



# ONSITE EX-SITU WASHING OF MULTI-CONTAMINATED SOILS

DESIGN USING TREATABILITY TESTS AND IMPLEMENTATION  
FOR THE REMEDIATION OF A LARGE INDUSTRIAL SITE

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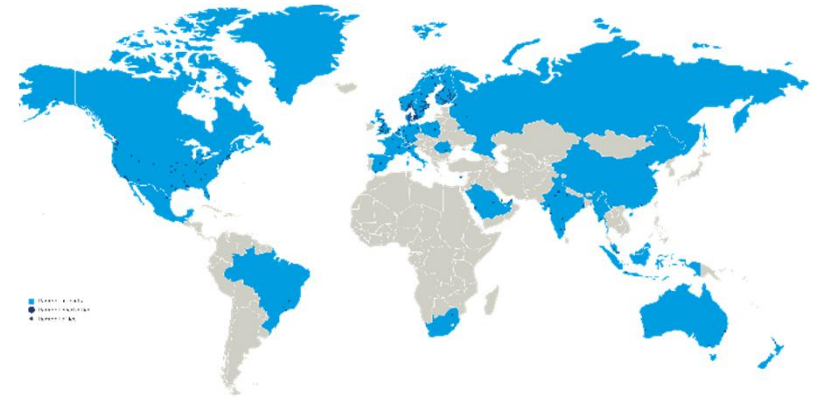
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## ABOUT RAMBOLL

- Independent consultancy and engineering firm, created in 1945 in Denmark (headquarters)
- Merger with Environ in January 2015
- 13,000 experts, 300 offices, 35 countries



## RAMBOLL FRANCE

- Part of Environment & Health division
- Presence in France since 2002
- 90 engineers & experts, 4 agencies



**RAMBOLL**

- Site Solutions and Remediation
- Industrial Risks Control and Prevention
- Air Quality Management
- Due Diligence Audits
- EHS Assistance
- ESIA and International Finance
- Biodiversity
- Water Resource Management





# CONTEXT

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- Closure of a large dye and pigment manufacturing site in France
- Remedial action plan developed by Ramboll after several investigation phases
- **Different types of contamination at source areas identified:**  
heavy metals, chlorinated solvents, agrochemical substances, specific organic molecules, colors





## CONTEXT

- ***In-situ* solutions: not applicable** due to nature and repartition of impacts
- **Excavation = sole effective remedial technique** to reach targeted mass removal in the timeframe of the project
- **Up to 67,000 m<sup>3</sup> of impacted soils** (coarse alluvial deposits)
  - Offsite disposal: prohibitive costs
  - Onsite *ex-situ* soil washing: the good solution ?
- Technical solutions of soil washing studied in **pilot & lab tests**

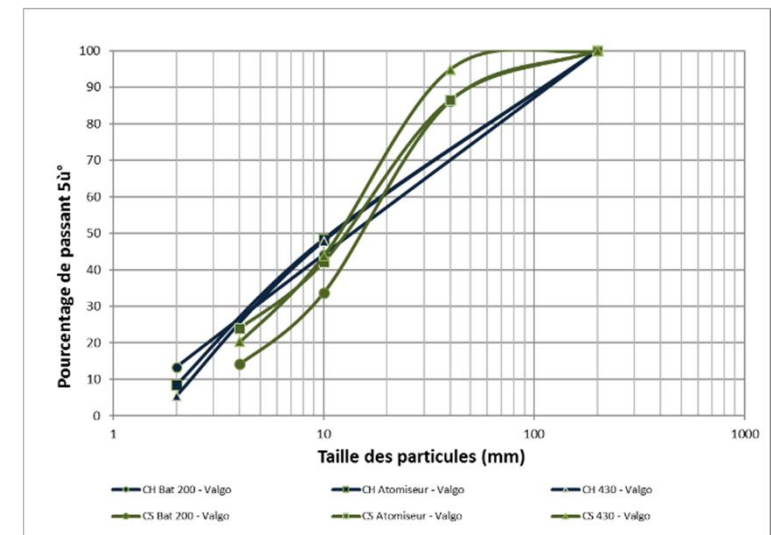
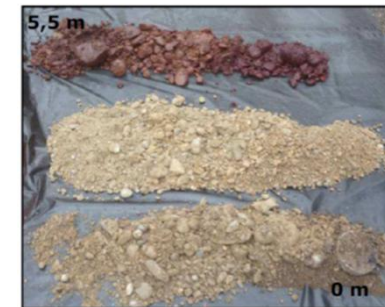




