File CG2430.1 E33

Sears Canada Inc.
Remediation Plan

Hounsfield Heights and Mall Areas
Calgary, Alberta

Clifton Associates

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1.0 Introduction

Clifton Associates Ltd., at the request of Mr. Greg Paliouras of Sears Canada Inc., has prepared the following "Remediation Plan" in response to Alberta Environment and Parks (AEPs) Environmental Protection Order No. EPO – 2018/01-SSR (EPO).

The EPO states the "Remediation Plan" is to be submitted by 15 December 2018, and is to include:

- A proposal outlining the remediation and/or risk management plan (RMP) for all substances in, or under the lands and off-Site areas, including all soil, subsoil and groundwater;
- A detailed description of the work that will be undertaken for both the lands and off-site areas to meet the Soil Vapour guidelines as per the Soil Vapour Quality Guidelines for Hounsfield Heights and Mall Areas and the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AEP Alberta Tier 1 Guidelines), as applicable for all other media; and
- A schedule to implement the Remediation Plan by March 2019.

A copy of the EPO has been attached in Appendix of A of this document.

In context of the EPO, the "Lands" refers to the area located on the North Hill Mall property with the civic legal address of Plan 8210266, Block 21 that was previously owned by Sears Canada Inc. and purchased by Concord North Hill GP Ltd. on 18 June 2015. The "Off-Site Areas" refer to any adjacent and down-gradient properties which have been impacted by the historical subsurface release originating from the automotive repair/gas bar ("service station") operated on the Lands between 1958 and 1995. Finally, the term "substances" refers to the presence of any residual petroleum hydrocarbons (PHCs) related to historical release from the former service station within the soil, subsoil and groundwater.

A Site Location Plan and Surrounding Land Use map has been presented as Figure 1 of the attachments. The Lands and Off-Site Areas have been visually depicted on Figure 2 of the attachments. For the remainder of this report, the term "Site" will be used to describe the combined areas of the Lands and Off-Site areas and is comprised of the "Mall Area" and the "Hounsfield Heights Area" as defined in Figure 3.

It is important to note that although this document is being referred to as the Remediation Plan, as stated in the EPO, it is to include a proposal outlining the "remediation and/or risk management plan" for all substances at the Site. Based on the current understanding of the Site, the data gaps resulting from limited Site access within the Hounsfield Heights Area and the logistics of performing remediation in a densely populated urban environment, the proposed plan is risk management focused, with active remediation as means of source removal and plume expansion control.

Sections 2.0 through 8.0 of this report will provide the necessary background information that has been used to form the basis of this Remediation Plan and Schedule, which are presented in Sections 8.0 and 9.0, respectively.

2.0 Project Background

The current location of the Kal-Tire was originally developed as a service station and automotive centre in 1958. The service station was located at the North Hill Shopping Centre on a property owned by Sears, and operated as a Sears Service Centre from 1958 to 1984. From 1984 to 1995, the location was operated under license as a Sunoco Service Station. An addition to the automotive centre building was constructed in 1982, and a separate gas bar kiosk was added in 1989. The original underground storage tanks (USTs) were replaced in 1984, and in October 1995, fuel storage and dispensing facilities at the gas bar were decommissioned. The former Sears Service Centre continues to operate under license to Kal-Tire.

Following the decommissioning of the service station in 1995, several environmental site assessments (ESAs) were completed in the Mall and Hounsfield Heights Areas, which revealed the presence of PHCs within the soil and groundwater, in addition to Liquid Petroleum Hydrocarbons (LPH). The PHCs and LPH are suspected to have resulted from a release from the USTs associated with the former automotive service station on the previously owned Sears property. A detailed description of the ESAs completed between 1995 and 2012 is presented in the *Updated Site Management Plan (2014) – North Hill Mall Area, Calgary, Alberta* (22 September 2014) and the *Updated Site Management Plan (2014) Final Version, Hounsfield Heights – Briar Hill Community, Calgary, Alberta* (11 July 2014).

The Updated Site Management Plans (SMPs) were created following a communication from AEP to Sears, requesting the following information:

- Fully delineate the dissolved plume south of 11th Avenue NW;
- Sample the groundwater adjacent to where it discharges to the surface in the southern portion of Zone 3 (south of 11th Avenue NW) and evaluate it for risk to ecological receptors;
- Delineate the soil gas/vapour plume at the Site;
- Assess potential risks from indoor air infiltration of PHC vapours in areas where the vapour inhalation pathway exceeds guidelines, and in areas where it has been determined that elevated soil gas/vapours are present;
- Establish a soil gas monitoring program on properties that may be at risk from vapour ingress to indoor air. Compare current needs with those previously identified in the Clifton response to Alberta ESRD regarding the soil vapour monitoring (5 April 2007);
- Implement additional remediation techniques to deal with the expanding dissolved phase plume. As previously discussed, this could include enhanced bioremediation. Monitored natural attenuation is not appropriate while LPH is being removed and the dissolved plume is not stable. Multiple remediation approaches are needed to address the PHC impacts;
- Review the groundwater monitoring and sampling program to ensure there is adequate coverage based on current conditions and trends; and
- Apply the AEP 2016 Tier 1 Guidelines to monitoring well locations along 11th Avenue NW and include these wells in the groundwater monitoring and sampling program.

A copy of the communication provided by AEP is presented in Appendix B of the attachments.

To address these requirements, Clifton conducted a series of investigations and prepared plans for approval, including monitoring well abandonment, borehole drilling and well installation, indoor air quality assessment, soil

vapour sampling plan preparation and implementation, a revised Detailed Quantitative Human Health and Ecological Risk Assessment (DQHHERA) and additional delineation.

The above investigations are documented in the following reports:

- Updated Site Management Plan – Groundwater Monitoring Wells Abandonment Report – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, March 2015);
- Sampling Plan for the Limited Indoor Air Quality Assessment of Five Homes Along 11th Avenue in Hounsfield Heights (Intrinsik, July 2014);
- Subsurface Investigation – Mall and Hounsfield Heights Areas, Calgary, Alberta (Clifton, January 2016);
- Revised Soil Vapour Monitoring Program (Update Fall 2016) – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, October 2016);
- Soil Vapour Monitoring Points Installation Report – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, October 2016);
- Human Health and Ecological Risk Assessment for the Hounsfield Heights and North Hill Mall Areas, Calgary, Alberta (Intrinsik, April 2017); and
- Supplemental Phase II Environmental Site Assessment – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, June 2018).

In addition to completing these investigations, routine groundwater monitoring and sampling has been conducted since the implementation of the Updated SMP. The following reports document the groundwater monitoring and sampling program since 2015:

- 2015 Third Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, 2015);
- 2015 Fourth Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, 2015);
- 2016 Second Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, 2016);
- 2016 Fourth Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, February 2017);
- 2017 Second Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, July 2017); and
- 2018 Second Quarter Monitoring and Sampling Report – Hounsfield Heights and Briar Hill Community, Calgary, Alberta (Clifton, May 2018).

Upon approval of the Soil Vapour Monitoring Program and installation of the soil vapour probes, Clifton conducted the following soil vapour sampling programs as part of the on-going risk management of the Site:

- Soil Vapour Monitoring Report, Spring 2016 – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, December 2016);
- Soil Vapour Monitoring Report, Winter 2017 – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, July 2017); and

- Soil Vapour Monitoring Report, Summer 2017 and Spring 2018 – Hounsfield Heights and North Hill Mall, Calgary, Alberta (Clifton, May 2018).

All reports referenced above can be accessed for review through the AEP Environmental Site Assessment Repository database by entering a PBL search for Plan 8210266.

3.0 Site Overview

The Site consists of two distinctive areas - the Hounsfield Heights Area and the North Hill Mall (Mall) Area, defined as follows:

- The Hounsfield Heights Area is bound by: the southern edge of the LRT line to the north; 14th Street NW to the east; 10th Avenue SW (extending west to 17A Street NW) to the south; and, 17A Street NW to the west. The area is zoned as residential, as it primarily consists of single detached dwellings with basements. There are three areas of the Site that are zoned as Special Purpose: Hounsfield Heights Park; a parcel of land along 10th Avenue SW between 16th Street NW and 16th A Street NW; and the area between the LRT line and 13th Avenue NW; and
- The Mall Area is bound by: 16th Avenue NW to the north; 14th Street NW to the east; the northern edge of the LRT line to the south; and the western edge of the North Hill Centre property and a line extending south to the northern edge of the LRT line to the west.

Capitol Hill, a residential area, is located to the north of the Site. To the east is SAIT Polytechnic and the Alberta College of Art & Design. Hillhurst and Briar Hill, both residential communities, are found south and west of the Site, respectively.

The Site topography is characterized by a gently south-sloping river valley plateau on the northern portion of the Site, and a more moderately sloping valley wall towards the southeast portion. The Site varies in elevation from approximately 1,094 m above sea level (m asl) in the northwestern corner along 13th Avenue NW, to approximately 1,068 m asl in the southeastern corner, north of the intersection of 15th Street NW and 10th Avenue NW.

4.0 Site Geology and Hydrogeology

4.1 Lithology

The observed lithology in the upper layers of the Site includes: an upper silty sand unit, a clayey silt unit with occasional interbedded fine silt lenses; and, a lower interbedded sandy silt unit with coarse silt seams. However, the lithology significantly differs with depth and varies from north to south, as units outcrop on the hillside.

Eight lithologic cross-sections were developed to visually characterize the geology under the Site. The lithological cross-sections are presented in Appendix C1.

4.1.1 North – Mall Area

4.1.1.1 Unit 1 – Upper Silty Sand

The upper silty sand unit consisted of a brown, well-sorted, fine- to medium-grained, loose sand near the surface that transitioned to a silty sand through the formation, with more clays near the base. Trace gravels were found in the material and the sand becomes wet near the base. The unit is approximately three and a half to five meters thick in the northern portions of the Mall Area, and decreases in thickness from west to east, while increasing in thickness as the unit extends to the south.

4.1.1.2 Unit 2 – Upper Clayey Silt

The upper clayey silt unit consists of a brown, moist, plastic clay near the top of the unit that transitioned to a silty clay or clayey silt through the formation, with more silt near the base. Trace sand and gravels are found in the material. The unit is approximately two meters thick in the northwestern portions of the Mall Area, and increases in thickness from west to east, to approximately four meters. The unit increases in thickness as the unit extends to the south to a maximum thickness of approximately nine meters in the west within the northern section of the Hounsfield Heights Area. In general, as the formation moves towards the east, the unit thickens and then maintains a relatively constant thickness of approximately four meters.

4.1.1.3 Unit 3 – Middle Sandy Silt

The middle silty sand unit consists of a brown, fine-grained, loose sand near the top of the formation that transitions to a silty sand through the formation, with more clays near the base. Trace gravels are found in the unit, and the sand is wet throughout. The unit is approximately seven to ten meters thick in the northern portions of the Mall Area, and decreases in thickness from west to east, while increasing in thickness as the unit extends to the south in the central portion of the Site. The unit decreases in thickness from north to south in the western portion of the Site, while maintaining a constant eight meters in thickness on the eastern portion of the Site.

4.1.1.4 Unit 4 – Lower Clayey Silt

The lower clayey silt unit consists of a grey, medium-plastic clay near the surface of the unit that transitions to a silty clay or clayey silt through the formation, with more clay near the base. The unit is approximately three meters thick in the west-central portions of the Site, at the northern portions of the Hounsfield Heights Area. In the western portions of the Site, the unit pinches out midway into the Hounsfield Heights Area. In the north-central portions of the Mall Area, the unit is approximately eight meters thick and decreases in thickness from north to south, to approximately one meter in the far south. In the eastern portions of the Site, the unit maintains a fairly consistent one to three-meter thickness, decreasing in thickness to the south.

4.1.1.5 Unit 5 – Undefined Silty Sands and Gravels

Unit 4 is underlain by deposits of silt, sand, and gravel. This underlying unit is quite variable, and insufficient stratigraphic data is available to establish this as a consistent, defined unit. For the purposes of this Remediation Plan, we have identified the unit underlying Unit 4 as Unit 5 – Undefined Silty Sands and Gravels.
Unit 5 is a silty sand and gravel unit consisting of a rounded gravel with loose sand, occasional cobbles, and trace silt and clay. The gravel is wet throughout.

4.1.2 Central – Hounsfield Heights Area

The lithology in the central portion of the Site is very much as described for the Mall Area, except that the river valley slope begins a steep decline to the south.

4.1.3 South – Hounsfield Heights Area

The lithology in the southern portion of the Site is as previously described; however, there is a significant slope between 13th Avenue NW and 11th Avenue NW. This elevation change has Unit 1 truncating near 11th Avenue, while Unit 2 is continuous in the western portions of the Site to midway between 11th Avenue NW and 10th Avenue NW. Unit 2 truncates at the surface south of 11th Avenue NW in the central and eastern portions of the Site.

Several residential properties (beginning approximately 50 m south of 11th Avenue NW) have Unit 3 soils at or near the surface. Homes with basements or foundations crossing the 1,078 m asl reference have likely encountered the top of Unit 3. Therefore, homes built on the 1,081 m asl surface contour that have basements are likely in contact with Unit 3. Based on work completed in 2017 and 2018, Unit 3 truncates north of 10th Avenue NW.

4.2 Hydrogeology

There are currently 120 groundwater monitoring wells on-Site. Each well has been screened across a selected lithologic interval to collect representative samples to characterize the groundwater specific to that unit. The groundwater elevation on-Site varies from 1061 m above sea level (asl) to 1086 m asl.

The groundwater flow direction is consistently determined for the uppermost four lithologic units. A discussion of the groundwater flow direction for Units 1 to 4 are provided below, and in Appendix C2.

4.2.3 Unit 1 – Upper Silty Sand

The groundwater flow direction in Unit 1 has generally been to the south-southwest (Figure C.2-1, Appendix C2). In the Fall 2018 groundwater monitoring and sampling event completed by Clifton, only five groundwater monitoring wells in Unit 1 had sufficient water to be used for development of a potentiometric surface.

4.2.4 Unit 2 – Upper Clayey Silt

The interpreted groundwater flow direction in Unit 2 is generally to the south. The flow direction varies seasonally from southwest to southeast. Nine groundwater monitoring wells screened in Unit 2 had sufficient water during the Fall 2018 monitoring and sampling event to develop a potentiometric surface. The potentiometric surface for Unit 2 provided as Figure C.2-2 (Appendix C2).

4.2.5 Unit 3 – Middle Sandy Silt

The groundwater flow direction in Unit 3 is consistently to the southeast (Figure C.2-3, Appendix C2). Thirty-seven groundwater monitoring wells were used to develop the potentiometric surface for Unit 3 following the Fall 2018 monitoring and sampling event.

4.2.6 Unit 4 – Lower Clayey Silt

The interpreted groundwater flow direction for Unit 4 is generally to the south (Figure C.2-4, Appendix C2). All six groundwater monitoring wells in Unit 4 had sufficient water during the Fall 2018 monitoring and sampling event to develop a potentiometric surface. This is consistent with previous investigations, which indicated that the groundwater flow direction was south-southeast.

5.0 Contaminant Characterization

To characterize the substances on-Site, laboratory analyses have included benzene, toluene, ethylbenzene, total xylenes (BTEX), PHC fractions F1 to F4, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). Out of these analyses, the contaminants of potential concern (CoPCs) that are focussed on for the purposes of contaminant characterization include benzene, naphthalene, and 1,2-dichloroethane (1,2-DCA) representing each analytical suite. The rationale for concentrating on these three constituents is based on the following observations:

- They were the most frequently detected and most commonly exceeded the AEP 2016 Tier 1 Guidelines within their contaminant categories; and
- With few exceptions, the remainder of the constituents detected were associated with a detection of their representative constituent, benzene, naphthalene, or 1,2-DCA, depending on the contaminant category.

5.1 Soil

Based on historic investigations, the original contamination source was leaking USTs associated with the former Sears Service Centre in the Mall Area. Between 2006 and 2007, a remedial excavation to remove the impacted soils beneath the parking lot of the Mall Area was completed. A total of approximately 69,000 m^3 of PHC impacted soil and approximately 12,000 m^3 of clean overburden were excavated from the parking lot area. Soil treatment was done using Allu buckets to volatize PHC constituents. The excavation was subsequently backfilled with the remediated soil.

Soil contamination has been noted throughout not only the Mall Area, but also the Hounsfield Heights Area. There have been no historic spills in the Hounsfield Heights Area that would contribute to soil contamination; the contamination in this area is the result of migration of the CoPCs in groundwater from the Mall Area.

The following discussion of soil chemistry is based on laboratory analytical results compiled from the 2015 Subsurface Investigation (Clifton, 2016), the 2016 Supplementary Drilling Report (Clifton, 2016), and the Supplemental Phase II ESA (Clifton, 2018). Where available, these results have been supplemented by results for soil samples collected prior to 2015.

The lateral distribution of the soil contamination is depicted in Figures D.1-1 to D.1-3 (Appendix D1). The vertical distribution of the soil contamination is depicted on four representative cross-sections, presented as Figures D.2-1 through D.2-4 (Appendix D2).

5.1.1 Benzene and PHC Fractions F1 to F4

Of the BTEX and PHC Fractions F1 to F4 analytical suite, benzene was the most frequently detected and most commonly exceeded the AEP Alberta Tier 1 Guidelines. Also, with few exceptions, the remainder of the TEX and PHC F1 and F4 compounds detected were associated with a detection or exceedance of benzene. For these reasons, benzene is considered representative of the BTEX and PHC Fractions F1 and F4 throughout this discussion. For the BTEX and PHC F1 and F4 constituents, the plume margin is defined by the AEP Alberta Tier 1 Guidelines for benzene in fine-grained soil, 0.046 mg/kg.

Benzene has been detected in concentrations above the AEP Alberta Tier 1 Guidelines in all five Units (Figure D.1-1; Appendix D1). Concentrations ranged from below the laboratory detection limit to 10.40 mg/kg (BH1956, Unit 3). Guideline exceedances were limited to the northern portion of the Site for Units 1 and 2. There has only been one reported exceedance in Unit 1 (BH1983). Elevated benzene concentrations in Unit 3 are located centrally on-Site, which is consistent with the current Conceptual Site Model (CSM; Section 6.0). Benzene exceedances in Units 4 and 5 are limited to the southern portion of the Site, where boreholes were advanced deep enough to intersect these units downgradient of the source. Selected cross-sections showing the vertical distribution of soil benzene exceedances on-Site are provided in Appendix D2. The soil benzene plume on-Site has been laterally delineated in all five units (Figure D.1-1; Appendix D1).

5.1.2 PAHs

Naphthalene was the most frequently detected PAH, and most commonly exceeded the AEP Alberta Tier 1 Guidelines. Also, with few exceptions, the remainder of the PAH compounds detected were associated with a detection or exceedance of naphthalene. For these reasons, naphthalene is considered representative of the PAHs throughout this discussion.

Naphthalene has historically been detected at concentrations above the AEP Alberta Tier 1 Guidelines in the three uppermost stratigraphic units: Units 1, 2, and 3. The lateral distribution of naphthalene is provided in Figure D.1-2 (Appendix D1). Naphthalene is most widespread in Unit 3, and appears to have been laterally delineated. There have been no exceedances of naphthalene north of 11th Avenue NW. The vertical distribution of naphthalene is provided in Appendix D2.

5.1.3 VOCs

1,2-DCA was the most frequently detected VOC, and most commonly exceeded the AEP Alberta Tier 1 Guidelines. Also, with few exceptions, the remainder of the VOC compounds detected were associated with a detection or exceedance of 1,2-DCA. For these reasons, 1,2-DCA is considered representative of the VOCs throughout this discussion. The plume margin is defined as the AEP Alberta Tier 1 Guideline for 1,2-DCA in fine-grained soils of 0.025 mg/kg.

1,2-DCA has been detected in concentrations in excess of the AEP Alberta Tier 1 Guidelines in BH1904 (Unit 2) and BH1921 (Unit 3). Concentrations were below the guidelines in all other boreholes. The lateral distribution of 1,2-DCA is shown on Figure D.1-3 for each stratigraphic unit mapped in the study area, and select cross-sections showing the vertical distribution of 1,2-DCA are provided in Appendix D2.

5.2 Liquid Petroleum Hydrocarbon

LPH has been intermittently present on-Site since 1998, when it was first documented. Between 1998 and 2012, LPH was encountered in twelve groundwater monitoring wells within the Hounsfield Heights Area (Figure D.3). These monitoring wells were screened primarily across Unit 3, or Unit 2 and Unit 3. As part of the Updated SMP, a dual-phase vapour extraction (DPVE) system was installed north of 13th Avenue NW, with seven extraction wells screened through Unit 3 to the south, to capture and treat LPH. All infrastructure and extraction wells were installed on City of Calgary property for ease of access and regular maintenance.

Following completion of the 2015 Subsurface Investigation (Clifton, 2016), there was no LPH observed in the newly-installed groundwater monitoring wells, or the historic wells that were left in-place. LPH was encountered for the first

time in BH1704 in September 2015 (Figure D.3). Between 04 September 2015 and 27 May 2016, approximately 4.2 L of LPH was extracted from BH1704.

In October 2018, LPH was once again encountered in BH1704. The DPVE was intermittently operational in July and August 2018 due to pump repairs; this may be the cause for LPH recurrence. Since the 2015 Subsurface Investigation (Clifton, 2016), LPH has not been encountered in any other groundwater monitoring wells.

The extent of the current LPH plume is difficult to approximate, as subsurface investigations are restricted to publicly owned property, such as right-of-ways. The groundwater flow direction in Unit 3 is directly to the south; therefore, it is not possible to delineate the LPH plume in the direction of groundwater flow north of 11th Avenue NW.

5.3 Groundwater

The following discussion of groundwater chemistry on-Site is based on the laboratory analytical results from the Fall 2018 monitoring and sampling event. Both lateral distributions (Appendix D4) and vertical cross-sections (Appendix D5) have been provided.

5.3.1 Benzene and PHC Fractions F1 and F2

Benzene was the most frequently detected and most commonly exceeded the AEP Alberta Tier 1 Guidelines of the BTEX and PHC Fractions F1 and F2 analytical suite. Also, with few exceptions, the remainder of the TEX and PHC F1 and F2 compounds detected were associated with a detection or exceedance of benzene. For these reasons, benzene is considered representative of the BTEX and PHC Fractions F1 and F2 throughout this discussion. For the BTEX and PHC F1 and F2 constituents, the plume margin is defined by the AEP Alberta Tier 1 Guideline for benzene, 0.005 mg/L.

Benzene has been detected in concentrations in excess of the AEP Alberta Tier 1 Guidelines in Units 1, 2, 3, and 4. Concentrations of benzene ranged from below detection (<0.00040 mg/L) to a maximum of 3.2 mg/L in BH1982 (Unit 3). The lateral distribution of benzene in groundwater is shown in Figure D.4-1 for each stratigraphic unit mapped in the study area.

The Middle Sandy Silt (Unit 3) shows the most extensive distribution of benzene, and the lateral extent of the benzene plume is largely defined in this Unit. The benzene concentrations in BH1928 (2.5 mg/L) and in BH1944 (0.016 mg/L) were above the AEP Alberta Tier 1 Guidelines. These wells represent the southernmost exceedances in Unit 3. Monitoring wells BH1954, BH1981, and BH2003 had benzene concentrations that were below the reportable detection limit or the AEP Alberta Tier 1 Guidelines near the downgradient plume margin in Unit 3. Based on previously completed Mann-Kendall Plume Stability Analyses, the benzene plume is either stable or declining at the southern plume margin in Unit 3.

Benzene has been detected at concentrations above the AEP Alberta Tier 1 Guidelines in the underlying lower clayey silt (Unit 4) in the southern portion of the Site. BH1939 represents the southernmost exceedance in Unit 4. Monitoring wells BH1964, BH1980, and BH2002 currently serve as the southernmost downgradient indicators of the plume extent in Unit 4 with concentrations below the reportable detection limit or the AEP Alberta Tier 1 Guidelines.

Mann-Kendall analyses for BH1937 and BH1939 indicate the plume is declining. The PlumeStop™ pilot study application, implemented 03 August 2016, is within 5 meters of BH1939. The pilot study is discussed in greater detail in Section 8.0 of this report.

5.3.2 PAHs

Naphthalene was the most frequently detected PAH, and most commonly exceeded the AEP Alberta Tier 1 Guidelines. Also, with few exceptions, the remainder of the PAH compounds detected were associated with a detection or exceedance of naphthalene. For these reasons, naphthalene is considered representative of the PAHs throughout this discussion.

Naphthalene has historically been detected at concentrations above the AEP Alberta Tier 1 Guidelines in the three uppermost stratigraphic units: Units 1, 2, and 3. In the 2018 monitoring and sampling event, naphthalene was only detected in Unit 1 and Unit 3. Naphthalene is most widespread in Unit 3, and appears to have been laterally delineated. All monitoring wells installed in Unit 4 and Unit 5 had reported concentrations of naphthalene below the laboratory detection limit. The lateral distribution of naphthalene is shown on Figure D.4-2 for each stratigraphic unit mapped in the study area.

5.3.3 VOCs

1,2-DCA was the most frequently detected VOC, and most commonly exceeded the AEP Alberta Tier 1 Guidelines. Also, with few exceptions, the remainder of the VOC compounds detected were associated with a detection or exceedance of 1,2-DCA. For these reasons, 1,2-DCA is considered representative of the VOCs throughout this discussion. The plume margin is defined by the AEP Alberta Tier 1 Guideline for 1,2-DCA of 0.005 mg/L.

1,2-DCA has been detected at concentrations more than the AEP Alberta Tier 1 Guidelines in Units 1, 2, 3, and 4. Concentrations were below the analytical detection limits in Unit 5 except for BH2001, which had a detectable concentration of 0.0017 mg/L, below the AEP Alberta Tier 1 Guidelines. Concentrations of 1,2-DCA on-Site ranged from below detection (<0.001 mg/L) to 0.37 mg/L (BH1928). The lateral distribution of 1,2-DCA is shown on Figure D.4-3 for each stratigraphic unit mapped in the study area.

Monitoring wells BH1928, BH1954, BH1981, and BH2003 serve as useful indicators of the 1,2-DCA concentrations near the downgradient VOC plume margin. A Mann-Kendall analysis of the plume based on historic 1,2-DCA concentrations in BH1928 indicated that the plume has been expanding since Spring 2017; it was stable in the fourth quarter of 2016. Concentrations of 1,2-DCA in BH1954 and BH1981 indicate that the plume is expanding at these locations. The plume was stable at BH1954 in the Spring 2017 sampling event. BH1981 represents the southernmost exceedance in Unit 3. Further analysis will be required to determine if the plume will continue to grow at these locations, which represent the south-southwest plume margins.

There was an exceedance of 1,2-DCA in monitoring well BH1939 installed in Unit 4, the lower clayey silt. A Mann-Kendall analysis of the 1,2-DCA plume in BH1939 indicated that the plume is stable at this point. The Mann-Kendall analysis on the adjacent well, BH1937, indicated a fluctuating trend that was generally declining. The downgradient lateral extent of 1,2-DCA in Unit 4 may be delineated by wells BH1980 and BH2002, which have both been non-detect for 1,2-DCA in all monitoring and sampling events. There is some uncertainty as to the extents of the 1,2-DCA plume immediately south and southwest of BH1939.

5.4 Soil Vapour

The DQHHERA completed by Intrinsik following the 2015 Subsurface Investigation (Clifton, 2016) included a detailed investigation of the vapour inhalation pathway for human receptors in both soil and groundwater. This was completed in response to the communication provided by AEP (Appendix B), requesting a soil vapour monitoring program be established.

In 2016, Clifton prepared and implemented a Soil Vapour Monitoring Program for the Site. The program included the advancement of forty soil vapour monitoring points to assess the soil vapour concentrations across the Site. Three of these points included nested soil vapour points, with one point just above the water table, one between 2 and 3 m below ground surface (m bgs), and a third spaced evenly between the upper and lower two. Additionally, indoor air quality and sub-slab vapour samples are consistently collected from some private residences. The location of the soil vapour monitoring points is provided in Appendix D6.

Site-specific soil vapour quality guidelines (SVQG) were developed by Intrinsik for comparison of the soil vapour and sub-slab soil vapour samples. The guidelines were developed based on the 2014 CCME *A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures via Inhalation of Vapours*.

To date, there have been no exceedances to the SVQG in the sub-soil.

6.0 Conceptual Site Model

A Conceptual Site Model (CSM) is a visual representation and narrative description of the physical, chemical, and biological processes occurring, or that have occurred, at a site as related to the CoPC and their migration. The CSM for the Site is presented in Appendix E. The CSM is based on a representative cross section of the Site, and captures all significant infrastructure and remedial measures that have been applied.

7.0 Regulatory Framework for Remediation Plan

The regulatory framework through which this Remediation Plan will be administered is based off the AEP Alberta Tier 1 and 2 Guidelines. Through the guidance provided within these documents and the work completed by Intrinsik, the Remediation Plan is governed by two sets of regulatory criteria. To achieve unconditional Site closure, the AEP Alberta Tier 1 Guidelines for soil and groundwater apply. A second set of guidance values for soil, groundwater and soil vapour were also calculated by Intrinsik for application during Site remediation for the protection of human health.

These guidelines include:

- AEP Alberta Tier 2 Guidelines, Groundwater Remediation Guidelines for the Protection of Vapour Inhalation during Site Management and Remediation (13 April 2017);
- Calculated Residential and Commercial Soil-gas Remediation Guidelines (13 April 2017); and

- AEP Alberta Tier 2 Guidelines, Soil Guidelines for the Protection of Vapour Inhalation in the Mall Area (13 April 2017).

Further information regarding the application of this regulatory framework is provided in Section 8.3 and Section 8.4 of this report.

8.0 Remediation Plan

As mentioned within the introduction section of this report, the Remediation Plan being proposed is risk management focused, with active remediation as means of source removal and plume expansion control. In addition to active remediation, part of this Remediation Plan includes details on obtaining evidence that natural attenuation is occurring within certain parts of the groundwater plume that are not being affected by the residual LPH within the Hounsfield Heights Area.

The EPO specifically states the Remediation Plan shall include a detailed plan to address the following:

- Remediation and/or risk management plan for all substances in, or under the Site, including all soil, subsoil and groundwater; and
- A detailed description of the work that will be undertaken for both the Site to meet the Soil Vapour guidelines as per the Soil Vapour Quality Guidelines for Hounsfield Height and Mall Areas and the AEP Alberta Tier 1 Guidelines, as applicable for all other media.

With respect to the first requirement of the EPO, the proposed Remediation Plan will address through either risk management and remediation all substances in, or under, the Site, in all applicable media, including the soil, subsoil, and groundwater. With respect to the second requirement, the Remediation Plan will also include detailed plans on the work required to ensure the soil vapour at the Site meets the SVQG and that remediation to the AEP Alberta Tier 1 Guidelines is achieved, where practicable, as described below.

The requirement to meet the AEP Alberta Tier 1 Guidelines for all substances, in all media, across the entire Site should be applied under the assumption that all areas of the Site can be accessed for investigative and remedial purposes. This assumption does not hold true for the Site, particularly for the portions occupied by private residences. In addition to this, as it pertains to the substances of concern at the Site, the AEP Alberta Tier 1 Guidelines are governed by the Domestic Use Aquifer (DUA) pathway. Although this pathway cannot be eliminated based on the protocol provided within the guidelines, this pathway should be considered incomplete based on the following rationale:

- According to the AEP Alberta Water Well Information Database, there are no wells listed within the NE ¼ - 20 - 024 – 01 W5M which covers the extent of the delineated groundwater plume; and
- It is assumed that all residences within the affected area are supplied water for domestic use from the City of Calgary water utility network. This is further supported by City of Calgary Bylaw 40M2006 which states, all residential dwellings within the City of Calgary must be metered, precluding the use of a water well within the City for domestic purposes.

An administrative removal of this pathway should be considered by AEP.

A Remediation Plan that is implemented for the purposes of achieving the AEP Alberta Tier 1 Guidelines, with consideration of the DUA pathway, would require full access to all areas of the Site, including commercial, public, and private properties. Currently, access is restricted to only allow investigative and remedial activities within commercial and public properties. Soil and groundwater contamination, and the potential presence of LPH beneath the private residences of the Hounsfield Heights Area, has not yet, and may never be, fully characterized. Although remediation and confirmation of remediation within commercial and public properties is possible, any Remediation Plan implemented to treat these unknown, privately-owned areas and more importantly confirm that the AEP Alberta Tier 1 Guidelines have been achieved, would be limited. Therefore, the requirement of meeting the AEP Alberta Tier 1 Guidelines across the entire Site, in all media, for all substances, has been determined to not be achievable, at this time.

Based on this rationale, a Remediation Plan consisting of the following four primary components has been proposed:

1. Source Removal: Delineating the extent of any residual LPH, if practicable, and active LPH removal using a DPVE.
2. Plume Expansion Control: Controlling the plume from expanding further to the south by reducing groundwater concentrations using a permeable reactive barrier (PRB) along 11th Avenue NW.
3. Plume Monitoring: Continuing with routine groundwater monitoring and sampling and determining if natural attenuation is occurring within certain portions of the Site.
4. Risk Management: Continued source removal and plume expansion control with routine soil vapour monitoring and sampling program to ensure risks to human health are not present through the soil vapour inhalation pathway.

The pertinent background information, objectives, and scope of work for each component of the Remediation Plan are provided in the subsequent sections.

8.1 Source Removal

8.1.1 Source Removal Background Information

The original source of the subsurface PHC contamination across the Site is believed to be a leak from the USTs associated with the former service station and automotive center operated within the Mall Area parking lot between 1958 and 1995. During this time, the original USTs were replaced in 1984, the new USTs were then removed in 1995 during the decommissioning of the service station. Removal of the USTs represented the original source removal from the Site.

LPH on-Site is considered a secondary source. Through the processes of volatization and solubilization, portions of the LPH will partition into the soil vapour as well as the groundwater. As a result, any treatment that only addresses the soil vapour or dissolved phase components of the plume will fail to address their source. Theoretically, the LPH would continue to partition into the soil vapour and groundwater until the entire mass has been distributed. A more effective means of treatment would be to remove the source and then address the residual PHCs within the soil vapour and groundwater.

Historically, LPH was identified in two monitoring wells within the Mall Area; subsequently, two remedial excavations were completed to address these “hot spots”. In addition to these two smaller excavations, a larger remedial excavation was completed between 2006 and 2007 within the Mall Area to remove PHC impacted soil and any residual LPH that may not have been detected in the monitoring well network. Since the completion of the remedial excavation in 2006 and 2007, LPH has not been encountered within the Mall Area.

Between 1998 and 2012, LPH was encountered in the following twelve groundwater monitoring wells within the Hounsfield Heights Area (Figure D.3):

- BH209, BH213, BH214, BH702 and BH1703 - located on 13th Avenue near 16th Street NW;
- BH509, BH705 and BH706 – located on 16th Street NW near 13th Avenue NW;
- BH510, BH510A and BH725 – located in the laneway between 15th Street NW and 16th Street NW; and,
- BH1105 (sheen only) – located in Lions Park.

Each of the wells historically containing LPH were either screened in stratigraphic Unit 2 or Unit 3 or were screened across both Unit 2 and Unit 3.

In October 2010, as part of the original SMP created in 2006 for the Site, a DPVE system was installed north of 13th Avenue NW, with seven extraction wells to the south, to capture and treat LPH and dissolved phase PHCs.

The extent of the LPH within the Hounsfield Heights Area is currently not well understood due to the location of private residences and the inability to access these properties for additional investigation. Figure D.3 (Appendix D) shows the historical and current locations of LPH within the groundwater at the Site. As evident from the Figure, a large area beneath the private residences remains unknown. It should be noted that the DPVE was designed with a radius of influence that would overlap these residences, capturing the entire area of potential concern. However, the potential for LPH to have migrated beyond the extent of the DPVE influence, beneath the private residences to the south, exists. Without access to these properties to confirm the extent of LPH, it will remain undefined. It is also possible that the LPH extent has been significantly reduced through the operation of the DPVE and is bound to areas immediately surrounding monitoring well BH1704. Currently the DPVE is operating on extraction wells EX-4, EX-5, EX-6 and EX-7 as they are closest in proximity to monitoring well BH1704 which contains the LPH.

On-going removal of LPH is a critical component for the success of this Remediation Plan.

8.1.2 Source Removal Objectives

The primary objectives of the Source Removal component of this Remediation Plan are:

- Confirm the extent of the residual LPH within the Hounsfield Heights Area; and
- Continue to remove residual LPH to the extent practicable from the groundwater within the Hounsfield Heights Area.

The recommended scope of work to meet the above objectives is presented in the following section.

8.1.3 Source Removal Scope of Work

Currently, the extent of the LPH within the Hounsfield Heights Area is undefined and is limited to one monitoring well, BH1704. The LPH on-Site may extend beneath the residences located adjacent to this monitoring well or it may be confined to the immediate area surrounding this well. The potential for additional pockets of LPH that have not been previously been identified may also exist beneath the private residences within Hounsfield Heights Area.

The first component of the Source Removal portion of this Remediation Plan is to delineate the LPH, to the extent practicable. The assistance of AEP is required to approach residences to discuss the rationale behind accessing their properties for additional investigation to delineate the presence of LPH. If access is granted, a subsurface drilling investigation, including the installation of monitoring wells to delineate the LPH present in monitoring well BH1704, is recommended.

A defined extent of LPH will allow for the creation of a source removal plan that the can be designed to specifically address the entire area of concern. If access is not permitted to the private residences, the removal of LPH will be restricted to the continued operation of the DPVE in its current configuration.

8.1.3.1 Assessment and Continued Operation of the DPVE

The DPVE is currently housed in Lions Park and consists of an extraction well network of seven wells situated around the residences located between 16th Street NW and the laneway separating 15th and 16th Street NW. Figure F.1 of Appendix F shows the location of the extraction well network.

The DPVE has been in operation since 2010, and continued operation will require an upgrade to several of the pumps and motors to ensure that it can continue to run until the removal of LPH is confirmed. As part of continued use of the DPVE, it is recommended that a qualified contractor review the electrical and mechanical components of the system, and recommend and complete the required upgrades to ensure the system can continue to run efficiently.

In addition to the electrical and mechanical component upgrades, an assessment of the current extraction well network should be completed to ensure that the wells are capturing the radius of influence required to remove the interpreted extent of the LPH. This may involve the decommissioning and installation of new extraction wells. Currently, the DPVE is operating on extraction wells EX-4, EX-5, EX-6 and EX-7 due to their proximity to monitoring well BH1704.

Upon completion of this work, the DPVE will remain operational until it is determined that the LPH has been removed, to the extent practicable. Source removal also provides risk management associated with the presence of LPH and the dissolved phase PHCs.

As part of this Source Removal program, a summary of the LPH volumes removed through the continued operation of the DPVE will be presented within the semi-annual groundwater monitoring and sampling reports.

In addition to removal of the LPH using the DPVE, it is also recommended that LPH be removed from any wells through passive bailing when the DPVE is shut-down for the semi-annual groundwater monitoring and sampling events.

8.2 Plume Expansion Control

8.2.1 Plume Expansion Control Background Information

Plume expansion control is being proposed as part of this Remediation Plan along 11th Avenue NW. Plume expansion control will be achieved through the installation of a PRB that transects the primary units through which groundwater CoPCs are laterally migrating. The location of the PRB along 11th Avenue NW has been selected for the following three reasons:

- This is the first area, south of Lions Park, that completely transects the groundwater plume and is fully accessible for remedial and investigative purposes;
- This area of the Site, between 10th and 11th Avenue NW, represents the extents of where horizontal delineation of the groundwater plume has been achieved; and
- The clay layer between the groundwater table and the surface in this area reduces in thickness and as a result the Tier 2 Risk Based Guidelines calculated for these areas are more stringent, supporting the need for a reduction in contaminant mass passing through this area to ensure risk thresholds are not exceeded.

To support the implementation of a PRB in this area, Clifton has performed two pilot studies along portions of 11th Avenue NW using a liquid activated carbon. The addition of an oxygen release amendment was also used in the first pilot study, as the concentrations of the CoPCs in this area were significantly higher. The specific trademarked name of the liquid activated carbon and oxygen release products applied at the Site as part of the pilot studies were PlumeStop™ and ORC-A, respectively.

PlumeStop™ is a colloidal activated carbon reagent. The activated carbon particles in PlumeStop™ have a diameter of 1 – 2 µm, which allows it to suspend in liquid form. As a result, PlumeStop™ can achieve wide spread, low pressure distribution through the soil matrix to provide a long-term barrier.

The activated carbon forms a colloidal biomatrix which is favorable for microbial colonization and growth. The CoPCs sorb to the activated carbon, and microbes are drawn to this as a source of nutrition. Digestion of the CoPCs by microbial activity reopens sorption sites on the activated carbon. The application of ORC-A further promotes biodegradation of the CoPCs that have been sorbed to the activated carbon matrix.

The first pilot study was implemented along 11th Avenue NW in an area with some of the highest reported benzene concentrations across the Site. Nine injection points were advanced, spaced over 21 metres along 11th Avenue NW, based on the estimated radius of influence of 2.4 m determined in the design verification test. In total, 13,720 litres of PlumeStop ™ solution and 540 litres of ORC-A were injected into the subsurface. The injections were made at a depth range of 6.1 m to 8.8 m below ground surface (bgs), which intersected Unit 3 and the upper portion of Unit 4.

Three down-gradient groundwater monitoring wells screened across three Units (BH1982 - Unit 3, BH1939 - Unit 4, and BH1937- Unit 5) were used to assess remedial progress during the pilot study performance monitoring program.

Details of the down-gradient monitoring wells are provided below:

- Monitoring well BH1982 is screened in a sand layer (Unit 3) from a depth of 1.6 to 7.8 m bgs;
- Monitoring well BH1939 is screened in a clay layer (Unit 4) from a depth of 8.2 m to 8.6 m bgs; and
- Monitoring well BH1937 is screened across an alternating silt and clay layer with a sand lens (Unit 5) from a depth of 8.8 m to 13.7 m bgs.

All three monitoring wells are located approximately 3.5 m down-gradient of where the barrier was installed.

Monitoring wells BH1937, BH1939, and BH1982 were sampled prior to application and on a bi-weekly basis for three months following installation of the PRB to assess remedial progress. Following three months of bi-weekly sampling, performance sampling was then conducted on a monthly-basis for an additional three months. These wells were subsequently sampled two more times as part of the routine semi-annual groundwater monitoring and sampling program. It should be noted that monitoring well BH1937 was removed from the performance sampling program after the bi-weekly events as this well is screened below the injection zone and therefore contaminant reductions resulting from the PRB were not expected.

