

Remedial Action Plan

Mall and Hounsfield Heights Areas
Calgary, Alberta

Clifton Associates



Executive Summary

Pursuant to the submission of the Updated 2014 Site Management Plan (11 July 2014), Sears Canada Inc. (Sears) has committed to the implementation of additional remedial efforts in order to address the dissolved phase petroleum hydrocarbon (PHC) plume associated with the former Service Center located at the North Hill Mall property, Calgary, Alberta.

In a letter dated 22 December 2015, Alberta Environment and Parks (AEP) requested that Sears provide a Remedial Action Plan (RAP) by the end of the first quarter of 2016. The RAP is expected to address the entire Site (North Hill Mall and the community of Hounsfield Heights), and is to include the following information:

- Remediation methods proposed/selected;
- Location of the remedial efforts;
- When the remedial efforts will be implemented;
- Remedial efforts effectiveness for site-specific conditions; and,
- Proposed monitoring for remedial effectiveness.

The RAP was completed in accordance with the principles and practices outlined in the AEP *Contaminated Sites Policy Framework* dated 31 October 2014 and the draft *Alberta Environmental Site Assessment Standard* dated July 2013.

The scope of work for the RAP included completing the following tasks:

- Reviewing of the historic environmental reports regarding contamination;
- Discussing the applicable regulatory criteria that may affect the implementation of the RAP;
- Evaluating the potential pathways through which the contamination may affect the Site; and,
- Presenting the RAP to address on-Site contamination.

The source of the hydrocarbon contaminant plume in the Mall and Hounsfield Heights Areas is the former Sears Service Centre, located at 1614 – 14th Avenue NW; now operated under license to Kal-Tire Automotive Centre, which does not engage in retail fuel sales. The location was originally developed as a service station and automotive centre in 1958, owned, and operated by Sears. Some underground storage tanks (USTs) were replaced in 1984, and in October 1995, fuel storage and dispensing facilities at the gas bar were decommissioned.

There have historically been many environmental reports and investigations completed with respect to the Site. The Updated SMP (2014) for the Hounsfield Heights area as well as the Subsurface Investigation – Mall and Hounsfield Heights Area (2016) report provides a summary of all previous environmental work completed, and indicate that hydrocarbon contamination is still present.

Currently, there are two on-going remedial efforts being undertaken at the Site. First, the use of the Dual Phase Vapor Extraction (DPVE) system and secondly, bi-weekly active bailing. The original purpose of the DPVE was to remove, to the extent practicable, the LPH present on-Site. Since the implementation of the DPVE system, LPH has not been observed in any of the monitoring wells. However, during the past year of activities, the DPVE was purposely shut down, and since then, the LPH returned in one the monitoring wells which is believed to be associated with the rebounding of the water table. Since the LPH detection within the monitoring well, Clifton has completed weekly, then bi-weekly, active bailing of that well and also re-started the DPVE system. Clifton recommends that the DPVE system and active bailing program continue until the LPH is no longer present. Once the LPH is no longer observed, Clifton recommends that the continued operation of the DPVE system be assessed to determine if it is still required.

In addition to the continued use of the DPVE system and the active bailing program, Clifton is proposing the application of PlumeStop™, an in-situ bioremediation method. PlumeStop™ is a Liquid Activated Carbon system with enhanced biodegradation created by Regenesis Remediation Services.

The proposed PlumeStop™ application will involve an injection along 11th Avenue NW, with a co-application of ORC-Advanced (and oxygen release compound) up-gradient of the area of highest benzene concentrations to minimize breakthrough. Breakthrough can occur if concentrations are too high, reducing the effectiveness of the activated carbon thereby allowing contaminants to flow through the biomatrix without being fully adsorbed and subsequently degraded. Approximately 72 injection points spaced approximately 2.4 meters (8 feet) apart will be placed along 11th Avenue NW to address the advance of the PHC plume. Approximately 79 application points at 1.5-meter spacing will be placed up-gradient of the PlumeStop™ application zone to apply ORC-Advanced. It is anticipated that the full scale application along 11th Avenue will begin at the end of June 2016 and will take approximately 20 days to complete. A design verification test was completed in March 2016 to confirm the remedial design assumptions.

Clifton has identified two areas of potential future application of PlumeStop™ in the Mall and Hounsfield Heights Areas: 14th Avenue NW and 10th Avenue NW. The expected limits of application are 16A Street NW and 15th Street NW for the application along 14th Avenue NW and from 16th Street NW to 15th Street NW for the application along 10th Avenue NW. The application on the north side of 14th Avenue NW, adjacent to the Bentall and Sears property, is intended to treat and aid in the prevention of any further migration of PHCs from the source. The application along 10th Avenue NW is intended to be placed as a contingency to aid in the prevention of the plume from migrating beyond this point.

Clifton is planning on completing a Design Verification Test (DVT) in each of these areas in 2016 in order to determine the remedial design requirements.

List of Acronyms

ACMs	Asbestos-Containing Materials
AENV	Alberta Environment
AEP*	Alberta Environmental Protection
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AESRD	Alberta Environment and Sustainable Resource Development
AHS	Alberta Health Services
asl	above sea level
AST	Above ground Storage Tank
ATS	Alberta Township System
bgs	below the ground surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CCME	Canadian Council of Ministers of the Environment
Clifton	Clifton Associates Ltd.
CSA	Canadian Standards Association
DUA	Domestic Use Aquifer
ELC	Environmental Law Center
EPA	Environmental Protection Agency
ERCB	Energy Resources Conservation Board
ERIS	Environmental Risk Information Services
ESA	Environmental Site Assessment
ESAR	Environmental Site Assessment Repository
F1 – F2	Petroleum Hydrocarbon Fractions F1 – F2
F1 – F4	Petroleum Hydrocarbon Fractions F1 – F4
FAL	Freshwater Aquatic Life
FIPs	Fire Insurance Plans
FOIP	Freedom of Information and Protection of Privacy
GIS	Groundwater Information System
ha	hectare
IACR	Index of Additive Cancer Risk
IBL	Isobutylene
LEL	Lower Explosive Limit
LPH	Liquid Petroleum Hydrocarbons
mg/L	milligrams per liter
MSDS	Material Safety Data Sheet
msl	mean sea level
MTBE	methyl tertiary butyl ether

MUST	Management of Underground Storage Tanks
NPRI	National Pollutant Release Inventory
ODS	Ozone-depleting Substances
OVA	Organic Vapour Analyzer
OWS	Oil/Water Separator
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCP	Pentachlorophenol
PCS	Petroleum Contaminated Soils
PHC	Petroleum Hydrocarbon
PID	Photoionization Detector
ppb	parts per billion
ppm	parts per million
PST	Petroleum Storage Tank
PTMAA	Petroleum Tank Management Association of Alberta
RAP	Remedial Action Plan
RDL	Reportable Detection Limit
RMC	Risk Management Criteria
RMP	Risk Management Plan
ROW	Right-Of-Way
RPD	Relative Percent Difference, $RPD = \left[\frac{C_1 - C_2}{(C_1 + C_2)/2} \right] \times 100$
SVE	Soil Vapour Extraction
SWCRR	Southwest Calgary Ring Road
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
UFFI	Urea Formaldehyde Foam Insulation
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

