Use of Screening Tools to Quickly and Efficiently Update the CSM at a CN Site

Presented by Robert Noel de Tilly

October 24th, 2017

19th RAILROAD ENVIRONMENTAL CONFERENCE

Presentation Outline

- Site History
- Initial Conceptual Site Model (2015)
- Use of Screening Tools to Quickly and Efficiently Update the CSM
- Updated Conceptual Site Model
- Path to moving Forward
- Conclusion

Site History

- Since 1994, a series of studies have been carried out on a CN site.
- The studies help in understanding the problem with chlorinated VOCs
- This problem seems to have been observed in the old diesel shop, since 2005
- The source of chlorinated VOCs appears to have been located in areas where the degreasing operations of equipment, at the periphery and inside the old diesel shop, were carried out
- In September 2015, WSP Canada Inc. was mandated to manage the chlorinated solvent issues at that property.
- CN’s goal is to resolve the issues related to chlorinated solvents, in the short to medium term
- CN wants to use an aggressive strategy to resolve the chlorinated solvent related issues

Objectives of the project

Initial

- Ensure the protection of downstream drinking water wells and the eventual closure of this site (resolve the chlorinated VOC related issues)
- Provide a relatively aggressive management plan for the chlorinated solvents.

Panel 2016

- Solicit an informed discussion on the optimal path forward to achieve CN's site specific objectives.

Panel 2017

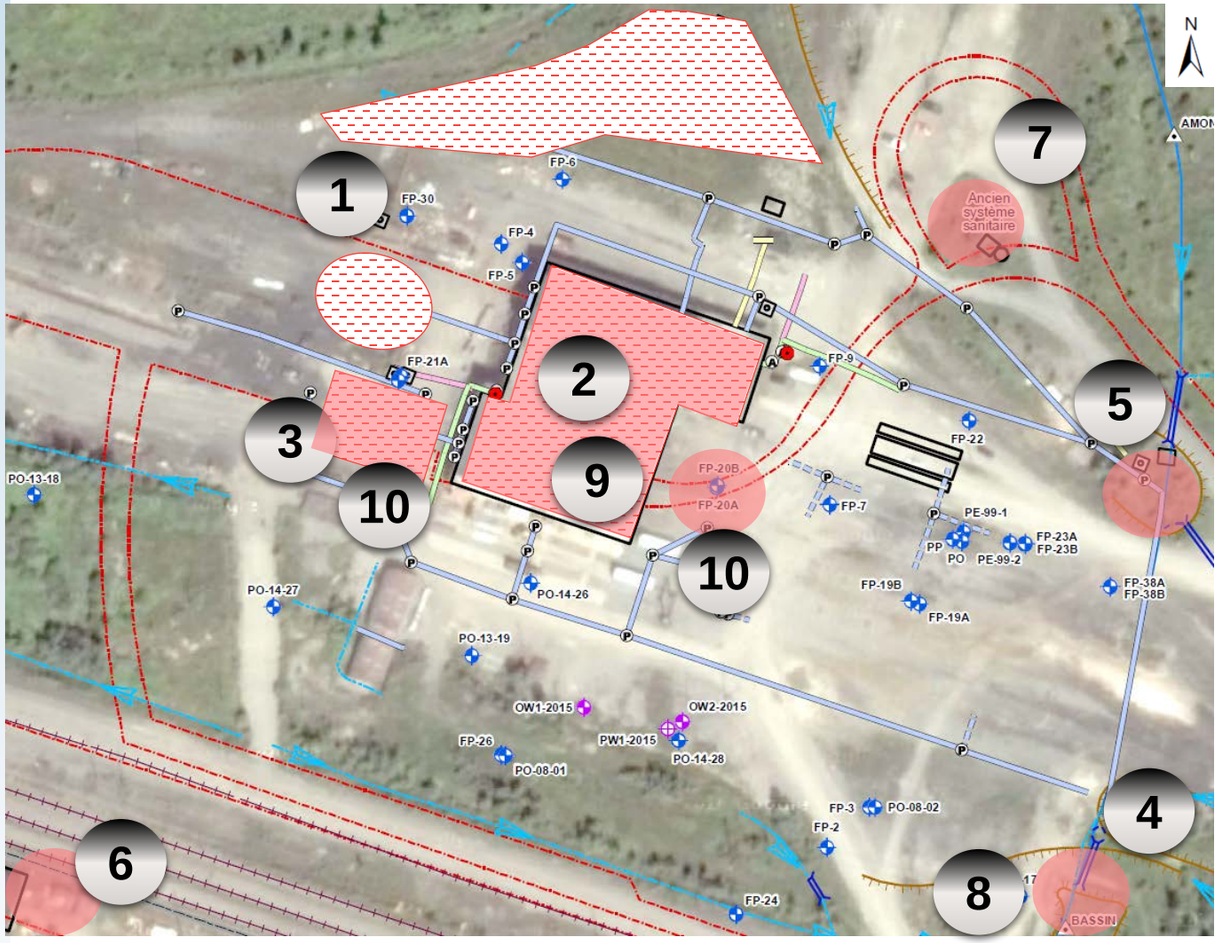
- Solicit an informed discussion on the optimal path forward, in achieving CN's site specific objectives after completing recommended investigation activities.

Field Work Completed 2017

Survey	• **Surveyed local and regional features.**
Passive Samplers	• **Installed 131 passive samplers (Gore-Sorbers) in the presumed source areas.**
VOC PID	• **Performed a site-wide gas survey using a PID with 11.7 eV lamp to detect vapours at subsurface access points.**
MIP / "HPT"	• **25 MIP screening surveys completed in the source and plume areas to a maximum depth between 4m and 15m.** • **The HPT data did not produce adequate results.**

Initial Conceptual Site Model (2015)

Chlorinated Solvent Sources from Historical Records



Source: WSP 2016

Previously identified sources

Newly identified sources, specific to chlorinated VOCs

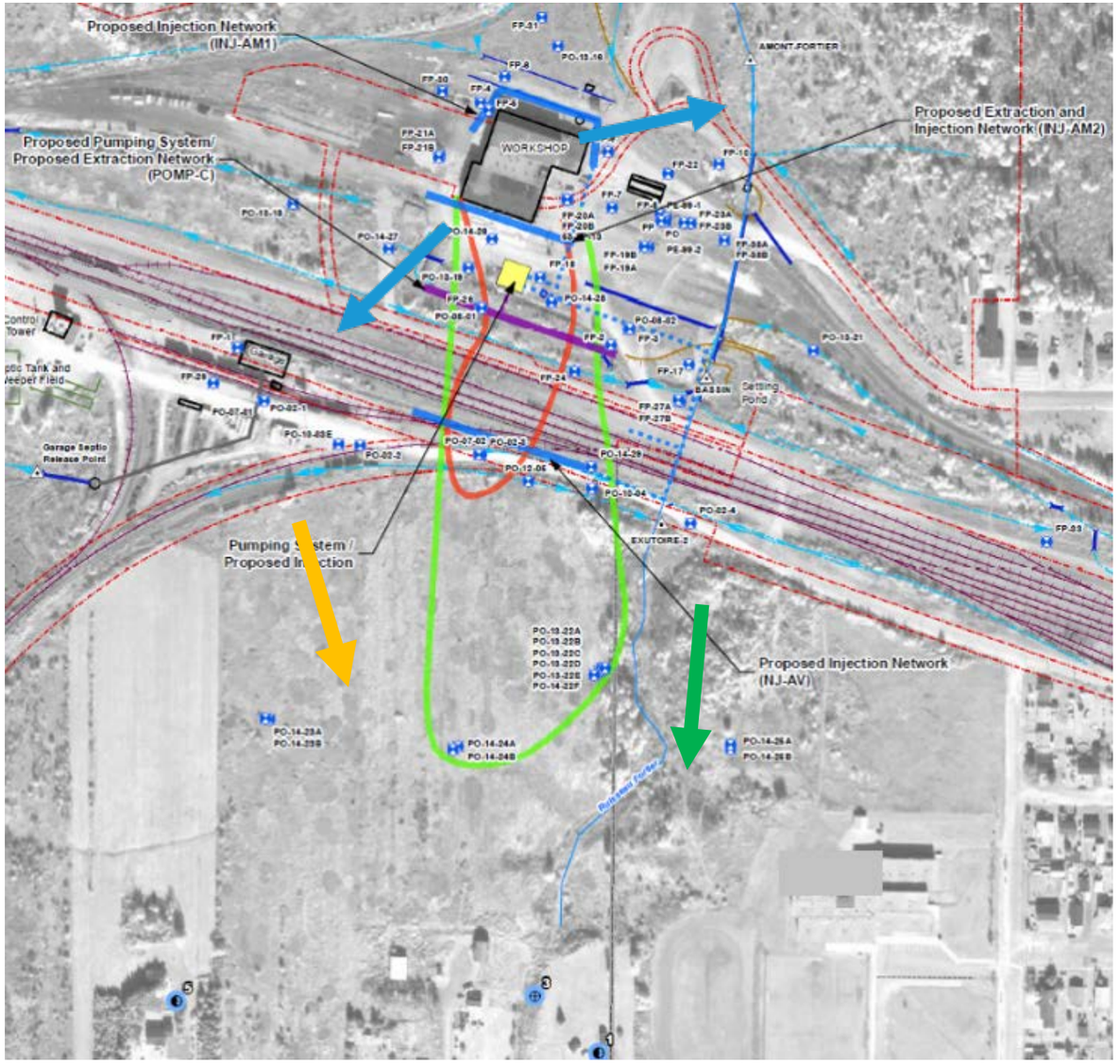
Sources of chlorinated VOCs identified in historical reports:

1. Storage area for contaminated soils generated from washing activities (hydrocarbons)
2. Locomotive washing area
3. Axle washing area
4. Settling pond
5. Release point for the northern branch of the drainage system
6. Garage (2 septic drains and used solvents)
7. Historical sanitary system
8. Release point for the southern branch of the drainage system
9. Topographic depression in the native clay horizon
10. Axle washing area

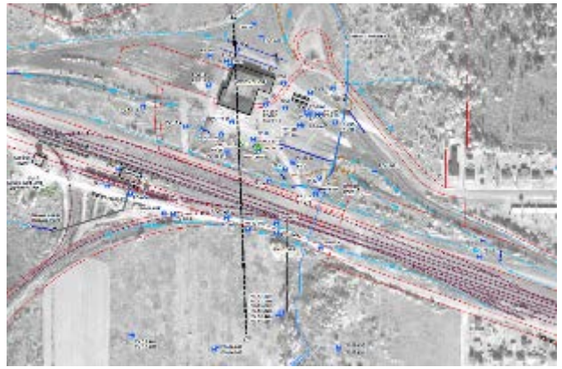
Initial Conceptual Site Model (2015)

- Conceptual Site Model
- Geology (next slide)
- Hydrogeology
- Chlorinated VOCs
- Pathways and Receptors

Surficial Flow Direction	→
Clay Flow Direction	→
Confined Granular Aquifer Flow Direction	→
Concentration of chlorinated VOCs greater than drinking water criteria	○
Concentration of chlorinated VOCs greater than threshold limits for drinking water criteria	○

