Presentation

Dutch Advanced In Situ Remediation Technologies in Canada

A “success” story on Canadian-Dutch co-operation in Canada between private Solution Providers supported by both Canadian and Dutch Governments

Yvo M.M. Veenis
Managing Director Groundwater Technology BV
Yve@gtbv.nl
www.gtbv.nl

Introduction

Topics

1. Canadian Perspective
2. Dutch Perspective
3. Business Perspective
4. Cases

Canadian Perspective

Canadian Governmental institutions involved:

- Provincial Governments (AB, ON, QU)
- Local (City) Governments
- Support from National Government
- Support from Centers of Excellence (e.g. OCE, MCEBR)

Scientific Institutions and private businesses

Missions & meetings

Dutch Perspective

Dutch Governmental institutions involved:
- Dutch ministry of Housing, Spatial Planning and Environment (VROM);
- Ministry of Agriculture, Nature and Food Quality (LNV)
- Ministry of Economic Affairs (EZ).

Scientific Institutions (e.g. Deltares) and private businesses (e.g. Groundwater Technology)

Under 2g@there/NSP support for network/business development and demonstration projects; missions, meetings & conferences

Dutch Perspective

NSP is financially supported by its participants and the Dutch government through the 2g@there program administered by the EVD office for the Dutch ministry of Economic Affairs.

NSP is a collective network, introducing Dutch state-of-art technologies and sustainable integrated solutions to its partner countries. It offers participants a platform to:

- Exchange information about the international soil market
- Create opportunities to access the international soil market
- Organize workshops or seminars to promote Dutch solutions
- Organize incoming missions and outgoing missions
- Obtain reports about the development of international markets

Private Business point of view

Market	Canada	Europe	Netherlands
People	33.487.208	491.582.852	16.715.999
Size (land) (km2)	9.093.507	4.324.782	33.893
people/km2	4	114	493
Economy (GDP in 2008 US$)	1,30E+12	14,9E+12	0,67E+12
Economy per capita	38.821	30.310	40.081

Economies comparable, land use pressure vastly different

Netherlands: accustomed to high pressure on land use

Canada: increasing pressure on land use through legislation

Business culture: compatible

Private Business point of view

Therefore: mutual business opportunities:

- Bring Dutch experience & know how to Canadian Market
- Bring Canadian experience & know how to Dutch Market