Benzene and 1,2-DCA concentrations were used as the primary indicators for contaminant reduction based on their prevalence throughout the Site. The results from the initial pilot study performance monitoring program showed a decrease in concentrations of benzene and 1,2-DCA of 60% and 48%, respectively. Results obtained from the most recent sampling event carried out in these wells shows benzene concentration reductions of 73% and 98% for monitoring wells BH1982 and BH1939, respectively. During this same sampling event, 1,2-DCA concentration reductions of 68% and 25% were also observed for monitoring wells BH1982 and BH1939, respectively.

A second pilot study was conducted on the western portion of 11th Avenue near monitoring well BH1929 to assess the ability of PlumeStop^{TM} to reduce concentrations to the AEP Alberta Tier 1 Guidelines. Between 10 and 13 September 2018, a total of three injection points, spaced approximately 2.4 m apart, were used to inject a total mass of 2,173 kg of PlumeStop^{TM} into the subsurface between depths of 7.6 m to 14.9 m bgs. This depth range of injection was almost entirely within stratigraphic Unit 3. Due to the lower concentrations of the CoPC in monitoring well BH1929, ORC-A was not recommended for application.

Current performance monitoring results show a reduction of 86% and 71% for benzene and 1,2-DCA, respectively, within monitoring well BH1929. Performance monitoring is recommended to continue for a minimum of one year to determine if the PRB was successful in achieving the AEP Alberta Tier 1 Guidelines.

Pre-application and post application sampling results for both pilot studies are provided in Tables G1 and G2 of Appendix G.

The results from both pilot studies suggest that the application of a PRB can reduce CoPC concentrations down-gradient through sorption and biodegradation of the sorbed contaminants within the barrier. This method of

remediation will help to reduce the contaminant mass moving south of 11th Avenue NW, providing a method of plume expansion control and risk management.

8.2.2 Plume Expansion Control Objectives

The primary objective of the installation of the PRB portion of this Remediation Plan is to achieve plume expansion control south of 11th Avenue NW, by reducing CoPC concentrations as they migrate to an area of higher potential risk.

Currently, it is unclear if the PRB will be able to achieve the AEP Alberta Tier 1 Guidelines within the groundwater to the south of this area.

8.2.3 Plume Expansion Control Scope of work

The following scope of work is recommended for the application of a PRB at the Site.

8.2.3.1 Design Verification Testing

Prior to the installation of a PRB, it is recommended that additional design verification testing be completed along 11th Avenue NW. This design verification testing will include completing the following activities:

- Verifying the radius of influence;
- Determining the volume of PlumeStop™ required;
- Determining the volume and frequency of ORC-A injections, if required; and
- Determining the injection zone thickness by location along 11th Avenue NW.

Upon finalizing the PRB design, installation may occur.

8.2.3.2 Performance Monitoring

Following the installation of the PRB, a performance monitoring plan including down-gradient well sampling should be completed. The sampling will be conducted on a bi-weekly basis for the first three months following application, followed by monthly sampling for an additional 3 months and then quarterly for the remainder of the first year. The performance monitoring program will include Mann-Kendall Plume Stability Analyses of down-gradient monitoring wells to determine if concentrations are statistically decreasing. Results may suggest that additional amendments, such as oxygen release compound may need to be injected. Select down-gradient monitoring wells will also be used to assess geo-chemical parameters indicative of biodegradation.

The results of the performance monitoring program will be submitted to AEP on a quarterly basis.

8.3.1 Plume Monitoring Background Information

In the absence of risk to human health and the environment related to the CoPCs, along with active source removal and the application of a PRB as a means of plume expansion control, plume monitoring and obtaining evidence to determine if natural attenuation is occurring in portions of the Site, is recommended as part of this Remediation Plan.

Currently, delineation of the CoPCs has been achieved within the soil and groundwater at the Site. To develop a greater understanding of how the groundwater PHC plume is changing, it is recommended that the data obtained from the monitoring wells at the margins of the plume be continued to be used for Mann-Kendall Plume Stability Analyses.

The second component of the Plume Monitoring portion of this Remediation Plan will be to obtain data to determine if natural attenuation of the CoPCs within the groundwater is occurring within certain areas of Site. While monitored natural attenuation (MNA) may not be applicable at the Site in the area being impacted by LPH, there may be evidence to suggest the LPH is not affecting all areas of the Site and that MNA is applicable in those areas. By assessing certain areas of the Site for specific geochemical parameters indicative of biodegradation an assessment on the application of MNA can be made. These areas may include areas up-gradient of the LPH, within the Mall Areas as well as areas cross-gradient to the currently known extent of LPH, along the plume margins.

The objectives and scope of work as they pertain to the Plume Monitoring component of this Remediation Plan are presented in the following sections.

8.3.2 Plume Monitoring Objectives

The primary objectives of the Plume Monitoring component of this Remediation Plan are:

- Develop an understanding of how the plume is changing over time (increasing, decreasing and/or stable); and
- Determine if MNA is applicable in certain portions of the Site not impacted by LPH.

An assessment of the above objectives will be completed as part of the semi-annual groundwater monitoring and sampling events conducted at the Site.

8.3.3 Plume Monitoring Scope of work

The following scope of work is recommended for the Plume Monitoring component of this Remediation Plan.

8.3.3.1 Semi-annual Groundwater Monitoring and Sampling for Plume Stability Analysis

As part of the Plume Monitoring approach for the Site, it is recommended that semi-annual monitoring and sampling of the groundwater at the Site be completed. A routine groundwater monitoring and sampling program has been implemented at the Site since 2015, when quarterly events were completed. In 2016, the program included quarterly monitoring and semi-annual sampling events. In 2017, quarterly monitoring was completed for Q1, Q2, and Q3; one semi-annual sampling event was completed in Q2. In 2018, semi-annual groundwater monitoring and sampling was completed in Q2 and Q4.

It is recommended that this frequency of sampling be maintained for an additional three years. Upon completion of the three-year time-period, an evaluation of the groundwater monitoring and sampling results should be completed to determine if the same frequency and extent of sampling is required.

The scope of work for the proposed semi-annual groundwater monitoring and sampling program includes:

- Measure organic vapour concentrations in all monitoring wells;
- Measure LPH thickness (if present) and depth of groundwater in all monitoring wells;
- Collect groundwater samples using the bailer method from 40 monitoring wells on-Site;
- Collect one discrete sample using the HYDRASleeve™ method from 51 monitoring wells on-Site;
- Collect a quality assurance/quality control (QA/QC) sample for every ten samples taken;
- Submit groundwater samples from 86 monitoring wells for laboratory analysis of BTEX, PHC Fractions F1 and F2, and VOCs;

- Submit groundwater samples from 48 monitoring wells for laboratory analysis of PAHs;
- Compare the results to the AEP 2016 Tier 1 Guidelines and the Risk Based Guidelines developed by Intrinsik (Section 8.4); and
- Prepare a report documenting the results of the groundwater monitoring and sampling events which includes groundwater plume modelling and plume stability analyses and discussion.

Any changes to monitoring well network in the future should be reflected in the on-going groundwater monitoring and sampling program.

8.3.3.2 Natural Attenuation Assessment

Prior to MNA being selected as a viable and effective component of this Remediation Plan for specific areas of the Site, it must first be proven. A method of showing that natural attenuation is occurring at the Site includes the analysis of geochemical parameters indicative of the biodegradation process. As part of the semi-annual groundwater monitoring and sampling program, it is recommended that monitoring wells, up-gradient of the LPH as well as cross-gradient, at the margin of the plume extents, be selected for analysis of dissolved oxygen (DO), nitrate, iron, manganese, sulfate, methane, and total alkalinity ($CaCO_3$). Upon receipt of the laboratory analysis, an assessment of whether or not the concentrations of these parameters suggest that biodegradation is occurring will be made and presented in the semi-annual groundwater monitoring and sampling reports.

8.4 Risk Management

8.4.1 Risk Management Background Information

Risk management is the basis of this proposed Remediation Plan. As part of the Risk Management component of this Remediation Plan, an assessment of the actual potential risks associated with the CoPC was completed. Once the risks at the Site were understood, implementation of remedial measures to reduce the potential risks and a system for on-going monitoring of risk is recommended for implementation.

To establish actual potential risks at the Site, Intrinsik finalized an updated DQHHERA for the Site in April 2017. The objectives of the updated DQHHERA were as follows:

- To assess risks to human and ecological receptors based on the 2014 and 2015 subsurface investigation;
- To update the previous DQHHERA (2006) based on the most recent guidance provided by the Government of Alberta and Canadian Council of Ministers of the Environment (CCME);
- To develop Tier 2 risk management guidelines that are required to address immediate risks and would be in effect during the remediation; and
- To develop Tier 2 guidelines that are required to achieve unconditional Site closure.

The 2014 and 2015 subsurface investigations were used to identify the primary CoPCs through a risk-based screening process. Through the screening process, benzene, xylene(s), PHC Fraction F1, and 1,2- DCA were identified as the primary CoPCs within the Hounsfield Heights Area for the vapour inhalation pathway. Within the Mall Area, benzene and 1,2-DCA were identified as the CoPCs for the vapour inhalation pathway. While other CoPCs were identified within the soil and groundwater across the Site, the DQHHERA determined that a human health risk is not posed by their presence, and risk-based guidelines did not need to be calculated for them.

The primary pathway of concern with respect to the protection of human health was determined to be the vapour inhalation pathway. The following pathways for the protection of human health were eliminated based on Site-specific conditions: drinking water pathway; and direct soil contact. With respect to ecological health, no receptors were identified to be at risk and therefore risk-based guidelines were not calculated.

Risk-based guidelines within the Hounsfield Heights Area were calculated for the groundwater as the soil contamination within this area was primarily confined to the saturated zone. Through the guidance provided by the Government of Alberta (GoA) and the CCME, the Hounsfield Heights Area was subdivided into four risk zones, based on local topography, groundwater elevation, and geology. Figure H.1 of Appendix H shows the locations of the zones identified by Intrinsik. Zone-specific guidelines for each of the CoPCs were then calculated by Intrinsik. The zone-specific guidelines are presented in the table below.

Table 8.1 – Risk Based Groundwater Guidelines for Site Management during Risk Management and Remediation for the Hounsfield Heights Area (mg/L)

Input Variable	North of 11th Avenue NW (N1)	North of 11th Avenue NW (N2)	South of 11th Avenue NW (S1)	South of 11th Avenue NW (S2)
Benzene	12	11	9.1	2.8
Toluene	NGR	NGR	NGR	NGR
Ethylbenzene	NGR	NGR	NGR	NGR
Xylenes	NGR	NGR	NGR	80
F1 – BTEX	43	42	35	19
F2	84	81	69	NGR
1,2 – DCA	0.60	0.58	0.47	0.17

Notes:
NGR indicates no guideline required because calculated value exceeds solubility limits.

Within the Mall Area, risk-based guidelines were calculated based on soil concentrations as these impacts were present above the groundwater table and pose a more significant risk to human health through the vapour inhalation pathway due to their closer proximity to the surface. The following table presents the Tier 2 risk-based guidelines for the Mall Area, within the soil, for risk management purposes.

Table 8.2 – Risk Based Soil Guidelines for Site Management during Risk Management and Remediation of the Mall Area (mg/kg)	
Chemical	**Calculated Tier 2 Guideline**
Benzene	15
1,2 – DCA	0.51

Based on the current data set, none of the soil samples obtained within the Mall Area exceeded the calculated Tier 2 Guidelines for protection of human health through the vapour inhalation pathway. Since soil concentrations cannot be monitored on a routine basis, the SVQG (presented below) calculated for the Site will be used as the basis for on-going risk management assessment.

The final set of risk-based guidelines created by Intrinisk are the Tier 2 SVQG for the protection of human health through the vapour inhalation pathway. These guidelines consider the risks posed by any soil vapour generated from the dissolved phase CoPCs within the Hounsfield Heights Area and the residual soil contamination present within the Mall Area. The following table presents the risk-based SVQG for the Hounsfield Heights and Mall Areas for implementation during risk management and remediation of the Site.

Table 8.3 – Calculated Risk Based Residential and Commercial Soil-gas Guidelines during Risk Management and Remediation (µg/m^3)		
Chemical	**Residential Tier 2 Guidelines**	**Commercial Tier 2 Guidelines**
Benzene	303	1,122
Toluene	187,790	695,519
Ethylbenzene	49,625	183,796
Xylene(s)	8,909	32,996
Aliphatic C6 - C8	915,445	3,390,537
Aliphatic >C8 - C10	48,060	178,000
Aromatic >C8 - C10	8,125	30,093
Aliphatic >C10 - C12	50,000	185,185
Aliphatic >C12 - C16	50,000	185,185
Aromatic >C10 - C12	10,000	37,037
Aromatic >C12 - C16	10,000	37,037
1,2 – DCA	38	142

To date, four soil vapour sampling events have been conducted at the Site. No exceedances of these guidelines have occurred.

The final aspect of the work completed by Intrinsik was to develop Tier 2 guidelines to achieve unconditional Site closure. Based on the guidance documents available through AEP, the DUA pathway cannot be eliminated through the protocol provided. This pathway governs the most stringent allowable concentrations for the COPCs in soil and groundwater across the Site. Therefore, the Tier 2 guidelines required to achieve unconditional Site closure are in fact the Alberta Tier 1 Soil and Groundwater Remediation Guidelines. It should be noted that although this pathway cannot be eliminated based on the protocol provided in the Alberta Tier 2 Soil and Groundwater Remediation Guidelines, this pathway should be considered incomplete as described in Section 8.0. Therefore, an administrative removal of this pathway should be considered by AEP.

The work completed by Intrinsik developed an understanding of the actual risks presented by the CoPCs at the Site in addition to developing a set of guidelines to assess risk. Currently, results do not show risks to human health through the vapour inhalation pathway; however, reducing concentrations of the CoPCs through active source removal and the application of the PRB still serve as mitigative measures with respect to risk. Both remedial measures are intended to reduce groundwater concentrations of the CoPCs within the Hounsfield Heights Area. The groundwater in this area is the primary source of the soil vapour PHCs. By reducing the concentrations in the groundwater, soil vapour concentrations are also expected to be reduced, therefore lowering the risks associated with soil vapour through the vapour inhalation pathway.

The remainder of the Risk Management section of this Remediation Plan will focus on the efforts surrounding on-going assessment of risk as well as the potential application of contingency measures, should they be required.

8.4.2 Risk Management Objectives

The objectives of the Risk Management component of this Remediation Plan are:

- Continued source removal and installation of a PRB to reduce groundwater concentrations of CoPCs that may pose a risk through the vapour inhalation pathway;
- Assess and report potential risk to human health by comparing results of the CoPCs in the groundwater, soil, and soil vapour to the calculated Tier 2 Guidelines until unconditional Site closure is achieved; and
- Implement contingency measures, should results from the groundwater and soil vapour sampling programs suggest an actual risk is present.

The recommended scope of work and contingency plan to be implemented as part of the Risk Management component of this Remediation Plan are presented below.

8.4.3 Risk Management Scope of Work

The following scope of work is recommended as part of the Risk Management component of this Remediation Plan. It is important to note that the following section discusses the risk monitoring component of this remediation plan. Actual risk reduction by reducing CoPC concentrations in the groundwater is discussed in the Source Removal and Plume Expansion Control sections of this report.

8.4.3.1 Semi-annual groundwater monitoring and sampling

As part of the Risk Management approach for the Site, it is recommended that semi-annual monitoring and sampling of the groundwater at the Site be completed. The proposed groundwater monitoring and sampling program will follow the protocol outlined in the Plume Monitoring component of this Remediation Plan. In the context of Risk Management, groundwater concentrations will be assessed against the Tier 2 Risk Based Guidelines calculated by Intrinsik for purposes of assessing risk to human health through the vapour inhalation pathway.

8.4.3.2 Semi-annual Soil Vapour Monitoring and Sampling

The continuance of the semi-annual soil vapour monitoring and sampling program will form the basis of the risk monitoring portion of this Remediation Plan. The soil vapour sampling program was first implemented in June 2016, when the first event was completed. Since that time, subsequent soil vapour sampling events have been conducted in January 2017, July 2017 and April 2018.

As part of this Remediation Plan, it is recommended that semi-annual soil vapour sampling be completed. It is recommended that this frequency of sampling be completed for an additional three years and that events are conducted in the Winter and Summer, capturing any potential effects related to seasonal weather extremes. Upon completion of the three-year time-period, an evaluation of the soil vapour sampling results should be completed to determine if the same frequency and extent of sampling is required.

The primary objectives of the soil vapour sampling program are to:

- Assess and report soil vapour concentrations with respect to the Tier 2 SVQG created for the Site for the protection of human health within the Hounsfield Heights and Mall Areas; and
- Trigger the implementation of a contingency plan if the soil vapour quality guidelines are exceeded.

The scope of work for the proposed semi-annual soil vapour sampling program includes:

- Collecting representative soil vapour samples from areas identified by the 2016 subsurface investigations as having CoPC concentrations in groundwater or soil exceeding the AEP Alberta Tier 1 Guidelines for the vapour inhalation exposure pathway;
- Sampling nested soil vapour monitoring points at locations representing changing stratigraphy on-Site to provide representative data for evaluation of the Site-specific vertical soil vapour migration and biodegradation;
- Sampling soil vapour monitoring locations constituting lateral transects to facilitate lateral delineation of the soil vapour plume extent at the Site;
- Conducting sub-slab soil vapour sampling and indoor air quality monitoring at one residential property within the Hounsfield Heights Area;
- Forwarding collected soil vapour and air samples to certified lab under Chain-of -Custody protocols for laboratory analyses of CoPCs;
- Implementing QA/QC procedures to assure quality and defensibility of the collected data;
- Comparing CoPC concentrations in soil vapour from soil vapour monitoring points against the Site-specific SVQG developed based on the 2014 CCME Protocol by Intrinsik; and
- Comparing CoPC concentrations in soil vapour from soil vapour monitoring points against trigger threshold values for additional investigation set as 90% of guidelines.

A figure showing the locations of the current soil vapour probes is presented in Figure D.6-1 of Appendix D. Any changes to soil vapour monitoring network in the future should be reflected in the proposed soil vapour monitoring and sampling program.

8.4.3.3 Contingency Plan

As part of the assessment of the results obtained from the semi-annual groundwater and soil vapour sampling programs, a determination of risk to human health will be considered based on the risk-based guidelines generated by Intrinsik. Should the results of these programs reveal a potential risk to human health, additional investigation as part of a contingency plan shall be implemented.

Implementation of the contingency plan will be focussed on the areas of concern as identified from the groundwater and soil vapour sampling program. Upon confirmation of the areas of concern the following protocol will be implemented:

- Immediate re-sampling of any areas of concern (may include groundwater and soil vapour sampling);
- Upon confirmation of exceedance of risk-based guidelines, approach potentially impacted residents to discuss the results and obtain approval for additional assessment within the property;
- If access is provided, perform an indoor air quality and sub-slab soil vapour assessment in the potentially impacted dwellings;
- Should results from these assessments reveal evidence to suggest there is a direct risk to the occupants of the dwelling through the vapour inhalation pathway, the recommendation for the installation of a sub-slab devaporization system (SSDS) should be made;
- Upon approval to install to the SSDS, installation should occur, and the system shall be initiated; and
- Adjust the semi-annual soil vapour sampling program to include an indoor air quality and sub-slab soil vapour assessments of the affected dwelling.

During this process residents should be offered temporary relocation assistance from the time of confirmation of risk to when the SSDS system has been installed and initiated. Should the owner of the dwelling not agree to the installation of an SSDS system, alternate agreements may be required between the owner the Site and the property.

If at any time during the contingency program additionally obtained data suggests that actual risks are not present, the program will be halted, and the potentially impacted property will be added to the on-going soil vapour sampling program, including an indoor air quality and sub-slab soil vapour assessment of the home.

9.0 Remediation Plan Schedule for Implementation

As per the requirements of the EPO, a schedule for implementation of this Remediation Plan has been provided in the table below. Completion of Remediation by 04 March 2019 is not feasible, however the Remediation Plan as shown in the table below will be implemented by this time.

Table 9.1 – Proposed Remediation Schedule

Activity	Description	Schedule
Source Removal	LPH extent assessment; working with AEP and land-owners to discuss and acquire access to private property to complete an LPH delineation program*	01 March 2019 – 30 April 2019
	DPVE assessment of mechanical and electrical components and repairs*	01 March 2019 – 31 May 2019
	DPVE extraction well assessment*	01 May 2019 – 31 May 2019
	Continued operation of DPVE	01 June 2019 – Until LPH removal confirmed to extent practicable
Permeable Reactive Barrier	Barrier installation preliminary design	01 March 2019 – 22 March 2019
	Design verification testing	01 April 2019 – 12 April 2019
	Barrier installation	22 April 2019 – 17 May 2019
	Barrier performance monitoring	20 May 2019 – 19 May 2020
Plume Monitoring	Semi – annual groundwater monitoring and sampling	April and October of each year program continued semi-annually
	Plume stability analysis	
	Natural attenuation assessment	
Risk Management	Source removal and PRB installation	See above for schedule
	Groundwater monitoring and sampling program	April and October of each year program continued semi-annually
	Soil vapour sampling program	January and August of each year program continued semi-annually
	Risk assessment summary	

*The DPVE will continue to operate in its current configuration during this time-period.

10.0 Closure

This report was prepared by Clifton Associates Ltd. for the account of Sears Canada Inc. The material in it reflects Clifton Associates Ltd. best judgment available to it at the time of preparation. Any use that a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Clifton Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted engineering practice common to the local area. No other warranty, expressed or implied is made.

No conclusions should be made based on this report regarding any concentrations of substances in other areas of the Site. Other Contaminants of Concern may be present at the Site in areas that were not investigated. Clifton Associates Ltd. accepts no responsibility for any deficiencies or inaccuracies in the information provided in this report that are the direct result of intentional or unintentional misrepresentations, errors or omissions of the persons interviewed, or information reviewed.

No environmental site investigation or remediation can wholly eliminate uncertainty regarding environmental conditions in connection with a property. This investigation is intended to reduce, but not eliminate the uncertainty regarding environmental conditions. Conclusions regarding the condition of the Site do not represent a warranty that all areas within the site and beneath structures are of the same quality as those sampled. Further, contamination could also exist in forms not indicated by the investigation.

The work was based in part upon the environmental quality guidelines and regulations in effect when the work was begun. Future regulatory changes may require reassessment of the findings of this investigation.

Clifton Associates Ltd.

Stephen d'Abadie, MEng
Environmental Scientist

David Pritchard, PGeol
Senior Environmental Geoscientist

Association of Professional Engineers
and Geoscientists of Alberta
Permit to Practice P4823

Reference List

Alberta Environment and Parks. (2016). *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*

Alberta Environment and Parks. (2016). *Alberta Tier 2 Soil and Groundwater Remediation Guidelines*

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Clifton Associates Ltd.: *Updated Site Management Plan (2014), Hounsfield Heights-Briar Hill Community, Calgary, Alberta,* April 2014

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Clifton Associates Ltd.: *Sears Canada Inc., Soil Vapour Monitoring Points Installation Report, Hounsfield Heights and North Hill Mall, Calgary, Alberta*, 20 October 2016.

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Zhu, J., Wong, S.L., and Cakmak, S. *Selected volatile organic compounds in residential air in the city of Ottawa, Canada*. Environ Sci Technol. 39(11): 3964-3971. 2005.

Zhu, J., Wong, S.L., and Cakmak, S. *Nationally representative levels of selected volatile organic compounds in Canadian residential indoor air: population based survey.* Environ Sci Technol. 2013;47(23):13276-83.

Figures

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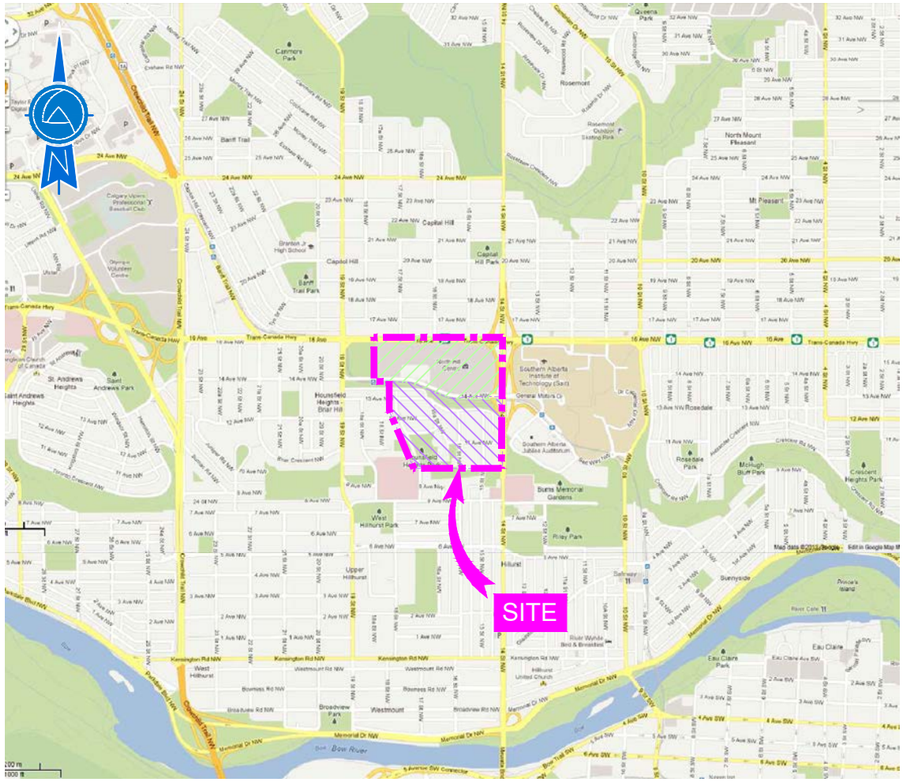
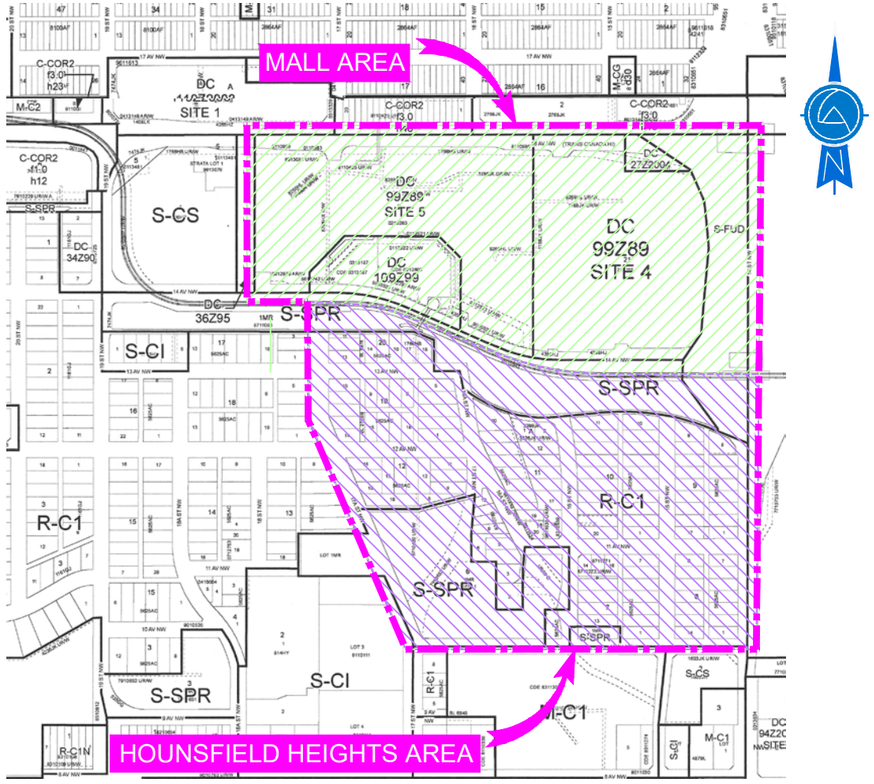


GENERAL SITE LOCATION

SCALE 1:30,000

0 0.5 1.0 1.5 km



SURROUNDING LAND USE

SCALE 1:7,500

0 100 200 300 m

LEGEND:

- SITE BOUNDARY
- MALL AREA
- HOUNSFIELD HEIGHTS AREA
- CITY OF CALGARY BY-LAW ZONING

LAND USE DISTRICTS:

RESIDENTIAL - CONTEXTUAL ONE DWELLING DISTRICT	R-C1
MULTI-RESIDENTIAL - CONTEXTUAL LOW-PROFILE DISTRICT	MC-1
MULTI-RESIDENTIAL - CONTEXTUAL GRADE-ORIENTED DISTRICT	MC-G
COMMERCIAL - CORRIDOR 2 DISTRICT	C-COR2
SPECIAL PURPOSE - SCHOOL, PARK, AND COMMUNITY RESERVE DISTRICT	S-SPR
SPECIAL PURPOSE - COMMUNITY INSTITUTION DISTRICT	S-CI
SPECIAL PURPOSE - COMMUNITY SERVICE DISTRICT	S-CS
SPECIAL PURPOSE - FUTURE URBAN DEVELOPMENT DISTRICT	S-FUD
DIRECT CONTROL DISTRICT	DC

NOTES:

1. CITY OF CALGARY ROAD MAP PROVIDED BY CANADIAN CARTOGRAPHICS CORPORATION, 2012.
2. LAND USE MAP PROVIDED BY THE CITY OF CALGARY.

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: SITE LOCATION AND SURROUNDING LAND USE

DESIGNED	SCALE: AS SHOWN	DATE: 2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: 1
CHECKED: TK	FILE NO.: CG2430.1-E33-01	

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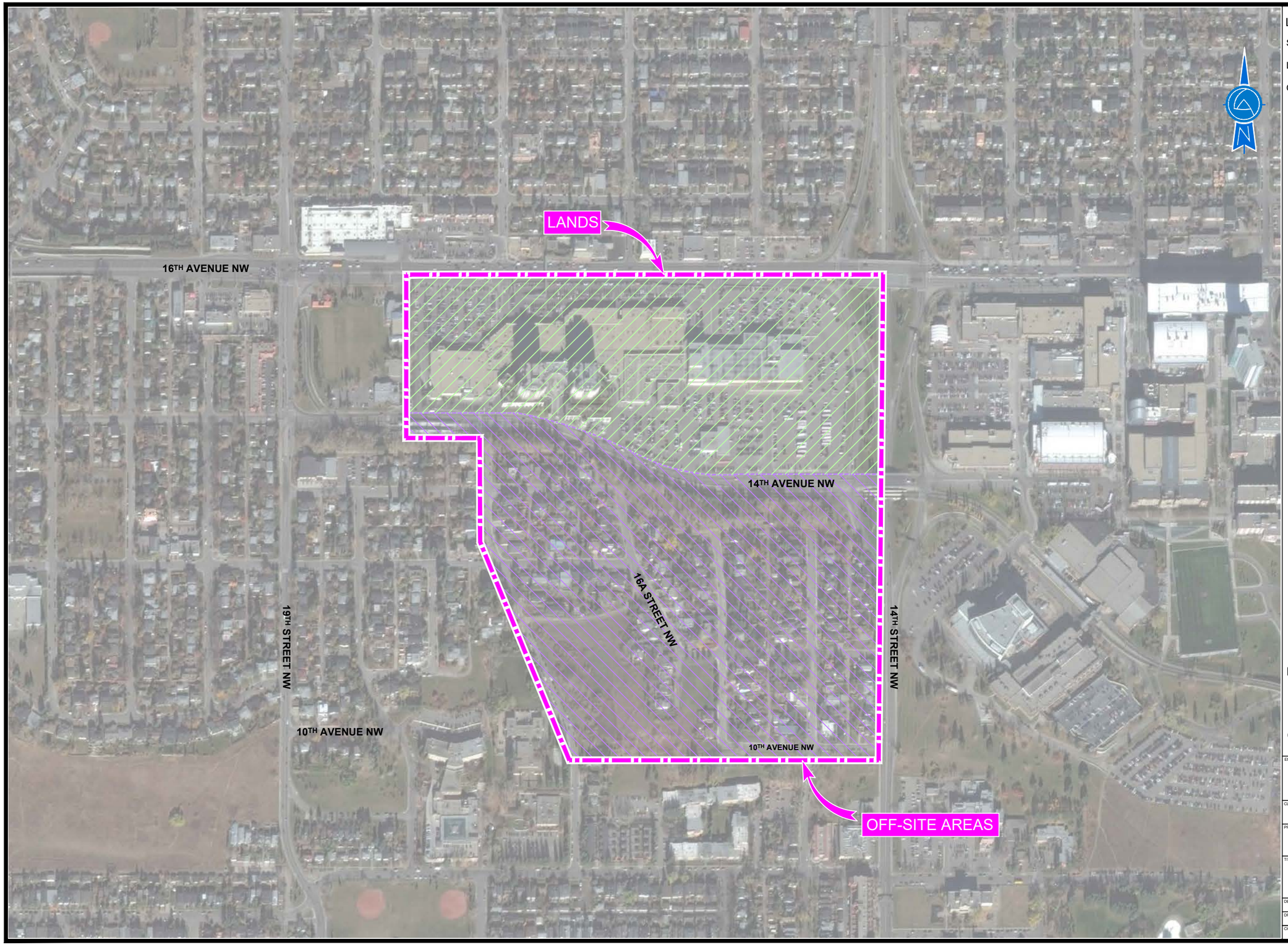

LEGEND:

- SITE BOUNDARY
- LANDS
- OFF-SITE AREAS

NOTES:

1. AERIAL PHOTOGRAPH PROVIDED BY GOOGLE EARTH PRO. AIR PHOTO DATE: OCT 23, 2015.

0 50 100 150 200 250m

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: LANDS AND OFF-SITE AREAS

DESIGNED	SCALE 1:5000	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. 2
CHECKED TK	FILE NO. CG2430.1-E33-02	

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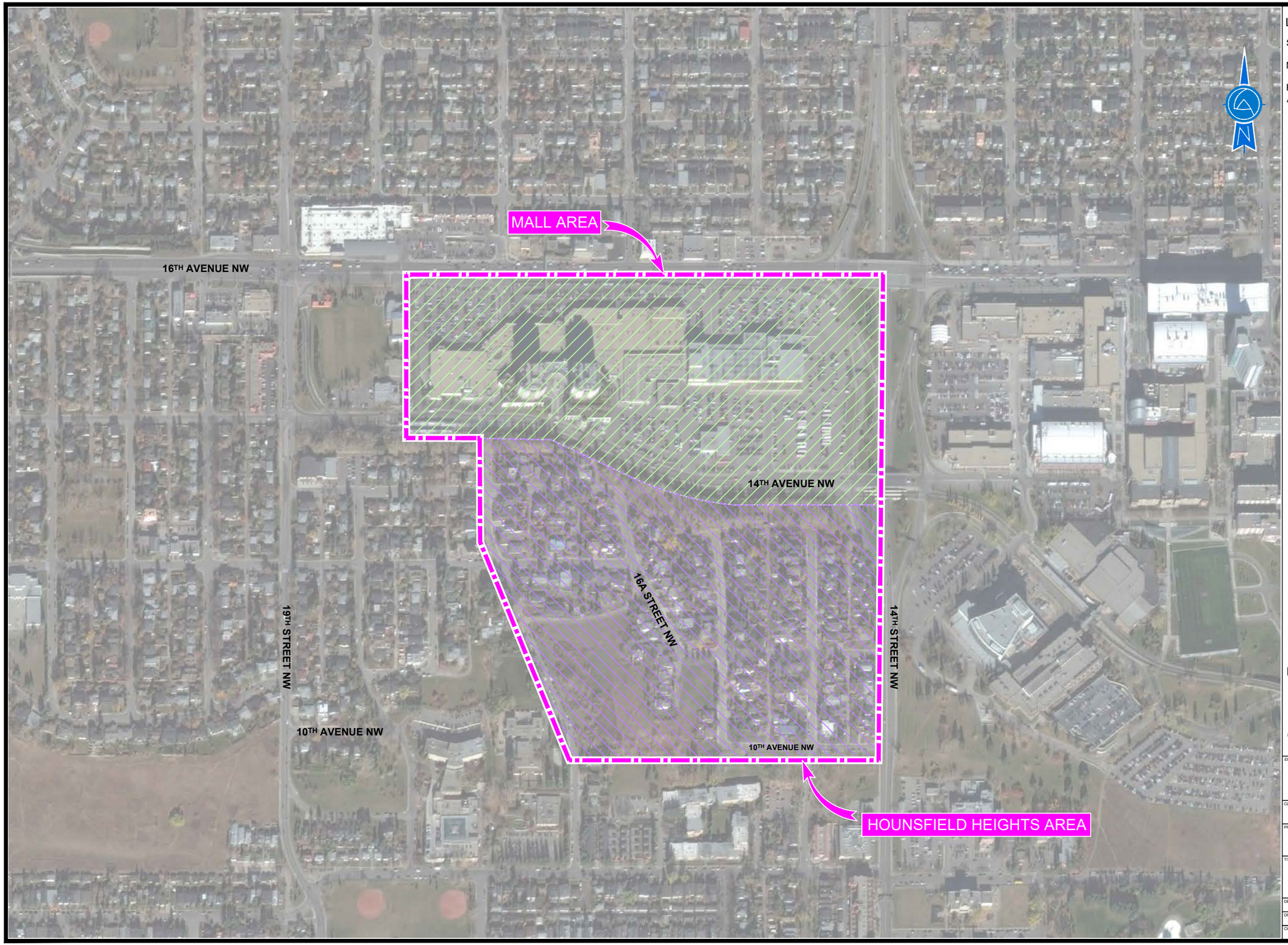

LEGEND:

- SITE BOUNDARY
- MALL AREA
- HOUNSFIELD HEIGHTS AREA

NOTES:

1. AERIAL PHOTOGRAPH PROVIDED BY GOOGLE EARTH PRO. AIR PHOTO DATE: OCT 23, 2015.

0 50 100 150 200 250m

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: SITE AND SURROUNDING PROPERTIES

DESIGNED	SCALE: 1:5000	DATE: 2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG. 3
CHECKED: TK	FILE NO.: CG2430.1-E33-03	

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Appendix A
Environmental Protection Order

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Alberta Environment and Parks

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

BEING CHAPTER E-12 R.S.A. 2000 (the "Act")

ENVIRONMENTAL PROTECTION ORDER NO. EPO-2018/01-SSR

Sears Canada Inc. [Sears]
C/O
Lloyd McLellan
FTI Consulting Canada Inc.
1900, 520 – 3rd Avenue SW,
Calgary, Alberta T2P 0R3

And

Concord North Hill GP Ltd. [Concord]
4000, 421 – 7 Avenue SW
Calgary, Alberta T2P 4K9

[Collectively the "Parties"]

WHEREAS Sears or one of its predecessor companies (Contill Realty Ltd.), was the registered owner of the lands legally described as Plan 8210266, Block 21 [the "Lands"] located in the City of Calgary, Alberta from October 31, 1958 until June 18, 2015;

WHEREAS Sears operated both a retail clothing store and an automotive repair/Gas Bar [the "Service Station"], which were located in two separate buildings on the Lands;

WHEREAS Sears owned and/or operated the Service Station from 1958 until the decommissioning in 1995;

WHEREAS in a SEACOR Environmental Engineering Inc. ("SEACOR") report titled "Environmental Activities Synthesis Report – October 1995 To August 1997 – North Hill Sears Gas Bar", dated August 1997 [the "SEACOR August 1997 Report"], the Service Station was identified as commencing operation in 1958 and ceasing operation in 1995;

WHEREAS the SEACOR August 1997 Report identified that an underground storage tank at the Service Station leaked gasoline sometime between the late 1970's to early 1980's;

WHEREAS the SEACOR August 1997 Report identified exceedances of then applicable provincial guidelines of that time (Alberta Environmental Protection (AEP) Risk Management Criteria (RMC) Level II and Level III course grained soil (CGS) criteria) for both the Lands and the adjacent/downgradient properties (the "Off-Site") n both soil and groundwater for hydrocarbon residuals and benzene (the "Substances");

WHEREAS the Lands were purchased by Concord on June 18, 2015 and Concord is the current registered owner of the Lands;

WHEREAS on March 29, 2016, the environmental consultant, Clifton Associates Ltd, ("Clifton") on behalf of Sears, submitted a reported titled "Remedial Action Plan for Mall and Hounsfield Heights Areas Calgary, Alberta" [the "RAP"], which identified in section 4.1 of the RAP, that the Alberta Tier 1 Soil and Groundwater Remediation Guidelines [the "Tier 1 Guidelines'] would be used as remediation targets;

WHEREAS on August 31, 2016, another consultant, Intrinsik Corp. on behalf of Sears, submitted a reported titled "Soil Vapour Quality Guidelines for Hounsfield Heights and Mall Areas" [the "Soil Vapour Guidelines"] to Alberta Environment & Parks ("AEP"), which were accepted by AEP as identified in a letter to Mr. Greg Paliouras of Sears, dated January 27, 2017;

WHEREAS Clifton Associates on behalf of Sears, submitted a report to AEP titled, "Revised Soil Vapour Monitoring Program (Update Fall 2016)", dated October 20, 2016 [the "Soil Vapour Monitoring Program"]. The Soil Vapour Monitoring Program was approved by AEP by letter dated January 27, 2017;

WHEREAS, numerous delineation and sampling events have been undertaken since the SEACOR August 1997 Report. The most recent Annual Summary Report completed by Clifton and dated May 19, 2017 (Annual summary report Hounsfield Heights – Briar Hill Community Calgary Alberta) identified that Substances are still present above the current Alberta Tier 1 Criteria;

WHEREAS there are several data gaps in the information regarding contamination both on the Lands and Off-Site which required additional work including:

- Completion of additional groundwater monitoring wells to characterize benzene and 1,2-DCA in groundwater in the southern extent of the plume in the Off-Site;
- Continue to conduct semi-annual groundwater sampling events to characterize the groundwater plume on the Lands and Off-Site;
- Continue to conduct semi-annual soil vapour sampling events as per the approved Soil Vapour Monitoring Program to characterize soil vapour; and
- Continued operation and maintenance of the DPVE system.

WHEREAS Craig Knaus, Compliance Manager, South Saskatchewan Region, has been appointed a Director for the purposes of issuing environmental protection orders under the Act (the "Director");

WHEREAS the Director is of the opinion that a release of a Substance has occurred, and that the Substance has caused, is causing or may cause an adverse effect on the environment;

WHEREAS the Director is of the opinion that the remedial actions taken to date by the Parties are not sufficient to confine, manage or remediate the Substances and that further work to delineate remediate and/or manage the Substances is required;

WHEREAS the Parties are a "person responsible" for the Substance, as defined in section 1(tt) of the Act;

THEREFORE, I, Craig Knaus, the Director, pursuant to section 113 of the *Environmental Protection and Enhancement Act*, DO HEREBY ORDER:

1. The Parties shall immediately re-commence the semi-annual soil vapour monitoring (high and low water table events) as described in the Soil Vapour Monitoring Program, including a sampling event prior to March 30, 2018);

2. Immediately recommence the Groundwater sampling and monitoring program as described in most recent program demonstrated in 2017 Second Quarter Groundwater Monitoring and Sampling Report, July 14, 2017.

