Characterization of Contaminated Groundwater and Remediation Plans in Namphu and Rangbua Subdistricts, Ratchaburi Province, Thailand

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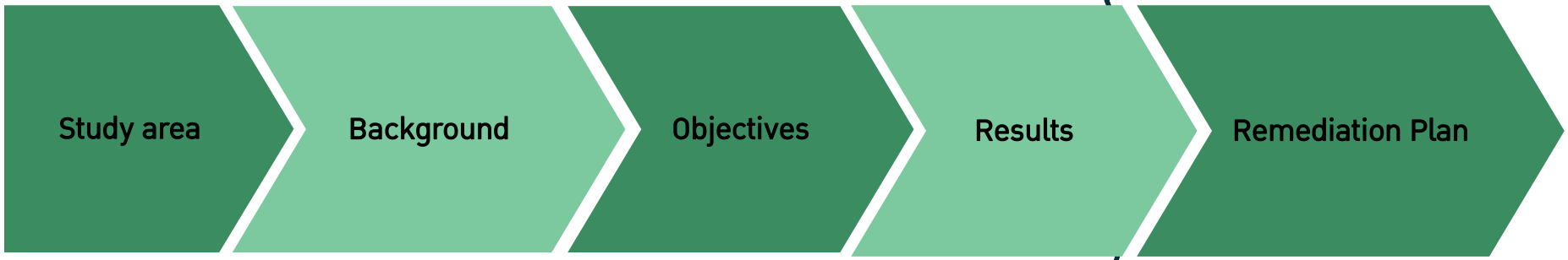
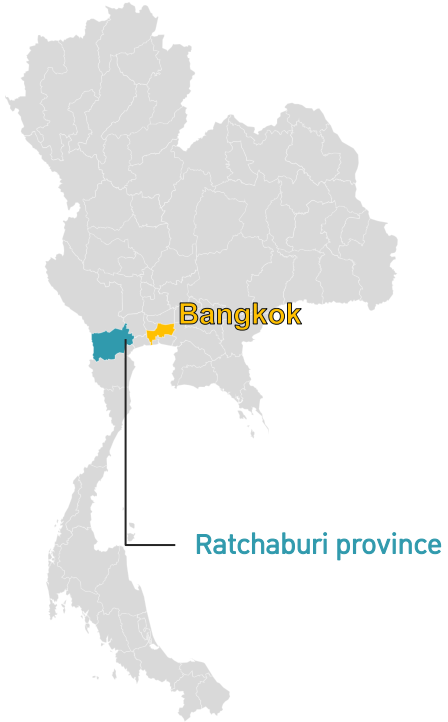
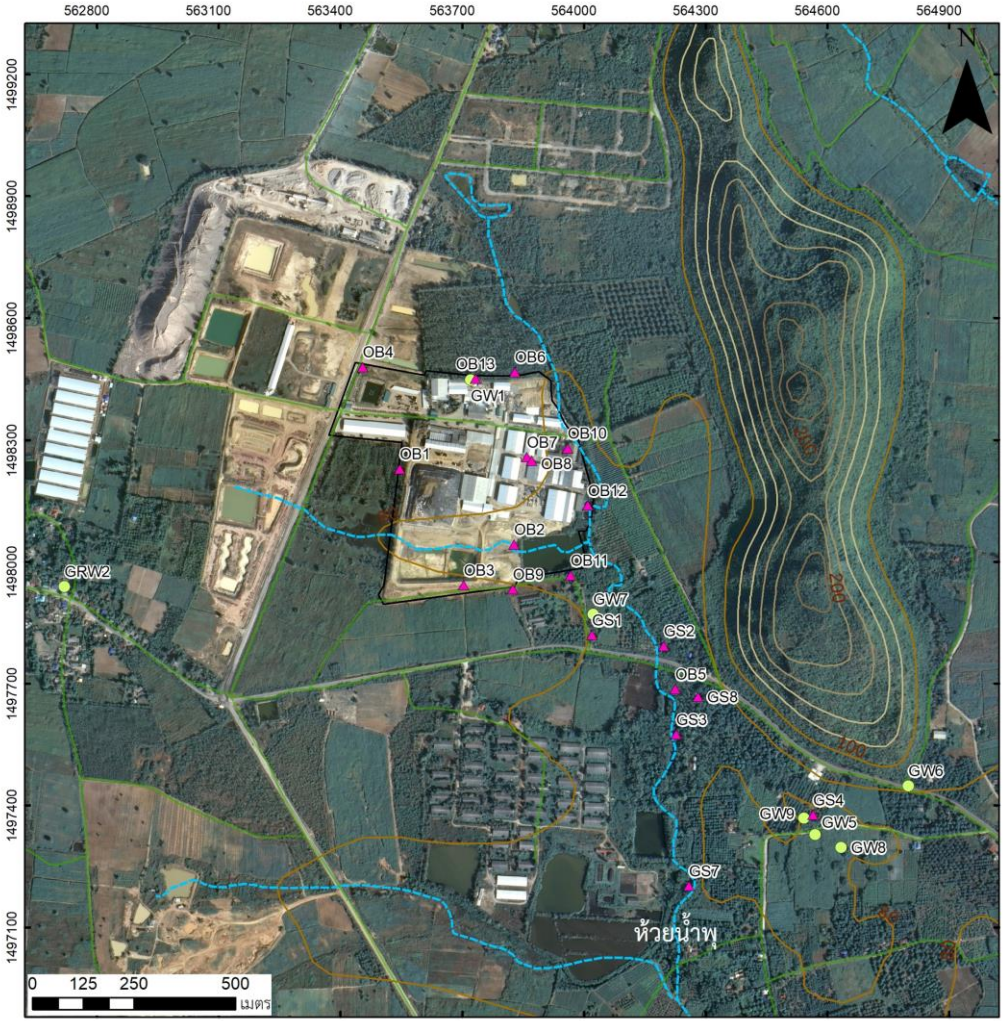
OUTLINE