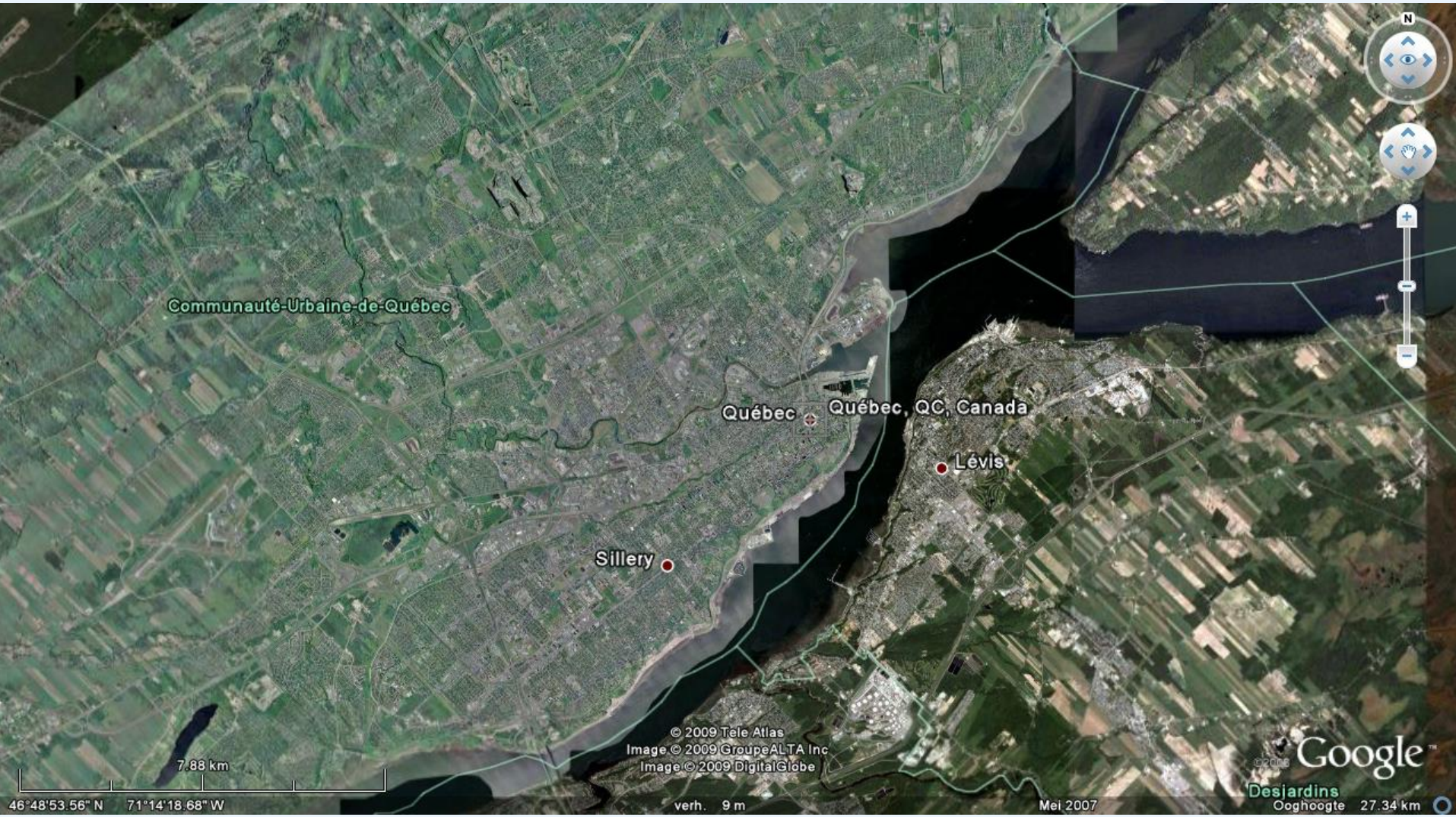
Case 1

Province of Quebec, Major City

- Down town site, ex service station
- Prime real-estate, in use as day care centre
- Contaminated, free product, migrating towards river

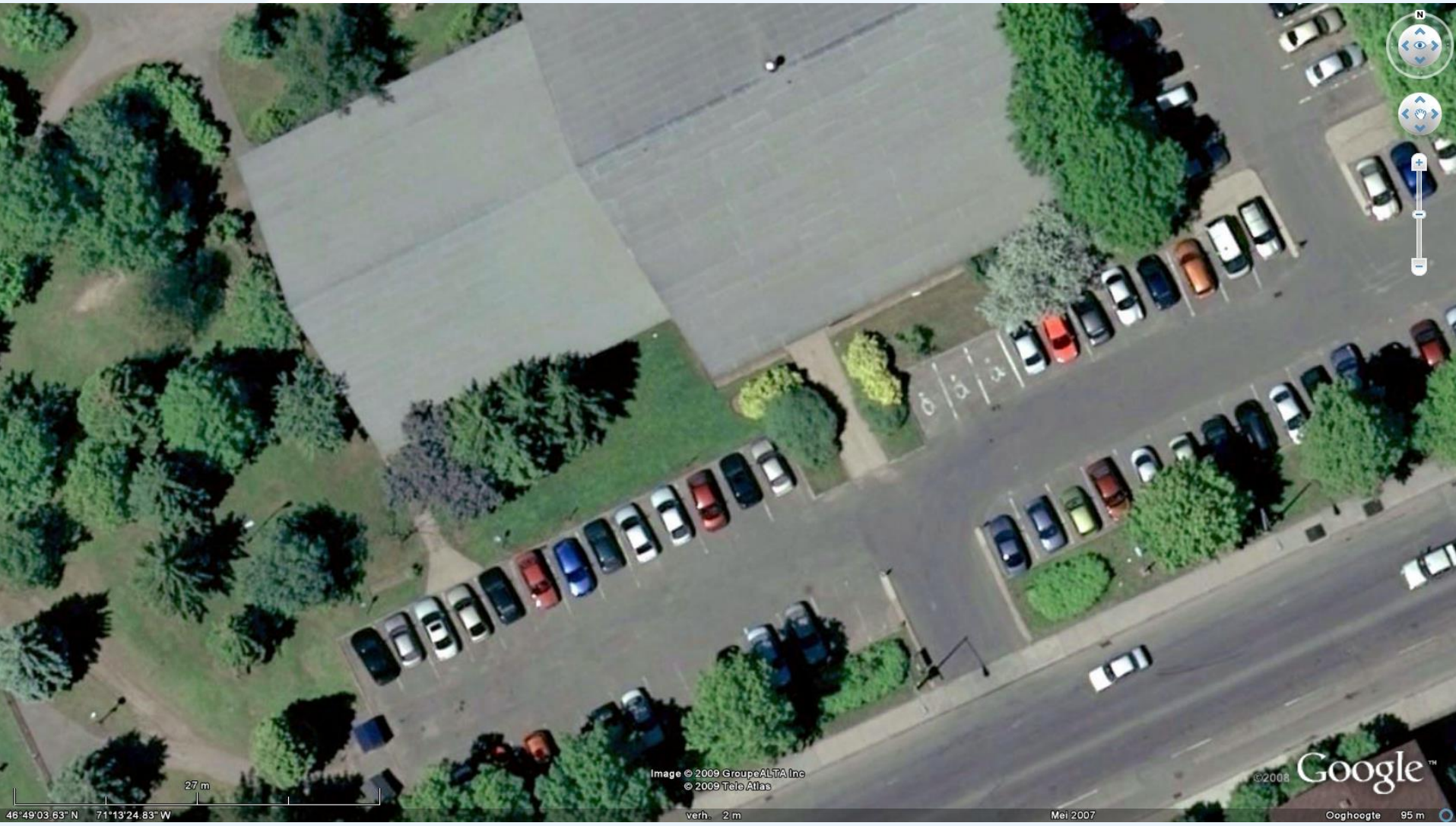
Case 1

Groundwater Technology



Case 1

Groundwater Technology



Case 1

Groundwater Technology

Oct 2009

Case 1

Solutions:

