Remediation Technologies Symposium
October 21st, 2011

REMEDIATION OF A SAND AQUIFER BENEATH RESIDENTIAL/ COMMERCIAL PROPERTIES USING A MULTI-PHASE EXTRACTION (MPE) SYSTEM

Stantec Consulting Ltd.

Dele Akinnola, M.Eng., P.Eng., EP | Garry Bain, P.Eng.

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OUTLINE

- Site Description
- Background
- Site Geology
- Multi-Phase Extraction (MPE) Pilot Test
- MPE System Installation
- MPE System - Performance Evaluation
- Current Status and Future Plan
- Conclusions
- Questions

SITE DESCRIPTION

- Site is located in a commercial/residential area of Edmonton, Alberta.
- Site operated as a service station for a period of over 20 years.
- Site infrastructure included:
  - Convenience store
  - Carwash building
  - Storage sheds
  - Two underground storage tanks (USTs – 3,000 gal and 5,000 gal)
  - Pump islands
  - Associated distribution lines
- Adjacent sensitive receptors:
  - Residential and commercial properties
  - Underlying potential domestic use aquifer

SITE DESCRIPTION

September 27, 2011

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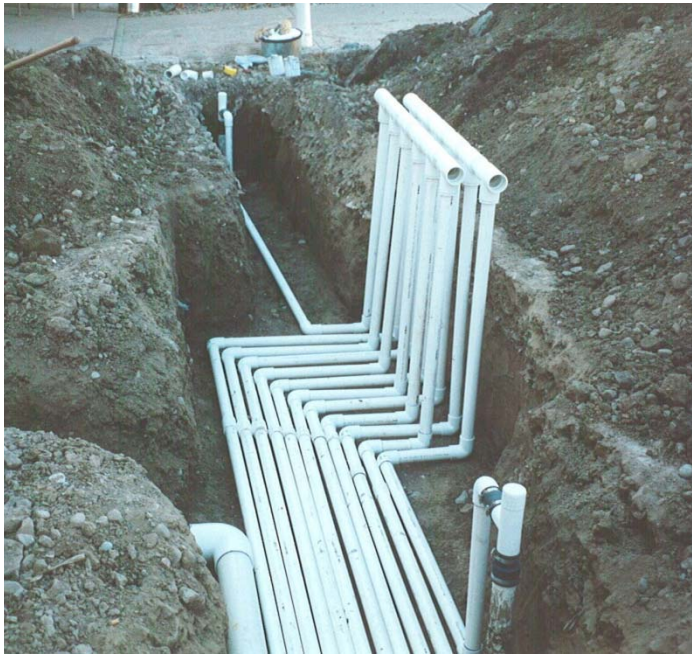
0 25 50 75 100 m
1:2500

Client/Project
FORMER SERVICE STATION
MPE SYSTEM OPERATIONS

Figure No.
1.0

Title
1988 Air Photo

200 - 325 25th St. SE Calgary, AB T2A 7H8



BACKGROUND

- Investigations conducted by others between 1995 and 1999 identified petroleum hydrocarbons (PHC), including light non-aqueous phase liquids (LNAPL) beneath the site and adjacent commercial/residential receptors.
- LNAPL thickness ranged from 4 mm to 690 mm.

BACKGROUND

- Remedial efforts implemented involved:
  - Excavation of contaminated soils around tank nest and pump islands during underground storage tank (UST) removal in 1995
  - USTs contained numerous corrosion holes and impacts to soils in the tank area were observed
  - LNAPL removal via skimmer operations (12 V purge pump)
  - Pump and treat system installed in Fall 1995 with a venturi pump installed in one well onsite
  - Vapour extraction system (VES) was also utilized with four onsite wells tied into system

BACKGROUND

- Pumping system was discontinued in the summer of 1997.
- Rebound of LNAPL in Fall 1997 resulted in re-activation of the pumping system in Fall 1997.
- System was removed from site in 1998.
- Skimming operations and vapor extraction activities continued in late 1998 to 1999 and a rebound of LNAPL (30 mm thickness) was observed downgradient of the site in 1999.

BACKGROUND

- Between 1999 and 2000, Stantec conducted subsurface investigations and monitoring programs which identified PHC and LNAPL (200 mm thickness) beneath the site and adjacent offsite properties to the southwest.
- PHC impacts beneath the site and immediately downgradient (southwest) were characterized by the presence of elevated benzene, toluene, ethylbenzene, xylenes (BTEX) and PHC fractions in soil and select BTEX constituents in groundwater.
- PHC impacted soil was identified in near surface clay and within an underlying sand zone.
- PHC impacted groundwater was also widespread, extending 140 m offsite.
- Applicable site criteria were the Alberta Environment (AENV) Guidelines for coarse-grained soils with the freshwater aquatic life (FAL) pathway excluded.

Estimated Extent of Impacted Soil Plume (Pre-MPE System)