3. By **July 1, 2018**, complete delineation activities to fully delineate the dissolved gasoline plume based on the data gaps identified in the Clifton Associates report July 2016 titled, "2016 Supplemental Drilling Report Hounsfield Heights-Briar Hill Community, Calgary, AB";

4. The Parties shall by **December 15, 2018**, submit a written plan to the Director to remediate the Substances on the Lands or any of the Substances from the Lands that have migrated to the Off-Site areas (the "Remediation Plan").

5. The Remediation Plan shall be prepared by a qualified environmental professional that meets the requirements for professional sign criteria as established by Remediation and Reclamation Sign Off Advisory Committee.

6. The Remediation Plan shall include, at a minimum, the following:

    a. A proposal outlining:

        i. the remediation and/or Risk Management Plan for all Substances in, on or under the Lands including all soil, subsoil and groundwater; and

        ii. the remediation and/or Risk Management Plan for all Substances in, on or under all Offsite areas, including to the North, South, East and West to which the Substances may have migrated including all soil, subsoil and groundwater.

    b. A detailed description of the work that will be undertaken for both the Lands and the Off-Site areas to meet the Soil Vapour guidelines as per Soil Vapour Quality Guidelines for Hounsfield Heights and Mall Areas August 31, 2016 and Alberta Tier 1 Soil and Groundwater Remediation Guidelines, as applicable [the "Criteria"] for all other media; and

    c. A schedule of implementation to implement the

Remediation Plan, with a completion date of no later than **March 4, 2019,** or as otherwise approved by the Director.

7. The Company shall implement the work set out in the Remediation Plan in accordance with the schedule of implementation that is approved by the Director.

8. The Parties shall submit written status reports to the Director as follows:

   a. Final, stamped versions of sampling and monitoring reports (for any media – soil, vapour, ground water) are to be submitted to the Director by the end of the 2nd month following the month the sampling and/or monitoring event occurred.

   b. Annual Report are required to be submitted to the Director by **March 31 of each year** for the previous January 1st to December 31st time period, with the first submission due March 31, 2019.

      i) At a minimum, each Annual Report all of the following:
      - Summary of the communications with the affect landowners that occurred during the year;
      - List of any concerns that arose from other parties;
      - An explanation of how these concerns were addressed;
      - Any recommended changes to improve communication;
      - A summary description of all assessment, remediation and monitoring work undertaken;
      - A summary of the results obtained within the year;
      - Details on the operation of the Soil Vapour Extraction system and an evaluation of the effectiveness of the system;
      - Identification of data gaps with recommendations to address them, and;
      - Recommendations and commitments for future assessment, monitoring and remediation work.

9. The Parties shall respond to inquiries from Off-Site landowners affected by the release within 3 business days of the inquiry being sent to the Parties individually or collectively.

10. The Parties shall within 30 days of the date of this Order, create, publish and activate a communications website.

11. Within 5 business days of the communications website being activated, the Parties shall provide the web address for the website to the Off-Site landowners affected by the release.

12. The Parties shall post on the communications website:

    a. regular status updates
    b. copies of all finalized and stamped sampling and monitoring reports.
    c. A summary of the results of the posted finalized and stamped reports

DATED at the City of Calgary in the Province of Alberta, this 28 day of February, 2018.

Craig Knaus
Compliance Manager (the Director)
South Saskatchewan Region

Section 91 of the *Environmental Protection and Enhancement Act* may provide a right of appeal against this decision to the Alberta Environmental Appeals Board. There may be a strict time limit for filing such an appeal. A copy of section 91 is enclosed. For further information, please contact the Board Secretary at #306 Peace Hills Trust Tower, 10011 - 109 Street, Edmonton, Alberta, T5J 3S8; telephone (780) 427-6207; fax (780) 427-4693.

Notwithstanding the above requirements, the Parties shall obtain all necessary approvals in complying with this order.

Take notice that this environmental protection order is a remedial tool only, and in no way precludes any enforcement proceedings being taken regarding this matter under this Act or any other legislation.

Appendix B
Alberta Environment and Parks Communication

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Southern Region
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Telephone: 403-297-7605
Fax: 403-297-2749
www.environment.alberta.ca

July 20, 2012

File No.: 00141934

Mr. Greg Paliouras
Associate VP Construction, Energy and Maintenance
Sears Canada Inc.
Dept 702CE, Suite 700
290 Yonge Street
Toronto, Ontario M5B 2C3

Dear Mr. Paliouras:

Subject: Sears North Hill - Hounsfield Heights Briar Hill Remediation and Monitoring NW Calgary, Alberta

Environment and Sustainable Resource Development (ESRD) has reviewed the following Clifton Associates Ltd. reports regarding remediation and monitoring activities in the area including Hounsfield Heights Briar Hill community and City of Calgary property:
Pre-Commissioning Monitoring Report. January 17, 2011.
First Quarter Site Monitoring Report. July 11, 2011.
Status Update of Activities Site Management Plan. July 18, 2011.
Second Quarter Site Monitoring Report. October 5, 2011.
Third Quarter Site Monitoring Report. March 2012.

ESRD met with Clifton Associates (Clifton) on June 20, 2012; and with Clifton, Alberta Health Services, and representatives from the Hounsfield Heights Briar Hill community association (HHBHCA) on June 28, 2012. The following comments are based on our review of the above captioned reports and the discussions at the June 20th and 28th meetings.

ESRD principles of contaminated sites management require that sources be removed or controlled as soon as practicable. There is a concern that source material may remain on the Sears site to the north and that it could continue to affect the Hounsfield Heights Briar Hill community located downgradient. ESRD requests the Sears provide information on whether areas remain on the Sears site that may need further assessment. We acknowledge that Sears undertook significant remedial activities on an area of the Sears North Hill property. Confirmation is needed for other areas to ensure source removal has been completed to the extent possible.

A dual phase vapour extraction system (DPVES) was commissioned in February 2011 to remove liquid phase petroleum hydrocarbons (LPHC) from the northern area of 13 Avenue between 16 and 15 Streets NW in the Hounsfield Heights Briar Hill community. The extent of LPHC plume appears to have reduced in the area where the DPVES has been operating although LPHC remain in the area of BH1703. Removal of LPHC needs to continue and we understand that the DPVES may be adjusted to focus on the area where LPHC remain.

Results from the groundwater monitoring and sampling program show that the dissolved phase plume is expanding to the south/southwest. Groundwater analytical results from selected monitoring wells located south of 11 Avenue NW exceeded the Alberta Tier 1 groundwater

remediation guidelines. In particular, Benzene exceeded the vapour inhalation guideline for residential land use in fine grained soil at monitoring well BH1303 in 2011.

Site conditions and the requirements under the Alberta Tier 1 and Tier 2 guidelines have changed since the acceptance of the May 31, 2006 Site Management Plan, therefore ESRD requires that the following actions be undertaken by Sears Canada Inc. (Sears) including:

- Fully delineate the dissolved plume south of 11th Avenue;
- Sample the groundwater adjacent to where it discharges to the surface in the south portion of zone 3 and evaluate it for risk to ecological receptors. There would be no risk from petroleum hydrocarbons to humans having direct contact with the surface water from these seepages;
- Delineate the soil gas/vapour plume in Zones 1, 2 and 3;
- Assess potential risks from ingress of petroleum hydrocarbon vapours to indoor air in areas where the guidelines are exceeded for the vapour inhalation pathway, and in areas where it has been determined that elevated soil gas/vapours are present;
- Establish a soil gas monitoring program on properties that may be at risk from vapour ingress to indoor air. Compare current needs with those previously identified in the Clifton April 5, 2007 response to Alberta Environment regarding the soil vapour monitoring;
- Implement additional remediation techniques to deal with the expanding dissolved phase plume. As discussed, this could include enhanced bioremediation. Monitored natural attenuation is not appropriate while LPHC are being removed and when the dissolved plume is not stable. Multiple remediation approaches are needed to address the petroleum hydrocarbon impacts;
- Review the groundwater monitoring and sampling program to ensure adequate coverage based on current conditions and trends; and,
- Apply the Tier 1 guidelines to monitoring well locations along 11th Avenue NW and include these wells in the groundwater monitoring and sampling program.

At the June 28 meeting, all parties agreed that there could be improvements in communication between Sears and community representatives: as activities are to be implemented at the site; for interpretation of the technical information by enhancing the presentation of information to improve the communication of the results; and, for evaluation of remediation progress. Therefore ESRD requires that Sears establish a communication protocol and schedule that will meet the needs of all parties.

A time line for remediation needs to be established which could identify key milestones along the time line and evaluate progress. We understand that these would be estimates and that plans change over time, but it is important to manage the site activities within a timeframe for reaching the remediation objectives.

As part of the ongoing management of risks at the site while remediation is undertaken, ESRD requests a commitment letter from Sears to undertake remediation and management of the site

over the long term. This is a standard requirement of the Department when risk management is undertaken.

Sears shall incorporate all of the above into a new Site Management Plan for the Hounsfield Heights Briar Hill area going forward. Parts of the original Site Management Plan from 2006 are outdated, and the July 18, 2011 Status Update of Activities Site Management Plan does not address the changes at the site and the need for additional assessment, monitoring and remediation activities. ESRD suggests that the SMP for the Hounsfield Heights Briar Hill area be a separate document from the SMP for the North Hill shopping area as separate approaches are needed for each area.

ESRD requests that Sears submit a new Site Management Plan to our office by December 2012 which shall contain a plan to address all of the points identified in this letter. Without delay, Sears should proceed with further assessment work at the site in conjunction with developing the new Site Management Plan.

Please contact me at 403-297-8270 if you wish to discuss the contents of this letter further.

Sincerely,

Kim Kirillo
Contaminated Sites Coordinator

cc: Stephen d'Abadie, Clifton Associates
Emmanuel Malterre, Sears Gas Plume Committee
David Crowe, Alberta Health Services

Appendix C1
Lithological Cross-Sections

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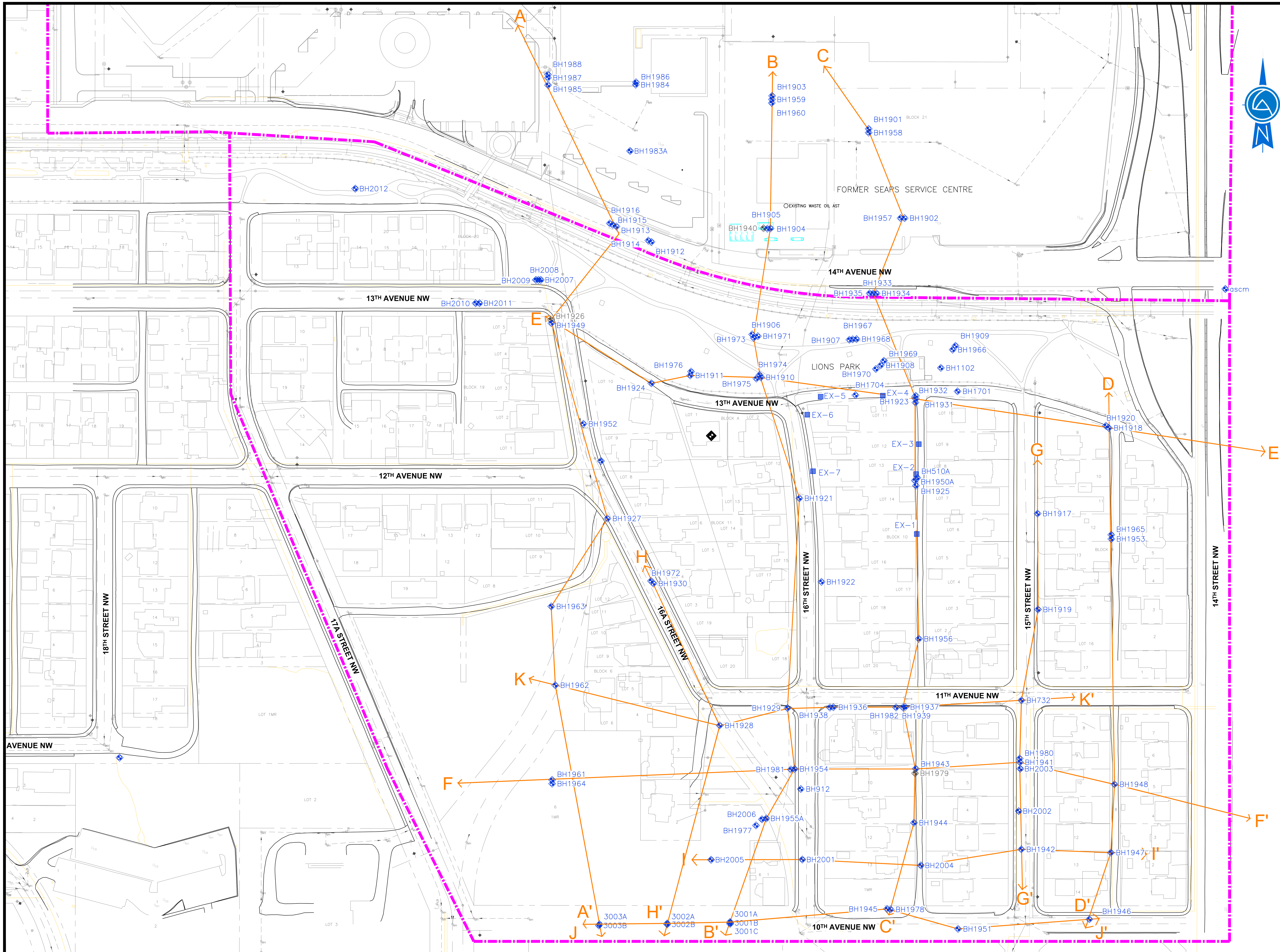

LEGEND

SITE BOUNDARY	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
EXISTING GROUNDWATER MONITORING WELL	

UTILITY LINES & SYMBOLS

NATURAL GAS LINE	
SANITARY SEWER	
STORM SEWER	
WATER	
CATCH BASIN	CB
FIRE HYDRANT	
LIGHT STANDARD	
MANHOLE	MH
UTILITY POLE	

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: SECTION PLAN

DESIGNED	SCALE	DATE
	1:1000	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.
CHECKED: TK	FILE NO.: CG2430.1-E33-C.1-1	C.1-1

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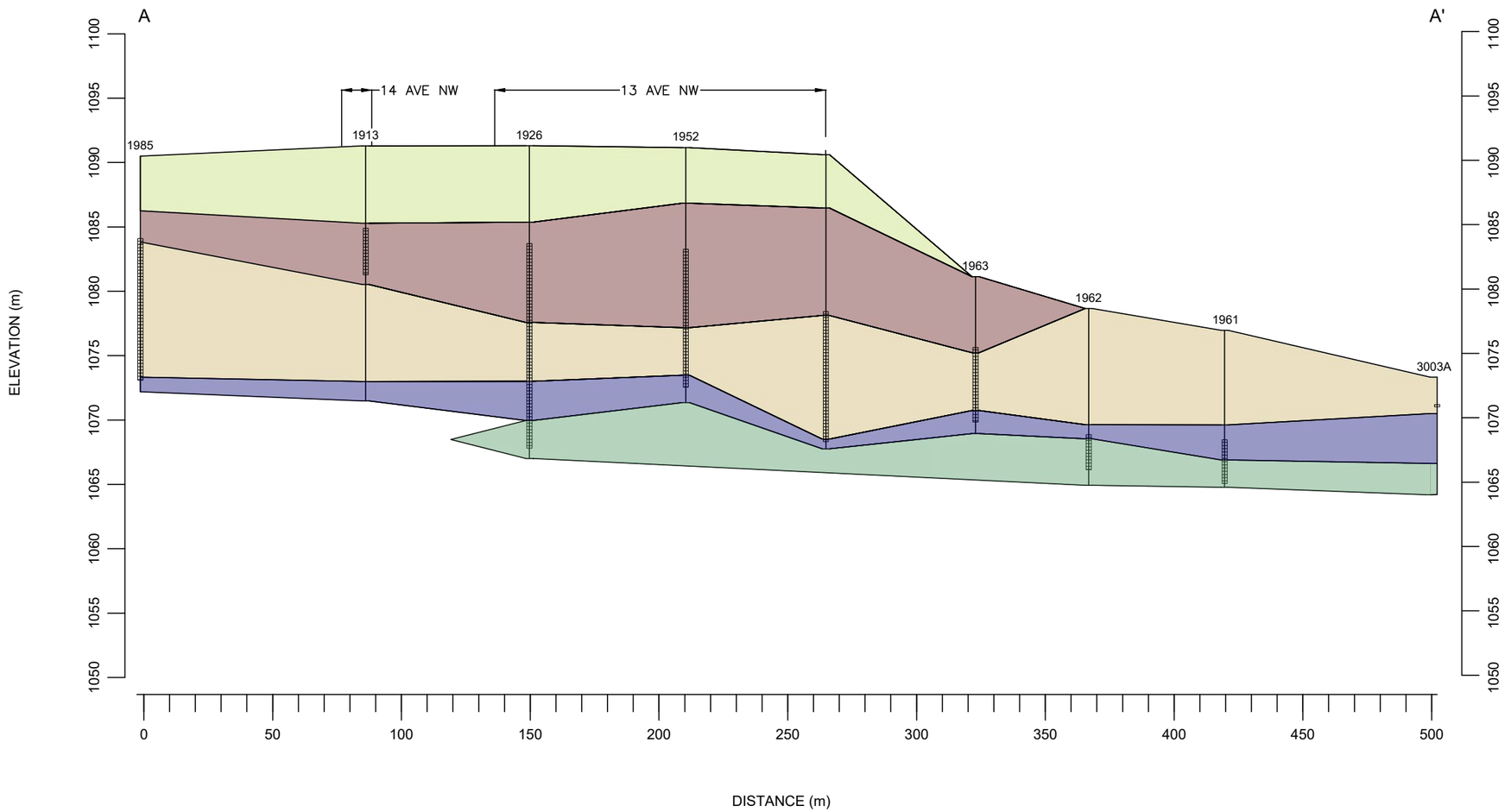
CROSS SECTION A-A'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
Clifton Associates

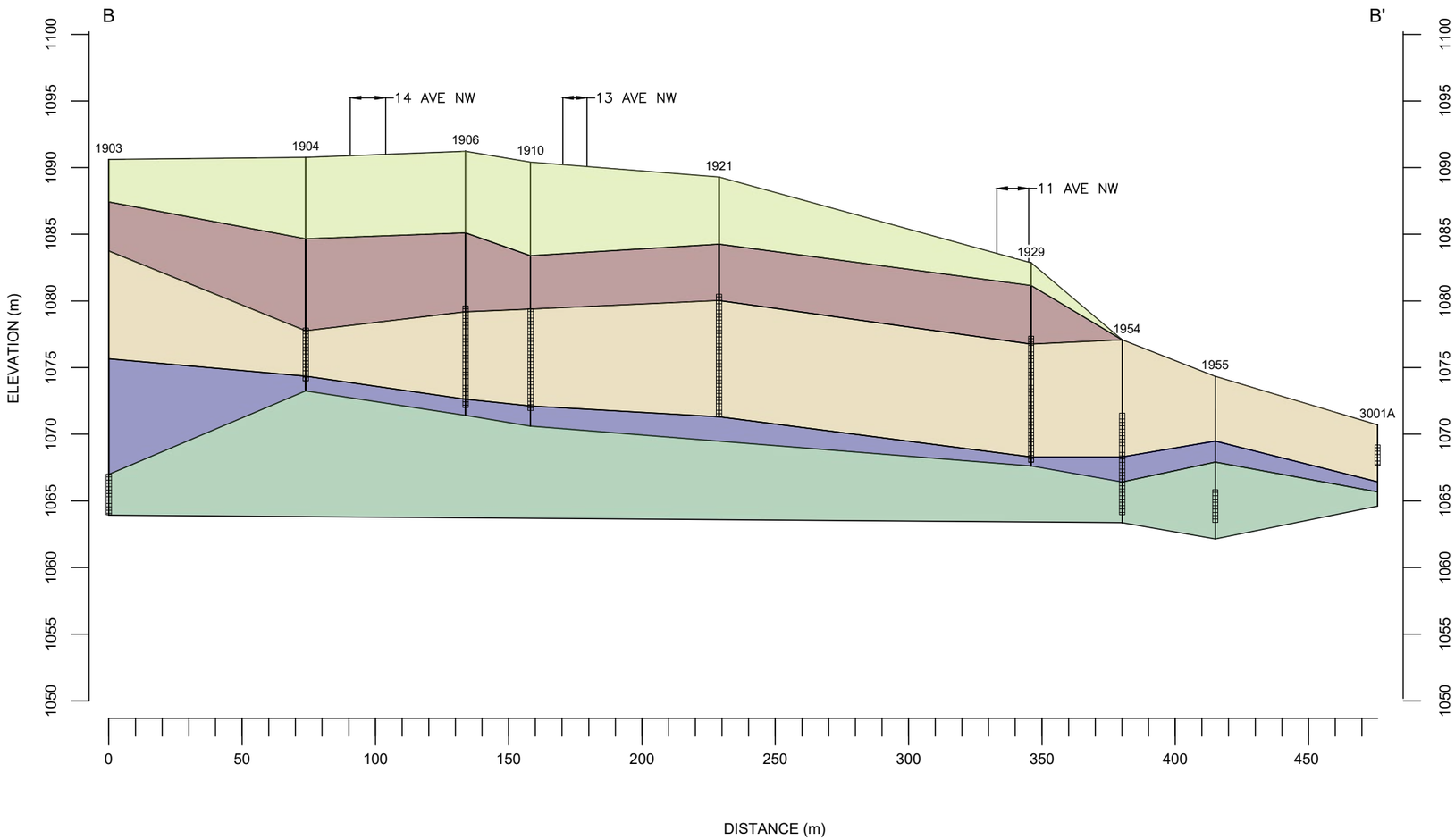
CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION A-A'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C.1-2
CHECKED TK	FILE NO. CG2430.1-E33-C.1-2	

CROSS SECTION B-B'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17
0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: CROSS SECTION B-B'

DESIGNED	SCALE: HOR 1:2000 VERT 1:200	DATE: 2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: C.1-3
CHECKED: TK	FILE NO.: CG2430.1-E33-C.1-3	

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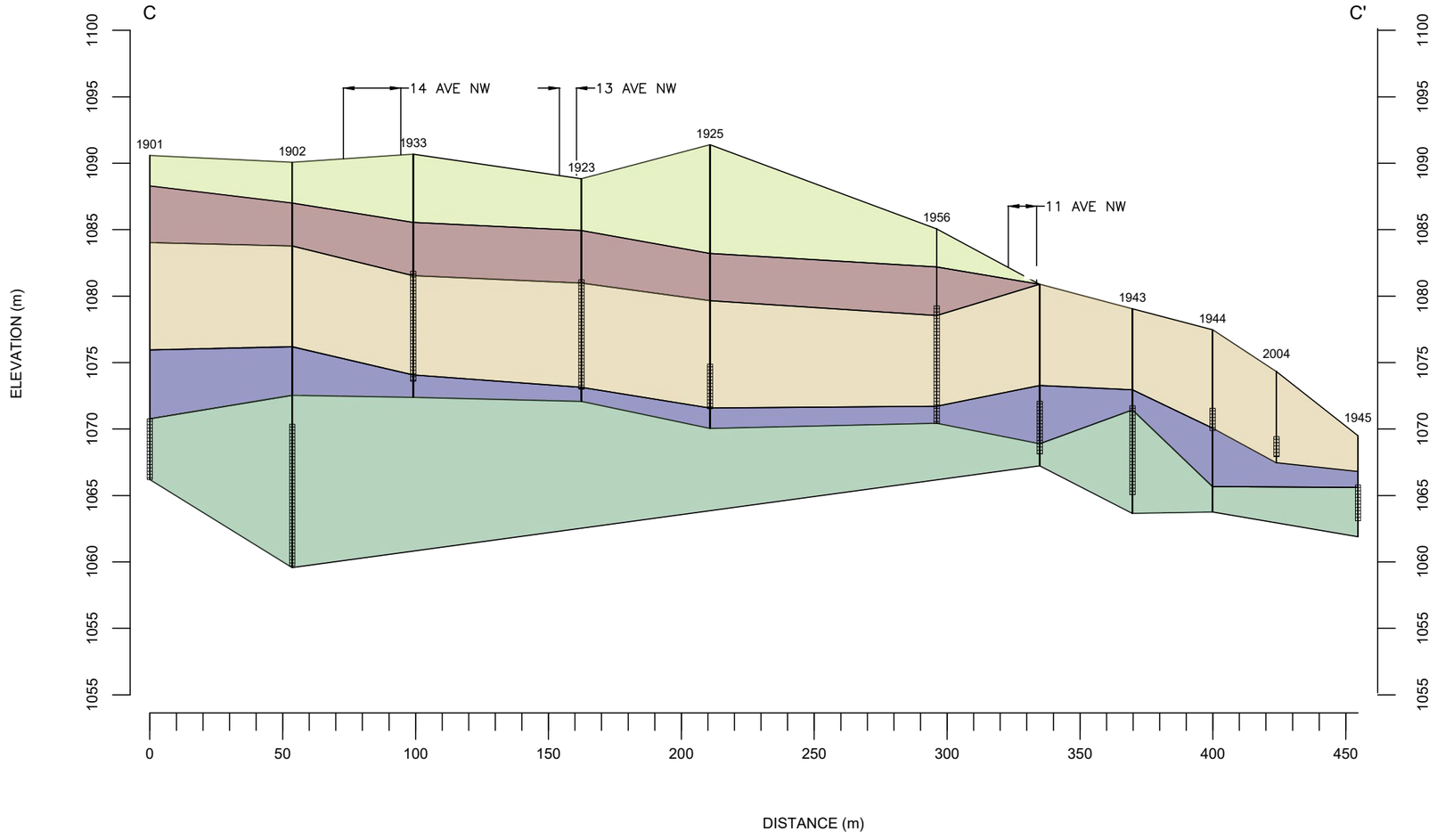
CROSS SECTION C-C'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
Clifton Associates

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PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION C-C'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.4
CHECKED TK	FILE NO. CG2430.1-E33-C-1.4	

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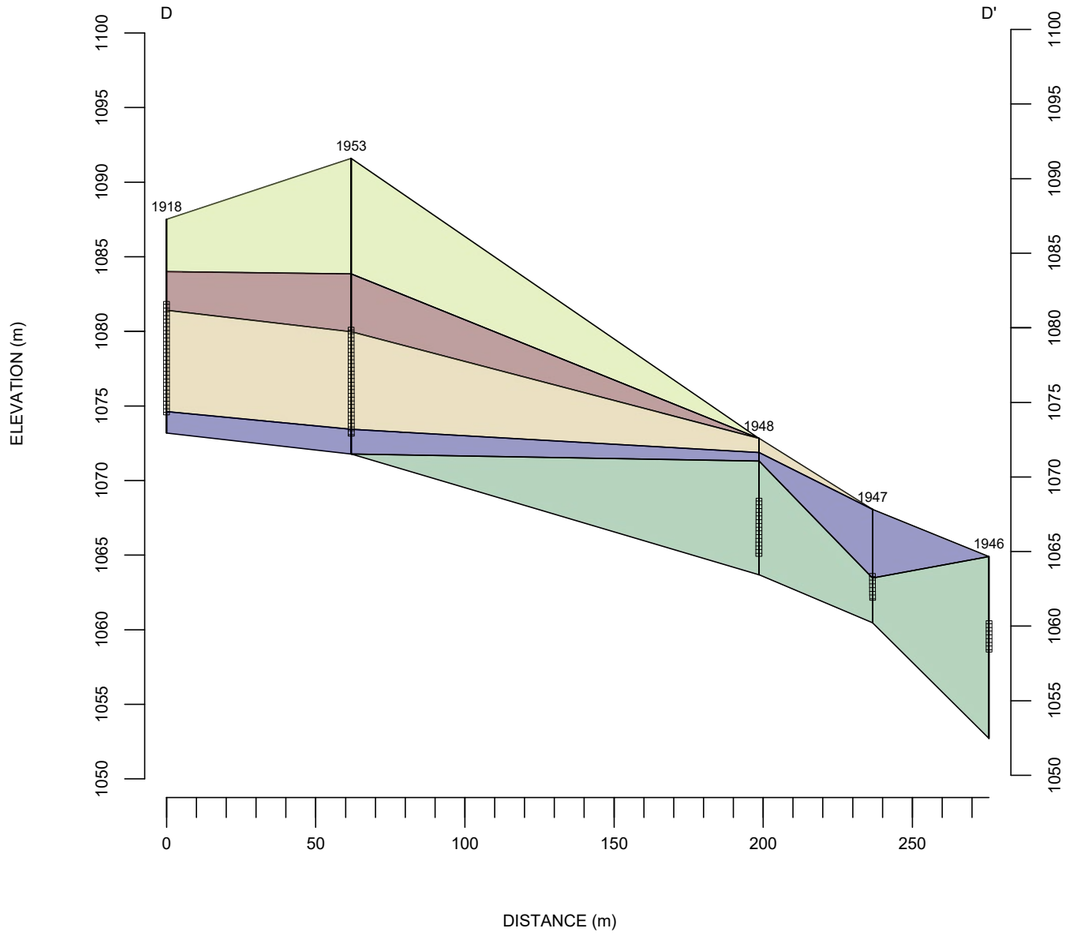
CROSS SECTION D-D'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17
0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
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PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION D-D'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.5
CHECKED TK	FILE NO. CG2430.1-E33-C-1.5	

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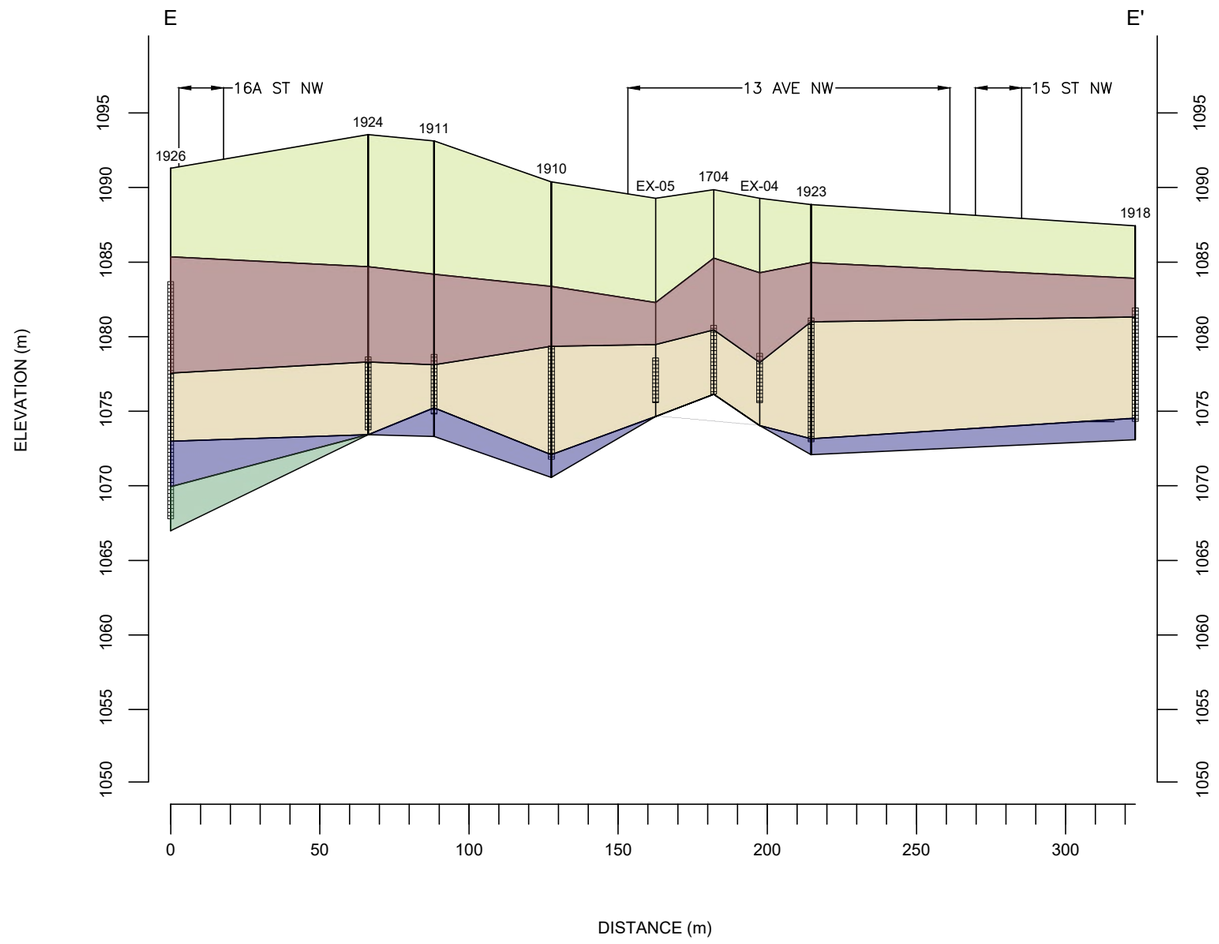
CROSS SECTION E-E'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
Clifton Associates

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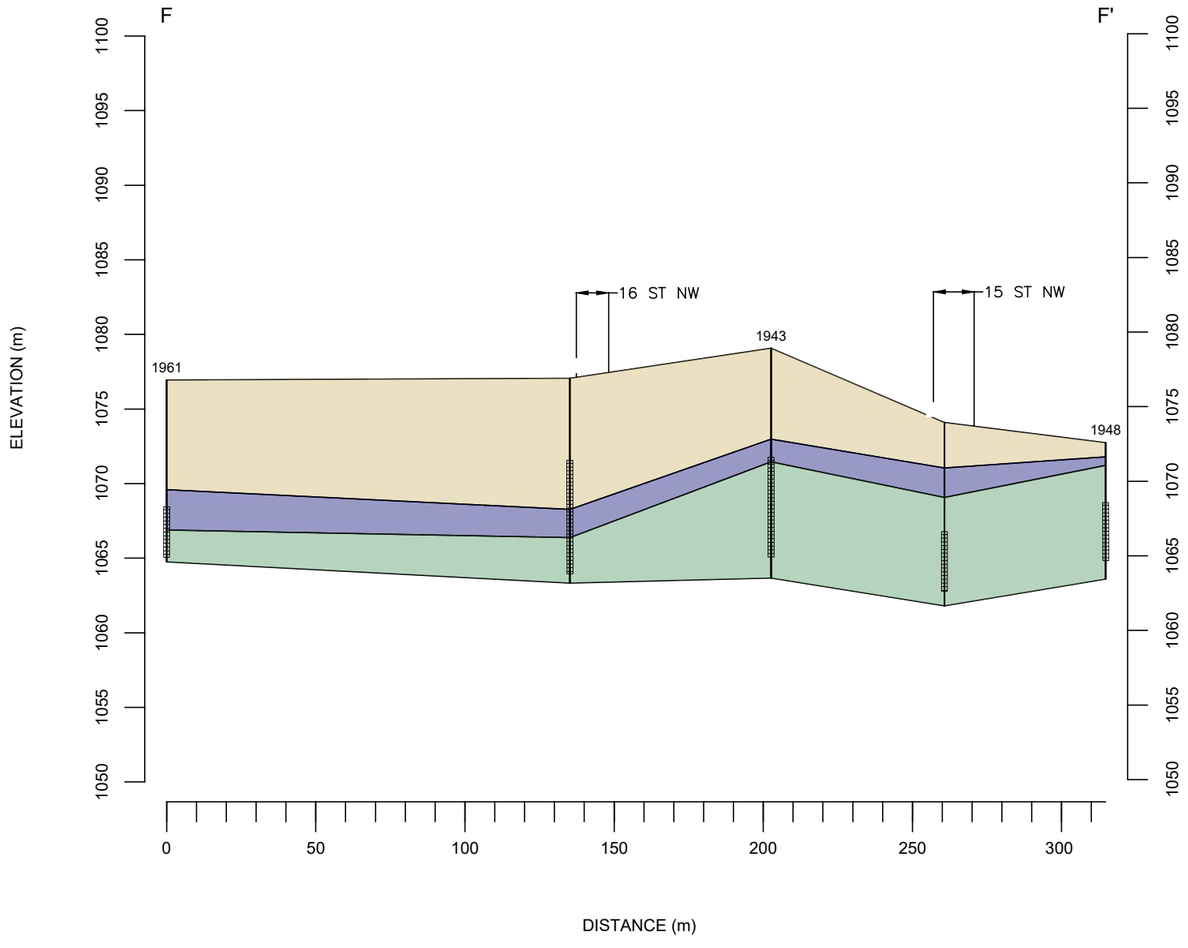
PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION E-E'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03	
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.6	
CHECKED TK	FILE NO. CG2430.1-E33-C-1.6		

CROSS SECTION F-F'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
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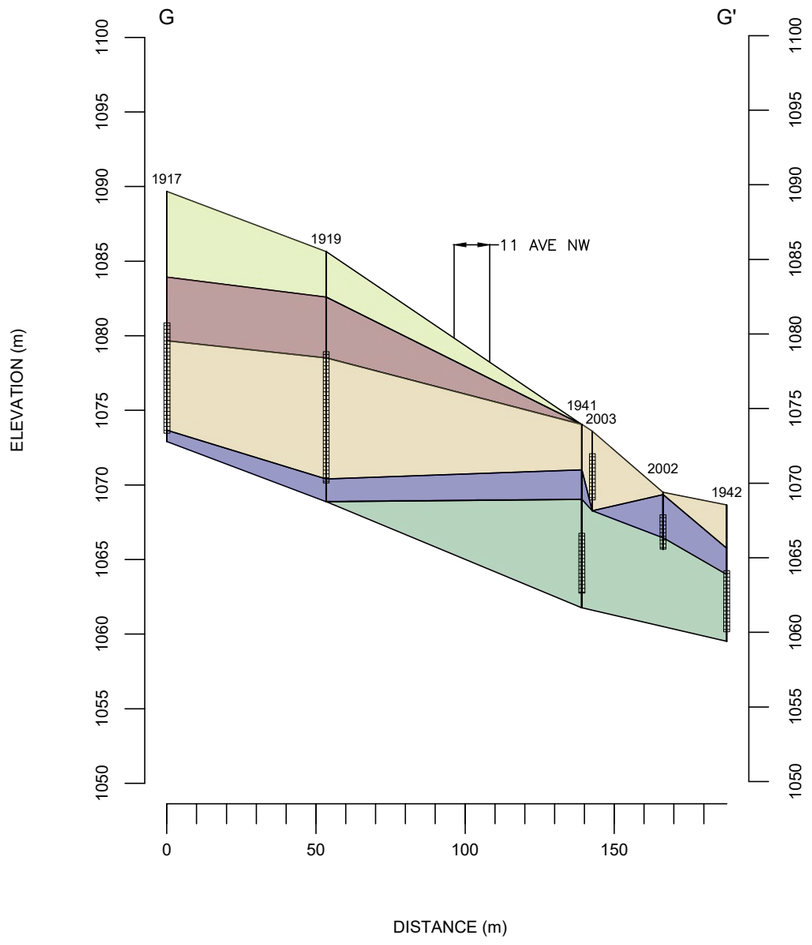
PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION F-F'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03	
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.7	
CHECKED TK	FILE NO. CG2430.1-E33-C-1.7		

CROSS SECTION G-G'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
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PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION G-G'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.8
CHECKED TK	FILE NO. CG2430.1-E33-C-1.8	

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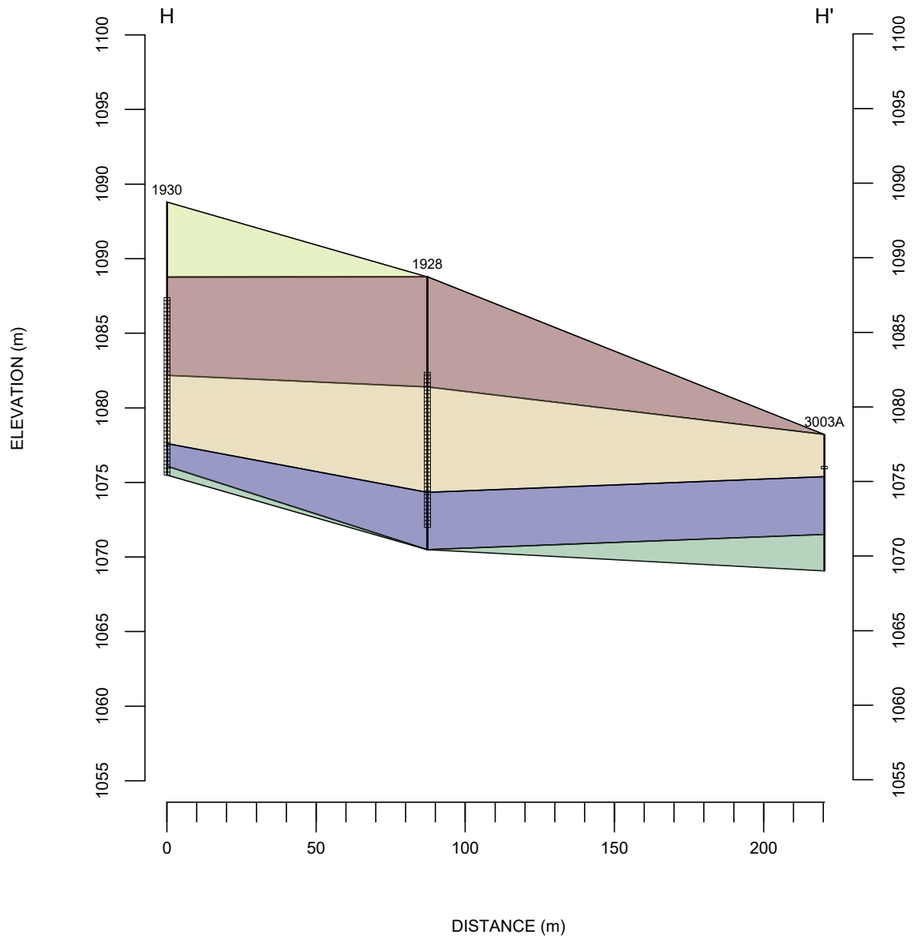
CROSS SECTION H-H'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
Clifton Associates

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PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION H-H'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.9
CHECKED TK	FILE NO. CG2430.1-E33-C-1.9	