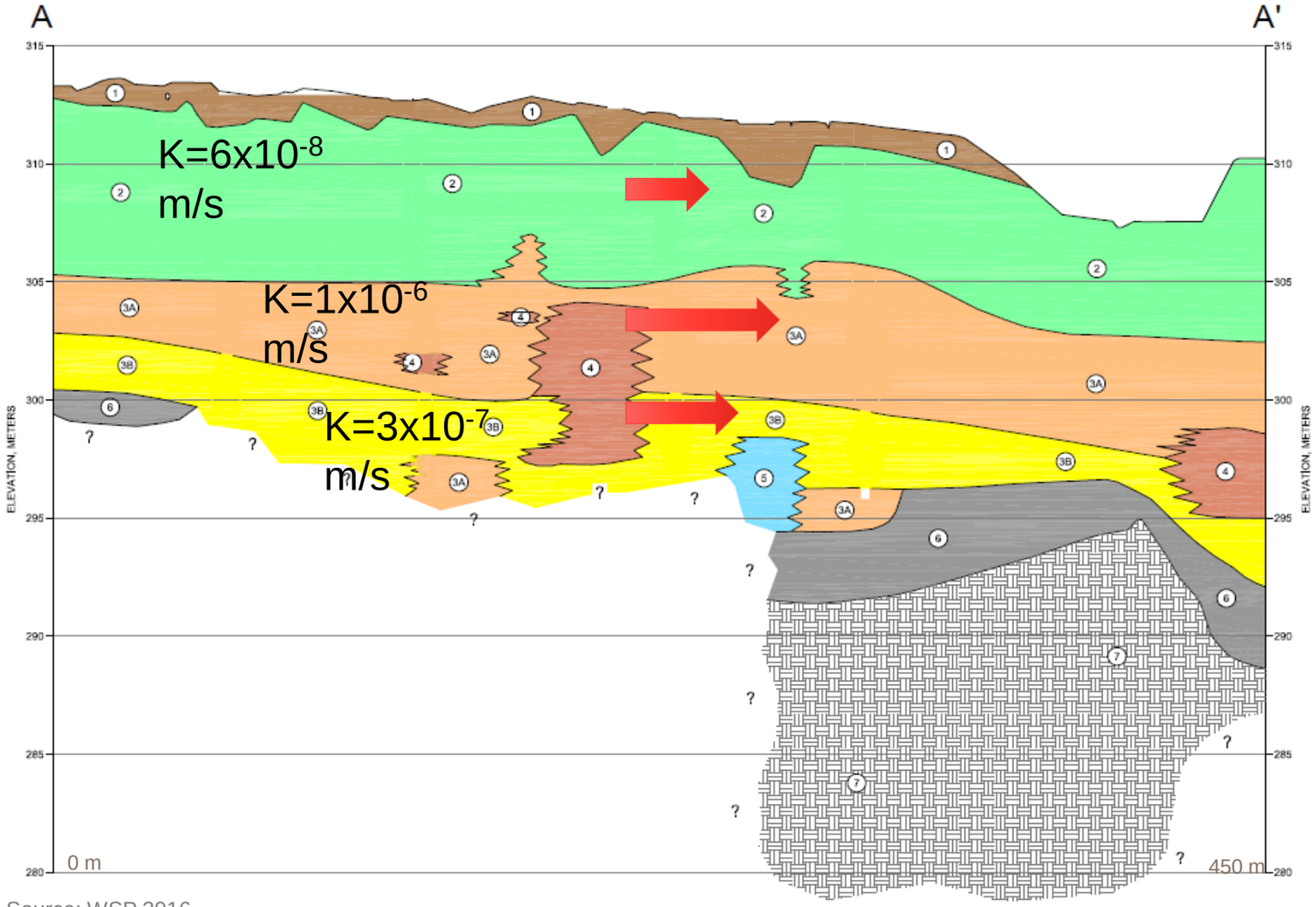


Conceptual Site Model: Geology and Hydrogeology



Stratigraphy

1. Surficial Soil, Composition varies between sand and gravel or silty clay
2. Clay or Silty Clay
3A. Sand and Gravel, Loose to compact
3B. Sand and Gravel, Dense to very dense
4. Silt, Variable sand composition
5. Sand and Gravel, Pockets of silt
6. Sandy Silt or Silty Sand, Dense
7. Rock



Source: WSP 2016

Data Gaps

- A technical review panel was held at CN on March 31st, 2016
- This technical panel gave recommendations to fill data gaps that were still present on the site
- Data Gaps :
  - *More information was required to evaluate the chlorinated VOC source areas*
  - *Migration pathways of contaminants*
  - *Off-Site Issues*
  - *Injection of Amendment Strategy*
  - *General Rehabilitation Strategies*
- Work realized in 2016 was focused on the contaminants' source areas and migration pathways
- Instead of working with conventional methods (drilling, soil and groundwater analysis, etc), screening tools were used to fill the data gaps

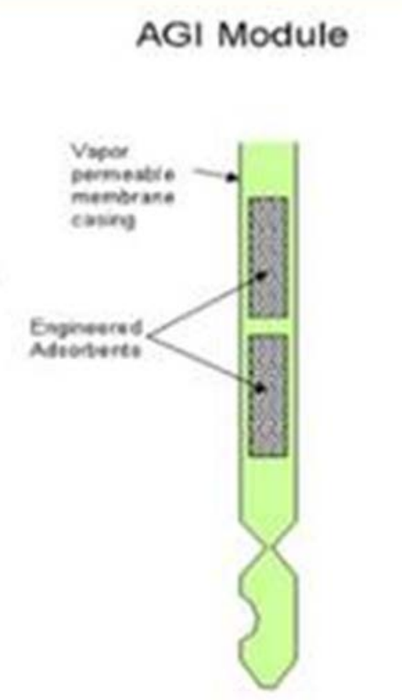
Use of Screening Tools to Quickly and Efficiently Update the CSM

Screening Tools to Identify Chlorinated VOC Sources and migration pathways

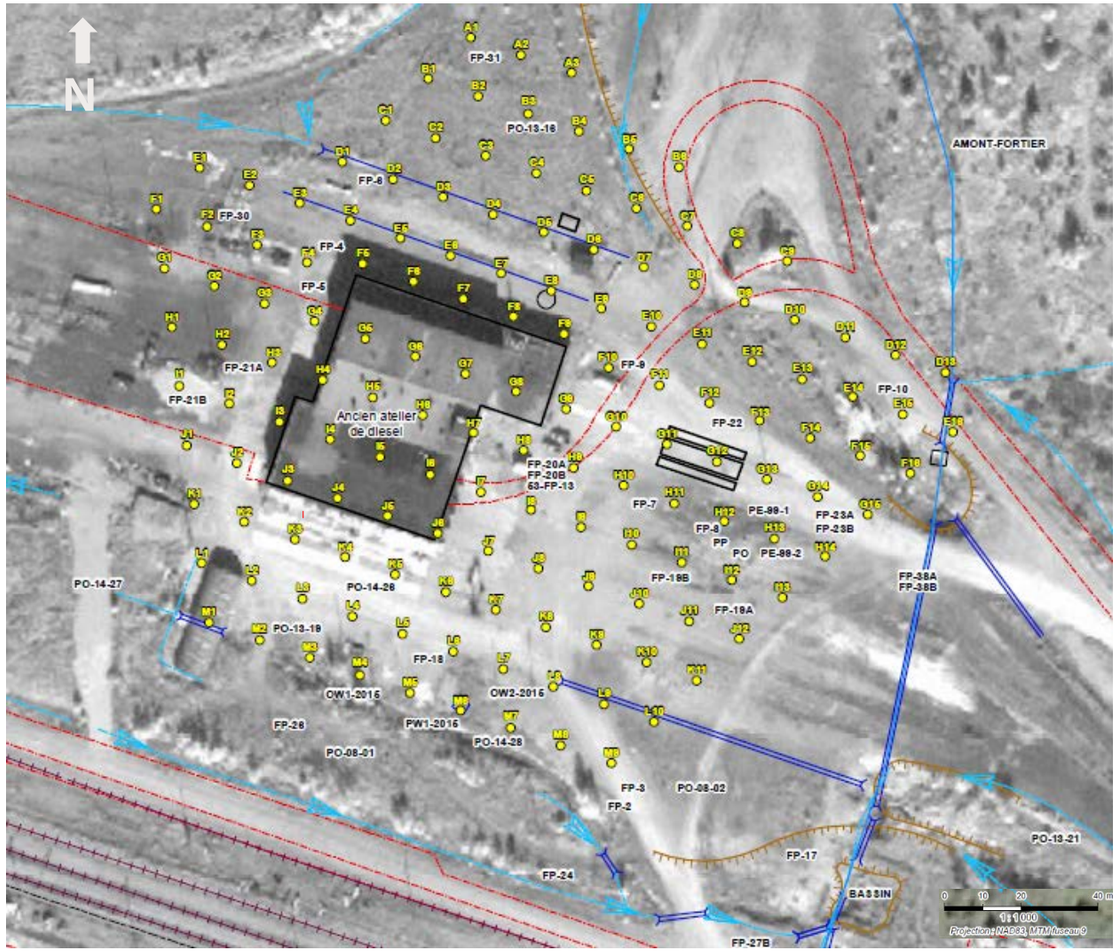
- Various types of surveys were used to identify chlorinated VOC sources at the periphery, and underneath, the old diesel shop
- WSP used the following methods:
  - *The use of passive samplers (Gore-Sorber®);*
  - *Direct readings using a photoionizer (PID);*
  - *Direct-push sinks to obtain readings of "Hydraulic Profiling Tool "(HPT) and" Membrane Interface Probe "(MIP).*

1st Screening tool : Gore-Sorber® (AGI)

- Use of passive samplers to conduct surveys of chlorinated vapors and VOCs in the embankment, clay, surface aquifer and under the building
- The Gore-Sorber® were provided by the "Amplified Geochemical Imaging" (AGI) laboratory
- The installation was planned according to a 15m x 15m mesh on a 33 000 m² surface area
- The installation of the passive samplers was carried out according to targeted insertions, between 2.0 and 3.0m deep, or to the saturation point
- The samplers were installed using a 203.0 mm hollow auger drill type "Diedrich D-50“
- Once the Gore-Sorber® were put in place, a rope was attached to the ring of a cork stopper, closing the boreholes
- Out of the 36 parameters analyzed, five parameters (111TCA, 11DCE, 11DCA, c12DCE, TPH) were selected according to their representativeness



Gore-Sorber® (AGI) Installation

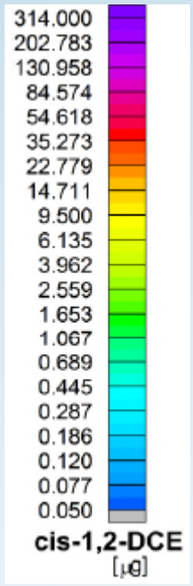


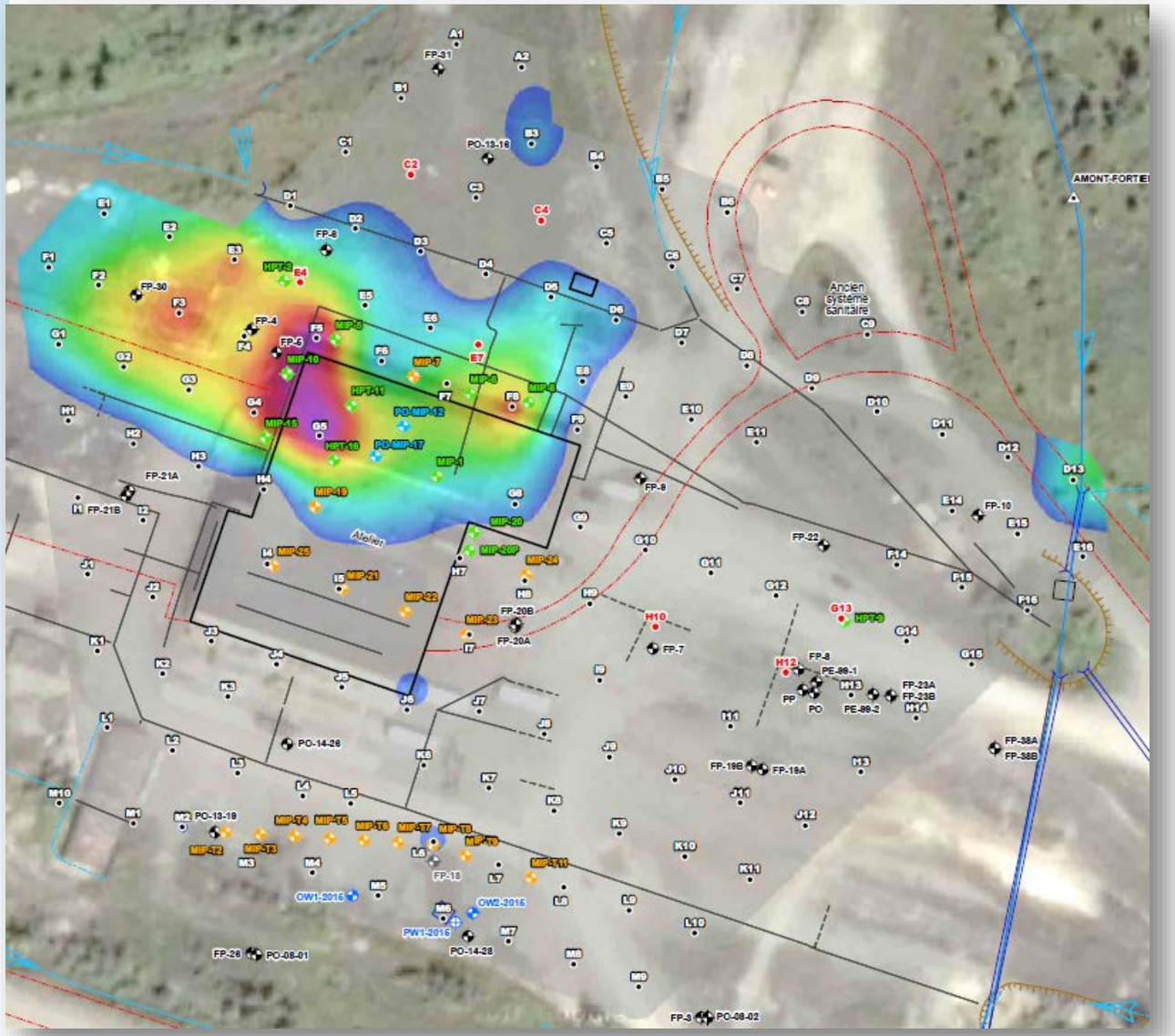
- 131 Gore-Sorber® installed
- 15m x15m survey grid with an approx. area of 33 000 m2
- Samplers were installed at the top of the saturated zone in the fill layer (~2,0-3,0 m).
- Sample transfer to AGI for analysis
- Screening samplers detected accumulated mass, but not concentration
- Detected parent and daughter compound distribution
- Out of the 36 parameters analyzed, five parameters (111TCA, 11DCE, 11DCA, c12DCE, TPH) were selected according to their representativeness