- Excavation impossible (building & too deep)
- Complicated geology & high concentrations
- Consultant interested in innovation
- Client (Municipality) interested in new technologies to remediate while minimising nuisance

Case 1

Co-operation between

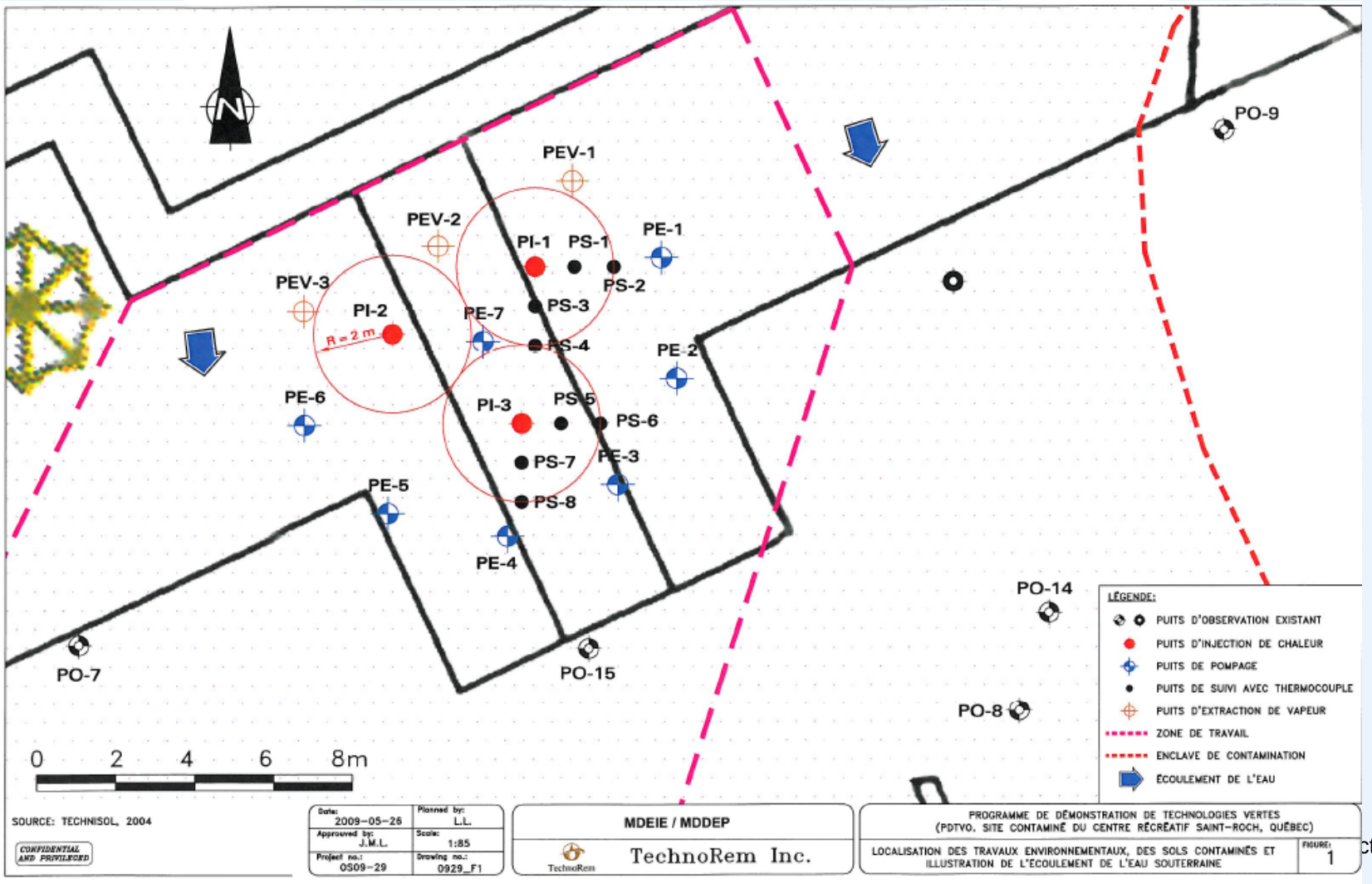
Technorem, Inc (Quebec)

Groundwater Technology BV (The Netherlands)

Deploy a train of in situ technologies to optimise remediation

- Heat enhanced recovery (Steam injection) for high mass removal, mobilisation and precursor to next step
- In Situ Chemical Oxidation in hot soil after steam injection
- Evaluation of effectiveness