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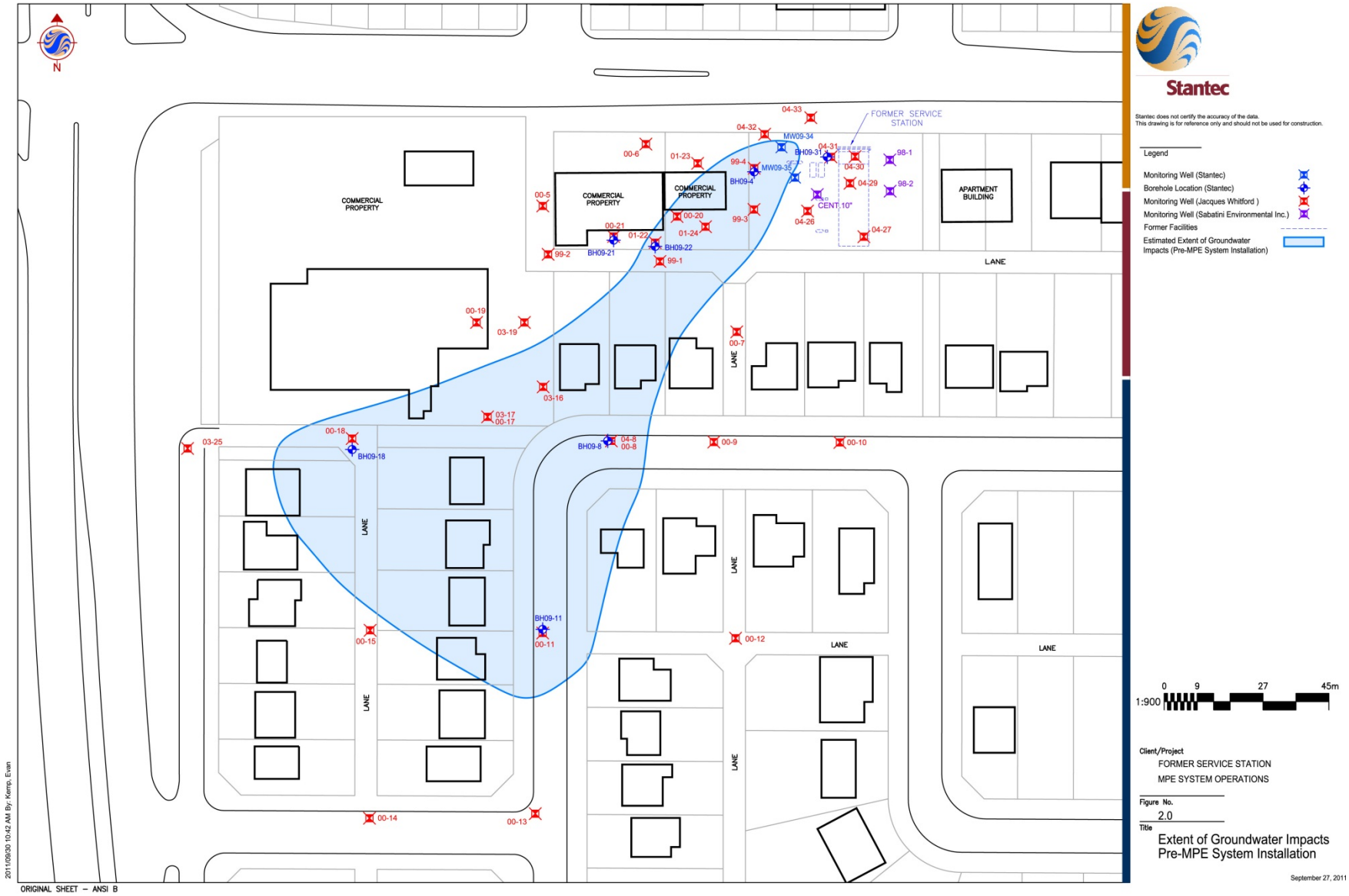
Estimated Extent of Impacted Groundwater Plume (Pre-MPE System)



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Estimated Extent of LNAPL (Pre-MPE System)

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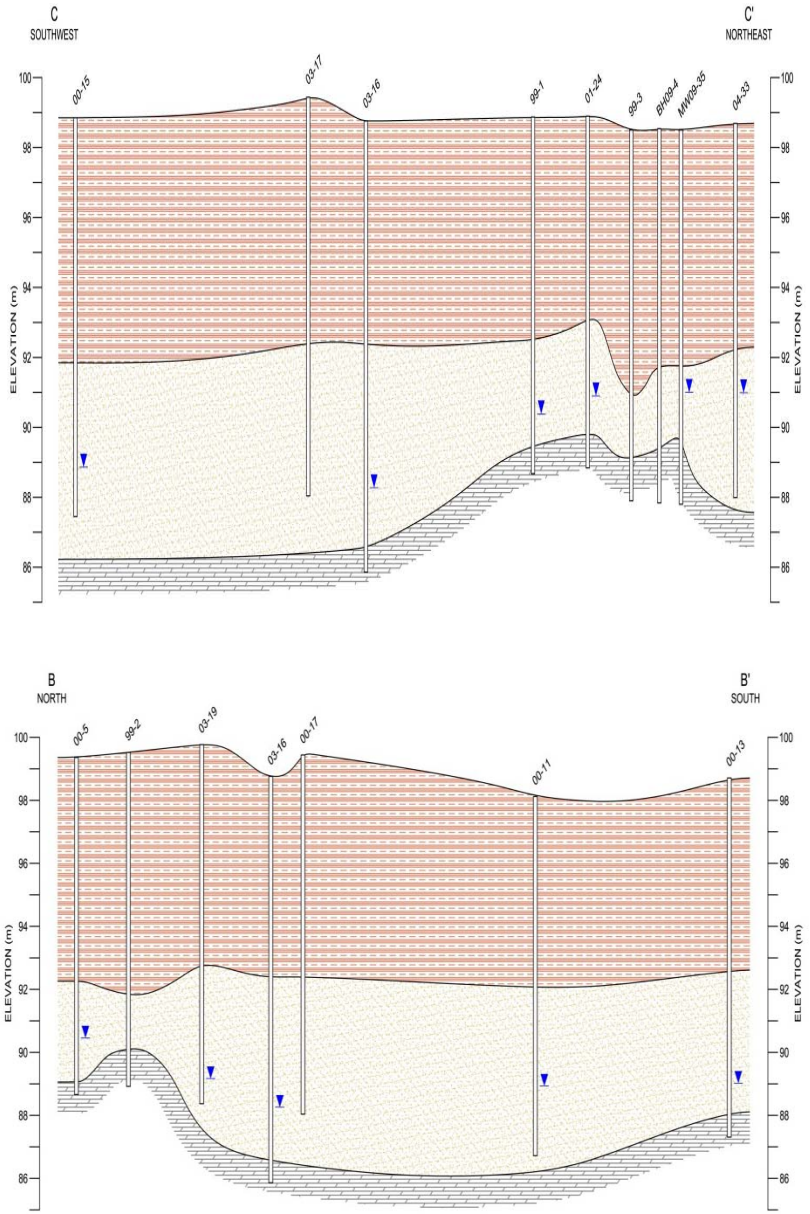
SITE GEOLOGY/HYDROGEOLOGY



- Soil profile consists of 6 m to 8 m of lacustrine clay, underlain by up to 5 m of sand above bedrock at 10 mbg.
- Groundwater is typically present in the sand zone at depths of 6 mbg to 10 mbg.
- Interpreted groundwater flow direction was west/southwest under phreatic (gravity) control.
- Bedrock surface topography and thickness of the underlying sand zone controls the migration of impacts.

