Off Site Chlorinated Solvent Plume Reaching Municipality Water Dam

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Investigation | Remediation | Audit | Permiting | Consultancy

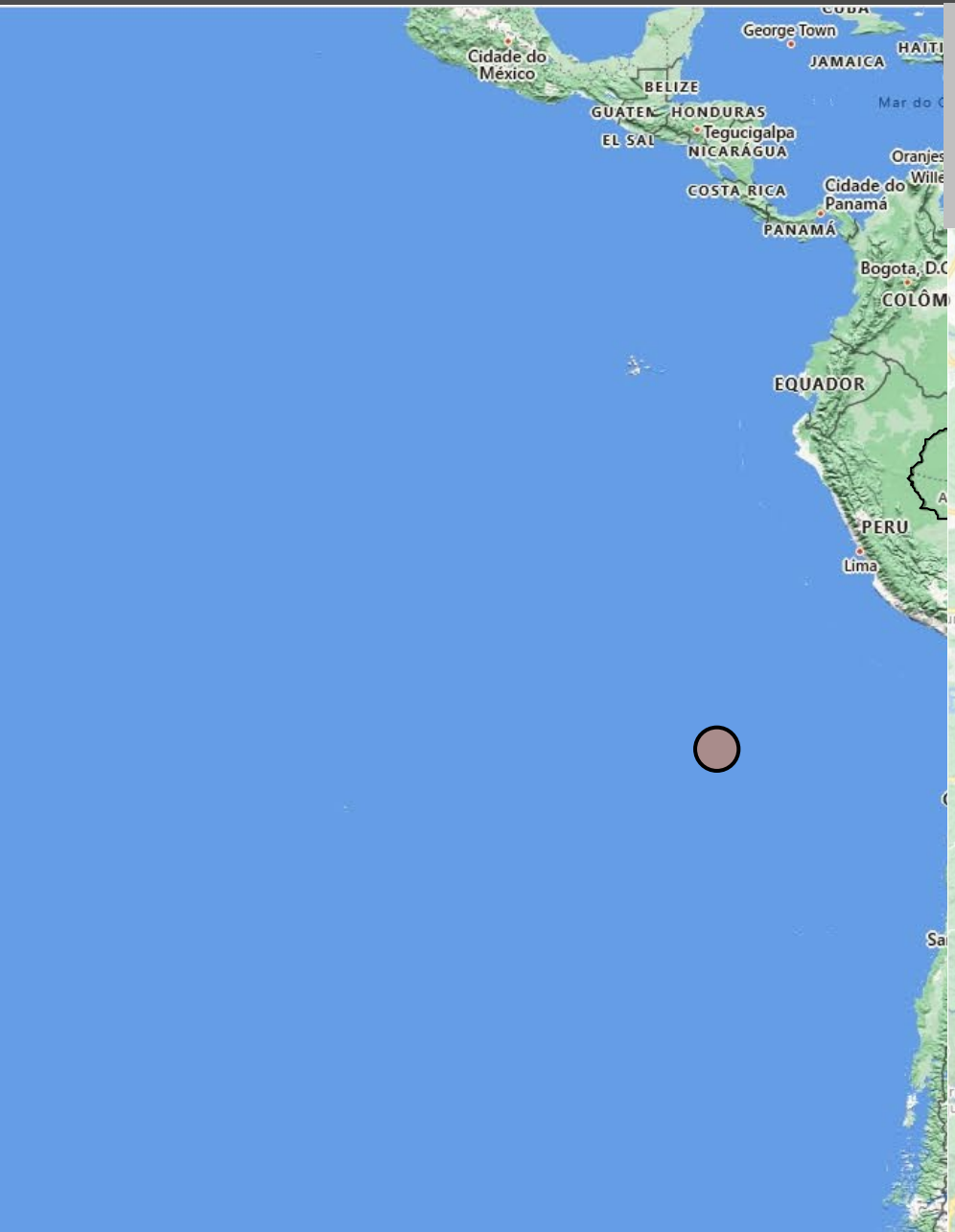
Twelfth International Conference on Remediation of Chlorinated and Recalcitrant Compounds

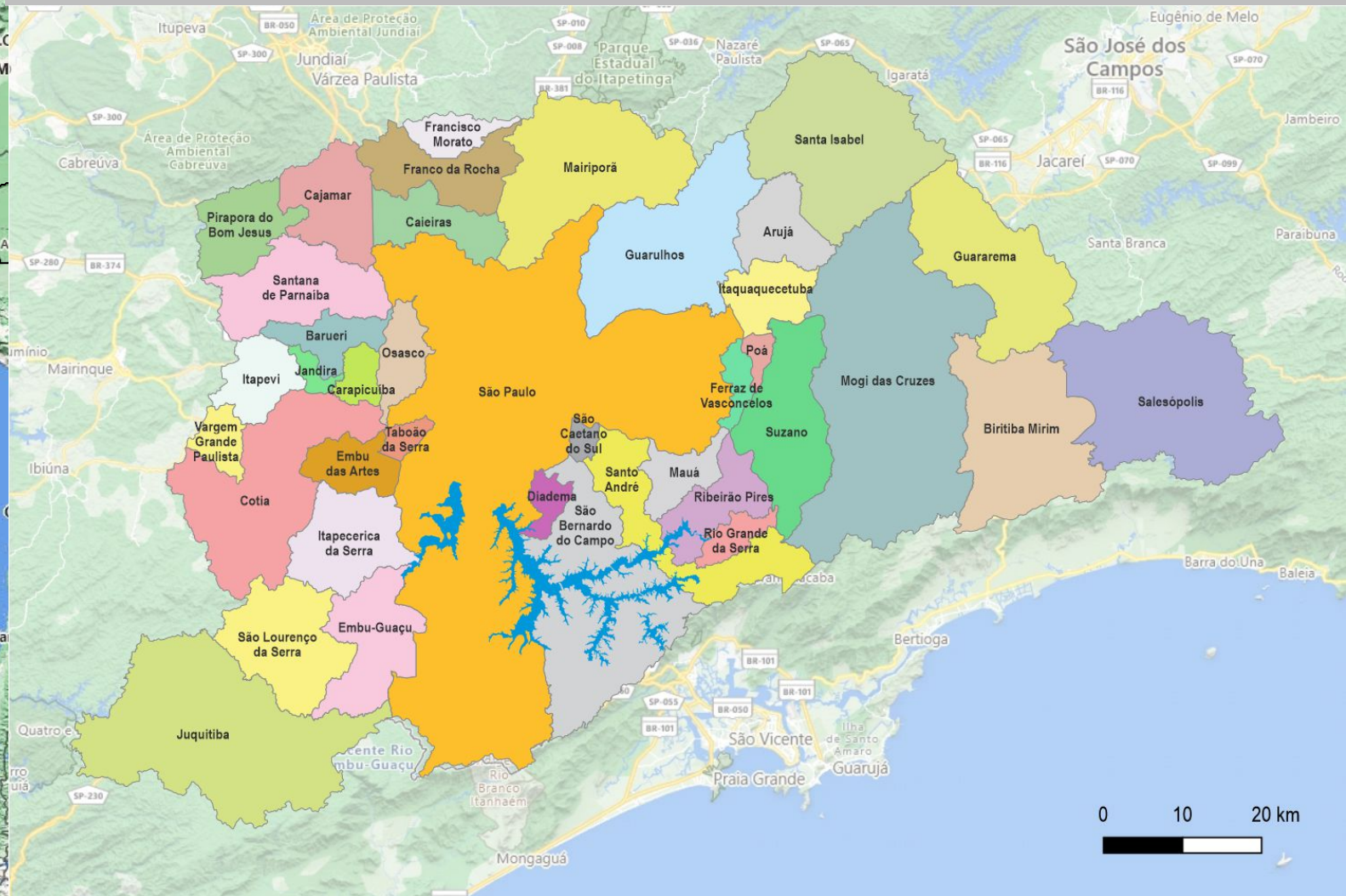
B1_1440_#308_Aluani

May 22-26, 2022

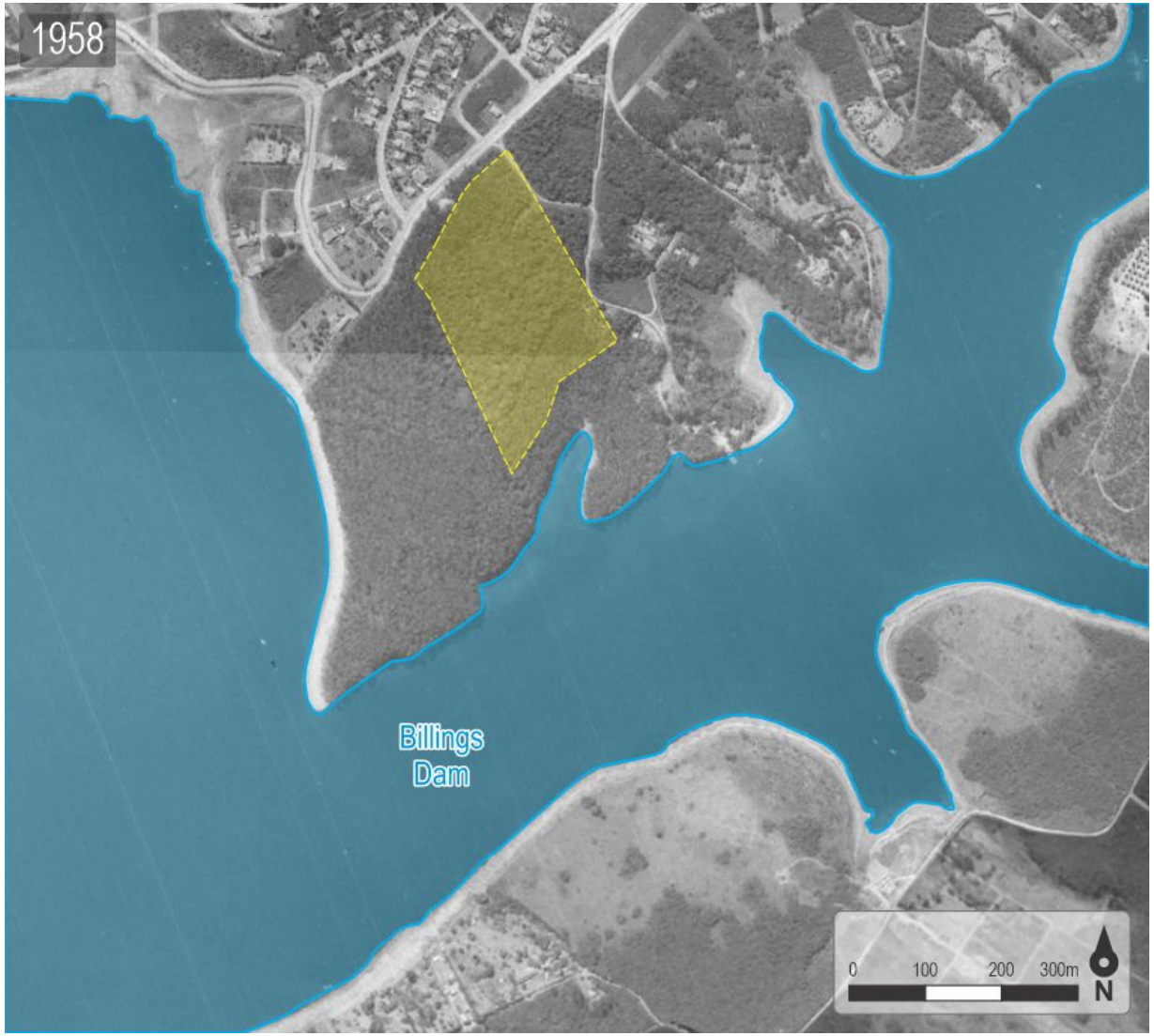
Scenario

Billings Dam is the biggest reservoir in São Paulo (population 23 million)
Total area: 108 km^2
Total volume: 1 billion m^3 water