- Field investigation
  - Geophysical survey
  - Hydrogeological setting
- MiHPT investigation
  - Groundwater quality
  - Monitoring wells installation

STUDY AREA


Bangkok
Ratchaburi province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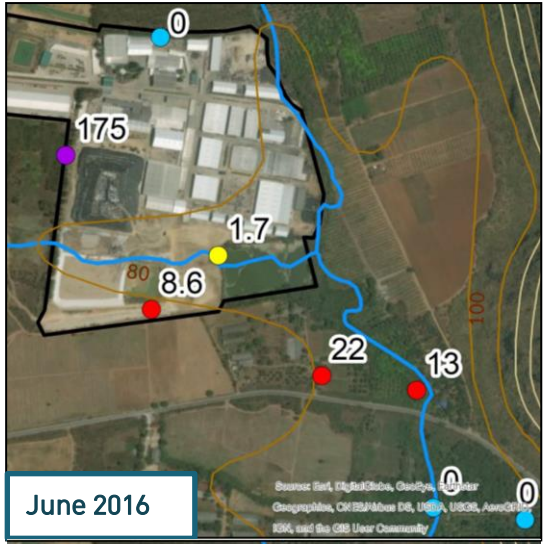
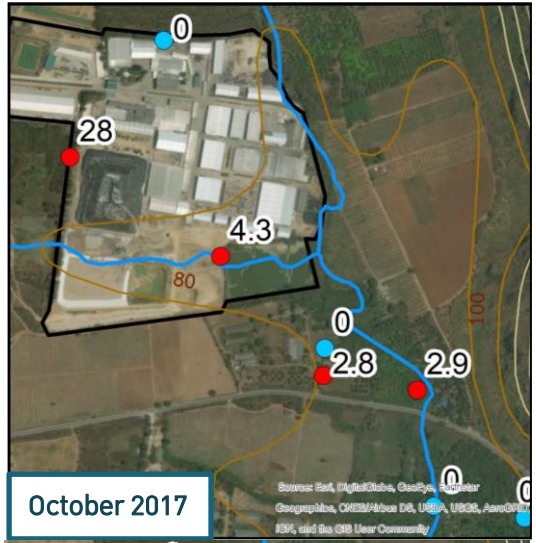
GW8
GS7
ห้วยน้ำพุ
200
250
100
0
125
250
500
เมตร

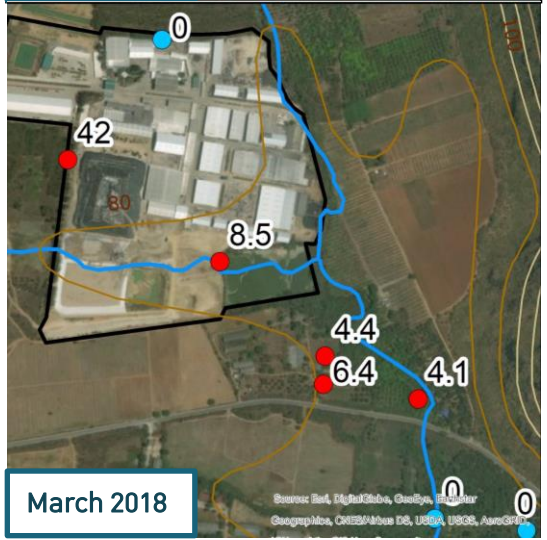
BACKGROUND

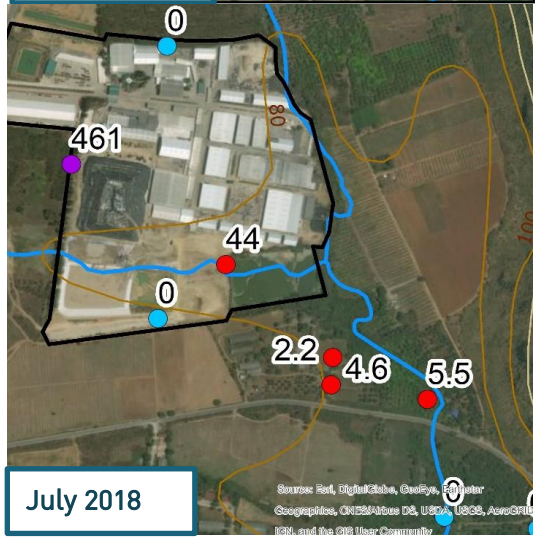

VOCs and heavy metals were higher than standards in groundwater monitoring wells and domestic wells.
2014
2015
The presence of cis-1,2-DCE, TCE, benzene, vinyl chloride, Mn, and Ni in the area
2016
2017
Vinyl chloride concentration increased to 461 µg/L
2018
2020
Started to conduct the research project

