

Innovative ISCO injection Technology

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Env. Geologist Ole P. Stubdrup
ostubdrup@yahoo.dk

Swedish Geotechnical Institute / Ejlskov

FP7 Collaborative Project
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**Sustainable Soil Upgrading by Developing
Cost-effective, Bio-geochemical Remediation Approaches**



UPSIL - WP 4:

“System Driven Injection”



Objective:

“to take forward, testa new innovative design based on system driven injection....”



Overall achievements:

Improved Cost-effectiveness' and sustainability

- When in-situ injection approach to remediate soil & GW is applied.

- Cost effective

- Reduced consumption of product
- Reduced project life span and time consumption
- Minimize required mobilizations (injections)
- Optimized effect of product injected
- An operational and solid system

- Environmental sustainable

- Minimized consumption of energy / product
- Minimize risks of negative environmental impact
- Minimize disturbance of uncontaminated soil/GW

- Targeted injection

- Only where contamination
- Injection vol. \leftrightarrow contamination level

- Flexible system

- Different products - “mixtures”
- Flow rate / pressure
- Concentration variability

- Real time data / logging

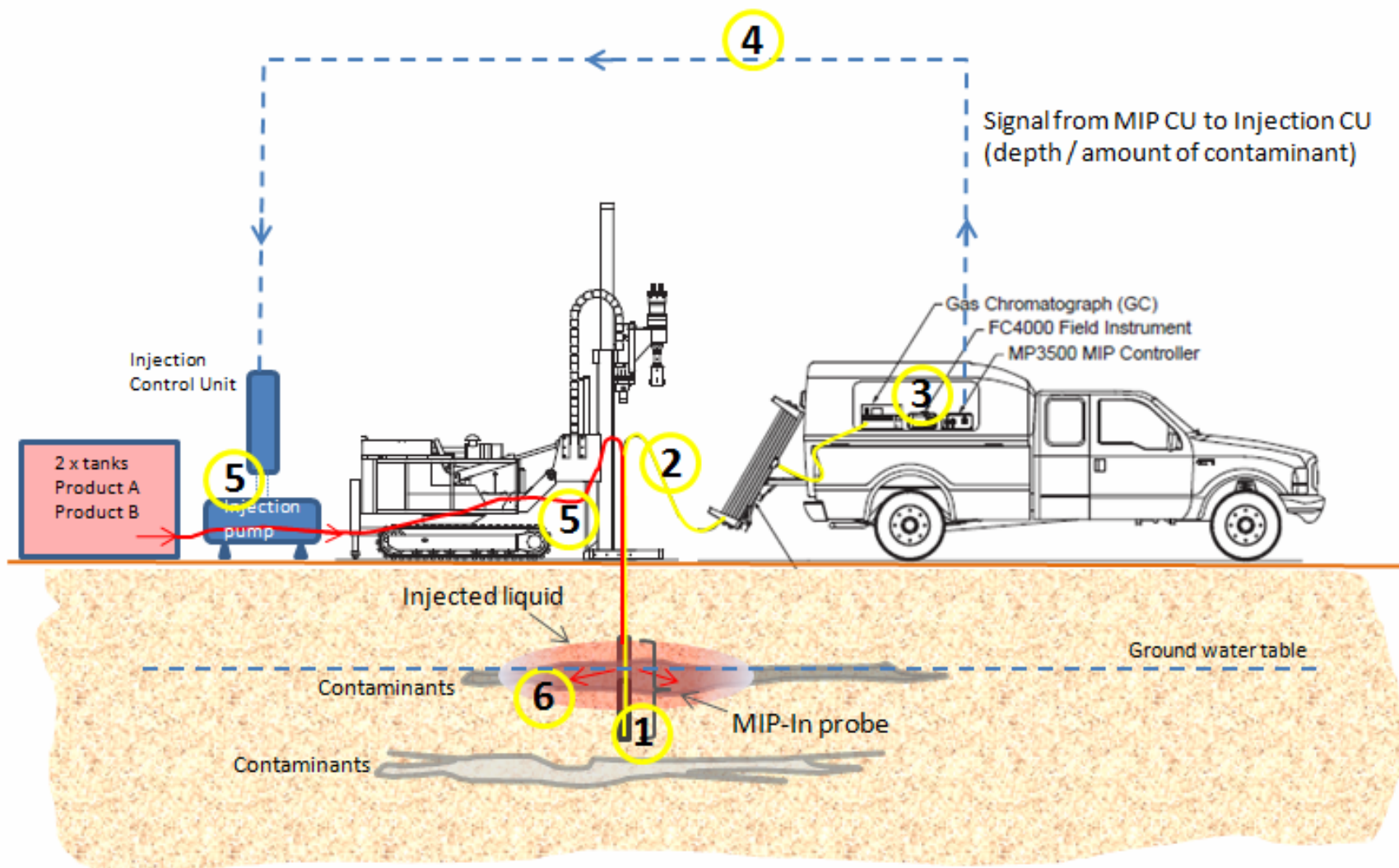
(contamination / injection)