Case 1



ct 2009

Case 1 Status

B2B matters: contracts in place

B2B plans (implementation, action plan etc): complete

Governmental positions: Positive view

Financial issues (government support, grants) developing

Start-up: awaiting final green light on government financing

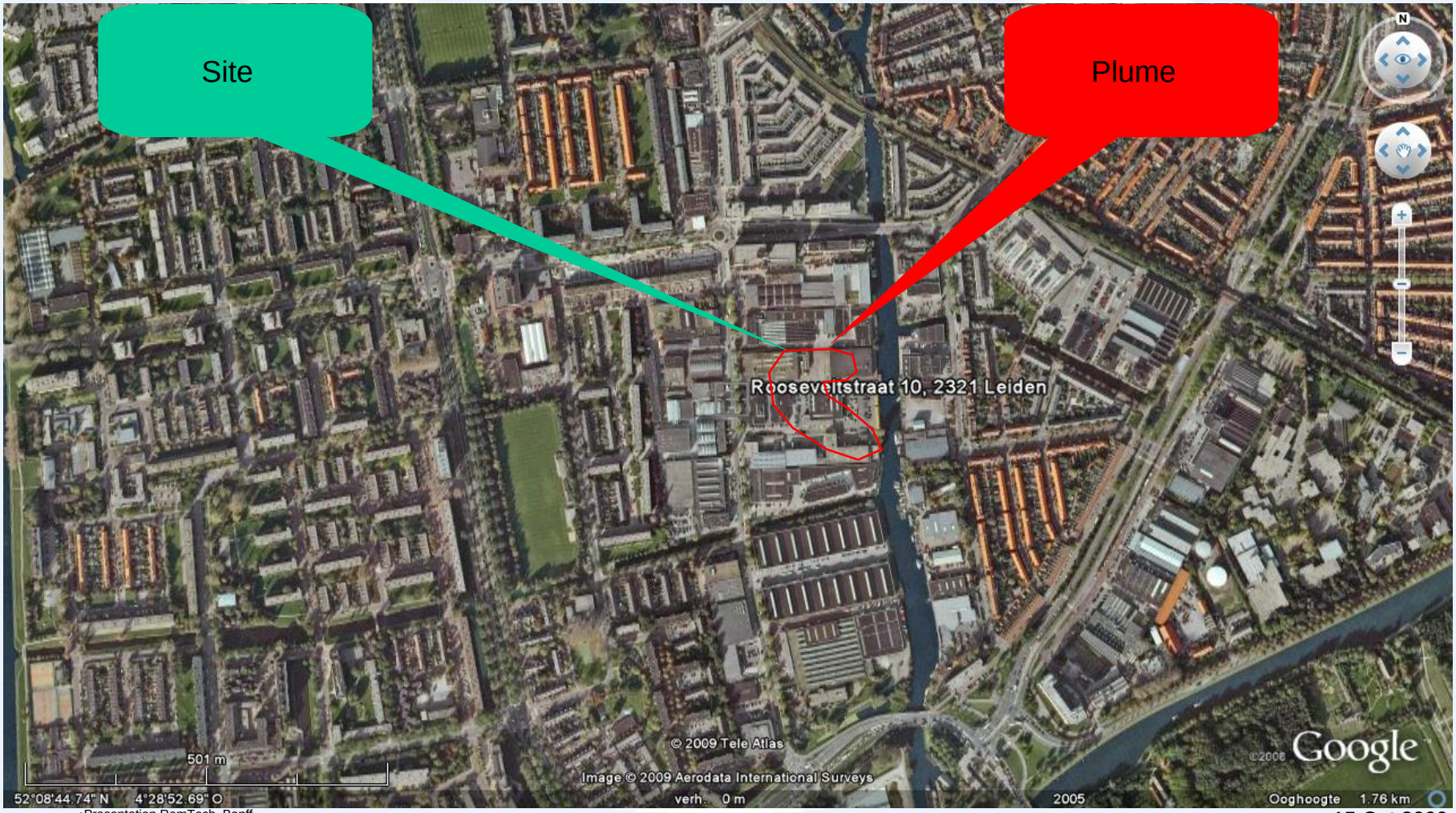
Case 2: ISMP

Former metal factory, soil and groundwater contaminated by heavy metals and Chlorinated Hydrocarbons
Site in urban redevelopment area