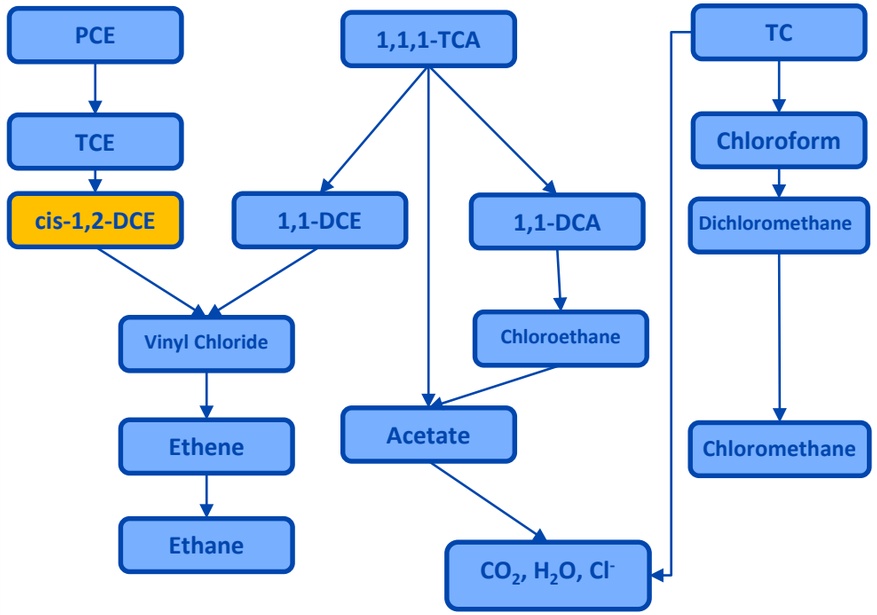
Scale

Results: Gore-Sorbers Cis 1,2-DCE

Cis 1,2-DCE

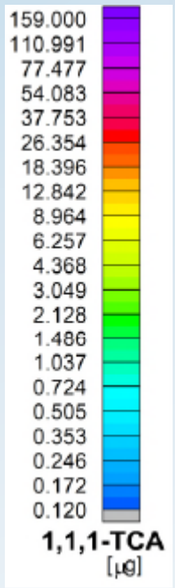


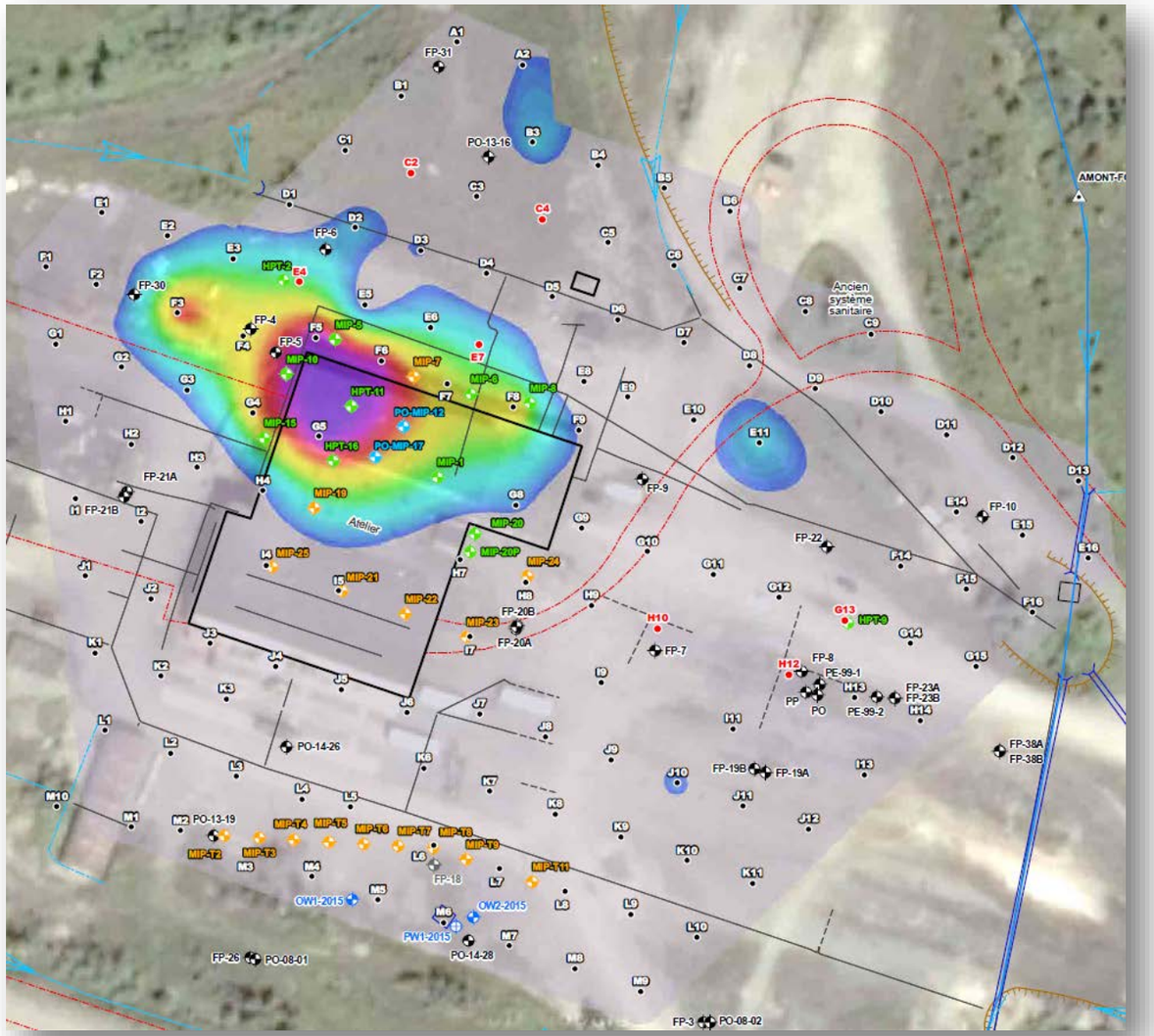


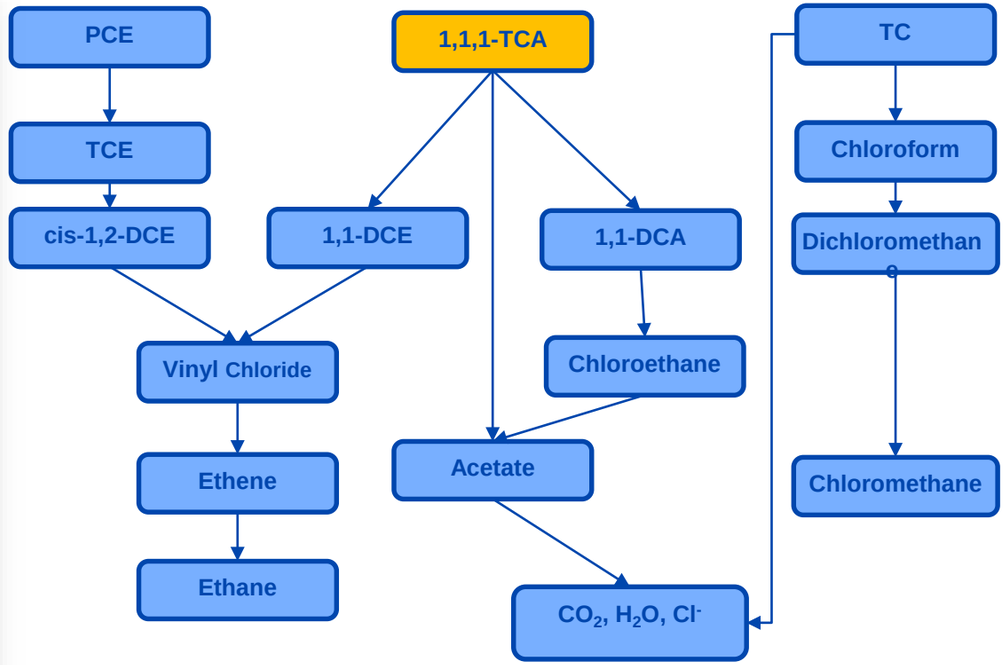


MAX	314 µg
MIN >0	0,02 µg
N >0	36

Results Gore-Sorber® 111-TCA

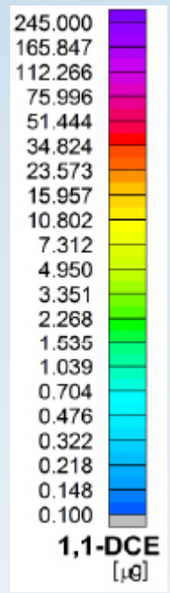


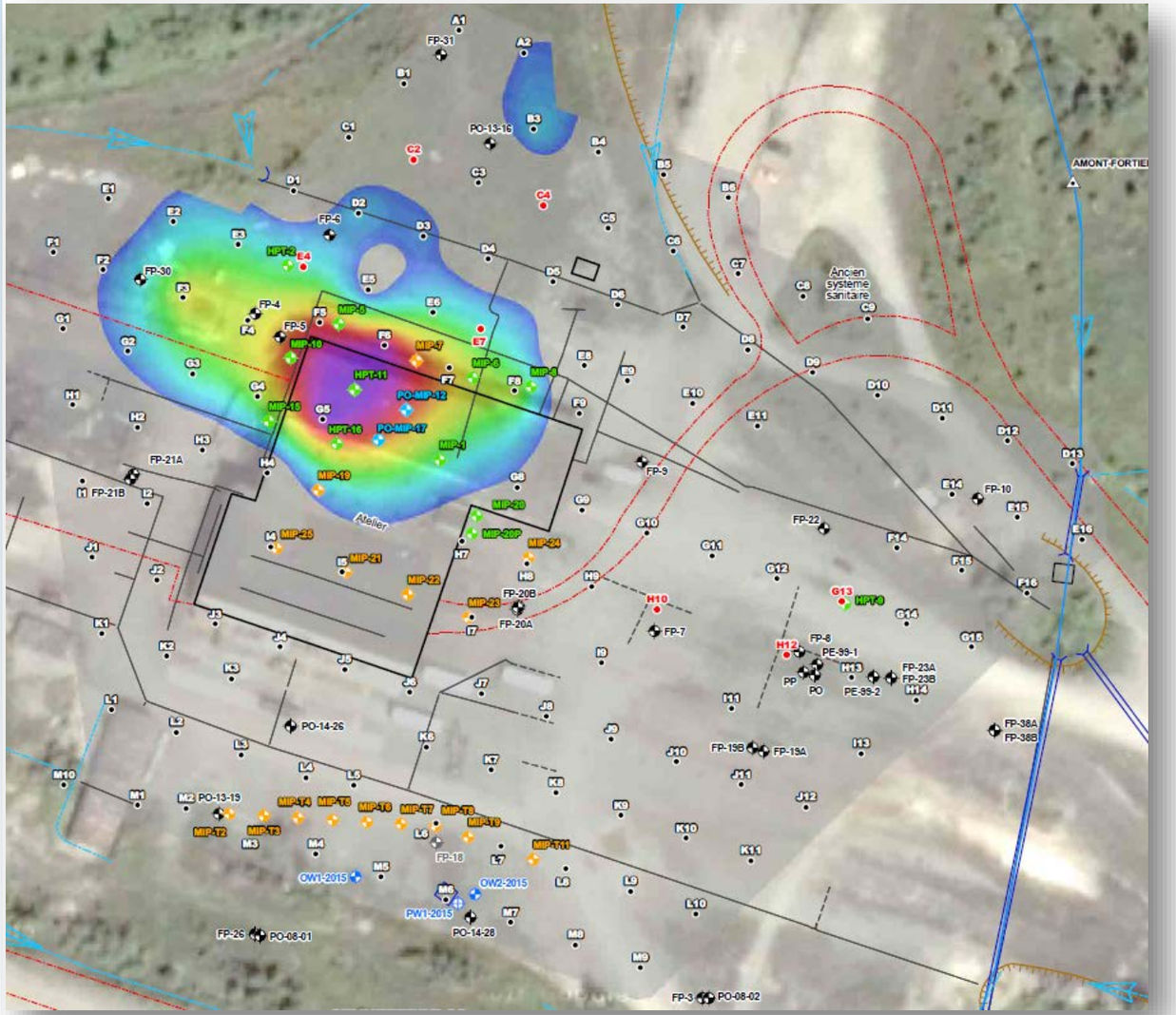


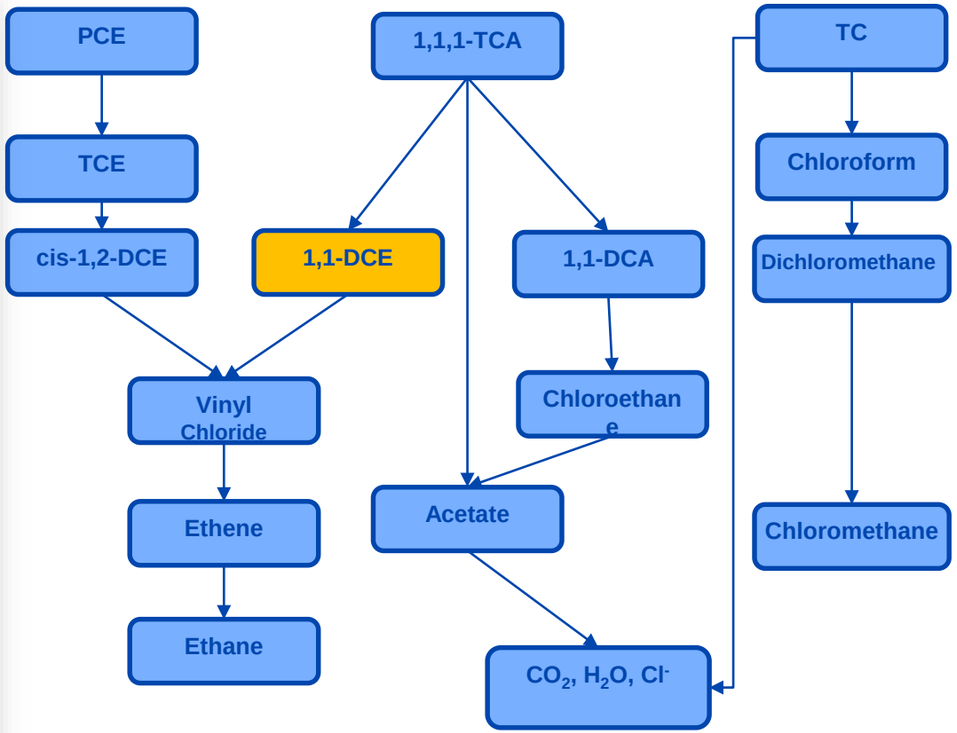


MAX	159 µg
MIN >0	0,02 µg
N >0	71

Results: Gore-Sorber® 1,1-DCE

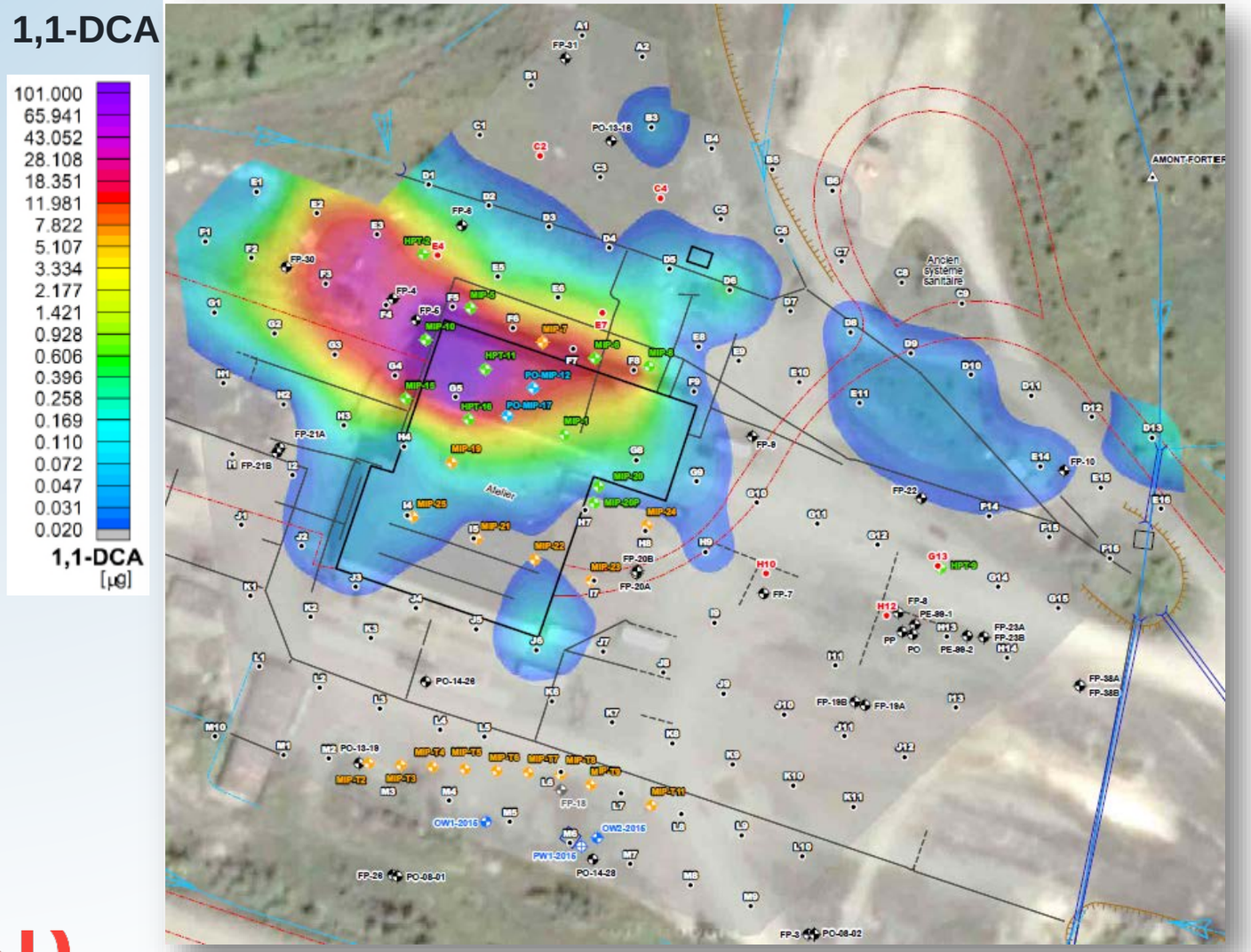


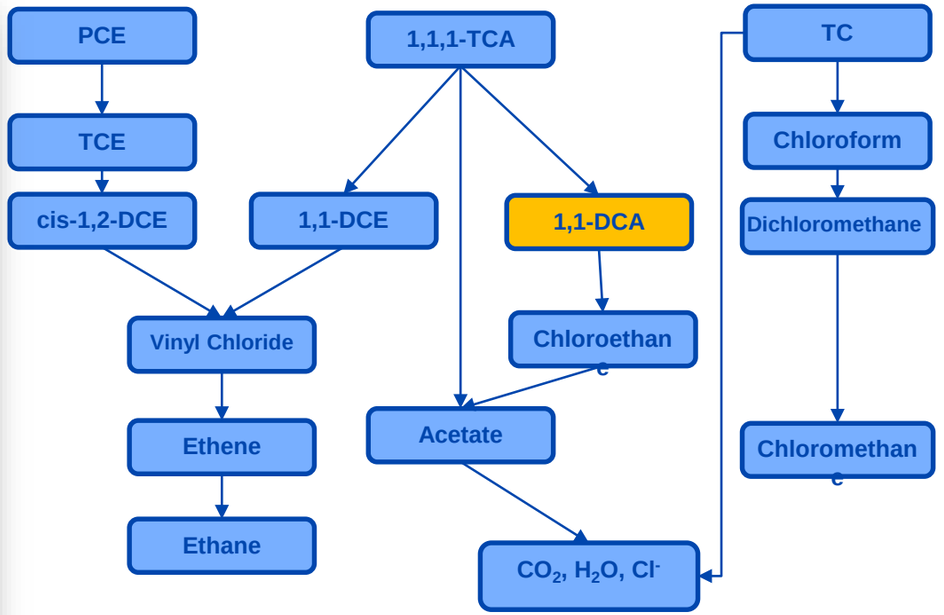




MAX	245 µg
MIN >0	0,02 µg
N >0	53

Results: Gore-Sorber® 1,1-DCA





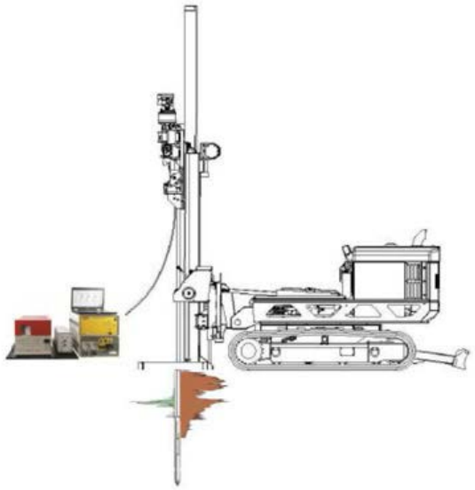
MAX	101 µg
MIN >0	0,02 µg
Nombre >0	45

Other Parameters Analyzed