Table of Contents

Executive Summary	i
List of Acronyms	iii
Table of Contents	v
1.0 Introduction	1
1.1 Objectives	1
1.2 Scope of Work	1
2.0 Site Description	2
2.1 Site Location and Surrounding Properties	2
2.2 Land Use	2
2.2.1 Site	2
2.2.2 Surrounding Properties	3
2.3 Setting	3
2.3.1 Topography	3
2.3.2 Geology	4
2.3.3 Hydrogeology	5
3.0 Site History	6
3.1 Prior Relevant Reports	6
4.0 Regulatory Framework	6
4.1 Guidelines Related to Site Use	7
4.1.1 Land Use and Buffer Zones	7
4.1.2 Grain Size	7
4.1.3 Guideline Selection	7
4.2 Guidelines Related to Site Risk	7
5.0 Potential Risk Pathways	8

6.0 Remedial Action Plan	8
6.1 Remediation Method Proposed	9
6.2 Location of Remedial Efforts	10
6.3 Remedial Efforts Schedule	10
6.4 Remedial Methods Effectiveness for Site Specific Conditions	11
6.5 Remedial Progress Monitoring	12

7.0 Safety Considerations	12
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8.0 Closure	12
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Figures

- Figure 1 Site Location and Surrounding Land Use Plan
- Figure 2 Site Location and Surrounding Properties
- Figure 3 PlumeStop™ Application Area

1.0 Introduction

Pursuant to the submission of the Updated 2014 Site Management Plan (11 July 2014), Sears Canada Inc. (Sears) has committed to the implementation of additional remedial efforts in order to address the dissolved phase petroleum hydrocarbon (PHC) plume associated with the former Service Center located at the North Hill Mall property, Calgary, Alberta.

In a letter dated 22 December 2015, Alberta Environment and Parks (AEP) requested that Sears provide a Remedial Action Plan (RAP) by the end of the first quarter of 2016. The RAP is expected to address the entire Site (North Hill Mall and the community of Hounsfield Heights), and is to include the following information:

- Remediation methods proposed/selected;
- Location of the remedial efforts;
- When the remedial efforts will be implemented;
- Remedial efforts effectiveness for site-specific conditions; and,
- Proposed monitoring for remedial effectiveness.

This document details the proposed RAP and for the purposes of this report, the term “Site” will refer to the entirety of the impacted zone and beyond, as defined in Figure 1. The term “Mall Area” will be used to define the property of North Hill Mall bound to the south by 14th Avenue and the term “Hounsfield Heights Area” will be used to define the area south of the Mall Area, bound to the east by 14th Street, to the south by 10th Avenue and to the west by 17A Street.

Clifton Associates Ltd. (Clifton) has prepared this RAP on behalf of Sears, at their request.

1.1 Objectives

The objectives of this RAP are to address the Site contamination through the selection of an appropriate remedial alternative.

1.2 Scope of Work

This RAP was completed in accordance with the principles and practices outlined in the AEP *Contaminated Sites Policy Framework* dated 31 October 2014 and the draft *Alberta Environmental Site Assessment Standard* dated July 2013.

The scope of work included the following tasks:

- Review of the historic environmental reports regarding contamination;
- Discuss the applicable regulatory criteria that may affect the implementation of the RAP;
- Evaluate the potential pathways through which the contamination may affect the Site; and,
- Present the RAP to address on-Site contamination.

2.0 Site Description

A Site Location and Surrounding Land Use Plan is provided for reference as Figure 1. A map of the Site Location and Surrounding Properties, using an aerial photograph dated 2012, is provided as Figure 2.

2.1 Site Location and Surrounding Properties

The ATS description of the Site is the north-eastern corner of Section 20, Township 24, Range 1, and West of the 5th Meridian (NE ¼ 20-24-1-W5M). The Site occupies approximately 40 hectares (100 acres). As defined by the Updated SMP (2014), the Site is composed of two distinct areas in Calgary, Alberta; the Mall Area, and the Hounsfield Heights Area.

The Mall Area is defined: to the north by the southern ROW of 16th Avenue NW; to the east by the eastern ROW of 14th Street NW; to the south by the northern edge of the LRT line within Lions Park; and, to the west by the western edge of the mall property and a line extending south to the northern edge of the LRT line within Lions Park.

The Hounsfield Heights Area is defined: to the north as the southern edge of the LRT line within Lions Park; to the east by the eastern ROW of 14th Street NW; to the south by the southern ROW of 10th Avenue NW; and, to the west by the western ROW of 17A Street NW and a line extending north to the southern edge of the LRT line within Lions Park.

North of the Site is a number of mixed auto-oriented and pedestrian-oriented commercial businesses situated along 16th Avenue NW. The Southern Alberta Institute of Technology (SAIT) is located to the east of the Site. To the south and west of the Site are residential properties.

Please refer to Figure 2 for the location of the Site and reference to the surrounding properties.

2.2 Land Use

Land use documents obtained from the City of Calgary indicate that the Site has a number of land use zones. The Mall Area of the Site is zoned, from west to east, as DC 99Z89 Site 5, DC 109Z99, and DC 99Z89 Site 4. The Hounsfield Heights Area of the Site is classified as R-C1, with three areas of S-SPR located on the periphery. A detailed discussion of the land use as it relates to each area of the Site is located below.

2.2.1 Site

2.2.1.1 Mall Area

The Mall Area consists of commercial and multi-family residential buildings. There are three distinct areas of DC zoning in the Mall Area – these correspond to the Sears property, the North Hill Shopping Centre, and *Renaissance at North Hill*, a condominium complex. There is a fourth area zoned as DC located in the north-eastern corner of the Mall Area, and the eastern edge is zoned as S-FUD along a transportation corridor. To the south is an area of S-SPR, which consists of 14th Avenue NW along with the LRT line.

The Mall Area boundaries were expanded as part of the Updated SMP (2014). The original boundaries were along the North Hill Shopping Centre parking lot, including the Kal-Tire Automotive Centre (1614 – 14th Avenue NW), and a portion of the 14th Avenue NW ROW to the south. The extension of area boundaries for the Mall Area resulted in the addition of the entirety of the North Hill Shopping Centre property, as well as the condominium complex at 1718 – 14th Avenue NW.

2.2.1.2 Hounsfield Heights Area

The Hounsfield Heights Area is comprised of single-family dwellings, some of which have basements. The majority of the area is zoned as R-C1. Within the Hounsfield Heights Area, there are three areas zoned as S-SPR; one to the north (Lions Park and the LRT line); one to the southwest (Hounsfield Heights Park); and, one along 10th Avenue NW, between 16th Street NW and 15th Street NW.