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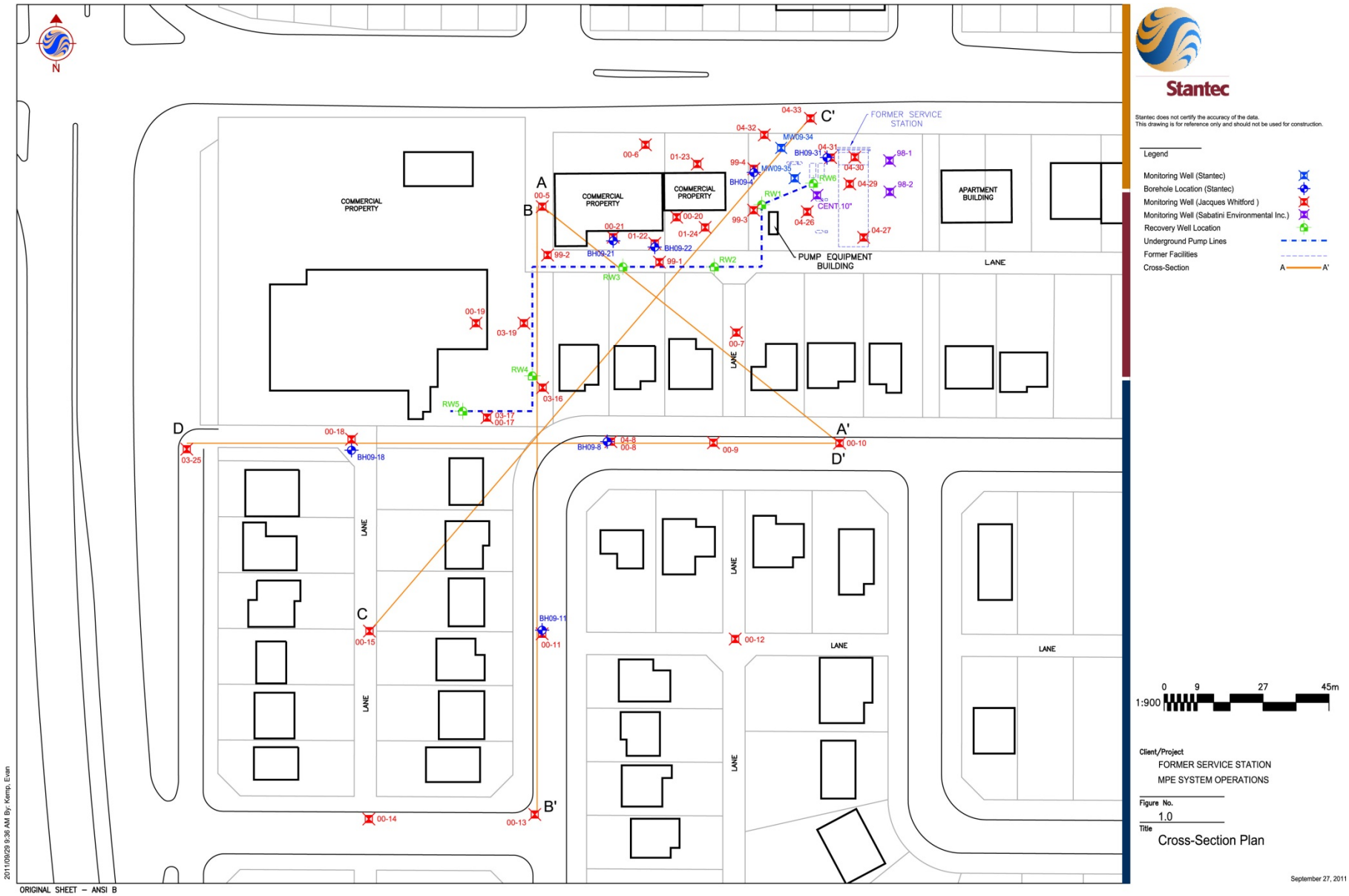
Cross-Section Plan