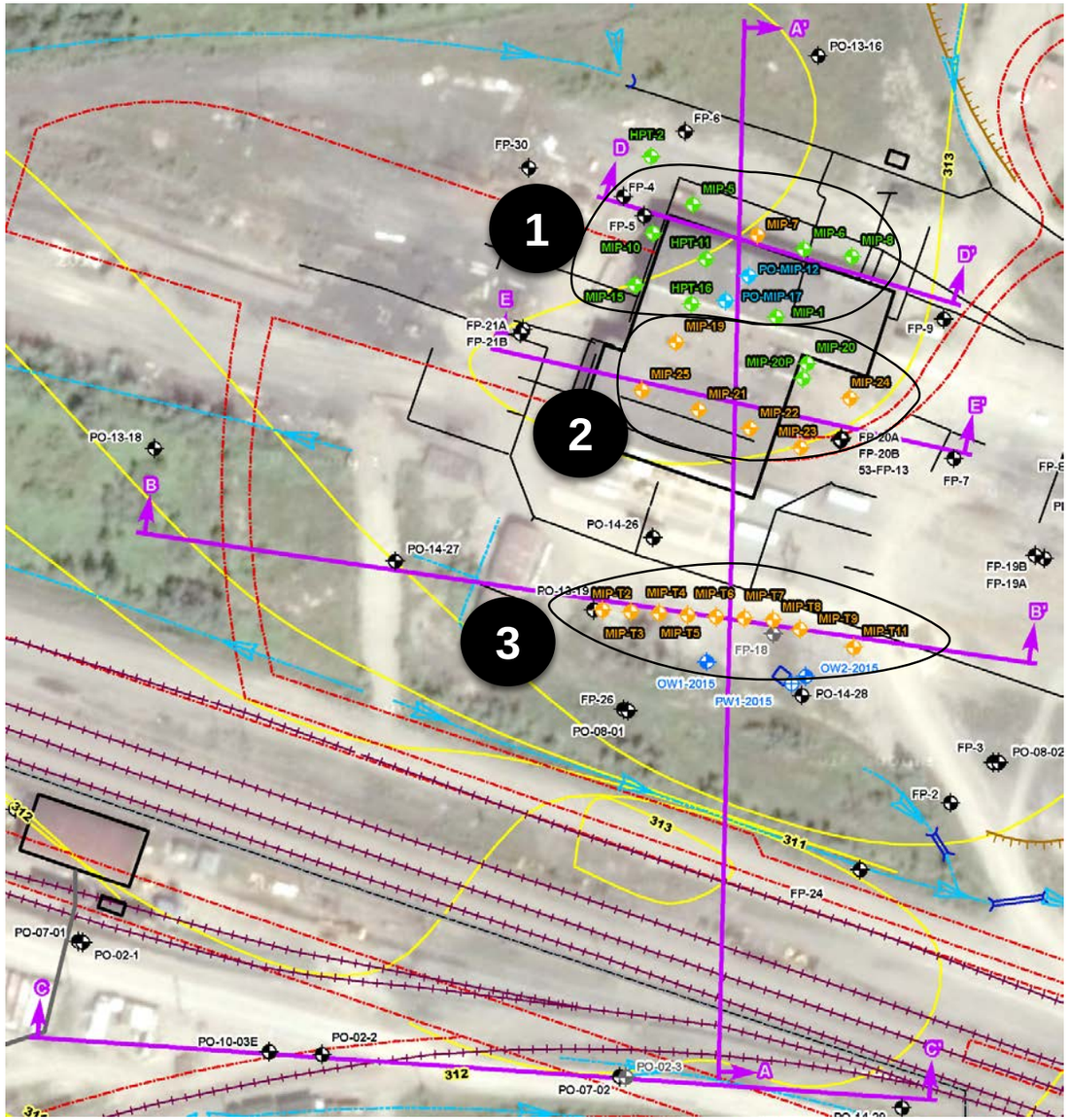
Cis 1,2-DCE
TPH

2nd Screening : MIP (Membrane Interface Probe)

- Source areas for chlorinated VOCs were measured using MIP (Membrane Interface Probe) with Geoprobe's direct-push technology
- The MIP sensor detects volatile contaminants with the combination of several probes including PID and XSD:
  - *PID detects aliphatic and aromatic hydrocarbons at about 0.5 to 1 ppm detection in all types of soil.*
  - *The XSD detects halogenated compounds (ie, TCE, PCE) at a detection limit of about 250 ppb.*
  - *Responses are recorded in microvolts*
- Reading graphs show the relative concentration of chlorinated VOCs as a function of depth (MIP-XSD)
- In addition, it can collect electrical conductivity (EC) as a function of the depth, which gives an indication of the type of soils the probe is getting through