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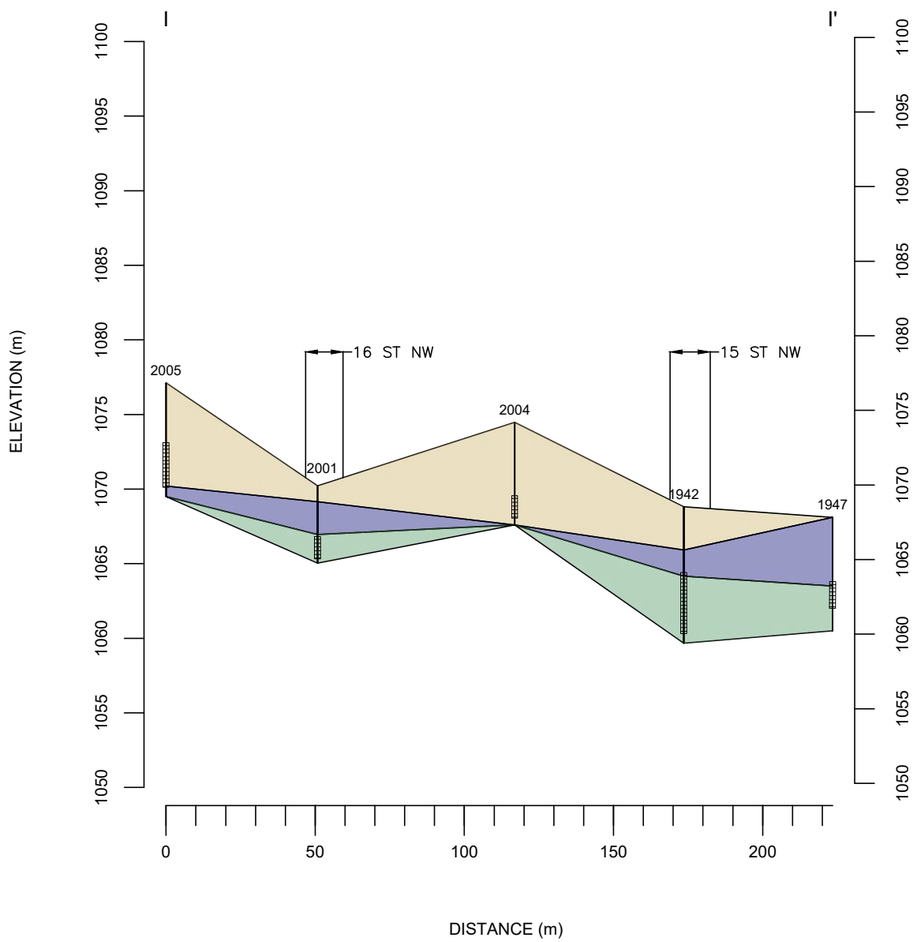
CROSS SECTION I-I'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER
Clifton Associates

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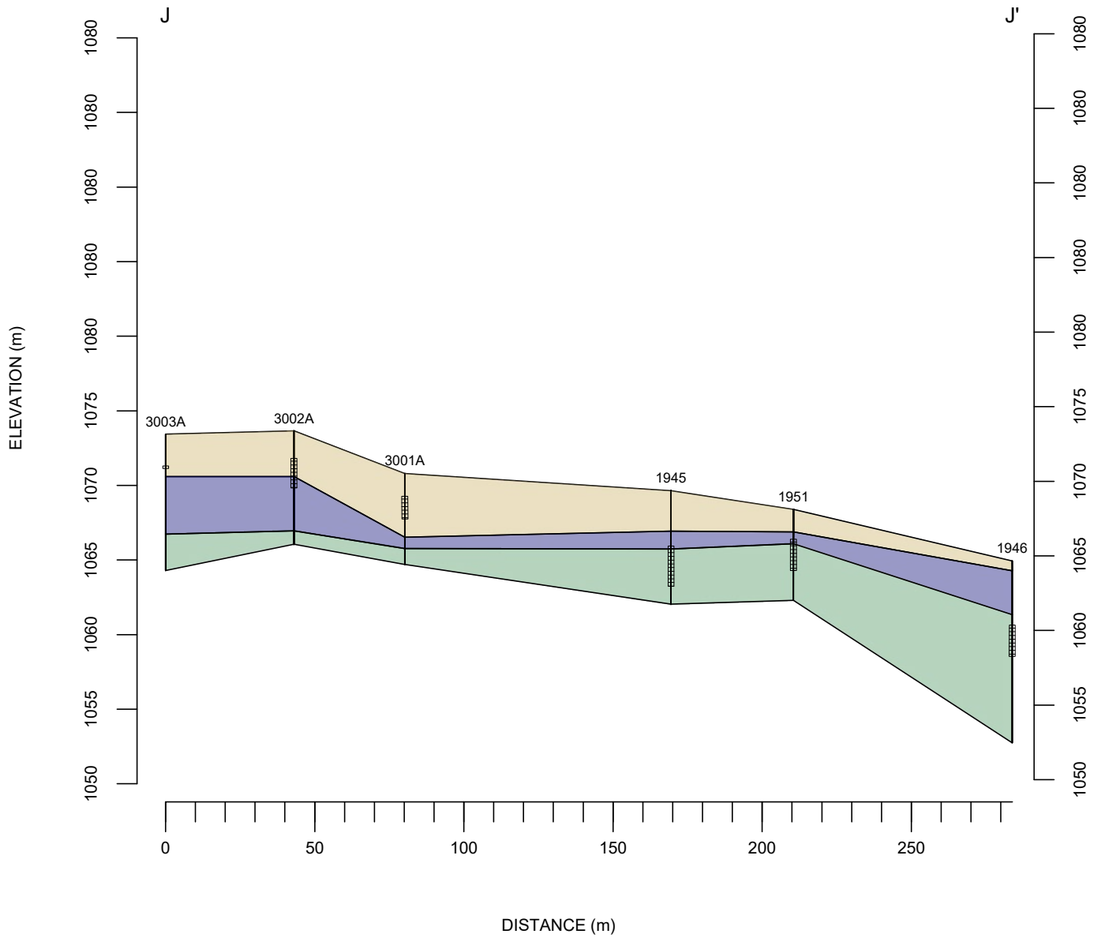
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION I-I'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.10
CHECKED TK	FILE NO. CG2430.1-E33-C-1.10	

CROSS-SECTION J-J'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 5

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: CROSS SECTION J-J'

DESIGNED	SCALE: HOR 1:2000 VERT 1:200	DATE: 2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: C-1.11
CHECKED: TK	FILE NO.: CG2430.1-E33-C-1.11	

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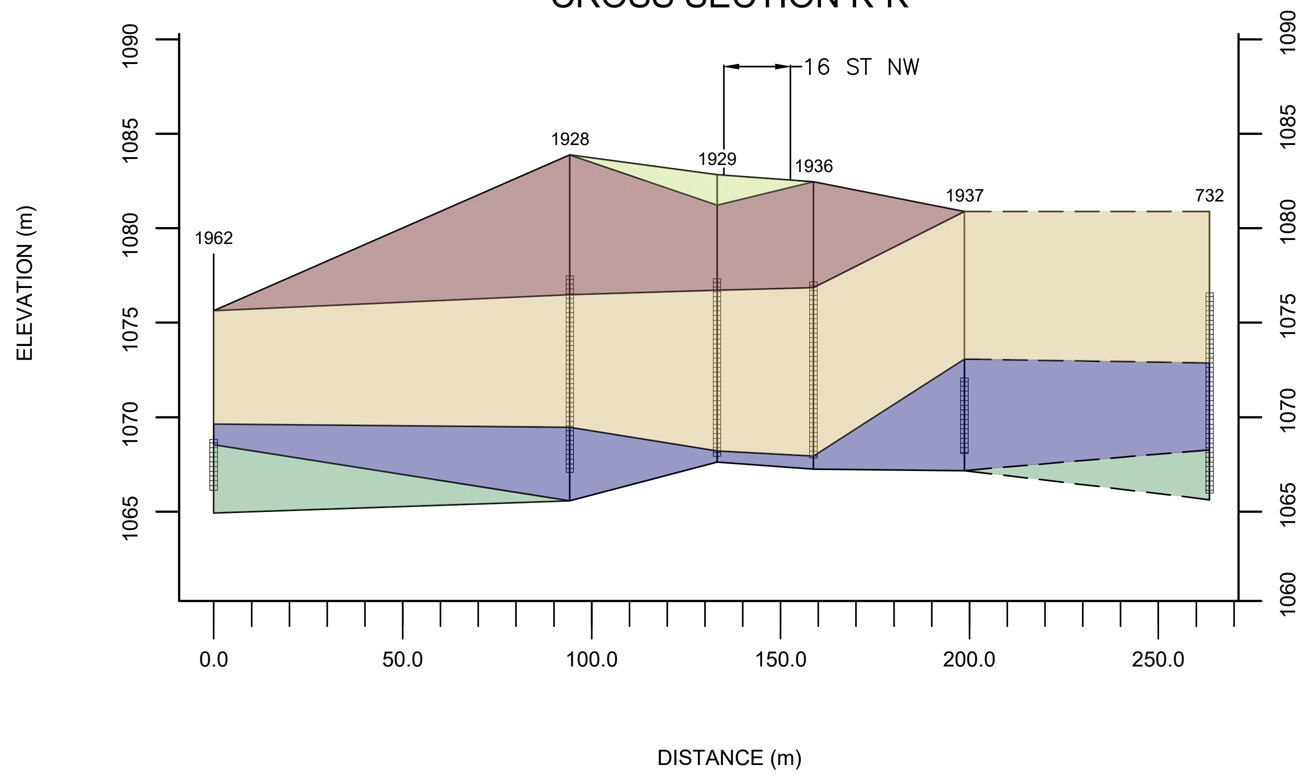
CROSS SECTION K-K'



LEGEND:

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- WELL SCREEN

NOTES:

1. VERTICAL EXAGGERATION OF 10

0 50 100 m
SCALE 1:2000 PLOT SIZE 11x17

0 5 10 15 m
SCALE 1:400 PLOT SIZE 11x17

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: CROSS SECTION K-K'

DESIGNED	SCALE HOR 1:2000 VERT 1:200	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. C-1.12
CHECKED TK	FILE NO. CG2430.1-E33-C-1.12	

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Appendix C2
Groundwater Flow Direction Maps

Clifton Associates

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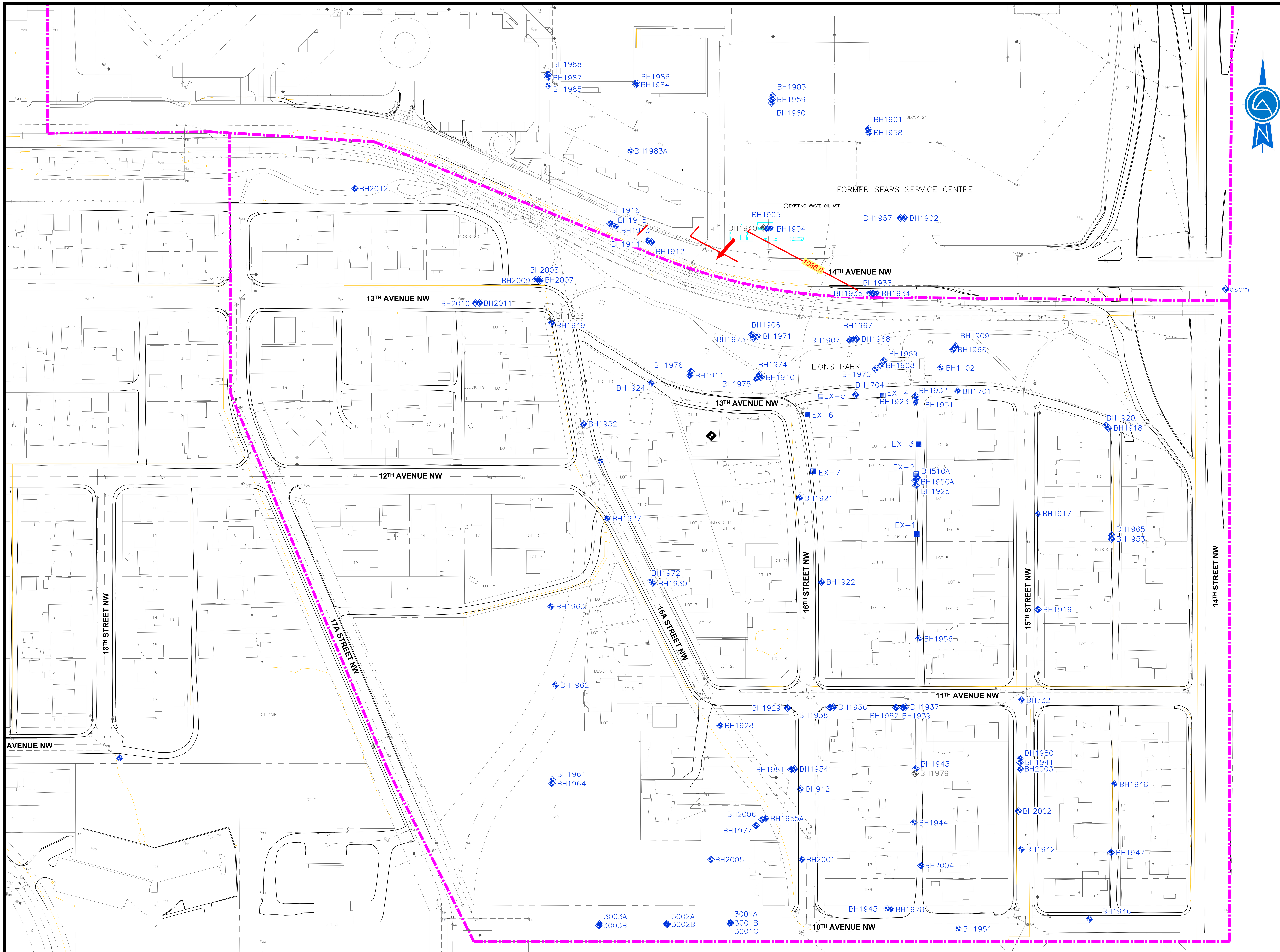
2222 30th Avenue NE
Calgary, Alberta T2E 7K9

T (403) 263 2556
F (403) 234 9033

calgary@clifton.ca
www.clifton.ca



LEGEND

SITE BOUNDARY	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
EXISTING GROUNDWATER MONITORING WELL	
POTENTIOMETRIC CONTOUR	
POTENTIOMETRIC ELEVATION	1080.0
INTERPRETED DIRECTION OF GROUNDWATER FLOW	

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN (CB)
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE (MH)
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: SUPPLEMENTAL PHASE II ESA
HOUNSFIELD HEIGHTS - BRIAR HILL COMMUNITY
CALGARY, ALBERTA

TITLE: POTENTIOMETRIC SURFACE UNIT 1

DESIGNED	SCALE	DATE
	1:1000	2018-06-08
DRAWN RD	PROJECT NO. CG2430.1 E28	FIG. C.2-1
CHECKED TK	FILE NO. CG2430.1-E33-C.2-1	

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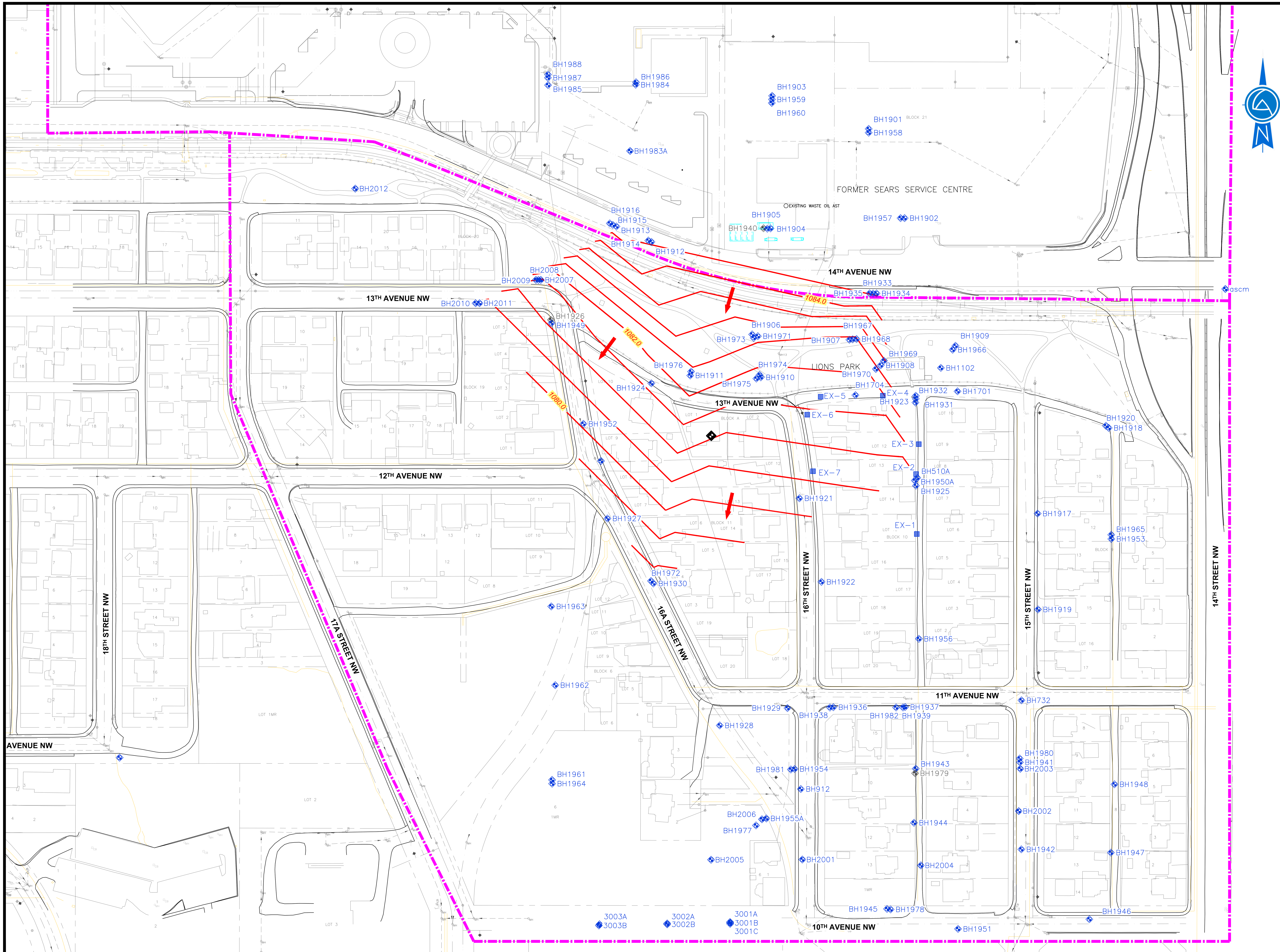

LEGEND

SITE BOUNDARY	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
EXISTING GROUNDWATER MONITORING WELL	
POTENTIOMETRIC CONTOUR	
POTENTIOMETRIC ELEVATION	1080.0
INTERPRETED DIRECTION OF GROUNDWATER FLOW	

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN (CB)
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE (MH)
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: SUPPLEMENTAL PHASE II ESA
HOUNSFIELD HEIGHTS - BRIAR HILL COMMUNITY
CALGARY, ALBERTA

TITLE: POTENTIOMETRIC SURFACE UNIT 2

DESIGNED	SCALE 1:1000	DATE 2018-06-08
DRAWN RD	PROJECT NO. CG2430.1 E28	FIG. C.2-2
CHECKED TK	FILE NO. CG2430.1-E33-C.2-2	

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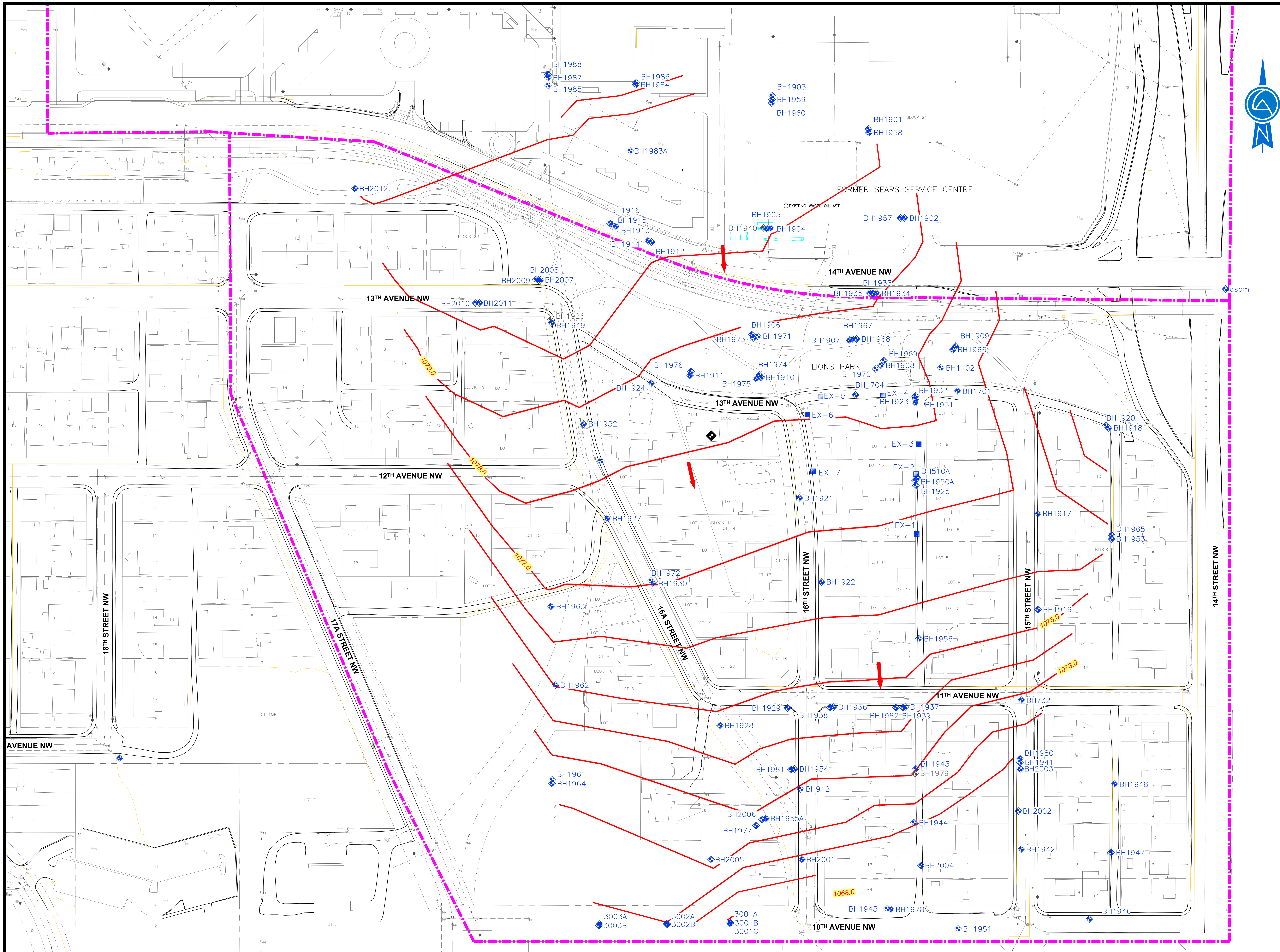

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXISTING GROUNDWATER MONITORING WELL
- POTENTIOMETRIC CONTOUR
- POTENTIOMETRIC ELEVATION — 1080.0
- INTERPRETED DIRECTION OF GROUNDWATER FLOW

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN — CB
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE — MH
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: SUPPLEMENTAL PHASE II ESA
HOUNSFIELD HEIGHTS - BRIAR HILL COMMUNITY
CALGARY, ALBERTA

TITLE: POTENTIOMETRIC SURFACE UNIT 3

DESIGNED	SCALE	DATE
	1:1000	2018-06-08
DRAWN: RD	PROJECT NO.: CG2430.1 E28	FIG.
CHECKED: TK	FILE NO.: CG2430.1-E33-C.2-3	C.2-3

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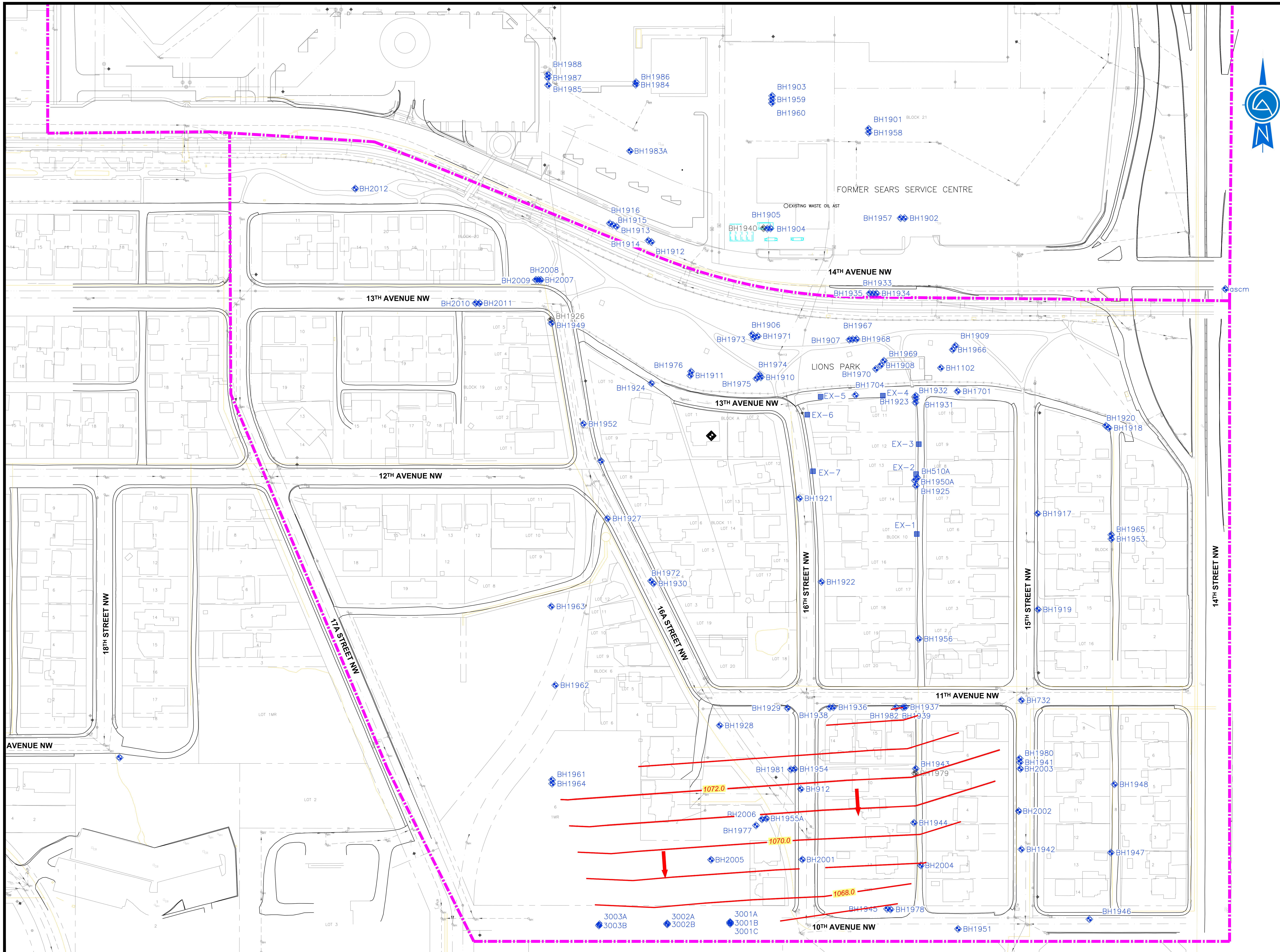

LEGEND

SITE BOUNDARY	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
EXISTING GROUNDWATER MONITORING WELL	
POTENTIOMETRIC CONTOUR	
POTENTIOMETRIC ELEVATION	1080.0
INTERPRETED DIRECTION OF GROUNDWATER FLOW	

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: SUPPLEMENTAL PHASE II ESA
HOUNSFIELD HEIGHTS - BRIAR HILL COMMUNITY
CALGARY, ALBERTA

TITLE: POTENTIOMETRIC SURFACE UNIT 4

DESIGNED	SCALE	DATE
	1:1000	2018-06-08
DRAWN: RD	PROJECT NO.: CG2430.1 E28	FIG. C.2-4
CHECKED: TK	FILE NO.: CG2430.1-E33-C.2-4	

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Appendix D1
Soil Exceedance Maps

Clifton Associates

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2222 30th Avenue NE
Calgary, Alberta T2E 7K9

T (403) 263 2556
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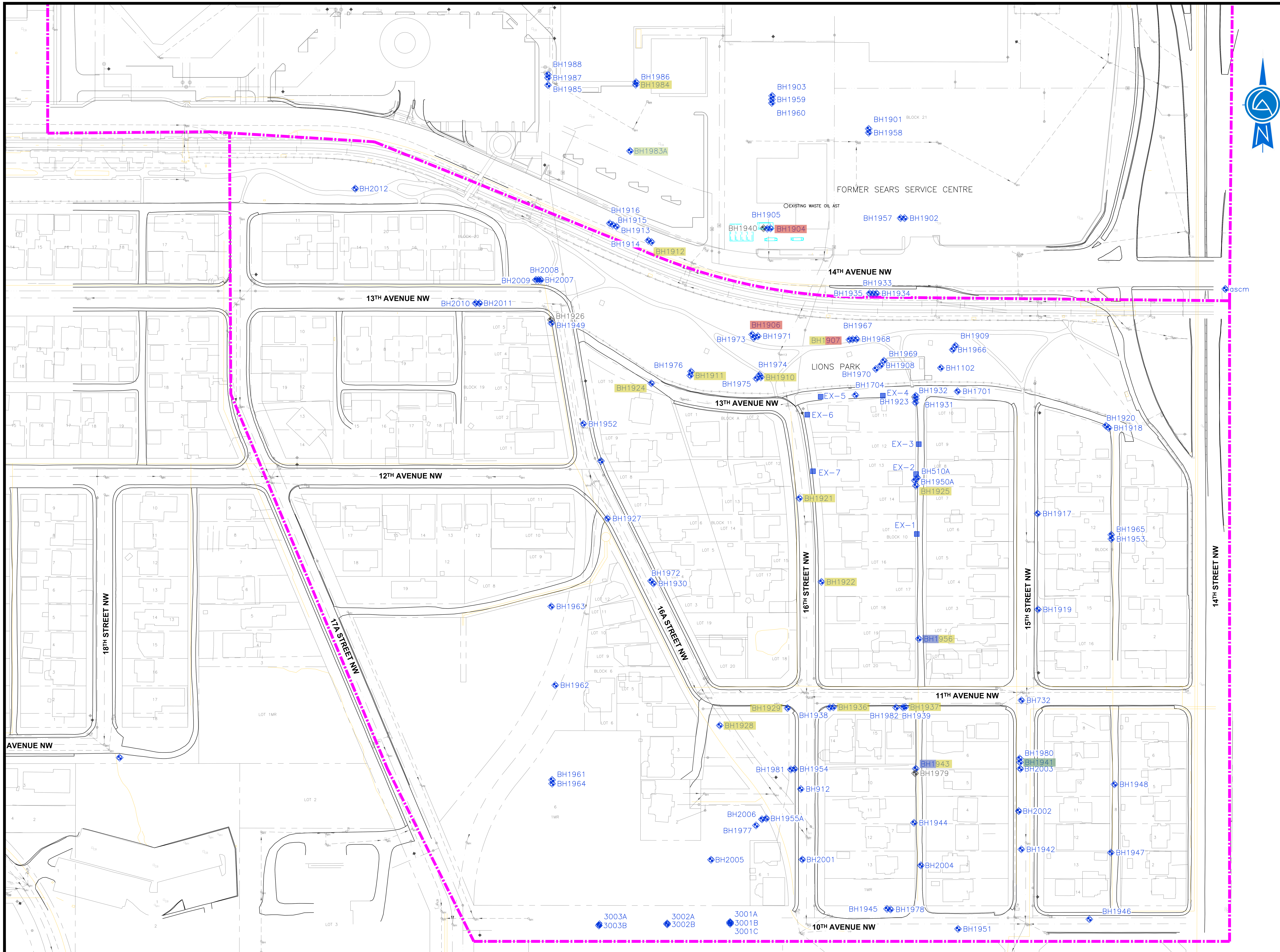
www.clifton.ca



LEGEND

SITE BOUNDARY	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
EXISTING GROUNDWATER MONITORING WELL	
EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 1)	
EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 2)	
EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 3)	
EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 4)	
EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 5)	

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m
PLOT SIZE 22x34

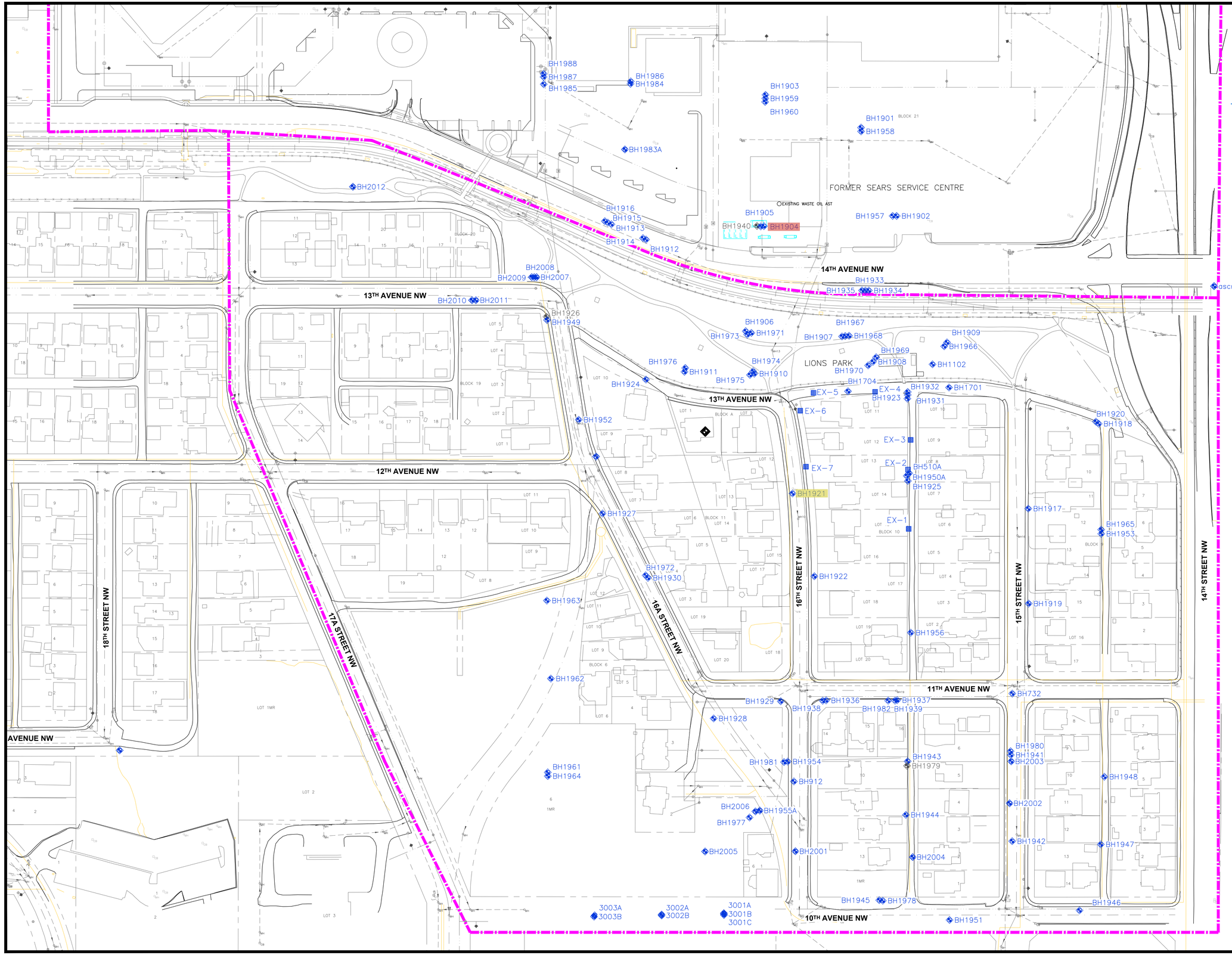
ENGINEER
Clifton Associates

CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
SOIL EXCEEDANCES - BENZENE

DESIGNED	SCALE 1:1000	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D.1-1
CHECKED TK	FILE NO. CG2430.1-E33-D.1-1	



LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXISTING GROUNDWATER MONITORING WELL
- EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 1)
- EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 2)
- EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 3)
- EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 4)
- EXCEEDS AEP 2016 TIER 1 GUIDELINES (UNIT 5)

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER

Clifton Associates

CLIENT

SEARS

PROJECT

REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE

SOIL EXCEEDANCES - NAPHTHALENE

DESIGNED	SCALE	DATE
	1:1000	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: D.1-2
CHECKED: TK	FILE NO.: CG2430.1-E33-D.1-2	

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: SOIL EXCEEDANCES - 1,2 - DCA

DESIGNED	SCALE	DATE
	1:1000	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: D.1-3
CHECKED: TK	FILE NO.: CG2430.1-E33-D.1-3	

W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.1-3.dwg, 12/05/2018 2:01:39 PM

Appendix D2
Soil Exceedance Cross-Sections

Clifton Associates

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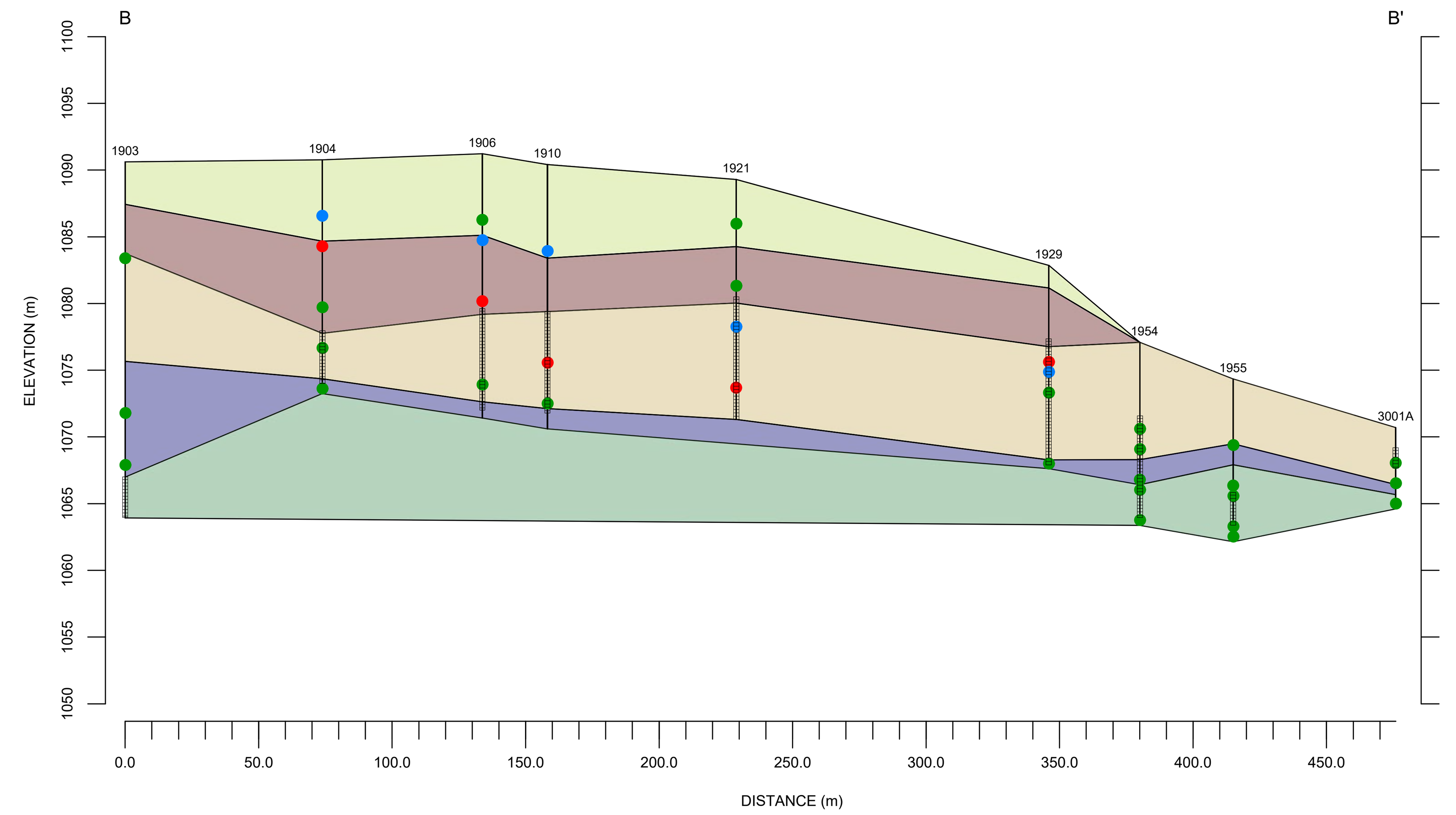
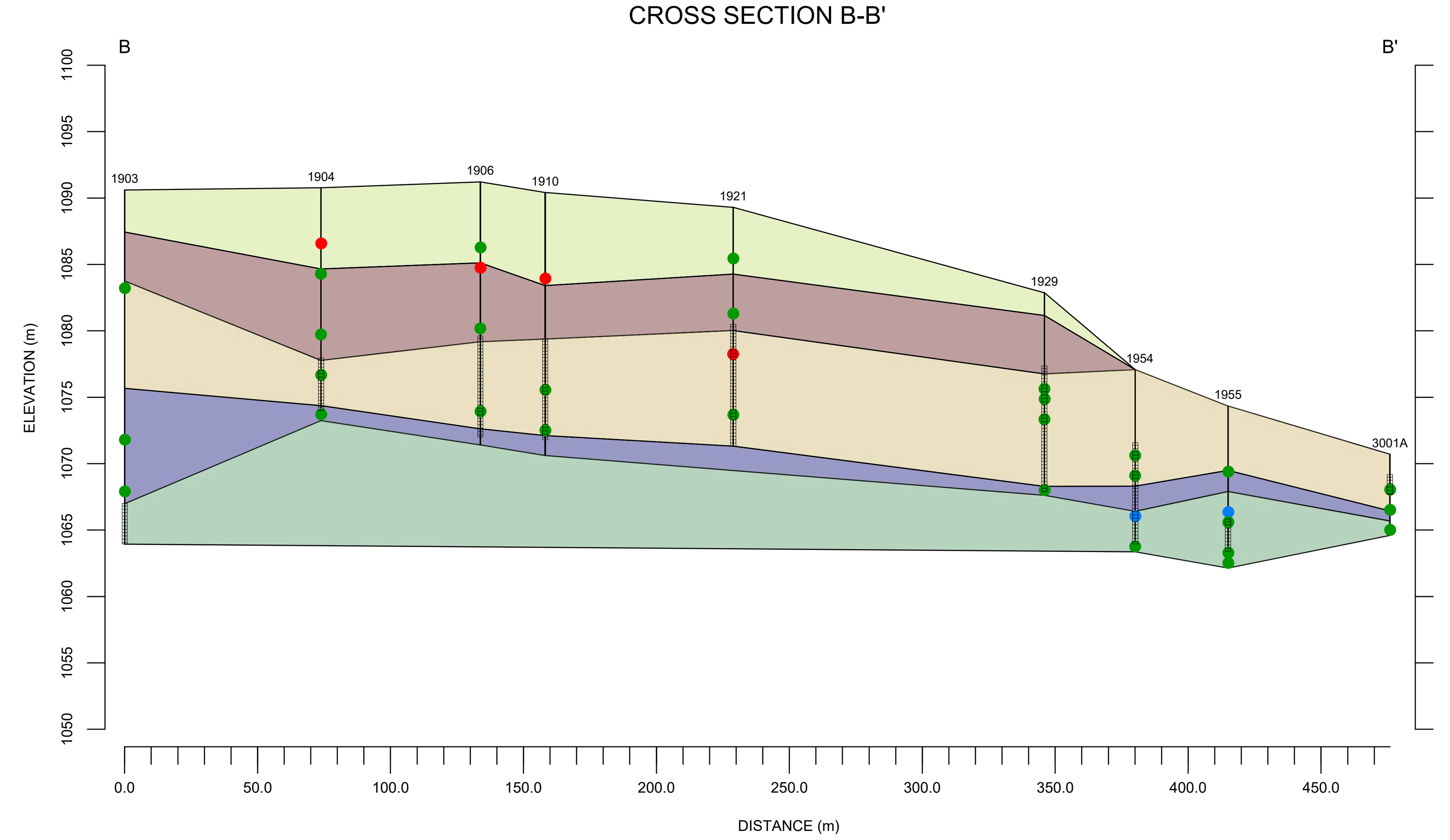
CROSS SECTION B-B'