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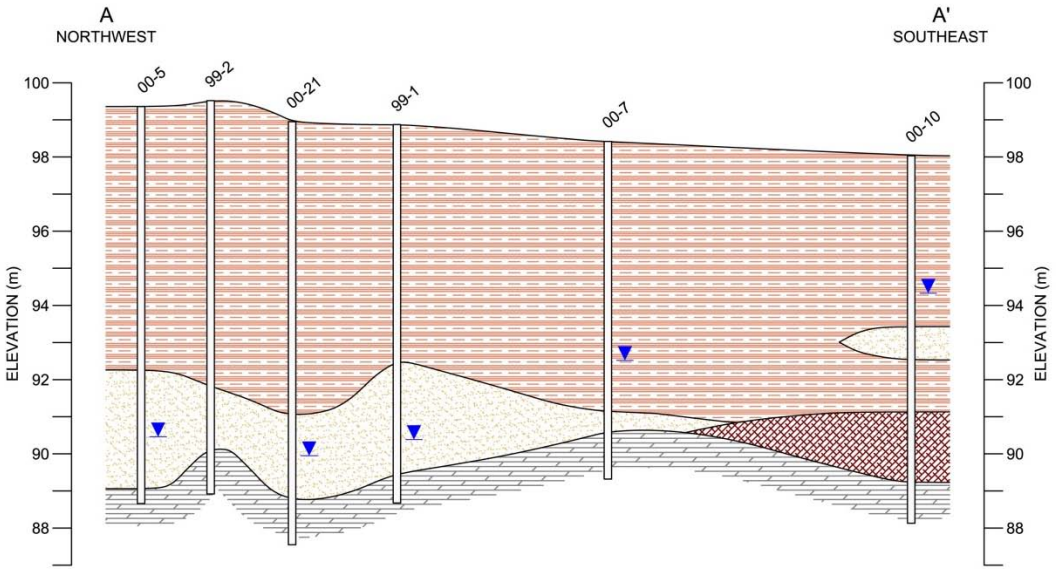
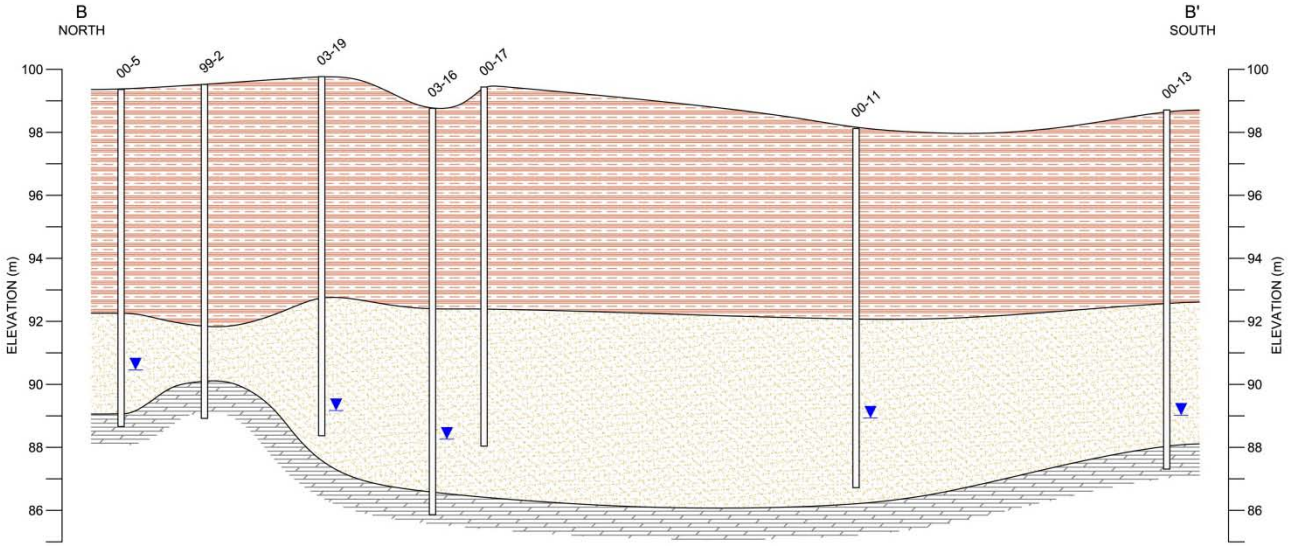
Cross-Sections



Cross-Section 'A-A'



Cross-Section 'B-B'

Legend:

- Clay
- Sand
- Bedrock
- Coal
- Water Level (October 2008)

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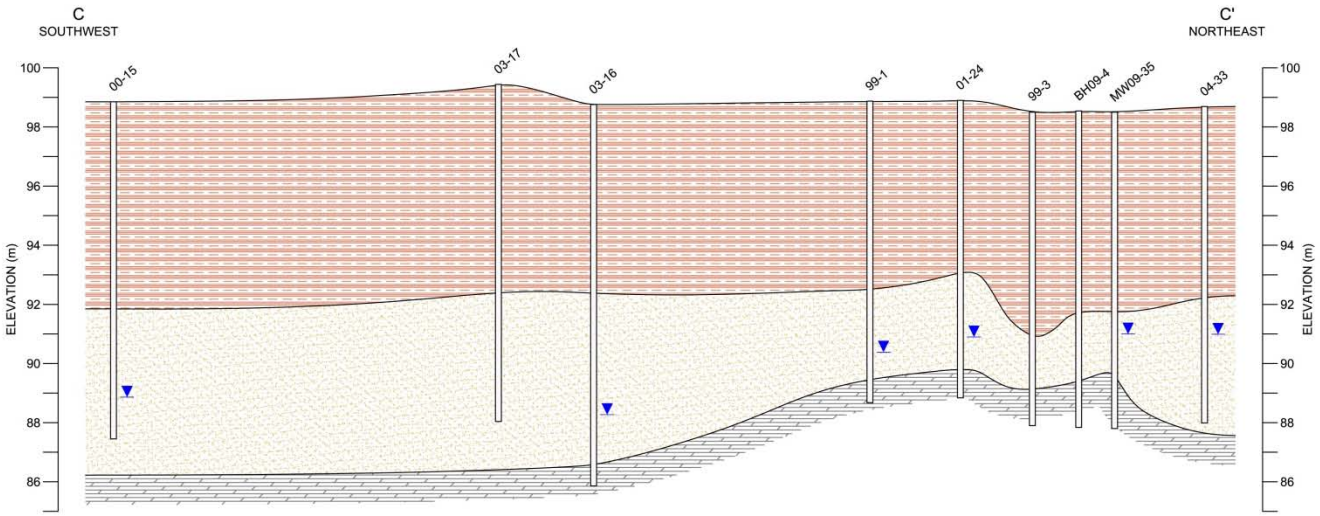
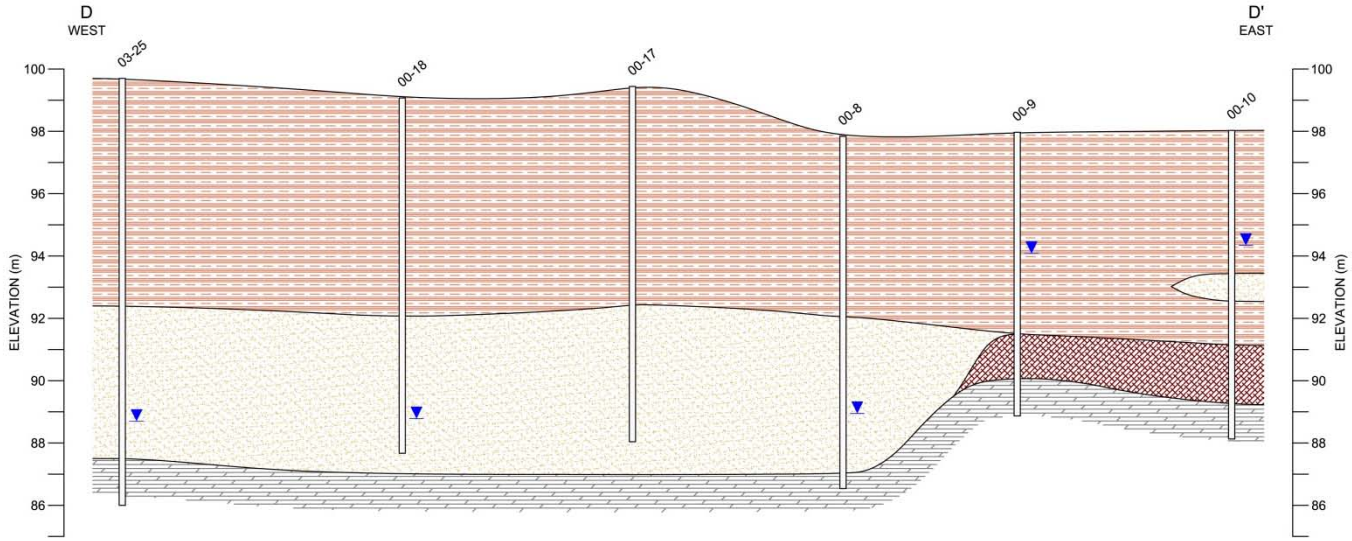
Cross-Sections