Development consortium handles redevelopment and source zone excavation

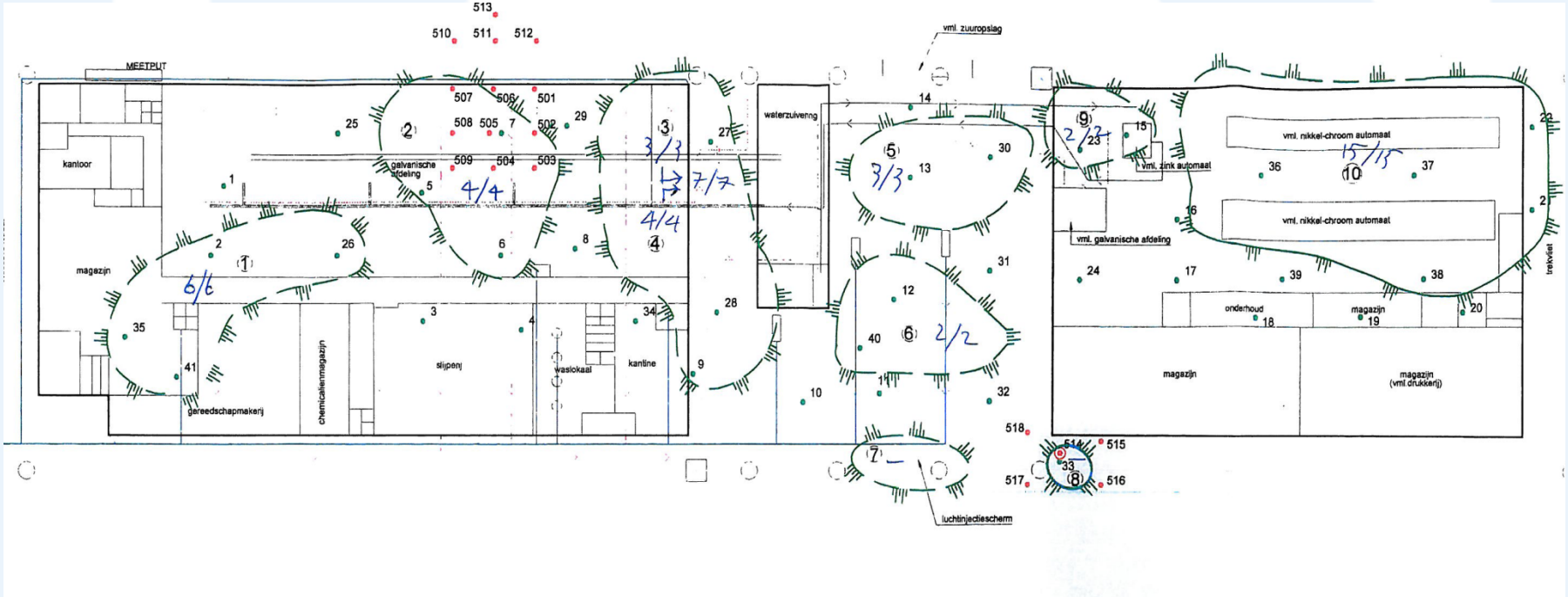
GT requested to address deep & off-site plume

Case 2: Site Overview



Case 2: First Phase

1. Demolish buildings and foundations
2. Excavation of the contaminated soil



Case 2: Second Phase

Direct injection of a mixture of methanol, lactate and protamylasse leads to biodegradation of the Chlorinateds