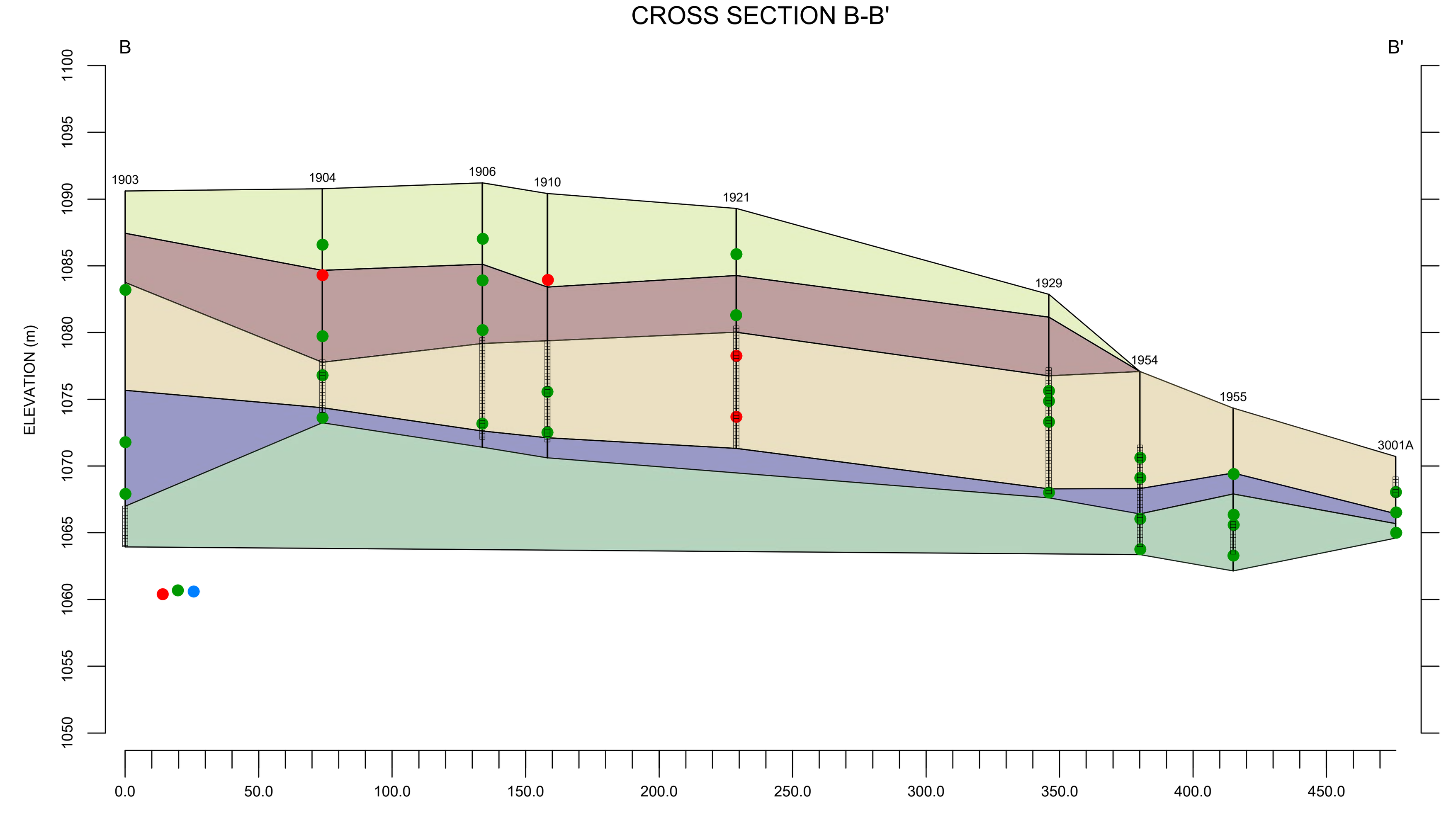
BENZENE

CROSS SECTION B-B'



NAPHTHALENE

CROSS SECTION B-B'



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR FINE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.046	0.046
NAPHTHALENE	0.014	0.014
1,2-DCA	0.025	0.025

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.073	0.073
NAPHTHALENE	0.017	0.017
1,2-DCA	0.095	0.095

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER
Clifton Associates

CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION B-B'
SOIL EXCEEDANCES

DESIGNED	SCALE HOR 1:2000 VERT 1:400	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-2.1
CHECKED TK	FILE NO. CG2430.1-E33-D-2.1	

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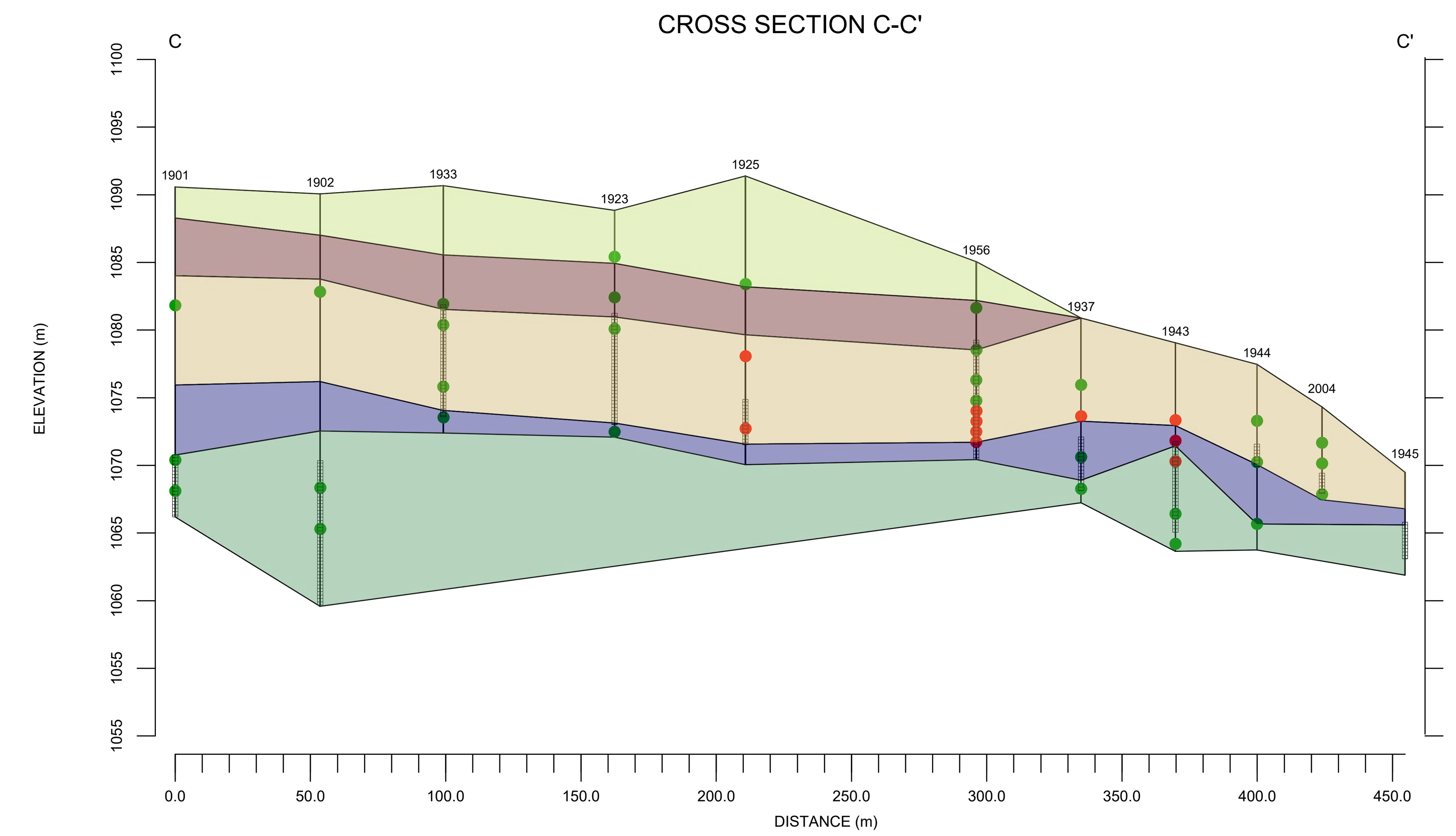
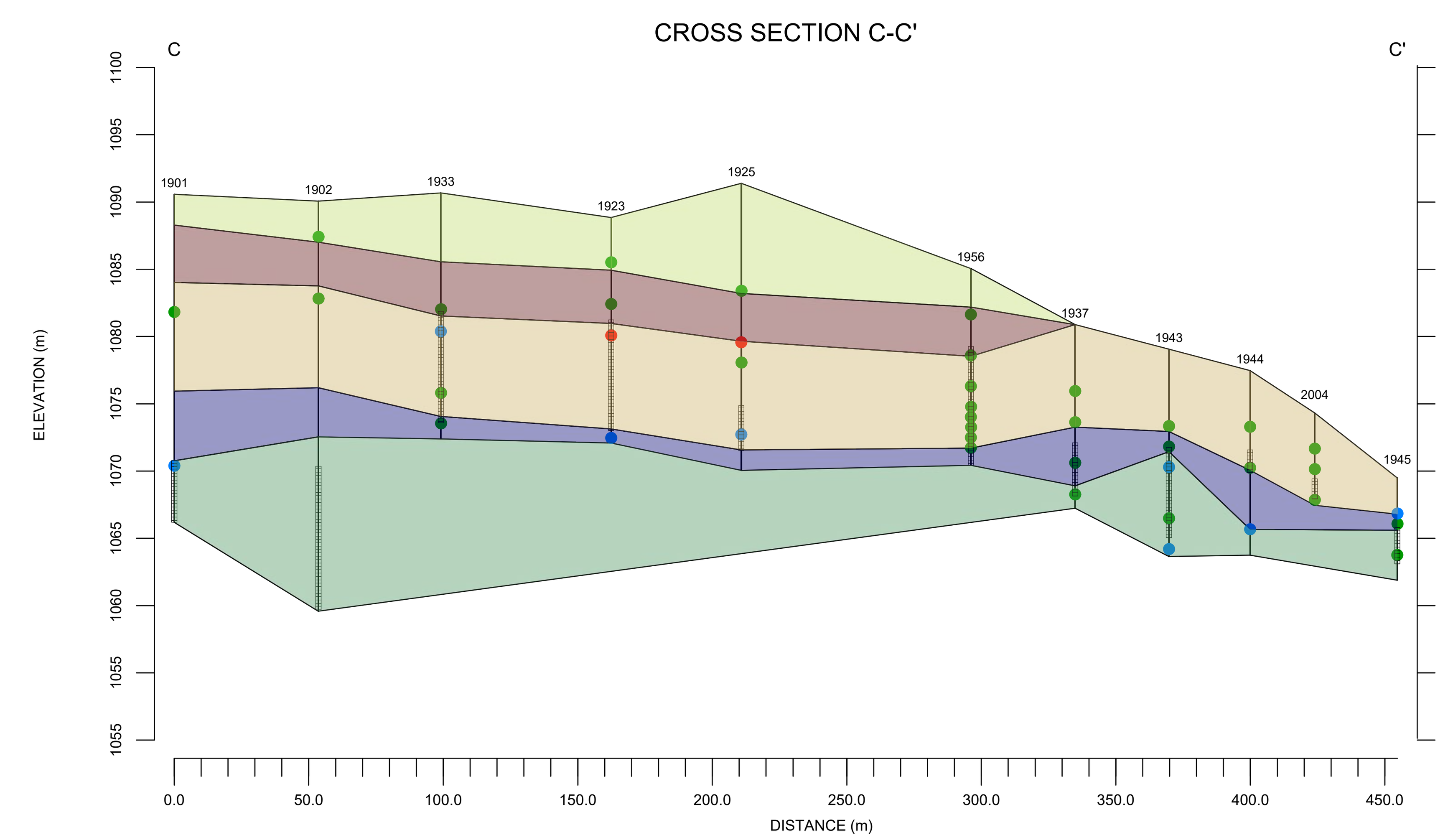
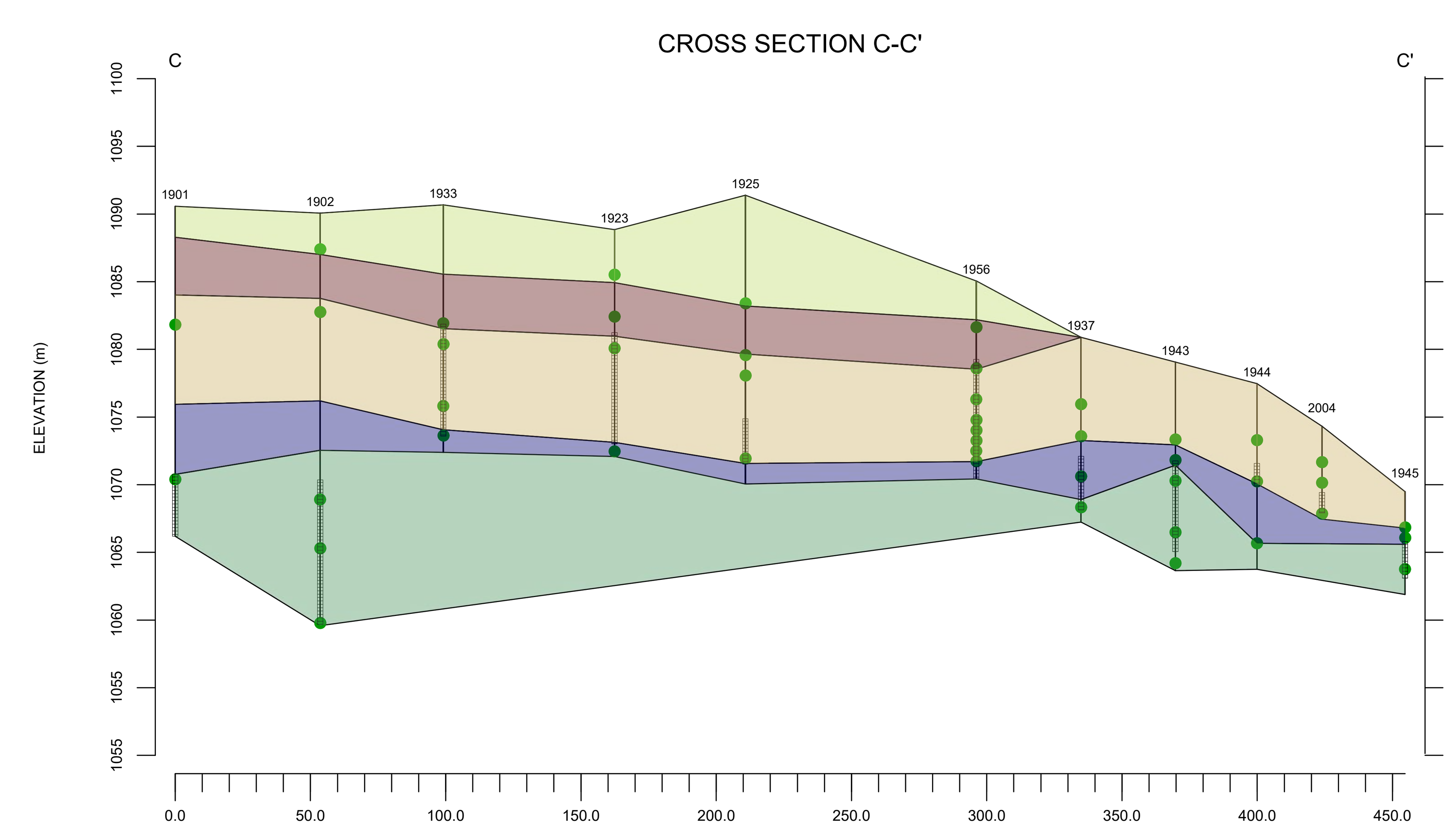


BENZENE



NAPHTHALENE



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR FINE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.046	0.046
NAPHTHALENE	0.014	0.014
1,2-DCA	0.025	0.025

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.073	0.073
NAPHTHALENE	0.017	0.017
1,2-DCA	0.095	0.095

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER

Clifton Associates

CLIENT

SEARS

PROJECT

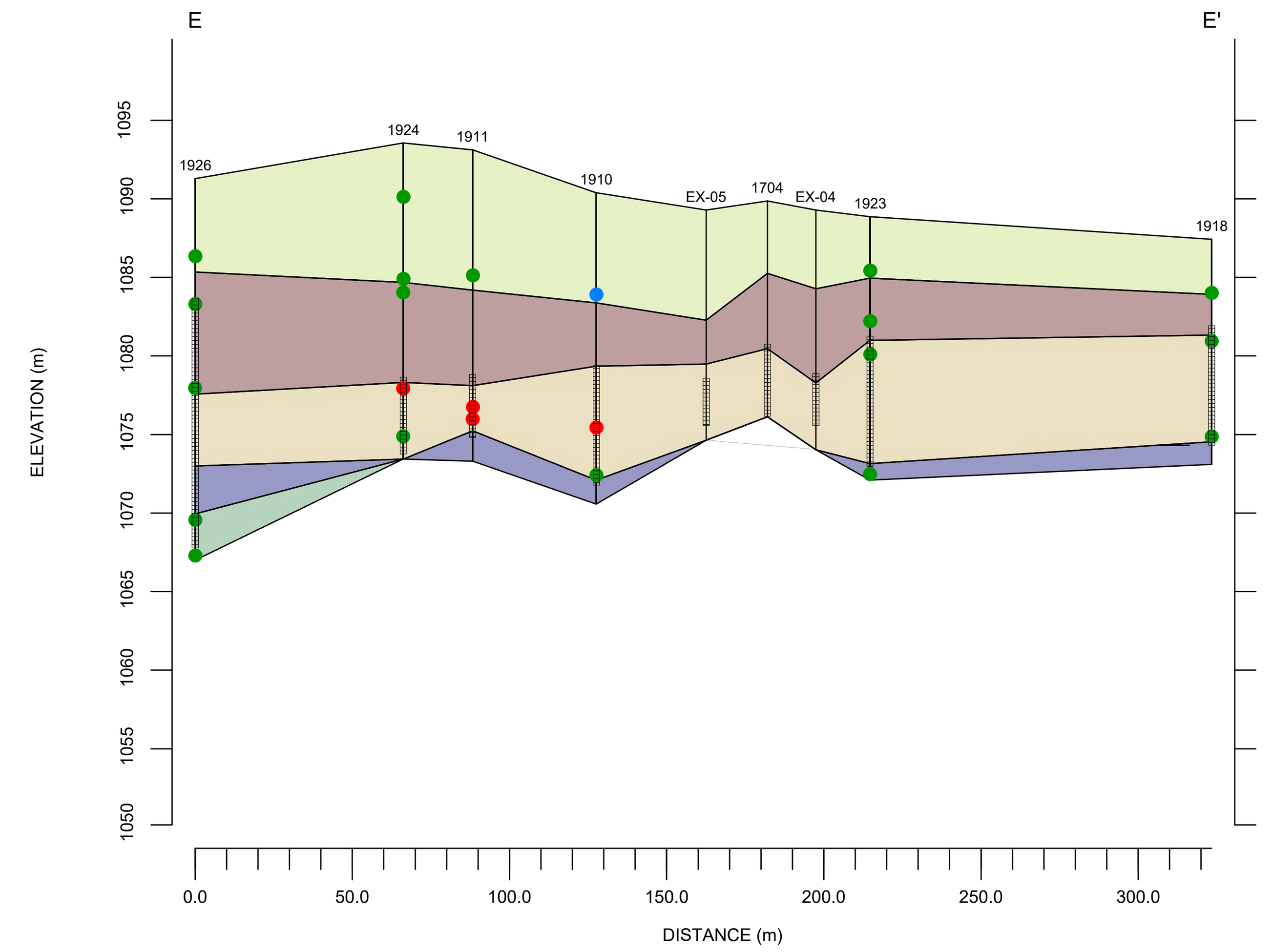
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE

CROSS SECTION C-C'
SOIL EXCEEDANCES

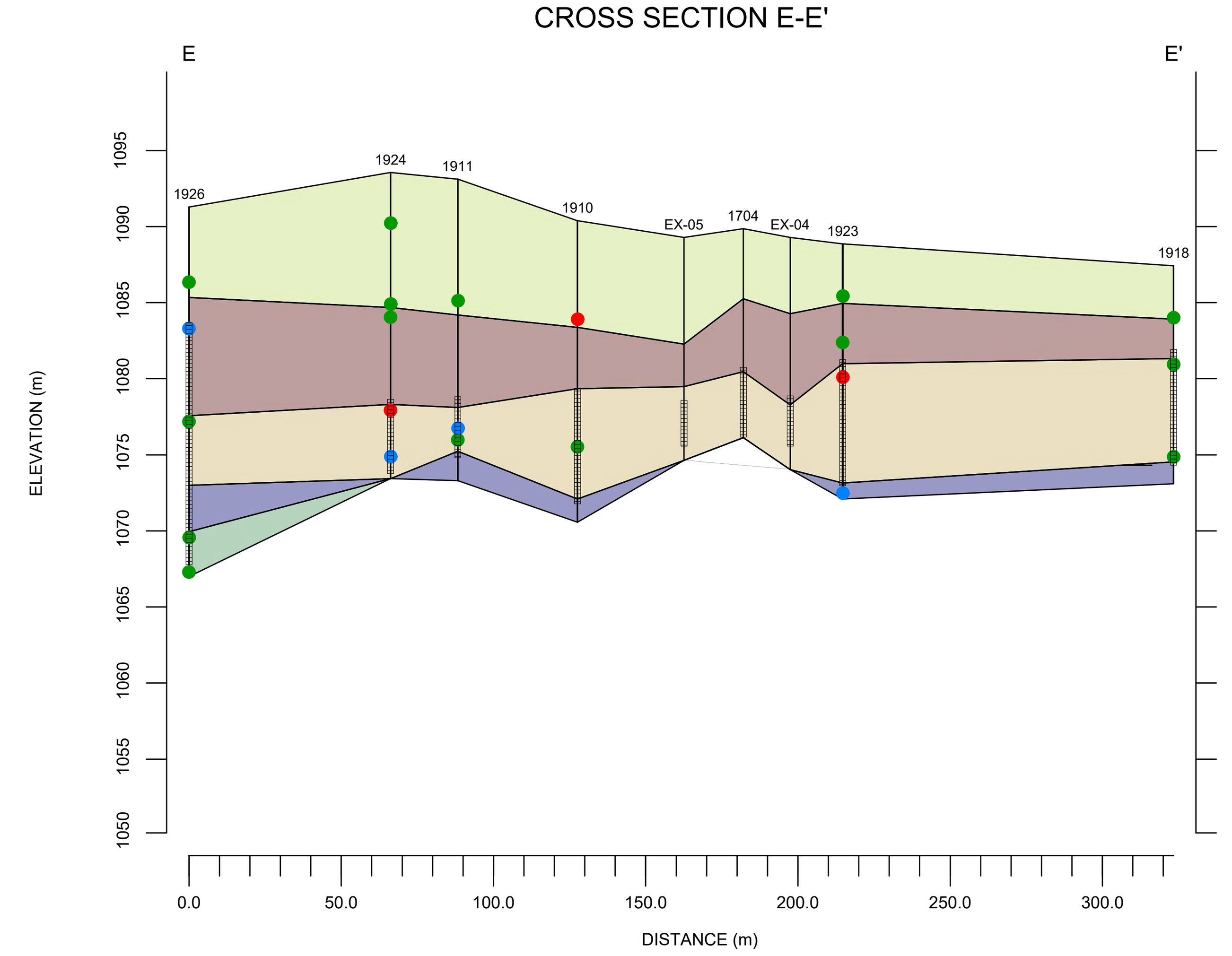
DESIGNED	SCALE HOR 1:2000 VERT 1:400	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D.2-2
CHECKED TK	FILE NO. CG2430.1-E33-D-2.2	

CROSS SECTION E-E'



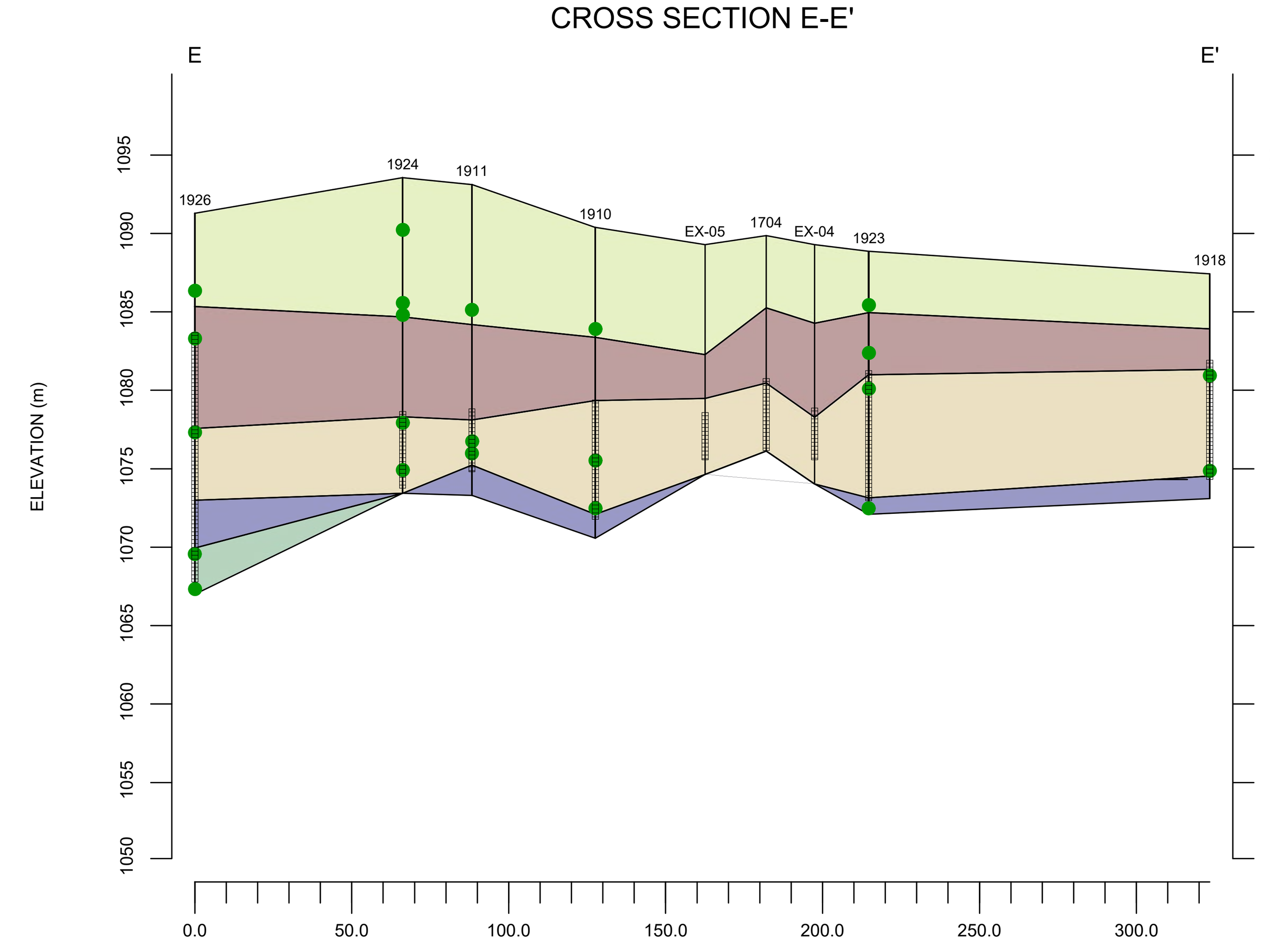
BENZENE

CROSS SECTION E-E'



NAPHTHALENE

CROSS SECTION E-E'



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR FINE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.046	0.046
NAPHTHALENE	0.014	0.014
1,2-DCA	0.025	0.025

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.073	0.073
NAPHTHALENE	0.017	0.017
1,2-DCA	0.095	0.095

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER
Clifton Associates

CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION E-E'
SOIL EXCEEDANCES

DESIGNED	SCALE HOR 1:2000 VERT 1:400	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-2.3
CHECKED TK	FILE NO. CG2430.1-E33-D-2.3	

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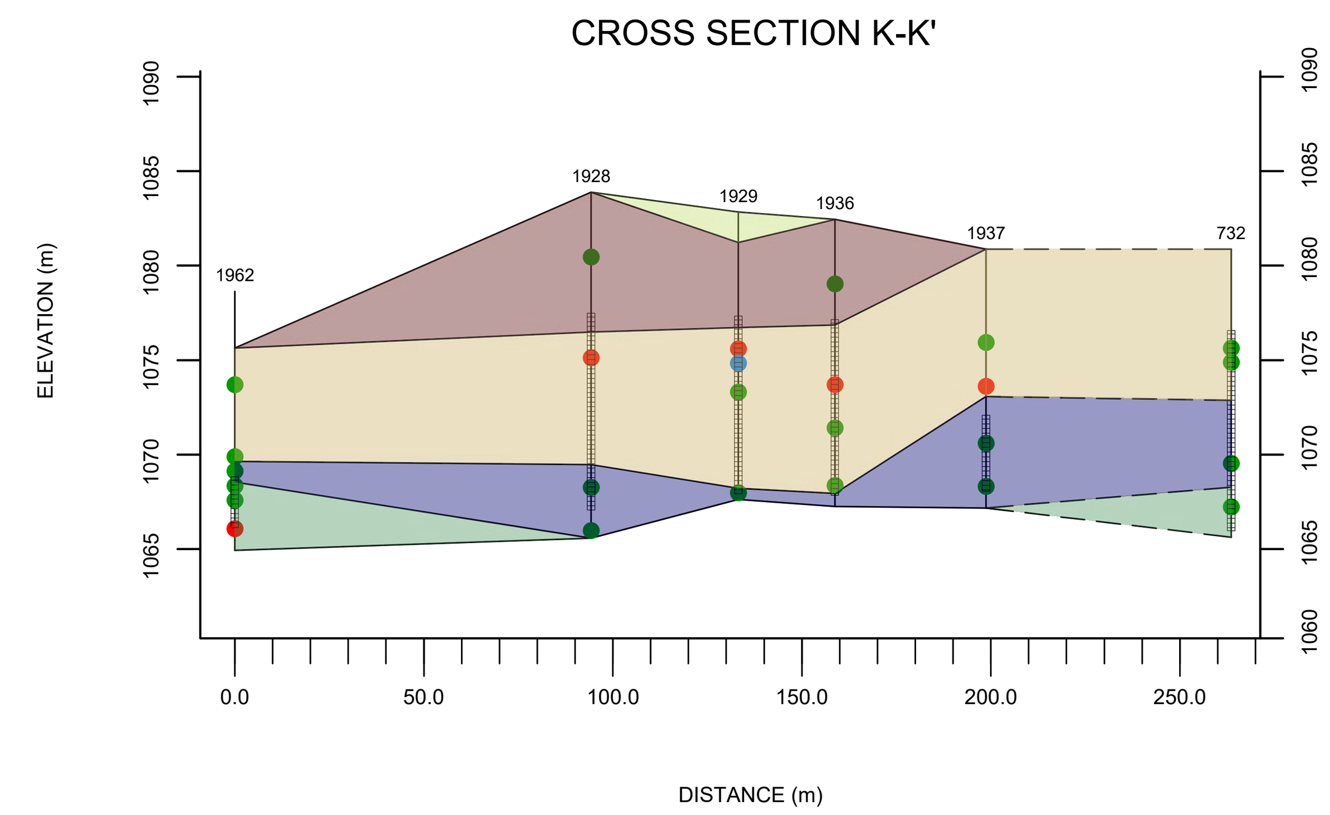
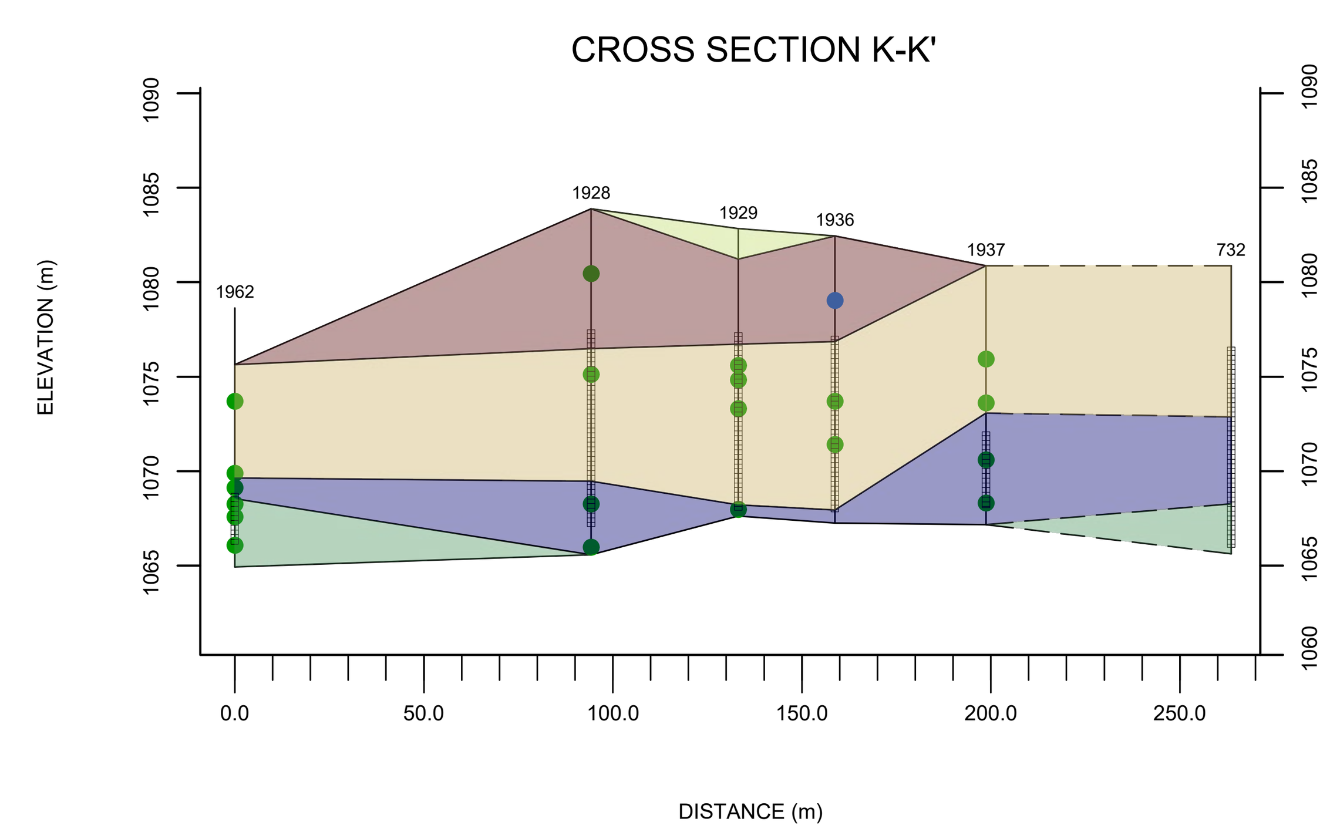
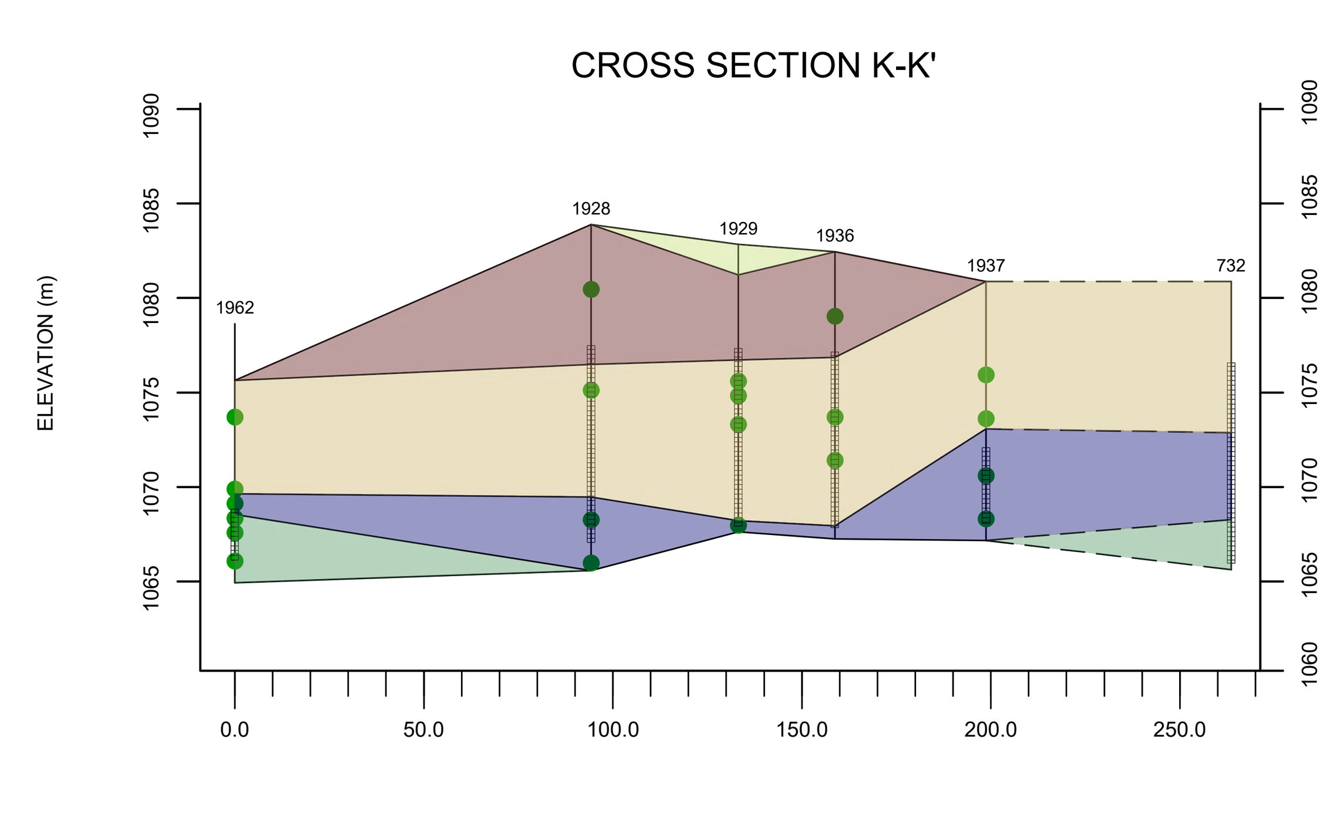


BENZENE



NAPHTHALENE



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR FINE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.046	0.046
NAPHTHALENE	0.014	0.014
1,2-DCA	0.025	0.025

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/kg)	COMMERCIAL GUIDELINE (mg/kg)
BENZENE	0.073	0.073
NAPHTHALENE	0.017	0.017
1,2-DCA	0.095	0.095

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER
Clifton Associates

CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION E-E'
SOIL EXCEEDANCES

DESIGNED	SCALE HOR 1:2000 VERT 1:400	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-2.4
CHECKED TK	FILE NO. CG2430.1-E33-D-2.4	

W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D-2.4.dwg, 11/30/2018 12:35:41 PM