Vinyl Chloride concentration in groundwater









Concentration in µg/L

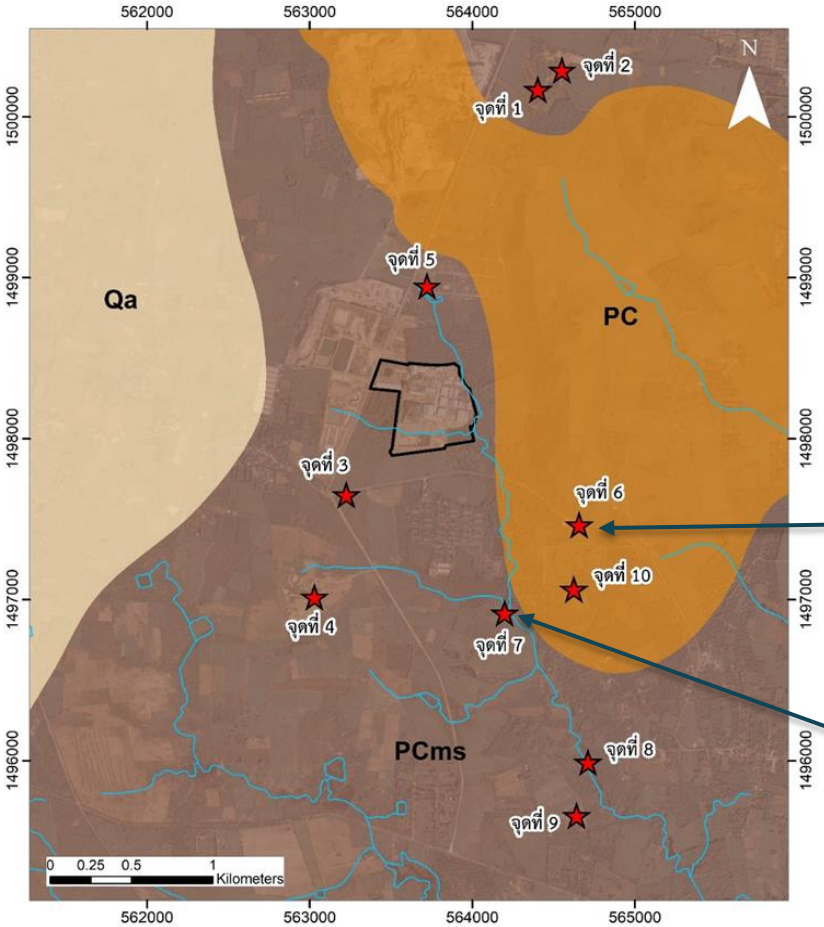
- < 0.2
- 0.2 - 1
- 1 - 2
- 2 - 100
- > 100

OBJECTIVES

- To identify the presence and characteristics of contaminants in the sub-surface.

- To propose potential remediation plans and provide guidance for the community and environmental agencies in terms of groundwater management in contaminated areas.

Geological setting



2 Rock Units

Quaternary Unconsolidated sediments: Sandy clay, Gravel, Rock fragment

Permo-Carboniferous: Meta-sandstone, Meta-mudstone, Siltstone, Quartzite, Dolomitic limestone

Dolomitic limestone

Meta-sandstone

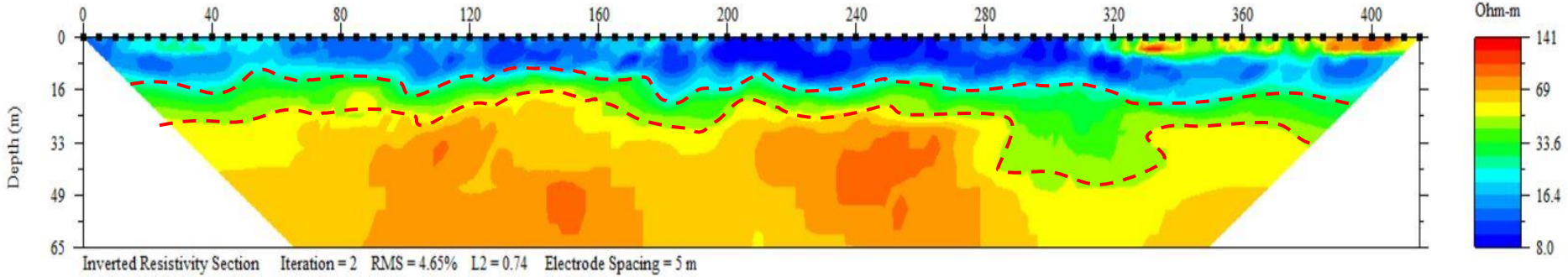
Geophysical survey by resistivity method

Layer 1: Low resistivity (1-50 Ω-m) composted of wet soil, clay, shallow aquifer at depth of 1-16 m.