The Hounsfield Heights Area boundaries were expanded as part of the Updated SMP (2014). The original boundaries were between 16A Street NW and 15th Street NW, and encompassed a total of 55 residential properties and associated buildings, with approximately 51 addresses. The extension of the area boundaries for Hounsfield Heights resulted in an increase of approximately 78 more lots that contain approximately 71 additional structures, and 76 additional addresses.

2.2.2 Surrounding Properties

Surrounding land use consists of:

- Northwest – DC district;
- North – Commercial – Corridor 2 District (C-COR2);
- East – S-FUD, followed by S-CI;
- Southeast – M-CG d72, followed by DC 94Z2001 Site 1 and Site 2;
- South – S-CS, M-C1, and R-C1;
- Southwest – S-CI; and,
- West – S-SPR and R-C1.

The related Surrounding Land Use Plan can be found in Figure 1.

2.3 Setting

2.3.1 Topography

The Site is characterized by a river valley plateau and associated upper valley wall. The gently south-sloping river valley plateau is located in the northern portion of the Site. The central portion of the Site is characterized by a more moderately sloped valley wall, and the southern portion of the Site returns to a gradual slope as the valley bottom is approached.

Based on the Site survey completed in May 2015, the surface elevations range from 1093.4 m asl in the north to 1064.7 m asl in the south, with an elevation difference of approximately 30 meters across the Site, inclusive of the Mall Area.

2.3.2 Geology

The known geology encountered on-Site consists of five distinguishable native soil units overlain by fill and road structure placed in areas of residential and commercial development, roads, alleys, and parking areas. The observed soil strata underlying the fill, fill-base, and sub-base gravels were, from top to bottom: an upper silty sand unit; an upper clayey silt unit; a middle sandy silt unit; a lower clayey silt unit; and, a lower silty sand and gravel.

Brief descriptions of the five strata encountered during the intrusive investigation completed in 2014/2015 (Clifton, 2015) are provided below.

2.3.2.1 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 gravel was found in the material and the sand became wet near the base, indicating a perched water unit. 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 transitions to the south.

The average clay composition of the unit as a whole was 20%. The unit is laboratory-identified as a sandy loam; however, on average it identifies as a medium loam.

2.3.2.2 Unit 2 - Upper Clayey Silt

The upper clayey silt unit consisted of a brown, moist, plastic, clay near the surface of the unit that transitioned to a silty clay or clayey silt through the formation, with more silt near the base. Trace sand and gravel were found in the material. The unit is approximately two meters thick in the north-western 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 transitions 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.

The average clay composition of the unit as a whole was 30%. The unit is generally laboratory-identified as a silt loam or a silty clay loam; however, on average it identifies as a silty clay loam.

2.3.2.3 Unit 3 - Middle Sandy Silt

The middle silty sand unit consisted of a brown, fine-grained, loose sand near the top of the formation that transitioned to a silty sand through the formation, with more clay near the base. Trace gravel was found in the material and the sand was wet throughout, indicating confined conditions. The unit is approximately seven to ten-meter thick in the northern portions of the Mall Area, and decreases in thickness from west to east, while increasing in thickness as the unit transitions 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.

The average clay composition of the unit as a whole was 12%. The unit is laboratory-identified as a loam, silt loam, or a sandy loam; however, on average it identifies as a medium loam.

2.3.2.4 Unit 4 – Lower Clayey Silt

The lower clayey silt unit consisted of a grey, medium-plastic clay near the surface of the unit that transitioned to a silty clay or clayey silt through the formation, with more clay near the base. The unit is approximately three-meter 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. In the southern portions of the Site, the unit appears to split and is identified as Unit 4a, Unit 4b, and Unit 4c. Where it splits, the unit maintains a thickness of approximately one meter.

The average clay composition of the unit as a whole was 25%. The unit is generally laboratory-identified as a silt loam or a silty clay loam; however, on average it identifies as a clay loam.

2.3.2.5 Unit 5 – Lower Silty Sand and Gravel

The lower silty sand and gravel unit consisted of rounded gravel, with loose sand, occasional cobbles, and trace silt and clay. The gravel was wet throughout, indicating a confined unit. The unit is approximately a half meter thick at first contact in the northern portions of the Mall Area, and decreases in thickness from west to east, while increasing in thickness as the unit transitions to the south. Below the gravel is a sand layer approximately 3 meters in thickness, followed by another gravel layer at least two meters in thickness. More gravel layers are found towards the north-central portion of the Site, separated by either thin silt or clay layers. The sand layer increases in thickness to approximately 5 meters.

The average clay composition of the unit as a whole was 15%. The unit is laboratory-identified as either a loam or a silt loam; however, on average it identifies as a silty loam. This is somewhat misleading, as the analysis only covers sand-sized particles and smaller. The total percentage of gravel from the sample was between 7% and 12%, while the samples preferentially avoided the main gravel units.

2.3.3 Hydrogeology

Groundwater elevations ranged from 1061.91 m asl at the very north end of the Site to 1086.28 m asl in the borehole located furthest to the south. The measured water levels indicate that the generalized shallow groundwater flow direction is to the south-southeast, consistent with the findings of previous investigations. The groundwater flow direction of the individual Units was not determined as part of the investigations completed to date and will be assessed during the 2016 monitoring and sampling reports.

2.3.3.1 Water Bodies

Surface runoff on-Site is topographically driven, owing to the drop in elevation between the northern portion of the Site and the southern portion located closer to the valley bottom. Surface run-off within the Mall Area is diverted to catch basins which are connected to the City storm water sewer system. In the Hounsfield Heights Area, runoff from impermeable surfaces (such as driveways and roads) is directed to storm drains in the streets, which convey the water to the municipal storm system.

The nearest surface water body to the Hounsfield Heights Area is the Bow River, located approximately 1.5 km to the south of the Site. An ephemeral marshy area may be present within the new boundaries of the Hounsfield Heights Area, east of 17A Street NW and south of 12th Avenue NW.

2.3.3.2 Water Wells

Clifton personnel reviewed AEP records for water wells located within a 500 m radius of the Site. The AEP database generally limits the results to the nearest quarter section in which the well is located, and does not give a specific well address. Therefore, the exact distances from the Site to the groundwater wells are unknown. Any wells within the adjacent quarter sections, which may be within 500 m of the Site, have been cited.

There were no registered water wells located either on-Site, or in any of the adjacent quarter sections; therefore, there are no potable water wells record within a 500 m radius of the Site. This does not mean that potable water wells do not exist within these areas at all, just that they are not publically identifiable and would require a more in-depth search to locate them.

3.0 Site History

The Kal-Tire Automotive Centre, located at 1614 – 14th Avenue NW, 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. USTs were replaced in 1984, and it is assumed that these were the original tanks. 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 as an automotive centre, and does not have retail fuel sales.