Cross-Section 'C-C'



Cross-Section 'D-D'

Legend:

- Clay
- Sand
- Bedrock
- Coal
- Water Level (October 2008)

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MULTI-PHASE EXTRACTION (MPE) PILOT TEST

- Single well extraction pilot test conducted in June 2000 to evaluate the feasibility of using a MPE remediation system to address identified impacts.
- Skid-mounted MPE unit with 7.5 hp vacuum pump blower capable of generating 26” Hg (88 kpa) was utilized.
- Extraction test well (MW00-16A) was located offsite and test duration was approximately 27 hrs.
- Fourteen surrounding monitoring wells were monitored for changes in well headspace vapours, water elevation, and vacuum response.
- Significant vacuum influence and hydraulic connection was established with monitoring wells located up to 130 m away from the extraction test well.

MULTI-PHASE EXTRACTION (MPE) PILOT TEST

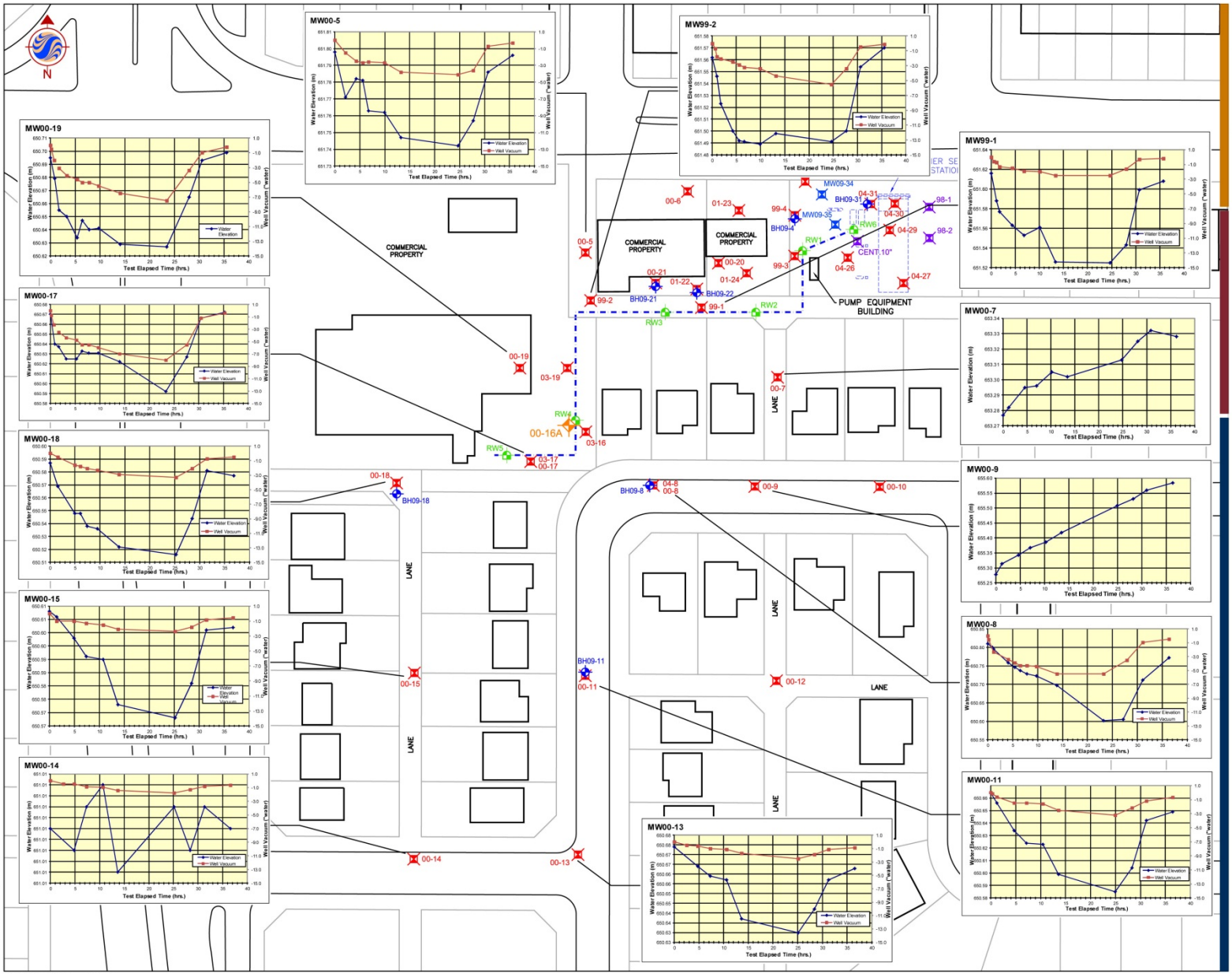
Pilot test equipment set-up. Test well (MW00-16A) in foreground.

