampling resources be focused on assessing concentrations for those constituents listed in the Ecology-approved SAP with cleanup levels listed in the Ecology-approved CAP. This would allow reducing the number of constituents requiring laboratory analysis and reporting, as described below.

- The SAP does not include bicarbonate, carbonate, and hydroxide in groundwater and surface water sampling lists. These constituents also do not have an associated CUL, and do not provide future value for compliance monitoring. Specifically, carbonate and hydroxide were not observed in groundwater or surface water. Historically, all alkalinity has been represented by bicarbonate. We recommend removing bicarbonate, carbonate, and hydroxide from the sampling scope for groundwater and surface water.
- The CAP includes a CUL for alkalinity in surface water, but not for groundwater. The CAP does not include a CUL for sulfate or chloride in groundwater. We recommend removing alkalinity, sulfate, and chloride from the sampling scope for groundwater.
- Neither the CAP nor the SAP identifies *E. coli* as a constituent. We recommend removing *E. coli* from the sampling scope for surface water.

An addendum to the SAP will be prepared by the City to incorporate sampling scope changes, and pertinent changes in cleanup levels, pending Ecology's review and approval of these recommendations.

4.2 Next Periodic Review Report

To return to the five-year review cycle, Ecology requested that the next report be submitted in 2021. The next reporting period will be from January 2018 through June 2021. In addition to the routine reporting scope, the next periodic review report will incorporate statistical trend analysis to demonstrate compliance with CULs. In addition, the next periodic review report will assess manganese concentrations over time, and, if concentrations continue to increase, recommend further action to address conditions causing elevated manganese.

5 References

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Limitations

Work for this project was performed for the City of Bainbridge (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

TABLES

Table 1-1 Monitoring Well Groundwater Elevation Data 2012-2017

Project # 120097-003, Bainbridge Island Landfill

Bainbridge Island, WA

Location ID	BMW-12		BMW-13		BMW-14		BMW-15	
PVC Casing Elevation ^{1,2}	278.43		255.92		271.42		277.69	
Date	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation
December 18, 2013	144.01	134.42	127.92	128.00	143.29	128.13	146.64	131.05
June 12, 2014	144.27	134.16	127.60	128.32	143.27	128.15	149.73	127.96
December 16, 2014	144.80	133.63	128.70	127.22	144.05	127.37	150.41	127.28
June 16, 2015	145.10	133.33	128.40	127.52	144.00	127.42	150.60	127.09
December 21, 2015	144.95	133.48	128.80	127.12	144.00	127.42	150.25	127.44
June 14, 2016	143.60	134.83	125.85	130.07	142.20	129.22	149.10	128.59
December 15, 2016	142.85	135.58	126.65	129.27	142.30	129.12	148.90	128.79
June 20, 2017	141.37	137.06	123.75	132.17	140.28	131.14	147.50	130.19
December 11, 2017	140.40	138.03	124.70	131.22	140.30	131.12	146.90	130.79

Notes

1. Measurements of the top of the PVC casing are based on available data from the First and Second Five-Year Review Reports.
2. Elevations are in feet NAVD-88.

Abbreviations

- PVC = polyvinyl chloride
DTW = depth to water

Table 1-2

Contaminants of Concern and Proposed Cleanup Levels¹

Third Five-Year Review Report
120097-003, Brainbridge Island Landfill, Bainbridge Island, WA

Contaminant	Analytical Method	Reporting Limit	Surface	Groundwater
			Cleanup Level ¹	
VOCs				
1,1-dichloroethene	EPA 6260 SIM	0.00212 ug/L	-	0.073 ug/L
vinyl chloride	EPA 6260 SIM	0.00418 ug/L	-	0.023 ug/L
Metals				
Copper ²	EPA 6020	1.0 ug/L	1.8 ug/L	-
Iron (Total)	EPA 6010	50.0 ug/L	1000 ug/L	-
Iron (Dissolved)	EPA 6010	50.0 ug/L	1000 ug/L	-
Manganese (Total)	EPA 6010	5.0 ug/L	-	50 ug/L
Manganese (Dissolved)	EPA 6010	5.0 ug/L	-	-
Zinc	EPA 6010	20.0 ug/L	21 ug/L	-
Conventionals				
Alkalinity	SM 2320B	5.0 mg/L	20 mg/L	-
Chloride	EPA 300.0	1.00 to 0.100 mg/L	-	-
Nitrate (and nitrite + nitrate)	EPA 300.0	0.100 to 0.200 mg/L	-	-
Sulfate	EPA 300.0	3.5 to 0.300 mg/L	-	-
Bacteria				
E. Coli	EPA 1604	10.0 CFU/100mL	-	-
Fecal Coliform	SM 9222D	1.00 CFU/100mL	<50 CFU/100mL	-
Total Coliform	EPA 1604	10.0 CFU/100mL	<50 CFU/100mL	-
Field Parameters				
Conductivity (indicator)			-	indicator ²
Dissolved Oxygen			>9.5 mg/L	-
pH			-	indicator ³
Turbidity			5.0 NTU	-

Notes

1. Cleanup levels adopted by the Consent Decree (Ecology 2001), adapted from Table 1 of the CAP.
2. EPA method 6010 has been used for Site samples, however the reporting limit is 10.0 ug/L which is well above the cleanup level.
3. The secondary drinking water standard for conductivity is 700 umhos/cm.
2. The secondary drinking water standard for pH 6.5-8.5.

Abbreviations

- µg/L = micrograms per liter
- mg/L = milligrams per liter
- VOCs = volatile organic compounds
- CFU/mL = colony forming units per 100 milliliters of sample
- (-) = Not established

Table 3.1 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well MW-12

Project No. 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BMW-12											
			6/29/12	12/18/12	10/3/13	12/18/13	6/12/14	12/16/14	6/16/15	12/21/15	6/14/16	12/15/16	6/20/17	12/11/17
Field Parameters²														
Conductivity	uS/cm		--	--	161.2	168.2	185.3	177.2	137.2	132.5	185.3	165.1	--	0.163
Dissolved Oxygen	mg/L		--	--	10.07	10.1	9.66	10.06	11.04	91.9	--	11.3	11.33	10.6
ORP	mV		--	--	126.1	96.5	141.6	62.4	46.5	39.5	7.4	38	42.9	150.8
pH	pH units		--	--	7.24	7.57	7.16	7.68	7.65	7.6	7.47	7.81	7.9	6.86
Temperature	C		--	--	10.3	13.2	13.7	12	14.6	14.5	13.7	13.4	12	13.8
Turbidity	NTU		--	--	2.95	0.54	0.24	0.14	0.18	0.15	0.69	0.21	0.21	0.48
Conventional Chemistry Parameters														
<i>Alkalinity</i>	mg/L as CaCO3		59.5	58.1	46.8	51	67.7	63.8	59.4	52.4	54.3	55.5	57.9	62
<i>Bicarbonate</i>	mg/L as CaCO3				46.8	51	67.7	63.8	59.4	52.4	54.3	55.5	57.9	62
<i>Carbonate</i>	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
<i>Chloride</i>	mg/L	250	2.7	3.7	6.9	9.31	8.19	5.83	5.24	6.02	9.57	7.33	5	4.05
<i>Hydroxide</i>	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
<i>Nitrate + Nitrite</i>	mg/L as N	10	0.72	0.85	2.6	2.6	2.41 ³	1.27	1.2 ³	2.8 ³	3.6 ³	2.4 ³	1.3 ³	1.3 ³
<i>N-Nitrate</i>	mg/L as N	10		0.85	2.6	2.6	2.41	1.27	1.34	2.61	3.38	2.51	1.26	1.25
<i>N-Nitrite</i>	mg/L as N			0.01 U	0.01 ² U	0.1 U	0.1 U	0.1 U	0.254	0.139	0.1 U	0.1 U	0.2 U	0.1 U
<i>Sulfate</i>	mg/L	250	9.8	9.2	8.3	7.89	8.47	7.99	8.18	7.26	7.47	8.52	7.86	6.7
Metals														
<i>Total Manganese</i>	mg/L	0.05	0.015 U	0.005 U	0.0108	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
<i>Dissolved Manganese</i>	mg/L	0.05	0.015 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0292	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Volatile Organic Compounds														
<i>1,1-Dichloroethene</i>	ug/L	0.073	0.073 U	0.073 U	0.073 U	0.00133 U	0.00418 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U
<i>Vinyl chloride</i>	ug/L	0.023/0.029 ¹	0.02 U	0.02 U	0.02 U	0.02 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Concent Decree are the same as the 2011 cleanup levels proposed in the Second Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride. The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

² Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO2 plus NO3 on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Table 3.2 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well MW-13

Project No. 120097-003, Brainbridge Island Landfill
 Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BMW-13												
			6/29/12	12/18/12	10/3/13	duplicate	12/18/13	6/12/14	12/16/14	6/16/15	12/21/15	6/14/16	12/15/16	6/20/17	12/11/17
Field Parameters²															
Conductivity	uS/cm		--	--	619.9		480.5	498.9	687	707	349.2	628.6	702.2	--	0.72
Dissolved Oxygen	mg/L		--	--	0.5		1.16	0.6	1.81	0.72	9.6	--	0.47	0.25	0.63
ORP	mV		--	--	131.2		109.6	146.4	87.2	67.5	27.8	1.61	53.2	65.9	170.1
pH	pH units		--	--	6.6		6.8	6.53	6.79	6.72	6.69	6.55	7.04	6.52	6.08
Temperature	C		--	--	14.5		11.6	14.2	12.5	14.2	13.2	13.7	12.5	12.1	13.9
Turbidity	NTU		--	--	0.6		0.94	0.3	0.9	0.37	0.48	0.55	0.44	0.19	--
Conventional Chemistry Parameters															
Alkalinity	mg/L as CaCO3		400	347	264	310	229	271	346	428	295	323	418	476	372
Bicarbonate	mg/L as CaCO3				264	310	229	271	346	428	295	323	418	476	372
Carbonate	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	250	5.9	5.3	5.4	5.4	6.33	5.94	6.49	7.6	6.18	6.34	10.4	9.83	8.2
Hydroxide	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrate + Nitrite	mg/L as N	10	0.13	0.18	0.36	0.35	0.631 ³	0.317	0.405	0.3 ³	0.19 ³	0.05 ³	0.02 U ³	0.02 U ³	0.022 U ³
N-Nitrate	mg/L as N	10		0.18	0.36	0.35	0.631	0.317	0.405	0.977	0.1 U	0.5 U	0.1 U	0.2 U	0.1 U
N-Nitrite	mg/L as N			0.01 U	0.01 ² U	0.01 ² U	0.1 U	0.1 U	0.1 U	0.405	0.131	0.5 U	0.1 U	0.2 U	0.1 U
Sulfate	mg/L	250	23.4	14.8	13.1	13.1	10.1	14	20.5	27.7	13.6	15	25	20.8	9.96
Metals															
Total Manganese	mg/L	0.05	2.58	2.12	2.01	2.07	1.59	1.75	2.17	3.02	1.9	2.22	3.29	3.64	2.95
Dissolved Manganese	mg/L	0.05	2.43	2.07	2.22	2.23	1.67	1.73	1.99	3.08	1.86	2.26	3.24	3.6	2.89
Volatile Organic Compounds															
1,1-Dichloroethene	ug/L	0.073	0.073 U	0.073 U	0.073 U	0.073 U	0.00133 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.01	0.00212 U	0.00212 U	0.00212 U
Vinyl chloride	ug/L	0.023/0.029 ¹	0.28	0.02 U	0.02 U	0.02 U	0.05	0.11	0.047	0.00418 U	0.00418 U	0.03	0.00418 U	0.00418 U	0.00418 U

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Consent Decree are the same as the 2011 cleanup levels proposed in the Second Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride.

The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

² Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO2 plus NO3 on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Table 3.3 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well MW-14

Project No. 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BMW-14										
			6/29/12	duplicate	12/18/12	duplicate	10/3/13	12/18/13	duplicate	6/12/14	duplicate	12/16/14	duplicate
Field Parameters²													
Conductivity	uS/cm		--	--			619.5	673		643		726	
Dissolved Oxygen	mg/L		--	--			0.5	0.7		0.59		0.54	
ORP	mV		--	--			145.9	107.2		135.6		84.3	
pH	pH units		--	--			6.7	6.78		6.59		6.78	
Temperature	C		--	--			10.8	13.8		15		13.1	
Turbidity	NTU		--	--			20.8	3.36		0.8		0.17	
Conventional Chemistry Parameters													
Alkalinity	mg/L as CaCO ₃		291	292	320	312	307	284	290	309	313	328	305
Bicarbonate	mg/L as CaCO ₃						307	284	290	309	313	328	305
Carbonate	mg/L as CaCO ₃						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	250	3.3	3.3	3.7	5.3	5.4	14.4	15.9	11.2	11.3	20.5	28.3
Hydroxide	mg/L as CaCO ₃						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrate + Nitrite	mg/L as N	10	7.6	7.4	5.6	3.6	6.2	4.65	4.19 ³	3.64	3.52	1.85	1.61
N-Nitrate	mg/L as N	10			5.6	3.6	6.2	4.65	4.19	3.64	3.52	1.85	1.61
N-Nitrite	mg/L as N				0.01 U	0.01 U	0.01 ² U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Sulfate	mg/L	250	54.4	49.5	41.1	13.4	35.1	35.4	37.5	35.3	35.4	41	37.2
Metals													
Total Manganese	mg/L	0.05	0.015 U	0.0165	0.0107	0.0108	0.0402	0.0326	0.0196	0.0123	0.0122	0.0236	0.0255
Dissolved Manganese	mg/L	0.05	0.015 U	0.015 U	0.0129	0.0169	0.0228	0.0217	0.0200	0.0248	0.0142	0.0329	0.0253
Volatile Organic Compounds													
1,1-Dichloroethene	ug/L	0.073	0.073 U	0.073 U	0.073 U	0.073 U	0.073 U	0.00133 U	0.00133 U	0.0206	0.0225	0.0268	0.029
Vinyl chloride	ug/L	0.023/0.029 ¹	0.23	0.22	0.02 U	0.02 U	0.02 U	0.17	0.19	0.36	0.35	0.351	0.361

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Concent Decree are the same as the 2011 cleanup levels proposed in the Second

Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride.

The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

² Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO₂ plus NO₃ on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Table 3.3 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well MW-14

Project No. 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BMW-14											
			6/16/15	(duplicate)	12/21/15	(duplicate)	6/14/16	(duplicate)	12/15/16	(duplicate)	6/20/17	(duplicate)	12/11/17	(duplicate)
Field Parameters²														
Conductivity	uS/cm		675		727		3.8		687		--		0.77	
Dissolved Oxygen	mg/L		0.69		9.6		--		9.04		0.16		0.48	
ORP	mV		60.4		27.4		3.7		46.3		55.6		167.5	
pH	pH units		6.82		6.75		6.2		7.01		6.53		6.18	
Temperature	C		16.3		14.7		14.3		14.6		13.2		15.3	
Turbidity	NTU		6.44		0.17		0.49		0.15		0.09		0.02	
Conventional Chemistry Parameters														
Alkalinity	mg/L as CaCO3		349	355	342	338	353	339	321	330	359	358	368	373
Bicarbonate	mg/L as CaCO3		349	355	342	338	353	339	321	330	359	358	368	373
Carbonate	mg/L as CaCO3		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	250	16.3	17	16.5	16.5	11	13	13.9	13.4	11.1	11	10.3	10.1
Hydroxide	mg/L as CaCO3		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrate + Nitrite	mg/L as N	10	2.9 ³	2.5 ³	1.6 ³	1.6 ³	0.71 ³	0.7 ³	0.84 ³	0.87 ³	0.02 ³	0.12 ³	0.02 ³	0.02 ³
N-Nitrate	mg/L as N	10	2.43	2.36	0.313	0.37	1 U	1 U	0.686	0.711	0.44	0.43	0.2 U	0.2 U
N-Nitrite	mg/L as N		0.775	0.805	0.304	0.311	1 U	1 U	0.1 U	0.1 U	1 U	1 U	0.2 U	0.2 U
Sulfate	mg/L	250	41.1	41	41.8	42.2	55.3	48.1	28.6	27.7	65.5	67.4	25.1	27.8
Metals														
Total Manganese	mg/L	0.05	0.0213	0.0209	0.0344	0.0329	0.0198	0.0185	0.0295	0.0299	0.0353	0.0353	0.0461	0.0458
Dissolved Manganese	mg/L	0.05	0.0205	0.0218	0.0348	0.0323	0.0217	0.021	0.0289	0.0293	0.0335	0.0352	0.0477	0.0476
Volatile Organic Compounds														
1,1-Dichloroethene	ug/L	0.073	0.00212 U	0.00212 U	0.0112	0.0117	0.03	0.02	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U
Vinyl chloride	ug/L	0.023/0.029 ¹	0.215	0.248	0.279	0.273	0.29	0.3	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Consent Decree are the same as the 2011 cleanup levels proposed in the Second Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride.