- The fieldwork was carried out by pressing with a Geoprobe 7822CDT drill, by Technofor, with a Vertex MIP

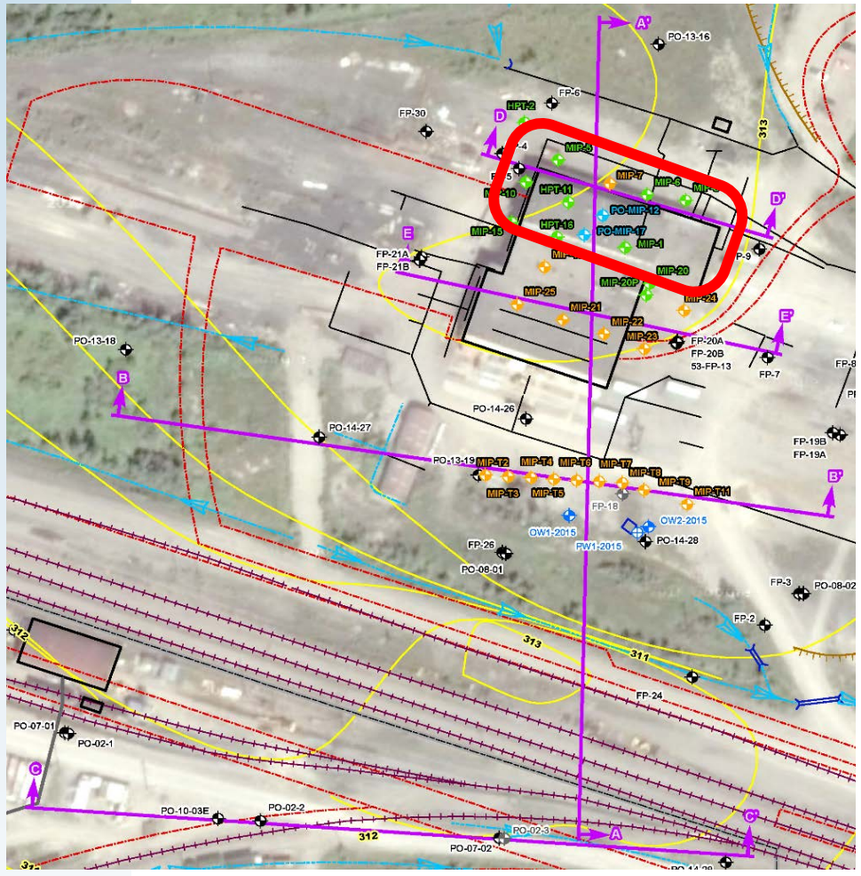


MIP Location

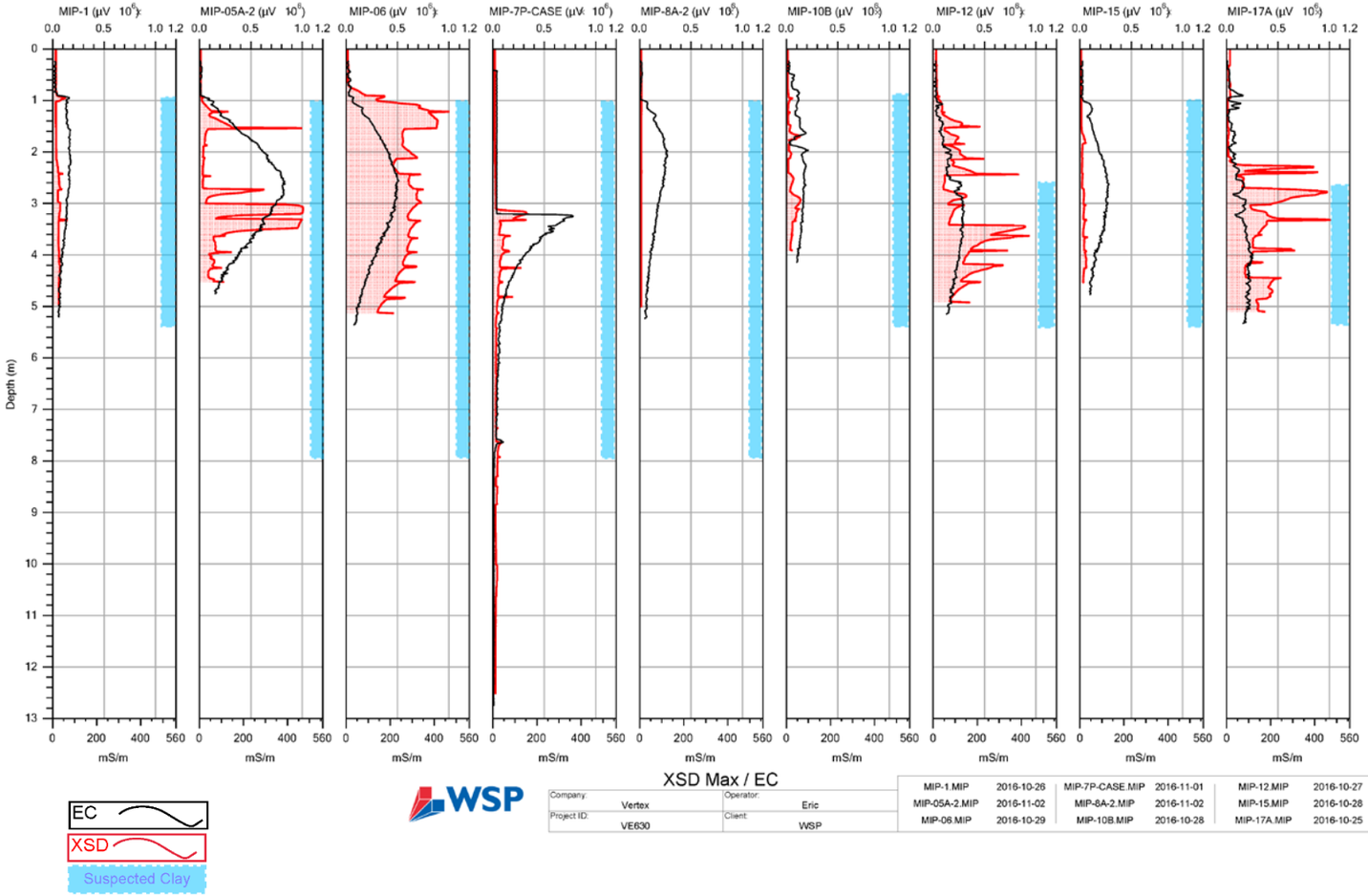


- Locations were chosen based on:
  - *GoreSorber® results (1,1-DCA) around the building for values greater than 3,34 µg*
  - *Direction of suspected plume in confined aquifer in the south portion of the building*
  - *Direction of suspected plume in confined aquifer downstream of the building*
- 17 drill holes in the old diesel shop area 1 2
  - *reaching depths of approximately 4 to 14 m*
- 9 holes on a nearly 75 m transect 3
  - *reaching depths of approximately 8 to 16 m*