# SOIL WASHING PILOT TRIALS

## SOIL WASHING PILOT TRIALS - #0 (2013)

- 1<sup>st</sup> lab tests (performed by Valgo): dry and wet sieving of soils from 3 contaminated areas of the site with additional hydrocycloning and evaluation of biodegradation potential
- Granulometric repartition:
- Contamination concentrated in fine fractions
- Wet sieving more efficient than dry sieving
- Relatively clean "Sands" after hydrocycloning
- No real biodegradation observed on organic molecules





# SOIL WASHING PILOT TRIALS - #1 (2014)

- 1<sup>st</sup> tests onsite: dry and wet sieving of soils from each contaminated areas of the site





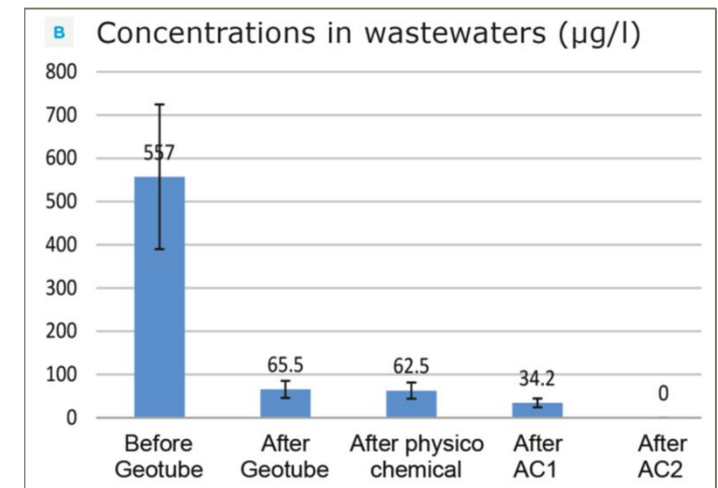
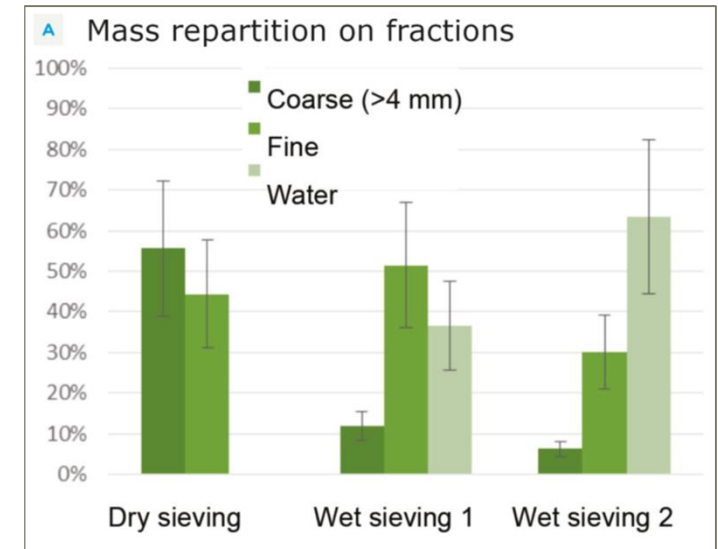
## SOIL WASHING PILOT TRIALS - #1 (2014)