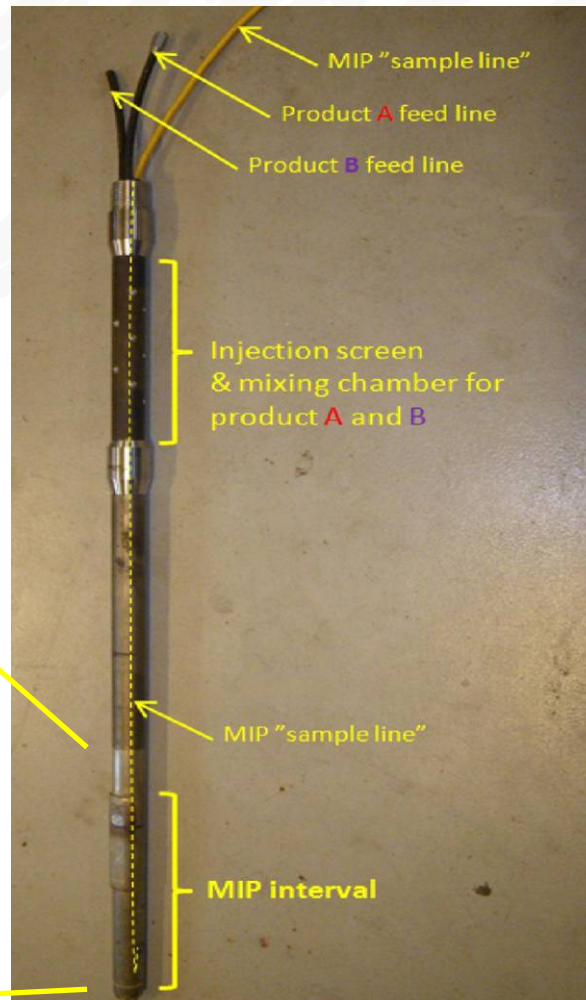
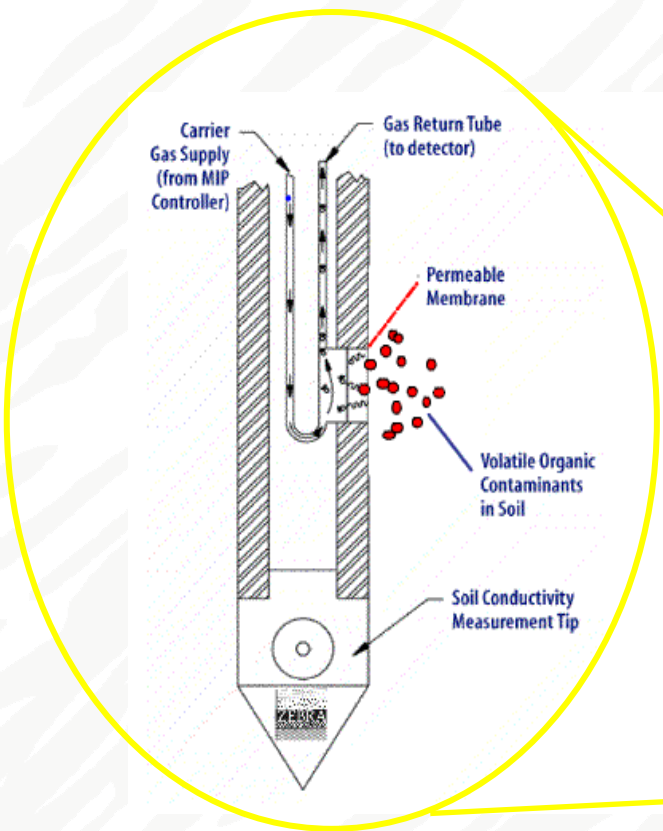
- Decision making in the field
- Documentation.