Low redox levels lead to sulphate reduction

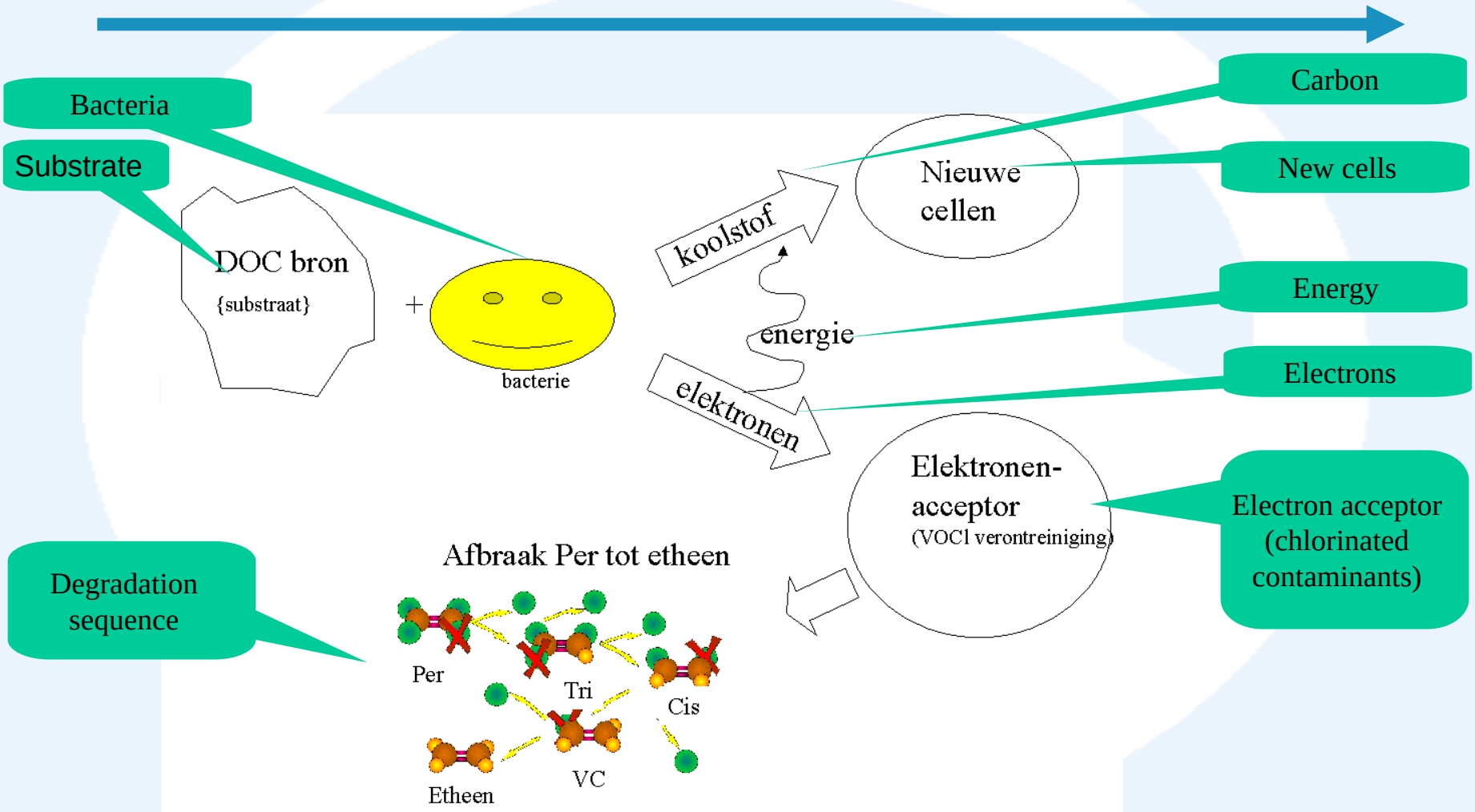
Sulphate reduces to Sulphite

Sulphite & nickel bond to form NiS

NiS has very low solubility => NiS precipitates

Case 2: Second Phase

Groundwater Technology



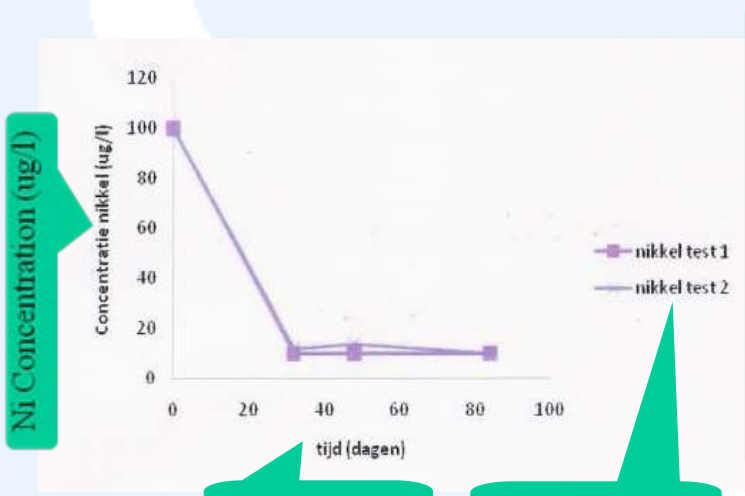
Case 2: Conceptual model

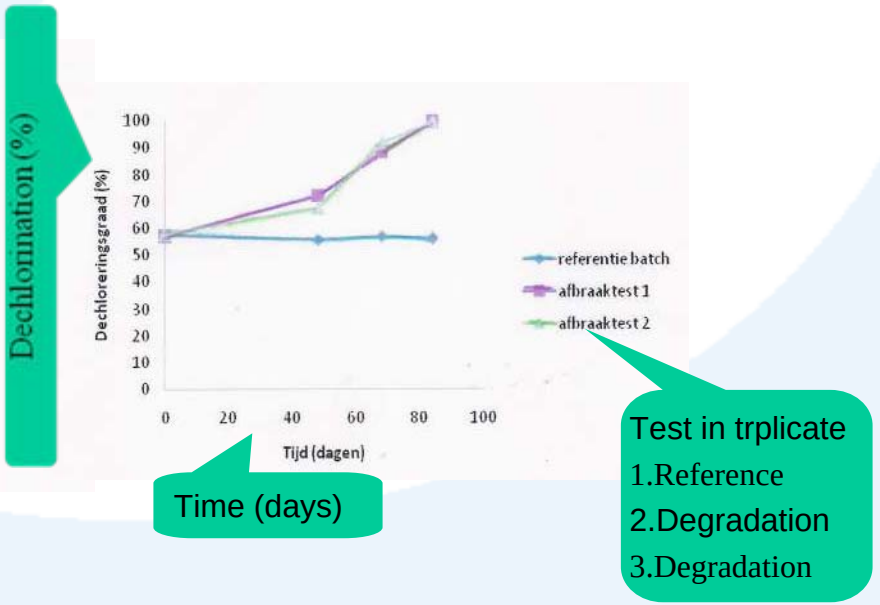
Basic model:

- Topsoil, very fine sand, slightly permeable; 0-2.5 m
- Clay 2– 6 m
- Clay & peat layers 6– 7 m
- Deeper than 7m: Aquifer (7 – 10 m: fine sand)

Case 2: Lab testing

- Biodegradation of the VOCl's takes place
- Immobilisation of the Ni takes place
- Extra addition of sulphates has a positive effect on the immobilisation of Ni