- Wet sieving effective to clean coarse fractions ( $> 4$  mm) on all types of contamination and colors
  - ➔ backfilling OK for  $>4$ mm
  - ➔ further testing required for  $<4$ mm
- Color removal = a good tracer of treatment efficiency
  - ➔ higher operational effectiveness expected during works owing to long analytical delays for several substances specific to the site



# SOIL WASHING PILOT TRIALS - #1 (2014)

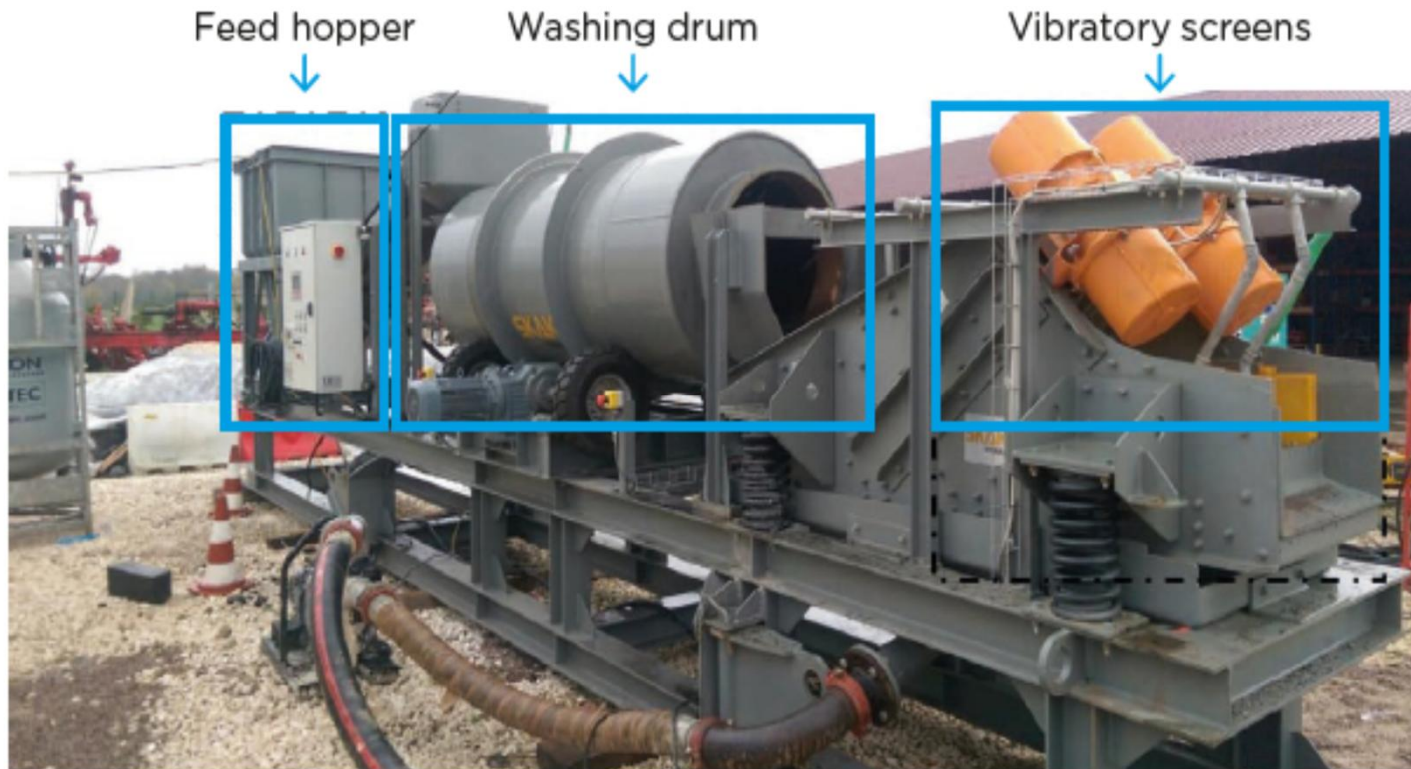
- Dry sieving not sufficient
- Contamination mass efficiently transferred from coarse to fine fractions and water
- Proper treatment of wastewater achieved using standard techniques
- Water reuse for the washing process achievable with adequate design