Appendix D3
LPH Contaminant Characterization

Clifton Associates

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2222 30th Avenue NE
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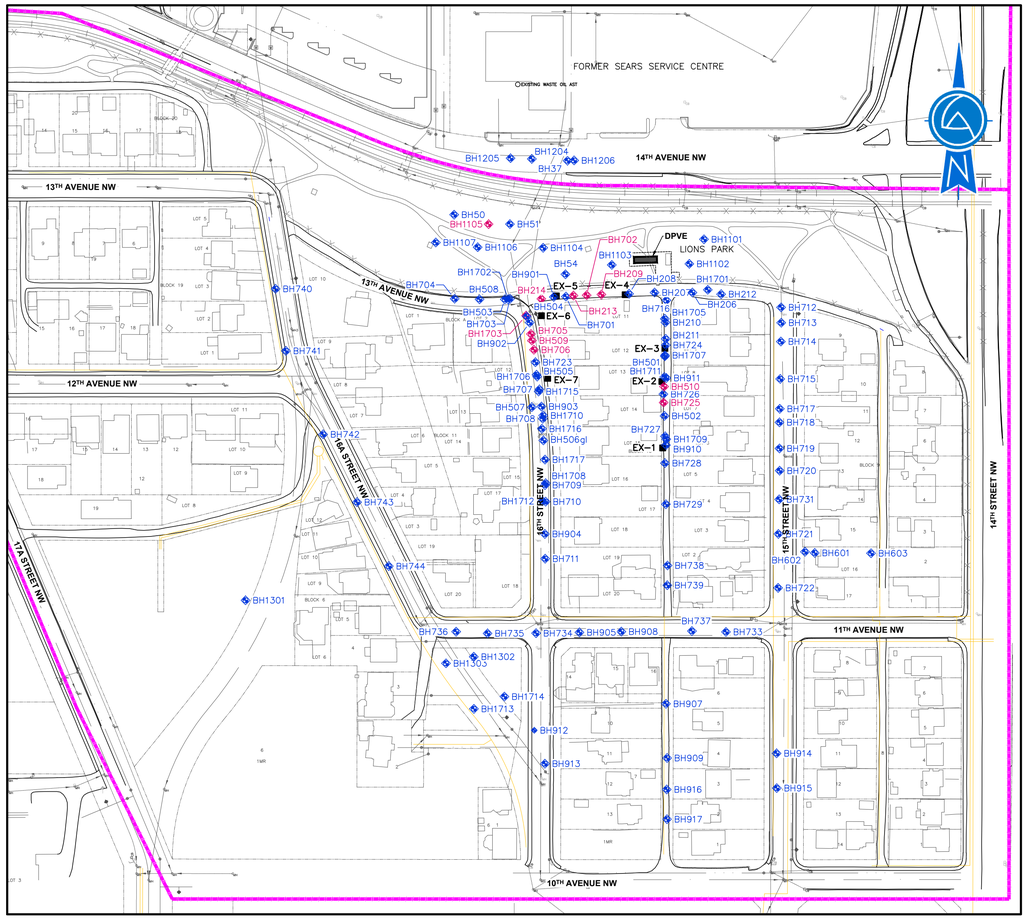
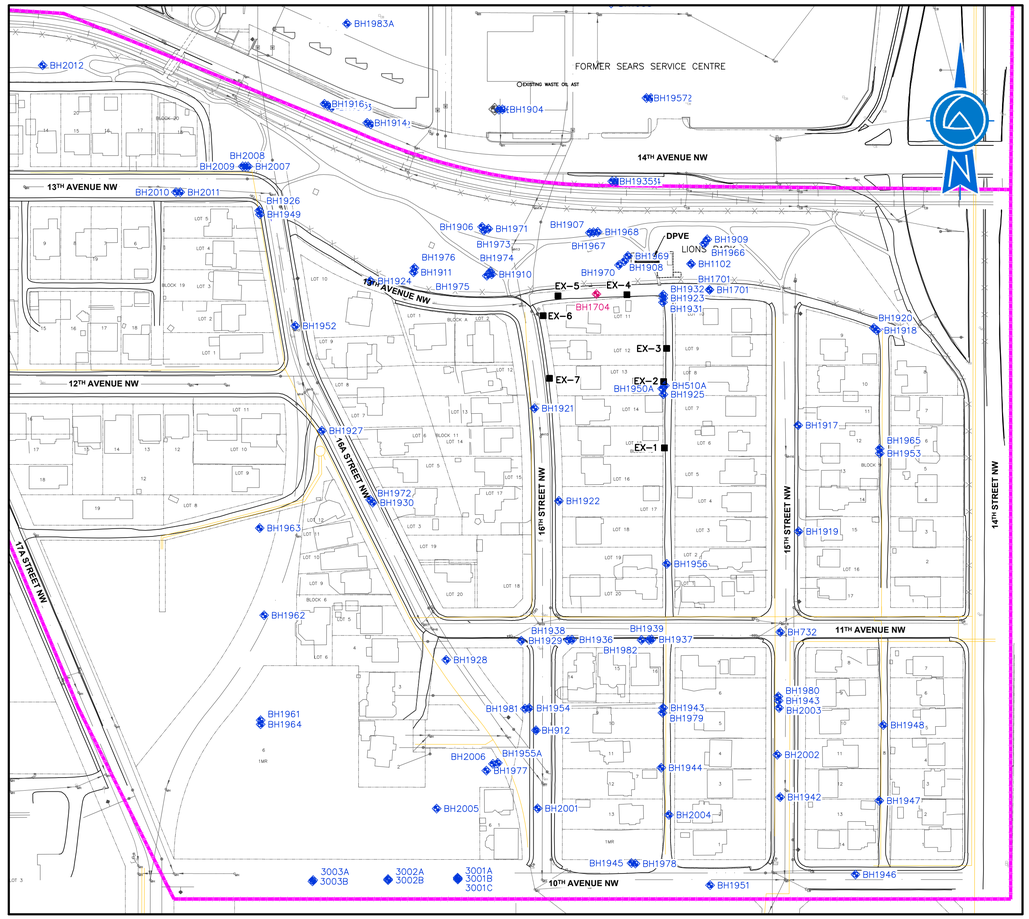
www.clifton.ca



HISTORIC LPH DISTRIBUTION



CURRENT LPH DISTRIBUTION

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- GROUNDWATER MONITORING WELL
- GROUNDWATER MONITORING WELL CONTAINING LPH

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 100 m

ENGINEER

Clifton Associates

CLIENT

SEARS

PROJECT

REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE

LIQUID PETROLEUM HYDROCARBONS (LPH)

DESIGNED	SCALE 1:1500	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D.3
CHECKED TK	FILE NO. CG2430.1-E33-D.3	

Appendix D4
Groundwater Exceedance Maps

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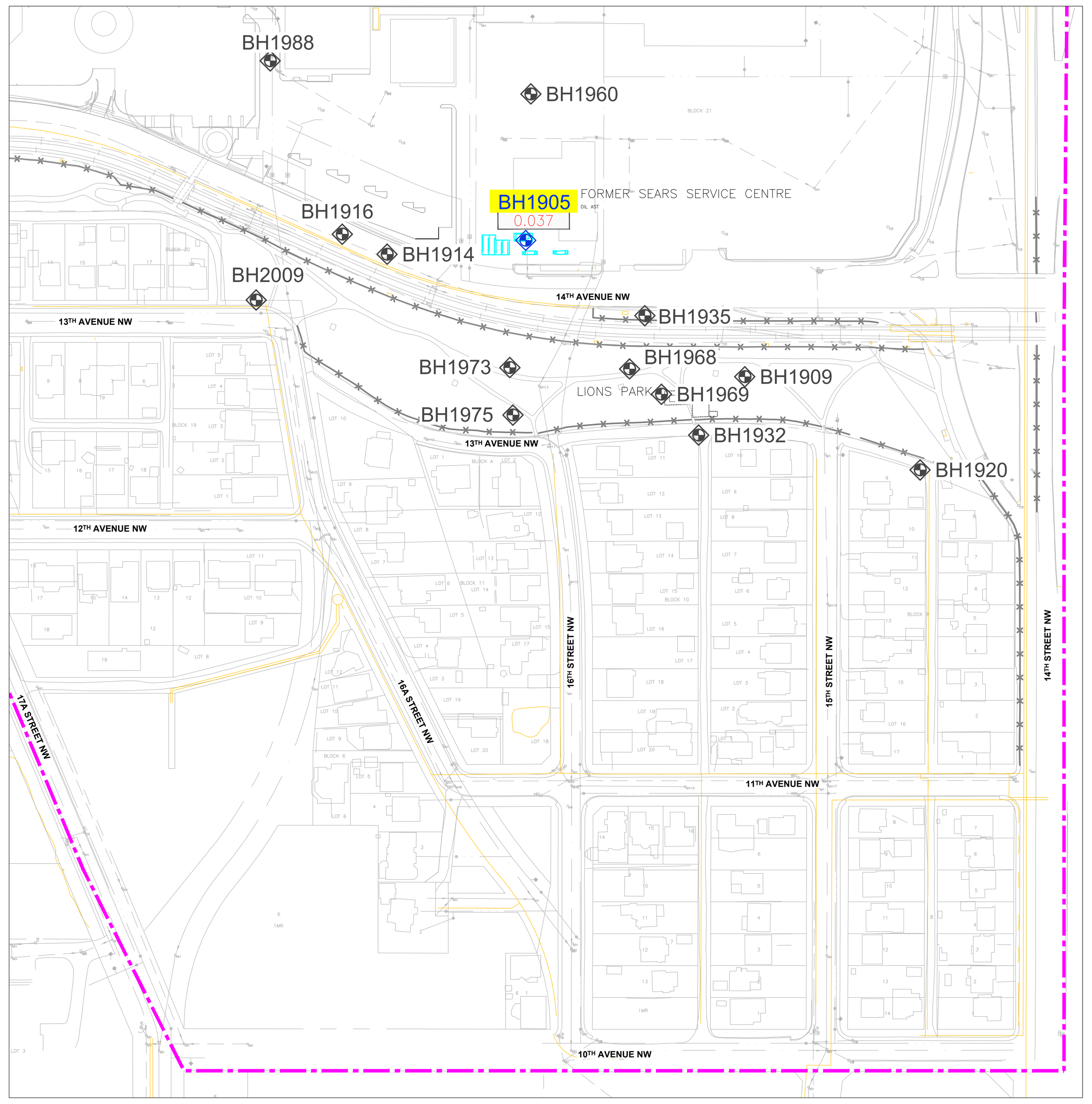
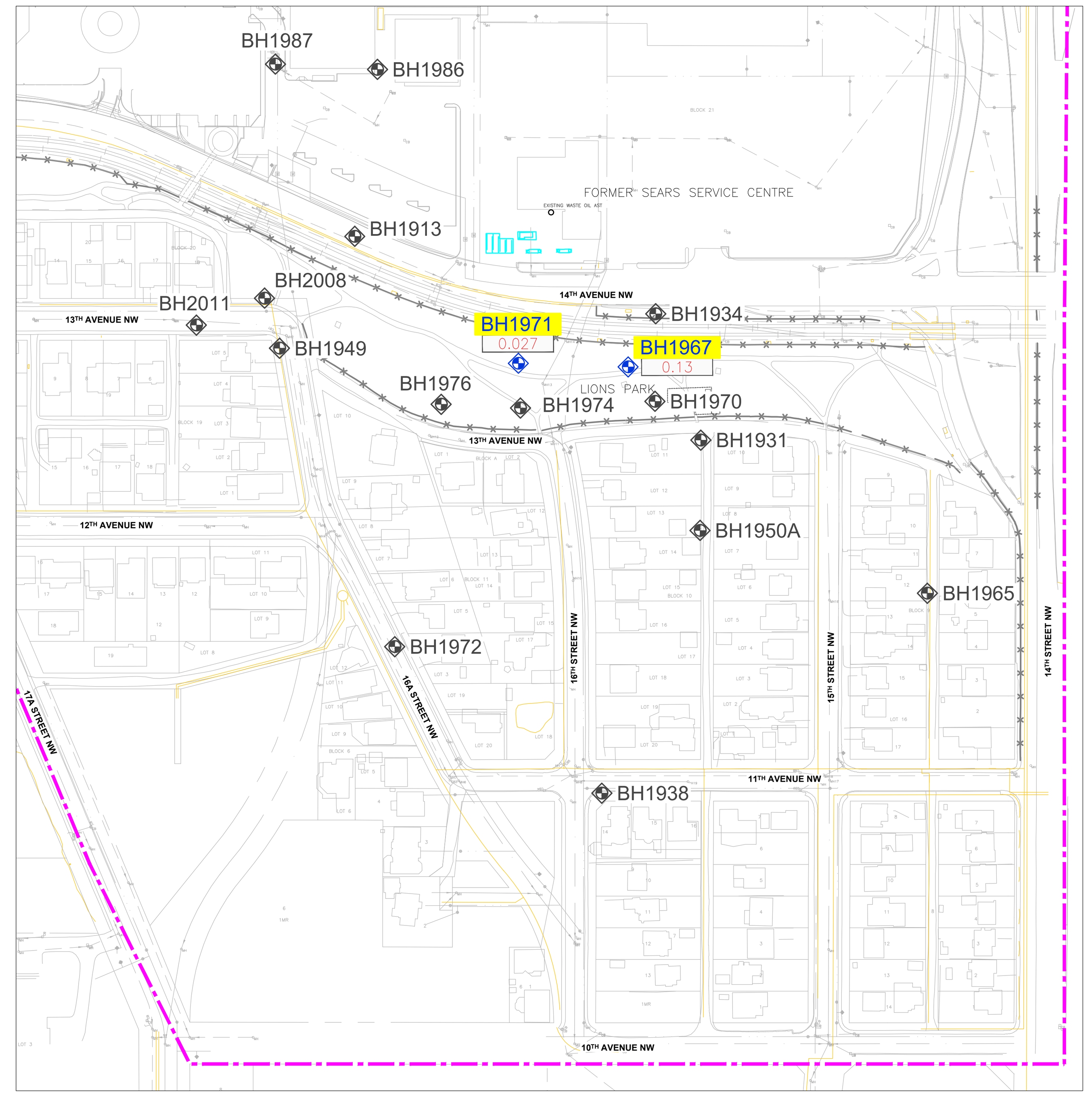
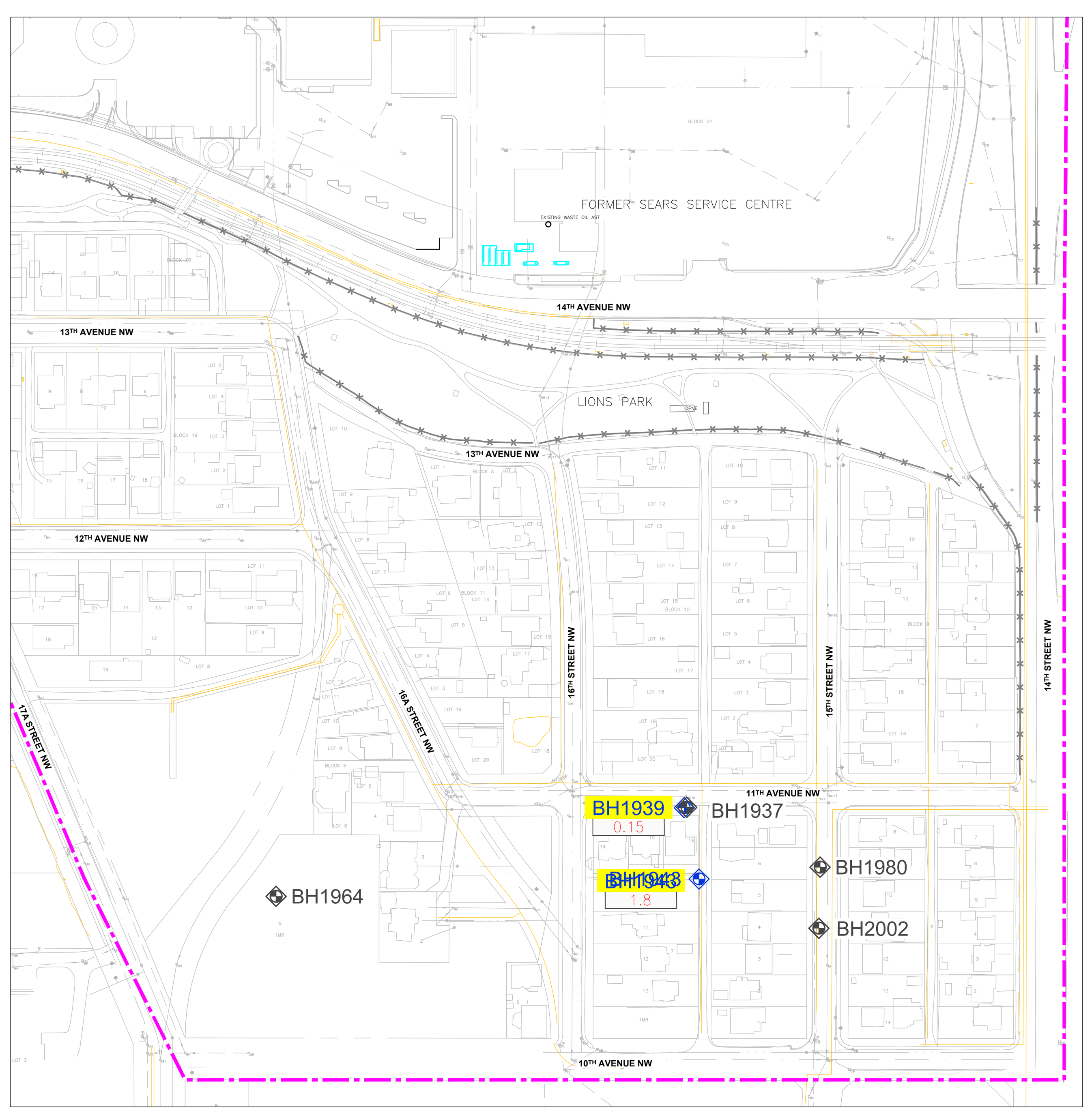


UNIT 1 - UPPER SILTY SAND

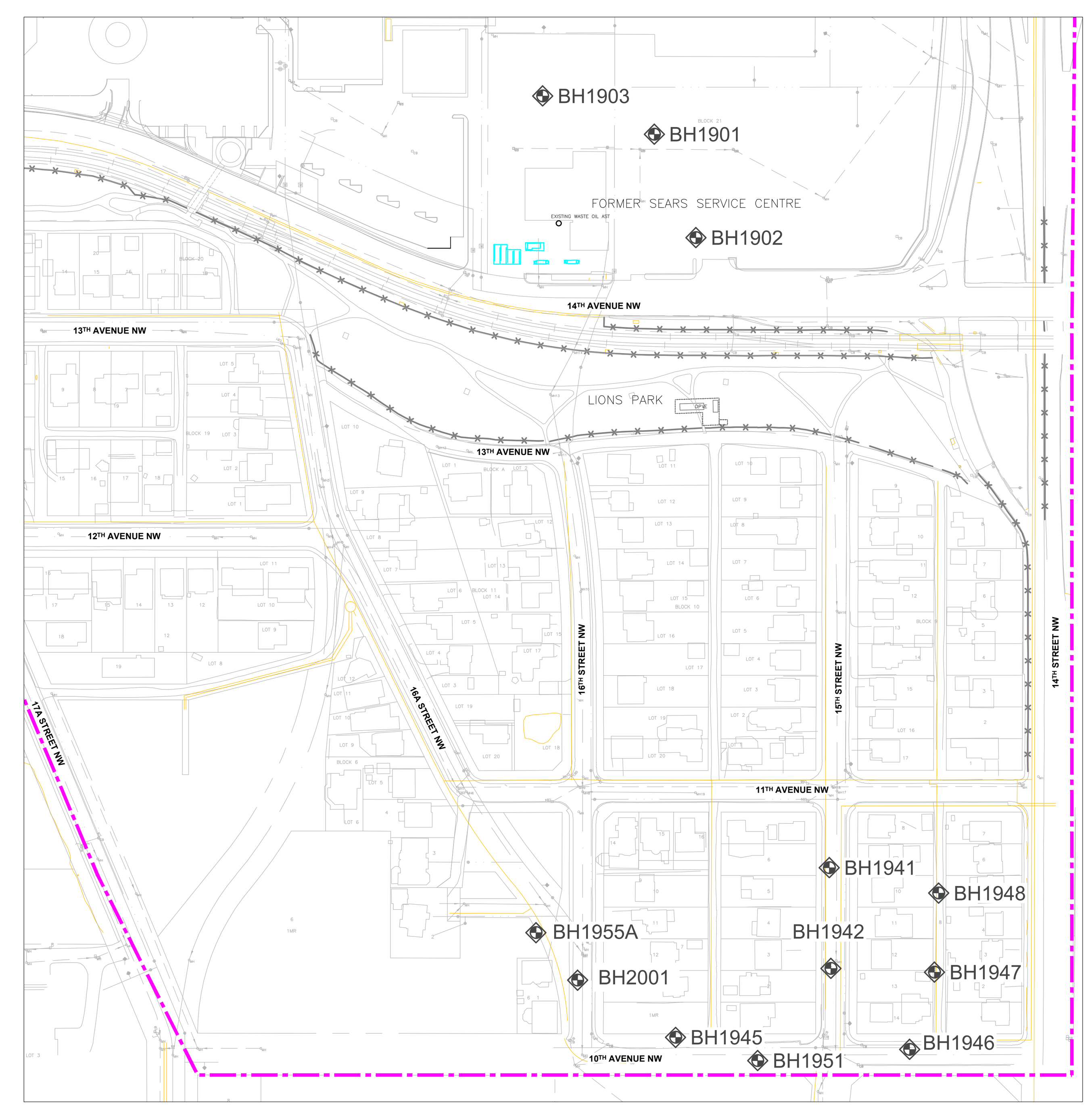


UNIT 2 - UPPER CLAYEY SILT

UNIT 3 - MIDDLE SANDY SILT



UNIT 4 - LOWER CLAYEY SILT



UNIT 5 - LOWER SILTY SAND AND GRAVEL

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXISTING GROUNDWATER MONITORING WELL
- CURRENT MONITORING WELL CONDITIONS — BH1963 <0.00040
- EXCEEDS AEP 2016 TIER 1 GUIDELINES — BH1905 0.055

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
BENZENE	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES
1:2500
PLOT SIZE 22x34

ENGINEER
Clifton Associates

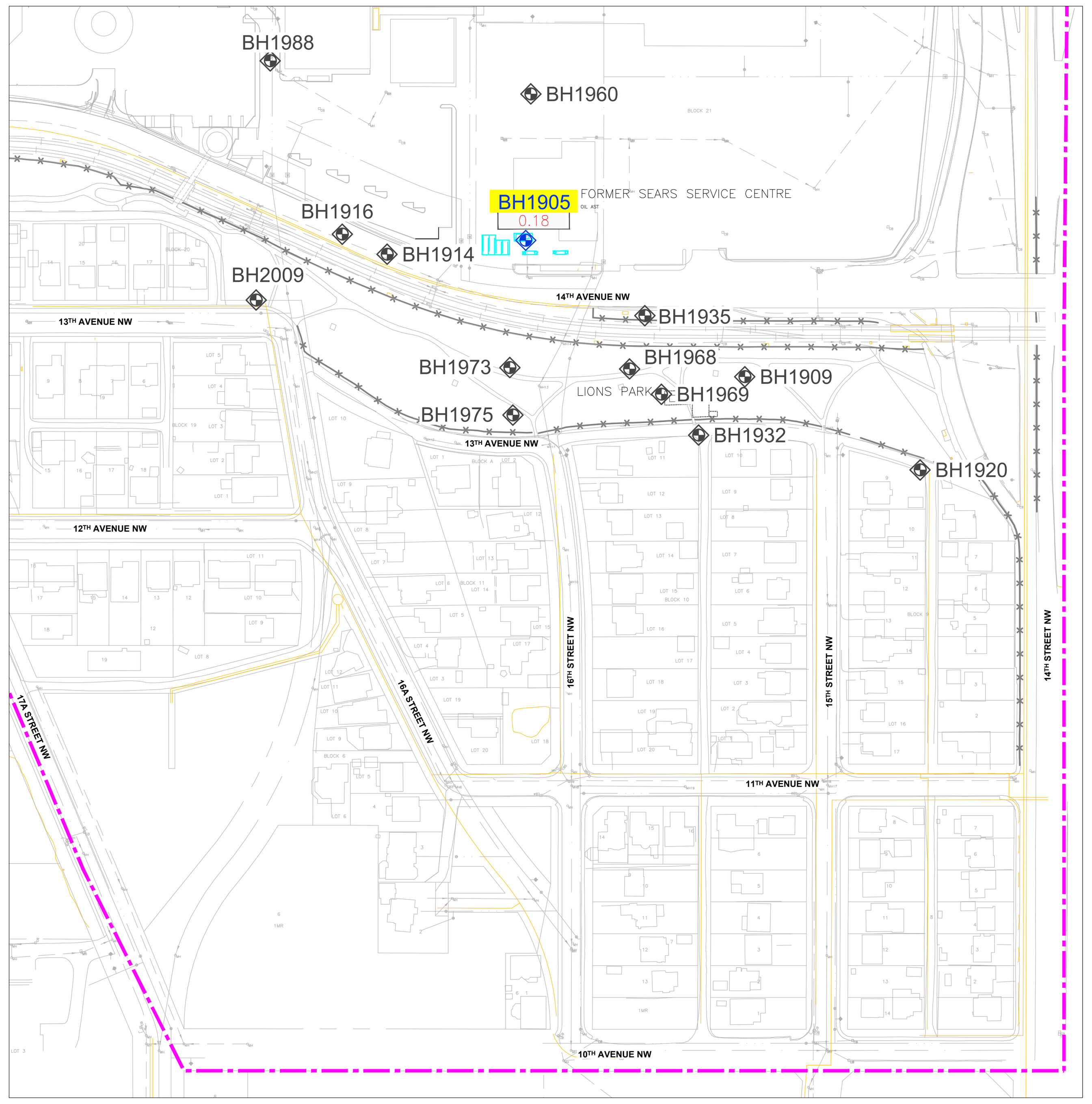
CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

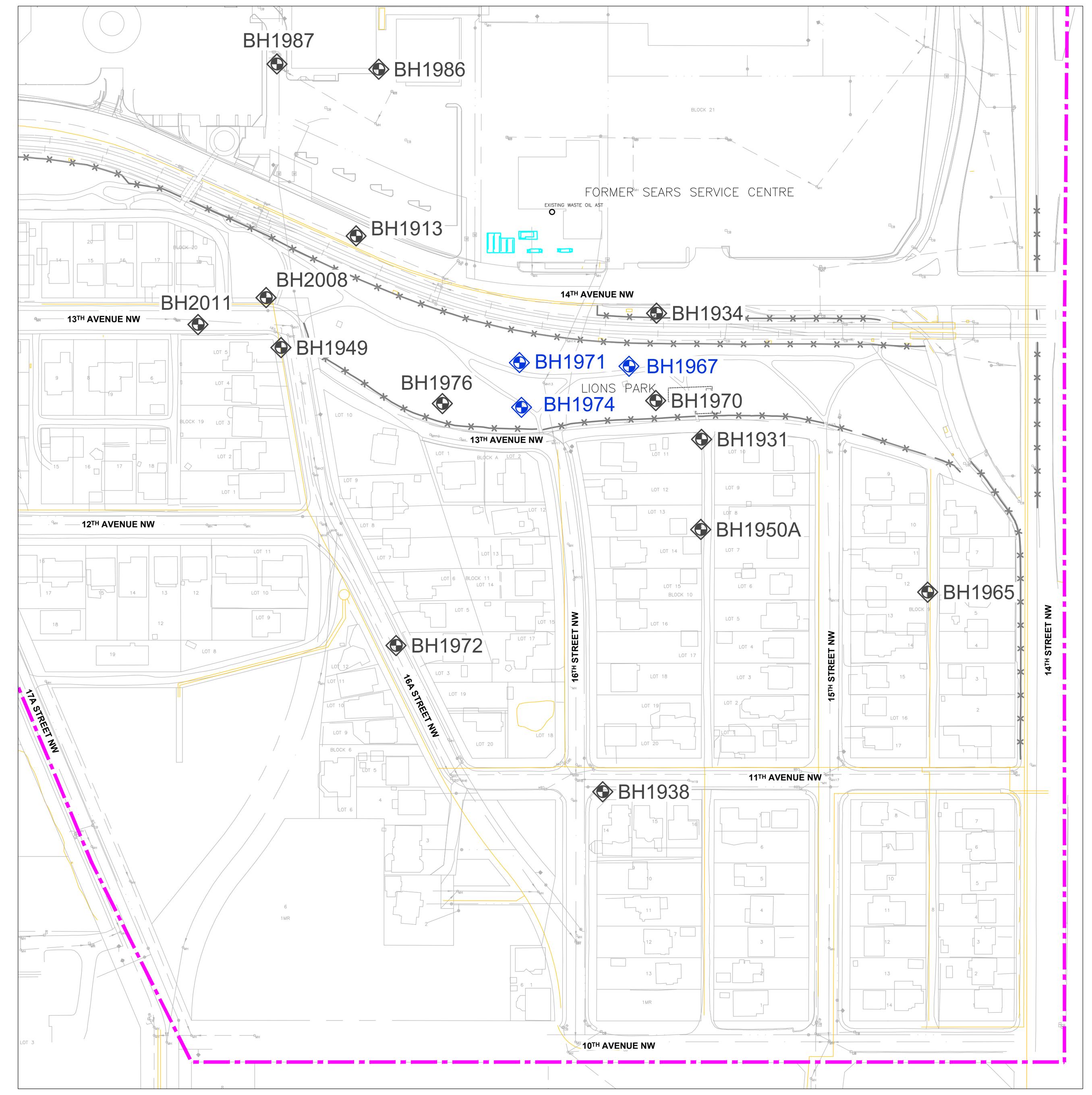
TITLE
GROUNDWATER EXCEEDANCES - BENZENE

DESIGNED	SCALE 1:2500	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-4.1
CHECKED TK	FILE NO. CG2430.1-E33-D.4-1	

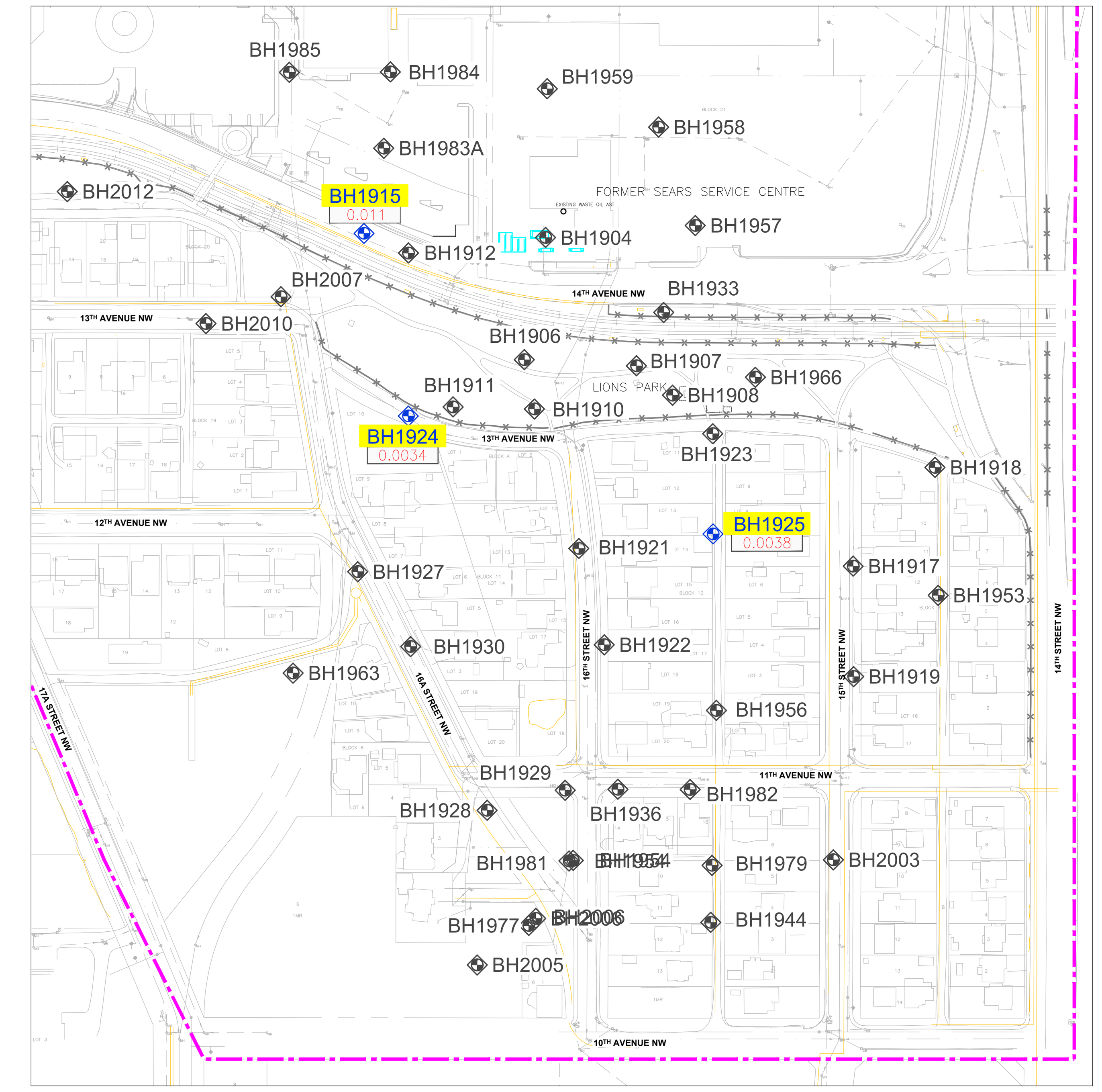
W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.4-1.dwg, 11/30/2018 12:08:20 PM



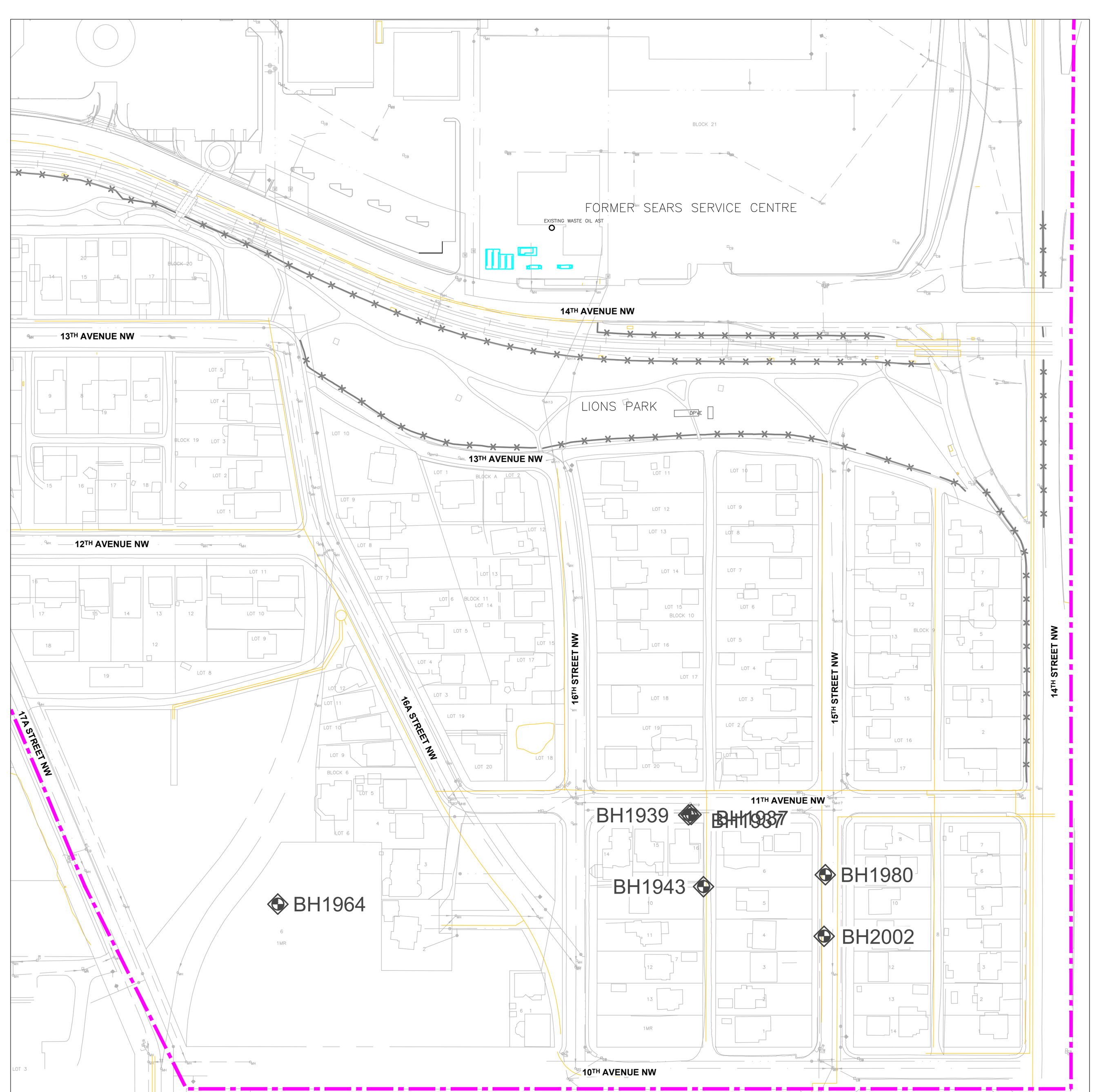
UNIT 1 - UPPER SILTY SAND



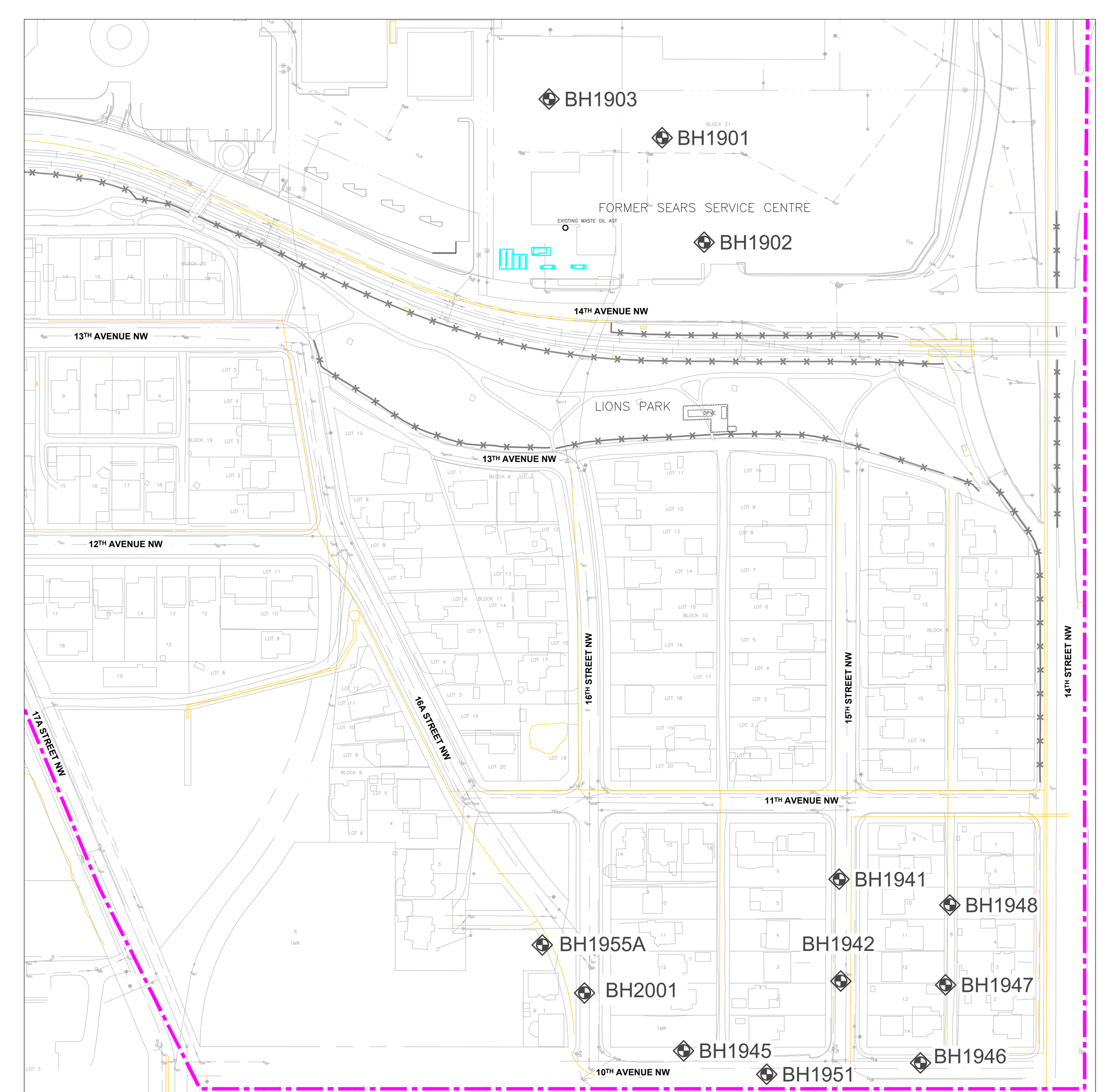
UNIT 2 - UPPER CLAYEY SILT



UNIT 3 - MIDDLE SANDY SILT



UNIT 4 - LOWER CLAYEY SILT



UNIT 5 - LOWER SILTY SAND AND GRAVEL

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXISTING GROUNDWATER MONITORING WELL
- CURRENT MONITORING WELL CONDITIONS — BH1963 <0.00040
- EXCEEDS AEP 2016 TIER 1 GUIDELINES — BH1905 0.055