Case 2: Implementation (1)

Phase 1: Application of 2.5 tons sulphates (solid form) in excavation

Case 2: Implementation (2)

- Phase 2: Direct injection;
- After backfilling: in total 254 injections
- 127 m^3 substrate mixture injected

Case 2: Monitoring (3)

Monitoring during 5 years

- 3 & 6 months,
- 1, 2, 3 and 5 years after the injections)

Case 2: Monitoring (3)

First results after 3 months:

- Ni concentrations dropped,
- DOC up to 1.000 mg/l
- PER/TRI/CIS concentrations decreasing
- VC, ethene, ethane increasing

Case 2: Costs / duration

Phase	Duration	Cost estimate (euro)
Lab testing	3 months	€ 25.000
Sulphates application	1 week;	€ 5.000
Injection (substrate) first round	3 weeks	€ 80.000
Injection (substrate) second round	3 weeks	€ 40.000
Monitoring	5 years	€ 30.000
Lump sum risk	-	€ 100.000

Case 3: Issue

- Ex dry-cleaners facility in 16th century building. Designated monument & on cultural heritage list; part of old city centre Weesp on water front
- Volatile chlorinated ethenes, degading
- Low permeability soil
- Highly susceptible to subsidence
- Transfer of ownership: future liability is an issue

Case 3: Situation

- Contamination extends over 150 m2 (source: 60 m2) ; vertical extent > 7 m (deeper unknown)
- Migration appears to be minimal
- Typical approach: ‘monitored natural attenuation)

Case 3: Actual question

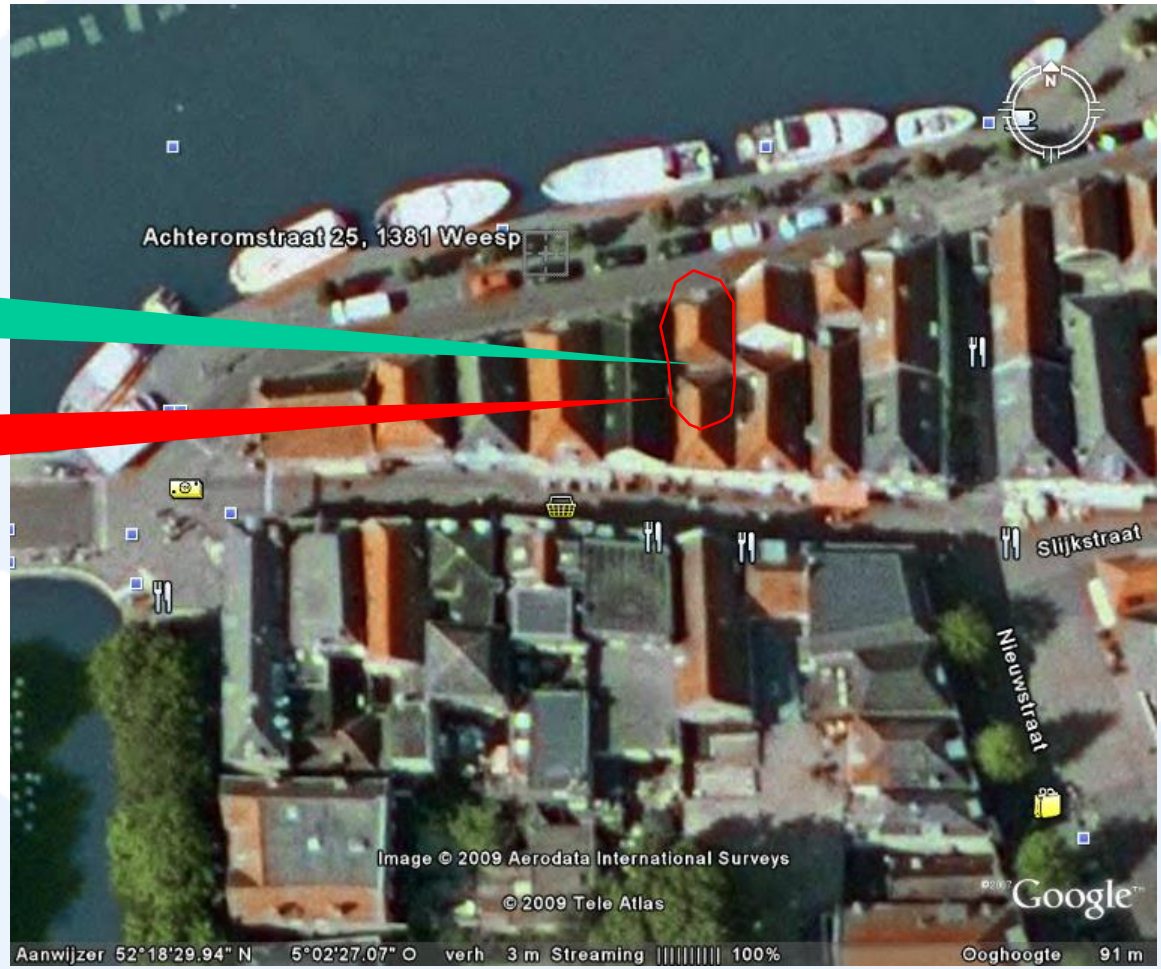
1. What GT can provide provide to avoid ‘perpetual’ monitoring
2. Perpetual monitoring is unwanted burden
3. Perpetual monitoring decreases value of site