Temporary water storage tank.

Typical well headspace vacuum monitoring equipment.

Test equipment location on subject property.

MULTI-PHASE EXTRACTION (MPE) PILOT TEST



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Legend

- Test Well (00-16A)
- Monitoring Well (Stantec)
- Borehole Location (Stantec)
- Monitoring Well (Jacques Whitford)
- Monitoring Well (Sabatini Environmental Inc.)
- Recovery Well Location
- Underground Pump Lines
- Former Facilities
- Building

Note: End of Test 27 Hours

1:1000 0 10 30 50m

Client/Project
FORMER SERVICE STATION
MPE SYSTEM OPERATIONS

Figure No.
1.0

Title
MPE Pilot Test Monitoring Data
July 11 & 12, 2000

September 27, 2011

2011/10/05 12:02 PM By: Kemp, Evan

ORIGINAL SHEET – ANSI B

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MULTI-PHASE EXTRACTION (MPE) SYSTEM INSTALLATION

- Based on the positive pilot test results, MPE system was installed onsite.
  - 20 hp liquid ring vacuum pump, capable of applying high vacuum in excess of 25” Hg
- Five recovery wells (RW1 to RW5) were installed in September 2000.
- Depths of recovery wells ranged from 10.7 mbg to 13.4 mbg.

MULTI-PHASE EXTRACTION (MPE) SYSTEM INSTALLATION

- Trenching was conducted to 1 mbg and 50 mm PVC vacuum lines installed from the system to the recovery wells.
- All vacuum lines were connected to 25 mm flexpipe drop tubes at recovery well location and were brought above ground and capped for connection to the MPE system.

MULTI-PHASE EXTRACTION (MPE) SYSTEM INSTALLATION

- Recovery wells were connected to the pumping system by a series of 50 mm diameter underground horizontal PVC vacuum lines. A 75 mm PVC treated water discharge line was also installed to the City sanitary system.
- Additional recovery well (RW6) installed on-site in 2006 via modification of existing monitoring well.