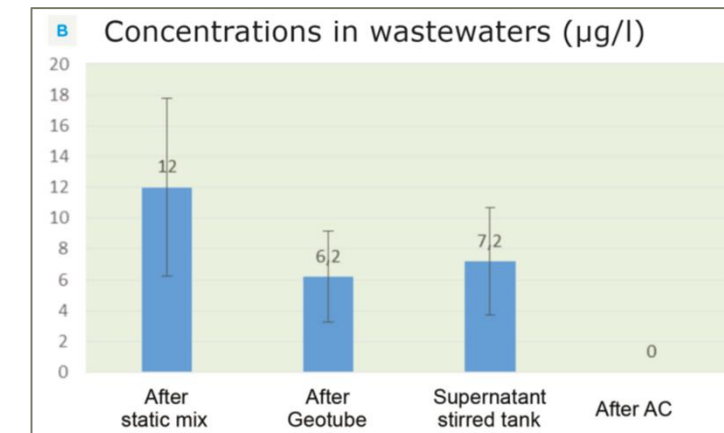
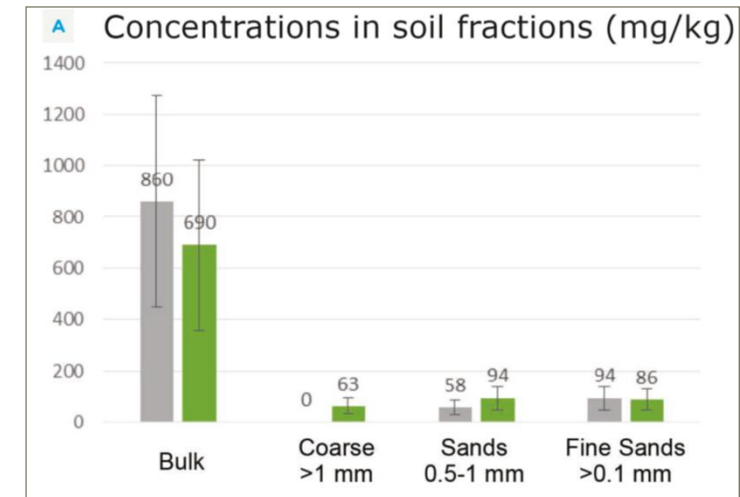
## SOIL WASHING PILOT TRIALS - #2 (2015)

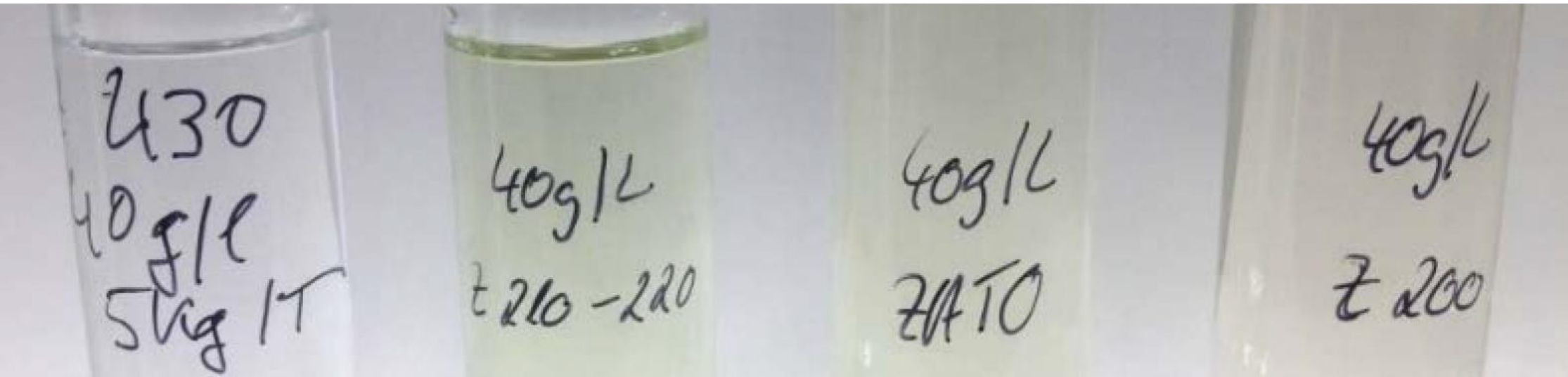
- 2<sup>nd</sup> tests: assess feasibility of soil washing in a “single run” & possibility of recycling washing waters to recirculate in a closed loop