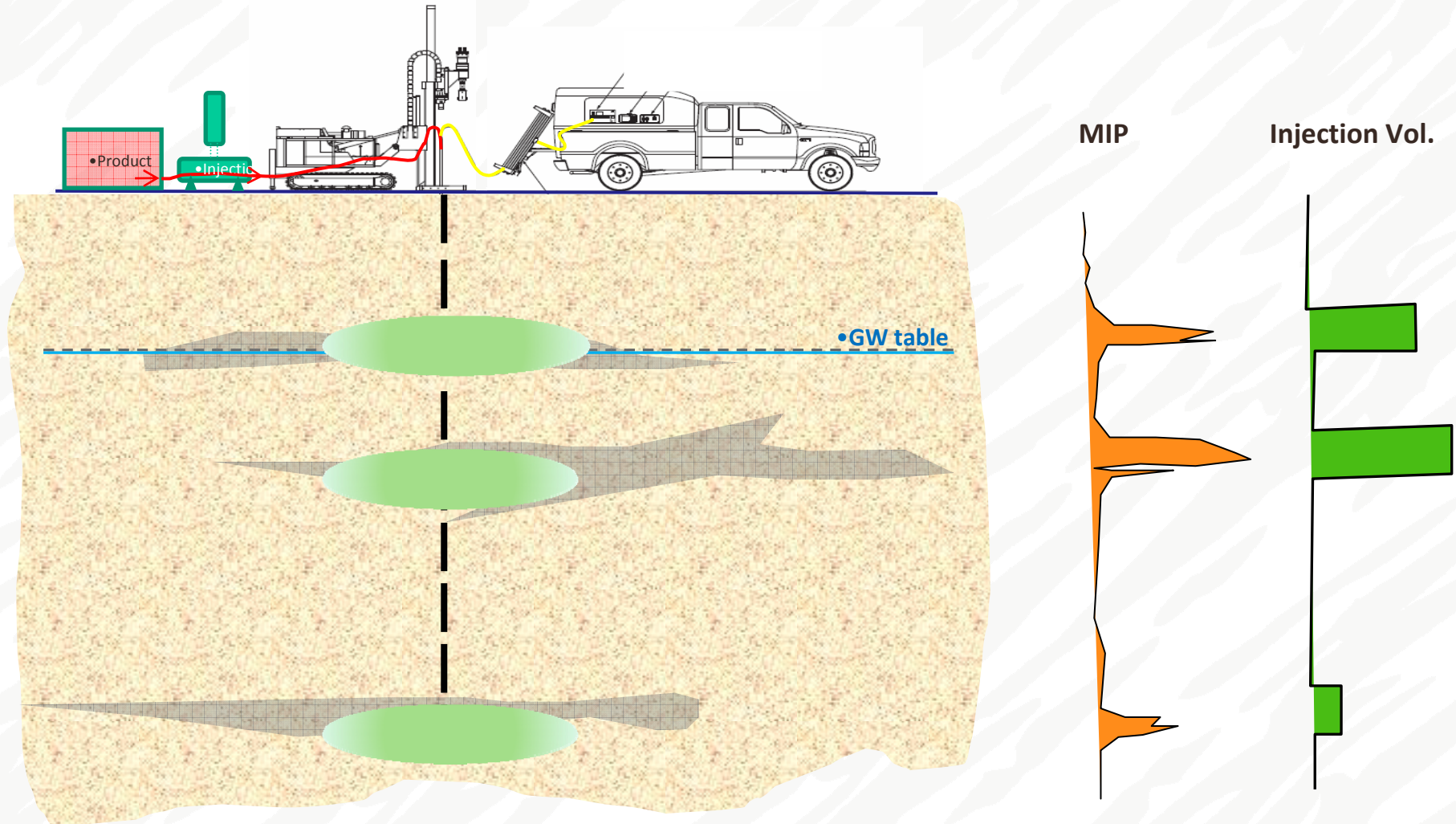
Data collection → Lab./reports/design/meetings etc. → **Injection**



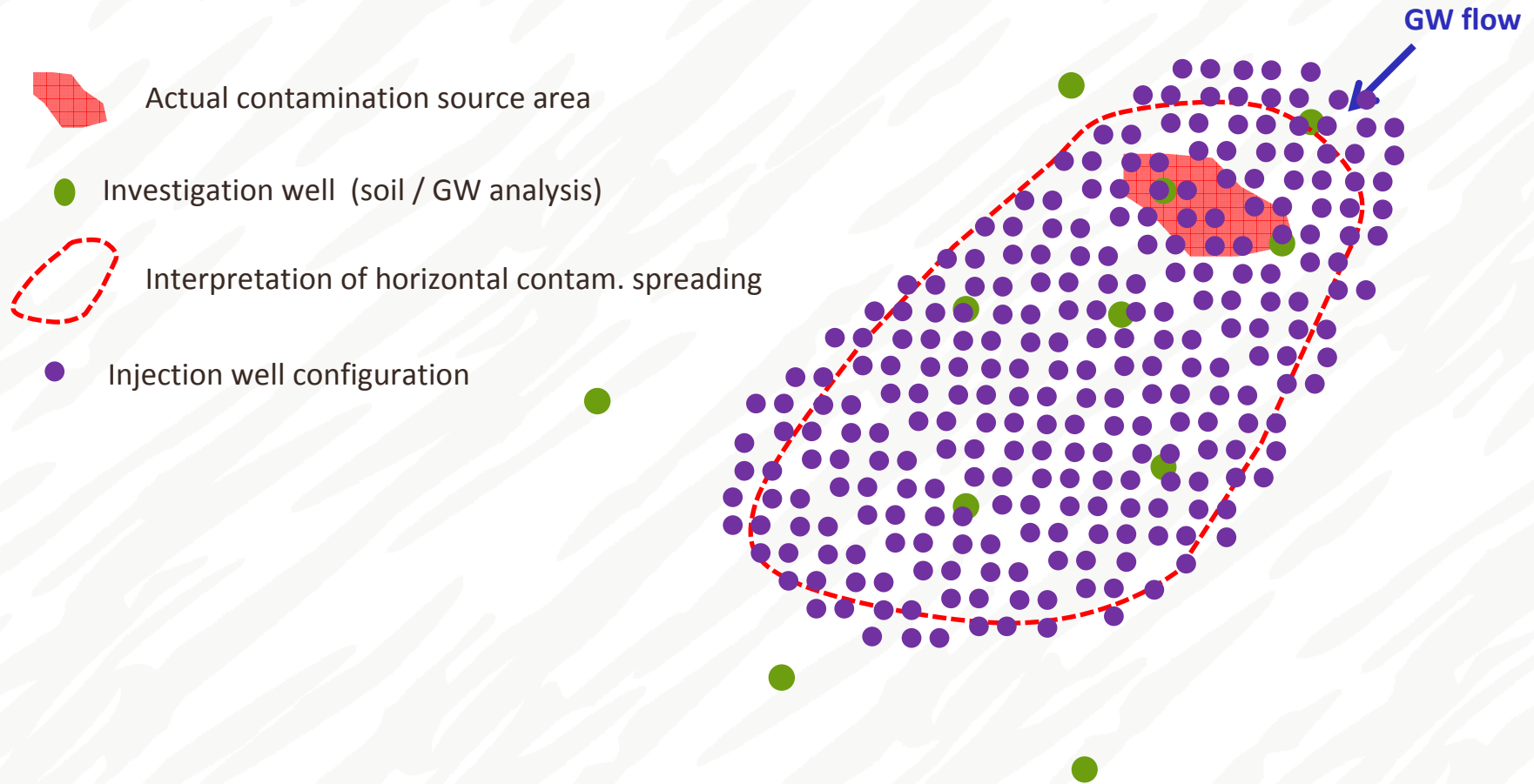
Principle of the new MIP-IN system (merging detection and injection)