The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

² Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO2 plus NO3 on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Table 3.4 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well MW-15

Project No. 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BMW-15											
			6/29/12	12/18/12	10/3/13	12/18/13	6/12/14	12/16/14	6/16/15	12/21/15	6/14/16	12/15/16	6/20/17	12/11/17
Field Parameters²														
Conductivity	uS/cm		--	--	576.9	565.7	523.6	588.4	565.6	568.2	5.2	6.3	--	0.83
Dissolved Oxygen	mg/L		--	--	2.7	3.1	3.71	2.6	8.84	32.5	--	2.03	0.44	0.61
ORP	mV		--	--	133.4	109.5	139.5	90.1	75.2	28.6	-26.4	49.3	34.4	165
pH	pH units		--	--	6.7	6.82	6.67	6.89	6.87	6.85	6.65	6.99	6.66	6.22
Temperature	C		--	--	14.6	11.2	14.4	13.4	15.7	14	14.7	12.8	12.8	14.3
Turbidity	NTU		--	--	20.8	0.59	0.33	0.21	0.35	0.41	1.02	0.35	0.11	0.02
Conventional Chemistry Parameters														
Alkalinity	mg/L as CaCO3		272	288	234	231	249	243	277	256	305	254	333	324
Bicarbonate	mg/L as CaCO3				234	231	249	243	277	256	305	254	333	324
Carbonate	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	250	7.8	6.2	5.4	6.31	5.54	4.92	7.93	7.61	11.2	5.36	14.6	16.9
Hydroxide	mg/L as CaCO3				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrate + Nitrite	mg/L as N	10	1.4	0.78	0.43	0.614 ³	0.435	0.484	0.52 ³	0.22 ³	0.59 ³	0.38 ³	0.65 ³	0.85 ³
N-Nitrate	mg/L as N	10		0.78	0.43	0.614	0.435	0.484	0.436	0.1 U	1 U	0.1 U	0.88	0.91
N-Nitrite	mg/L as N			0.01 U	0.01 ² U	0.1 U	0.1 U	0.1 U	0.423	0.11	1 U	0.1 U	1 U	1 U
Sulfate	mg/L	250	127	67.8	52.8	51.2	43	34.8	61.9	42.9	78	22.1	97.9	66.5
Metals														
Total Manganese	mg/L	0.05	0.015 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Dissolved Manganese	mg/L	0.05	0.015 U	0.0076	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Volatile Organic Compounds														
1,1-Dichloroethene	ug/L	0.073	0.073 U	0.073 U	0.073 U	0.00133 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U
Vinyl chloride	ug/L	0.023/0.029 ¹	0.02 U	0.02 U	0.02 U	0.02 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U	0.00418 U

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Concent Decree are the same as the 2011 cleanup levels proposed in the Second Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride. The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

² Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO2 plus NO3 on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Table 3.5 - Field and Analytical Data from Semi-Annual Groundwater Monitoring, 2012-2017, Monitoring Well Stetson Acres Well

Project No. 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	BOW-37 ²											
			(Stetson Acres Well)											
			6/29/12	12/18/12	10/3/13	12/18/13	6/12/14	12/16/14	6/16/15	12/21/15	6/14/16	12/15/16	6/20/17	12/11/17
Field Parameters³														
Conductivity	uS/cm		--	--	419.8	444	378.4	394.9	334.8	316.3	353.9	377.9	--	0.319
Dissolved Oxygen	mg/L		--	--	6.23	5.82	8.1	5.71	6.75	82.2	--	7.26	7.36	7.43
ORP	mV		--	--	138.2	119.5	146.4	129.9	80.8	39.2	20.7	59.6	86.3	154.1
pH	pH units		--	--	6.89	7.01	6.85	7.11	7.1	7.18	6.9	7.45	7.03	6.56
Temperature	C		--	--	10.7	9.1	11.1	9.7	10.7	8.5	10.9	8.2	11.3	9.5
Turbidity														
Conventional Chemistry Parameters														
Alkalinity	mg/L as CaCO ₃		219	227	189	202	192	180	177	193	167	163	148	135
Bicarbonate	mg/L as CaCO ₃				189	202	192	180	177	193	167	163	148	135
Carbonate	mg/L as CaCO ₃				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	250	5.4	3.7	5.3	6.09	4.79	5.09	5.73	6.01	4.82	5.53	4.82	5.92
Hydroxide	mg/L as CaCO ₃				5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrate + Nitrite	mg/L as N	10	1.4	1.4	1.9	1.86 ⁴	1.33	1.68	1.7 ⁴	1.8 ⁴	1.4 ⁴	2 ⁴	1.9 ⁴	2.5 ⁴
N-Nitrate	mg/L as N	10		1.4	1.9	1.86	1.33	1.68	1.69	1.65	1.24	1.8	1.88	1.73
N-Nitrite	mg/L as N			0.01 U	0.01 ² U	0.1 U	0.1 U	0.1 U	0.285	0.13	0.2 U	0.1 U	0.5 U	0.1 U
Sulfate	mg/L	250	12.9	53.2	12	12.1	11	9.92	10.7	10.6	9.21	10.4	9.06	6.74
Metals														
Total Manganese	mg/L	0.05	0.015 U	0.0134	0.0082	0.0050 U	0.005 U	0.005 U	0.0065	0.005 U	0.0056	0.005 U	0.005 U	0.005 U
Dissolved Manganese	mg/L	0.05	0.015 U	0.0113	0.0109	0.0054	0.0055	0.005	0.0062	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Volatile Organic Compounds														
1,1-Dichloroethene	ug/L	0.073	0.073 U	0.073 U	0.073 U	0.00133 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U	0.00212 U
Vinyl chloride	ug/L	0.023/0.029 ¹	0.02 U	0.02 U	0.02 U	0.02 U	0.07	0.032	0.00418 U	0.00418 U	0.00418	0.00418 U	0.00418 U	0.00418 U

Notes

Bolded values indicate an exceedance of the established 2001 cleanup levels.

¹Cleanup levels established by the 2001 Concent Decree are the same as the 2011 cleanup levels proposed in the Second Five-Year Review Report For Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012), except for vinyl chloride. The 2001 cleanup level is show first and the 2011 cleanup level is second for vinyl chloride.

²Conductivity measurements from 2014 through 2017 were taken at the time the sample was collected.

³Calculated value by analytical Method EPA 353.2: Nitrogen, NO₂ plus NO₃ on N-Nitrate + N-Nitrite analytical results.

(U) indicates result was is below the laboratory detection limit shown.

(--) indicates that field parameters were not collected.

Results meet State and Federal drinking water standards for all analytes.

Table 3.6 - Field and Analytical Data from Annual Surface Water Monitoring, 2012-2017, Surface Water Locations SWU

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	SW-U ²									
			12/18/12	1/29/14	12/16/14	duplicate	12/21/15	duplicate	12/14/16	duplicate	12/12/17	duplicate
Field Parameters												
Conductivity	uS/cm		--	46.1	3.3		43.1		46.9		0.06	
Dissolved Oxygen	mg/L		--	10.64	9.79		7.32		10.76		9.61	
ORP	mV		--	112.6	71.1		16		14.6		267.6	
pH	pH units		--	5.7	7.39		7.13		6.25		6.16	
Temperature	C		--	6.9	8.4		5.9		2.4		4.2	
Turbidity	NTU		--	33.5	16.2		15.9		12.1		7.3	
Conventional Chemistry Parameters												
Alkalinity	mg/L as CaCO3		5 U	11.8	13.5	13.4	7.3	6.7	11.7	11.7	23.1	17.8
Hydroxide	mg/L as CaCO3		--	2.5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate	mg/L as CaCO3		--	11.8	13.5	13.4	7.3	6.7	11.7	11.7	23.1	17.8
Carbonate	mg/L as CaCO3		--	2.5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Metals												
Total Iron	µg/L	1,000	784	1630	408	537	632	660	916	932	788	783
Dissolved Iron	µg/L	1,000	535	651	467	824	256	267	547	610	582	587
Dissolved Copper	µg/L	1.8/2.2 ³	1.5	1.6 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Dissolved Zinc	µg/L	21	5 U	4.4 UJ	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Dissolved Lead	µg/L	0.3	0.5	1.2 J								
Bacteria												
Total Coliform	CFU/100ml		>200	240	1510	52	286	268	46	44	116	206
E. coli	CFU/100ml		13	240	10	1 U	6	4	30	20	16	18
Fecal Coliform	CFU/100ml		23	340	1	1 U	2	6	29	27	15	11

Notes

¹Cleanup levels for surface water were first established by the March 2001 Consent Decree. In 2011, a new cleanup level for dissolved copper in surface water was propose in the Second Five-Year Review Report for Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012).

²Sample identification on laboratory reports is SW-1U followed by a six digit date. Duplicate samples are identified as SW-2U followed by a six digit date.

³The 2001 cleanup level is 1.8 µg/L and the 2011 cleanup level is 2.2 µg/L.

Bold = indicate an exceedance of the cleanup level.

U = indicates result below test detection limit.

J = indicates estimated result between practical detection limit (PQL) and method detection limit (MDL).

Table 3.7 - Field and Analytical Data from Annual Surface Water Monitoring, 2012-2017, Surface Water Locations SWD

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Chemical Name	Units	Cleanup Levels ¹	SWD ²																		
			12/18/12	duplicate	1/29/14	duplicate	12/16/14	duplicate	12/22/15	duplicate	duplicate-2	12/14/2016	duplicate	duplicate-2	12/12/17	duplicate	duplicate-2				
Field Parameters																					
Conductivity	uS/cm				46.2			49.7			41.4			4.6			0.059				
Dissolved Oxygen	mg/L				12.14			10.59			8.95			14.08			11.63				
ORP	mV				126.6			91.8			24.6			34			240				
pH	pH units				6.04			7.4			6.91			6.86			6.81				
Temperature	C				6.9			7.7			6.2			4.2			4.3				
Turbidity	NTU				40.2			17			10.8			19.7			6.47				
Conventional Chemistry Parameters																					
Alkalinity	mg/L as CaCO ₃		16.4	15.5	12.7		13	12.8		12.9		9.4	9.4	9.1		11.6	12.5	11.9	23.3	20.4	16.2
Hydroxide	mg/L as CaCO ₃				2.5 UJ		2.5 UJ	5 U		5 U		5 U	5 U	5 U		5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate	mg/L as CaCO ₃				12.7		13	12.8		12.9		9.4	9.4	9.1		11.6	12.5	11.9	23.3	20.4	16.2
Carbonate	mg/L as CaCO ₃				2.5 UJ		2.5 UJ	5 U		5 U		5 U	5 U	5 U		5 U	5 U	5 U	5 U	5 U	5 U
Metals																					
Total Iron	µg/L	1,000	726	714	2240		2200	497		507		936	935	899		1,200	1,330	1,290	826	689	745
Dissolved Iron	µg/L	1,000	467	407	721		542	537		666		196	190	210		489	606	590	453	456	475
Dissolved Copper	µg/L	1.8/2.2 ²	1.8	2	3.2 J		2.9 J	10 U		10 U		10 U	10 U	10 U		10 U	10 U	10 U	10 U	10 U	10 U
Dissolved Zinc	µg/L	21	<5.0	<5.0	4.4 UJ		4.4 UJ	20 U		20 U		20 U	20 U	20 U		20 U	20 U	20 U	20 U	20 U	20 U
Dissolved Lead	µg/L	0.3	0.41	0.75	1.4 J		1.2 UJ														
Bacteria																					
Total Coliform	CFU/100ml		>200	>200	310		420	1,240		450		>400	>400	>400		248	210	220	272	199	281
E. Coli	CFU/100ml		100	80	310		420	40		10		360	300	270		168	124	136	28	19	25
Fecal Coliform	CFU/100ml		220	200	1360		610	6		1 U		142	128	134		148	140	128	15	5	15

Notes

- ¹Cleanup levels for surface water were first established by the March 2001 Consent Decree. In 2011, a new cleanup level for dissolved copper in surface water was propose in the Second Five-Year Review Report for Bainbridge Island Landfill, Kitsap County, Washington by CH2MHILL (2012).
 - ²Sample identification on laboratory reports is SW-4D followed by a six digit date. Blind duplicate samples are identified as SW-5D followed by a six digit date. Some events include a duplicate of the blind duplicate. In that case the sample identification is SW-5D with six digit data and 'duplicate'.
 - ³The 2001 cleanup level is 1.8 µg/L and the 2011 cleanup level is 2.2 µg/L.
- Bold** = indicate an exceedance of the cleanup level.
 U = indicates result below test detection limit.
 J = indicates estimated result between practical detection limit (PQL) and method detection limit (MDL).

Table 4-1 - Summary of Compounds by Well from Semi-Annual Groundwater Monitoring, 2012-2018

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Well ID	Compound	Units	Number of Detections	Number of ND	Number of Samples	Frequency of Detections	Min ND Value	Max ND Value	Min Detect Value	Max Detected Value	2001 ¹			2011 ²			MTCA Method B ³		
											CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL
MW-12																			
Field Parameters	Dissolved Oxygen	mg/L	9		9	100%			9.66	91.9			0			0			0
	ORP	mV	10		10	100%			7.4	150.8			0			0			0
	pH	pH units	10		10	100%			6.86	7.9			0			0			0
	Specific Conductance	µS/cm	9		9	100%			0.163	185.3			0			0			0
	Temperature	deg C	10		10	100%			10.3	14.6			0			0			0
	Turbidity	NTU	10		10	100%			0.14	2.95			0			0			0
Conventionals	Alkalinity, Total	mg/L as CaCO3	12		12	100%			46.8	67.7			0			0			0
	Bicarbonate	mg/L as CaCO3	10		10	100%			46.8	67.7			0			0			0
	Carbonate	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Chloride	mg/L	12		12	100%			2.7	9.57	250		0	250		0			0
	Hydroxide	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Nitrate as Nitrogen	mg/L as N	11		11	100%			0.85	3.38	10		0	10		0	25.6		0
	Nitrate-Nitrite	mg/L as N	12		12	100%			0.72	3.6	10		0	10		0			0
	Nitrite as Nitrogen	mg/L as N	2	9	11	18%	0.01	0.2	0.139	0.254		0	0		0	0	1.6	0	0
Sulfate	mg/L	12		12	100%			6.7	9.8	250		0	250		0			0	
Metals	Dissolved Manganese	mg/L	1	11	12	8%	0.005	0.015	0.0292	0.0292	0.05	0	0	0.05	0	0	2.24	0	0
	Total Manganese	mg/L	1	11	12	8%	0.005	0.015	0.0108	0.0108	0.05	0	0	0.05	0	0	2.24	0	0
VOCs	1,1-Dichloroethene	µg/L		12	12	0%	0.00133	0.073			0.073	0		0.073	0		400	0	
	Vinyl Chloride	µg/L		12	12	0%	0.00418	0.02			0.023	0		0.029	0		24	0	
MW-13																			
Field Parameters	Dissolved Oxygen	mg/L	9		9	100%			0.25	9.6			0			0			0
	ORP	mV	10		10	100%			1.61	170.1			0			0			0
	pH	pH units	10		10	100%			6.08	7.04			0			0			0
	Specific Conductance	µS/cm	9		9	100%			0.72	707			0			0			0
	Temperature	deg C	10		10	100%			11.6	14.5			0			0			0
	Turbidity	NTU	9		9	100%			0.19	0.94			0			0			0
Conventionals	Alkalinity, Total	mg/L as CaCO3	12		12	100%			229	476			0			0			0
	Bicarbonate	mg/L as CaCO3	10		10	100%			229	476			0			0			0
	Carbonate	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Chloride	mg/L	12		12	100%			5.3	10.4	250		0	250		0			0
	Hydroxide	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Nitrate as Nitrogen	mg/L as N	6	5	11	55%	0.1	0.5	0.18	0.977	10	0	0	10	0	0	25.6	0	0
	Nitrate-Nitrite	mg/L as N	9	3	12	75%	0.02	0.022	0.05	0.631	10	0	0	10	0	0		0	0
	Nitrite as Nitrogen	mg/L as N	2	9	11	18%	0.01	0.5	0.131	0.405		0	0		0	0	1.6	0	0
Sulfate	mg/L	12		12	100%			9.96	27.7	250		0	250		0			0	
Metals	Dissolved Manganese	mg/L	12		12	100%			1.67	3.6	0.05		12	0.05		12	2.24		6
	Total Manganese	mg/L	12		12	100%			1.59	3.64	0.05		12	0.05		12	2.24		5
VOCs	1,1-Dichloroethene	µg/L	1	11	12	8%	0.00133	0.073	0.01	0.01	0.073	0	0	0.073	0	0	400	0	0
	Vinyl Chloride	µg/L	5	7	12	42%	0.00418	0.02	0.03	0.28	0.023	0	5	0.029	0	5	24	0	0

Table 4-1 - Summary of Compounds by Well from Semi-Annual Groundwater Monitoring, 2012-2018

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Well ID	Compound	Units	Number of Detections	Number of ND	Number of Samples	Frequency of Detections	Min ND Value	Max ND Value	Min Detect Value	Max Detected Value	2001 ¹			2011 ²			MTCA Method B ³		
											CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL
MW-14																			
Field Parameters	Dissolved Oxygen	mg/L	9		9	100%			0.16	9.6			0			0			0
	ORP	mV	10		10	100%			3.7	167.5			0			0			0
	pH	pH units	10		10	100%			6.18	7.01			0			0			0
	Specific Conductance	µS/cm	9		9	100%			0.77	727			0			0			0
	Temperature	deg C	10		10	100%			10.8	16.3			0			0			0
	Turbidity	NTU	10		10	100%			0.02	20.8			0			0			0
Conventionals	Alkalinity, Total	mg/L as CaCO3	12		12	100%			284	368			0			0			0
	Bicarbonate	mg/L as CaCO3	10		10	100%			284	368			0			0			0
	Carbonate	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Chloride	mg/L	12		12	100%			3.3	20.5	250		0	250		0		0	0
	Hydroxide	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Nitrate as Nitrogen	mg/L as N	9	2	11	82%	0.2	1	0.313	6.2	10	0	0	10	0	0	25.6	0	0
	Nitrate-Nitrite	mg/L as N	12		12	100%			0.02	7.6	10		0	10		0			0
	Nitrite as Nitrogen	mg/L as N	2	9	11	18%	0.01	1	0.304	0.775		0	0		0	0	1.6	0	0
Sulfate	mg/L	12		12	100%			25.1	65.5	250		0	250		0			0	
Metals	Dissolved Manganese	mg/L	11	1	12	92%	0.015	0.015	0.0129	0.0477	0.05	0	0	0.05	0	0	2.24	0	0
	Total Manganese	mg/L	11	1	12	92%	0.015	0.015	0.0107	0.0461	0.05	0	0	0.05	0	0	2.24	0	0
VOCs	1,1-Dichloroethene	µg/L	4	8	12	33%	0.00133	0.073	0.0112	0.03	0.073	0	0	0.073	0	0	400	0	0
	Vinyl Chloride	µg/L	7	5	12	58%	0.00418	0.02	0.17	0.36	0.023	0	7	0.029	0	7	24	0	0
MW-15																			
Field Parameters	Dissolved Oxygen	mg/L	9		9	100%			0.44	32.5			0			0			0
	ORP	mV	10		10	100%			-26.4	165			0			0			0
	pH	pH units	10		10	100%			6.22	6.99			0			0			0
	Specific Conductance	µS/cm	9		9	100%			0.83	588.4			0			0			0
	Temperature	deg C	10		10	100%			11.2	15.7			0			0			0
	Turbidity	NTU	10		10	100%			0.02	20.8			0			0			0
Conventionals	Alkalinity, Total	mg/L as CaCO3	12		12	100%			231	333			0			0			0
	Bicarbonate	mg/L as CaCO3	10		10	100%			231	333			0			0			0
	Carbonate	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Chloride	mg/L	12		12	100%			4.92	16.9	250		0	250		0		0	0
	Hydroxide	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Nitrate as Nitrogen	mg/L as N	8	3	11	73%	0.1	1	0.43	0.91	10	0	0	10	0	0	25.6	0	0
	Nitrate-Nitrite	mg/L as N	12		12	100%			0.22	1.4	10		0	10		0			0
	Nitrite as Nitrogen	mg/L as N	2	9	11	18%	0.01	1	0.11	0.423		0	0		0	0	1.6	0	0
Sulfate	mg/L	12		12	100%			22.1	127	250		0	250		0			0	
Metals	Dissolved Manganese	mg/L	1	11	12	8%	0.005	0.015	0.0076	0.0076	0.05	0	0	0.05	0	0	2.24	0	0
	Total Manganese	mg/L		12	12	0%	0.005	0.015			0.05	0	0	0.05	0	0	2.24	0	0
VOCs	1,1-Dichloroethene	µg/L		12	12	0%	0.00133	0.073			0.073	0	0	0.073	0	0	400	0	0
	Vinyl Chloride	µg/L		12	12	0%	0.00418	0.02			0.023	0	0	0.029	0	0	24	0	0

Table 4-1 - Summary of Compounds by Well from Semi-Annual Groundwater Monitoring, 2012-2018

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Well ID	Compound	Units	Number of Detections	Number of ND	Number of Samples	Frequency of Detections	Min ND Value	Max ND Value	Min Detect Value	Max Detected Value	2001 ¹			2011 ²			MTCA Method B ³		
											CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL
BOW-37 (Stetson Acres Well)																			
Field Parameters	Dissolved Oxygen	mg/L	9		9	100%			5.71	82.2			0			0			0
	ORP	mV	10		10	100%			20.7	154.1			0			0			0
	pH	pH units	10		10	100%			6.56	7.45			0			0			0
	Specific Conductance	µS/cm	9		9	100%			0.319	444			0			0			0
	Temperature	deg C	10		10	100%			8.2	11.3			0			0			0
	Turbidity	NTU	10		10	100%			0.02	0.47			0			0			0
Conventional	Alkalinity, Total	mg/L as CaCO3	12		12	100%			135	227			0			0			0
	Bicarbonate	mg/L as CaCO3	10		10	100%			135	202			0			0			0
	Carbonate	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Chloride	mg/L	12		12	100%			3.7	6.09	250		0	250		0			0
	Hydroxide	mg/L as CaCO3		10	10	0%	5	5				0		0			0		0
	Nitrate as Nitrogen	mg/L as N	11		11	100%			1.24	1.9	10		0	10		0	25.6		0
	Nitrate-Nitrite	mg/L as N	12		12	100%			1.33	2.5	10		0	10		0			0
	Nitrite as Nitrogen	mg/L as N	2	9	11	18%	0.01	0.5	0.13	0.285		0	0		0	0	1.6	0	0
Sulfate	mg/L	12		12	100%			6.74	53.2	250		0	250		0			0	
Metals	Dissolved Manganese	mg/L	6	6	12	50%	0.005	0.015	0.005	0.0113	0.05	0	0	0.05	0	0	2.24	0	0
	Total Manganese	mg/L	4	8	12	33%	0.005	0.015	0.0056	0.0134	0.05	0	0	0.05	0	0	2.24	0	0
VOCs	1,1-Dichloroethene	µg/L		12	12	0%	0.00133	0.073			0.073	0		0.073	0		400	0	
	Vinyl Chloride	µg/L	3	9	12	25%	0.00418	0.02	0.01	0.07	0.023	0	2	0.029	0	2	24	0	0

Notes

- 1) Cleanup levels presented in the Cleanup Action Plan (Ecology, 2001) in March 2001.
- 2) Cleanup levels proposed in the Second Five-Year Review Report (CH2MHill, 2011).
- 3) Most stringent model toxics control act (MTCA) method B cleanup levels for groundwater.
- ND = sample result was not detected above the laboratory detection limit.
- Min = minimum
- Max = maximum

- CUL = cleanup level
- ORP = oxidation reduction potential
- mg/L = miligram per liter
- mV = milivolt
- pH units = standard units of pH
- uS/cm = microseimens per centimeter

- deg C = degrees celcius
- NTU = nepelometric turbidity units
- CaCO3 = calcium carbonate
- N = Nitrogen
- µg/L = micrograms per Liter.