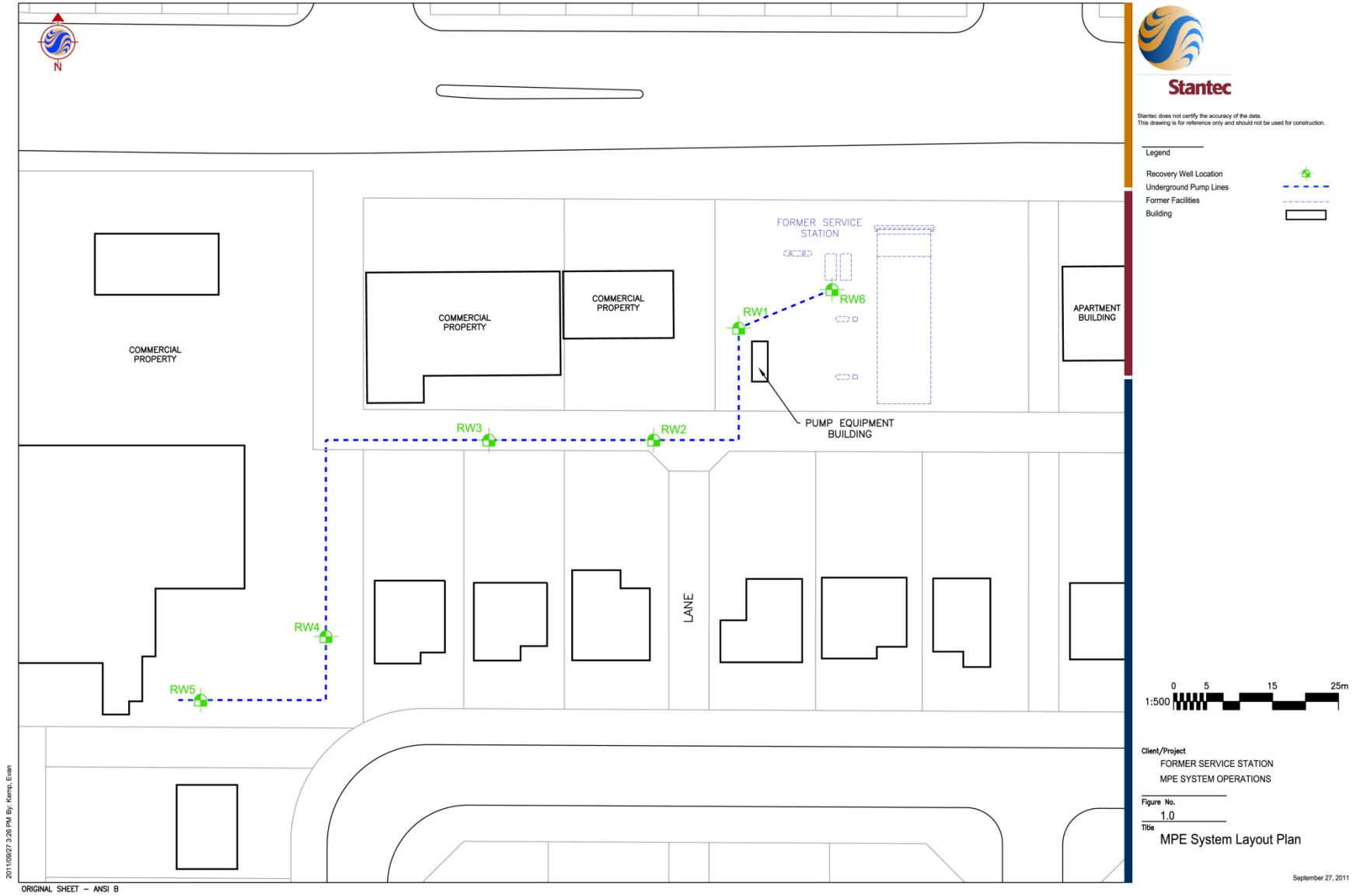
MULTI-PHASE EXTRACTION (MPE) SYSTEM INSTALLATION

- Modified cap installed at each recovery well for vacuum to be applied.
- Typical recovery well completion following installation of protective road box, backfilling and paving.
- Completed extraction well following installation of asphalt surfacing.

MULTI-PHASE EXTRACTION (MPE) SYSTEM INSTALLATION

- Treatment system consisted of:
  - knockout tank
  - bag filter
  - separator/air sparging tank
  - activated granular carbon vessel
  - water discharge to City sanitary system.

MPE System Layout Plan



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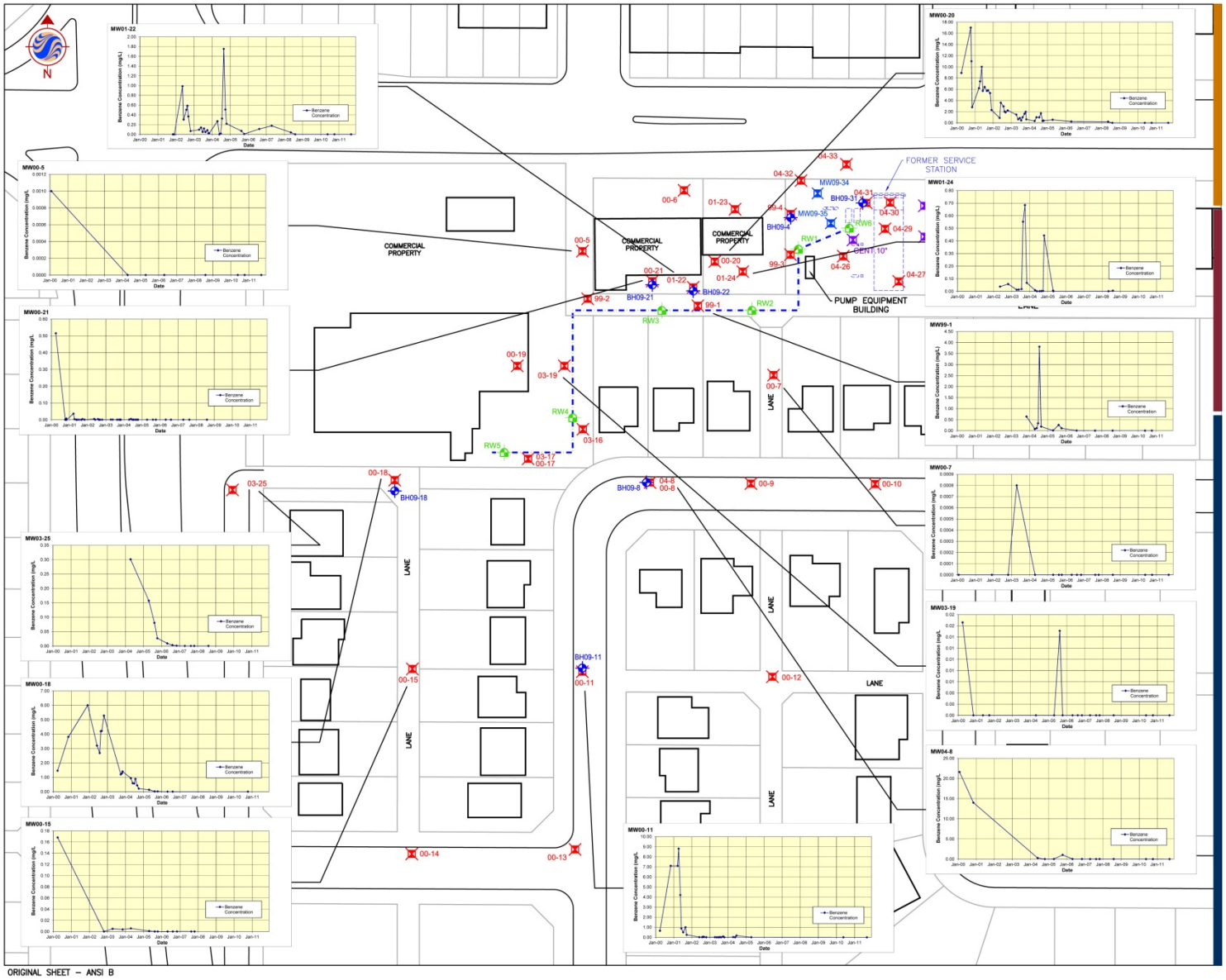
MULTI-PHASE EXTRACTION (MPE) SYSTEM – PERFORMANCE EVALUATION

- MPE system operated seasonally (May to November yearly) following installation to address PHC impacts.
- System operated from September 2000 to August 2008.
- System was converted to soil vapour extraction (SVE) mode during winter months.
- Average PHC vapour recovery rate ranged from 0.1 kg/day to 30 kg/day during system operation (2000 to 2008).
- Estimated 3,500 kg of PHC was removed as vapour by the system.
- Average groundwater extraction rate ranged from 4 L/min to 30 L/min during system operation (2000 to 2008).
- Approximately 17,500 m^3 of affected groundwater was removed and treated.