MIP Results – Building sector

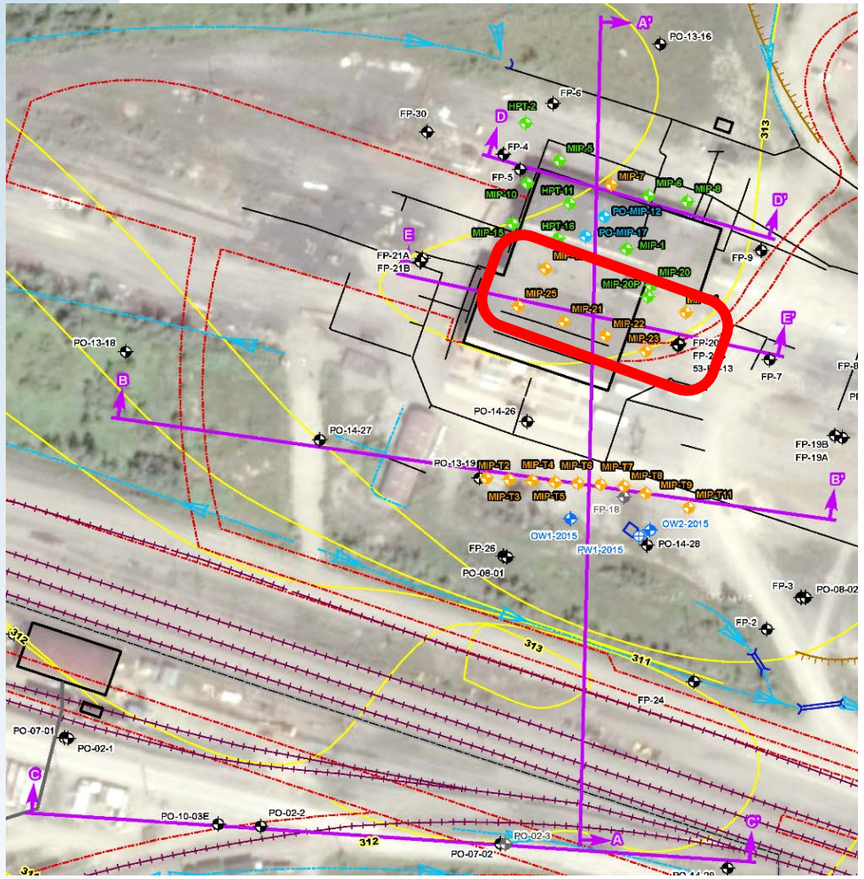


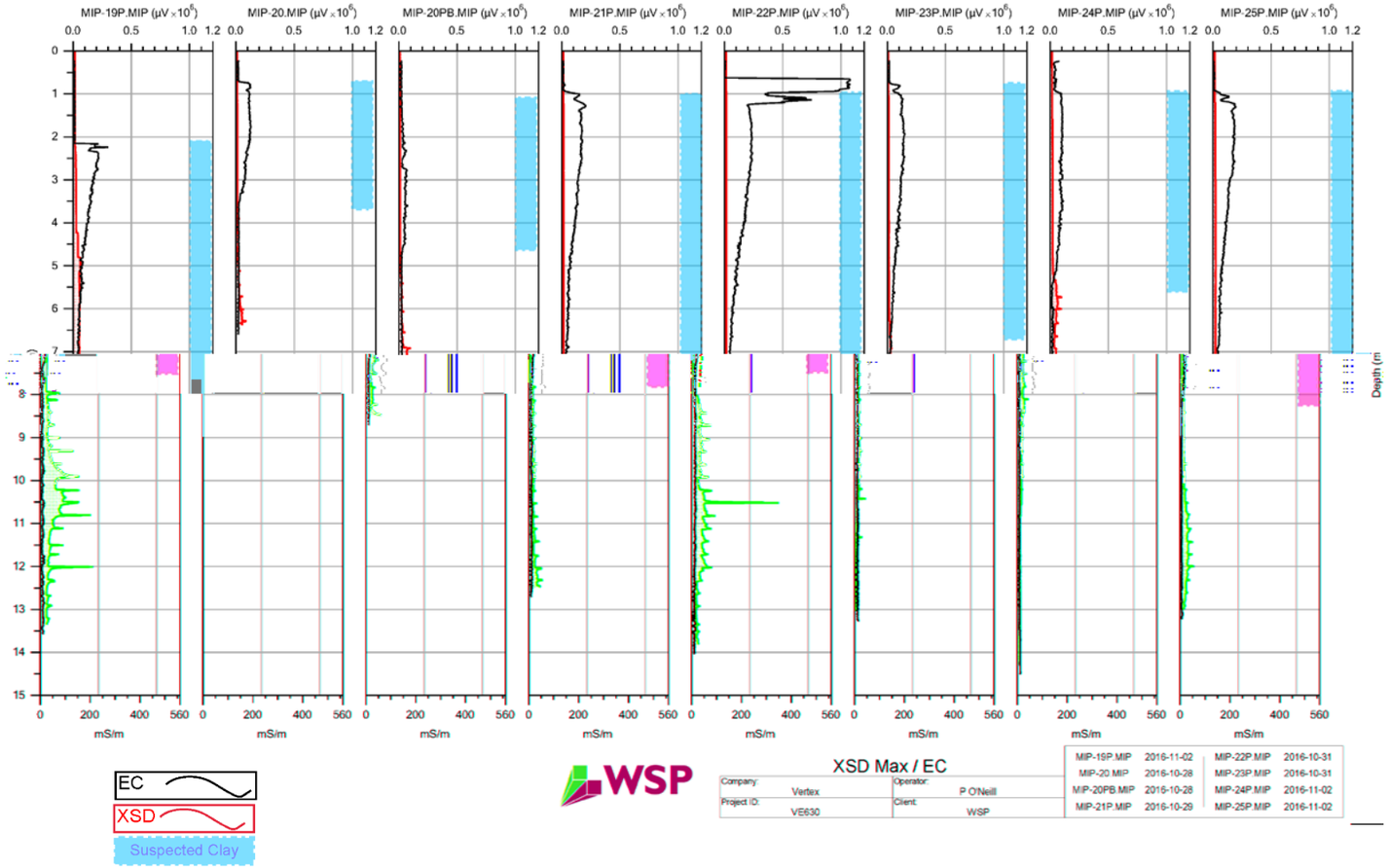
	MIP-1	MIP-5	MIP-6	MIP-7P	MIP-8	MIP-10	MIP-12	MIP-15	MIP-17
Depth reached (m)	4,983	4,526	5,135	12,527	5,013	3,916	4,922	4,541	5,105
Max (µV)	143 208	1 007 950	1 006 043	329 371	18 616	138 401	937 758	73 397	1 008 637
Depth max val. (m)	3,322	3,109	1,219	3,185	0,792	2,926	3,627	3,658	3,322
Min (µV)	27 696	13 886	13 047	16 633	13 810	11 597	28 459	11 444	8 087
GeoMean (µV)	47 182	75 128	322 929	31 697	15 754	31 722	158 964	24 001	92 649
Median (µV)	51 577	69 811	554 560	28 993	15 336	31 015	195 319	24 949	174 986
N	328	298	338	823	330	258	324	299	336



MIP Results – South of the Building (Transect 1)

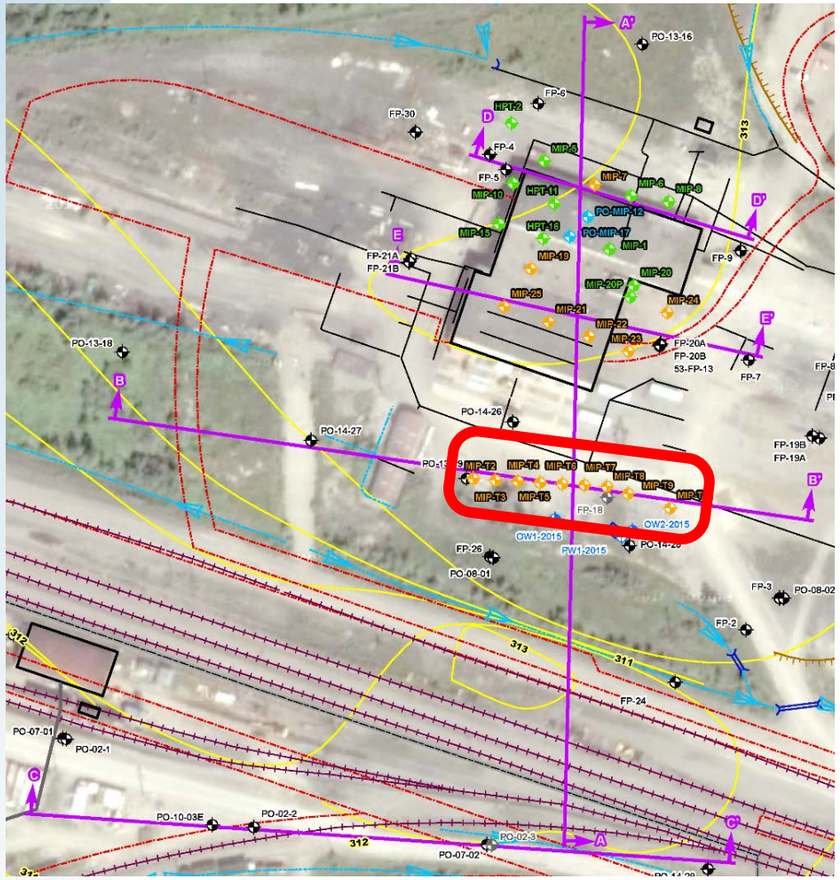
	MIP-19	MIP-20	MIP-20P	MIP-21	MIP-22	MIP-23	MIP-24	MIP-25
Depth reached (m)	13,349	6,37	8,473	12,481	13,807	13,045	14,279	12,999
Max (µV)	450 682	91 479	129 246	118 030	745 796	96 362	102 161	115 284
Depth max val. (m)	12,009	6,294	8,473	12,314	10,516	10,424	5,73	11,994
Min (µV)	15 946	9 308	9 384	12 360	11 673	8 927	15 793	13 810
GeoMean (µV)	47 872	14 921	16 991	22 721	28 764	17 211	26 799	25 293
Median (µV)	53 713	11 750	10 681	16 556	15 412	15 259	21 973	21 783
N	877	419	557	820	907	857	938	854

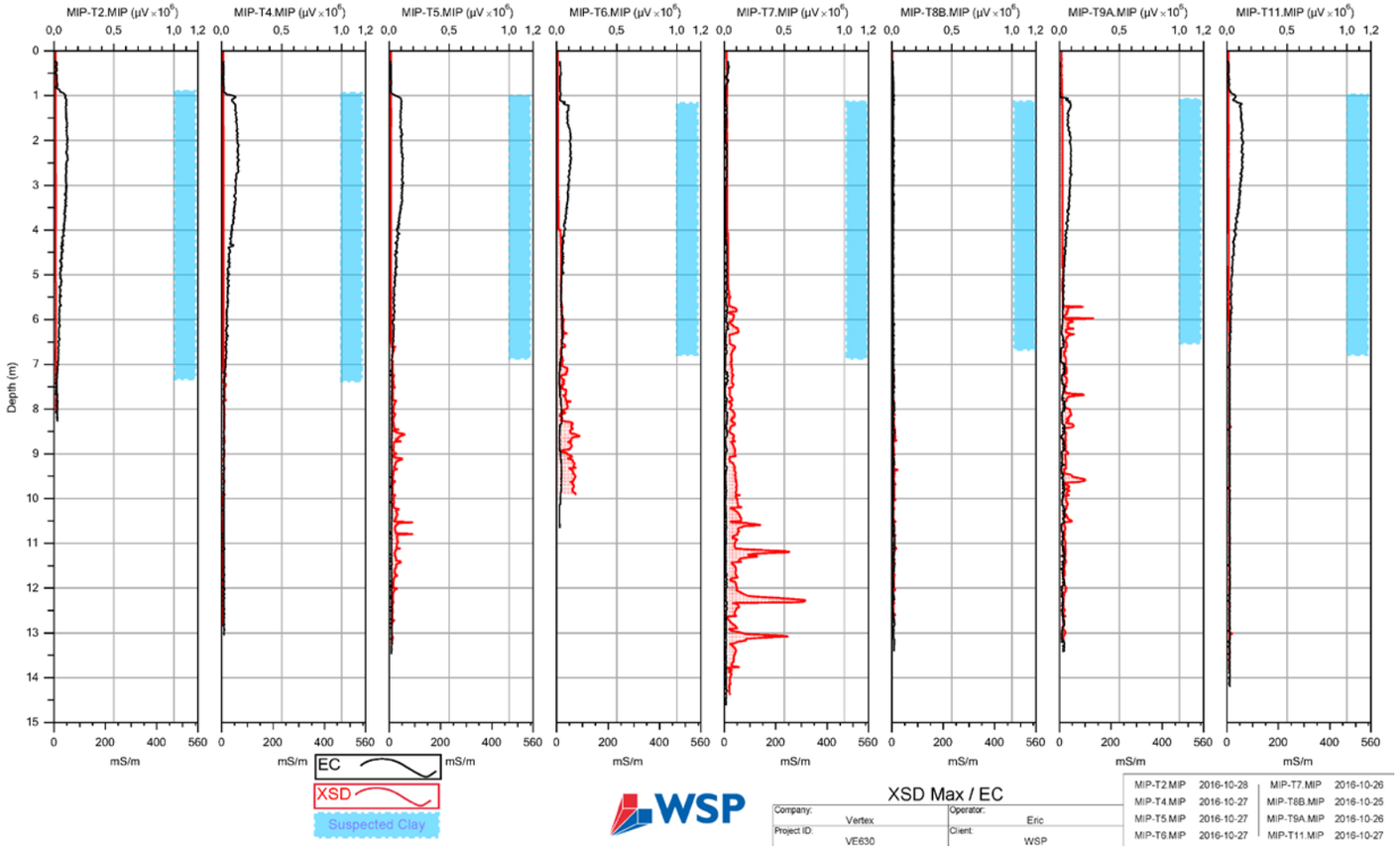




MIP Results – Downstream of the Building (Transect 2)