Table 4-2 - Summary of Compounds by Well from Semi-Annual Surface Water Monitoring, 2012-2018

Project # 120097-003, Bainbridge Island Landfill
Bainbridge Island, WA

Well ID	Compound	Units	Number of Detections	Number of ND	Number of Samples	Frequency of Detections	Min ND Value	Max ND Value	Min Detect Value	Max Detected Value	2001 ¹			2011 ²			MTCA Method B ³		
											CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL	CUL	Number of ND > CUL	Detects > CUL
SWD																			
Field Parameters	Dissolved Oxygen	mg/L	5		5	100%			8.95	14.08			0			0		0	
	ORP	mV	5		5	100%			24.6	240			0			0		0	
	pH	pH units	5		5	100%			6.04	7.4			0			0		0	
	Specific Conductance	uS/cm	5		5	100%			0.059	49.7			0			0		0	
	Temperature	deg C	5		5	100%			4.2	7.7			0			0		0	
	Turbidity	NTU	5		5	100%			6.47	40.2			0			0		0	
Conventionals	Alkalinity, Total	mg/L as CaCO3	6		6	100%			9.4	23.3			0			0		0	
	Bicarbonate	mg/L as CaCO3	5		5	100%			9.4	23.3			0			0		0	
	Carbonate	mg/L as CaCO3		5	5	0%	2.5	5				0		0			0		
	Hydroxide	mg/L as CaCO3		5	5	0%	2.5	5				0		0			0		
Metals	Dissolved Copper	ug/L	2	4	6	33%	10	10	1.8	3.2	1.8	4	1	2.2	4	1	2900	0	0
	Dissolved Iron	ug/L	6		6	100%			196	721	1,000		0	1,000		0		0	
	Dissolved Lead	ug/L	2		2	100%			0.41	1.4	0.3		2	0.3		2		0	
	Dissolved Zinc	ug/L		6	6	0%	4.4	20			21	0		21	0		17000	0	
	Total Iron	ug/L	6		6	100%			497	2240	1,000		2	1,000		2		0	
Bacteria	E.Coli	cfu/100mL	6		6	100%			28	360			0			0		0	
	Fecal Coliform	cfu/100mL	6		6	100%			6	1360			0			0		0	
	Total Coliform	cfu/100mL	6		6	100%			200	1240			0			0		0	
SWU																			
Field Parameters	Dissolved Oxygen	mg/L	5		5	100%			7.32	10.76			0			0		0	
	ORP	mV	5		5	100%			14.6	267.6			0			0		0	
	pH	pH units	5		5	100%			5.7	7.39			0			0		0	
	Specific Conductance	uS/cm	5		5	100%			0.06	46.9			0			0		0	
	Temperature	deg C	5		5	100%			2.4	8.4			0			0		0	
	Turbidity	NTU	5		5	100%			7.3	33.5			0			0		0	
Conventionals	Alkalinity, Total	mg/L as CaCO3	5	1	6	83%	5	5	7.3	23.1		0	0		0	0		0	
	Bicarbonate	mg/L as CaCO3	5		5	100%			7.3	23.1			0			0		0	
	Carbonate	mg/L as CaCO3		5	5	0%	2.5	5				0		0			0		
	Hydroxide	mg/L as CaCO3		5	5	0%	2.5	5				0		0			0		
Metals	Dissolved Copper	ug/L	2	4	6	33%	10	10	1.5	1.6	1.8	4	0	2.2	4	0	2900	0	0
	Dissolved Iron	ug/L	6		6	100%			256	651	1,000		0	1,000		0		0	
	Dissolved Lead	ug/L	2		2	100%			0.5	1.2	0.3		2	0.3		2		0	
	Dissolved Zinc	ug/L		6	6	0%	4.4	20			21	0		21	0		17000	0	
	Total Iron	ug/L	6		6	100%			408	1630	1,000		1	1,000		1		0	
Bacteria	E.Coli	cfu/100mL	6		6	100%			6	240			0			0		0	
	Fecal Coliform	cfu/100mL	6		6	100%			1	340			0			0		0	
	Total Coliform	cfu/100mL	6		6	100%			46	1510			0			0		0	

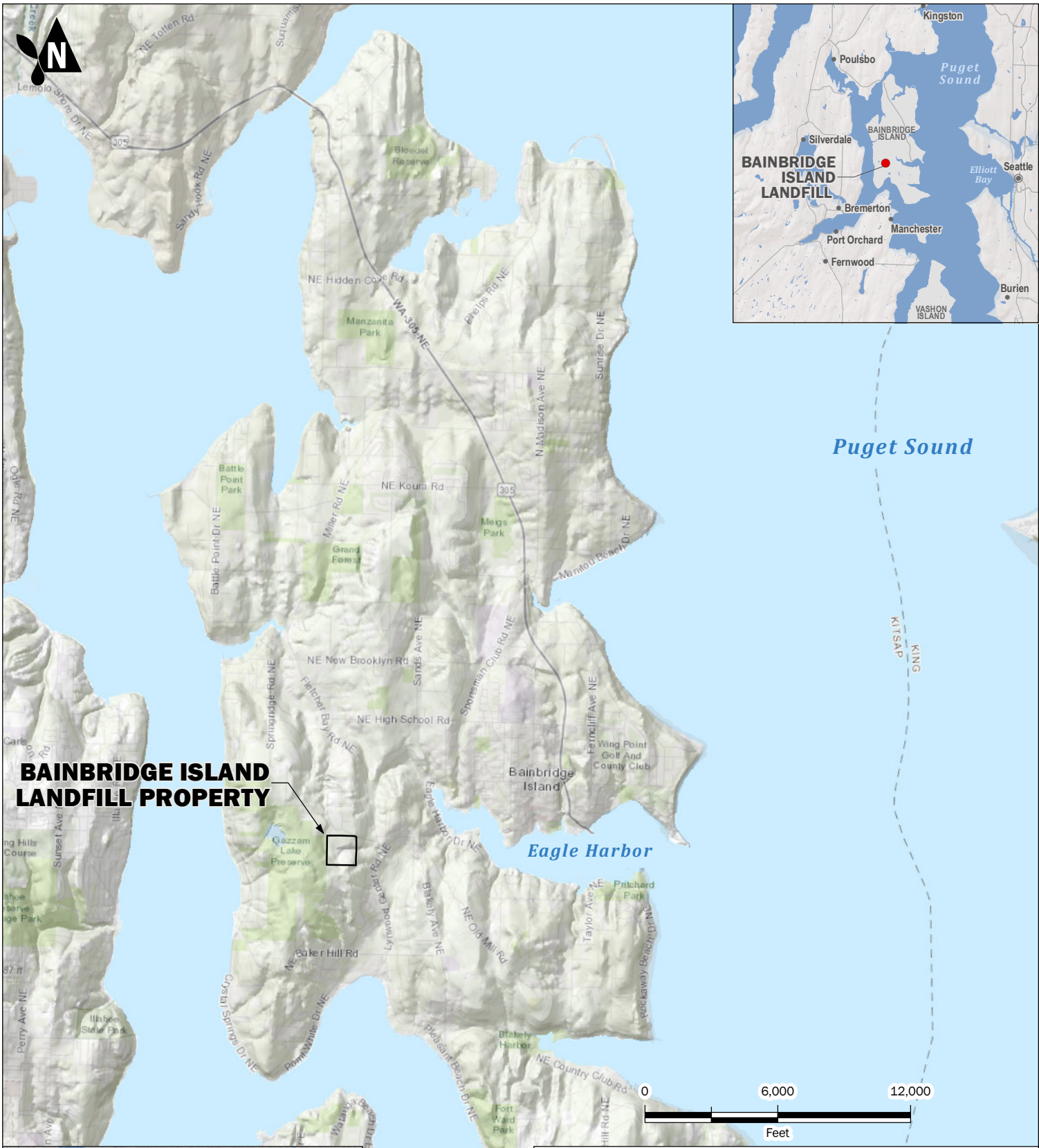
Notes

- 1) Cleanup levels presented in the Cleanup Action Plan (Ecology, 2001) in March 2001.
 - 2) Cleanup levels proposed in the Second Five-Year Review Report (CH2MHill, 2011).
 - 3) Most stringent model toxics control act (MTCA) method B cleanup levels for surface water.
- ND = sample result was not detected above the laboratory detection limit.
Min = minimum
Max = maximum

CUL = cleanup level
ORP = oxidation reduction potential
mg/L = milligram per liter
mV = millivolt
pH units = standard units of pH
uS/cm = microseimens per centimeter

deg C = degrees celcius
NTU =nepelometric turbidity units
CaCO3 = calcium carbonate
N = Nitrogen
µg/L = micrograms per Liter.

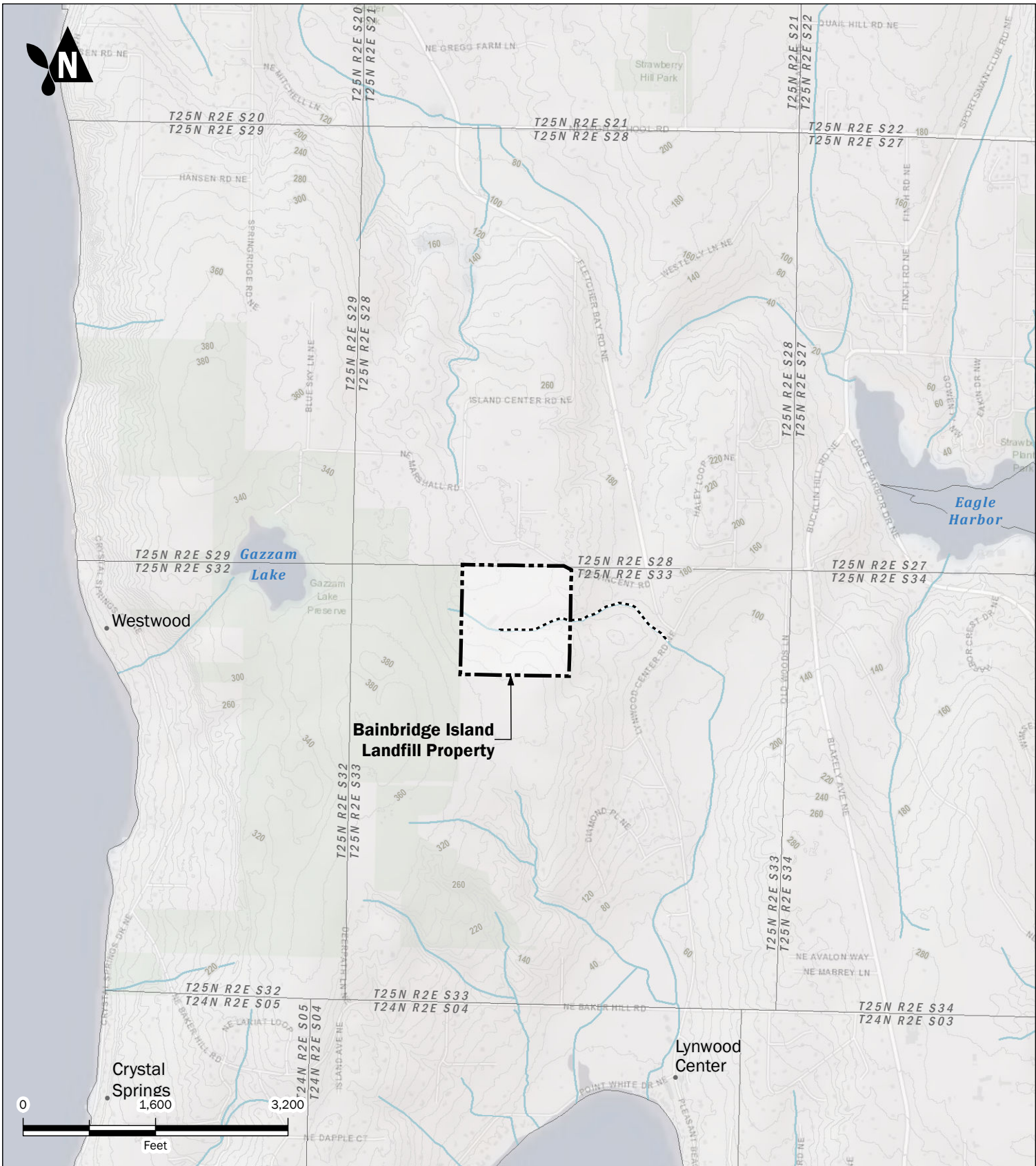
FIGURES



Site Location Map
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	MAR-2018	BY: MLK / KES	FIGURE NO. 1-1
	PROJECT NO. 120097-003	REVISED BY: ---	

GIS Path: I:\Projects_8\GIS\Bainbridge\VincentRoad\Landfill_120097\Deliverables\1-1_Site Location Map.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 3/29/2018 | User: rpepin | Print Date: 4/4/2018



GIS Path: I:\projects_8\GIS\Bainbridge\Bainbridge_VincetRoad\landfill_120097\Deliverables\2-Regional Topography.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/4/2018 | User: jrobin | Print Date: 4/4/2018

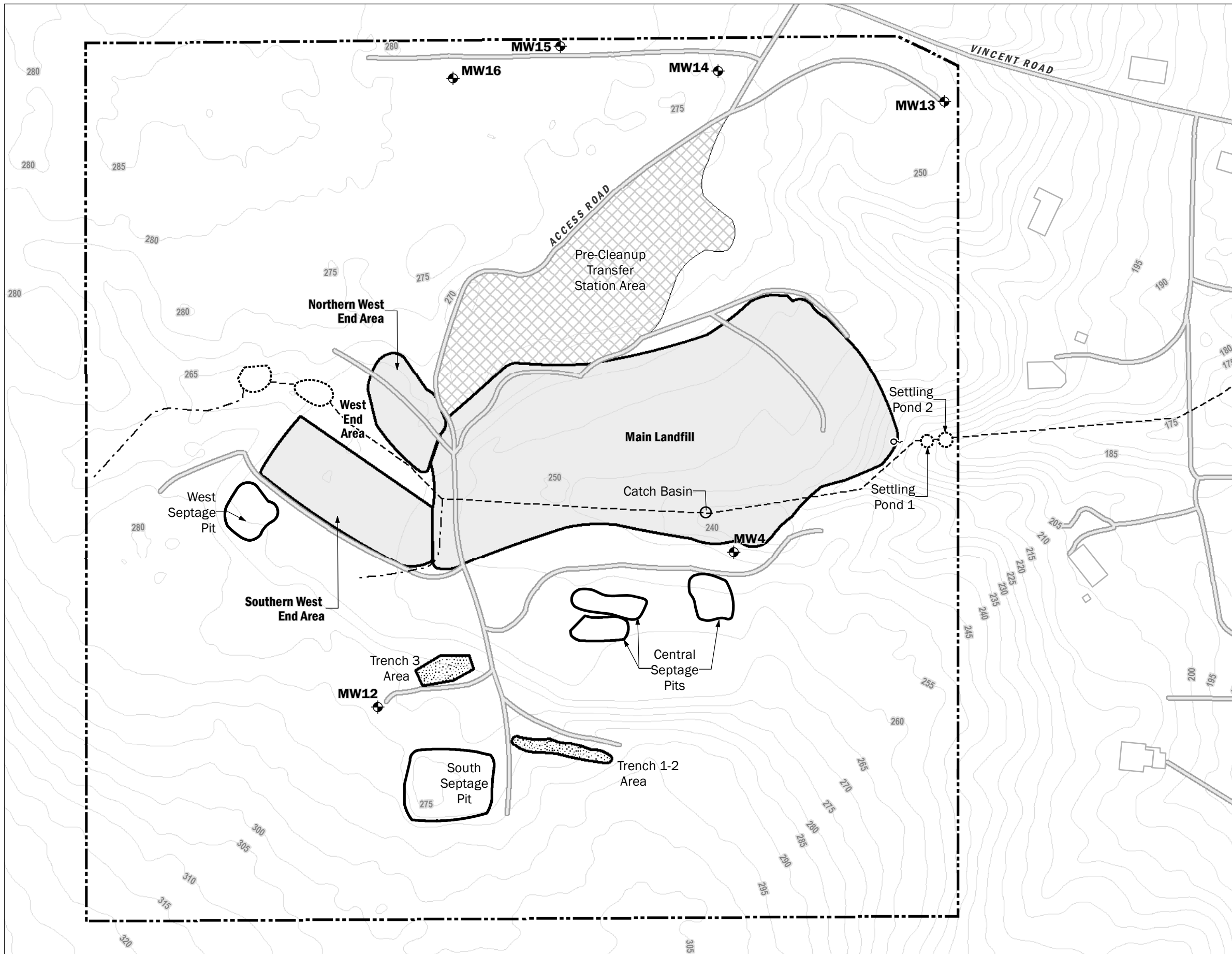
- Drainage Course
- Stream
- Township/Range/Section

Note:
 1. Topographic contours derived from 2015 Bainbridge Island LiDAR project, in NAVD88, ft.

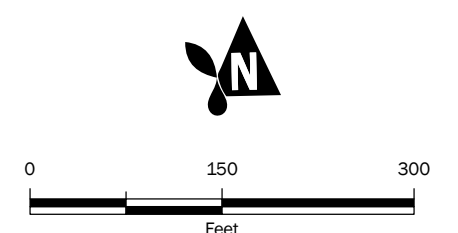
Regional Topography

Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	APR-2018	BY: MLK / KES	FIGURE NO. 1-2
	PROJECT NO. 120097-0003	REVISED BY: ...	