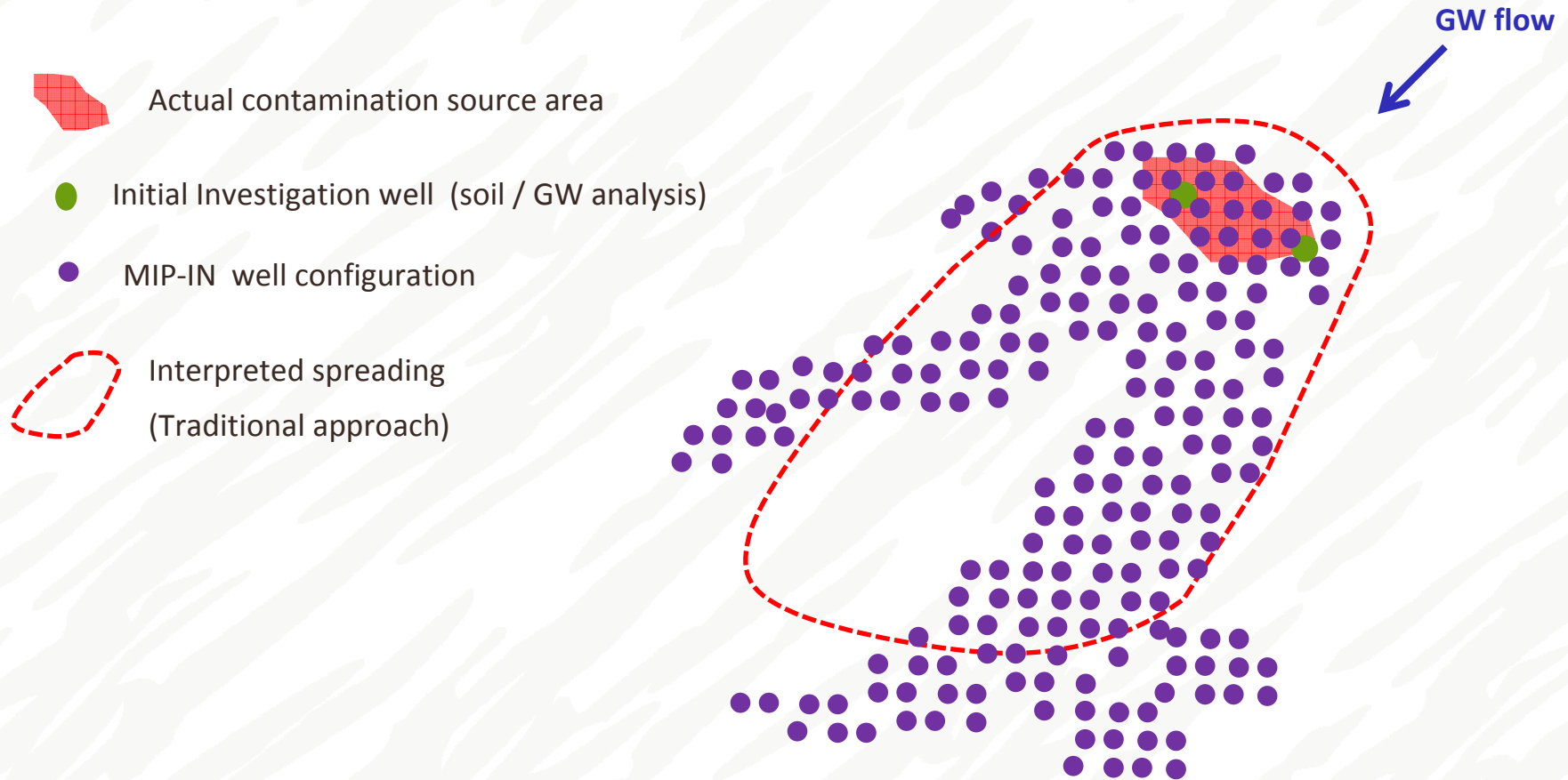




Traditional Approach




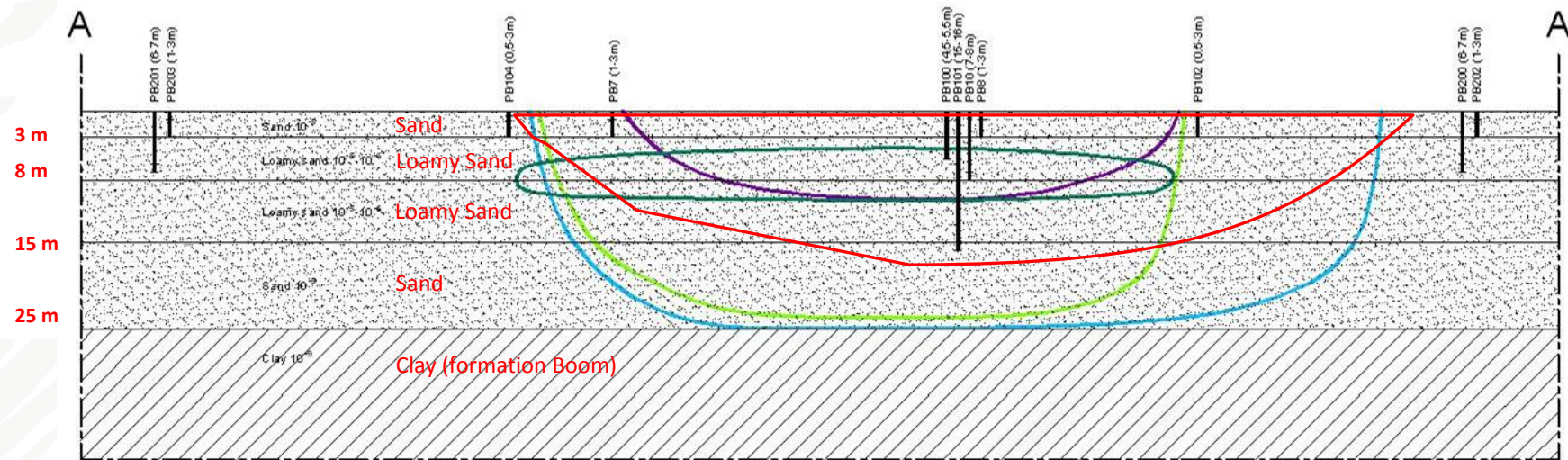
New Approach

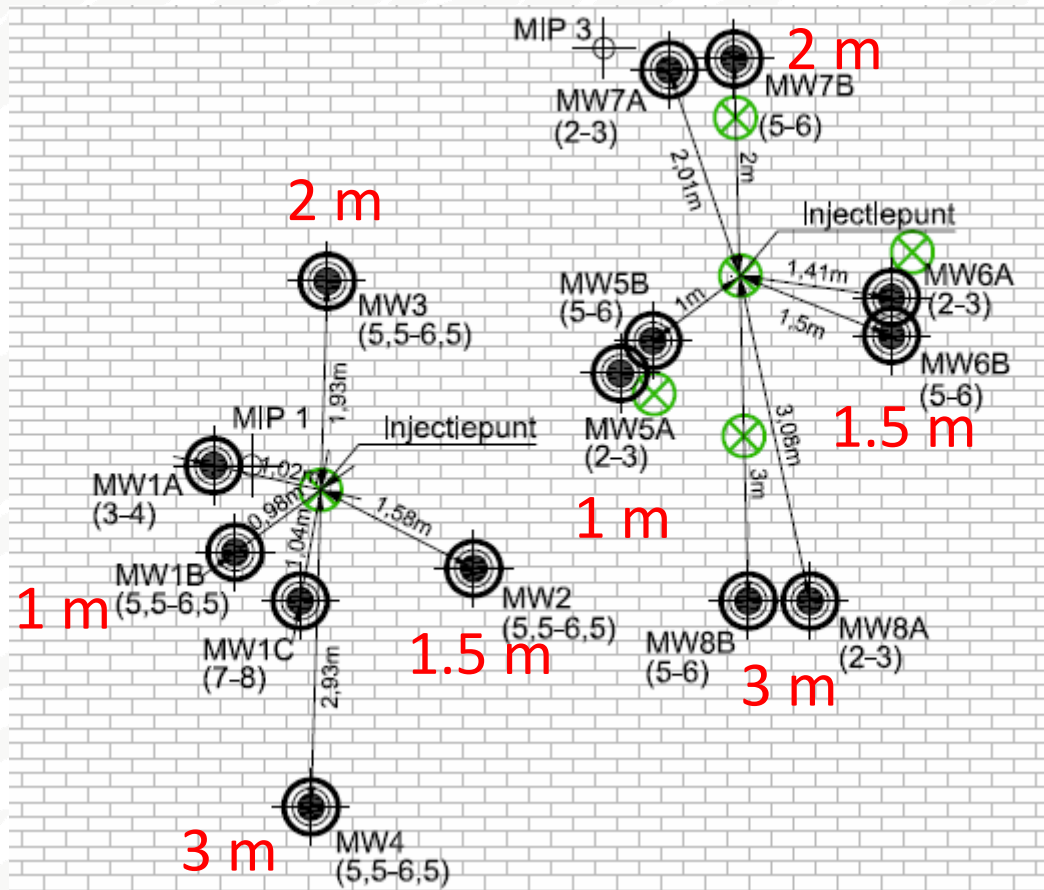


Site layout / contaminants:

Chlorinated hydrocarbons
(DCM, DCA, 1,2-DCE, VC)

BTEX's : 





Injection point -> MW 1 – 3 m

MW filters (1 m) in the depth interval 2 – 8 m b.g.l.