Layer 2: Moderate resistivity (25-300 Ω-m) composted of weathered rock, dry silty clay at depth of 15-45 m.

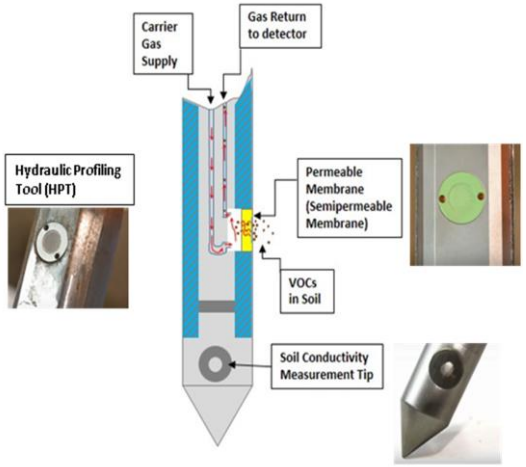
Layer 3: High resistivity (200-2,000 Ω-m) composed of bedrock at 30 m or deeper.

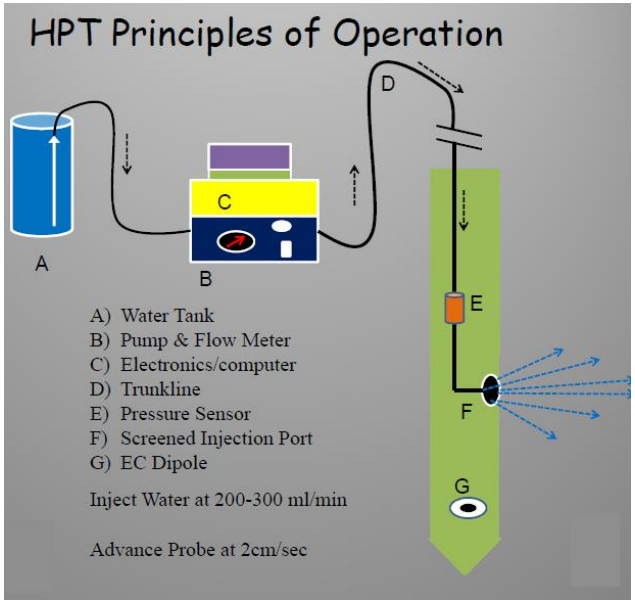
2D resistivity method Line A-B' (West-East)



Membrane Interface Probe and Hydraulic Profiling Tool (MiHPT)

- Real time mapping of volatile organic compounds (VOCs) at depth in the gaseous, dissolved and free phases
- Able to map petroleum hydrocarbons, chlorinated hydrocarbons (TCE,PCE) and unsaturated hydrocarbons (methane)
- Used in the saturated and unsaturated zones.
- Simultaneous log of soil electrical conductivity
- No vertical data gaps
- Calculates Hydrostatic Profile and Estimated K (True measurement of formation permeability.)





MIP Instruments

- **GC1000 Gas chromatograph**: PID, FID and XSD detectors
- **Operator Supplied Field Laptop**
- **FI6000 Field Instrument**
- **K6300 HPT Pump and Flow Controller**
- **MP6505 MIP Pressure and Temperature Controller**

MIP Detectors

- **PID (Photo Ionization Detector)** Response is based upon compound ionization potential. If the ionization potential is < PID lamp eV (10.6) then it is detected. Typically this is the Aromatic Hydrocarbons and Double Bonded cVOCs. **(e.g. toluene, benzene, ethylbenzene, xylene)**
- **FID (Flame Ionization Detector)** Responds to any organic compound (carbon based) – will burn and increase flame intensity and current output. **(e.g. methane, butane)**
- **XSD (Halogen Specific Detector)** Responds to halogenated compounds (Cl-, Br-, Fl-). Does not respond to non halogen containing compounds. **(e.g. chlorinated solvents PCE, TCE, cis-DCE, VC)**