3.1 Prior Relevant Reports

A summary of environmental reports completed for both the Mall and Hounsfield Heights Areas was compiled as a part of the Updated SMP (2014). These reports were obtained from the AEP ESAR database, or through the Client. For a full summary of the listed environmental reports, please refer to Appendix A in either of the documents, *Updated Site Management Plan (2014), Final Version, Hounsfield Heights – Briar Hill Community, Calgary, Alberta* (dated 11 July 2014), or the *Updated Site Management Plan (2014), North Hill Mall, Calgary, Alberta* (dated 22 September 2015). In addition to these documents, further information regarding the Site investigations conducted between 2014 and 2015 can be obtained from the report titled *Subsurface Investigation – Mall and Hounsfield Heights Areas, Calgary, Alberta* (dated 22 January 2016).

4.0 Regulatory Framework

The regulatory framework for this RAP has been put together based on the current (February 2016) Provincial guidelines incorporating site land use, site specific geology as well as risk pathways.

4.1 Guidelines Related to Site Use

The primary guidance document used to compare soil and groundwater analytical data against a guideline was the AEP, February 2016, *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (AEP 2016 Tier 1 Guidelines). The AEP 2016 Tier 1 Guidelines specify a land use and a receptor pathway approach that formulates a specific standard for each different chemical of potential concern (COPC).

4.1.1 Land Use and Buffer Zones

The Hounsfield Heights Area is currently zoned for residential/parkland land use; the Mall Area is currently zoned as direct control. While the zoning for the Mall Area does not directly indicate the appropriate land use, it has been classified as commercial for the purposes of this investigation.

The AEP 2016 Tier 1 Guidelines specify that if the adjacent land use has a more conservative guideline associated with it, then the more stringent guidelines for remediation of the lands within a 30 m buffer zone would apply. The residential/parkland criteria applicable to the Hounsfield Heights Area represent the most conservative guideline at this time. As the ROW along 14th Avenue NW in the Mall Area falls within the 30 m buffer of the Hounsfield Heights Area, the residential/parkland land use must be considered for wells located in that Area.

4.1.2 Grain Size

The soil texture from representative soil samples collected throughout the Site varied due to the large number of discrete soil intervals. Soil samples on-Site are representative of both coarse- and fine-grained soil textures.

4.1.3 Guideline Selection

The applicable guidelines for the Site have been determined to be the AEP 2016 Tier 1 Guidelines for residential/parkland land use in the Hounsfield Heights Area, and for commercial land use in the Mall Area. Soil samples were compared to the guideline values for the representative soil texture of the interval in which they were collected. Groundwater samples were compared to the guideline values for coarse-grained soil, as it is the more stringent guideline.

4.2 Guidelines Related to Site Risk

Intrinsic Environmental Services (Intrinsic) completed a Human Health and Ecological Risk Assessment (HHERA) for the Hounsfield Heights Area and North Hill Mall Area in December 2015 (Draft Version). The objectives of the HHERA were to:

- Assess the risks to human health and ecological receptors based on the 2014 and 2015 environmental site investigation;
- Update the previous HHERA (Intrinsic, 2006) based on the most recent guidance (AEP, 2014) provided by the Government of Alberta;
- Develop Tier 2 risk management guidelines that are required to address immediate risks and would be in effect during remediation; and,
- Develop Tier 2 remediation guidelines that are required to achieve unconditional Site closure.

It should be noted that at the time of the preparation of this RAP, the HHERA was still in Draft form and feedback from AEP had not yet been received. In addition to this, since the time of submission of the HHERA, the AEP 2015 Tier 1 Guidelines have been updated to the new AEP 2016 Tier 1 Guidelines, which may also potentially affect the generated Site-specific Tier 2 guideline values. Once the Site-specific Tier 2 guidelines for each portion of the Site are finalized, the remedial efforts will be measured against those criteria. It is not anticipated that the recent change in the guideline values will affect the proposed remedial methods.

The HHERA identified benzene, total xylenes, F1 PHCs and 1,2-dichloroethane (1,2-DCA) as COPCs for the indoor vapour inhalation pathway in the Hounsfield Heights Area. Risks were calculated based on the groundwater concentrations in the Hounsfield Heights Area, as soil impacts were found to be primarily in saturated soils. No potential risks to human health or ecology were identified in the Mall Area based on the Site-specific Tier 2 guidelines.

Intrinsik developed Tier 2 Groundwater Guidelines for the Protection of Vapour Inhalation for four separate areas in Hounsfield Heights (Intrinsik, 2015). Where encountered, the COPCs identified were compared against the guidelines derived by Intrinsik and used to assess risk to human and ecological health during the on-going management of the Site. The long term remedial objectives of the Site, to obtain unconditional Site closure, will remain as the land use specific AEP 2016 Tier 1 Guidelines.

5.0 Potential Risk Pathways

A full assessment and interpretation of the risk pathways as it relates to the COPC and site specific characteristics will be included in the HHERA, once finalized.

Based on our current understanding, there are three pathways of potential risk associated with the COPC and the site specific characteristics, these include:

- Vapour inhalation pathway;
- Direct soil contact pathway (from potential surface seeps and springs and for workers during field activities); and,
- Ingestion of soil pathway ((from potential surface seeps and springs and for workers during field activities).

The proposed remedial methods are intended to manage the concentrations of COPC such that the ecological and health risk based guidelines are not exceeded.

6.0 Remedial Action Plan

The RAP for the Site is intended to address any liquid petroleum hydrocarbon (LPH) and dissolved phase PHCs to meet the short term and long term human health and environmental risk-based guidelines which were established by Intrinsik.

The RAP, as requested by AEP, is to include:

- Remediation methods proposed/selected;
- Location of the remedial efforts;
- When the remedial efforts will be implemented;
- Remedial efforts effectiveness for site-specific conditions; and,
- Proposed monitoring for remedial effectiveness.

Each of these bulleted points is separately discussed below.

6.1 Remediation Method Proposed

Currently, there are two on-going remedial efforts being undertaken at the Site. First, the use of the Dual Phase Vapor Extraction (DPVE) system and secondly, bi-weekly active bailing. The original purpose of the DPVE was to remove, to the extent practicable, the LPH present on-Site. Since the implementation of the DPVE system, LPH has not been observed in any of the monitoring wells. However, during the past year of activities, the DPVE was purposely shut down, and since then, the LPH returned in one the monitoring wells which is believed to be associated with the rebounding of the water table. Since the LPH detection within the monitoring well, Clifton has completed weekly, then bi-weekly, active bailing of that well and also re-started the DPVE system. Clifton recommends that the DPVE system and active bailing program continue until the LPH is no longer present. Once the LPH is no longer observed, Clifton recommends that the continued operation of the DPVE system be assessed to determine if it is still required. Information regarding the DPVE effectiveness will be provided in the semi-annual groundwater monitoring and sampling reports on a go-forward basis.

