Farmland to Residential Community – Environmental Assessment, Remediation and Challenges

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1 Introduction

- Calgary is a young city and its population growth has been approximately 3 percent per year between 2005 and 2015 (Ref: Calgary Economic Development)
- Several new residential communities have been developed in Calgary in recent years to support the population growth
- Many of these communities were developed from existing farmsteads



2 Objectives

The objectives were to:

- Develop the farmland into single-family residential land
- Secure approval from The City of Calgary











Phase I ESA

To determine the Site's existing environmental condition a Phase I environmental site assessment (ESA) was conducted in 2007.

- Several areas of potential environmental concerns (APECs) were identified
- Recommended intrusive investigation (e.g., Phase II ESA) in order to assess soil and groundwater conditions



















Field Work

A Phase II ESA in 2011 to determine the shallow soil and groundwater conditions:

- Maximum depth of 4.6 metres below grade (mbg)
- Groundwater was determined to be deeper

Additional Phase II ESA was conducted in 2012 to a maximum depth of 15.0 mbg. In total following were completed during the Phase II ESAs:

<u>ASTs Area</u>

• 15 boreholes; 10 are monitoring wells

<u>Garbage Pit Area</u>

• 6 boreholes; 2 are monitoring wells and 24 test pits



Guidelines and Findings

All pathways were considered applicable and as such AEP Tier 1 guidelines (for fine grained soil and residential land use) were considered appropriate for the comparison.

<u>ASTs Area</u>

SOIL:

- Impacts of one or more of benzene, toluene, ethylbenzene, PHC fractions 2 and 3 within the former ASTs area; maximum depth of impacts (exceeding AEP Tier 1) was 7.6 mbg; lateral and vertical delineation achieved
- Detectable concentrations of one or more of the above to the maximum depth (15.0 mbg)

GROUNDWATER:

 Impacts of one or more of benzene, toluene, ethylbenzene and xylenes in the bedrock to ~13.0 mbg



Guidelines and Findings Garbage Pit Area

SOIL:

- Impacts of selenium to 3.0 mbg; maximum selenium concentration of ~ 9 mg/kg. Selenium could be due to site activities. Additional assessments beyond the pit debris identified highly variable metals results.
 GROUNDWATER:
- Impacts of selenium in the groundwater; consistent with selenium concentrations in the background locations



Uniqueness

- Single-family residential
- Shallow weathered bedrock; challenging excavations
- City's expectation of remediation end points (nondetectable for PHC parameters)
- Deep groundwater PHC impacts in the former ASTs area
- Potential elevated levels of naturally occurring selenium



Remedial Excavations

FORMER ASTS AREA:

- An irregular shaped excavation
- Depth of excavation 15.0 mbg; maximum width of 25.0 metres; 3,100 cubic metres of soil
- Groundwater measured at 13.0 mbg
- Installed three groundwater monitoring wells downgradient of the excavations

Remedial Excavations

FORMER ASTS AREA:

- Soil analytical (PHC parameters) from final limits of excavation were non-detect (below laboratory detection limits)
- Water samples from the excavation base were nondetect
- Water samples from the downgradient monitoring, wells were non-detect

Remedial Excavations

FORMER Garbage Pit AREA:

- An irregular shaped excavation
- Depth of excavation 5.5 mbg; maximum width of 58.0 metres; 7,400 cubic metres of soil
- Concentration of Arsenic, Barium and Selenium were found exceeding the AEP Tier 1 Guidelines;

In addition, the following were also observed in the metals concentrations:

- Metals (arsenic, barium and selenium) were highly variable in concentration; no apparent continuity that suggested an impact plume; no known source
 - Similar observations of metals in soil in the backfill area
 - Heavily weathered bedrock

Research Summary

Based on the discussion with Alberta Health Services (AHS) and Stantec's experience with a similar site located in Airdrie, Alberta (~20 km northeast of the subject Site), a review of the background information initiated.

- Similarity between the subject site and Airdrie site (e.g. historical land use (agricultural), geology, glacial history)
- Surrounding land uses are agricultural (north, east and west)/residential (south)



Research Summary A comparison of soil concentrations for Arsenic, Barium and Selenium between the Airdrie site (located ~20 km northeast) and the subject site reported similar findings.

	Airdrie			Subject Site		
Chemical of Concern (COC)	Arsenic	Barium	Selenium	Arsenic	Barium	Selenium
Sample size (n)	987	389	443	73	73	312
Max	110	1725	8.8	62	1300	5.7
Min	0.05	9.19	0.01	4.3	140	0.5
Median	15	229	0.57	8.3	330	0.64
Arithmetic Mean	17	296	0.66	12	365	0.9
Arithmetic Standard Deviation	12.20	264.57	0.55	10.64	168.75	0.66
Geometric Mean	10.66ª	193.27	0.51	9.85ª	336.93	0.75
Geometric Standard Deviation	0.59	0.44	0.34	0.25	0.17	0.22
97.5 th percentile	42	910	1.7	45	688	3.00
95 th percentile	37	829	1.3	34	614	2.25
90 th percentile	33	668	1.1	24	550	1.59
75 th percentile	25	402	0.8	12	420	0.92

Notes:

^a Not statistically different (t-test; p>0.6)



Research Summary

Review of regional background concentrations of arsenic, barium and selenium concluded the following:

• Large area in southern Alberta was subjected to volcanic ash deposition from the Mount Mazama volcanic eruption (circa 5700 B.C.); contributed elevated levels of metals







AHS's Recommendation

The background summary prepared by Stantec reported:

- The concentrations of arsenic, barium and selenium in the subject area (i.e., garbage pit) was naturally occurring
- Recommended (95th percentile values from Airdrie):

Arsenic: 40 mg/kg Barium: 830 mg/kg Selenium: 1.3 mg/kg

Following review of the background summary, AHS agreed to Stantec's findings and recommended that

 Hot spots for Arsenic values > 50 mg/kg (30 mg/kg as the reasonable maximum criterion for shallow soils with a relative bioavailability of 60%) be identified and remediated

Later, AEP issued a letter outlining the lines of evidence submitted in Stantec's reports and the AHS's recommendation are acceptable.



Conclusions and Lessons Learned

The Site is a developing residential community.

The following lessons were learned:

- The end land-use dictated the remediation end points; non-exceedance of AEP Tier 1 may not be sufficient
- Concentrations of metals may be naturally elevated; additional background data may be key



Thank you