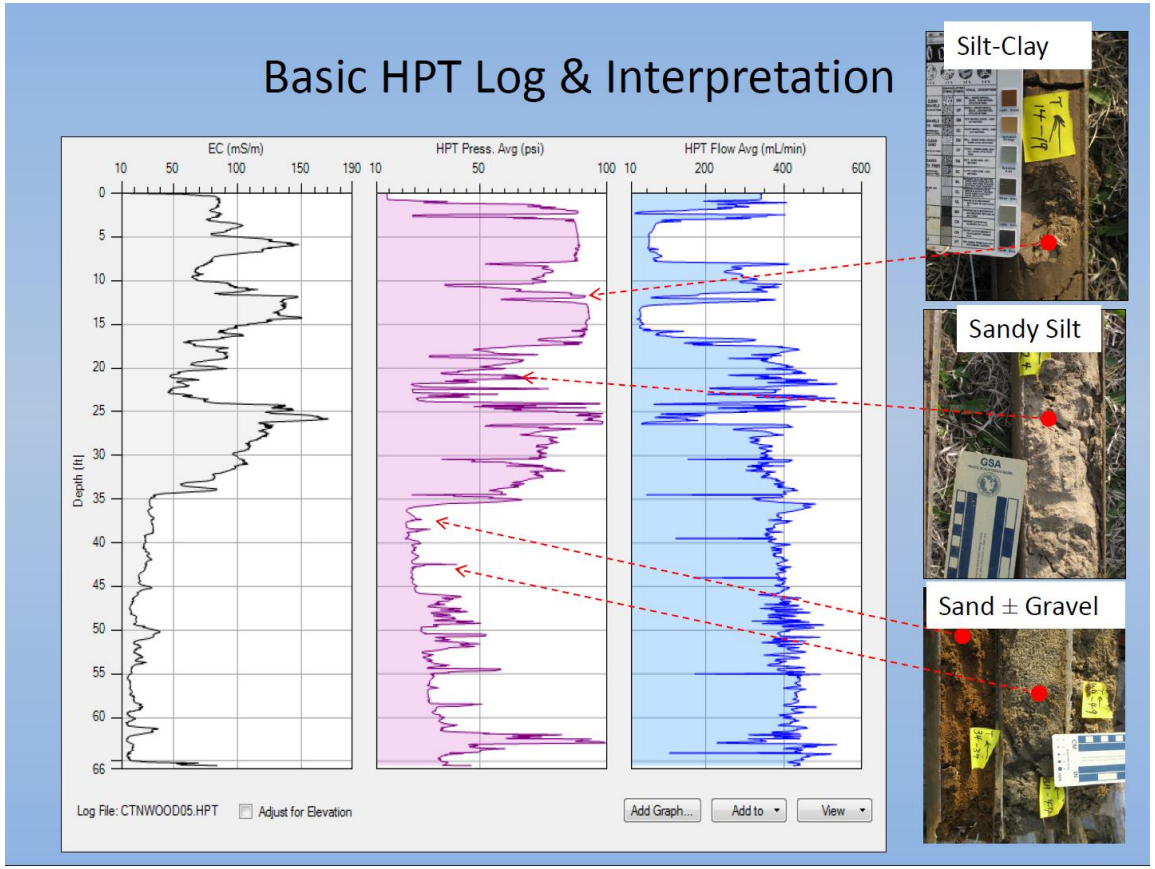
Basic HPT Interpretation Rules

Typically

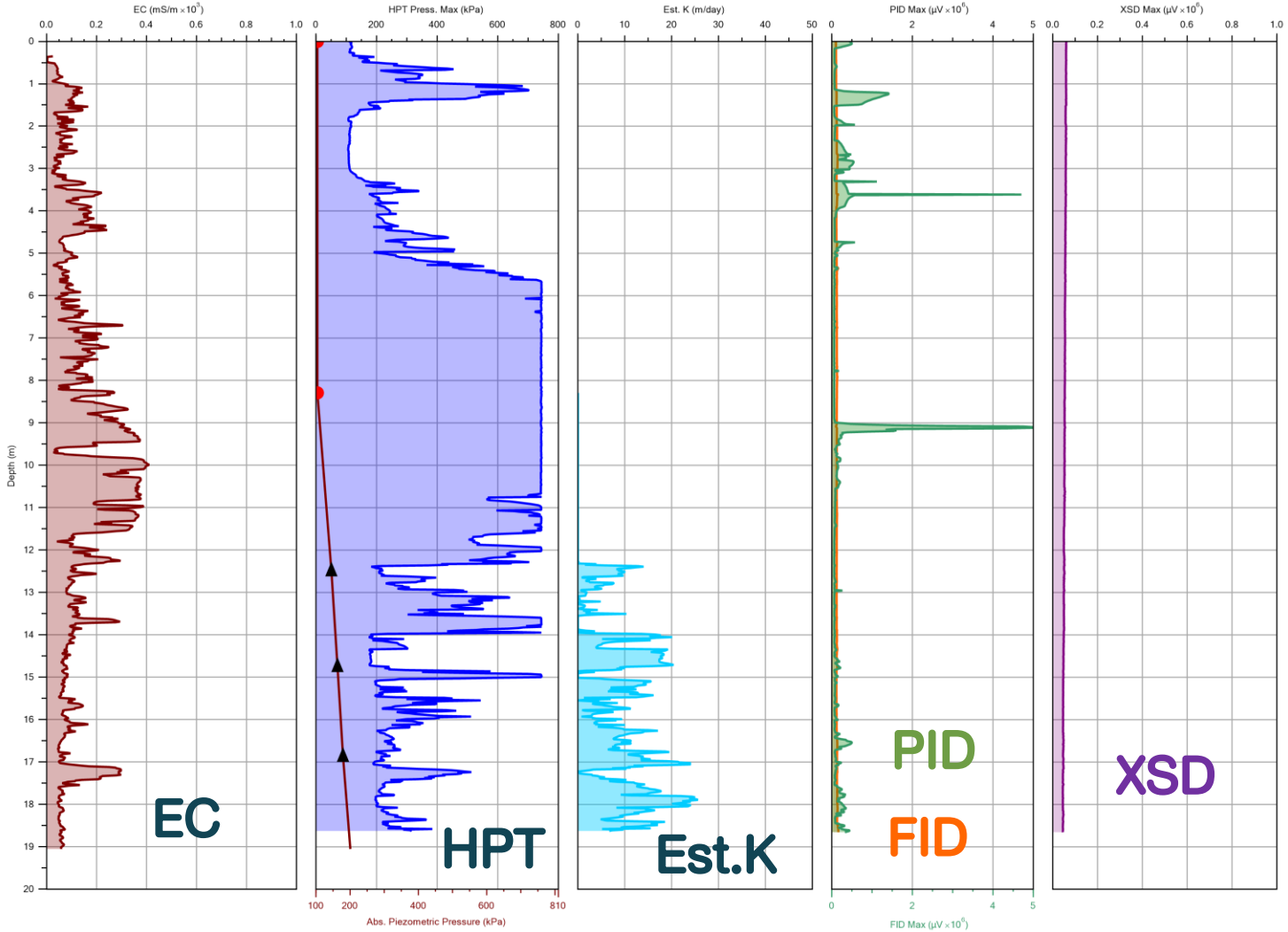
- **Low EC = Low HPT PSI**
  Course Grained Soils
- **High EC = High HPT PSI**
  Fine Grained Soils