In addition to the continued use of the DPVE system and the active bailing program, Clifton is proposing the application of PlumeStop™, an in-situ bioremediation method. PlumeStop™ is a Liquid Activated Carbon system with enhanced biodegradation created by Regensis Remediation Services.

PlumeStop™ consists of a colloidal biomatrix which allows for dual phase treatment of contaminated groundwater. The activated carbon used is approximately 1-2 micrometers in diameter, which allows it to be suspended in a liquid, and provides an exceptionally large surface area for treatment. Colloidal granular activated carbon (GAC) has a diameter that is even smaller than the soil pore throat diameter of silts and sands (3 – 30 µm), which allows for complete coating of the soil matrix. An anti-clumping / distribution supporting surface treatment (polymeric and molecular dispersion agents) is added to the colloidal GAC. This allows the PlumeStop™ to overcome the distribution limitation associated with the surface charge of the GAC, and flows freely through the aquifer, coating the soil matrix without clogging pore spaces. This allows for low pressure application without the use of hydraulic fracturing, which can create preferential flow paths in the subsurface.

Once the COPCs have been partitioned onto the surface of the PlumeStop™, the biomatrix may be colonized by naturally occurring bacterium, or by bacteria injected as an inoculum. The low-solubility / controlled-availability matrix nutrients incorporated into the biomatrix support biodegradation without causing eutrophication. PlumeStop™ increases the contaminant-microbe contact by concentrating the COPC in a nutrient and oxygen rich environment where biodegradation can occur. The microbial degradation of the COPCs in the biomatrix will continue indefinitely as long as electron donors/acceptors are present. The biodegradation of COPCs allows for the GAC to be continuously regenerated, as adsorption sites are freed up, and to further partition COPCs out of the groundwater.

6.2 Location of Remedial Efforts

It is expected that the DPVE system used will be continued, focussing on the extraction well located nearest to the monitoring well with LPH. The active bailing program for this monitor well will also continue as long as LPH remains present.

The proposed PlumeStop™ application will involve an injection along 11th Avenue NW, with a co-application of ORC-Advanced (and oxygen release compound) up-gradient of the area of highest benzene concentrations to minimize breakthrough (Figure 3). Breakthrough can occur if concentrations are too high, reducing the effectiveness of the activated carbon thereby allowing contaminants to flow through the biomatrix without being fully adsorbed and subsequently degraded. Approximately 72 injection points spaced approximately 2.4 meters (8 feet) apart will be placed along 11th Avenue NW to address the advance of the PHC plume. Approximately 79 application points at 1.5-meter spacing will be placed up-gradient of the PlumeStop™ application zone to apply ORC-Advanced.

Clifton has identified two areas of potential future application of PlumeStop™ in the Mall and Hounsfield Heights Areas: 14th Avenue NW and 10th Avenue NW. The expected limits of application are 16A Street NW and 15th Street NW for the application along 14th Avenue NW and from 16th Street NW to 15th Street NW for the application along 10th Avenue NW. The application on the north side of 14th Avenue NW, adjacent to the Bentall and Sears property, is intended to treat and aid in the prevention of any further migration of PHCs from the source. The application along 10th Avenue NW is intended to be placed as a contingency to aid in the prevention of the plume from migrating beyond this point.

Clifton is planning on completing a Design Verification Test (DVT) in each of these areas in 2016 in order to determine the remedial design requirements.

6.3 Remedial Efforts Schedule

On 21 March 2016, representatives from Clifton and Regenesys performed a DVT for the application of Plume Stop along 11th Avenue NW.

The test consisted of advancing 5 boreholes to a maximum depth of 15 m below ground surface at specific locations along 11th Avenue NW. A total of four soil samples were collected from each borehole to confirm the vertical extent of contamination in the soil. Groundwater samples were also obtained to confirm concentrations of COPC within the groundwater. The DVT was also used to obtain additional on the Site geology and groundwater depth data.

Following completion of the boreholes, a one-day water injection test was completed to confirm the validity of the remedial design assumptions, including the radius of influence of the injection points and rates at which the PlumeStop™ can be injected to ensure sufficient coverage within the soil matrix.

Following completion of the DVT, Regenesis was able to confirm their remedial design and make the necessary adjustments required for the full scale injection of PlumeStop™ along 11th Avenue NW.

It is anticipated that the full scale injection along 11th Avenue will begin at the beginning of June 2016 and will take approximately 20 days to complete.

6.4 Remedial Methods Effectiveness for Site Specific Conditions

Clifton has assessed a variety of remedial options and their potential application at the Site. Due to the nature of the Site being a densely populated urban area, in-situ remediation is the more suitable form of remediation for the Site. There are several in-situ remedial technologies available which fall into three broad categories including, in-situ physical extraction, in-situ chemical oxidation and in-situ bio-remediation. Clifton is currently employing in-situ physical extraction with the use of the DPVE system and the active bailing program.

Clifton assessed the potential use of other physical extraction systems to treat the dissolved phase COPC, however, our assessment revealed there are more appropriate, less invasive and unsightly remedial methods. Clifton also assessed the application of in-situ chemical oxidation, however, these highly exothermic reactions were determined to be unsuitable for application within a residential community. In addition, due to access restrictions, this method would be limited to treat areas only within the roadways, laneways and green spaces, leaving a majority of the Site un-remediated.

In-situ bioremediation was determined to be the most applicable form of remediation for the Site. The PlumeStop™ method selected is low maintenance, has minimal visual impact within the community and based on recommendations from Regenesis, an effective method of treating the concentrations of the COPC observed on-Site. PlumeStop™ has been successfully used at sites of similar nature across North America to reduce and eliminate the COPC which have been observed in the Mall and Hounsfield Heights Areas. Theoretically, PlumeStop™ will have an unlimited lifetime, ensuring that the Site is continually being remediated as the natural flow of groundwater continues to pass through the application zone. By means of this, the method should be effective in lowering concentrations/eliminating COPC thereby ensuring risk levels are not exceeded and the long term remedial objectives are met.

It is important to note that the PlumeStop™ is not designed to treat LPH, therefore it is imperative that the DPVE system and the active bailing program continue as long as LPH is present on-Site.

6.5 Remedial Progress Monitoring

Clifton is proposing to monitor the remedial progress by comparing pre and post groundwater monitoring and sampling results. The monitoring well network already established through the community will be sufficient for measuring the changes in concentrations as a result of the application of Plume Stop. The monitoring and sampling will be done on a semi-annual basis and the data and interpretation will be provided in the semi-annual monitoring and sampling letter reports.

Clifton is also proposing that the oxygen levels near the PlumeStop™ application zones be measured during the groundwater monitoring and sampling events to ensure adequate conditions for biodegradation to occur. The application of additional oxygen release compound may be required throughout the duration of the remediation program.

7.0 Safety Considerations

Safe work practices will be followed for all activities. A job safety assessment form will be completed for the work. Clifton can provide a copy of this assessment upon request.