MULTI-PHASE EXTRACTION (MPE) SYSTEM – PERFORMANCE EVALUATION

- During system operation in 2000 and 2001, LNAPL thickness ranged from 70 mm to 450 mm at MW00-8.
- No LNAPL accumulation in any monitoring wells after one year of system operation.
- Deeper impacts within the sand zone were the focus of the remedial system.
- Significant reduction in dissolved PHC levels observed in offsite wells.

Changes in Groundwater Quality



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1:1000 0 10 30 50m

Client/Project
FORMER SERVICE STATION
MPE SYSTEM OPERATIONS

Figure No.
2.0

Title
Post System Groundwater Analytical Benzene Results Comparison

September 27, 2011

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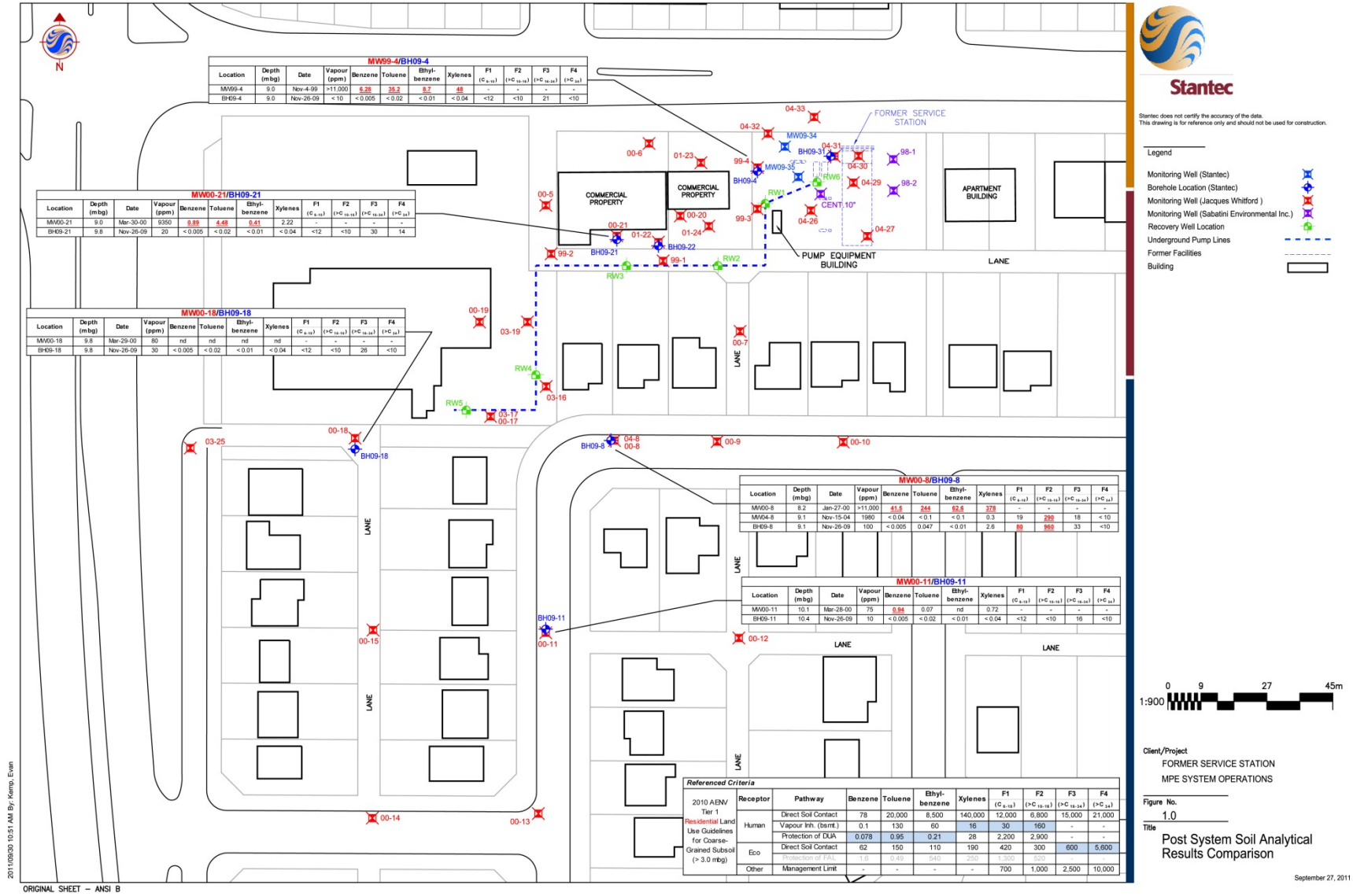
MULTI-PHASE EXTRACTION (MPE) SYSTEM – PERFORMANCE EVALUATION

- In August 2008, a detailed system reassessment was conducted to re-evaluate the effectiveness of continued MPE system operation.
- Single well extraction test periods using a combination of recovery wells and monitoring wells.
- Reassessment results indicated low hydrocarbon removal rate of 0.01 L/day to 0.24 L/day, which were considered too low to justify continued operations.
- MPE system discontinued in August 2008.
- Re-assessment of soil conditions in 2009 indicated significant reduction in PHC levels in soil and groundwater offsite.

Changes in Soil Quality



CURRENT STATUS AND FUTURE PLAN

- Onsite shallow impacts remain in the source area (fuel storage tank) where fine grained soils above the sand zone continue to exceed guidelines.
- Offsite impacts (soil and groundwater) remain at one localized area southwest of the site.
- Soil vapour extraction (SVE) system currently being utilized onsite to mitigate fugitive soil vapours.

CONCLUSIONS

- Success of the MPE system operations was mainly attributed to the following factors:
  - Strong hydraulic connection across site area due to site area lithology where the sand zone was vertically confined above and below with clay till and shale bedrock respectively.
  - In addition, the sand zone was laterally confined along the southeastern extent of the impacts due to the presence of relatively impermeable fine-grained soils.
  - Contaminants of concern were light-end hydrocarbons.

QUESTIONS?

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