## SOIL WASHING PILOT TRIALS - #2 (2015)

- Good cleaning of fractions  $>1$  mm in a **single washing run** and of sand fractions 0.1 to 1 mm with additional washing, allowing future reuse as backfill materials
- Adequate wastewater treatment allowing recycling, for closed loop recirculation





# WASTE WATER TREATMENT & SLUDGE LABORATORY TESTS



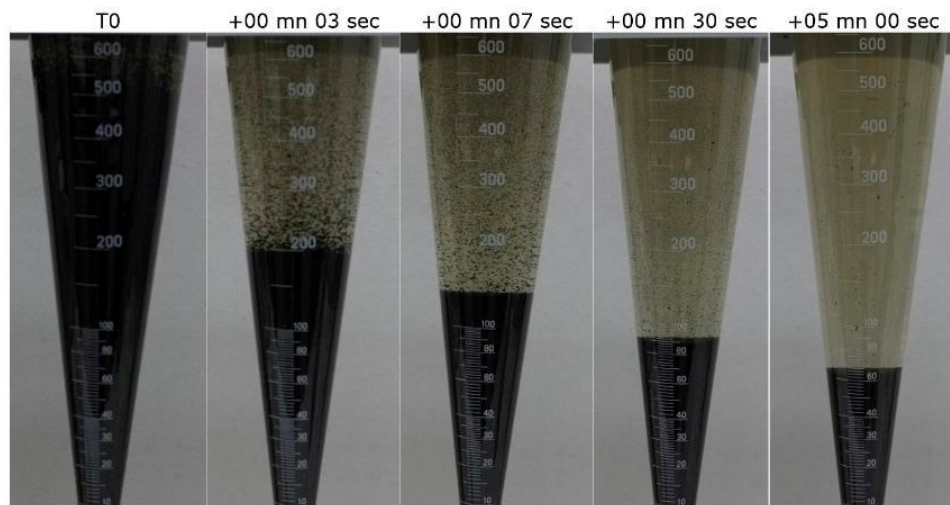
# WASTEWATER TREATMENT & SLUDGE LAB TESTS (2016)

- Wastewater treatment critical:
  - Large volume of water needed  $\sim 300\,000\text{ m}^3$  for  $\sim 70\,000\text{ m}^3$  of soil
  - High flow rate:  $200\text{ m}^3/\text{h}$  –  $1\,200\text{ m}^3/\text{day}$
  - Good quality critical for final washing result: low turbidity, low residual dissolved concentrations
- To ensure full recycling of washing water : additional water treatment and sludge dewatering tests performed
- Use of both conventional anionic polymer and innovative Clariant Invoque™ dewatering technology