In preparation for the start of field operations, a health and safety briefing will be completed prior to initiating work with all workers involved. This will include a review of the emergency plan for the Site. Copies of the emergency plan will be provided to all workers on-site and will be posted in vehicles.

8.0 Closure

This remedial action plan has been prepared and the work referred to in this report has been undertaken by Clifton Associates for Sears Canada Inc. It is intended for the sole and exclusive use of Sears Canada Inc. and their respective insurers, agents, employees and advisors. Any use, reliance on or decision made by any entity other than Sears Canada Inc. based on this report is the sole responsibility of such entity. Clifton Associates makes no representation or warranty to any other entity with regard to this report and the work referred to in this report and they accept no duty of care to any other entity or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other entity as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

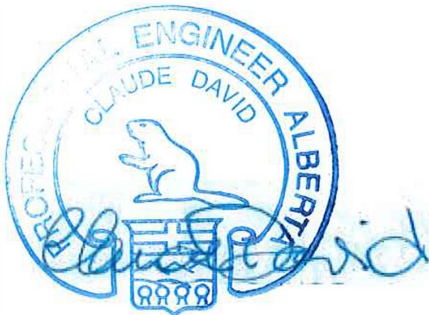
The remediation undertaken by Clifton Associates with respect to this report and any conclusions or recommendations made in this report reflect Clifton Associates judgment based on the Site conditions observed at the time of the Site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to this Site and it is based, in part, upon visual observation of the Site, and a review of available records documented in this report. Unless otherwise stated, the findings cannot be extended to previous or future Site conditions, portions of the Site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the Site.

Substances addressed by the investigation may exist in areas of the Site not investigated and concentrations of substances addressed, which are different than those reported, may exist in areas other than the location from which samples were taken.

If Site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

Other than by Sears Canada Inc., copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of Clifton Associates. Nothing in this report is intended to constitute or provide a legal opinion.

Yours Truly,
Clifton Associates Ltd.



Claude David P.Eng., P.Geo.
Director, Environmental Sciences

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

A handwritten signature in blue ink, appearing to read "Stephen d'Abadie".