- Monitoring Well
- Approximate Outline of Waste Source Area
- Approximate Outline of Main Landfill Mass
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Approximate Outline of Pond
- Gravel or Paved Road
- Leachate Seep
- Existing Structure
- Property Boundary

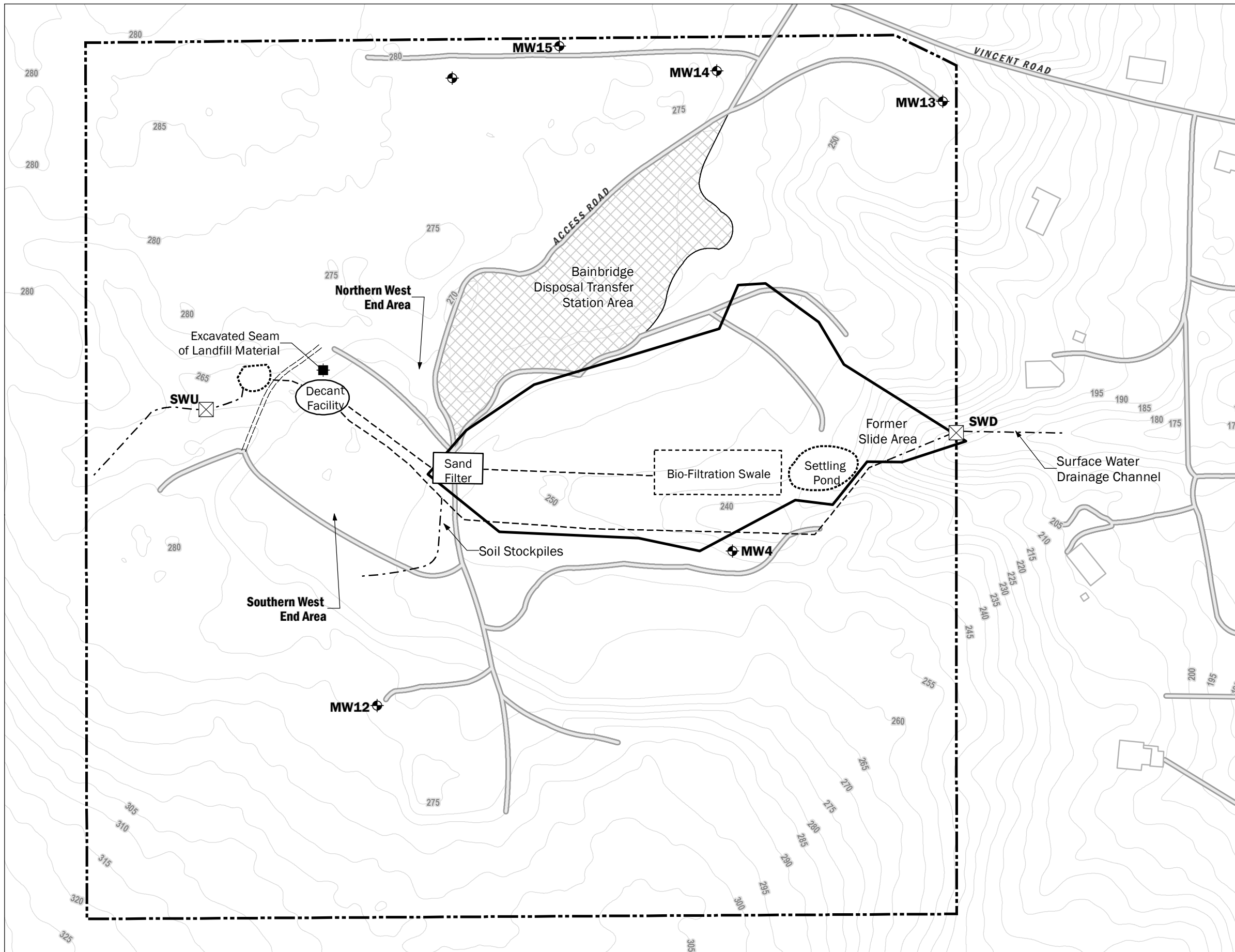











**Site Plan
(Pre-Cleanup Condition)**
Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

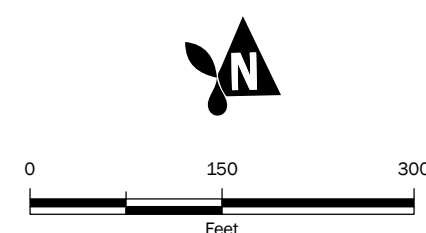
Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

	APR-2018	BY: MLK / KES	FIGURE NO. 1-3
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\GIS\Bainbridge\VincentRoad\anrfill_120097\Delivered_13 Site Plan (Pre-Cleanup Condition).mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/12/2018 | User: jpepin | Print Date: 4/12/2018




-  Monitoring Well
-  Surface Water Sampling Location
-  Surface Water Drainage Channel
-  Approximate Location of Surface Water Diversion Pipe (Buried)
-  Property Boundary
-  Approximate Outline of Final Cover Based on Design Limits
-  Approximate Outline of Pond
-  Gravel or Paved Road
-  Existing Structure

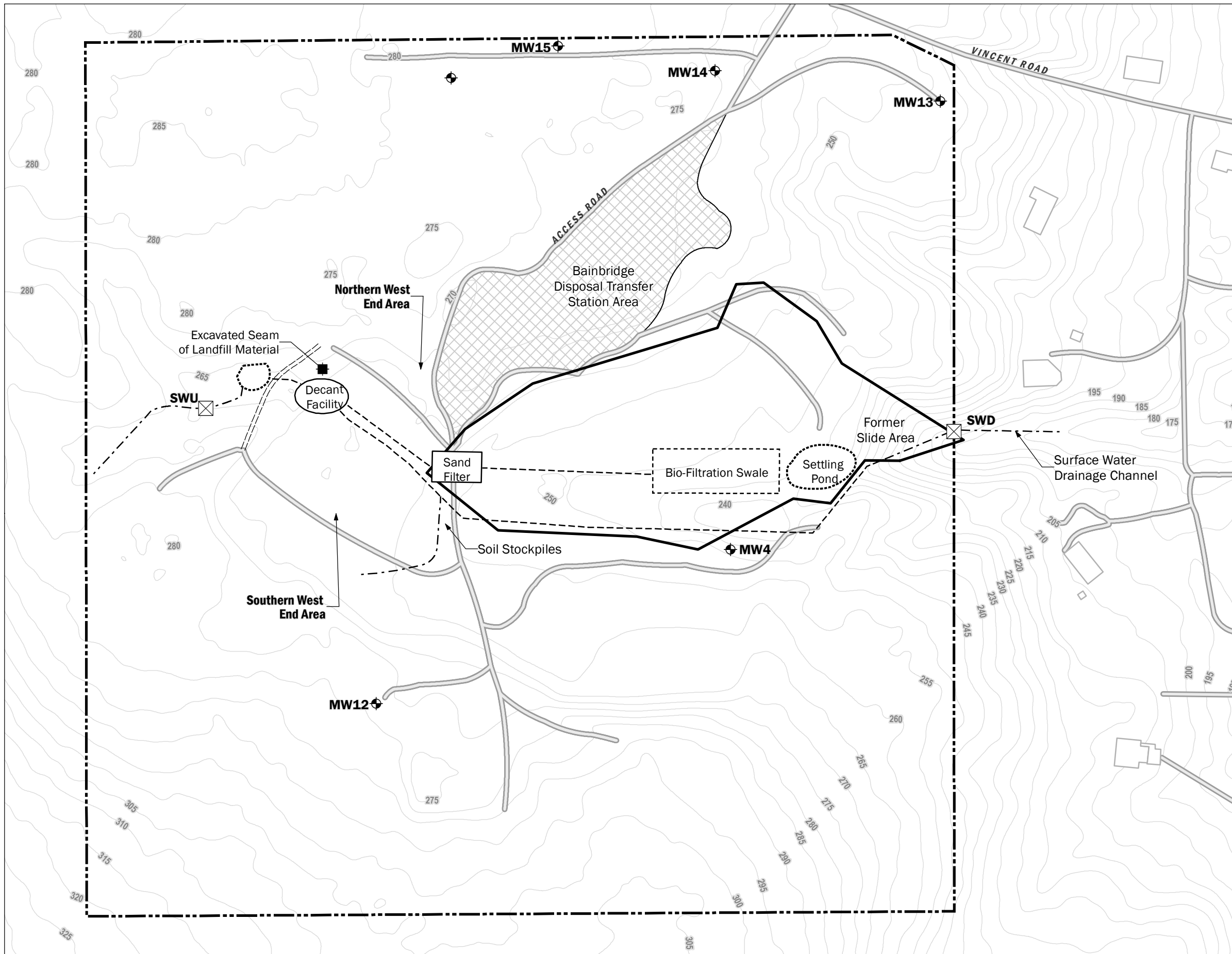











**Site Plan
(Post-Cleanup Condition)**
Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

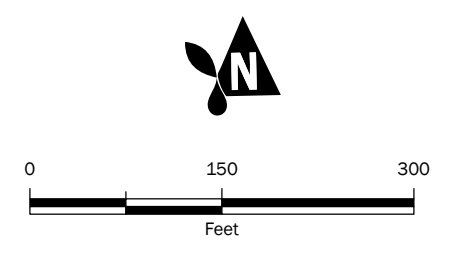
Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

	APR-2018	BY: MLK / KES	FIGURE NO. 1-4
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\CIN\Bainbridge\VincentRoad\anrfill_120097\Delivered_14 Site Plan (Post-Cleanup Condition).mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/4/2018 | User: gppain | Print Date: 4/4/2018



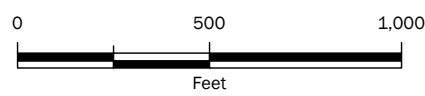
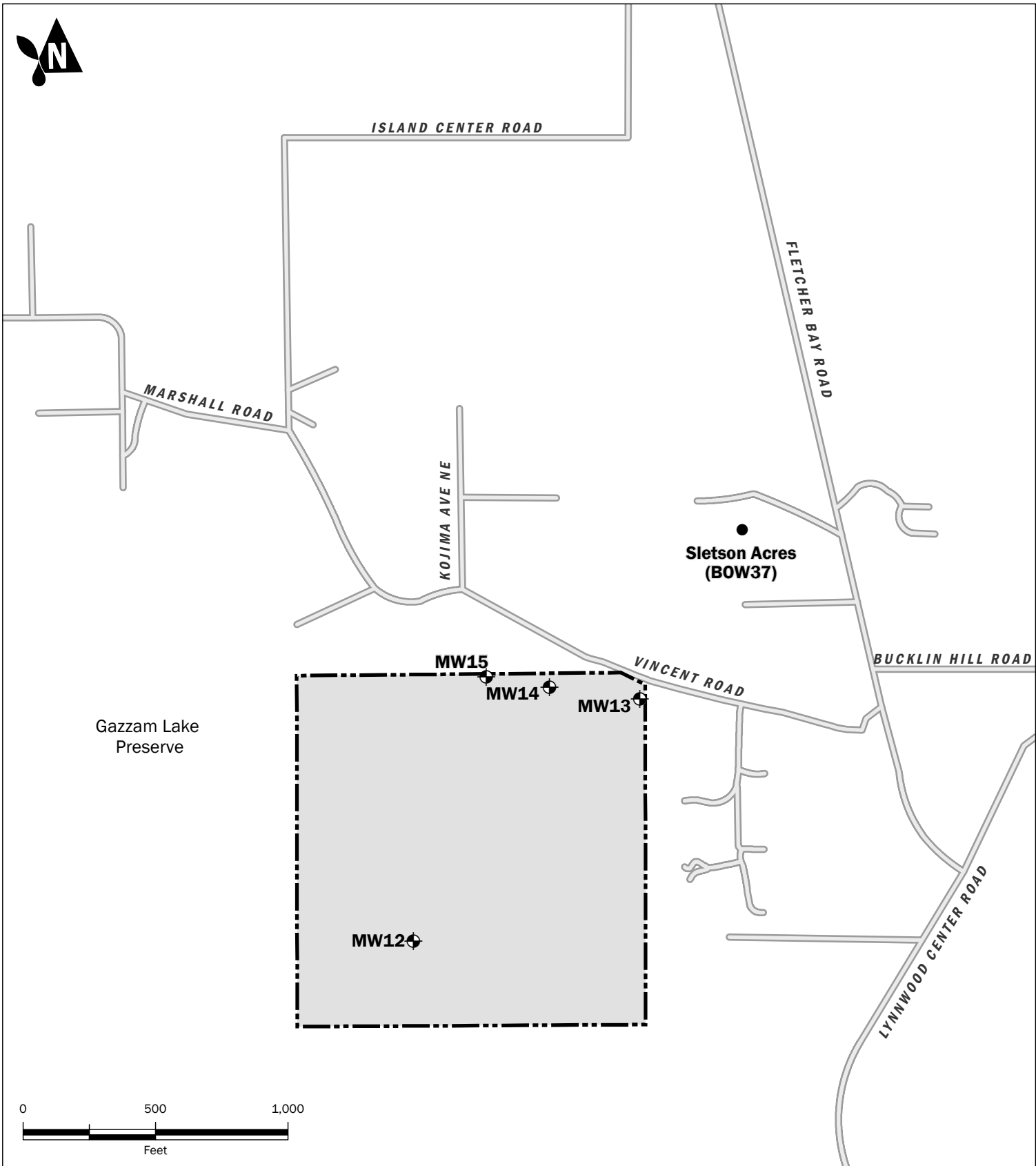
-  Monitoring Well
-  Surface Water Sampling Location
-  Surface Water Drainage Channel
-  Approximate Location of Surface Water Diversion Pipe (Buried)
-  Property Boundary
-  Approximate Outline of Final Cover Based on Design Limits
-  Approximate Outline of Pond
-  Gravel or Paved Road
-  Existing Structure



**Site Plan
(Post-Cleanup Condition)**
Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

Note:
 1. Basemap adapted from First Five-Year Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.

GIS Path: T:\projects_8\GIS\Bainbridge\VincentRoad\landfill_120097_Deliverables\14_Site Plan_Post-Cleanup Condition.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Data Saved: 3/29/2018 | User: mapin | Print Date: 3/29/2018



-  Approximate Monitoring Well Location
-  Approximate Domestic Well Location
-  Bainbridge Island Landfill Property

Monitoring Well Locations

Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

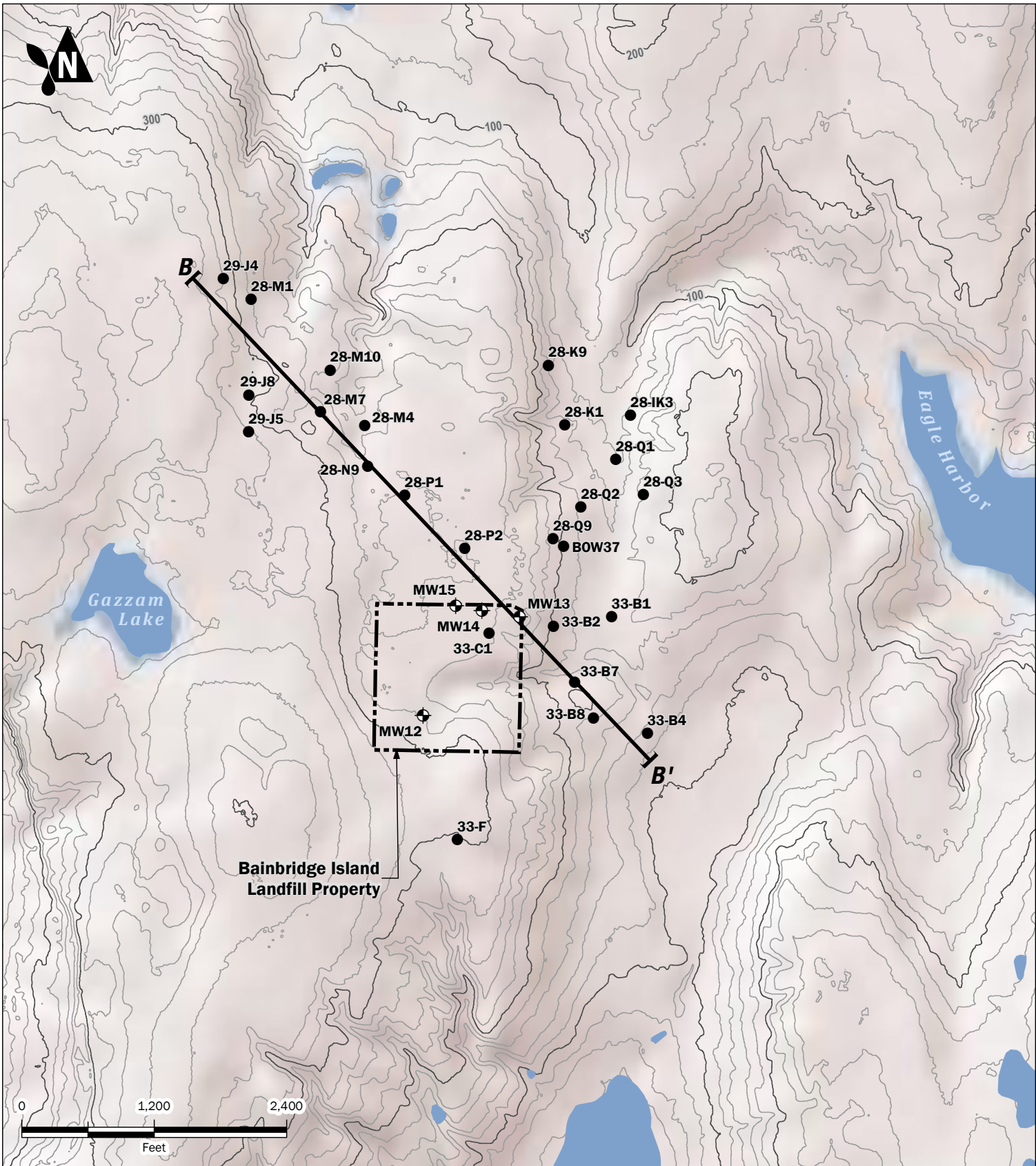
Note:
 1. Features adapted from First Five-Year Review Report (CH2MHill, 2006).






APR-2018
 PROJECT NO.
 120097-0003

BY:
 MLK / KES
 REVISED BY:
 - - -

FIGURE NO.
1-5



-  Approximate Monitoring Well Location
-  Approximate Domestic Well Location
-  Cross Section B-B'

Site Geological Cross-Section Location

Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

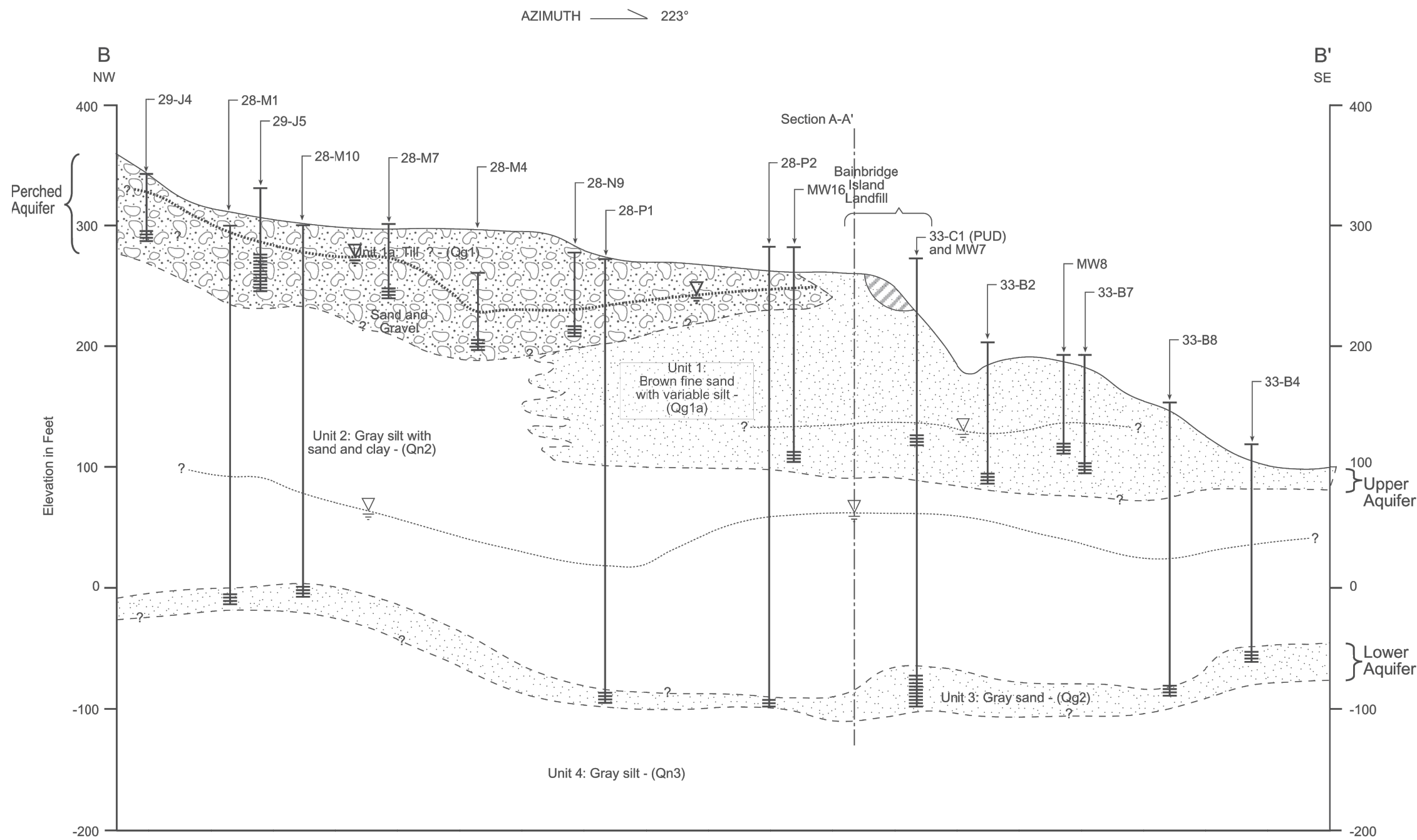
Note:
 1. Features adapted from First Five-Year Review Report (CH2MHill, 2006).
 2. Topographic contours derived from 2015 Bainbridge Island LIDAR project, in NAVD88, ft.