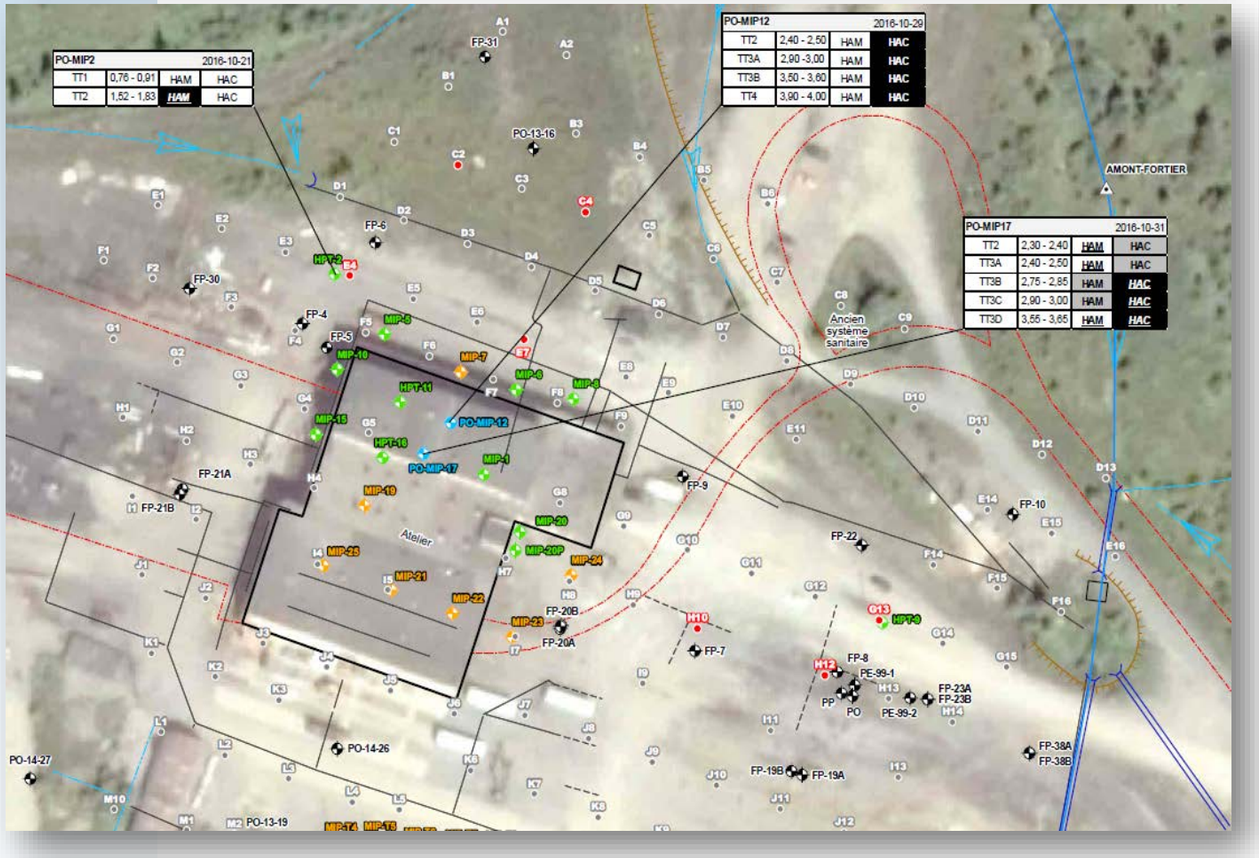
	MIP-T2	MIP-T4	MIP-T5	MIP-T6	MIP-T7	MIP-T8	MIP-T9	MIP-T11
Depth reached (m)	8,046	12,831	13,243	13,243	14,387	13,41	13,197	13,822
Max (µV)	21 592	38 911	196 081	190 283	674 154	49 059	286 569	45 854
Depth max val. (m)	7,422	7,803	10,79	8,595	12,283	9,357	5,974	13,015
Min (µV)	10 987	12 284	12 131	8 469	18 006	5 036	18 235	11 597
GeoMean (µV)	14 057	16 369	23 934	29 639	51 409	9 980	37 429	15 904
Median (µV)	13 962	15 717	21 668	36 927	50 508	9 003	36 546	16 709
N	529	843	870	653	945	839	867	908





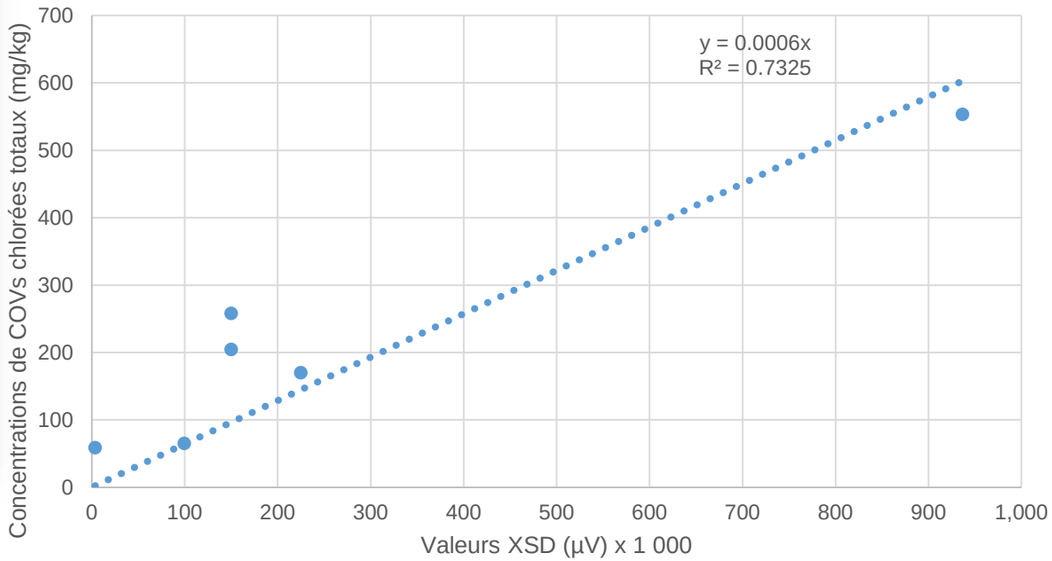
Results: MIP Confirmation Sampling

Soil Confirmation Results



Depth MIP (m)	Sample Depth (m)	XSD Reading (µV)	Soil Result (mg/kg)
2,20	2,30 - 2,35	3 370	58,9
2,45	2,40 - 2,45	99 200	65,3
2,60	2,75 - 2,80	15 000	258,3
2,60	2,75 - 2,80	15 000	204,5
3,55	3,55 - 3,60	225 000	169,9
2,75	2,90 - 2,95	936 000	553,2

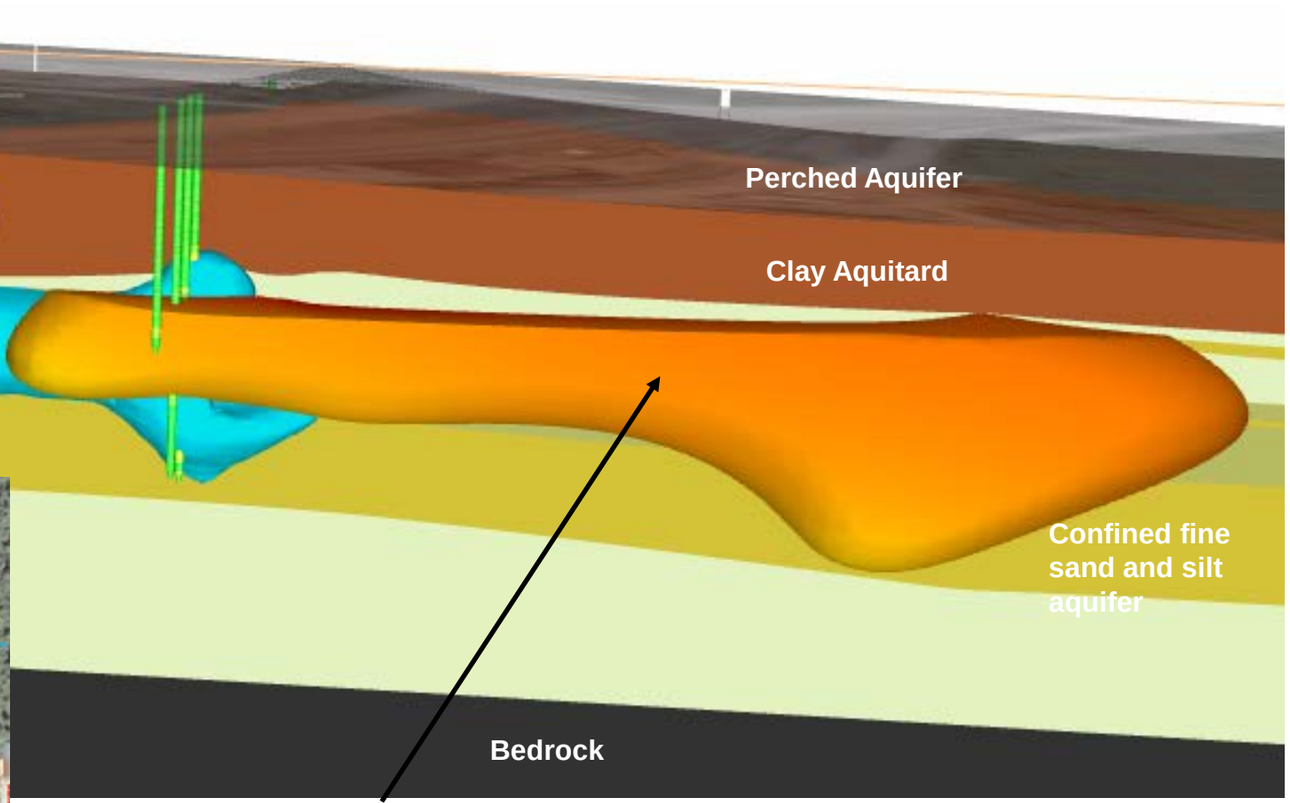
Concentrations of total chlorinated VOCs (mg/kg) in soil vs. XSD (µV)



Updated Conceptual Site Model

Conceptual Site Model: Chlorinated VOCs – Gore Sorber / MIP and Analytical Results

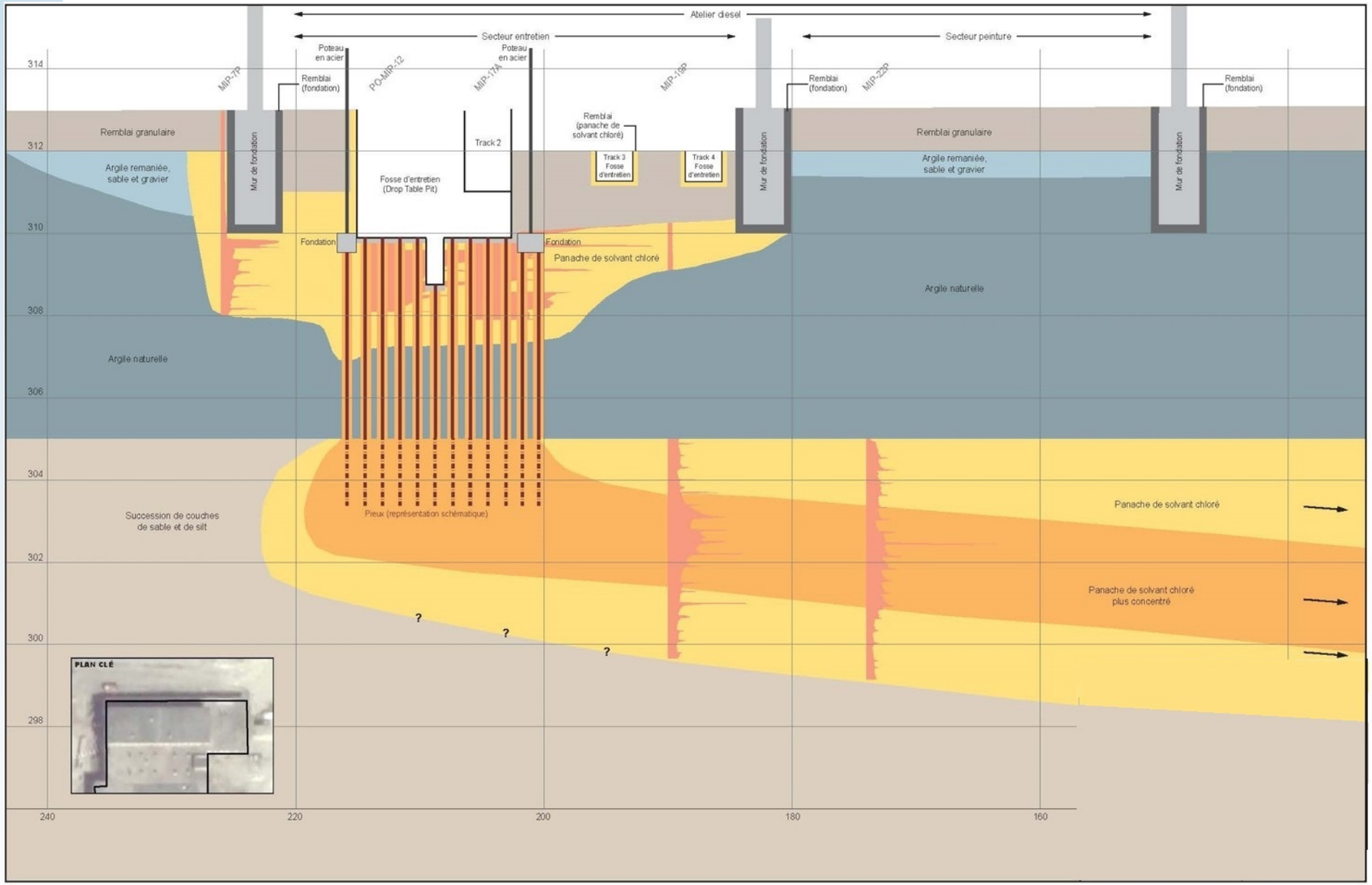
Contaminant distribution based on Gore Sorber / MIP results