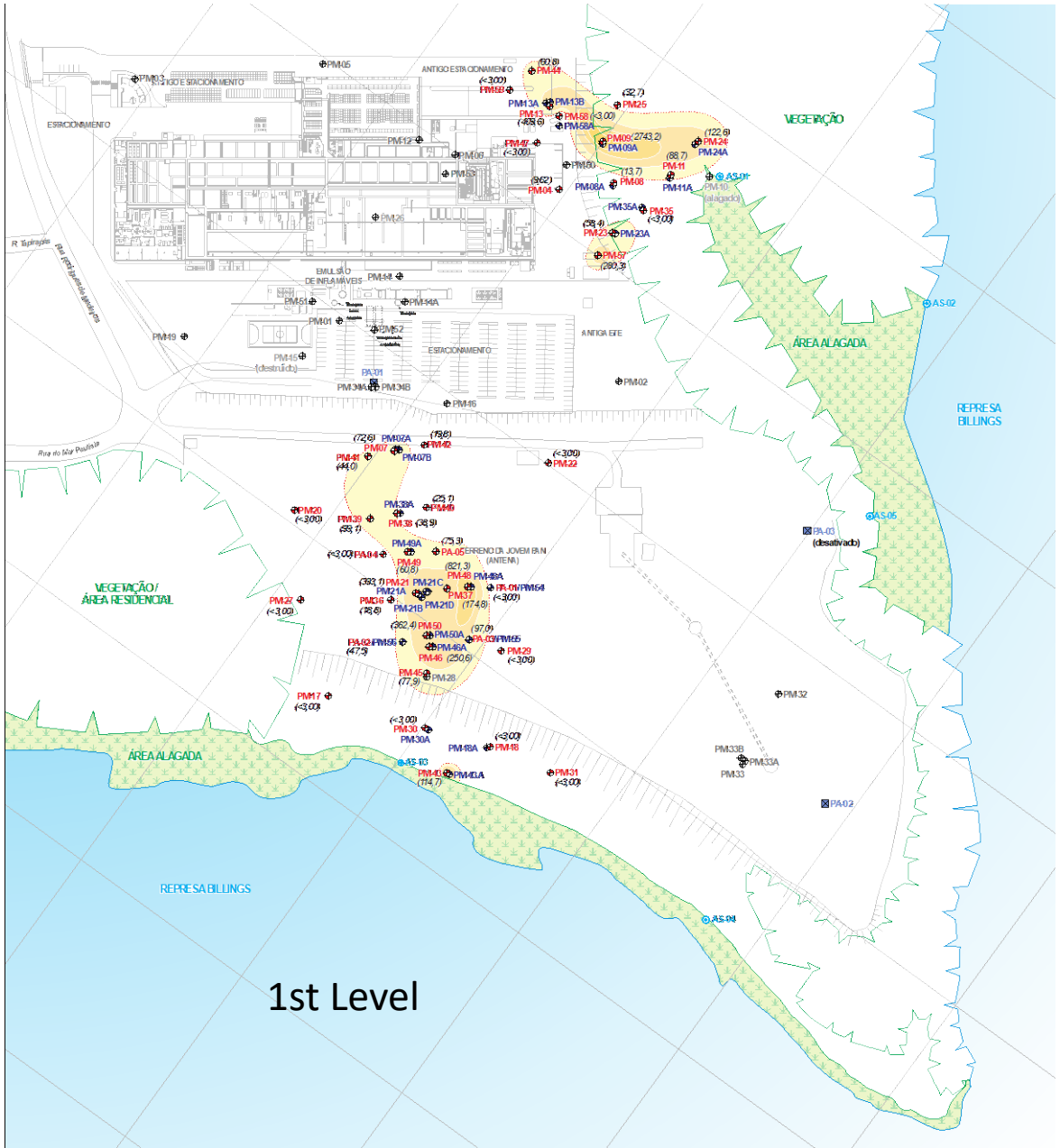


Project location

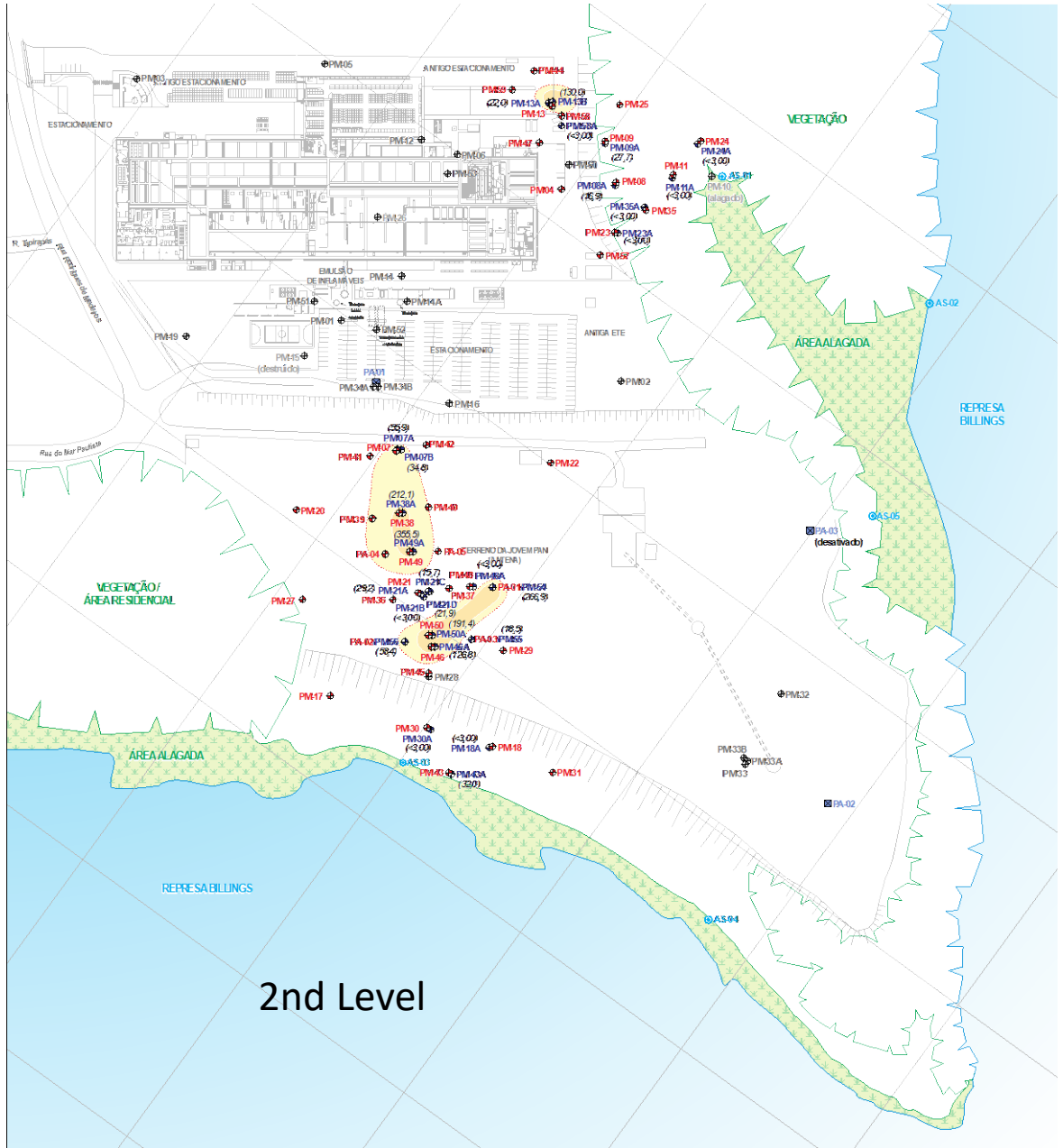


Project location

PCE Plume

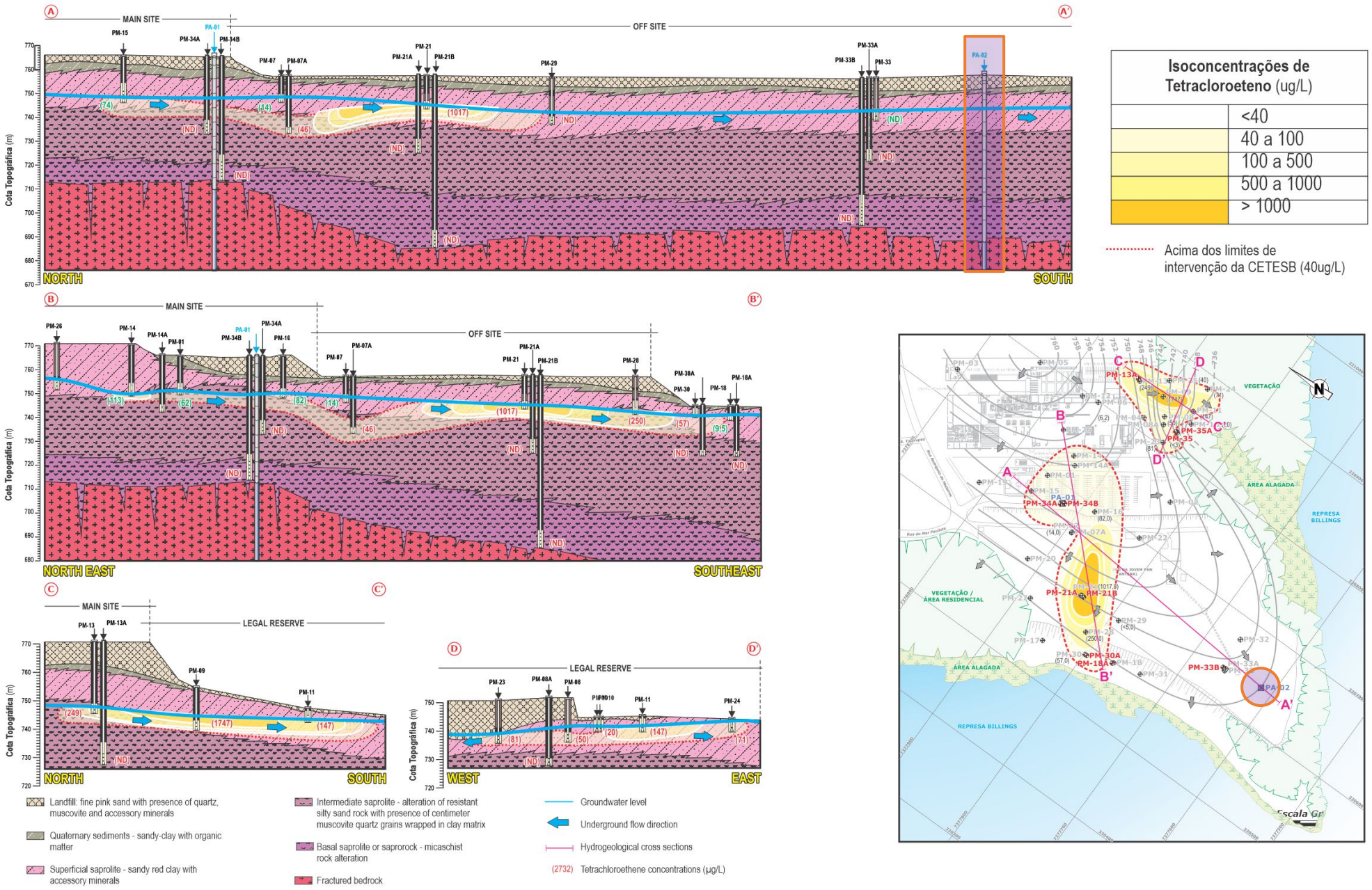


1st Level



2nd Level

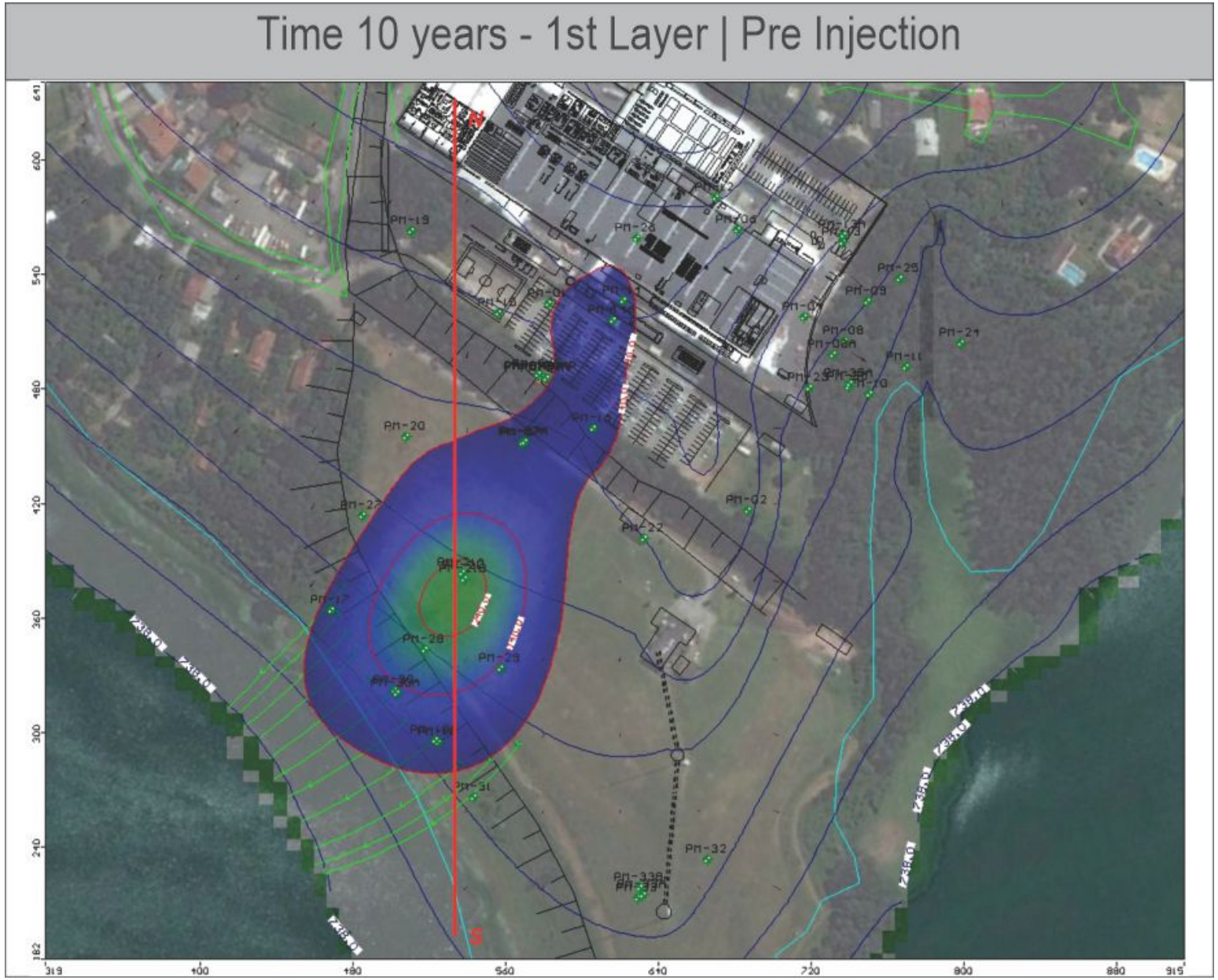