APR-2018
 PROJECT NO.
 120097-0003

BY:
 MLK / KES
 REVISED BY:

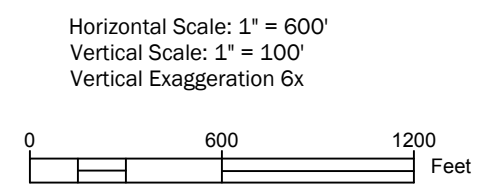
FIGURE NO.
1-6



LEGEND

- 33-F1 Well ID
- Potentiometric surface as reported on well log (depth)
- Well screen interval
- Water bearing zone

Note: For well locations, see Figure 1-6.

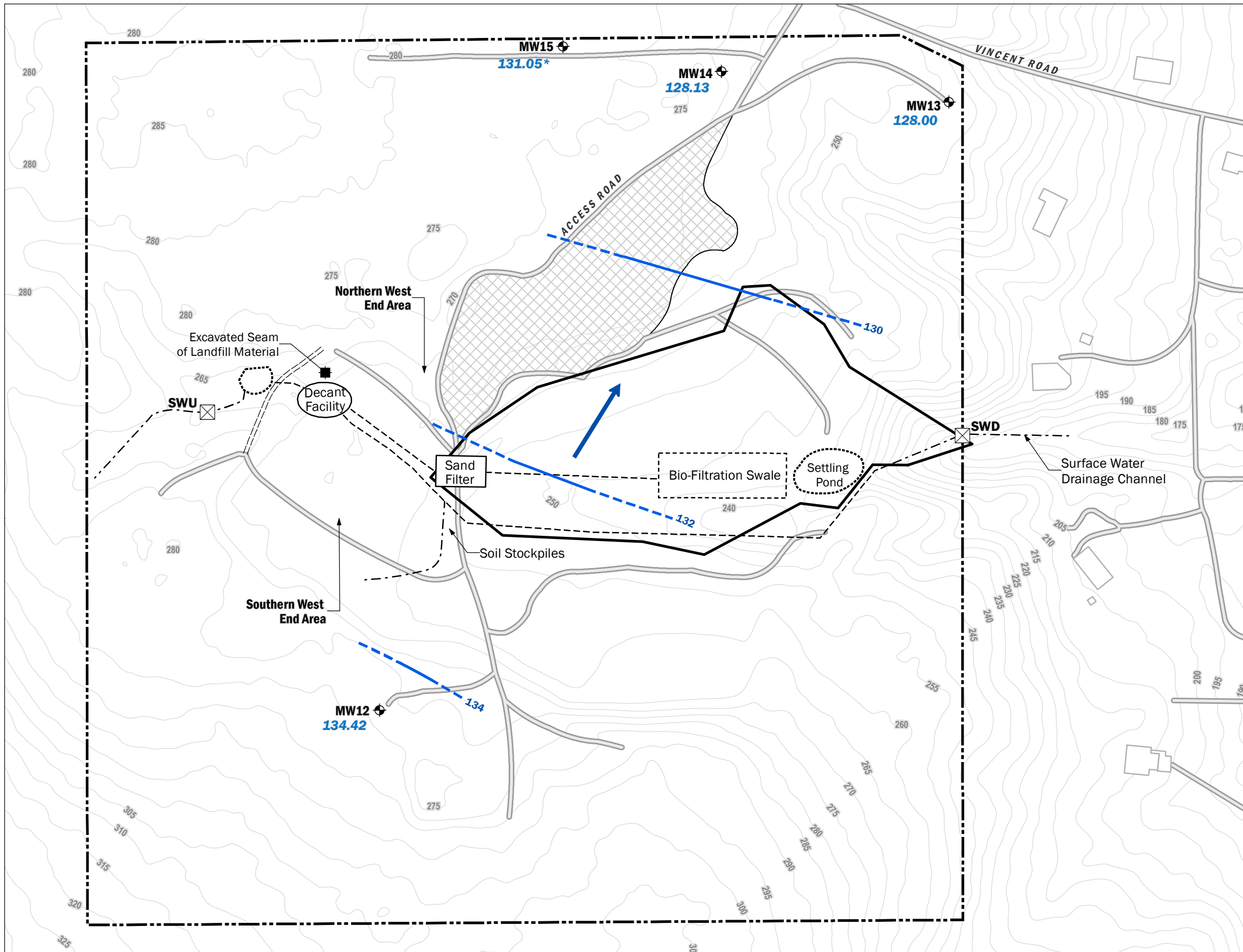


Source: This cross section and all subsurface data are from the *First Five-Year Review Report* by CH2MHill, 2006.

Site Geologic Cross Section B-B'
 Third Five-Year Review Report
 Vincent Road Landfill
 Bainbridge Island, Washington

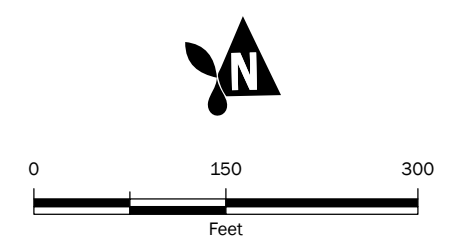
	Mar-2018	BY: MBK/SCC	FIGURE NO. 1-7
	PROJECT NO. 120097-003	REVISED BY: -	

CAD Path: Q:\City of Bainbridge\120097 Vincent Road Landfill\2018-03 5-Year Review Report\120097-AA.dwg Cross Section B-B' CH2MHill || Date Saved: Mar 29, 2018 2:48pm || User: scudd



Well Name → **MW13**
 Water Elevation (ft) → **128.00** Monitoring Well

- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

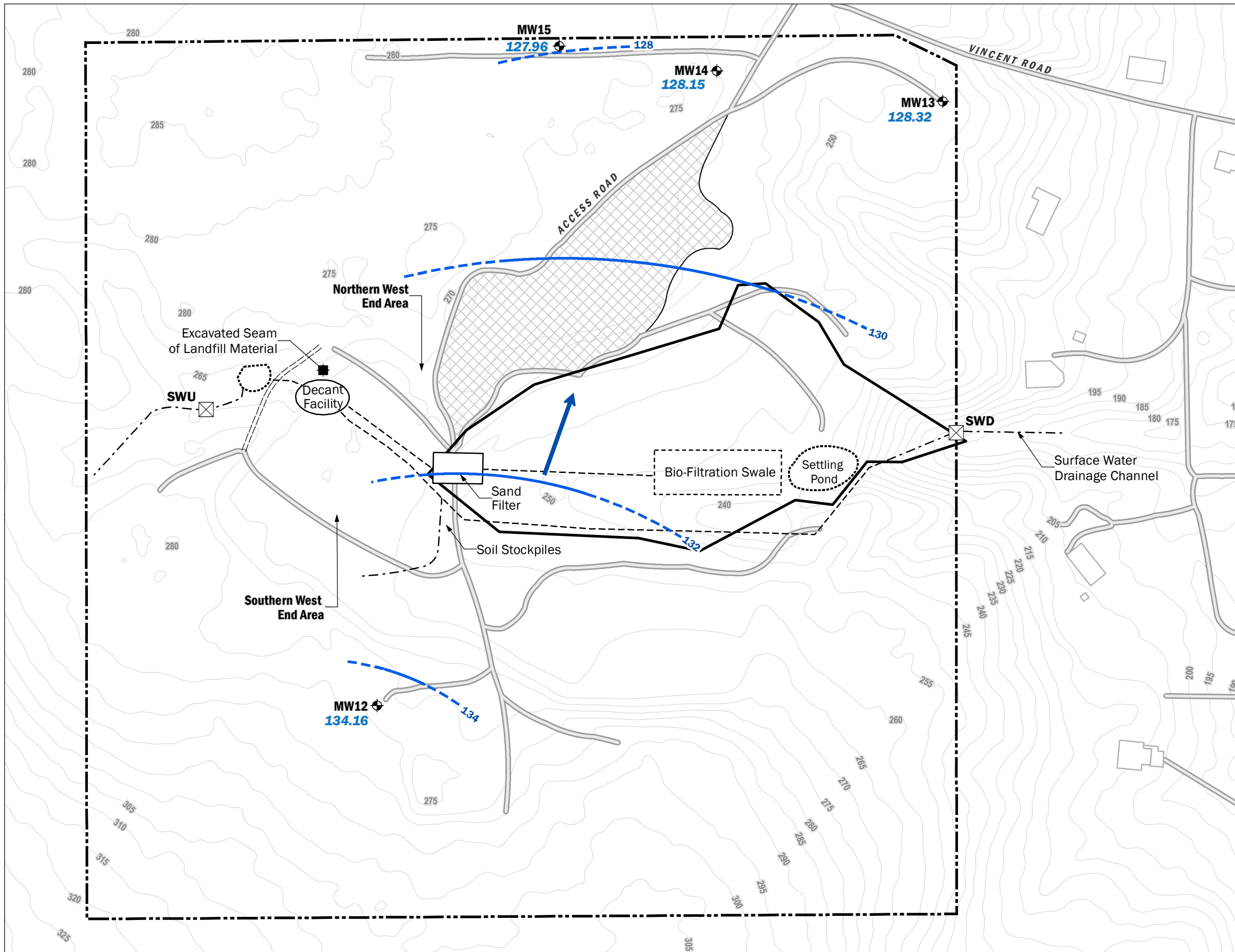


Groundwater Elevation Contour Map
December 18th 2013
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

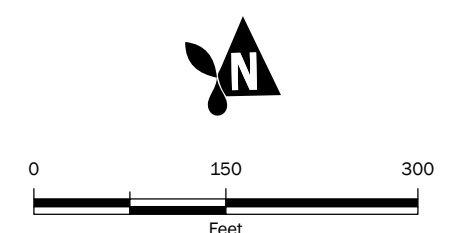
Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.
 *Indicates an anomalously high groundwater elevation that was not included in the interpretation of the groundwater contours or flow direction.

	APR-2018	BY: MLK / KES	FIGURE NO. 1-8
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\GIS\Bainbridge\VincentRoad\ariff_120097\Delivered_13 GW Elevation Contour Map Dec 18 2013.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/4/2018 | User: repin | Print Date: 4/4/2018



- Well Name → **MW13**
Water Elevation (ft) → **128.32** Monitoring Well
- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road



Groundwater Elevation Contour Map

June 12th 2014

Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

Note:

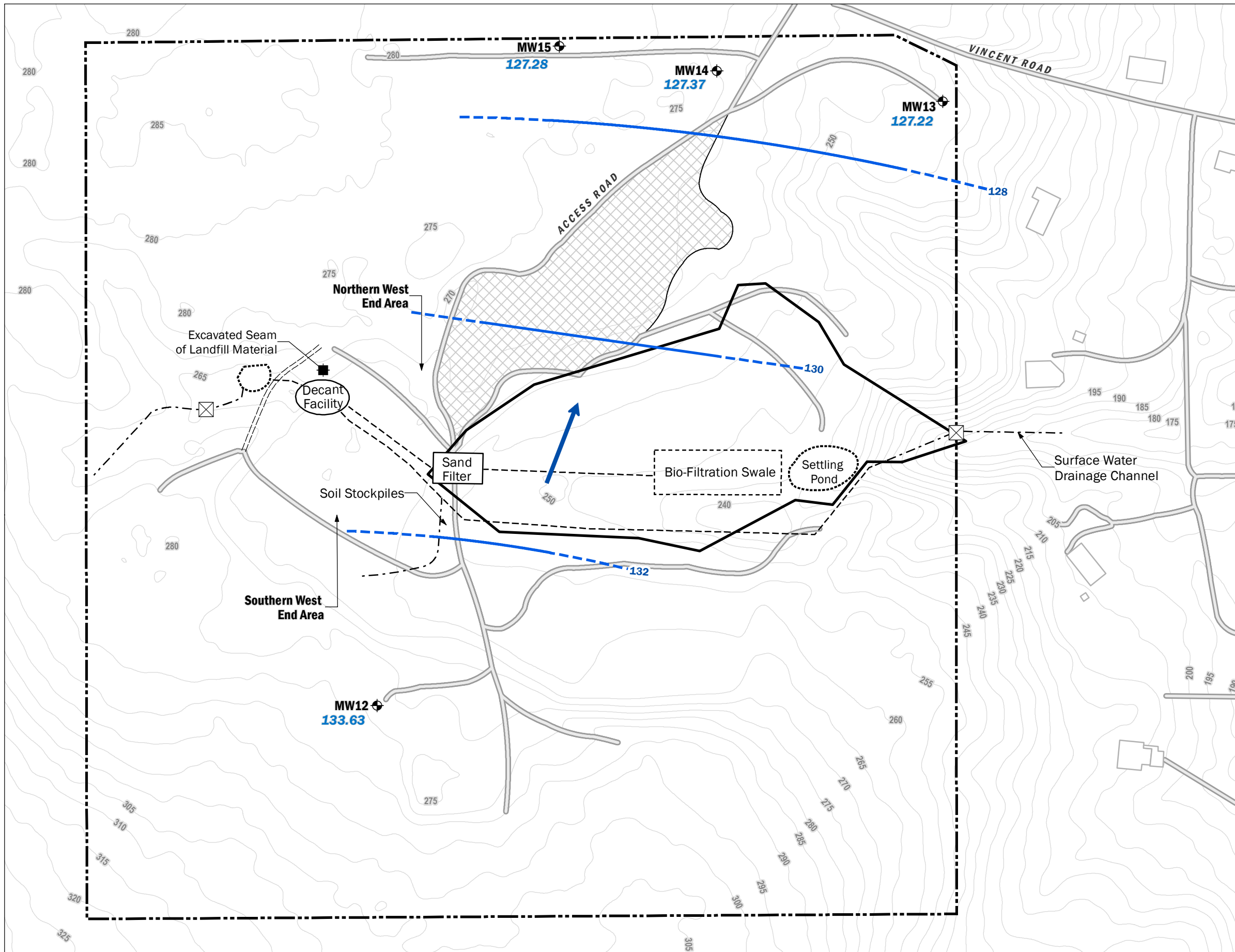
1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
3. Elevations are in NAVD88, ft.



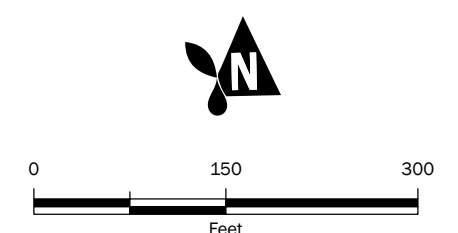
APR-2018
PROJECT NO.
120097-0003

BY:
MLK / KES
REVISED BY:

FIGURE NO.
1-9



- Well Name → **MW13**
Water Elevation (ft) → **127.22** Monitoring Well
- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road



Groundwater Elevation Contour Map December 16th 2014

Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

Note:

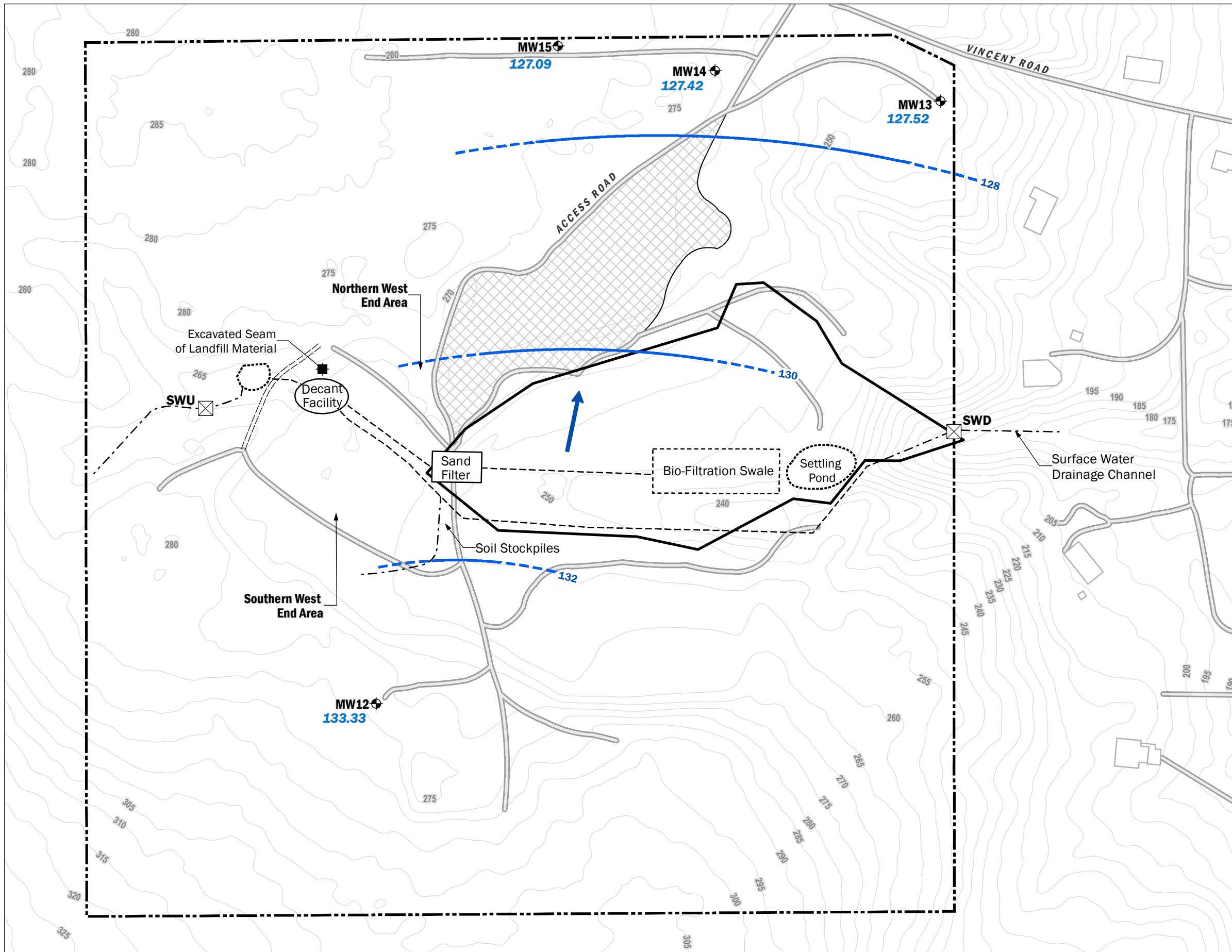
1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
3. Elevations are in NAVD88, ft.