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
NAPHTHALENE	0.001	0.001

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES
1:2500
PLOT SIZE 22x34

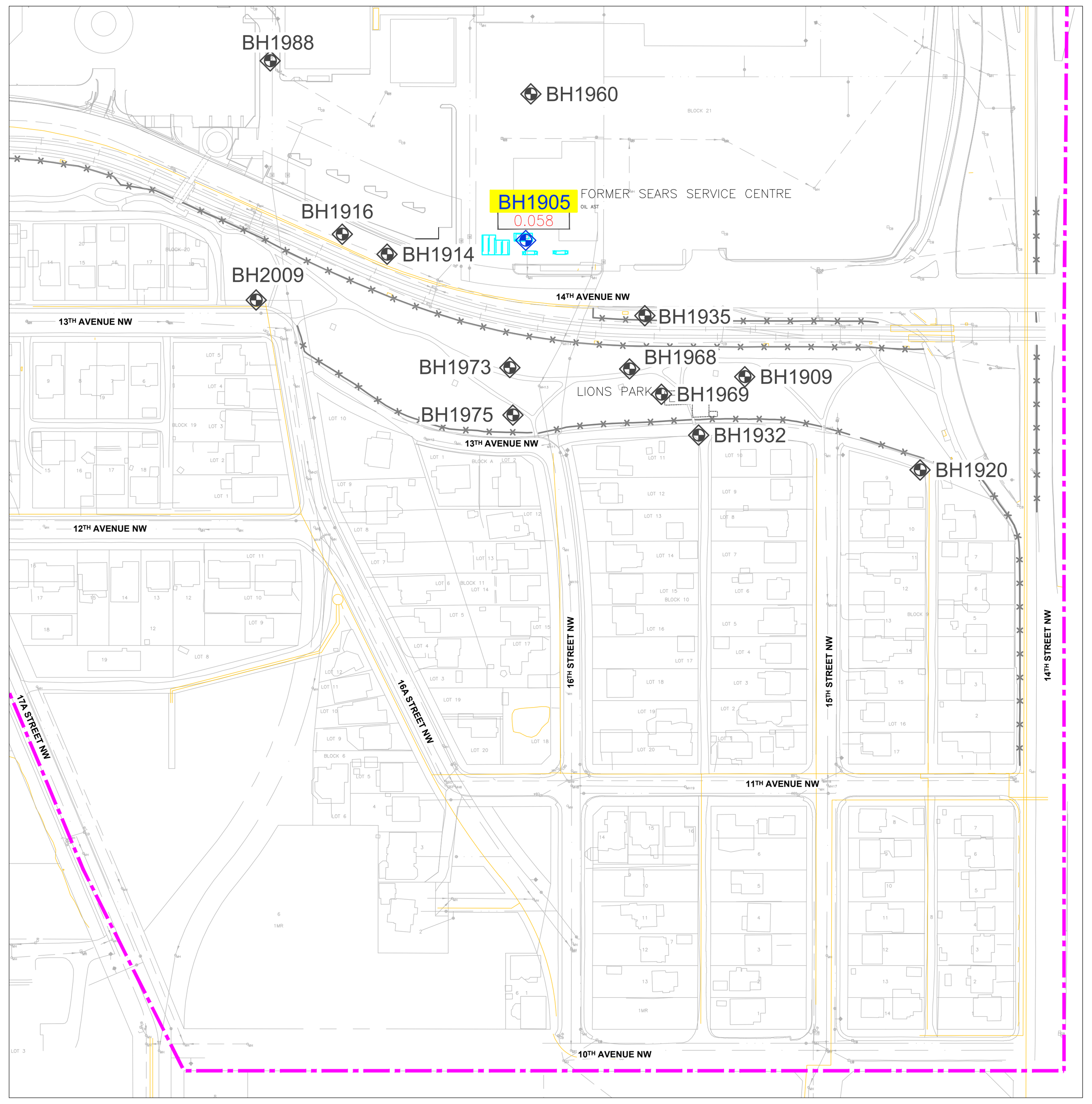
ENGINEER
Clifton Associates

CLIENT
SEARS

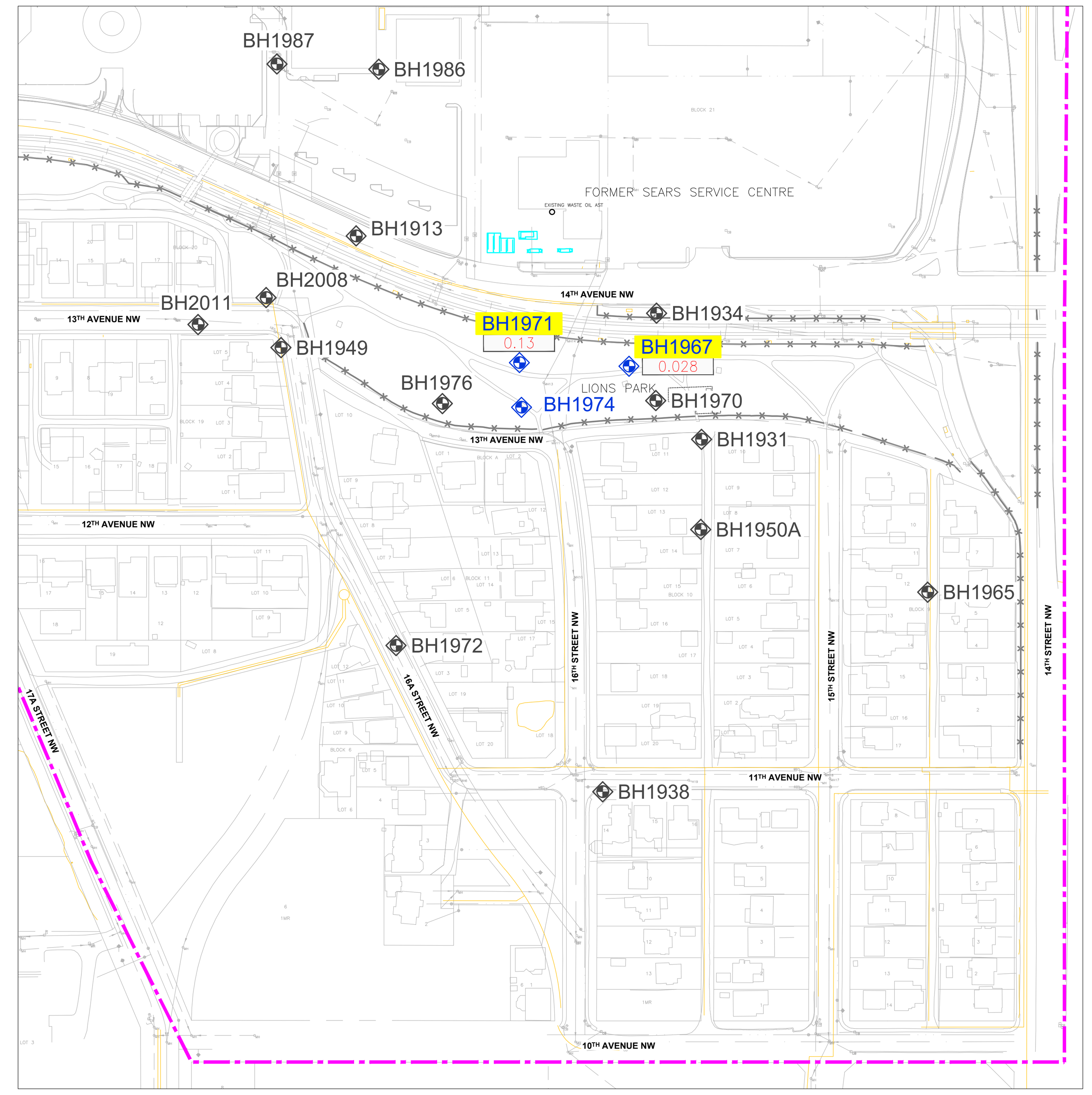
PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
GROUNDWATER EXCEEDANCES - NAPHTHALENE

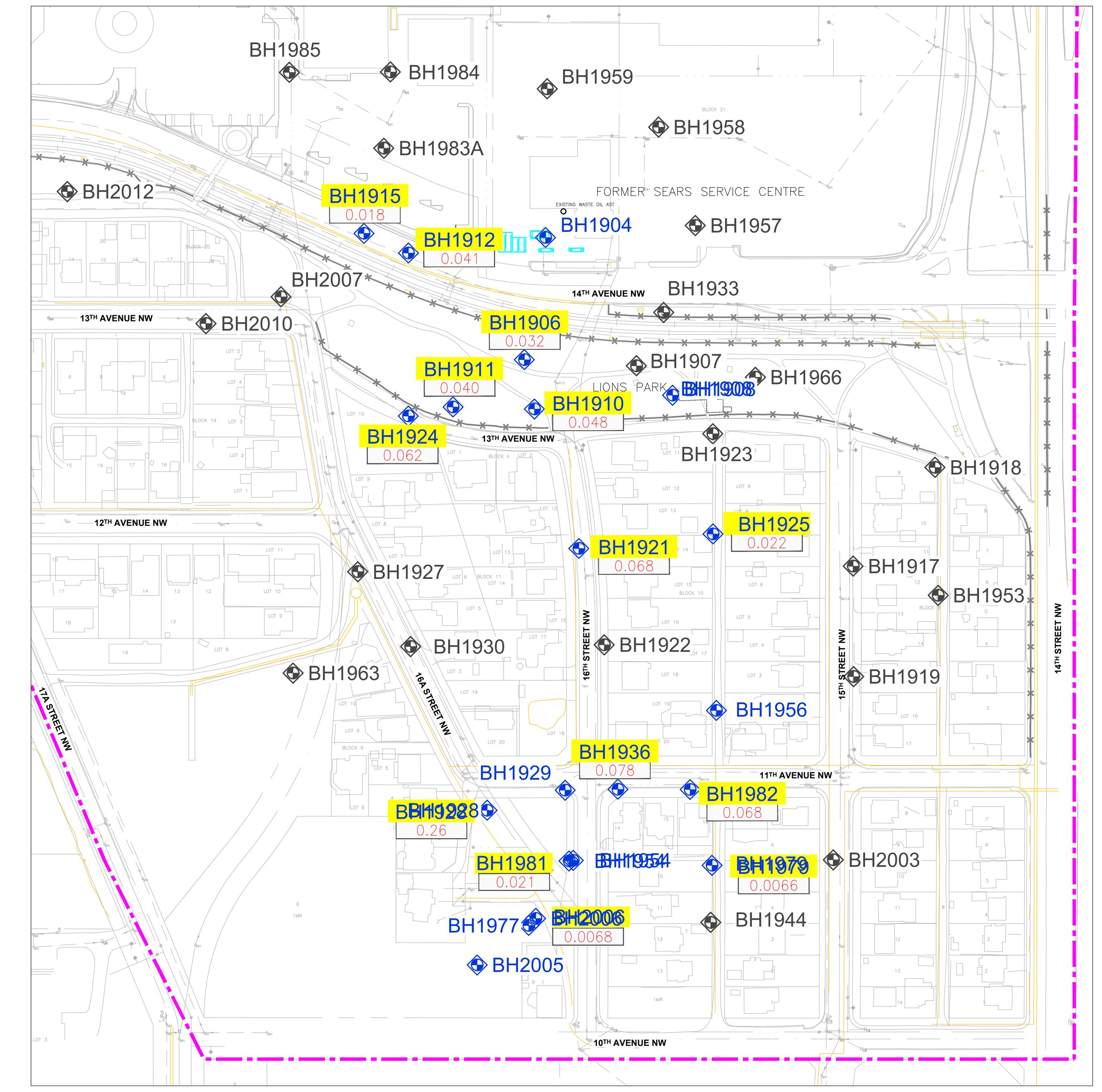
DESIGNED	SCALE 1:2500	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-4.2
CHECKED TK	FILE NO. CG2430.1-E33-D.4-2	



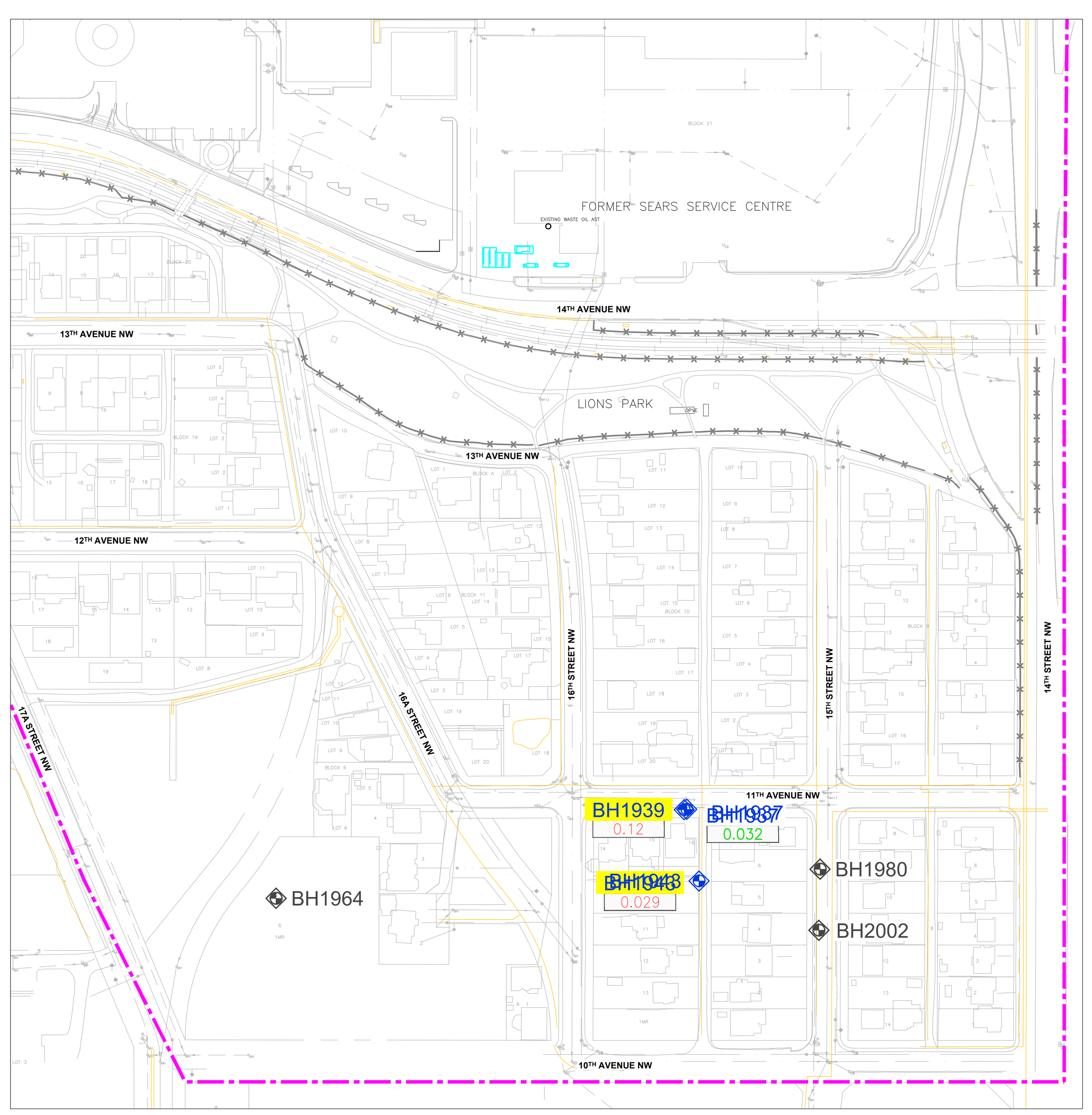
UNIT 1 - UPPER SILTY SAND



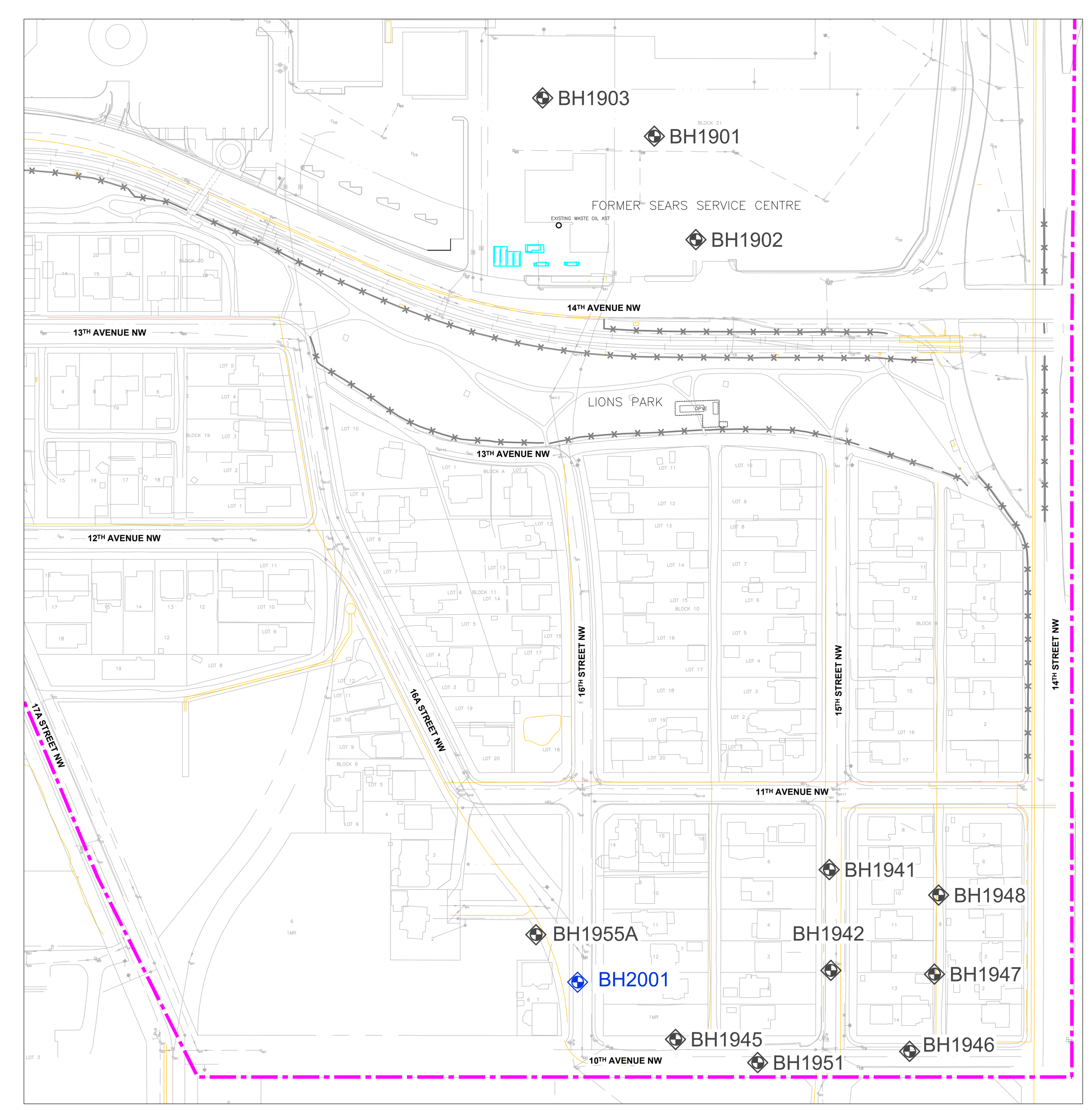
UNIT 2 - UPPER CLAYEY SILT



UNIT 3 - MIDDLE SANDY SILT



UNIT 4 - LOWER CLAYEY SILT



UNIT 5 - LOWER SILTY SAND AND GRAVEL

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXISTING GROUNDWATER MONITORING WELL
- CURRENT MONITORING WELL CONDITIONS — BH1963 <0.00040
- EXCEEDS AEP 2016 TIER 1 GUIDELINES — BH1905 0.055

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
1,2 - DCA	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2500
PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: GROUNDWATER EXCEEDANCES - 1,2-DCA

DESIGNED	SCALE 1:2500	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D-4.3
CHECKED TK	FILE NO. CG2430.1-E33-D.4-3	

W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.4-3.dwg, 11/30/2018 12:06:20 PM

Appendix D5
Groundwater Exceedance Cross-Sections

Clifton Associates

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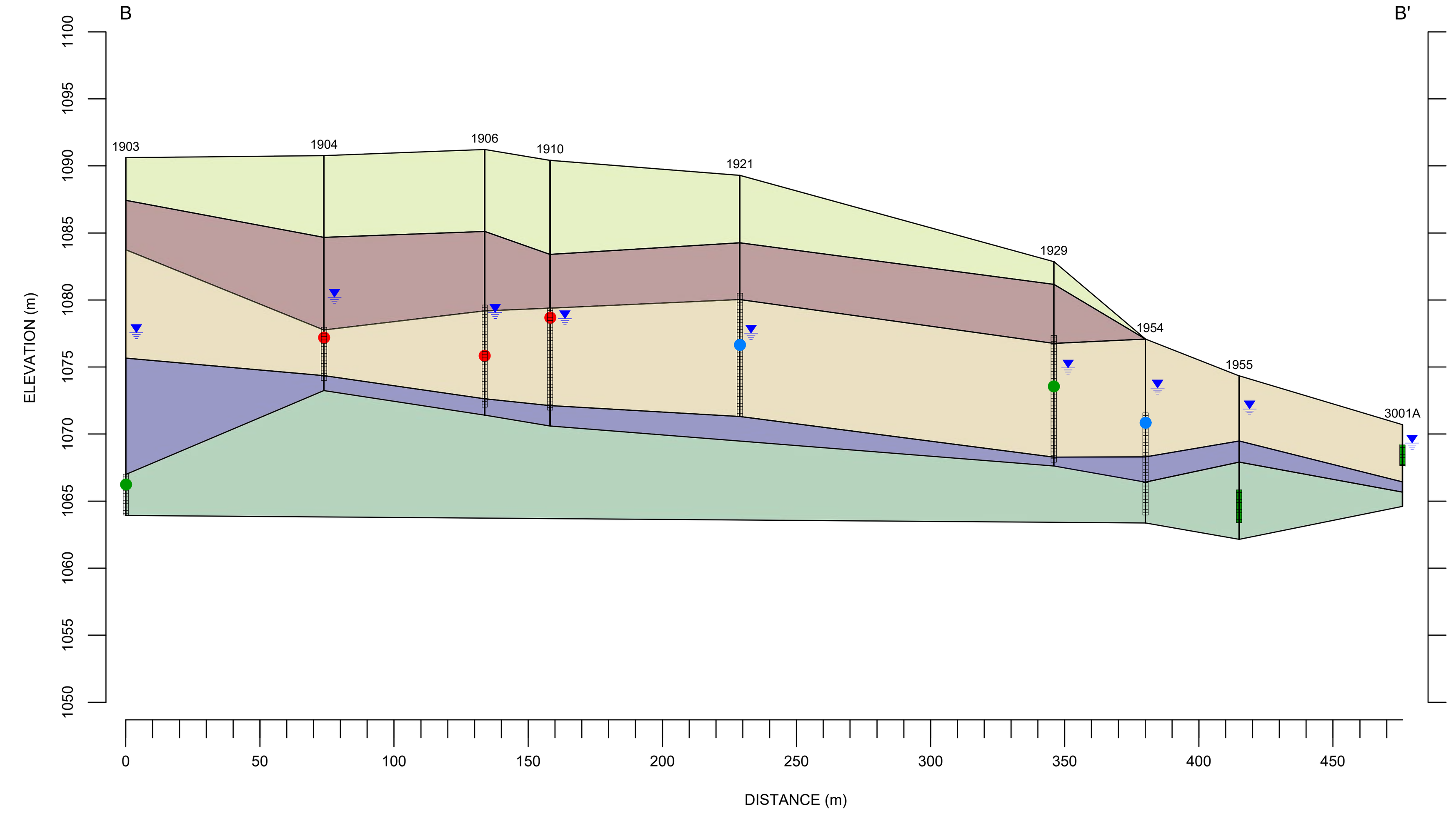
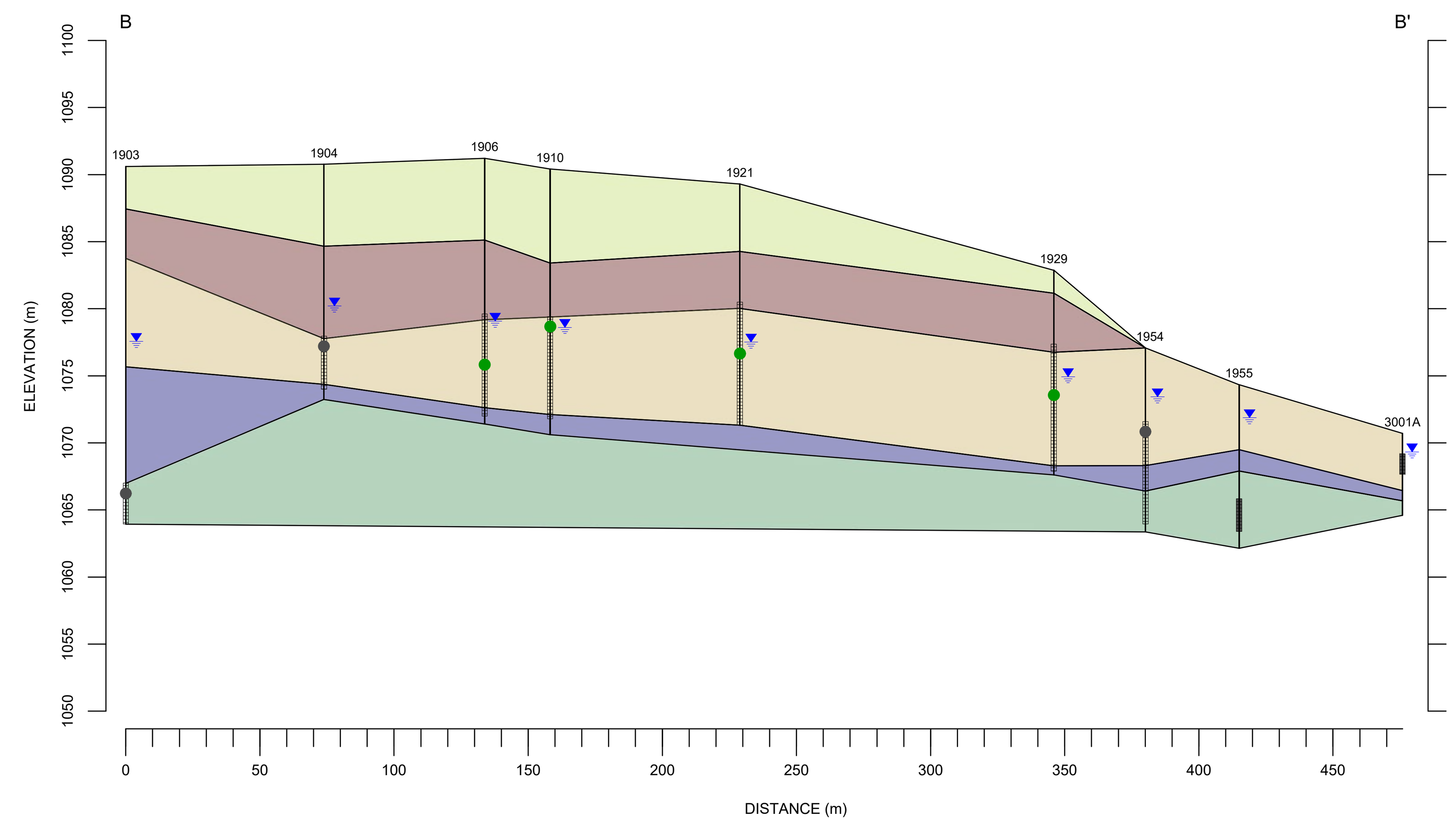
CROSS SECTION B-B'



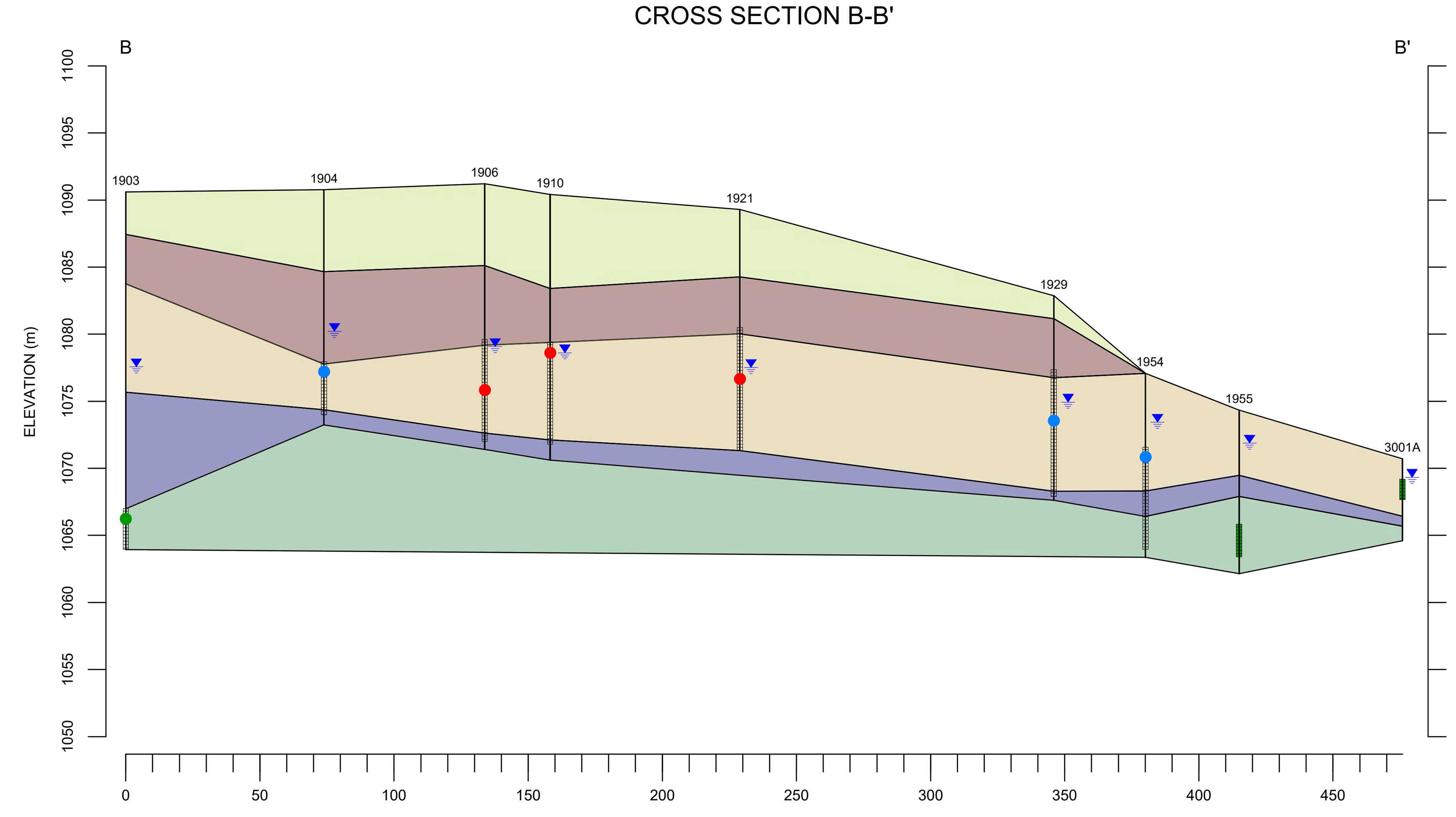
BENZENE

CROSS SECTION B-B'



NAPHTHALENE

CROSS SECTION B-B'



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT
- NOT SAMPLED

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
BENZENE	0.005	0.005
NAPHTHALENE	0.001	0.001
1,2-DCA	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER: Clifton Associates

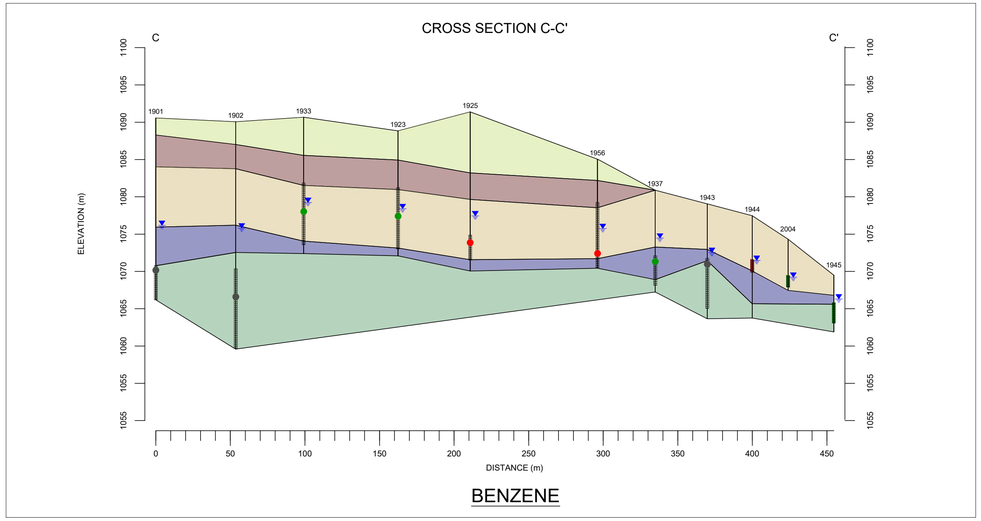
CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

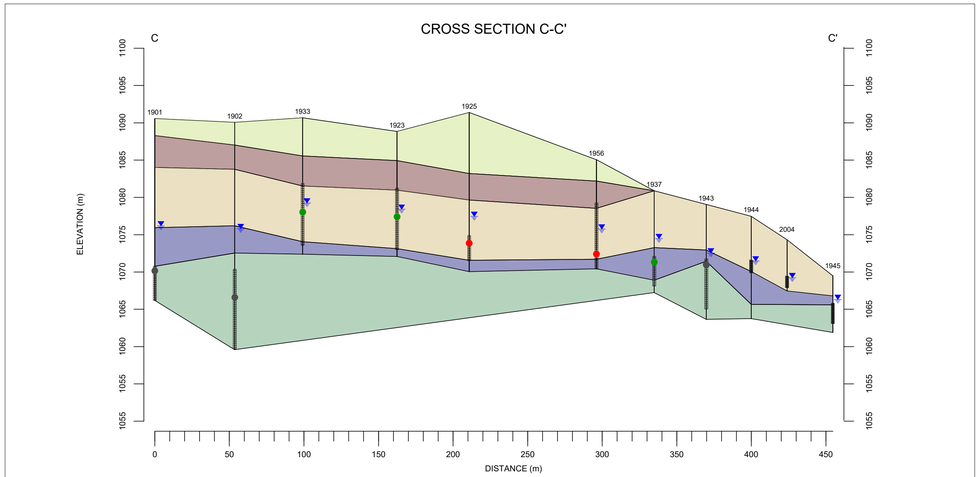
TITLE: CROSS SECTION B-B'
GROUNDWATER EXCEEDANCES

DESIGNED	SCALE HOR 1:2000 VERT 1:400	DATE 2018-12-03
DRAWN RD	PROJECT NO. CG2430.1 E33	FIG. D.5-1
CHECKED TK	FILE NO. CG2430.1-E33-D.5-1	

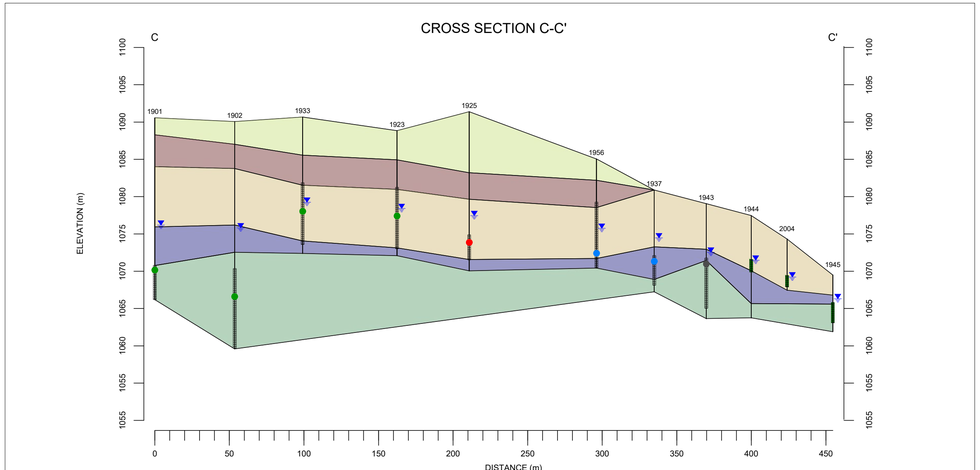
W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.5-1.dwg, 12/14/2018 8:47:39 AM



BENZENE



NAPHTHALENE



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT
- NOT SAMPLED

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
BENZENE	0.005	0.005
NAPHTHALENE	0.001	0.001
1,2-DCA	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER
Clifton Associates

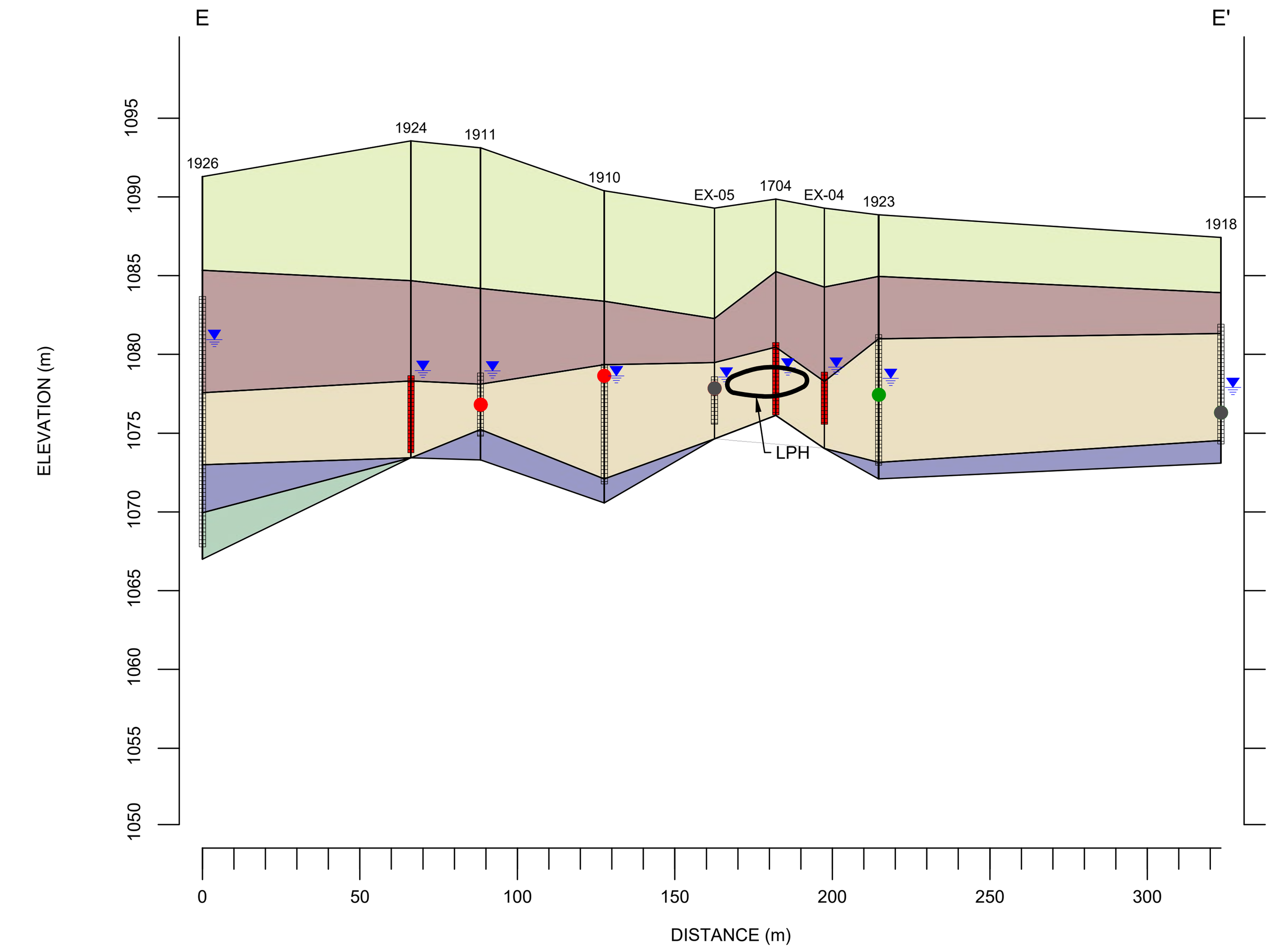
CLIENT
SEARS

PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION C-C'
GROUNDWATER EXCEEDANCES

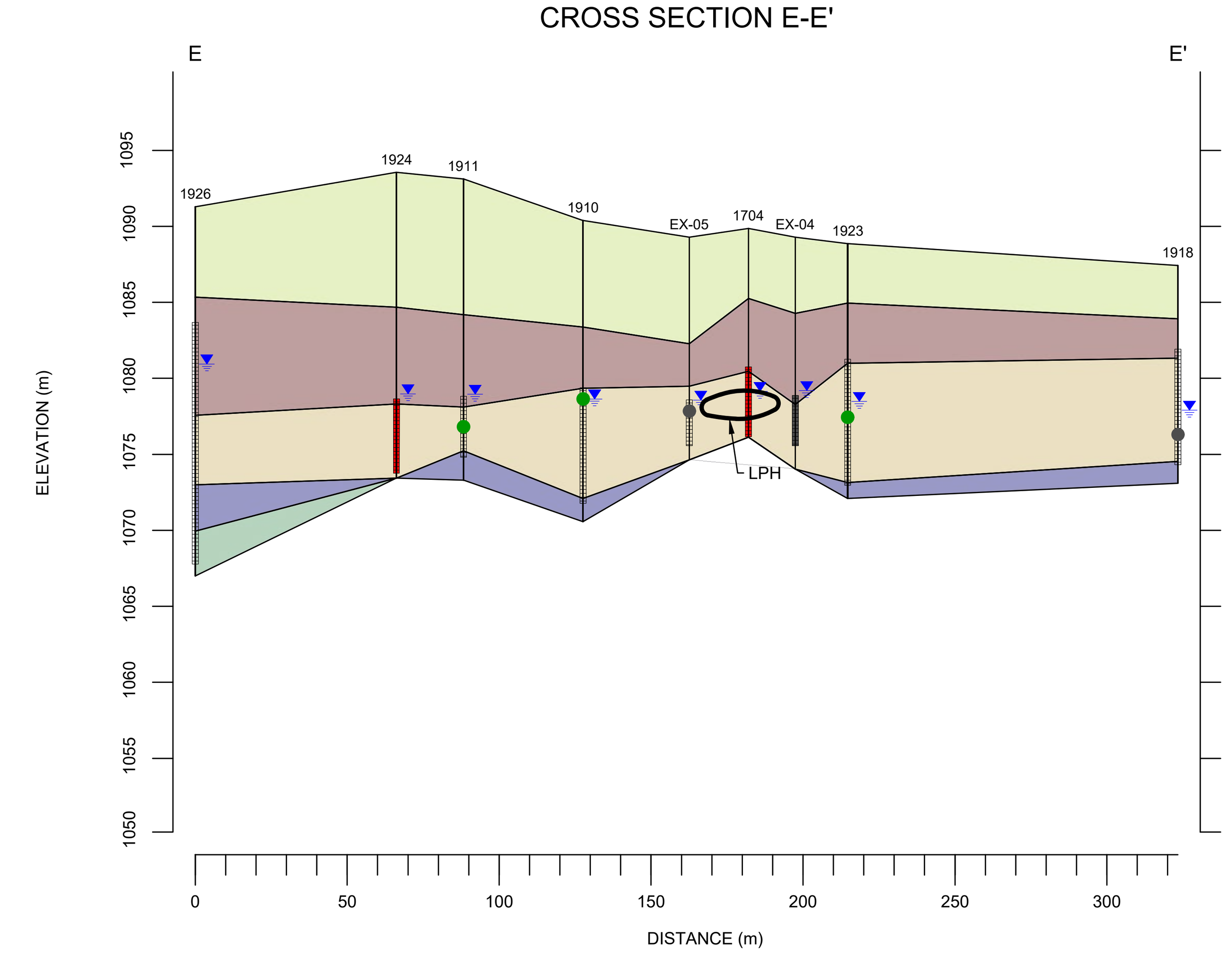
DESIGNED	SCALE	DATE
	HOR 1:2000 VERT 1:400	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: D.5-2
CHECKED: TK	FILE NO.: CG2430.1-E33-D.5-2	

CROSS SECTION E-E'