Geologic Section



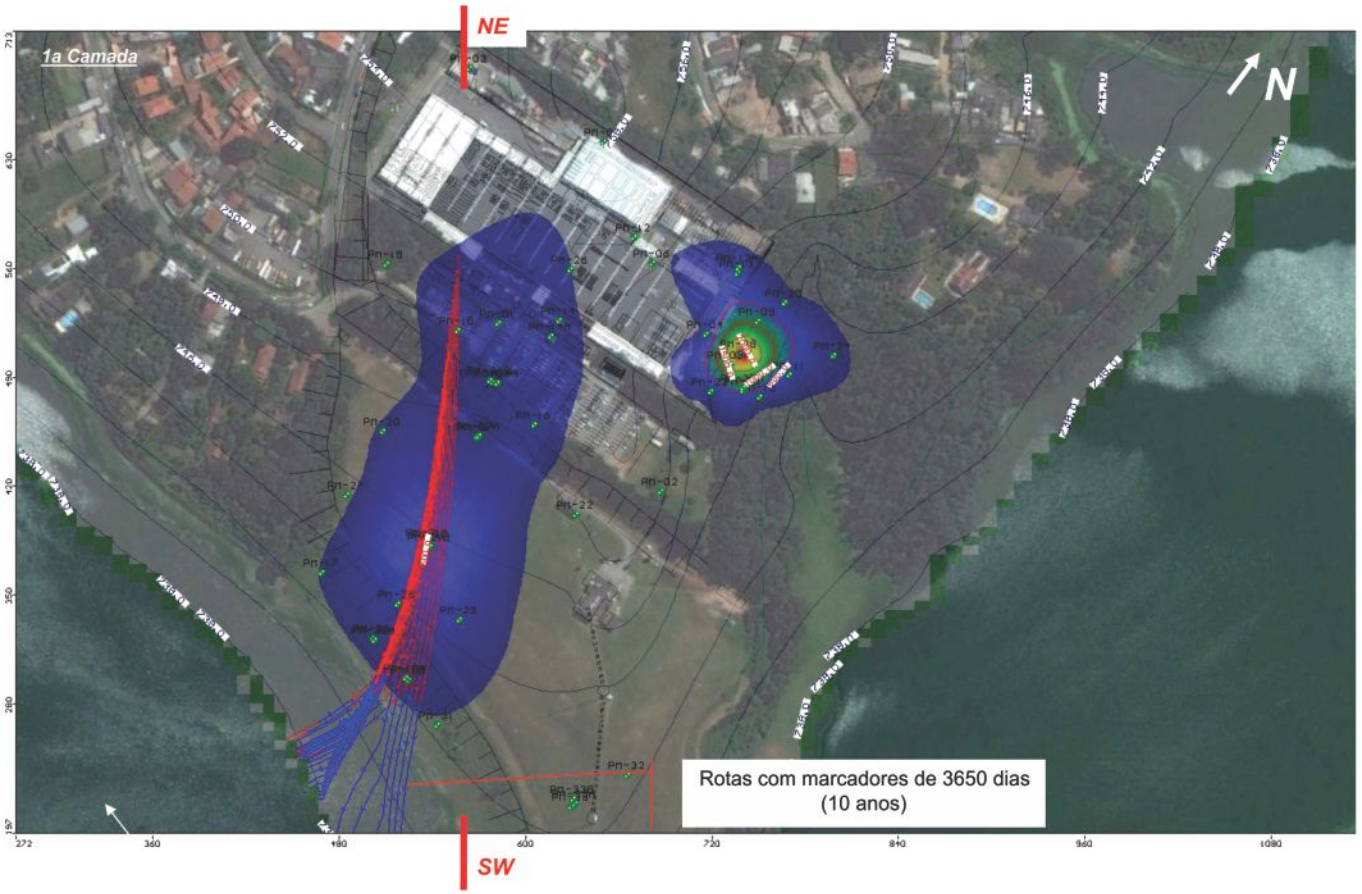
Isoconcentrações de Tetracloroeteno (ug/L)	
	<40
	40 a 100
	100 a 500
	500 a 1000
	> 1000

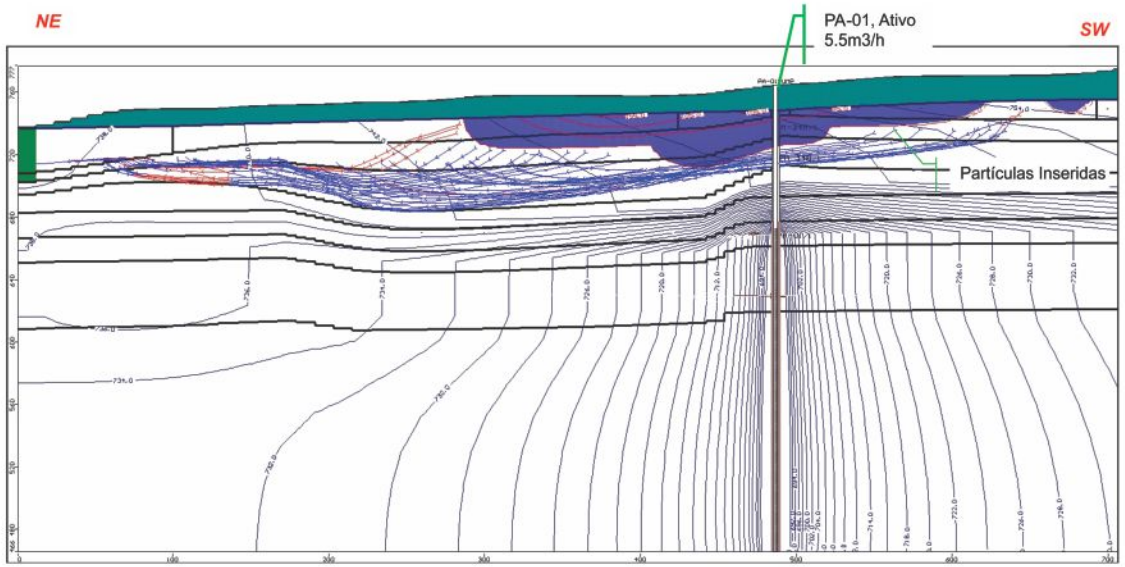
Acima dos limites de intervenção da CETESB (40ug/L)