APR-2018
PROJECT NO.
120097-0003

BY:
MLK / KES
REVISED BY:

FIGURE NO.
1-10



Well Name → MW13
Water Elevation (ft) → 127.52

Monitoring Well

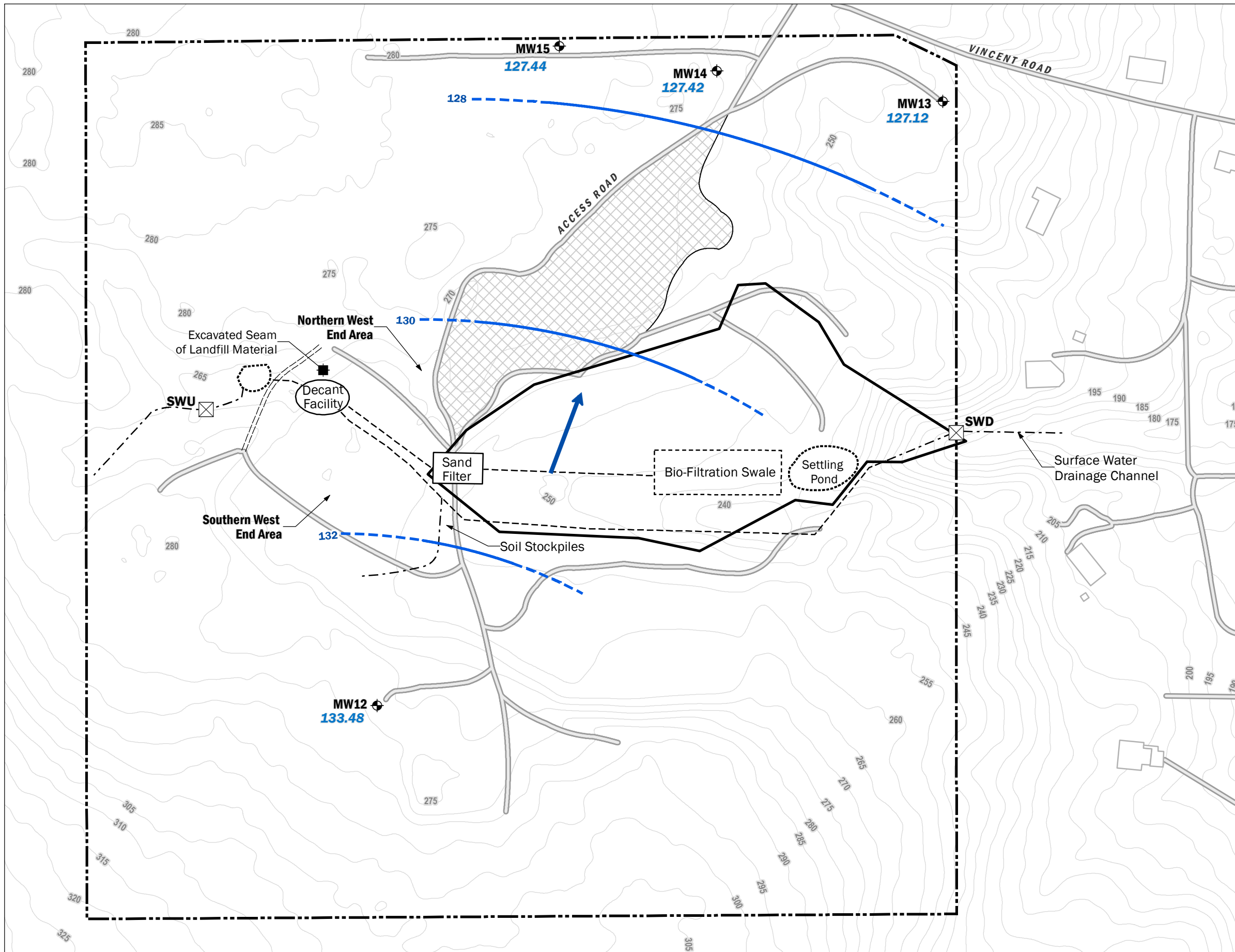
- ⊠ Surface Water Sampling Location
- ➔ Interpreted Groundwater Flow Direction
- ~ Shallow Aquifer Groundwater Elevation Contour
- - - Surface Water Drainage Channel
- - - Approximate Location of Surface Water Diversion Pipe (Buried)
- ▭ Bainbridge Island Landfill Property
- ⊕ Approximate Outline of Final Cover Based on Design Limits
- ⊗ Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

0 150 300
Feet

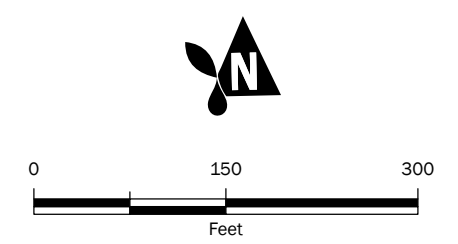
Groundwater Elevation Contour Map
June 16th 2015
Third Five-Year Review Report
Bainbridge Island Landfill
Bainbridge Island, Washington

Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

GIS Path: T:\projects_8\CIN\Bainbridge\VincentRoad\ariff_120097\Delivered_111 GW Elevation Contour Map June 16 2015.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Data Source: 4/4/2015 | User: papin | Print Date: 4/4/2015



- Well Name → MW13
Water Elevation (ft) → 127.12 Monitoring Well
- ⊠ Surface Water Sampling Location
- ➔ Interpreted Groundwater Flow Direction
- ~ Shallow Aquifer Groundwater Elevation Contour
- - - Surface Water Drainage Channel
- - - Approximate Location of Surface Water Diversion Pipe (Buried)
- ▭ Bainbridge Island Landfill Property
- ⊕ Approximate Outline of Final Cover Based on Design Limits
- ⊗ Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

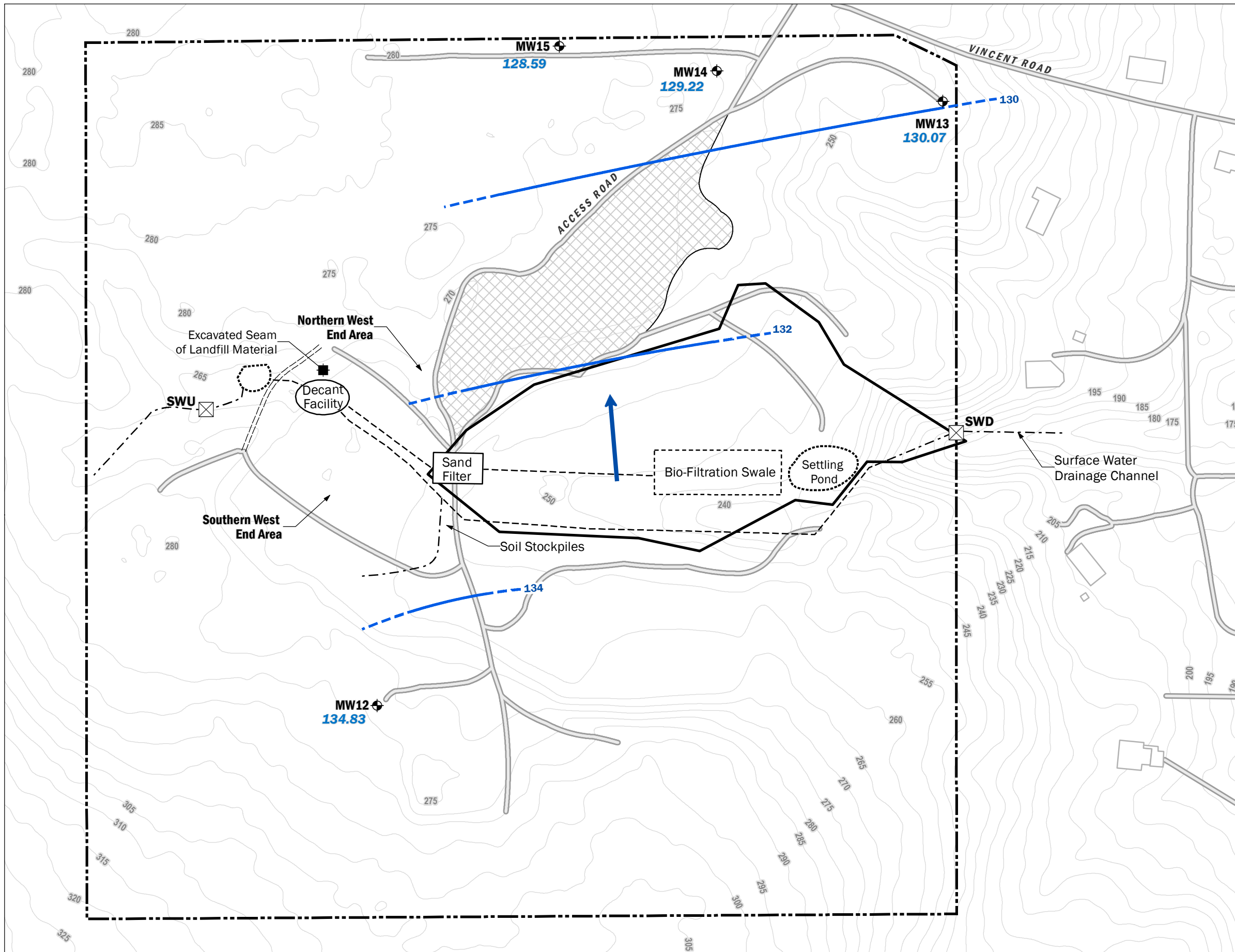


Groundwater Elevation Contour Map
December 21st 2015
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

	APR-2018	BY: MLK / KES	FIGURE NO. 1-12
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\CIN\Bainbridge\VincentRoad\ariff_120097\Delivered_112 GW Elevation Contour Map Dec 21 2015.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Data Source: 4/4/2018 | User: j.papin | Print Date: 4/2/2018



Well Name → **MW13**
Water Elevation (ft) → **130.07** Monitoring Well

- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

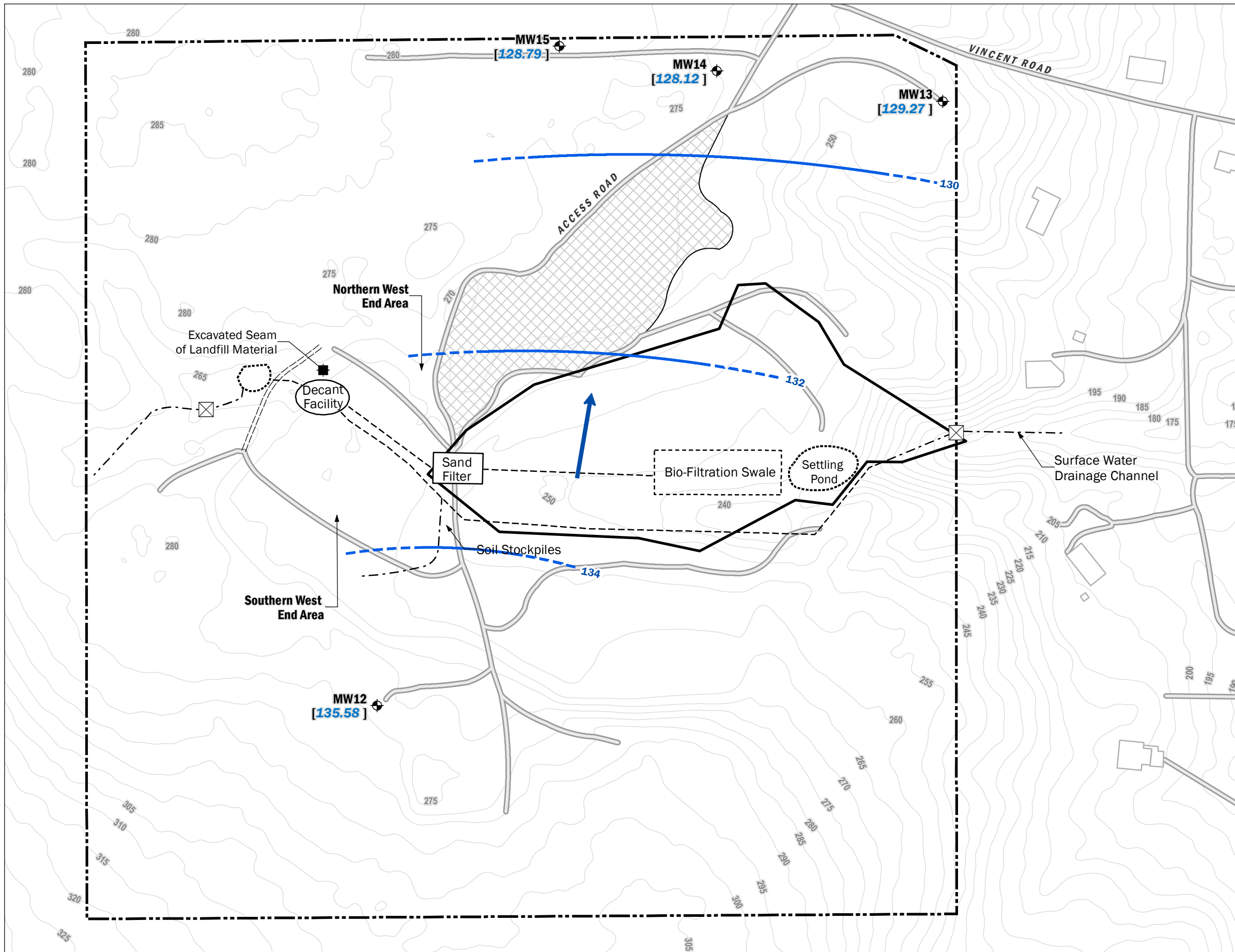
0 150 300
 Feet

Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

Groundwater Elevation Contour Map
June 14th 2016
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	APR-2018	BY: MLK / KES	FIGURE NO. 1-13
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\GIS\Bainbridge\VincentRoad\ariff_120097\Delivered_113 GW Elevation Contour Map June 14 2016.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Data Source: 4/4/2018 | User: papin | Print Date: 4/4/2018



Well Name → **MW13**
Water Elevation (ft) → **129.27** Monitoring Well

- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

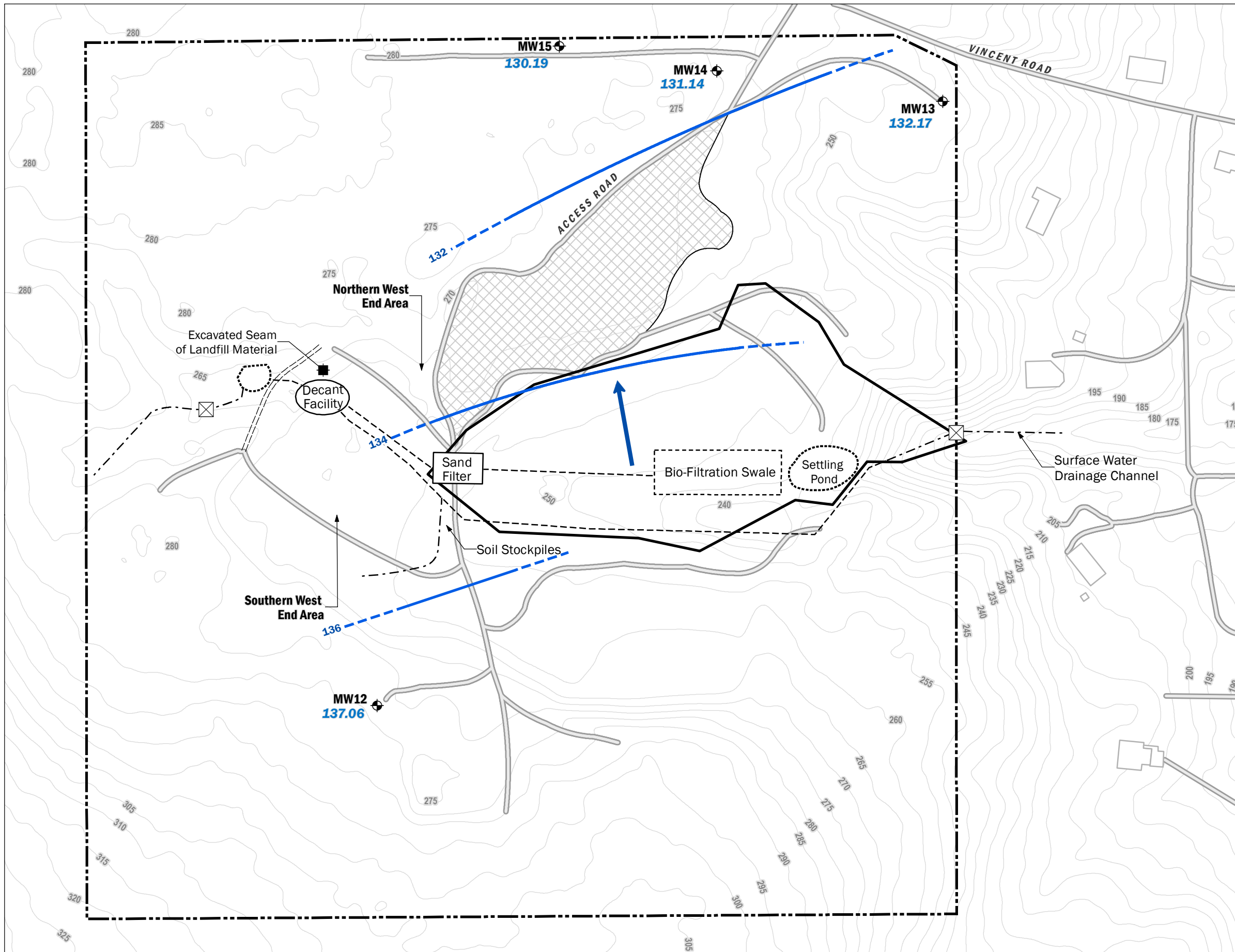
0 150 300
 Feet

Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

Groundwater Elevation Contour Map
December 15th 2016
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	APR-2018	BY: MLK / KES	FIGURE NO. 1-14
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\CIN\Bainbridge\VincentRoad\anr\120097\Delivered_114 GW Elevation Contour Map Dec 15 2016.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/4/2018 | User: mparh | Print Date: 4/4/2018



Well Name → **MW13**
Water Elevation (ft) → **132.17** Monitoring Well

- Surface Water Sampling Location
- Interpreted Groundwater Flow Direction
- Shallow Aquifer Groundwater Elevation Contour
- Surface Water Drainage Channel
- Approximate Location of Surface Water Diversion Pipe (Buried)
- Bainbridge Island Landfill Property
- Approximate Outline of Final Cover Based on Design Limits
- Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