Stephen d'Abadie M.Eng.
Project Manager

Figures

Clifton Associates Figures

Clifton Associates

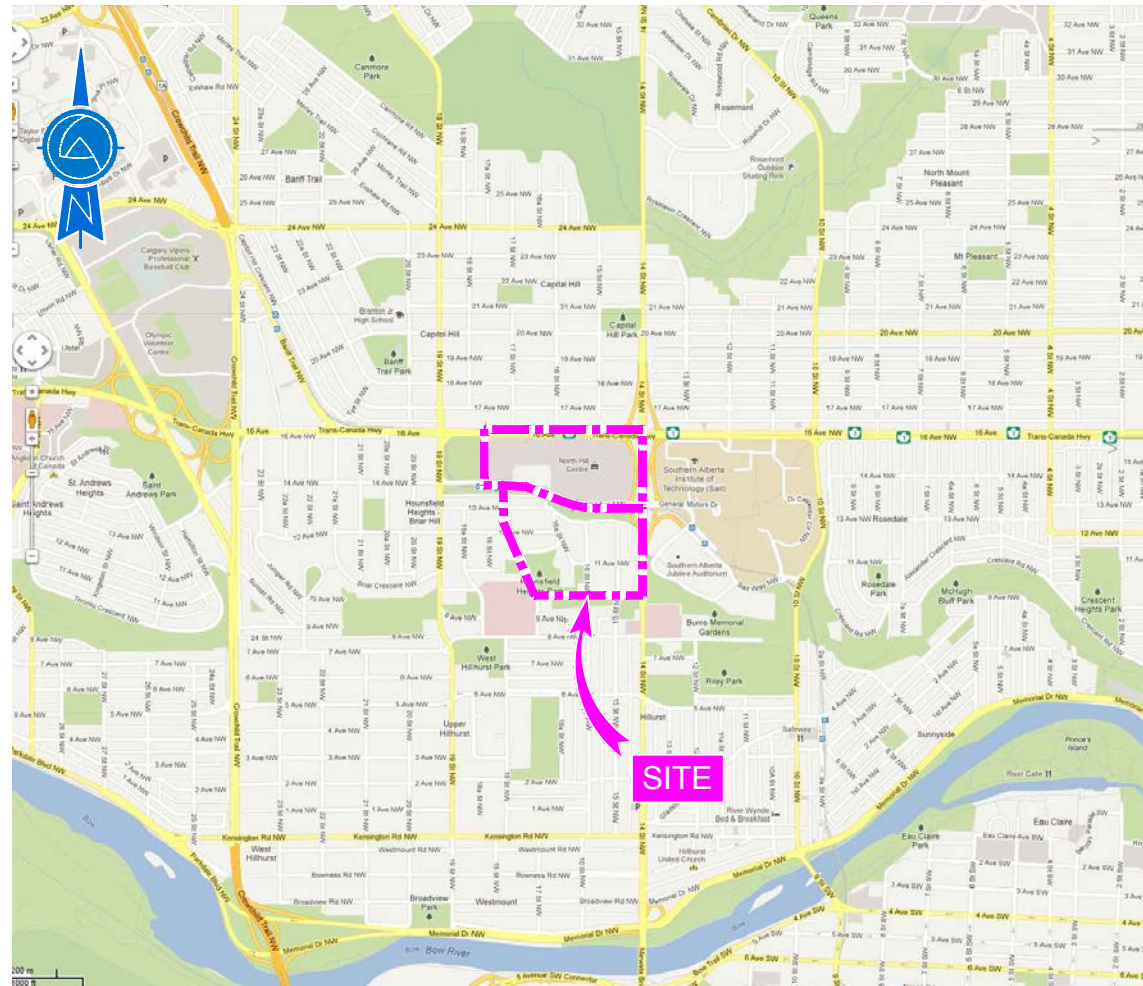


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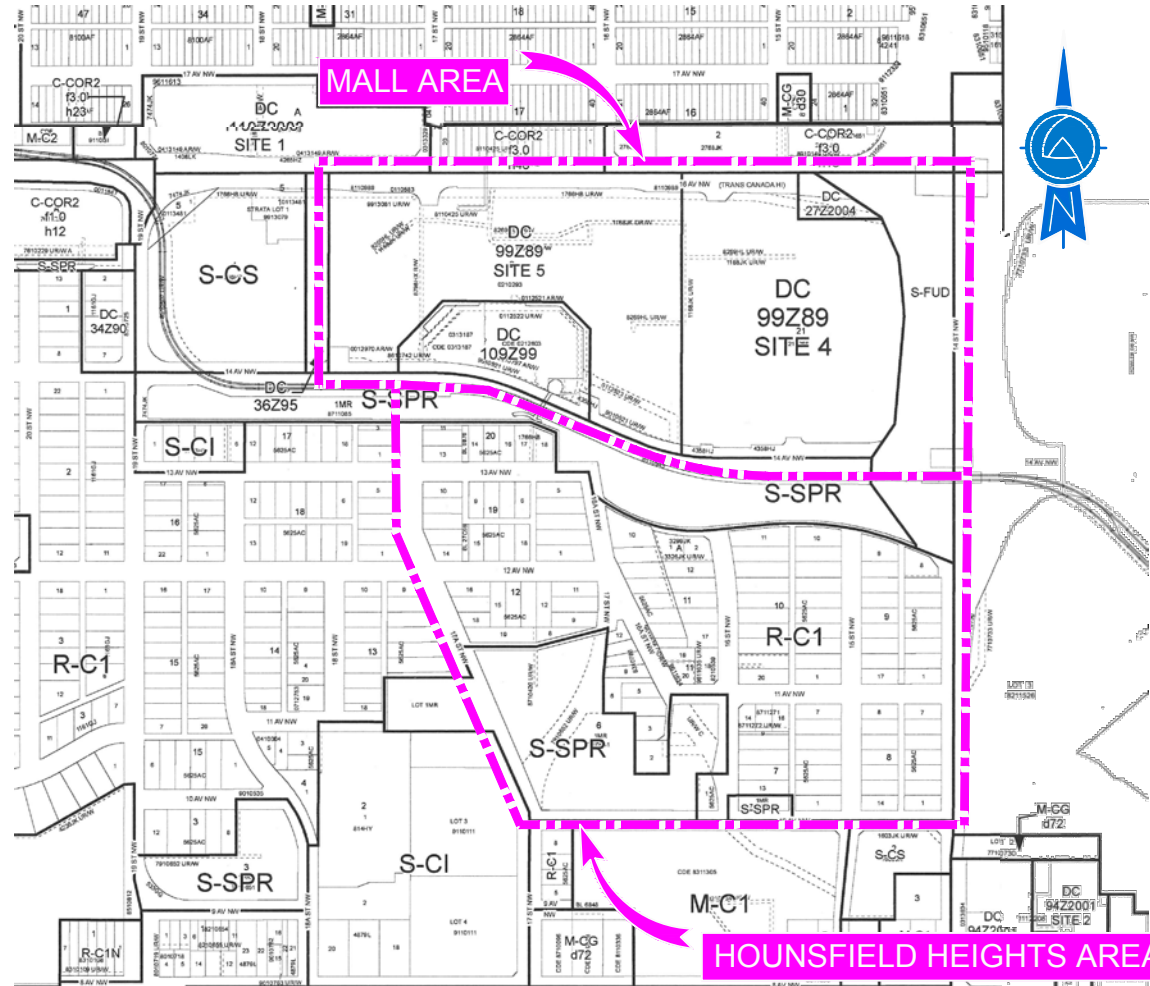
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www.clifton.ca



GENERAL SITE LOCATION

SCALE 1:30,000



SURROUNDING LAND USE

SCALE 1:10,000



LEGEND:

- SITE BOUNDARY — — — — —
- 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**

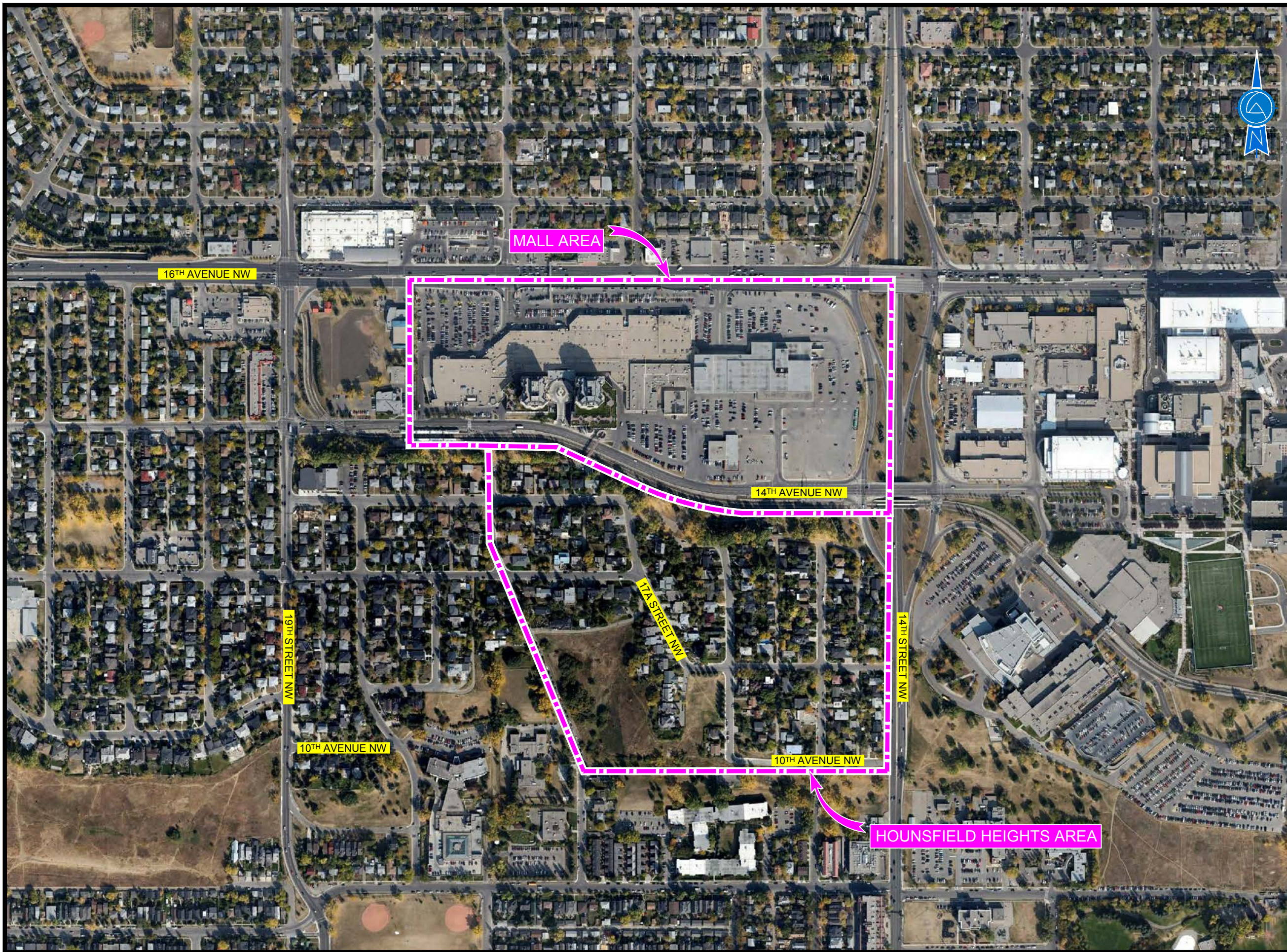
CLIENT **SEARS Canada Inc.**

PROJECT REMEDIAL ACTION PLAN
MALL AND HOUNSFIELD HEIGHTS AREA
CALGARY, ALBERTA

TITLE **SITE LOCATION AND SURROUNDING LAND USE PLAN**

DESIGNED	SCALE	AS SHOWN	DATE
DRAWN	PROJECT NO.	CG2430.1 E03	FIG.
CHECKED	FILE NO.	CG2430.1E03-RAP01	1

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LEGEND:

SITE BOUNDARY



NOTES:

1. IMAGERY FROM GOOGLE EARTH PRO
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DATE: 22 SEPT 2012.



ENGINEER



CLIENT

SEARS Canada Inc.