Monitoring equipment:



| | | Concentration (µg/L) | | | | |
|---|---------------|----------------------|---------|-----|---------|-----------|
| | | DCM | cis-DCE | PCE | Toluene | Ethylben. |
| Sterile control | | 120474 | 2113 | 149 | 1404 | 13543 |
| Oxidant | Activation | Degradation (%) | | | | |
| KMnO ₄ | - | 0 | 100 | 100 | 100 | 100 |
| Na ₂ S ₂ O ₈ | - | 14 | 78 | 36 | 81 | 59 |
| Na ₂ S ₂ O ₈ | Fe(II)citrate | 21 | 68 | 43 | 83 | 60 |
| Na ₂ S ₂ O ₈ | NaOH | 66 | 51 | 0 | 80 | 41 |
| Na ₂ S ₂ O ₈ | heat (50 °C) | 67 | 100 | 100 | 100 | 100 |

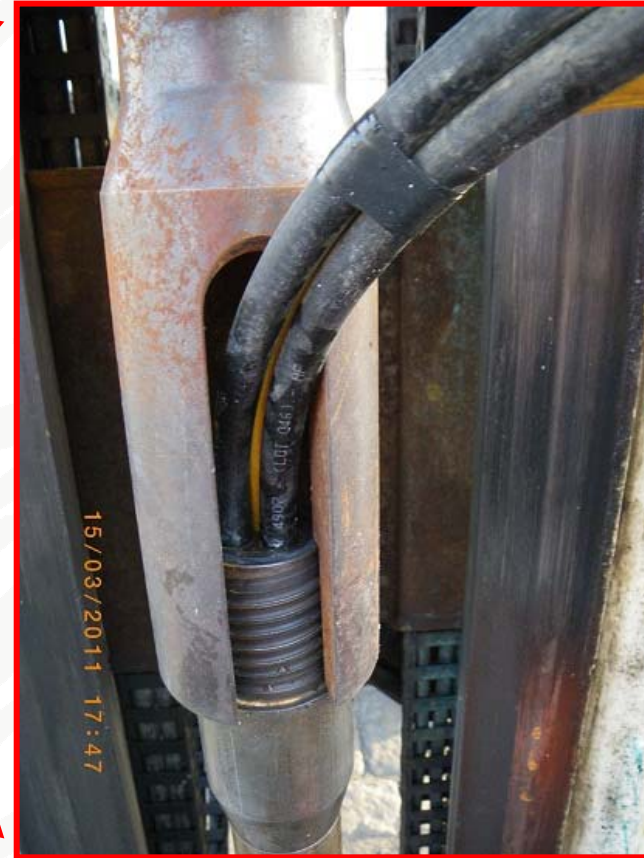
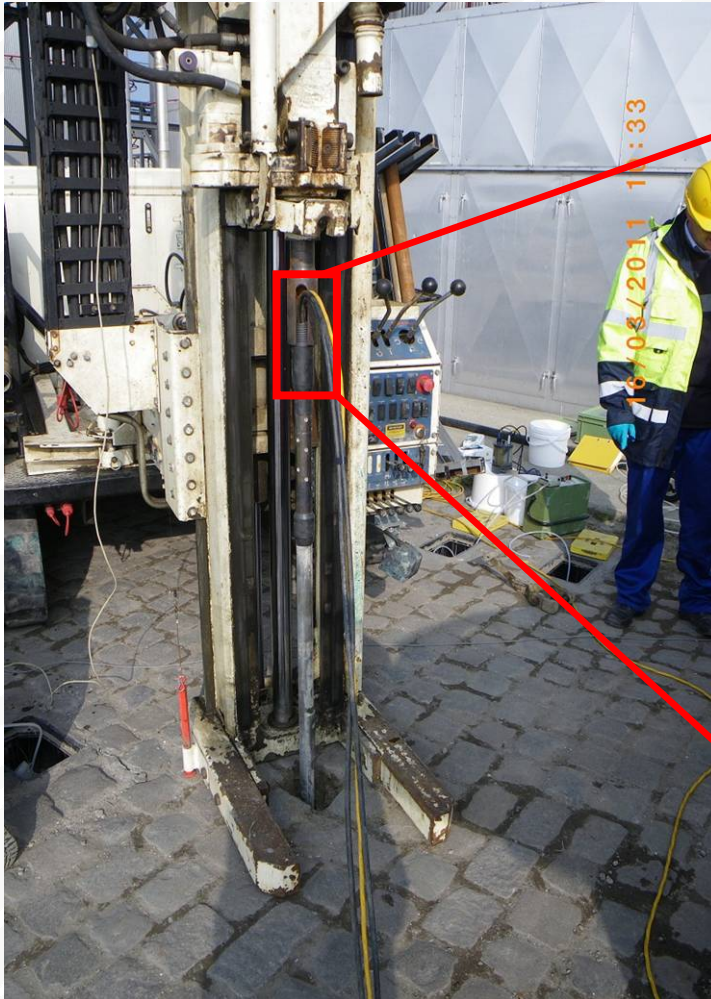
Conclusion:

Permanganate is the best oxidant – except DCM

NB ! Degradation test is important to choose the best oxidant and properly determination of oxidation demand.