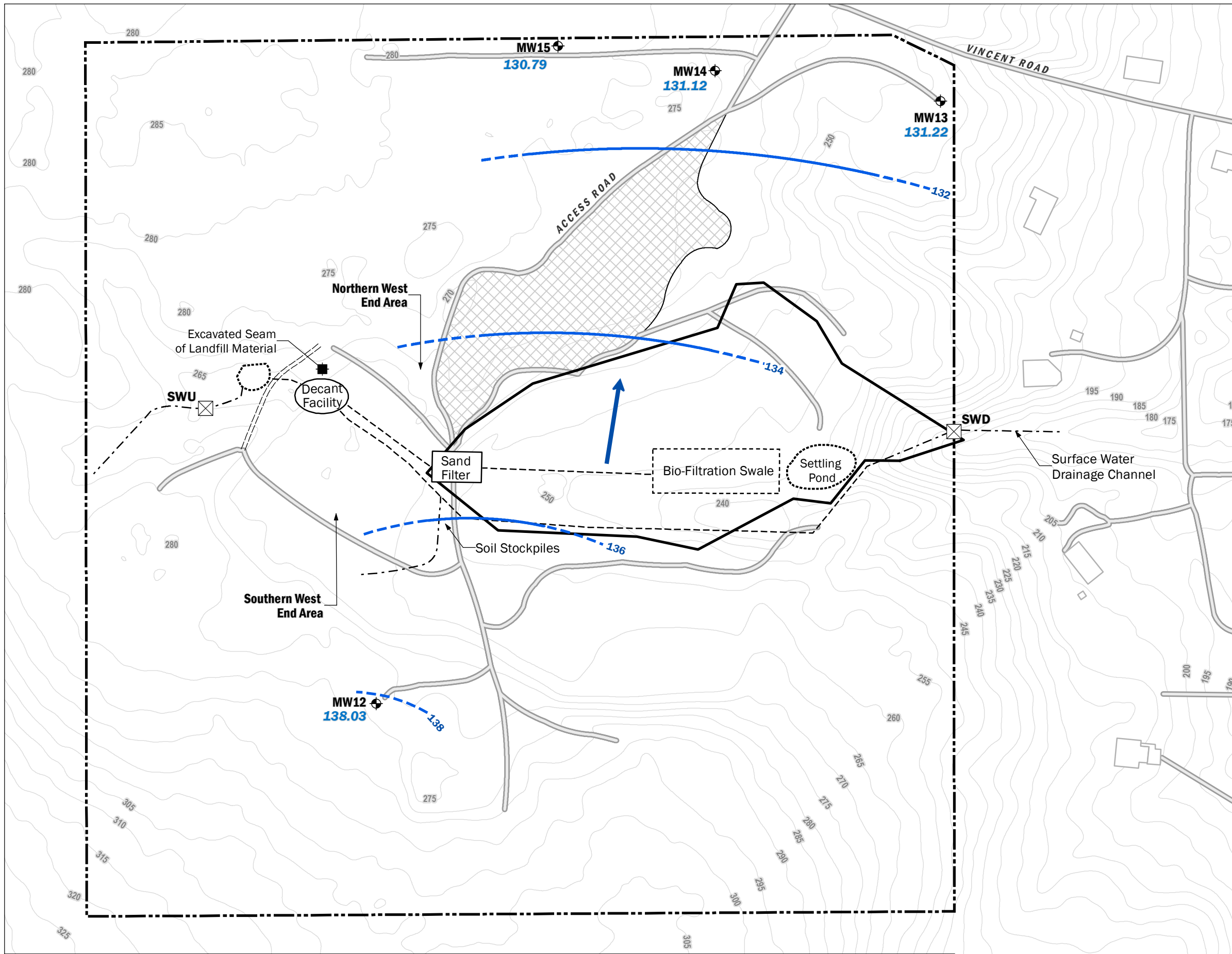
0 150 300
 Feet

Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

Groundwater Elevation Contour Map
June 20th 2017
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	APR-2018	BY: MLK / KES	FIGURE NO. 1-15
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\Projects_8\CIN\Bainbridge\VincentRoad\ariff\120097\Delivered\115 GW Elevation Contour Map June 20 2017.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet | Date Saved: 4/4/2018 | User: jpepin | Print Date: 4/4/2018



Well Name → MW13
Water Elevation (ft) → 131.22
Monitoring Well

- ⊠ Surface Water Sampling Location
- ➔ Interpreted Groundwater Flow Direction
- ~ Shallow Aquifer Groundwater Elevation Contour
- - - Surface Water Drainage Channel
- - - Approximate Location of Surface Water Diversion Pipe (Buried)
- ▭ Bainbridge Island Landfill Property
- ⊕ Approximate Outline of Final Cover Based on Design Limits
- ⊗ Bainbridge Disposal Transfer Station Area
- Approximate Outline of Pond
- Existing Structure
- Gravel or Paved Road

N

0 150 300
Feet

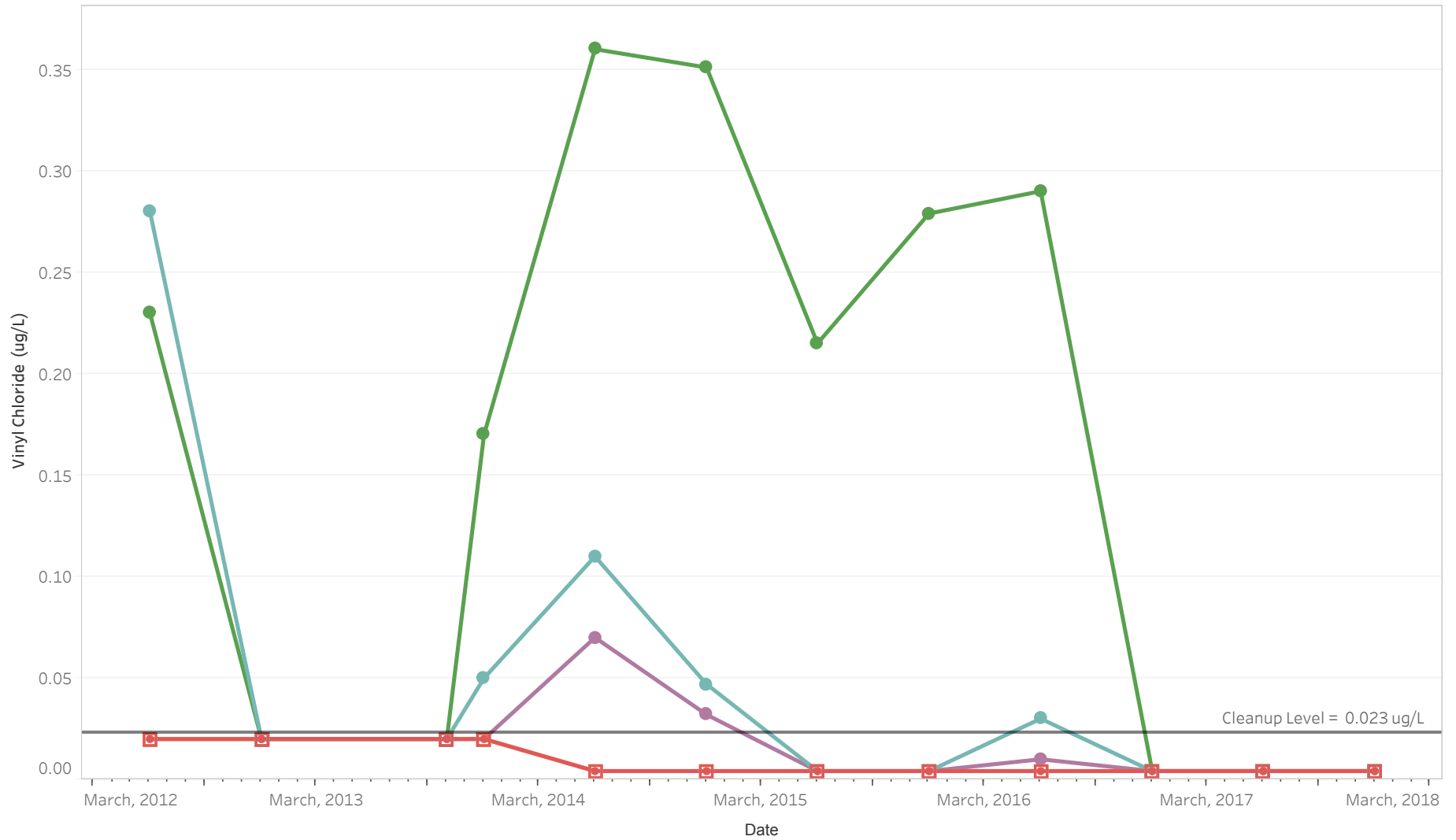
Note:
 1. Basemap adapted from First Five-Year Review Report (CH2MHill, 2006). Landfill features are approximate.
 2. Ground surface elevation contours are 5-foot intervals. Quantum Spatial collected the 2015 Bainbridge Island LiDAR data for the City of Bainbridge Island on July 3rd 2015.
 3. Elevations are in NAVD88, ft.

Groundwater Elevation Contour Map
December 11th 2017
 Third Five-Year Review Report
 Bainbridge Island Landfill
 Bainbridge Island, Washington

	APR-2018	BY: MLK / KES	FIGURE NO. 1-16
	PROJECT NO. 120097-0003	REVISED BY: ---	

GIS Path: T:\projects_8\GIS\Bainbridge\VincentRoad\ariff_120097\Delivered_116 GW Elevation Contour Map Dec 11 2017.mxd | Coordinate System: NAD 1983 StatePlane Washington North FIPS 4901 Feet | Date Saved: 4/4/2018 | User: mepin | Print Date: 4/4/2018

Figure 3-1: Vinyl Chloride Concentrations in Groundwater 2012-2017



Data Series

- BMW-12
- BMW-13
- BMW-14
- BMW-15
- BOW-37

Symbol Explanation

- Detected
- Not Detected

Figure 3-2: Chloride Concentrations in Groundwater 2012-2017

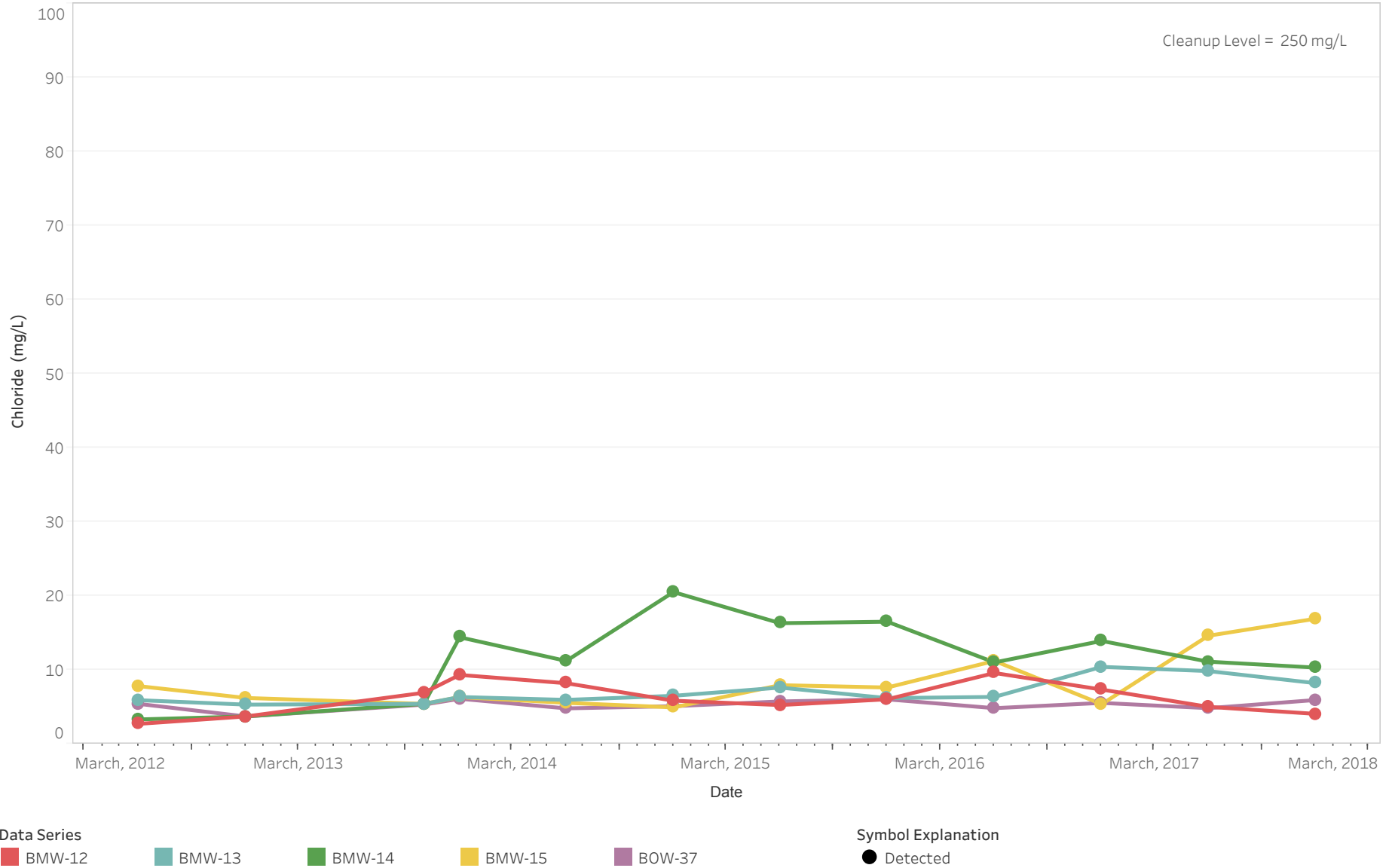


Figure 3-3: Nitrate Concentrations in Groundwater 2012-2017

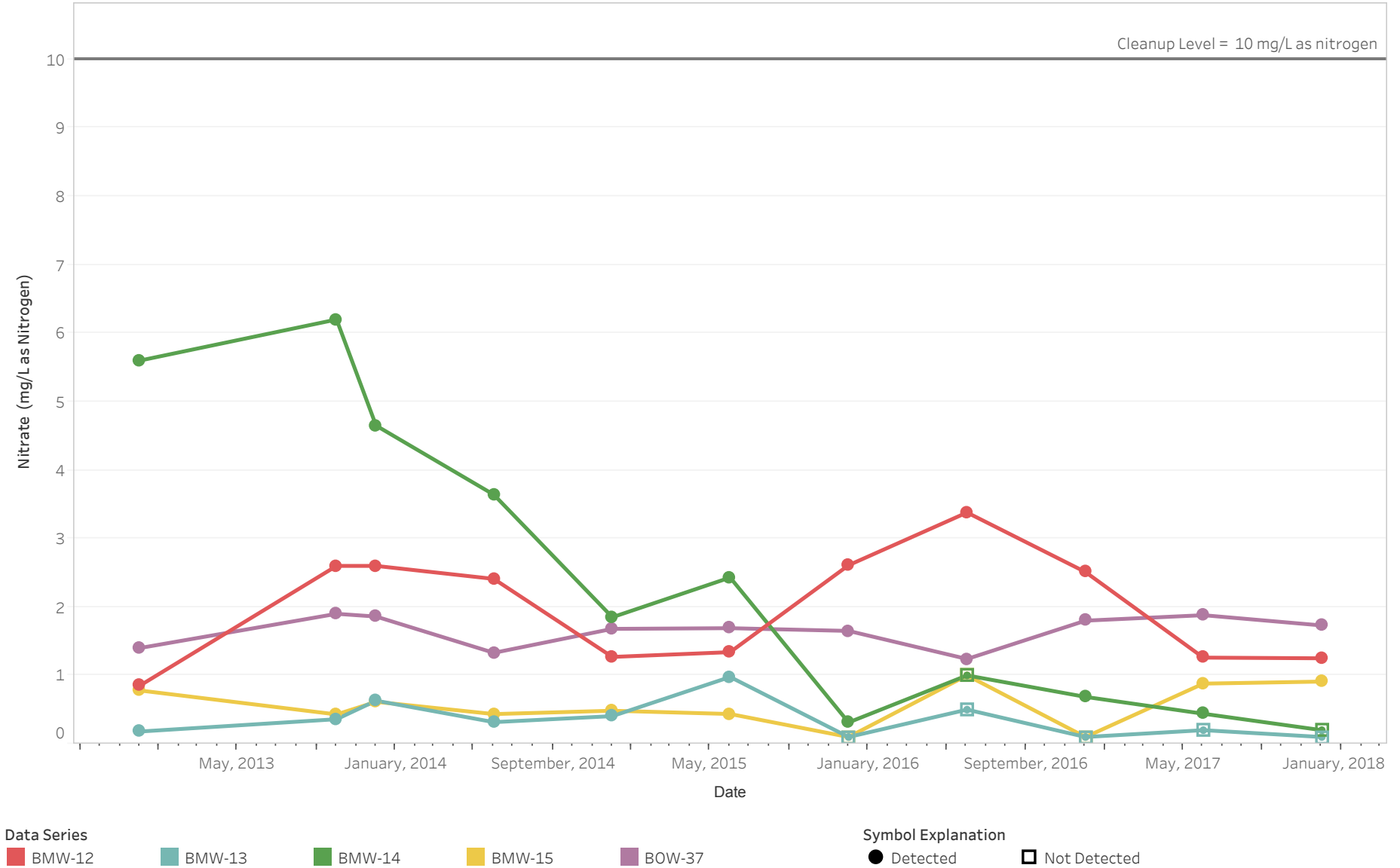
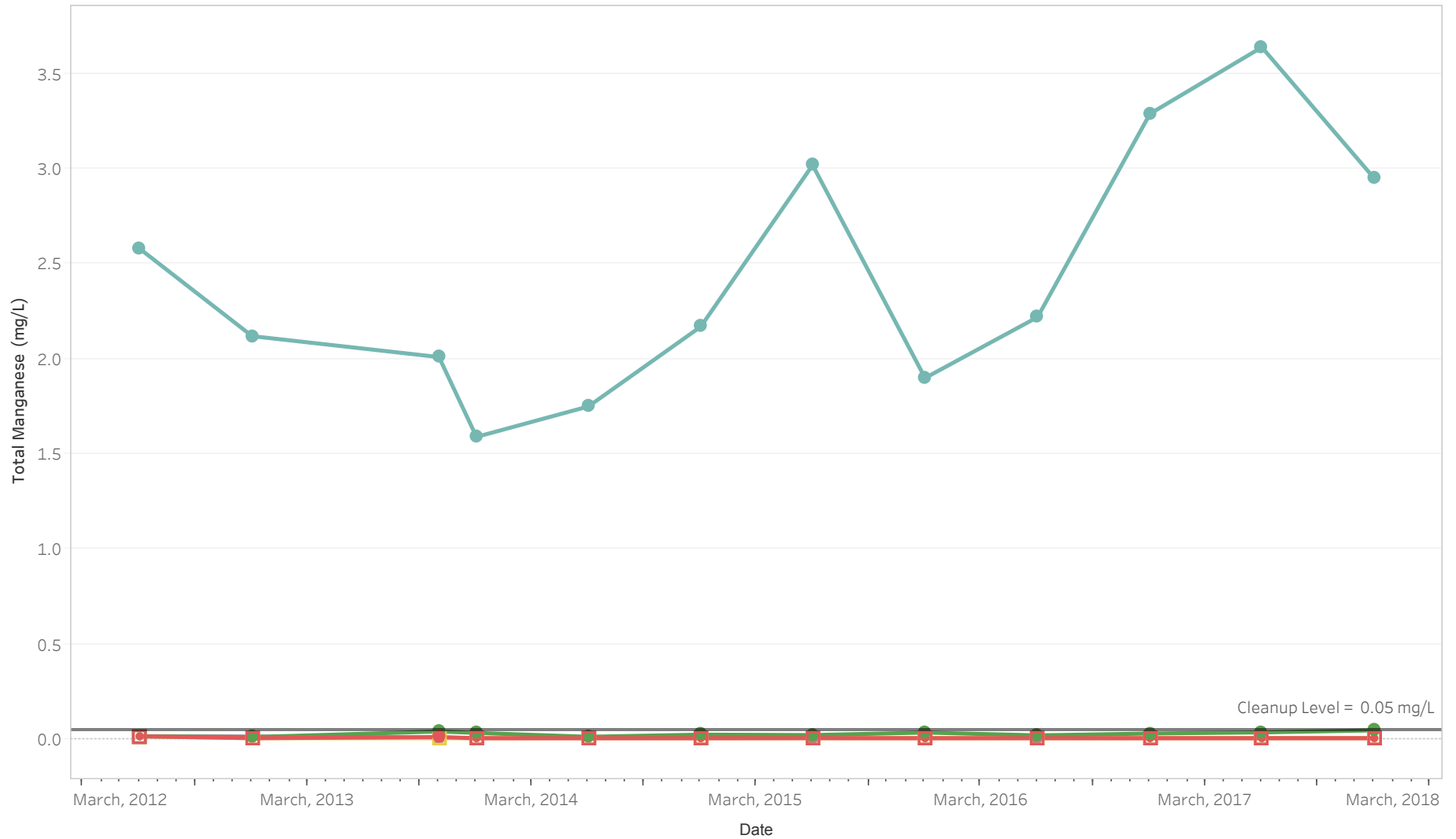