Exceptions !

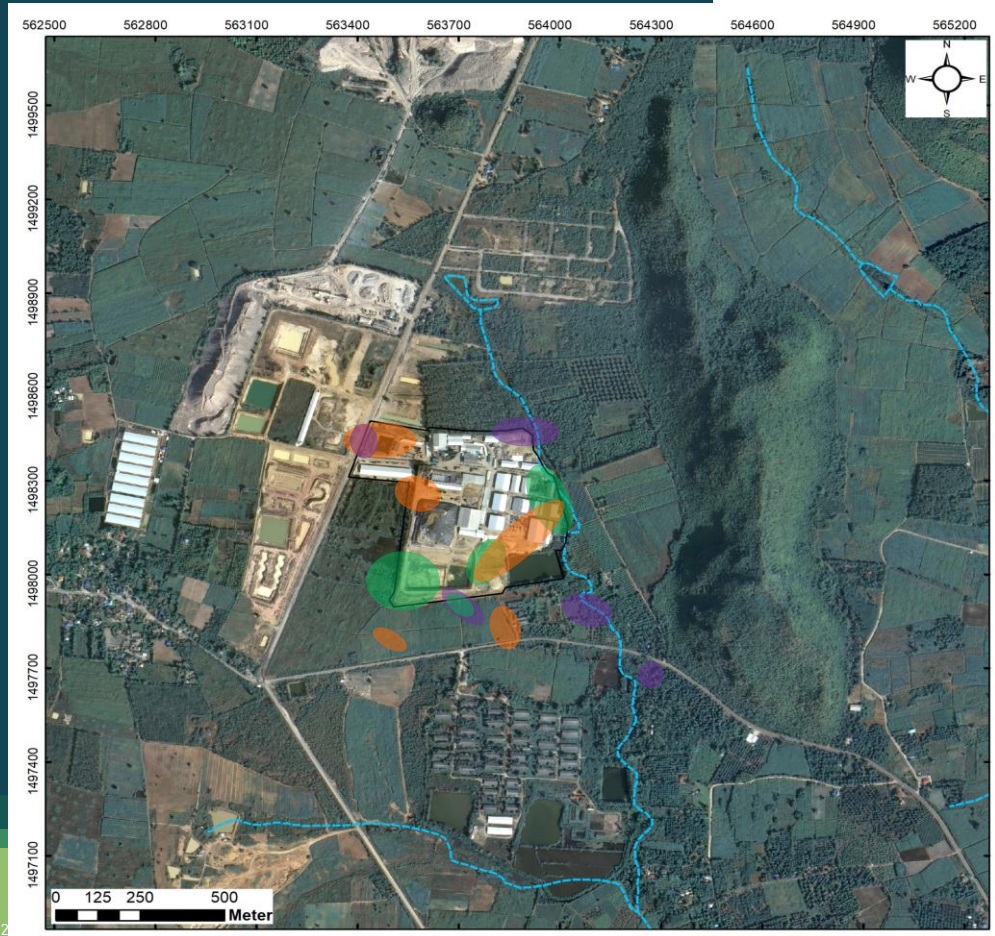
- **Low EC but High Pressure**
  Silts & cementing
  Not all clays = high EC
- **High EC can exhibit low HPT pressure**
  Seaeater
  Oilfield burine
  Ionic compounds