Fate and Flow Modeling



Fate and Flow Modeling



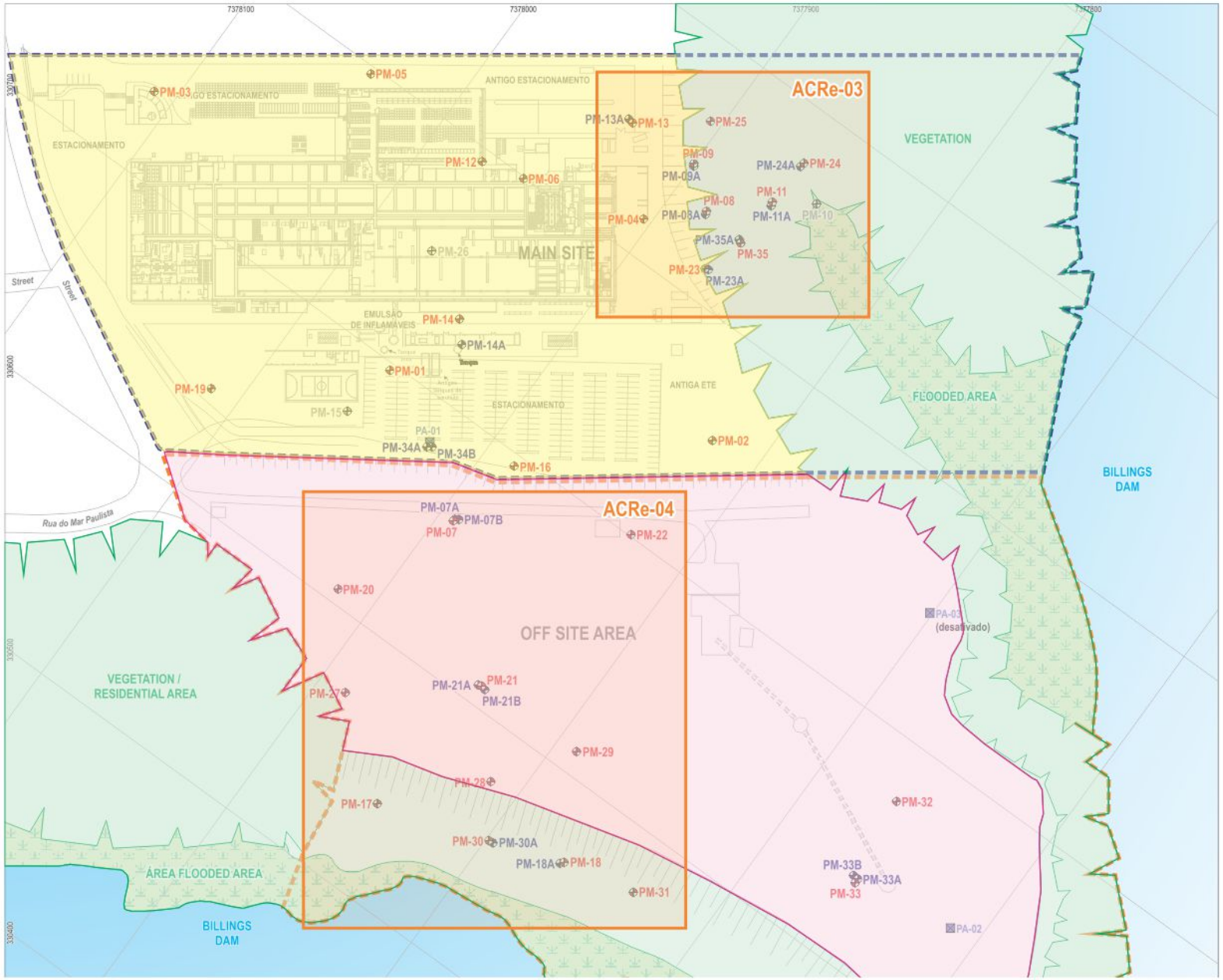


PCE plume in June 2009

Particle path lines

100 Equipotential hydraulic load lines

Intervention Plan / SSTLs



- Deep wells
- Destroyed monitoring wells
- Monitoring wells - 1st level
- Multilevel monitoring wells
- Main Site
- Off Site Area
- Permanent Preservation Area (PPA)
- Areas of interest

Industrial Area (Except PPA)	
Compound of Interest	**MAC[1] (µg/L)**
1,1-Dichloroethane	93600
1,1-Dichloroethene	277000
1,2-Cis-Dichloroethene	881
Vinyl chloride	7190
Tetrachloroethene	16000
Trichloroethene	58000

Off Site Area (Except PPA)	
Compound of Interest	**MAC[2](µg/L)**
1,1-Dichloroethane	1780
1,1-Dichloroethene	1960
1,2-Cis-Dichloroethene	156
Vinyl chloride	129
Tetrachloroethene	293
Trichloroethene	1080

Permanent Preservation Area PPA (Billings Dam)	
Compound of Interest	**MAC[3](µg/L)**
1,1-Dichloroethane	53
1,1-Dichloroethene	30
1,2-Cis-Dichloroethene	50
Vinyl chloride	2
Tetrachloroethene	40
Trichloroethene	20

0 20 40 60 80 m

Situation / Consequences

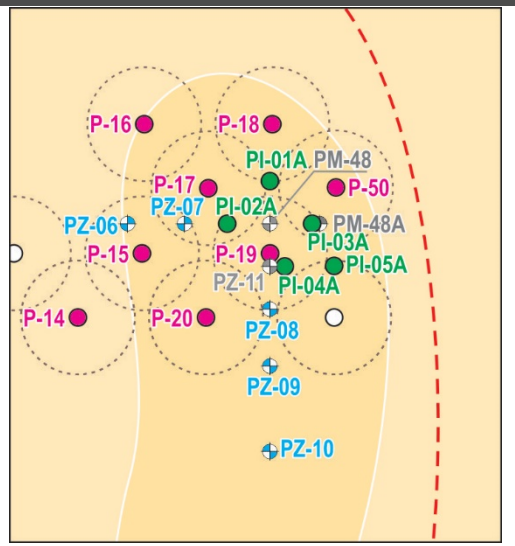
- ✓ Environmental Agency – plume must be stopped / remediated
- ✓ No Compliance – client costumers' auditings
- ✓ Legal Consequences
  - ✓ Operational Permit could be revoqued
  - ✓ Environmental Crime / Fine for contaminate a water body
  - ✓ If contamination affects the supply → water supply to population,

Bench and Pilot Test

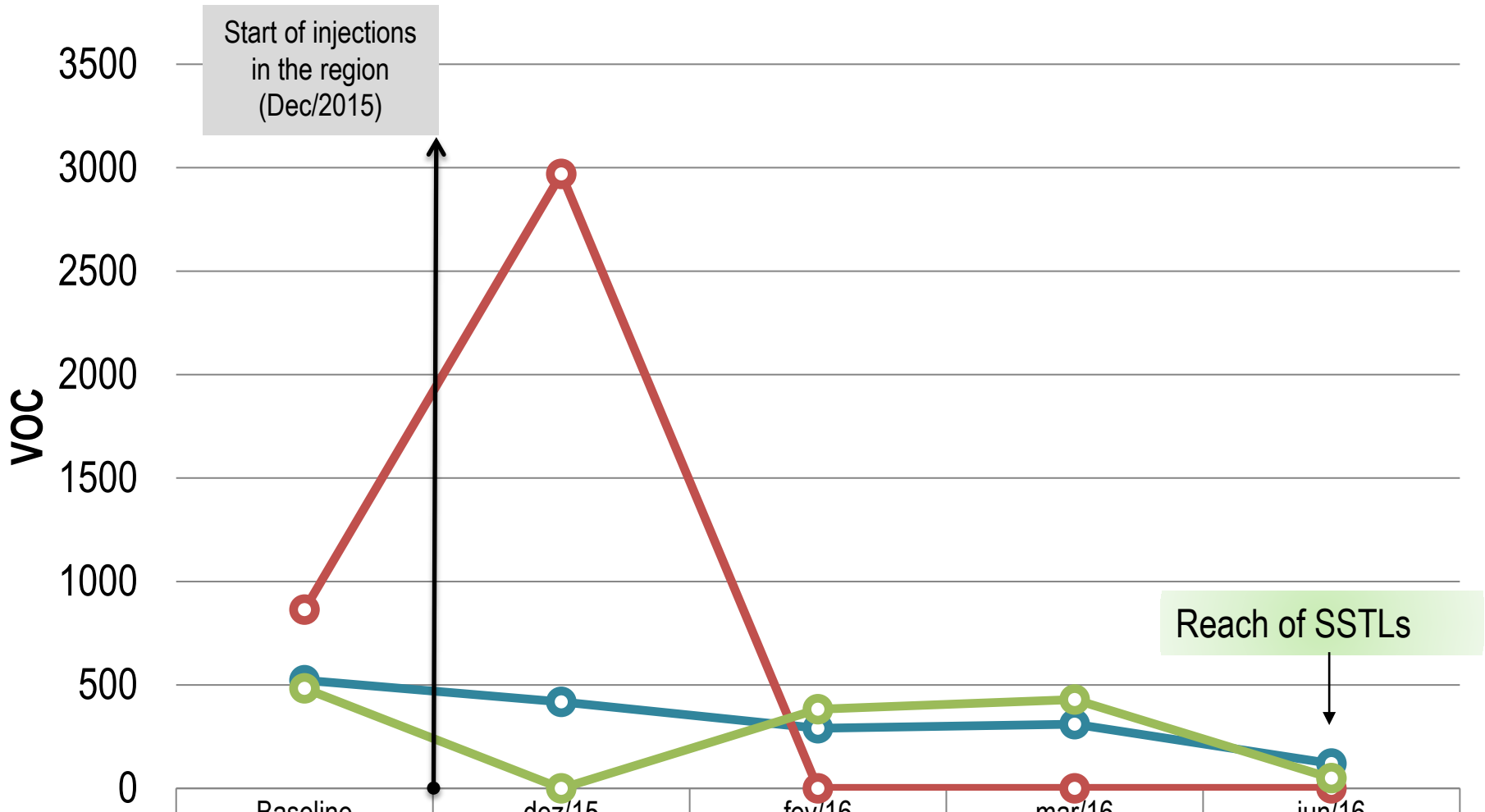
- ✓ ISCR was defined as the most efficient approach;
- ✓ Bench tests (stability of the reaction medium, pH correction and product formulation)

  → Increase of ZVI % in formula
- ✓ Full Scale injection parameters definition:

  → **radius of influence** and **distribution** of the amendment;