PROJECT

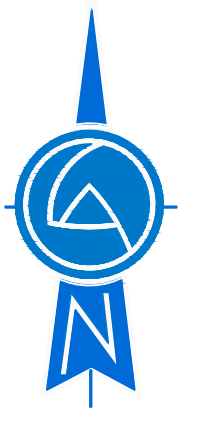
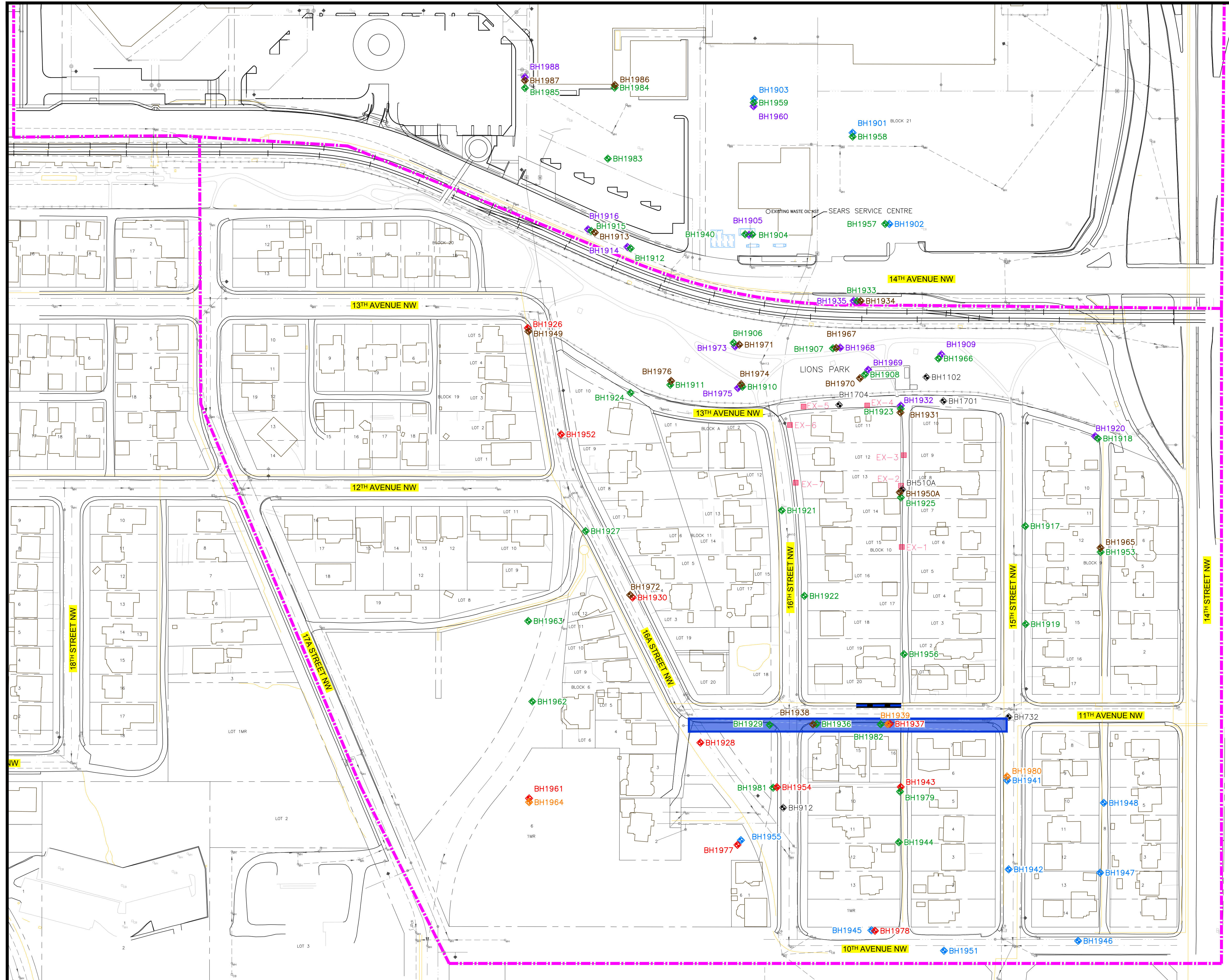
REMEDIAL ACTION PLAN
MALL AND HOUNSFIELD HEIGHTS AREA
CALGARY, ALBERTA

TITLE

SITE LOCATION
AND
SURROUNDING PROPERTIES

DESIGNED	SCALE	1:5000	DATE	2016-03-10
DRAWN	RD	PROJECT NO.	CG2430.1 E03	FIG.
CHECKED	FILE NO.	CG2430.1E03-RAP02		2

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LEGEND

SITE BOUNDARY	
PRE-EXISTING MONITORING WELL	
EXTRACTION WELL	
LRT TRACKS	
FENCE LINE	
LEGAL LINE	
FORMER FACILITY/FEATURE	
BUILDING	
MONITORING WELL SCREENED THROUGH UNIT 1 - UPPER SILTY SAND	
MONITORING WELL SCREENED THROUGH UNIT 2 - UPPER CLAYEY SILT	
MONITORING WELL SCREENED THROUGH UNIT 3 - MIDDLE SANDY SILT	
MONITORING WELL SCREENED THROUGH UNIT 4 - LOWER CLAYEY SILT	
MONITORING WELL SCREENED THROUGH UNIT 5 - LOWER SILTY SAND AND GRAVEL	
MONITORING WELL SCREENED THROUGH UNDETERMINED STRATA	
PLUMESTOP™	
ORC-ADVANCED APPLIED	
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 UG UTILITIES) & FROM SITE ASSESSMENT INFORMATION. ADDITIONAL REFERENCES FROM SEAROR ENVIRONMENTAL ENGINEERING INC., DRAWINGS 149-5A11.DWG, 149-5A6.DWG.



ENGINEER
 Clifton Associates

CLIENT
 SEARS Canada Inc.

PROJECT
 REMEDIAL ACTION PLAN
 MALL AND HOUNSFIELD HEIGHTS AREA
 CALGARY, ALBERTA

TITLE
 PLUMESTOP™ APPLICATION AREA

DESIGNED	SCALE	DATE
DRAWN	PROJECT NO.	FIG.
CHECKED	FILE NO.	

1:1000
 2016-03-10
 CG2430.1 E03
 CG2430.1E03-RAP03
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