Site Investigation


EC (mS/m ×10³)
HPT Press. Max (kPa)
Est. K (m/day)
PID Max (µV ×10⁶)
XSD Max (µV ×10⁶)
Depth (m)
Abs. Piezometric Pressure (kPa)
FID Max (µV ×10⁶)
EC
HPT
Est.K
PID
FID
XSD

Results



High response of detectors

- PID 500,000 µv
- FID 500,000 µv
- XSD 150,000 µv

Response of XSD PID and FID

- Vinyl Chloride
- cis-1,2-Dichloroethene
- Trichloroethylene Tetrachloroethylene

Response of PID and FID

- Benzene Ethylbenzene
- Toluene Xylene Styrene
- Acetone

Monitoring well installation

Soil core sampling using direct push

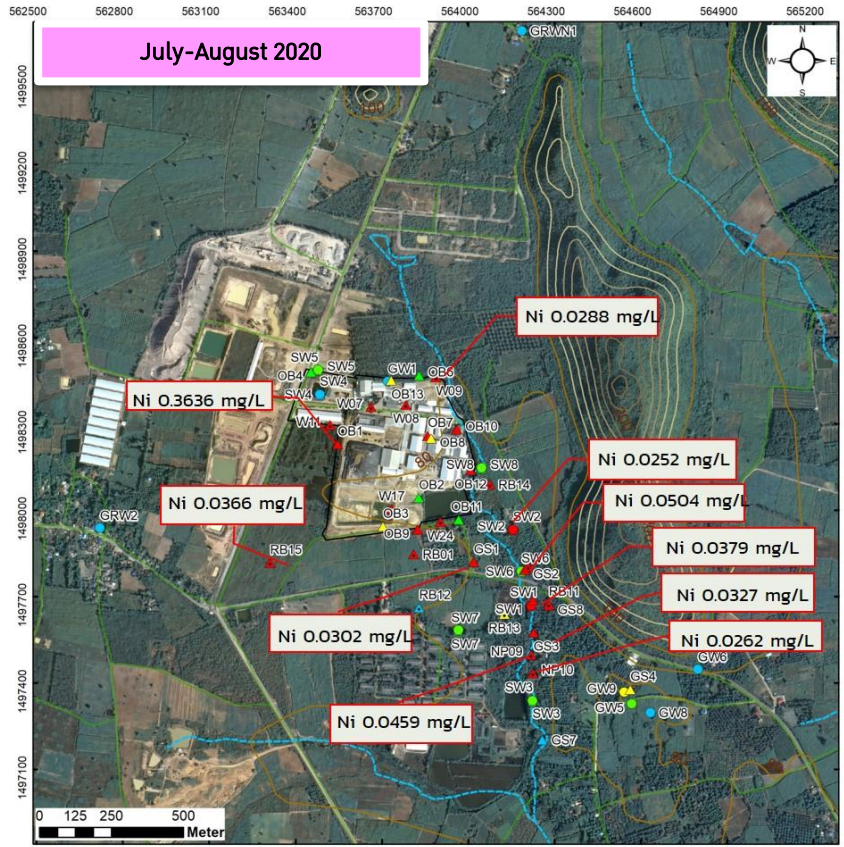



Groundwater Quality

Contaminants of concern

- Nickel, Manganese
- Vinyl Chloride, Benzene, cis-1,2-Dichloroethylene

Groundwater Quality



Nickel concentration in groundwater

- Shallow wells (< 15 m.)
- Deep groundwater wells (> 15 m.)
- Surface water
- 100 Elevation contour
- Stream
- Wax Garbage Recycle Center Ltd.CO.

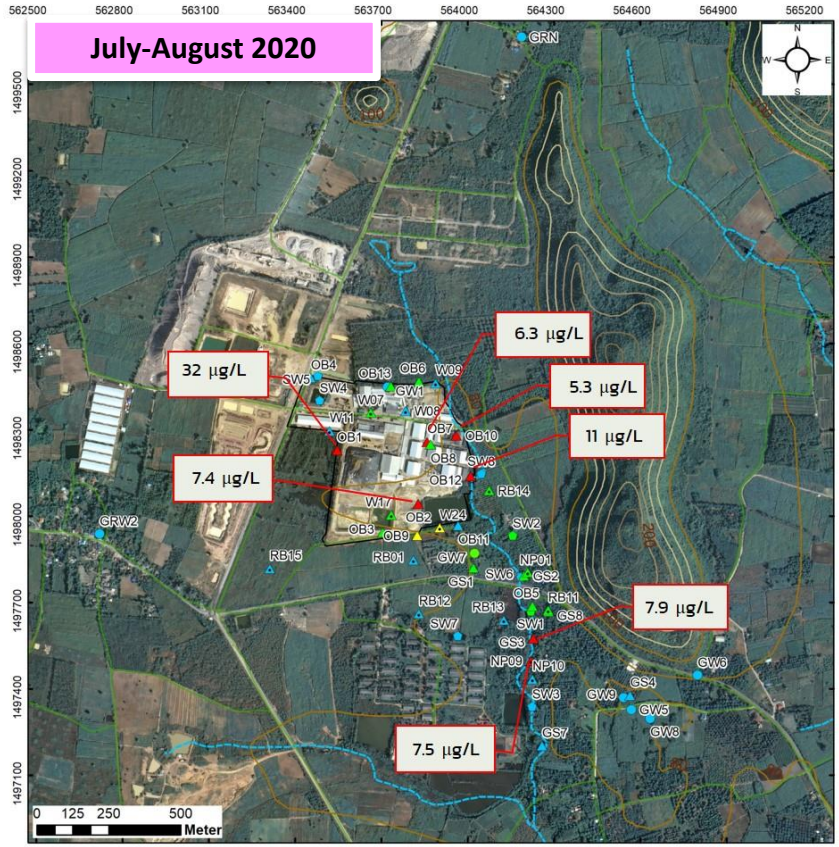
Nickel (milligram/liter)