Case 3: Site Overview

Groundwater Technology

Site

Plume



Case 3: Conceptual model

Basic model:

- Topsoil, very fine sand, slightly permeable; 0-2.5 m
- Clay 2– 6 m
- Clay & peat layers 6– 7 m
- Deeper than 7m: Aquifer (7 – 10 m: fine sand)

Case 3: GT Solutions

Ruled out:

- Standard approach is most cost-effective. (Costs of active measures will not be off-set by savings on monitoring)
- Pump & treat, sparge & vent ruled out (subsidence)
- ISCO ruled out (presence of peat)
- In Situ Anaerobic Biodegradation (monitoring phase too long)

Ruled in:

- In Situ chemical reduction
- In Situ stabilization

Case 3:
GT approach

Intensive mass reduction followed by in situ stabilization
Intensive step:
In Situ chemical reduction: inject nano-iron slurry in vegetable oil
Inject substrate & nutrients to promote in situ biodegradation
Polishing step:
Reduce permeability to stop migration

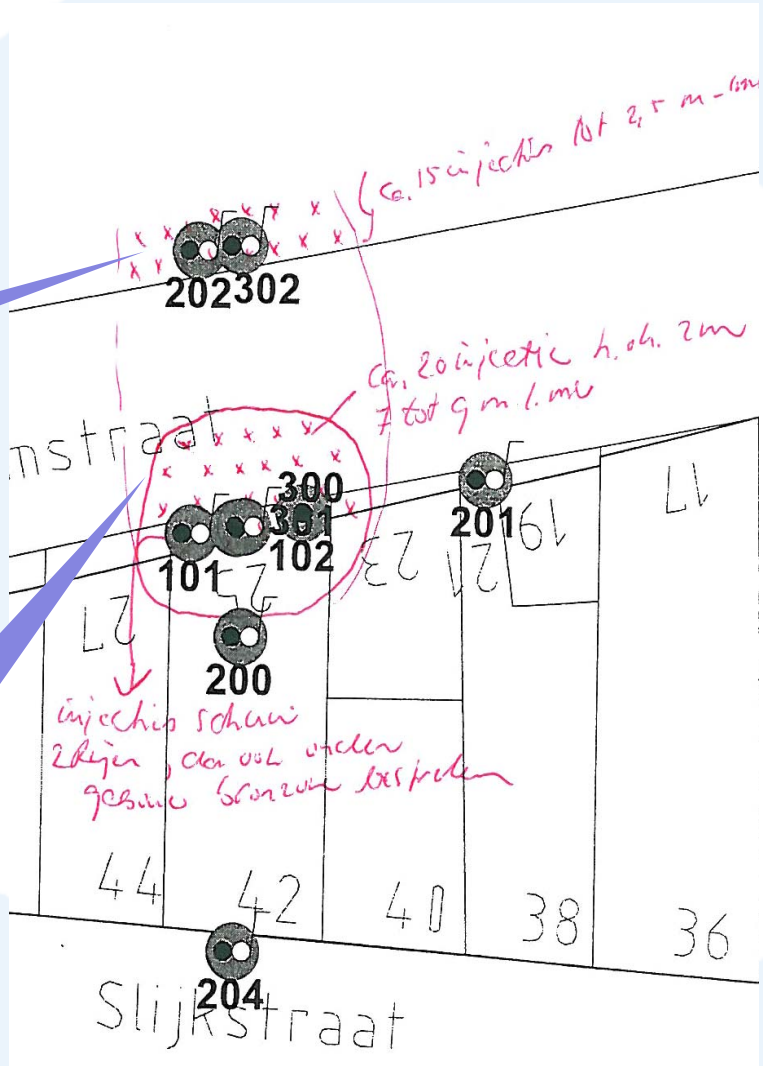
Case 3: Implementation

Two injection zones:

1. In front of premises
   - First round: 20 injection points, some oblique underneath building, to 7 m – grade: nano-iron & substrate
   - Second round: 20 injection points, some oblique underneath building, to 7 m – grade: to reduce permeability
2. At waterfront
   - 15 injection points (vertical) as precaution ('just in case')

Case 3: Conceptual model

Groundwater Technology



Approx. 15 injections, 2.5 m interval

Approx. 20 injections, 2 m interval

Case 3: Costs / duration

Option	Duration	Cost estimate (euro)
monitoring	perpetual	€1500 per annum
Basic injection (nano-iron)	Per injection event: 1 week; Total: 1-2 years	€35K
Additional injection (substrate)	No additional time; May save one basic injection round	€17K
In Situ Fixation	No additional time; May save one basic injection round	€16K

Thank You

Groundwater Technology

For Your Attention