- MIP-IN at 3 points between 2 to 7 m bgl
- Injection of 332 kg NaMnO_4 in app. 4 m³ injection solution
- Arrival of oxidant in closest wells:
 - purple colour
 - redoxpotential ↑↑
 - electrical conductivity ↑
- Immediate injection radius of influence: 1 to 2.2 m
- Heterogeneous geology → heterogeneous distribution of oxidant



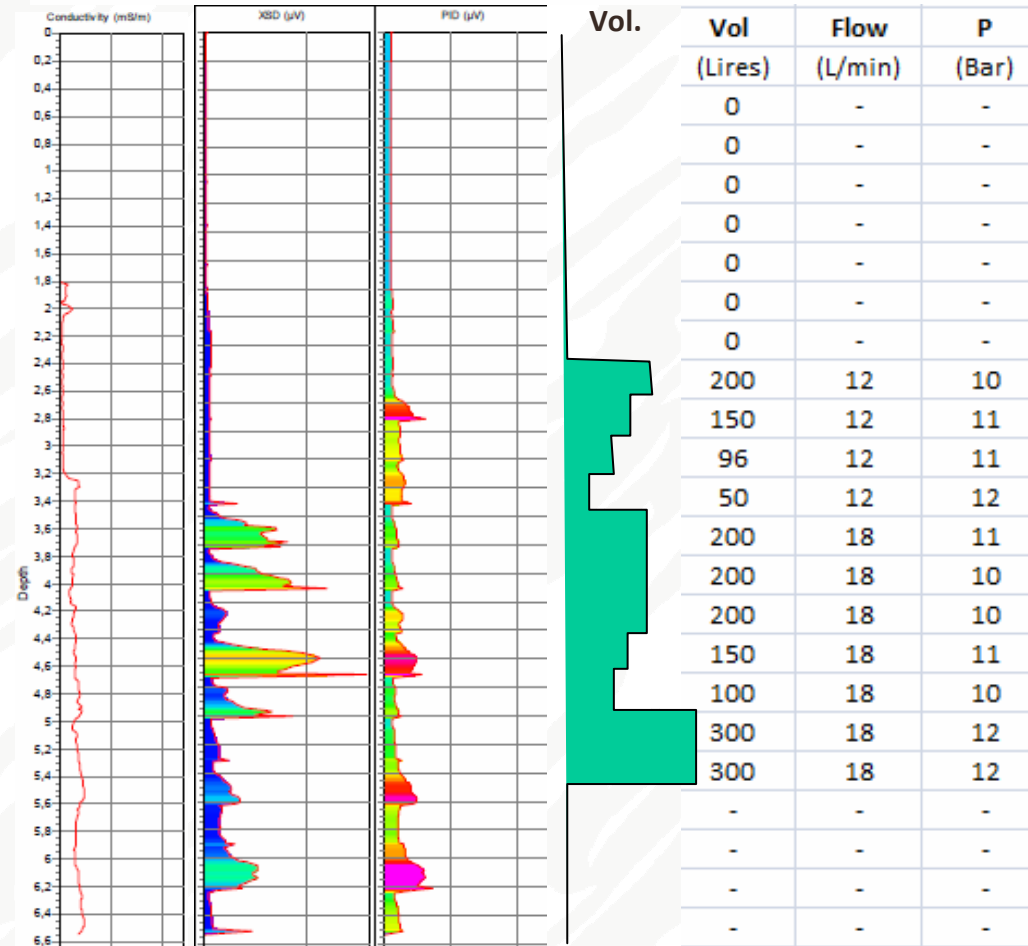
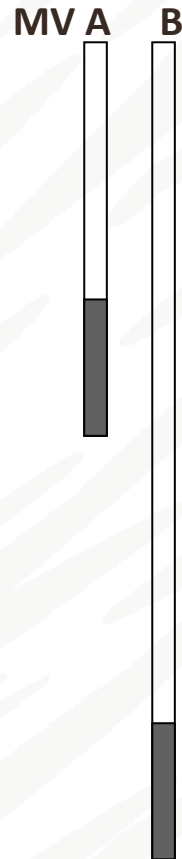