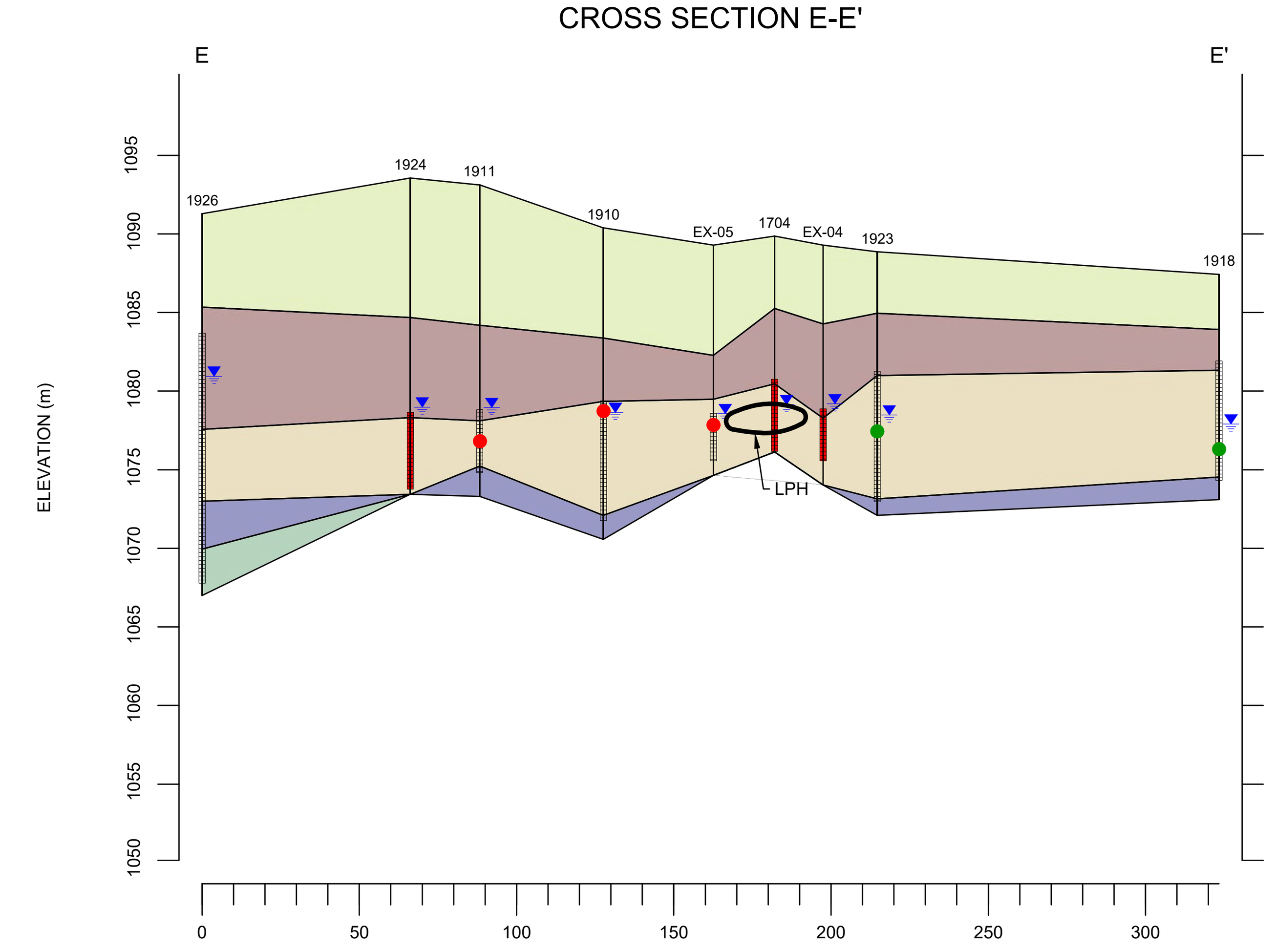
BENZENE

CROSS SECTION E-E'



NAPHTHALENE

CROSS SECTION E-E'



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT
- NOT SAMPLED

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
BENZENE	0.005	0.005
NAPHTHALENE	0.001	0.001
1,2-DCA	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

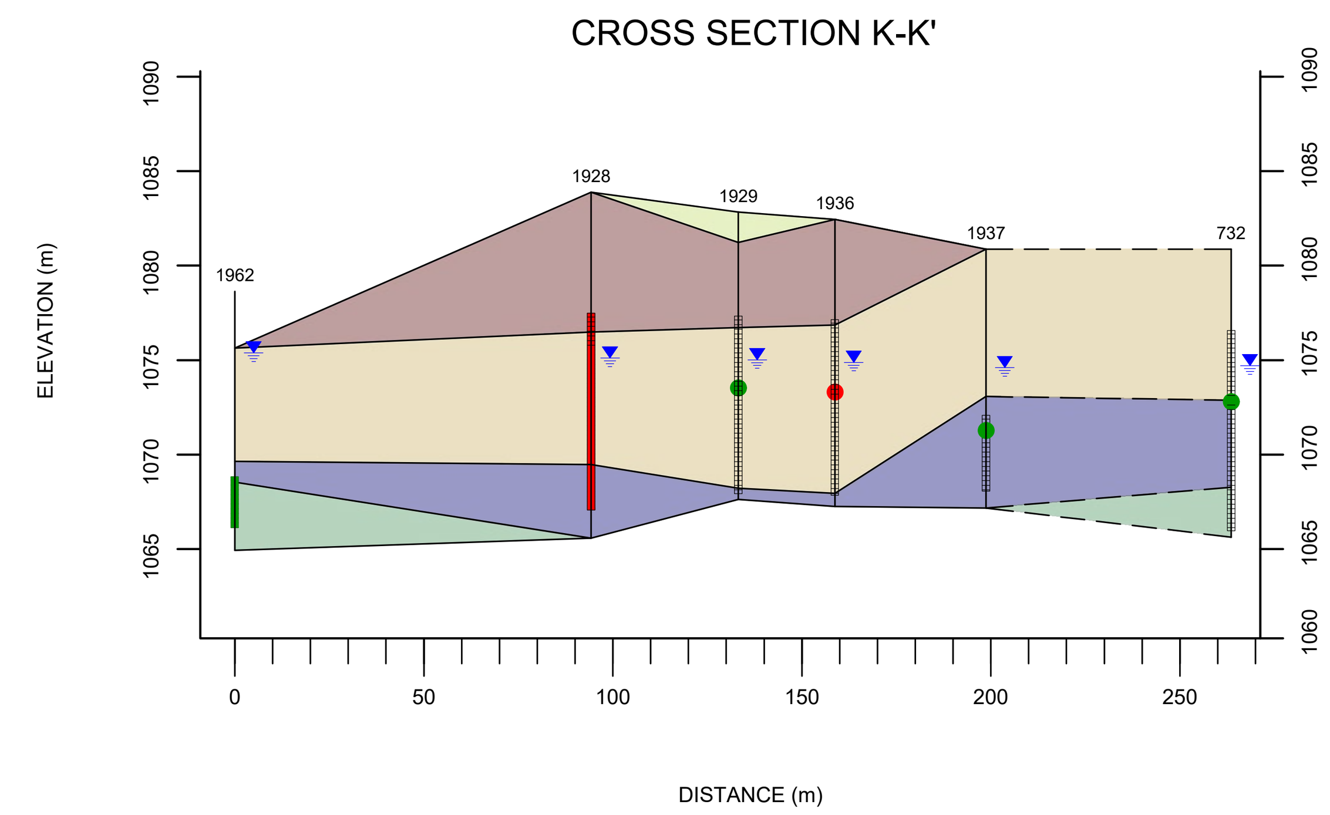
ENGINEER
Clifton Associates

CLIENT
SEARS

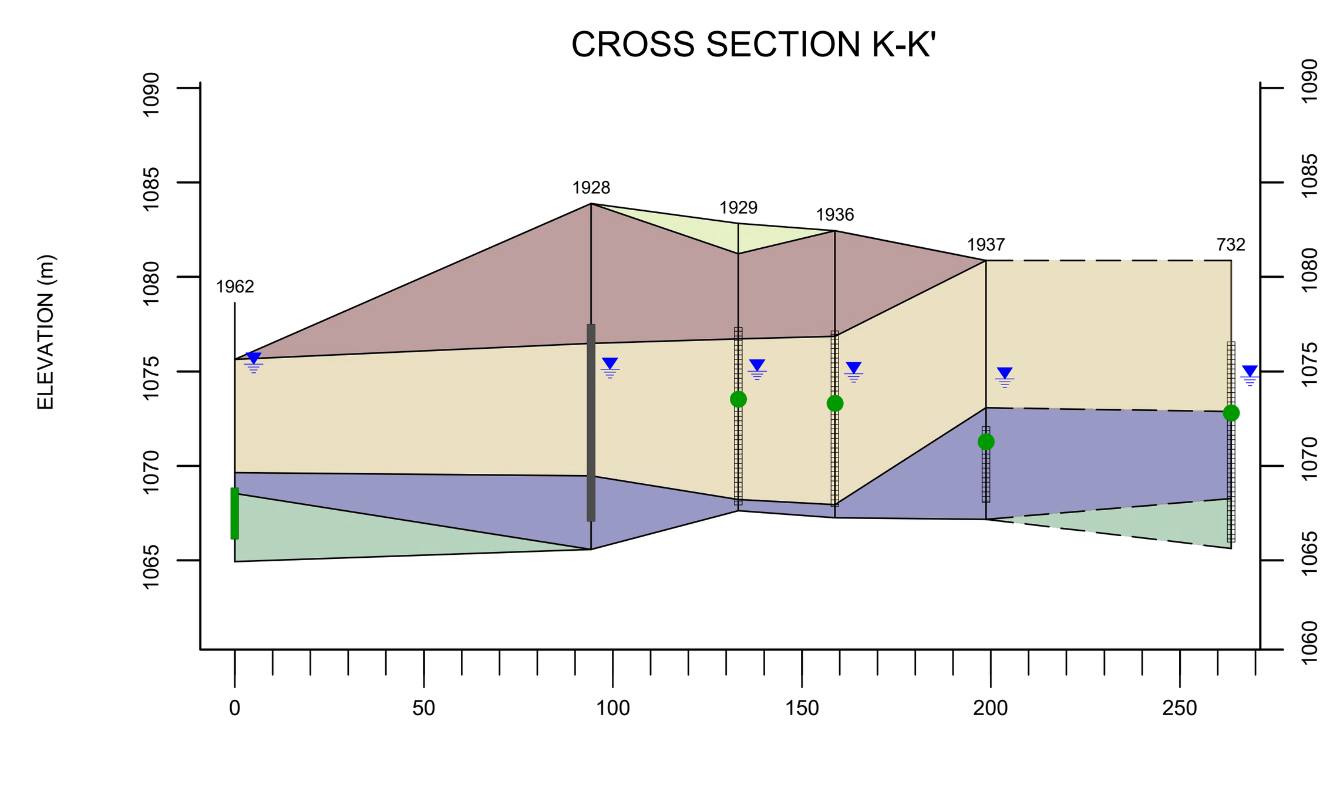
PROJECT
REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE
CROSS SECTION E-E'
GROUNDWATER EXCEEDANCES

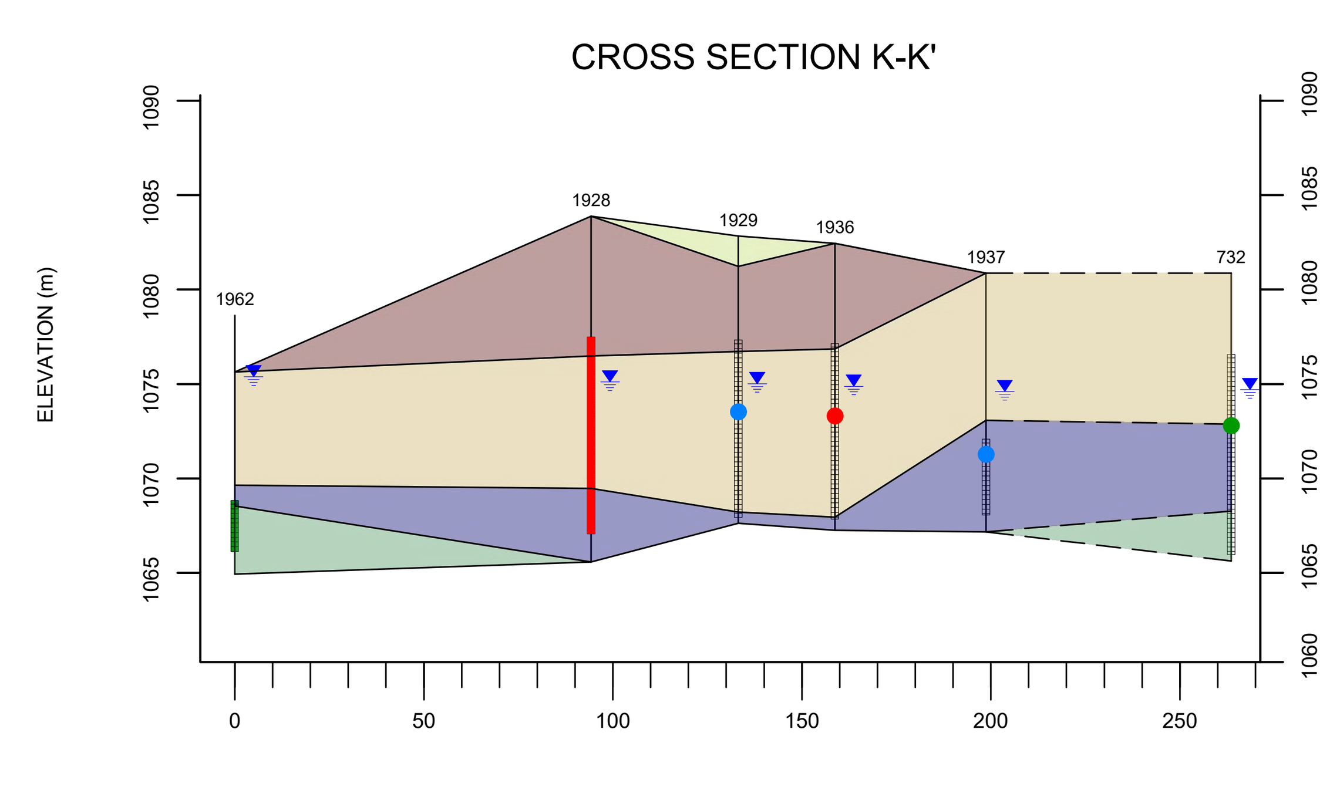
DESIGNED	SCALE: HOR 1:2000 VERT 1:400	DATE: 2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: D.5-3
CHECKED: TK	FILE NO.: CG2430.1-E33-D.5-3	



BENZENE



NAPHTHALENE



DCA

LEGEND

- UNIT 1 - UPPER SILTY SAND
- UNIT 2 - UPPER CLAYEY SILT
- UNIT 3 - MIDDLE SANDY SILT
- UNIT 4 - LOWER CLAYEY SILT
- UNIT 5 - UNDEFINED
- CONCENTRATION ABOVE THE APPLICABLE GUIDELINE
- CONCENTRATION IS ABOVE THE LABORATORY DETECTION LIMIT BUT BELOW THE APPLICABLE GUIDELINE
- CONCENTRATION IS BELOW THE LABORATORY DETECTION LIMIT
- NOT SAMPLED

ALBERTA ENVIRONMENT AND PARKS 2016 TIER 1 GUIDELINES FOR COARSE-GRAINED SOIL		
AEP CRITERIA CATEGORY	RESIDENTIAL GUIDELINE (mg/L)	COMMERCIAL GUIDELINE (mg/L)
BENZENE	0.005	0.005
NAPHTHALENE	0.001	0.001
1,2-DCA	0.005	0.005

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

50 0 50 100 150
METRES 1:2000

10 0 10 20 30
METRES 1:400

PLOT SIZE 22x34

ENGINEER

Clifton Associates

CLIENT

SEARS

PROJECT

REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE

CROSS SECTION E-E'
GROUNDWATER EXCEEDANCE

DESIGNED	SCALE	DATE
	HOR 1:2000 VERT 1:400	2018-12-03
DRAWN	PROJECT NO.	FIG.
RD	CG2430.1 E33	D.5-4
CHECKED	FILE NO.	
TK	CG2430.1-E33-D.5-4	

W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.5-4.dwg, 12/14/20

Appendix D6
Soil Vapour Probe Distribution Map

Clifton Associates

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2222 30th Avenue NE
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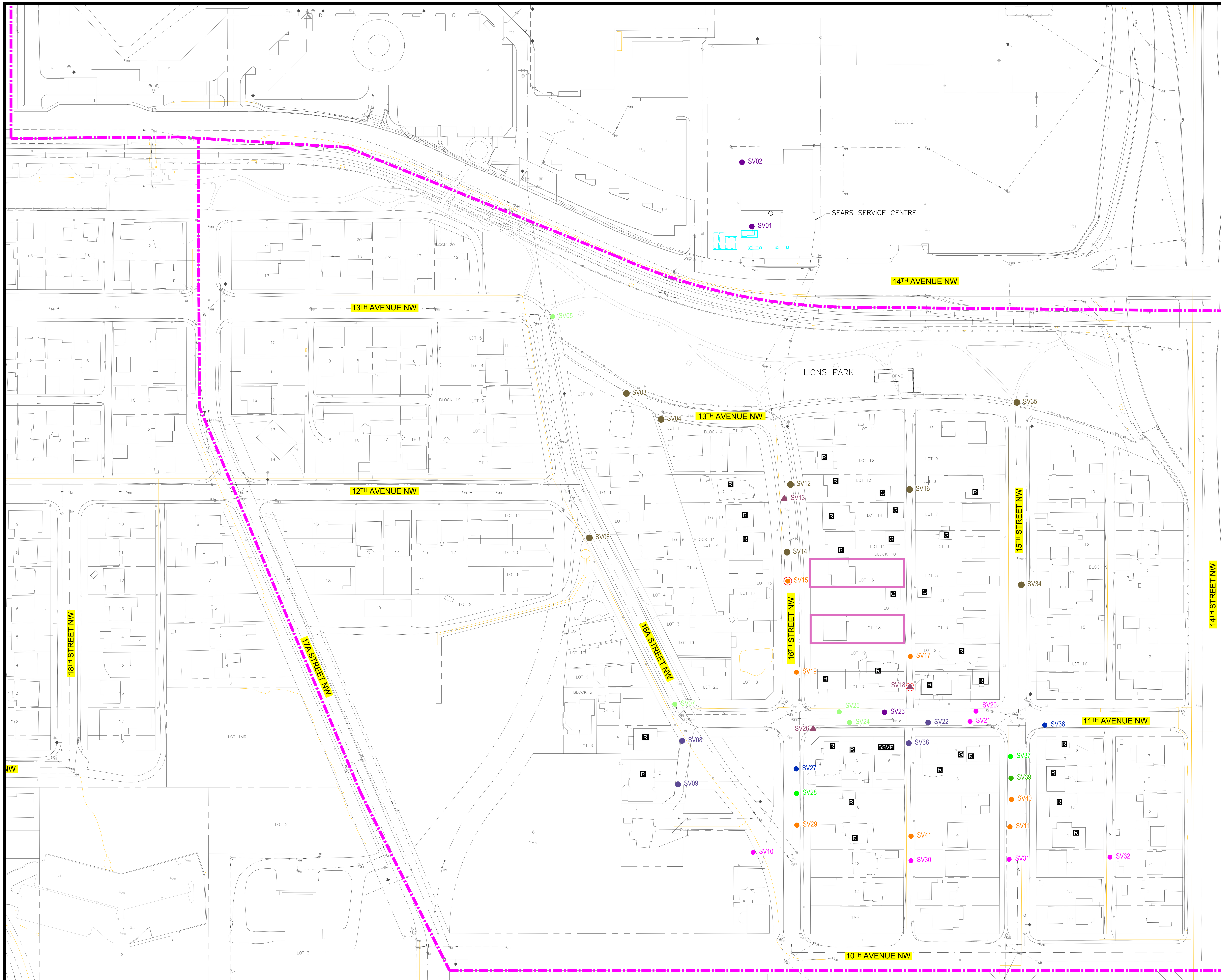
www.clifton.ca



LEGEND

SITE BOUNDARY	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
SOIL VAPOUR PROBES INSTALLED AT 1.0 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 1.5 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 2.0 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 2.5 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 3.0 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 3.5 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 4.0 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 4.5 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 5.0 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 5.5 mbgs	SV#
SOIL VAPOUR PROBES INSTALLED AT 6.0 mbgs	SV#
NESTED SOIL VAPOUR MONITORING POINT	SV#
RESIDENTIAL STRUCTURES WITH REPORTED UNUSUAL FEATURES (EARTHEN FLOORS)	
SOIL VAPOUR MONITORING POINT TO BE RE-INSTALLED	
RESIDENTIAL	R
DETACHED GARAGE	G
SUB-SLAB SOIL VAPOUR POINT	SSVP

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 m

PLOT SIZE 22x34

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: SOIL VAPOUR PROBE DISTRIBUTION

DESIGNED	SCALE	DATE
	1:1000	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: D.6
CHECKED: TK	FILE NO.: CG2430.1-E33-D.6	

W:\CG2430.1 SEARS\CURRENT\E33\CG2430.1-E33-D.6.dwg, 11/30/2018 1:31:15 PM

Appendix E
Conceptual Site Model

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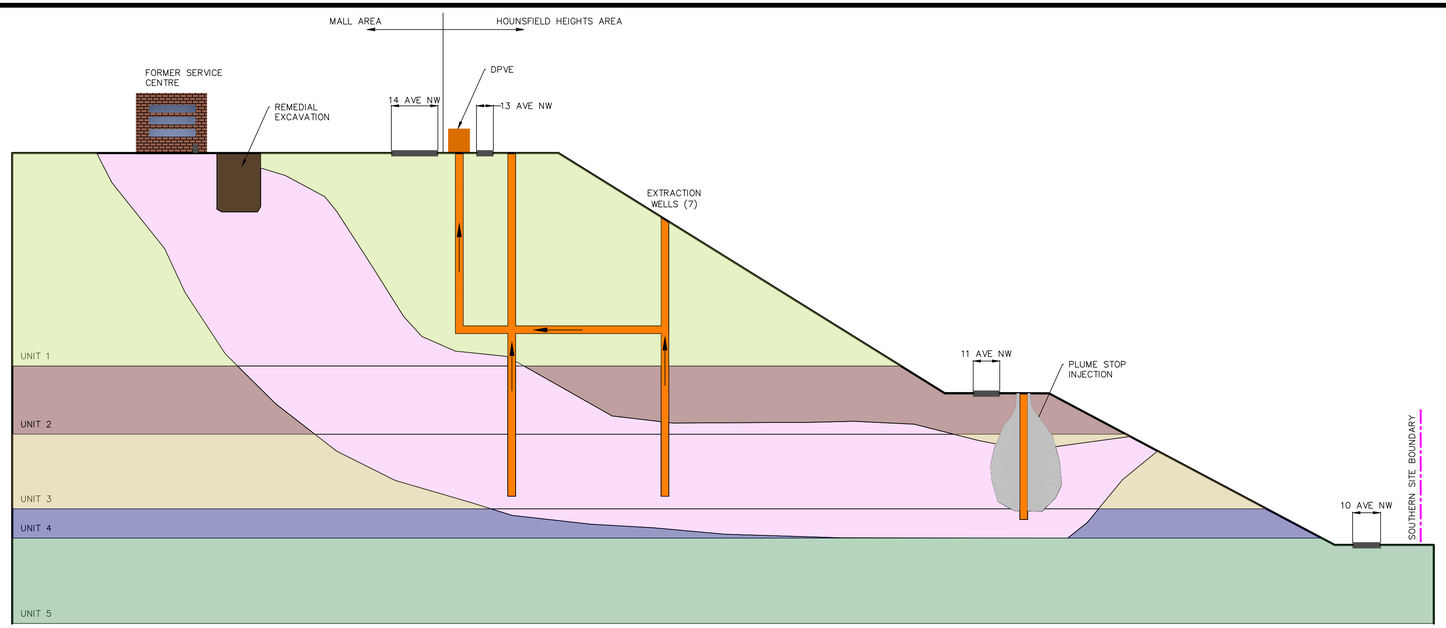


CONCEPTUAL SITE MODEL
NTS

GROUNDWATER MONITORING WELLS (ACTIVE): 120

SOIL VAPOUR PROBES (ACTIVE): 42

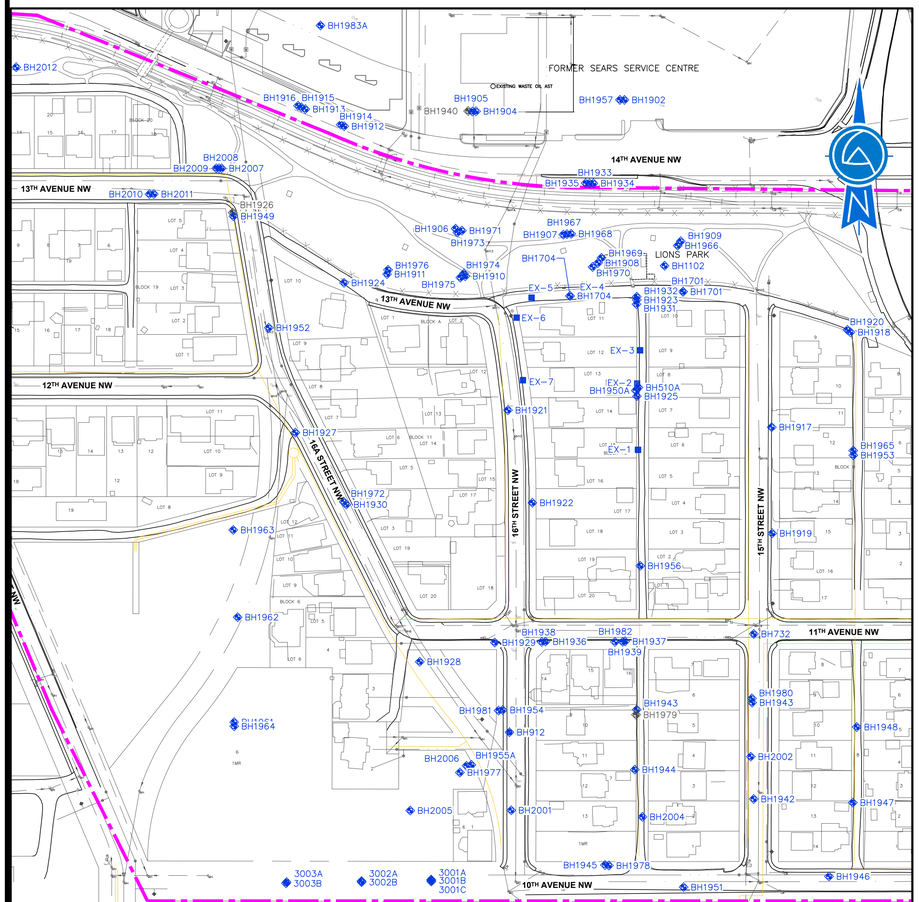
SUB-SLAB SOIL VAPOUR POINTS: 1

INDOOR AIR QUALITY POINTS: 1

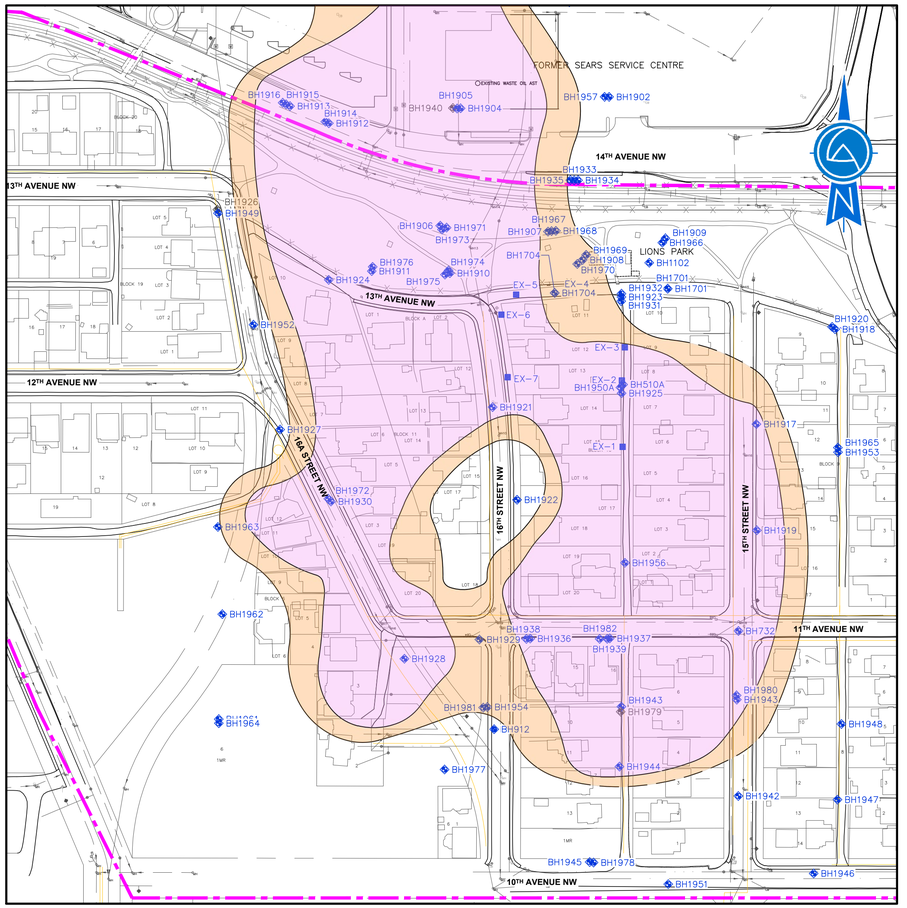
SOURCE: THERE WAS FORMERLY A SERVICE STATION AND AUTOMOTIVE CENTRE IN THE MALL AREA AT THE NORTHERN EXTENT OF THE SITE, WHICH IS NOW OPERATED AS A KAL-TIRE SERVICE CENTRE. THE SERVICE STATION OPERATED FROM 1958 TO 1995, WHEN THE FUEL STORAGE TANKS WERE REMOVED, AND FUEL DISPENSING FACILITIES WERE DECOMMISSIONED.

REMEDIATION TECHNOLOGY: TO ADDRESS THE CONTINUED MIGRATION OF THE GROUNDWATER PLUME TO THE SOUTH, THERE HAVE BEEN MULTIPLE REMEDIAL TECHNOLOGIES APPLIED TO THE SITE. A DUAL PHASE VAPOUR EXTRACTION SYSTEM (DPVE) WAS INSTALLED IN LION'S PARK, WHICH EXTRACTS AND VOLATILIZES LIQUID PETROLEUM HYDROCARBONS AND CONTAMINATED GROUNDWATER. THERE HAVE ALSO BEEN TWO APPLICATIONS OF A PERMEABLE REACTIVE BARRIER, COMPRISED OF COLLOIDAL ACTIVATED CARBON FOR ADSORPTION, AND OXYGEN REDUCING COMPOUND FOR DEGRADATION. BOTH APPLICATIONS HAVE BEEN ALONG 11TH AVENUE NW TO REDUCE DOWNGRADIENT GROUNDWATER CONCENTRATIONS.

DELINEATION: THE PLUME HAS BEEN DELINEATED IN BOTH SOIL AND GROUNDWATER IN ALL CARDINAL DIRECTIONS. PART OF THE ONGOING MONITORING AND SAMPLING PROGRAM ON THE SITE INCLUDES THE COMPLETION OF STATISTICAL ANALYSES AT THE DOWNGRADIENT / SOUTHERN PLUME MARGIN, TO EVALUATE THE STATUS OF THE PLUME. THE STATISTICAL ANALYSIS DETERMINES WHETHER THE PLUME IN EXPANDING, DECREASING, OR STABLE. ACCORDING TO THE MOST RECENT STATISTICAL ANALYSIS, THE GROUNDWATER PLUME IS EITHER STABLE OR DECLINING AT THE DOWNGRADIENT MARGIN.



BOREHOLE LOCATION PLAN
NTS



BENZENE PLUME
NTS

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- GROUNDWATER MONITORING WELL
- CONCENTRATION EXCEEDS THE DRINKING WATER GUIDELINE (0.005 - 2.8 mg/L)
- DETECTED, BUT BELOW THE AEP TIER 1 GUIDELINES (0.0004 - 0.005 mg/L)

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: CONCEPTUAL SITE MODEL

DESIGNED	SCALE	DATE
	NTS	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: E.1
CHECKED: TK	FILE NO.: CG2430.1-E33-E.1	

Appendix F
Source Removal

Clifton Associates

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www.clifton.ca

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- EXTRACTION NETWORK

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 5 10 15 m

ENGINEER

Clifton Associates

CLIENT

SEARS

PROJECT

REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE

DPVE SYSTEM LAYOUT

DESIGNED	SCALE	DATE
	1:200	2018-12-03
DRAWN: RD	PROJECT NO.: CG2430.1 E33	FIG.: F.1
CHECKED: TK	FILE NO.: CG2430.1-E33-F.1	

Appendix G
Permeable Reactive Barrier

Clifton Associates

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Table G1 - First Pliot Study Results

Sample ID	Land Use[1]	Sampling Depth (m bgs)	Sample Date	Unit	Benzene	1,2 - DCA
BH1939	R	Bulk	18-Oct-18	4	0.15	0.12
	R	Bulk	10-Apr-18	4	0.52	0.15
	R	Bulk	17-May-17	4	5.4*	0.17
	R	Bulk	19-Apr-17	4	4.8*	0.14
	R	Bulk	9-Mar-17	4	4.8*	0.18
	R	Bulk	6-Jan-17	4	5.4*	0.17
	R	Bulk	21-Dec-16	4	6.0*	0.19
	R	Bulk	12-Dec-16	4	5.8*	0.13
	R	Bulk	25-Nov-16	4	7.4*	0.21
	R	Bulk	10-Nov-16	4	7.1*	0.17
	R	Bulk	28-Oct-16	4	0.038	0.010
	R	Bulk	13-Oct-16	4	5.9*	0.18
	R	Bulk	10-Oct-16	4	7.2*	0.16
	R	Bulk	16-Sep-16	4	6.8*	0.18
	R	Bulk	3-Sep-16	4	7.1*	0.17
	R	Bulk	19-Aug-16	4	7.4*	0.21
	R	Bulk	5-Aug-16	4	8.1*	0.22
PRB Installation 03 and 04 August 2016						
	R	Bulk	17-May-16	4	6.6	<0.00050
	R	Bulk	20-Nov-15	4	8.99	0.160
	R	Bulk	21-Sep-15	4	8.00	0.167
	R	Bulk	11-Jun-15	4	8.57	0.154
	R	Bulk	1-Apr-15	4	9.31	0.124
BH1982	R	Bulk	18-Oct-18	3	3.2*	0.068
	R	Bulk	10-Apr-18	3	5.9*	0.11
	R	Bulk	17-May-17	3	6.6*	0.13
	R	Bulk	19-Apr-17	3	4.7*	0.087
	R	Bulk	9-Mar-17	3	5.0*	0.11
	R	Bulk	6-Jan-17	3	4.2*	0.091
	R	Bulk	21-Dec-16	3	2.6*	0.056
	R	Bulk	12-Dec-16	3	2.7*	0.065
	R	Bulk	25-Nov-16	3	3.1*	0.073
	R	Bulk	10-Nov-16	3	5.2*	0.099
	R	Bulk	28-Oct-16	3	4.4*	0.095
	R	Bulk	13-Oct-16	3	2.8*	0.072
	R	Bulk	3-Oct-16	3	5.3*	0.090
	R	Bulk	16-Sep-16	3	6.3*	0.12
	R	Bulk	3-Sep-16	3	6.9*	0.12
	R	Bulk	19-Aug-16	3	9.6*	0.18
	R	Bulk	5-Aug-16	3	5.7*	0.092
PRB Installation 03 and 04 August 2016						
	R	Bulk	17-May-16	3	12	0.21
	R	Bulk	20-Nov-15	3	11.6	0.150
	R	Bulk	21-Sep-15	3	10.7	0.177
	R	Bulk	11-Jun-15	3	13.8	0.159
	R	Bulk	1-Apr-15	3	13.1	0.124
			Residential Guideline[2]		0.005	0.005
			Commercial Guideline[2]		0.005	0.005

Notes:

* Detection limit raised due to dilution

** Detection limit raised due to interference

Table G2 - Second Pliot Study Results
Benzene and 1,2 - DCA

Sample ID	Land Use[1]	Sampling Depth (m bgs)	Sample Date	Unit	Benzene	1,2 - DCA
BH1929	R	8.53-10.06	8-Nov-18	3	0.013	0.021
	R	8.53-10.06	12-Oct-18	3	<0.00040	0.00082
	R	8.53-10.06	28-Sep-18	3	<0.00040	<0.0005
PRB Installation 10 and 13 September 2018						
	R	8.53-10.06	20-Aug-18	3	0.096	0.072
	R	8.53-10.06	28-Mar-18	3	0.10	0.048
	R	8.53-10.06	15-May-17	3,4	0.22	0.086
	R	8.53-10.06	9-Nov-16	3,4	0.31	0.084
	R	8.53-10.06	13-May-16	3,4	0.47	0.099
	R	8.53-10.06	24-Nov-15	3	0.664	0.090
	R	8.53-10.06	3-Sep-15	3	0.770	0.083
	R	8.53-10.06	18-Jun-15	3	0.681	0.075
	R	10.06-11.58	18-Jun-15	3	0.654	0.080
	R	11.58-13.11	18-Jun-15	3	0.641	0.078
	R	Bulk	4-May-15	3	0.920	0.093
				Residential Guideline[2]	0.005	0.005
				Commercial Guideline[2]	0.005	0.005

Notes:

* Detection limit raised due to dilution

** Detection limit raised due to interference

Appendix H
Risk Management

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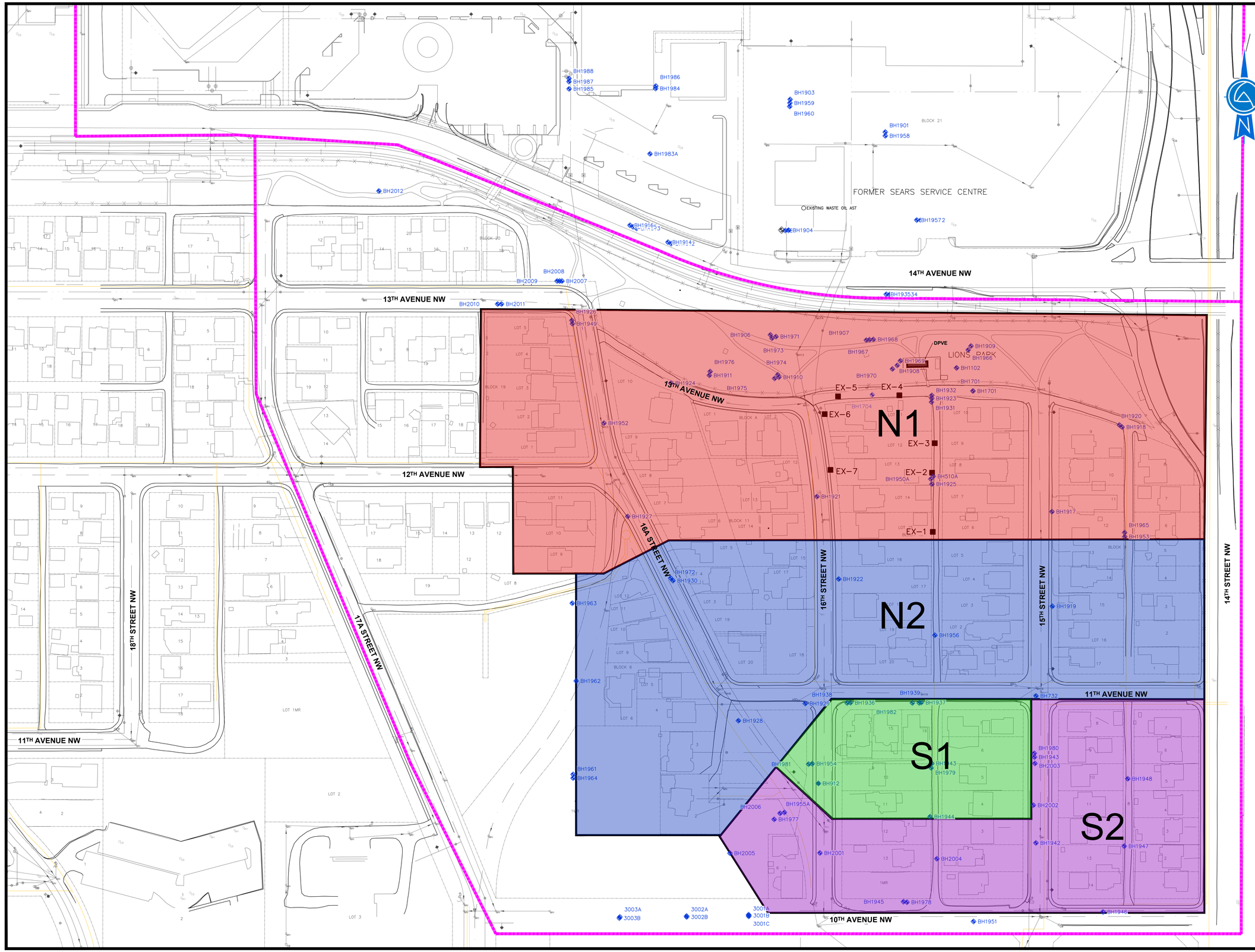

LEGEND

- SITE BOUNDARY
- EXTRACTION WELL
- LRT TRACKS
- FENCE LINE
- LEGAL LINE
- FORMER FACILITY/FEATURE
- BUILDING
- GROUNDWATER MONITORING WELL

UTILITY LINES & SYMBOLS

- NATURAL GAS LINE
- SANITARY SEWER
- STORM SEWER
- WATER
- CATCH BASIN
- FIRE HYDRANT
- LIGHT STANDARD
- MANHOLE
- UTILITY POLE

NOTES:

1 DRAWING COMPILED FROM PLANIMETRIC FILES SUPPLIED BY THE CITY OF CALGARY (INCLUDING U/G UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEACOR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.

0 10 20 30 40 50 100 m

ENGINEER: Clifton Associates

CLIENT: SEARS

PROJECT: REMEDIATION PLAN
HOUNSFIELD HEIGHTS AND MALL AREAS
CALGARY, ALBERTA

TITLE: RISK BASED ZONES

DESIGNED		SCALE: 1:1500	DATE: 2018-12-03
DRAWN	RD	PROJECT NO.: CG2430.1 E33	FIG.: H.1
CHECKED	TK	FILE NO.: CG2430.1-E33-H.1	

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