Contaminant distribution based on soils and groundwater analytical results
Chlorinated VOCs

Source: WSP 2017a

Schematic section of the conceptual model at the old diesel shop

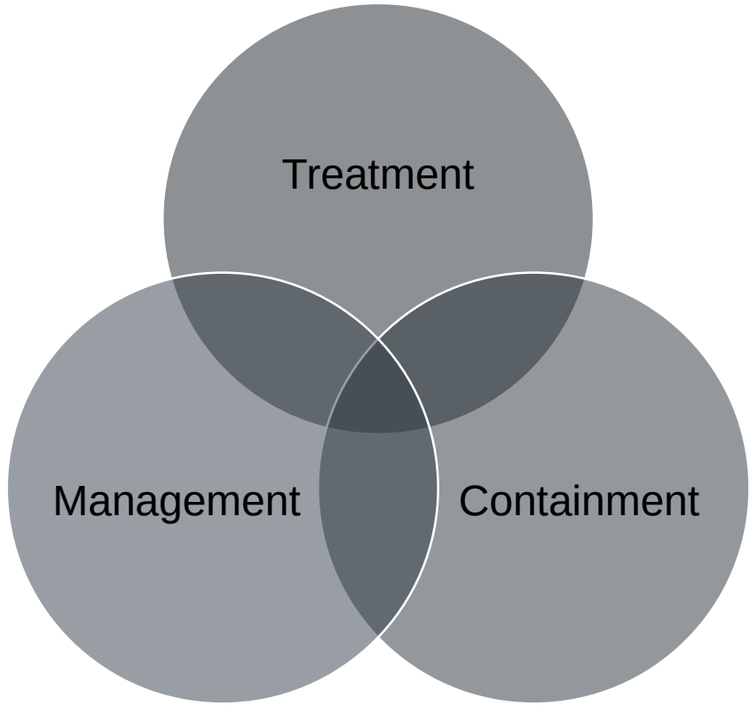


- Support piles assumed to be the important preferential pathway to the confined aquifer
- Contaminants flowed along the pit and piles
- The clay was less dense in this elevation below the shop due it being disturbed
- Flows horizontally to the south within the succession of layers of sand and silt

Path Forward

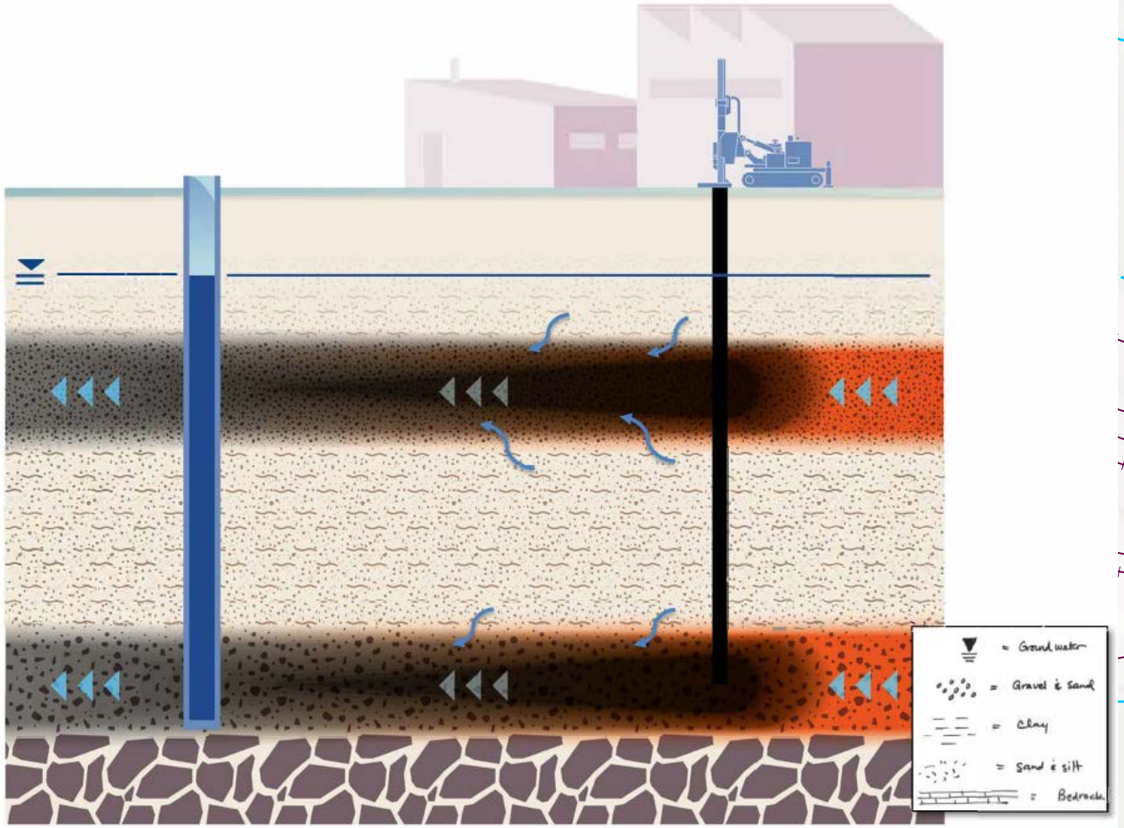
Path Forward – Two options are still under study

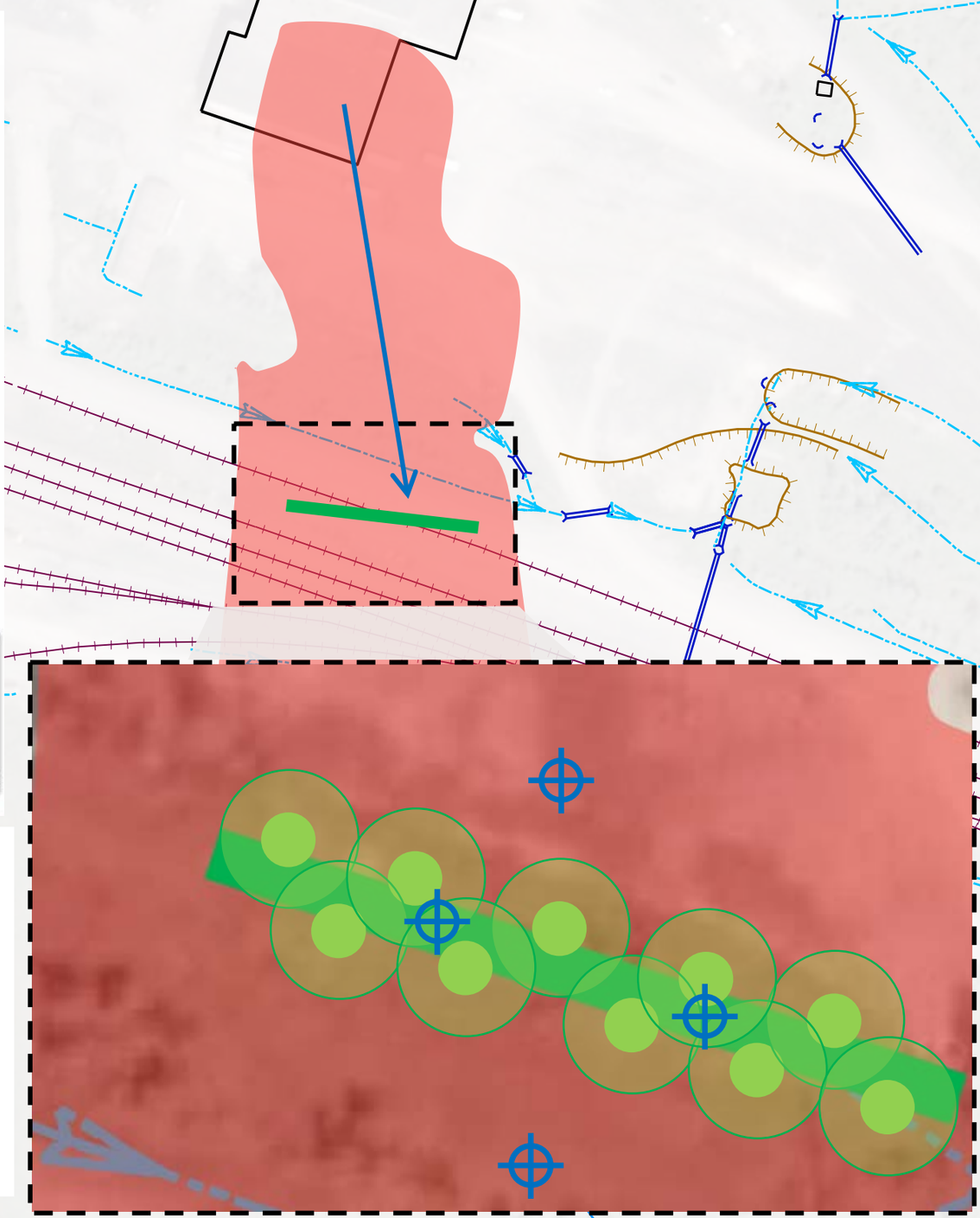
Management	1. Municipal aqueduc connecting downgradient properties
	2. Evaluation of Natural Attenuation
Containment	3. Pile grouting
	4. Hydraulic containment of the source (dewater perched WT)
Mass removal	5. MPX and MNA
	6. BiRD and MNA
	7. ZVI injection through direct-push drilling and MNA
Treatment to the potable criteria (Regulatory compliance)	8. Permeable reactive barrier
	9. Geosierra technology
	BiRD
	ZVI-based amendment



Passive treatment barrier by stimulation of abiotic, biotic and adsorption processes

Passive Treatment Barrier





Legend

- Groundwater flow Direction
- Location of barrier (Pilot test)
- Injection point
- Overlapping effect
- Observation monitoring well

All site features are approximate

Conclusion

Conclusion

- Since 1994, many studies have been carried out on the CN rail yard. The studies help in understanding the problem with chlorinated VOCs
- CN is now looking at solutions to it's problem and wants to move forward with a management / remedial strategy
- Within a few months of investigation work, using screening tool :
  - *a major infiltration source area for the contaminants had been identified*
  - *migratory pathways, through the clay and into the lower confined aquifer, were also identified*
  - *the information allowed for a better defined CSM*
  - *we got a better understanding of what remediation technologies will work best for cleaning up the site*
- The cost of doing these investigations would have tripled by going with conventional methods (drilling, coring, soil and groundwater results, etc.)

Thank you for your Attention and Input