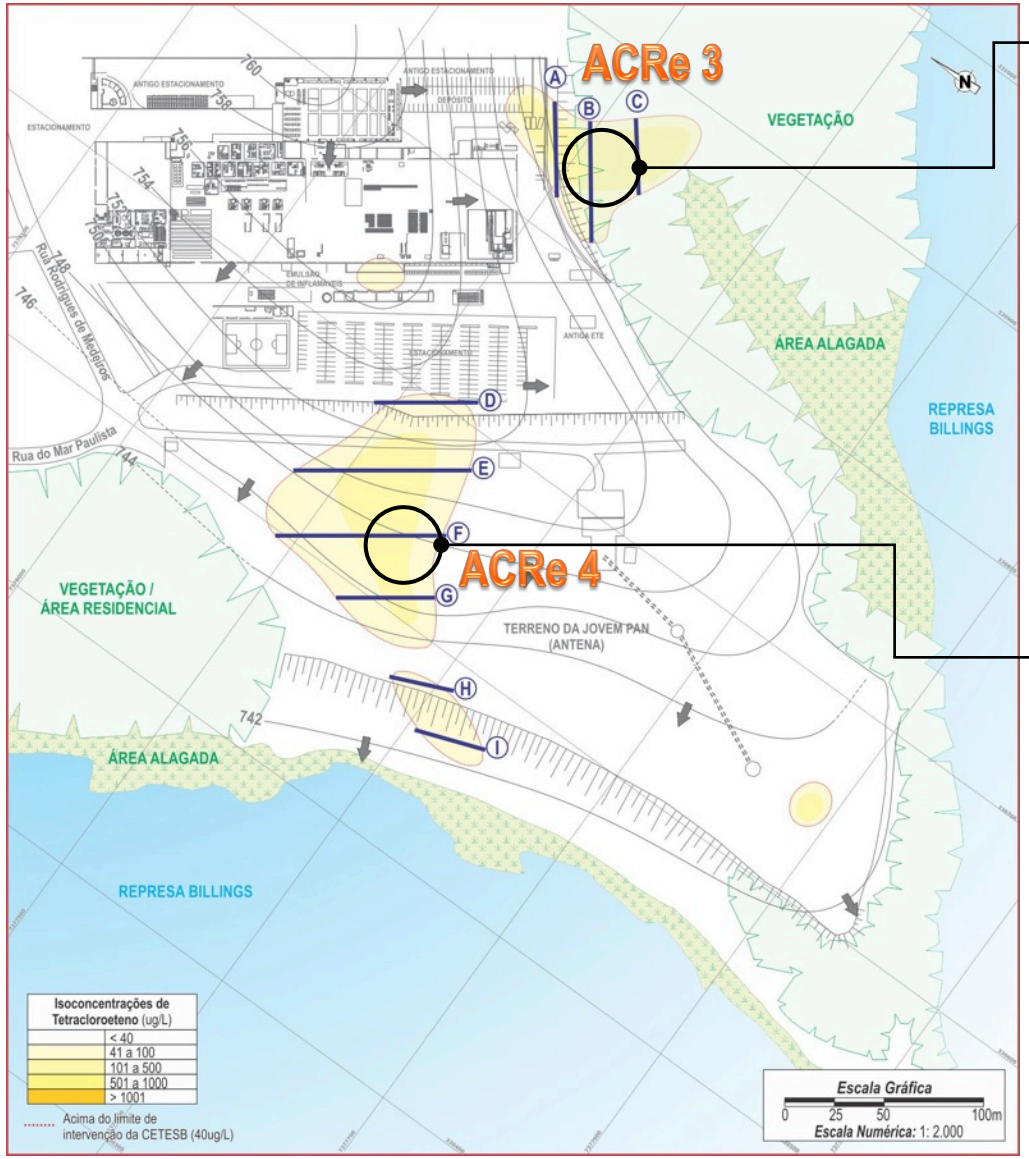
Analytical Result ACRe-04 - Pilot Test



	Baseline	dez/15	fev/16	mar/16	jun/16
PM-21	522,40	418,00	290,40	309,90	119,80
PM-48	864,20	2970,10	0	0	0
PM-50	483,33	0	382,60	429,59	49,20