- < 0.003
- 0.003 – 0.01
- 0.01 – 0.02
- 0.02* – 5.0
- > 5.0**

Pollution Control Department Standard

Department of Industrial Works Standard

Groundwater Quality



Benzene concentration in groundwater

- Shallow wells (< 15 m.)
- Deep groundwater wells (> 15 m.)
- Surface water
- Elevation contour
- Stream
- Wax Garbage Recycle Center Ltd.CO.

Benzene (microgram/liter)

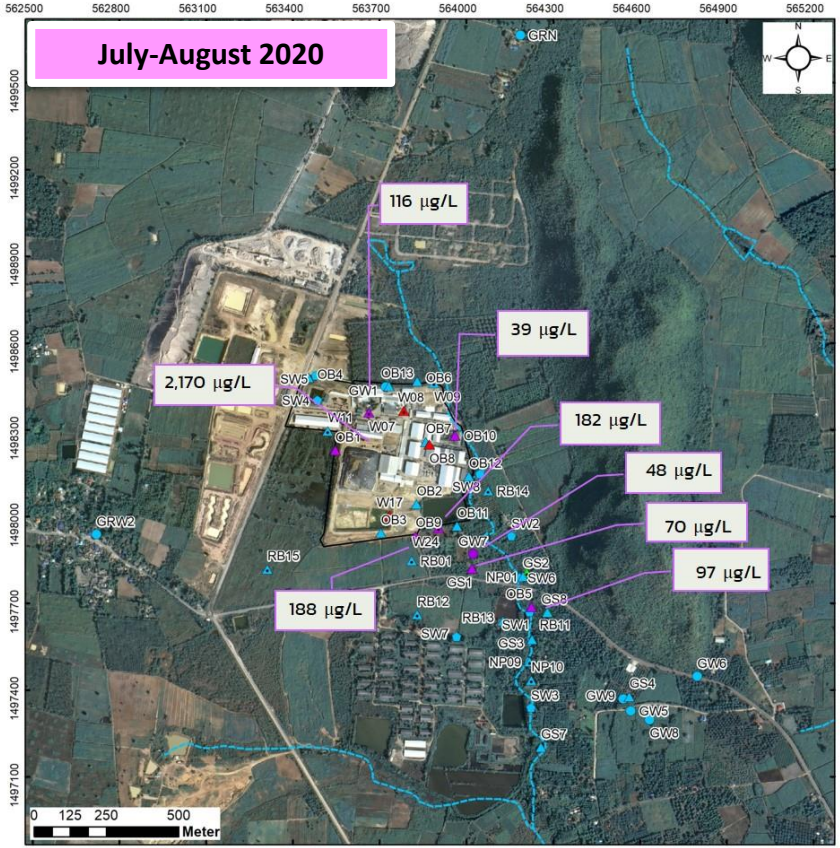
- < 0.2
- 0.2 – 2.5
- 2.5 – 5.0
- 5.0* – 200
- > 200**

Pollution Control Department Standard

Department of Industrial Works Standard

Groundwater Quality

Vinyl Chloride concentration in groundwater



- Shallow wells (< 15 m.)
- Deep groundwater wells (> 15 m.)
- Surface water
- 100 Elevation contour
- Stream
- Wax Garbage Recycle Center Ltd.CO.

Vinyl Chloride (microgram/liter)

	< 0.2
	0.2 – 2.5
	2.5 – 5.0
	2– 30
	> 30**

Pollution Control Department Standard

Department of Industrial Works Standard

Conclusion

The residents should be warned not to use groundwater from contaminated wells

Provide clean water sources for domestic uses.

Plug wells that installed well screen in contaminated aquifer.

Remove source of contamination or source control

Treat contaminated groundwater and soil with effective methods

REMEDIATION PLAN

Permeable reactive membrane

with nano zero valent iron coated activated carbon

$CH_2CHCl + Fe^0 + H_2O \rightarrow C_2H_4 + Fe^{2+} + Cl^- + OH^-$

Vinyl chloride -> Ethen

20 mL contaminated water in headspace vial

+

2 g material

100 rpm

60 hours

Chloride concentration (ppm)

material

nano zero valent iron coated activated carbon 337.6

nano zero valent iron 221.2

activated carbon 264.3

commercial iron particle 223.3

control 227.1