Figure 3-4: Total Manganese in Groundwater 2012-2017



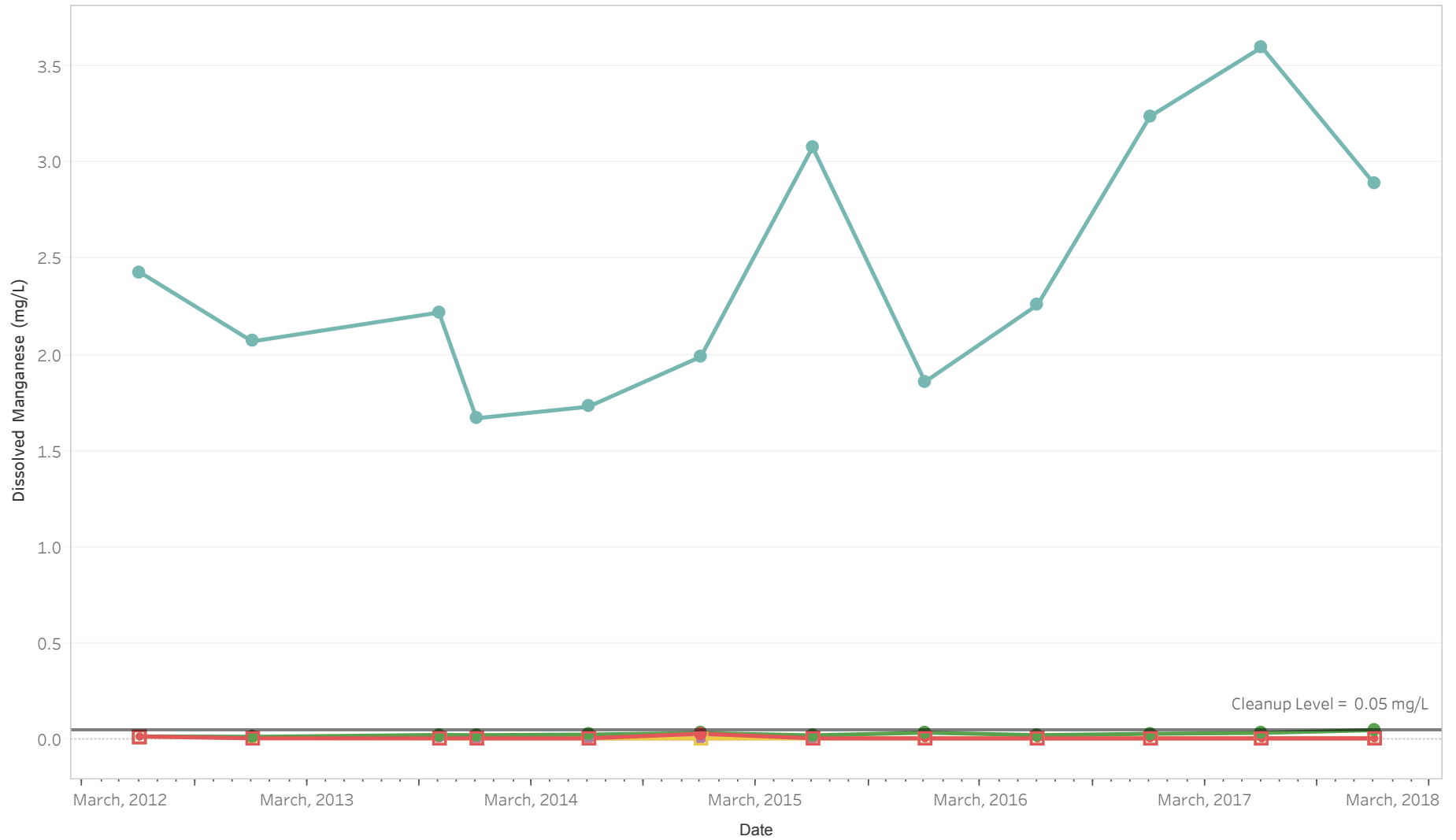
Data Series

- BMW-12
- BMW-13
- BMW-14
- BMW-15
- BOW-37

Symbol Explanation

- Detected
- Not Detected

Figure 3-5: Dissolved Manganese in Groundwater 2012-2017



Data Series

- BMW-12
- BMW-13
- BMW-14
- BMW-15
- BOW-37

Symbol Explanation

- Detected
- Not Detected

Figure 3-6: 1,1-Dichloroethene Concentrations in Groundwater 2012-2017

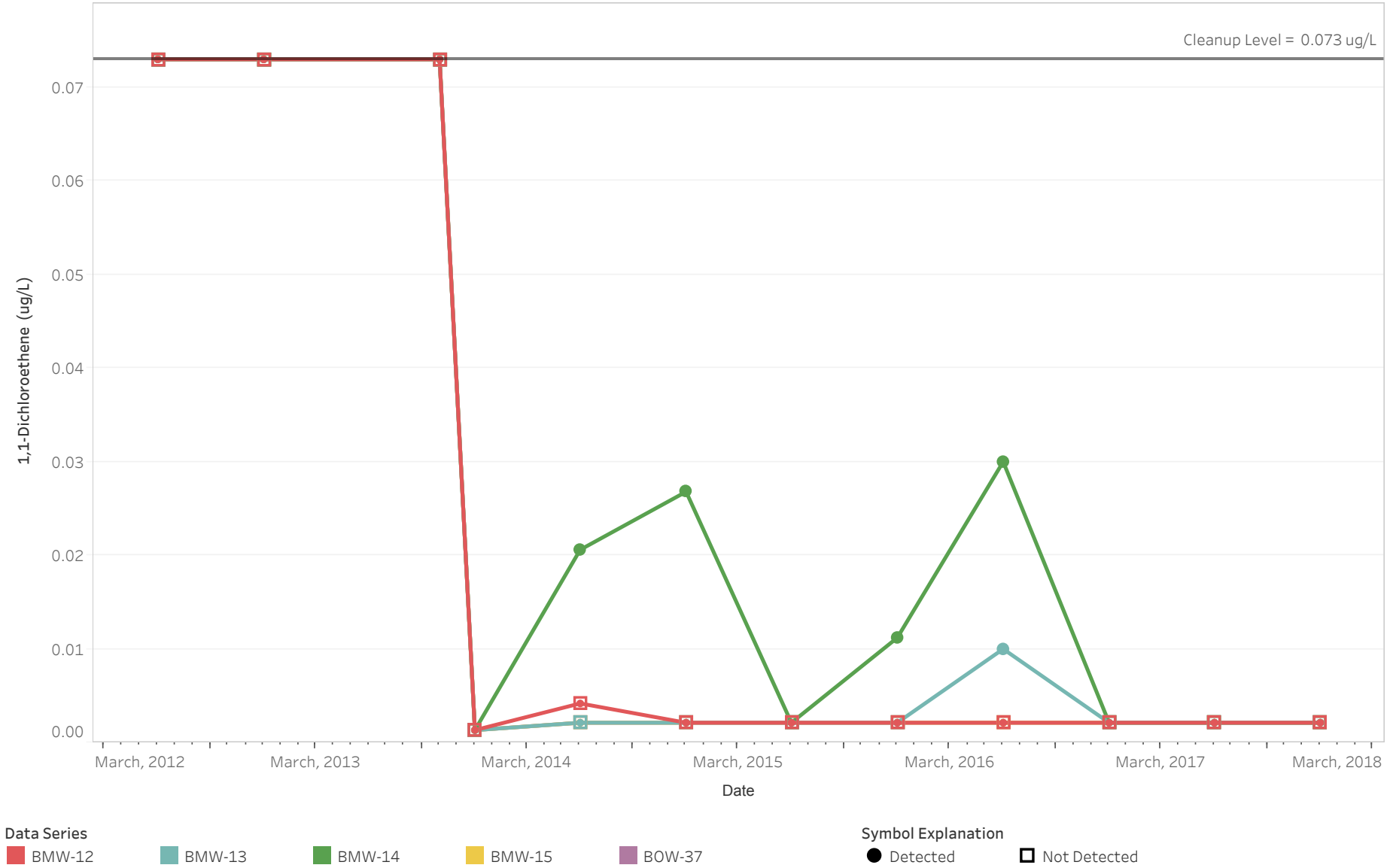


Figure 3-7: Total Iron Concentrations in Surface Water 2012-2017



Data Series

- SW-1U
- SW-4D

Symbol Explanation

- Detected

Figure 3-8: Dissolved Iron Concentrations in Surface Water 2012-2017

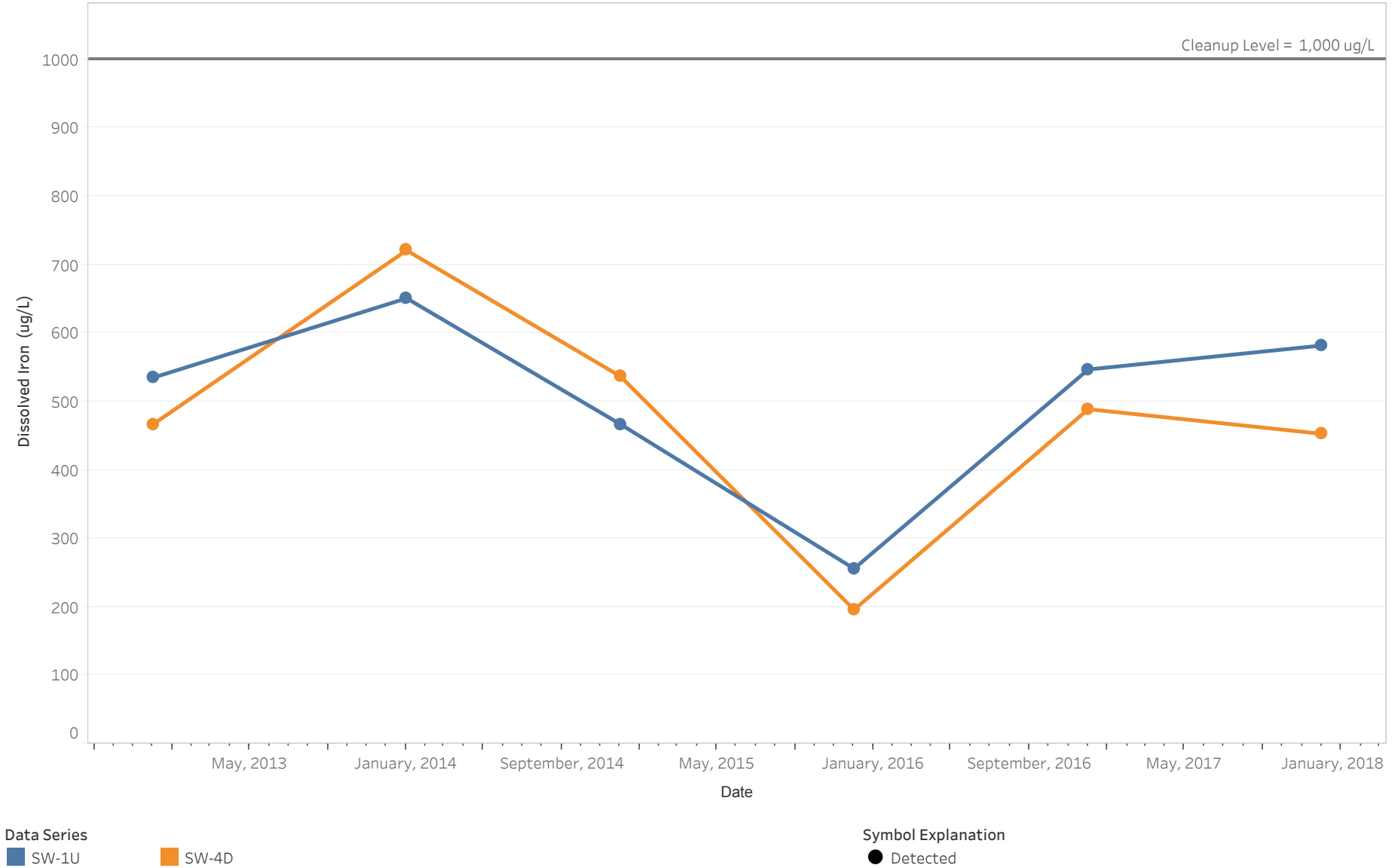
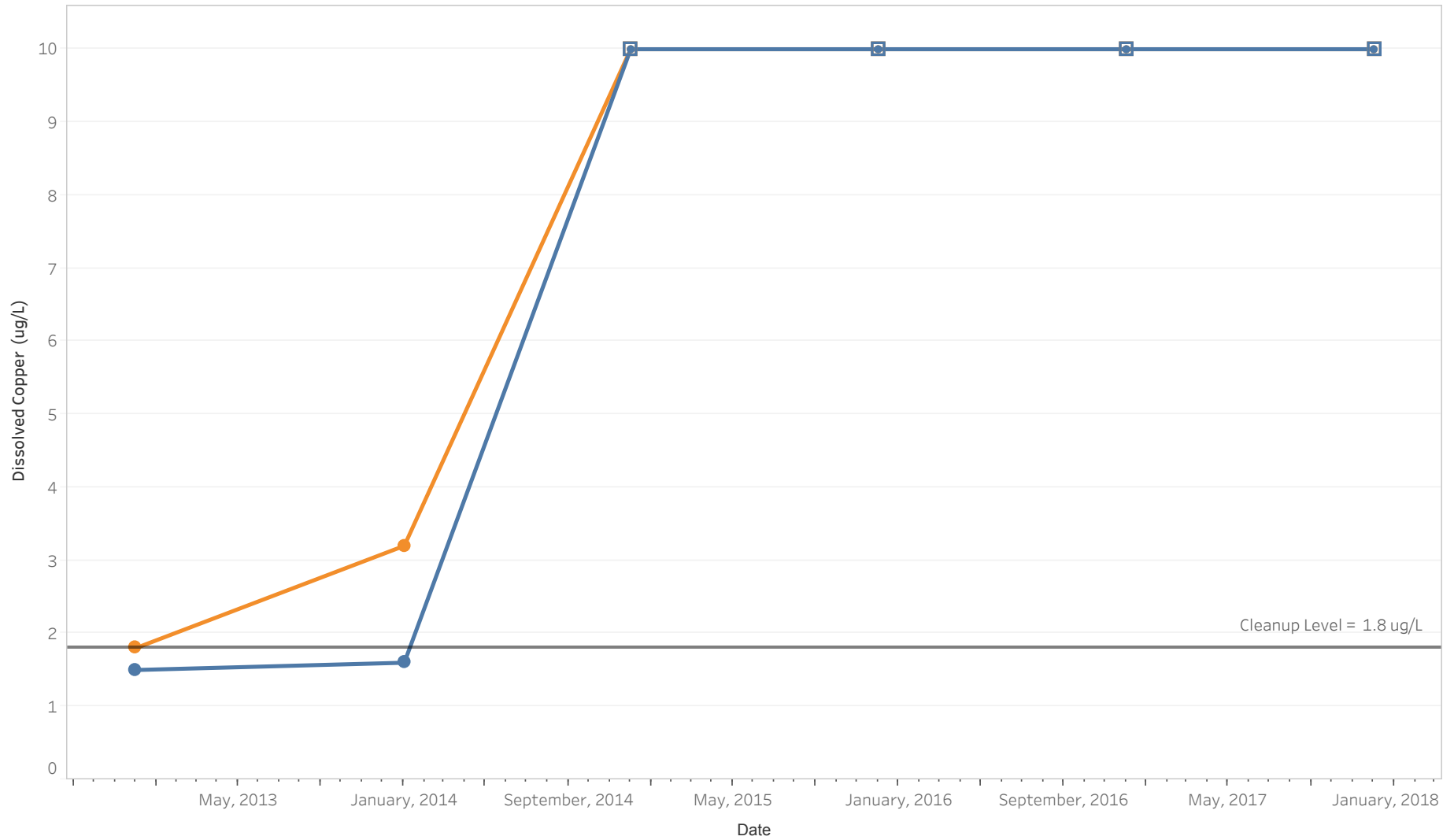


Figure 3-9: Dissolved Copper Concentrations in Surface Water 2012-2017



Data Series

- SW-1U
- SW-4D

Symbol Explanation

- Detected
- Not Detected

APPENDIX A

Kitsap County Public Health Email Summary of Annual Landfill Inspections

From: [Peter S. Bannister](#)
To: [Aron Claiborne](#)
Cc: [Meilani Lanier-Kamaha"o](#)
Subject: FW: Bainbridge Island Closed Landfill
Date: Thursday, March 29, 2018 11:37:53 AM
Attachments: [~WRD000.jpg](#)
[image001.jpg](#)
[image002.jpg](#)
[image003.jpg](#)

Aaron-

I contacted Kitsap Public Health District about any inspections they made at the former Bainbridge Island Landfill.

I spoke with Patrick Hamel, and he provided the email below.

We'll incorporate this info in the 5-year review report.

Thanks-

Peter Bannister, PE | Aspect Consulting LLC | Associate Engineer | Direct: 206.780.7728 | Cell: 206.276.4509

This email is intended solely for the addressee(s) and may contain confidential or legally privileged information. If you are not the intended recipient, please immediately alert the sender by reply email and delete this message and any attachments without storing, copying, distributing, or using the contents.

From: Patrick Hamel [mailto:patrick.hamel@kitsappublichealth.org]
Sent: Thursday, March 29, 2018 11:28 AM
To: Peter S. Bannister <pbannister@aspectconsulting.com>
Subject: Bainbridge Island Closed Landfill

Peter, here is what we have for inspections and document reviews in our database:

Inspections:

- 06/10/08 – No issues.
- 07/08/09 – Downslope and face fixed.
- 08/26/09 – No issues.
- 07/26/10 – No changes, undisturbed.
- 08/24/11 – Unchanged.
- 10/31/12 – No change.
- 09/04/13 – Unchanged.
- 10/02/14 – No Comments.
- 09/30/15 – Recent vegetation removal. Approximately one dozen piles of vegetation remain on site. No apparent problems.
- 12/04/17 – No issues.

Document Reviews:

- 09/21/06 – Review and Comments on 1st 5 year review.
- 09/21/12 – Reviewed Monitoring Data for 2006 to 2012.

This is all I have. Let me know if you have any questions.

Thanks,
Patrick

Patrick Hamel | Environmental Health Specialist

Solid & Hazardous Waste Program

Kitsap Public Health District

345 6th St., Suite 300 | Bremerton, WA 98337

(360) 728-2274 Office | (360) 728-2235 Main

patrick.hamel@kitsappublichealth.org | kitsappublichealth.org