Full Scale Remediation – Initial Design

Injection in lines in the impacted area



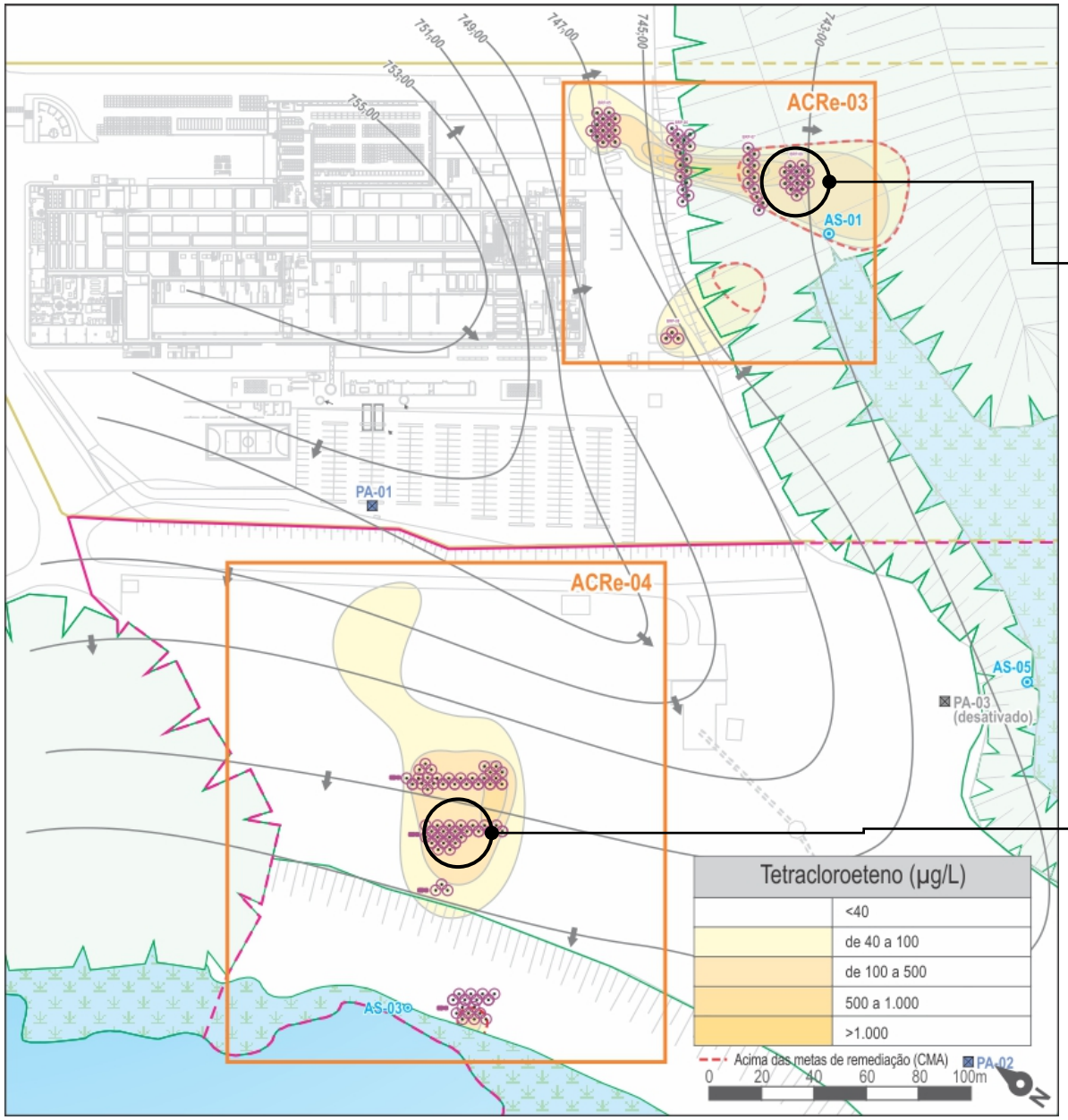
ACRe 3

- ✓ Area: 1.450 m²
- ✓ Llines A, B and C

ACRe 4

- ✓ Area: 7.900 m²
- ✓ Lines D, E, F, G, H and I

Full scale ISCR injection



Inte

-
- 24 m in the ACRe-04 area

Injected product: 81 tons

Inje ns +

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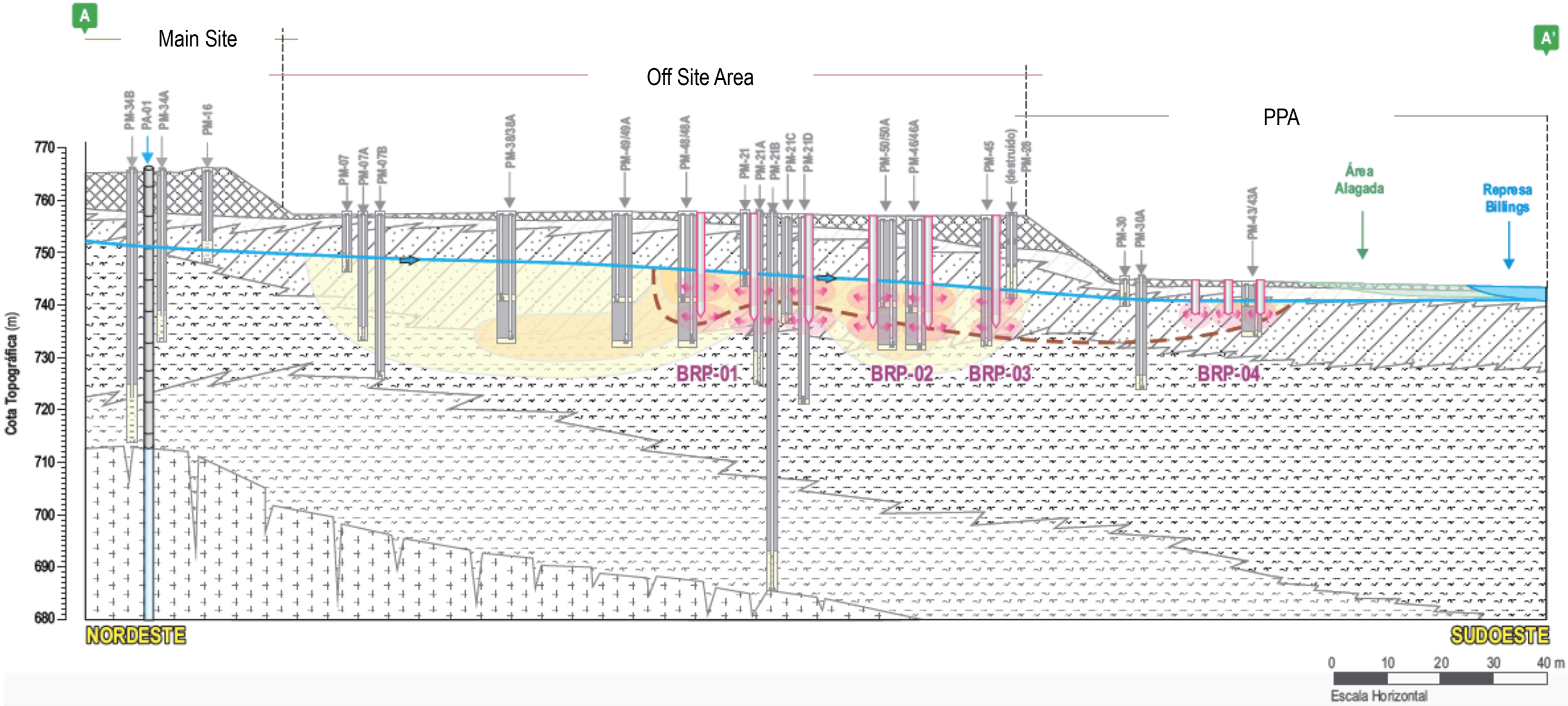
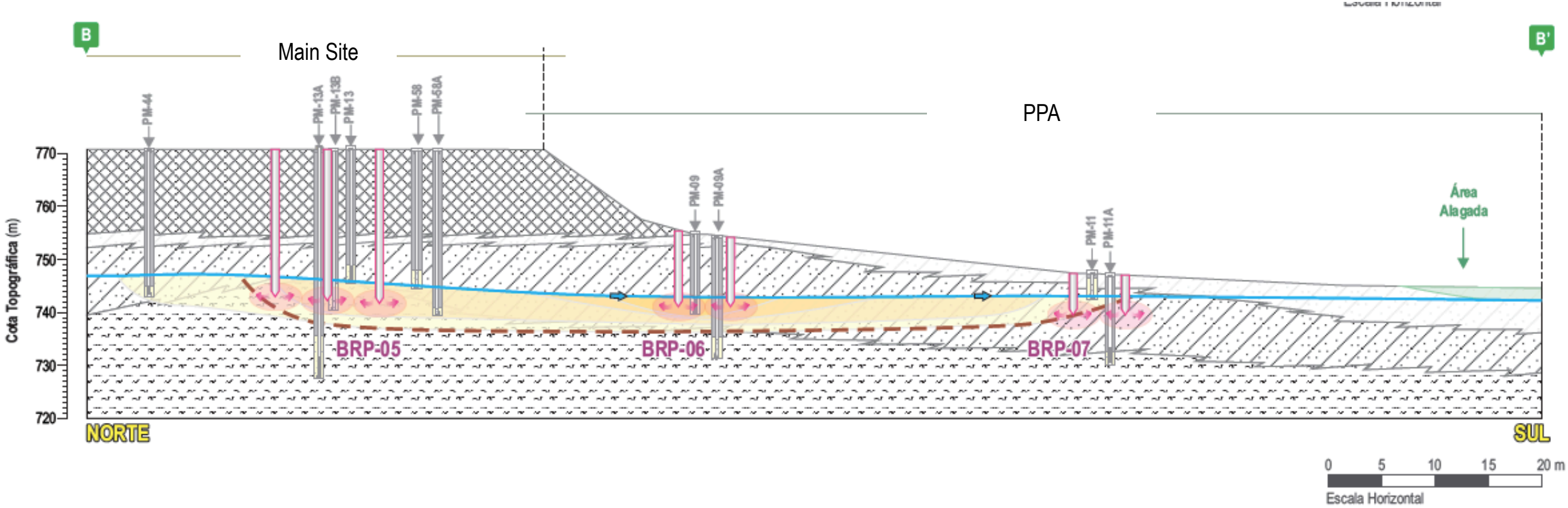
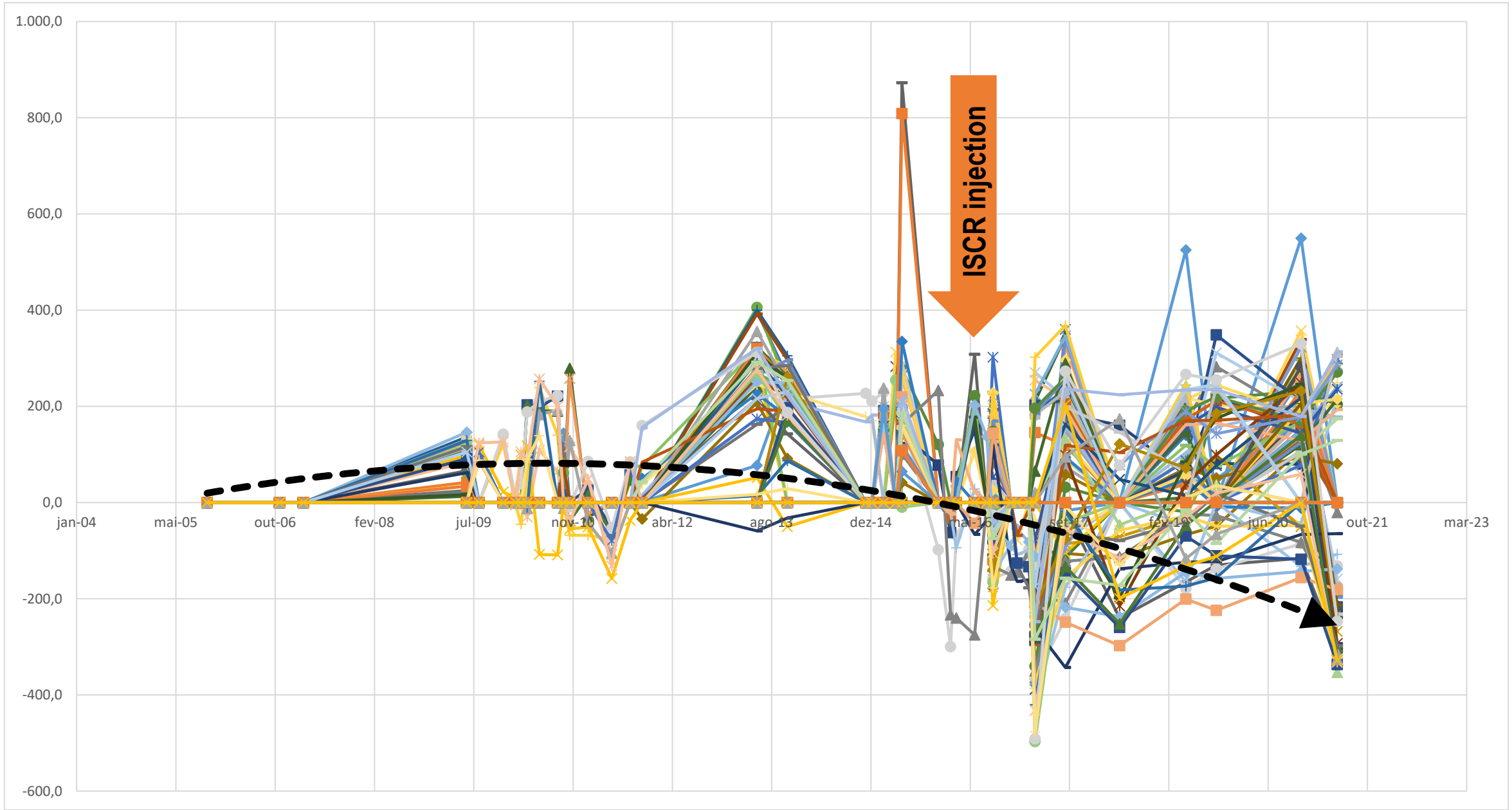
Full Scale Remediation - Executed and Planned Injection - ACRe-04



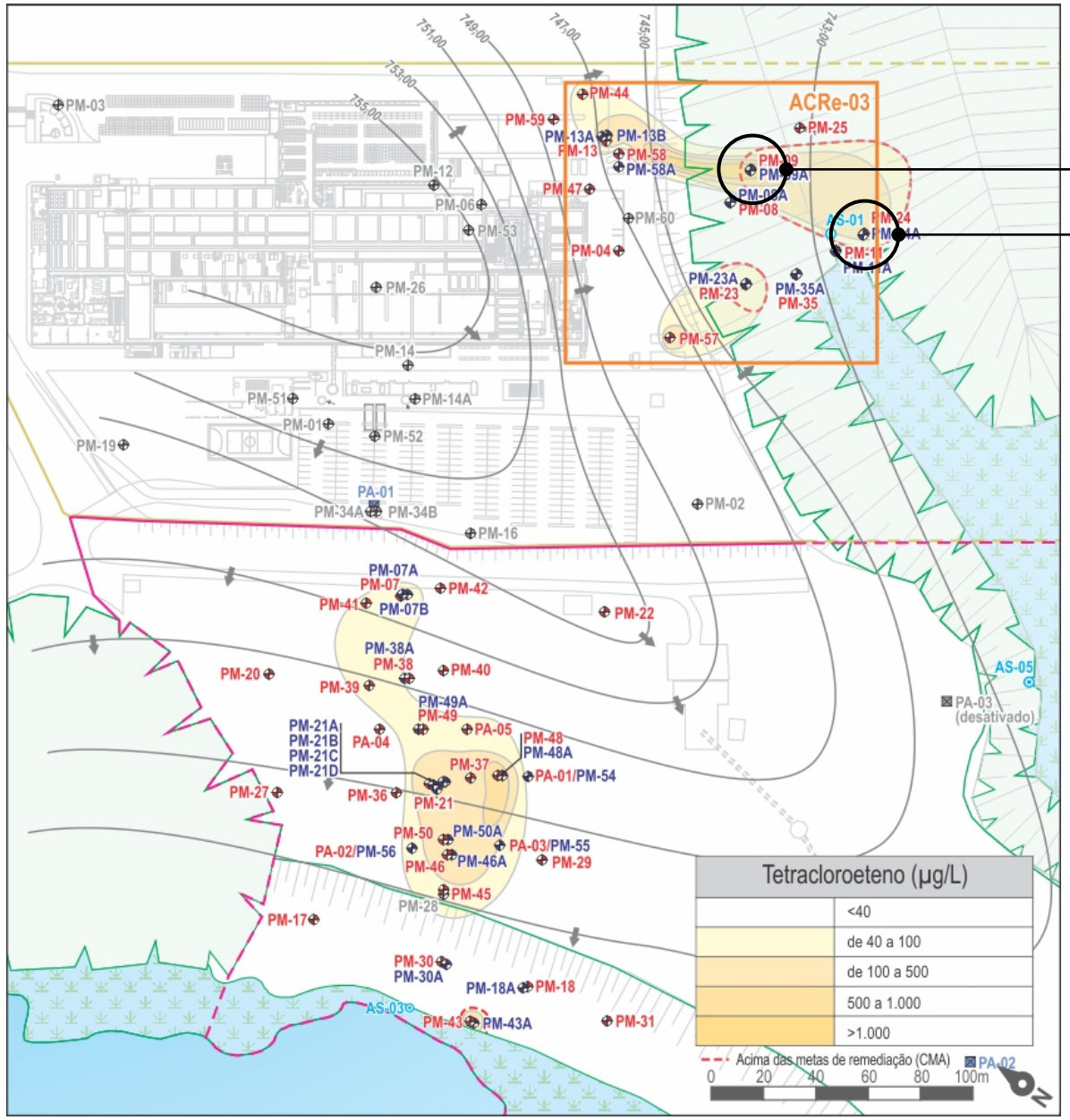
Full Scale Remediation - Executed and Planned Injection - ACRe-03