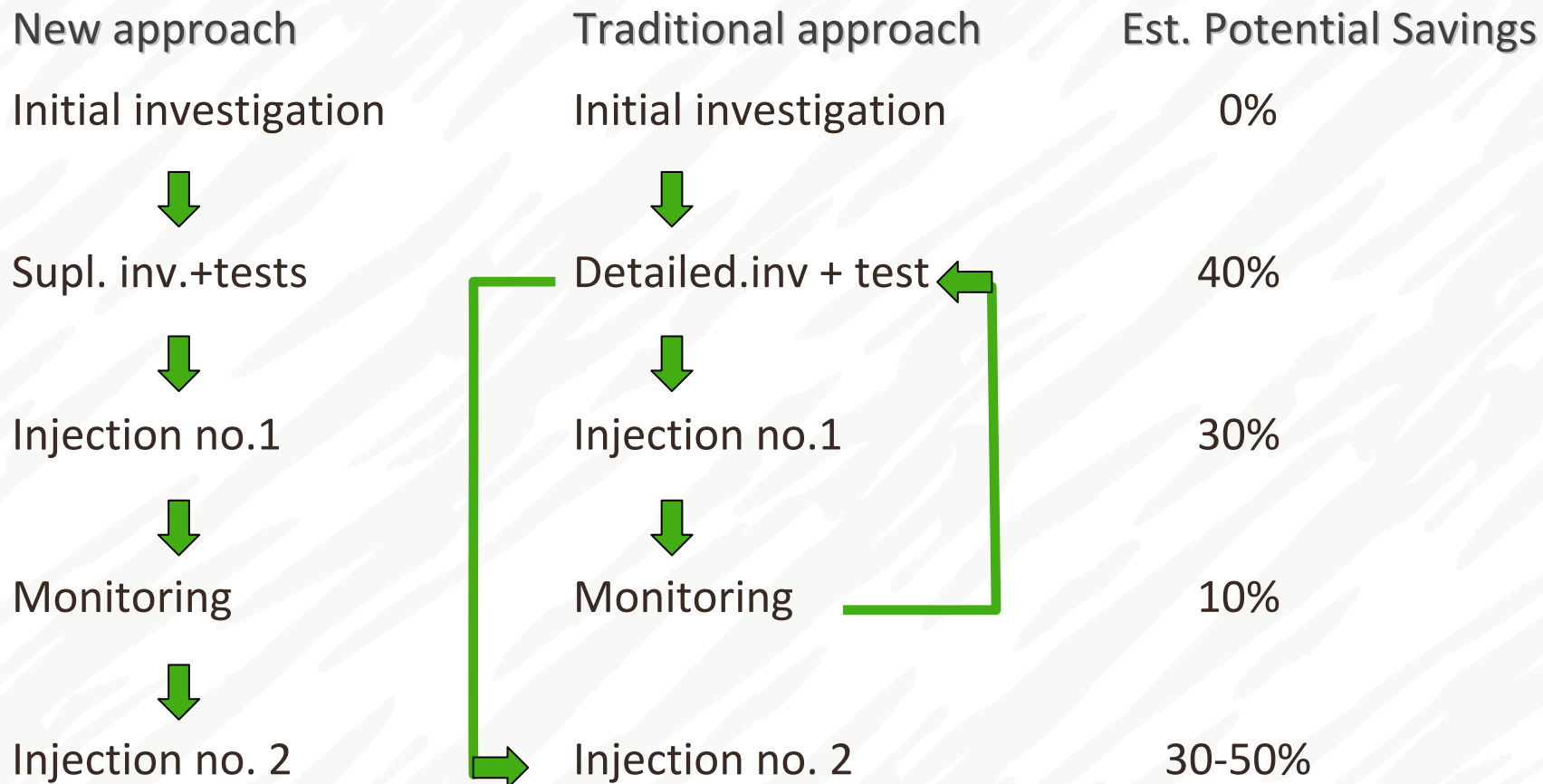


Verified immediate ROI was 1 – 2,25 m



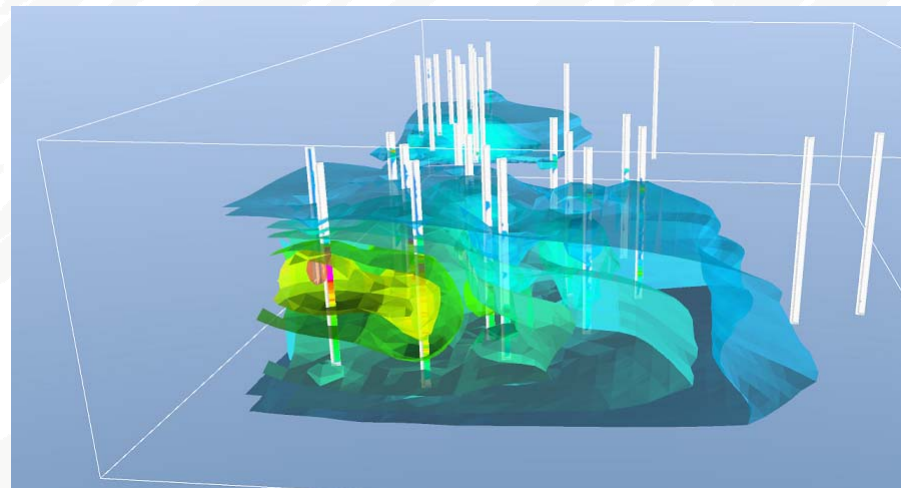
| | | |
|---------------------|-------------------|---------------|
| Project: Upsoil WP4 | Date: 2011-03-18 | Operator: SNA |
| Location: Flanders | Project id: 08078 | QC: OPS |
| Client: EU | MIP id: Upsoil-1 | |





- Cost effective 😊
 - Reduced consumption of products; equipment; “time”
 - Optimized effect of product injected - targeted and balanced injection
 - Increased probability for full “remediation coverage” - large quantities of MIP data
- Environmental sustainable 😊
 - Minimize risks of negative environmental impact
 - Minimize disturbance of uncontaminated soil/GW
 - Minimized consumption of energy / product.

- Flexible system 😊
 - Different products - “mixtures”
 - Flow rate / pressure
 - Concentration variability
- Real time data / logging 😊
 - Decision making in the field (Triad Approach)
 - Documentation
 - Large data amount – quality / decision making.



Interpretation of MIP data

- Applicable also for more viscose remediation products like: EHC, Newman Zone, EZVI, BOS100/200, -
 - Injection depth challenges when increasing radius of rods
- Also high flow / pressure applications (fracturing)
- Full scale project experiences required => limitations / challenges etc.
- Optimize operation and improve solidity of the system .

MIP-IN is the outcome of an interesting collaboration between researchers, authorities, SME's and contractors !

Further development and divulgation of the system could result in significant environmental and social impact – and exports ?!

Thank you –