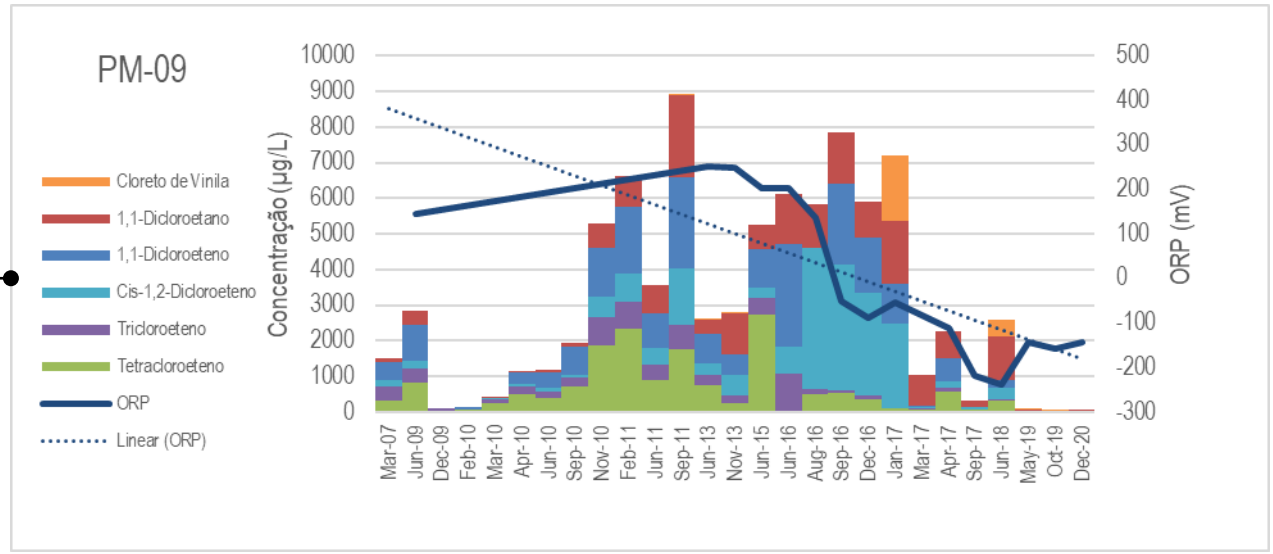


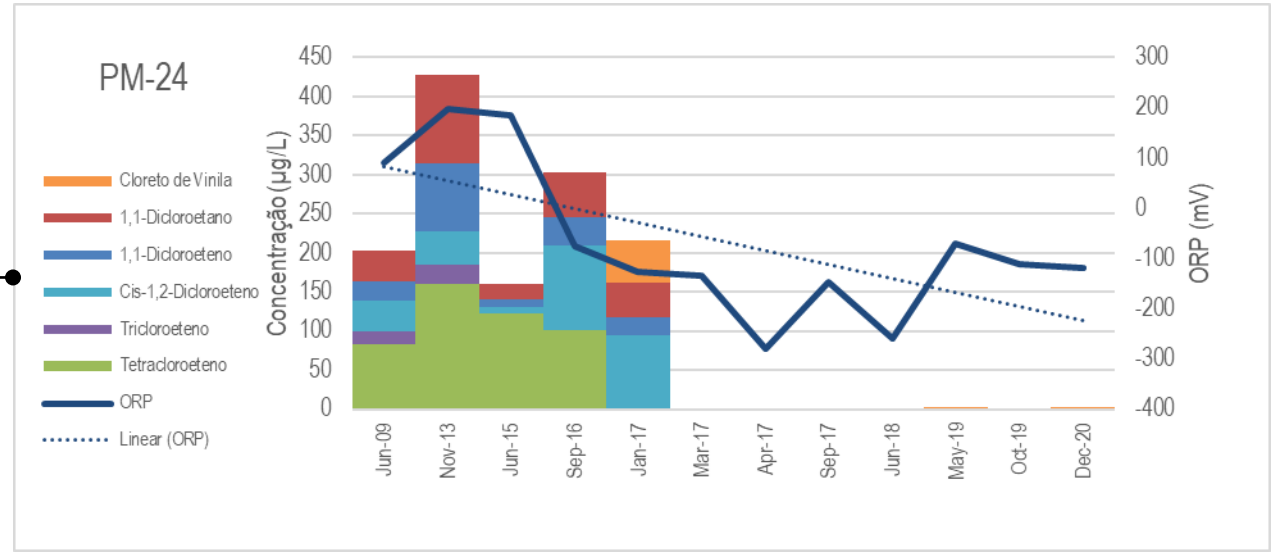
ORP Variation



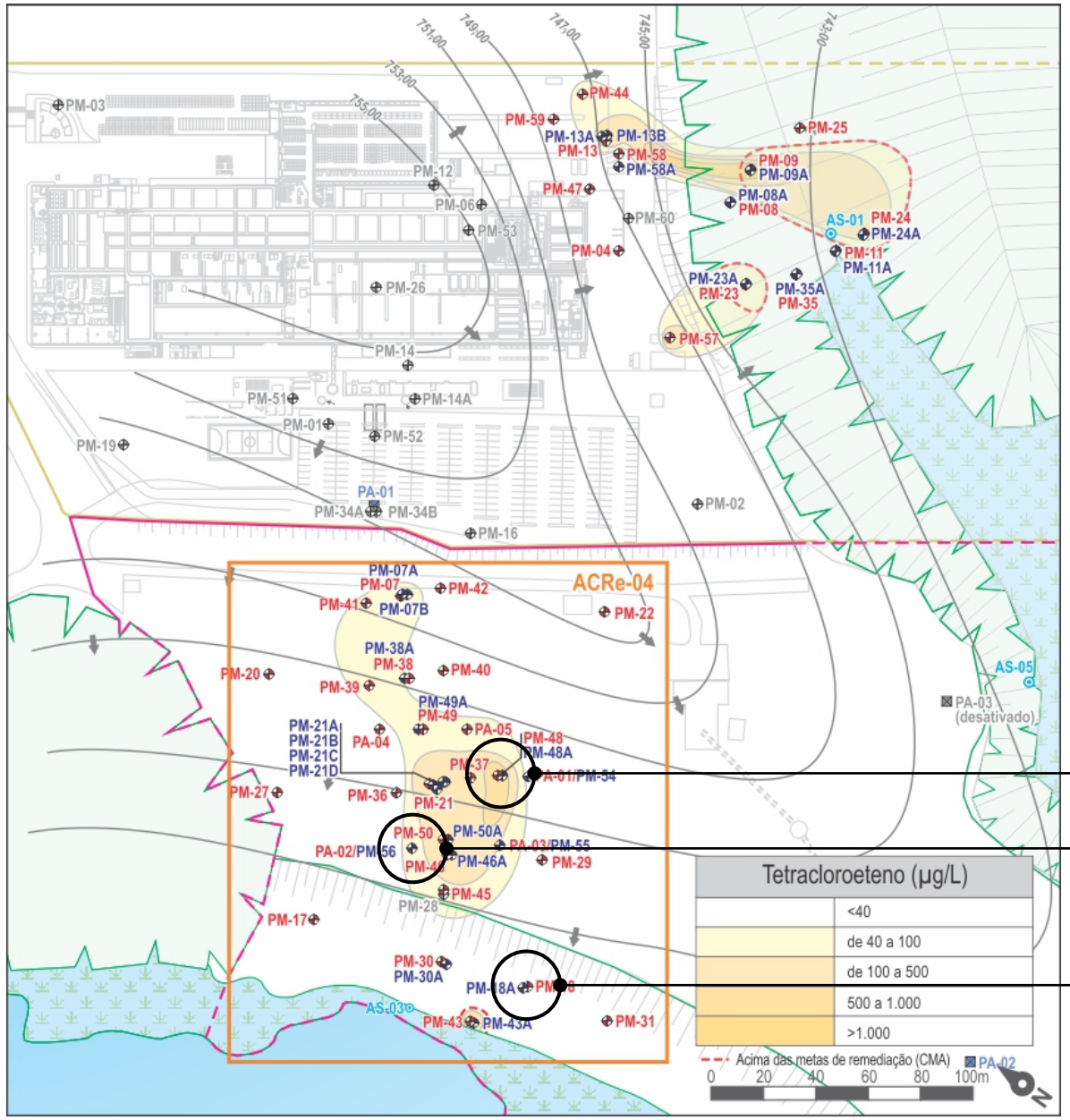
Performance Results - ACRe-03

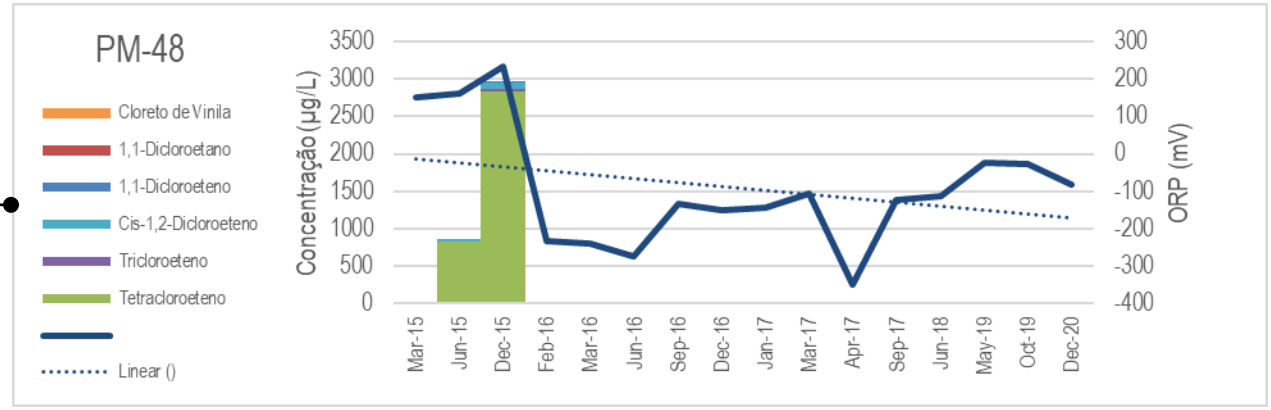


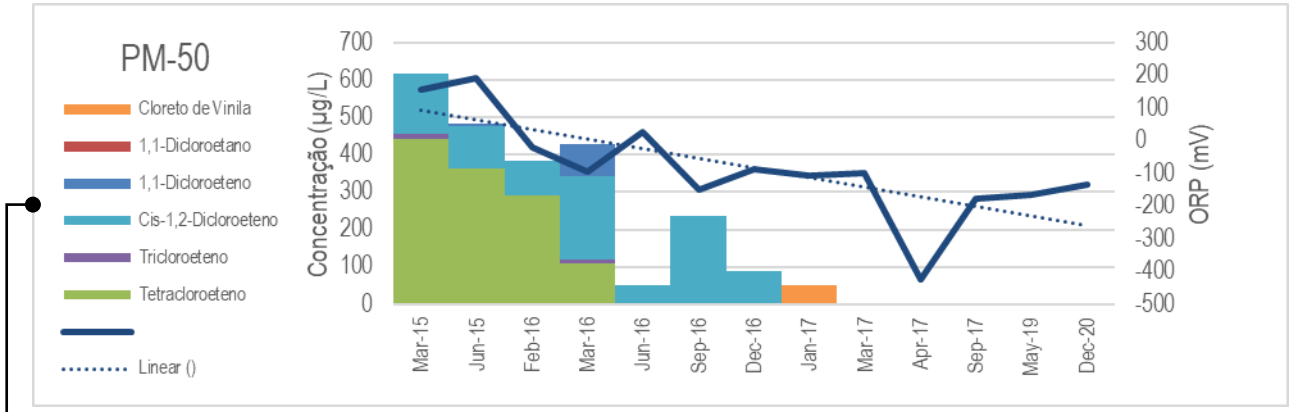


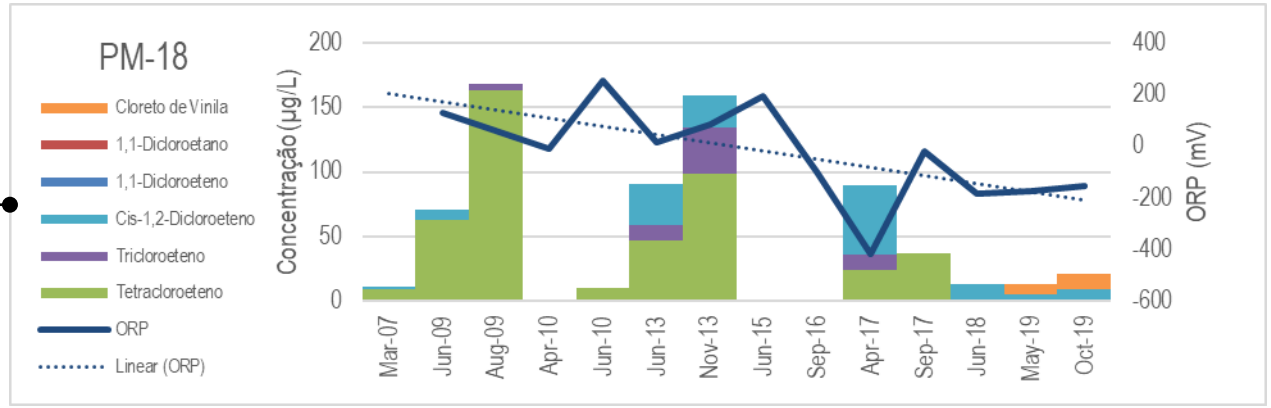


Performance Results – ACRe-04

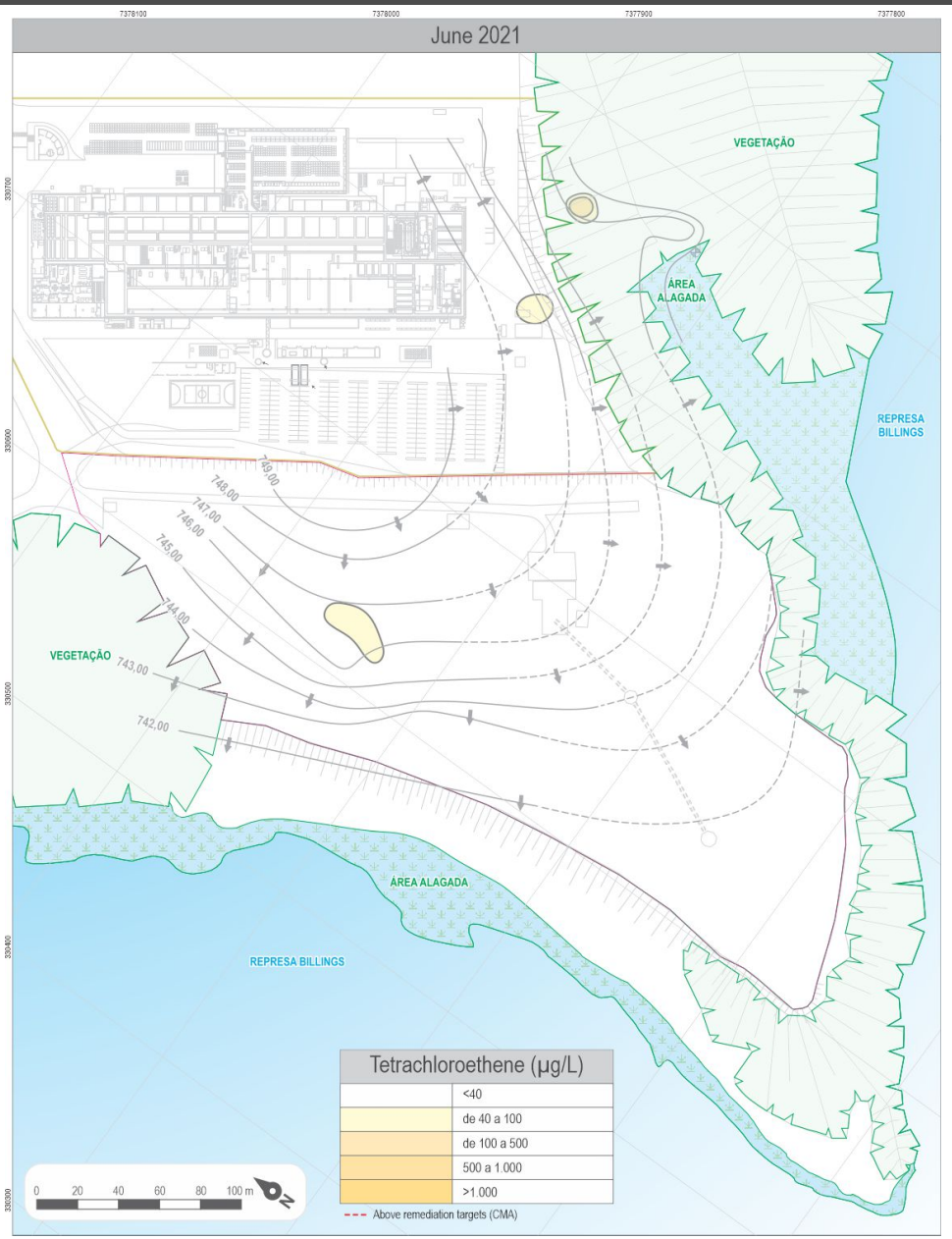


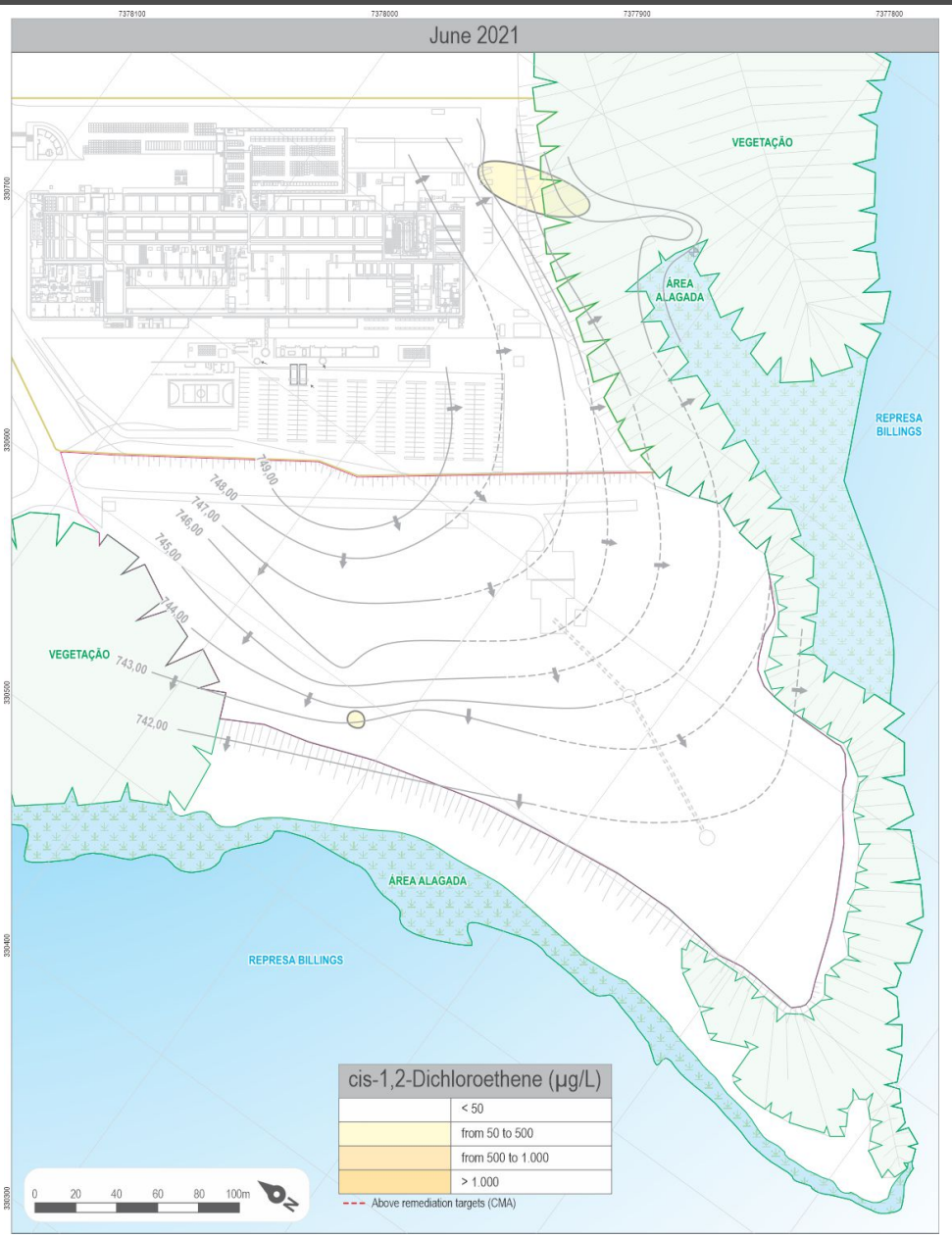






Plumes Evolution





Conclusions and Lessons Learned

- ✓ **Refining the contamination plumes** and understanding the **Hydrogeological Model** were essential for the correct development of the remediation project
  - ✓ 3 different stakeholders – Client, Env. Agency and Neighbors
  - ✓ 3 different SSTLs, including potability (MCL)

- ✓ The **amendment** must be **dosed and applied in a customized way** for each site, and calibrated for each area, layer and hydrogeochemical condition.
  - ✓ Slurry viscosity enhancement to help avoiding daylighting

- ✓ The **injection challenges** in the vegetation areas were solved after several attempts, approaches and help from **Provectus** and **IET** team
  - ✓ Reduction of fracturing to avoid daylighting through trees' roots

- ✓ The presented project is currently in **no further action** stage

Thank You!

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