# WASTEWATER TREATMENT & SLUDGE LAB TESTS (2016)

Floculation + sedimentation lab tests



Baroid lab tests



Sand filter tests

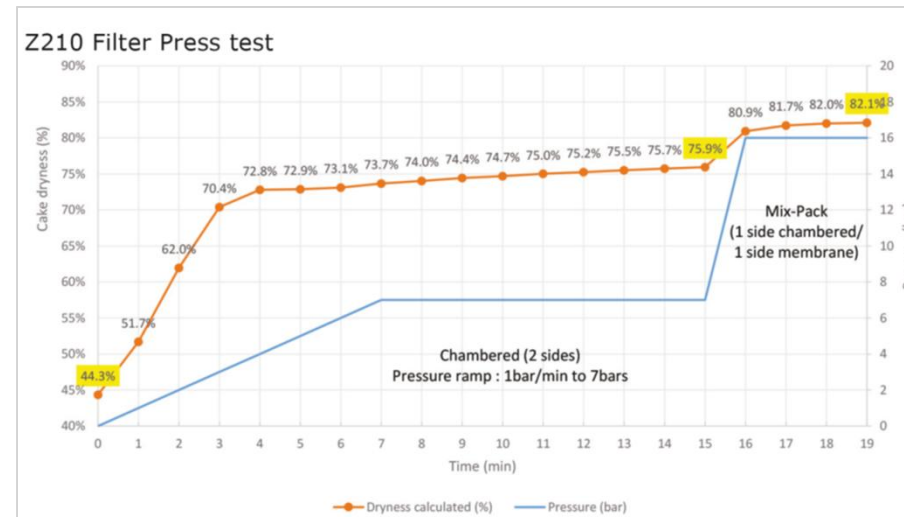
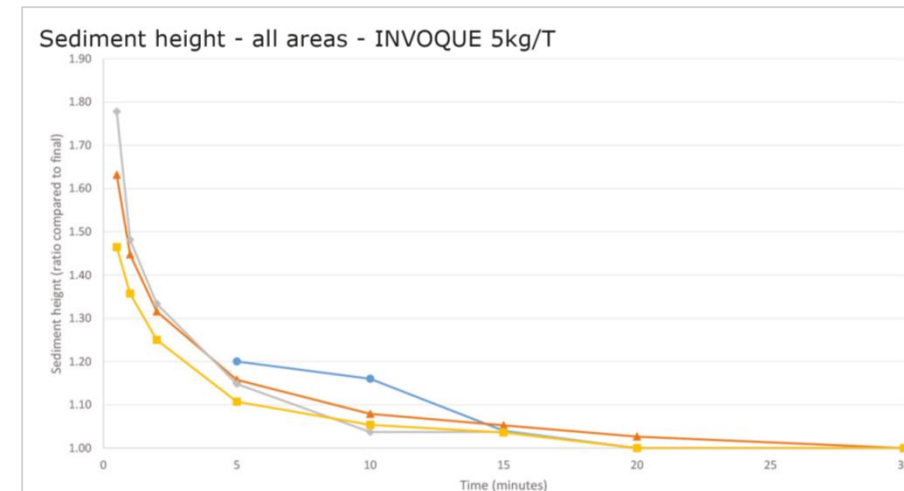
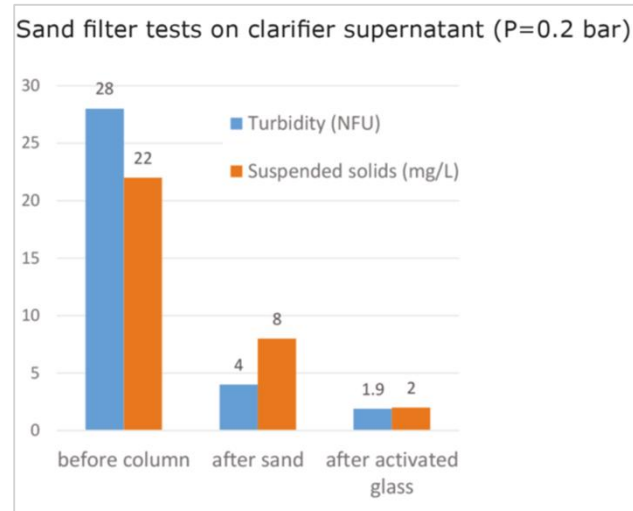


Filter press pilot tests



# WASTEWATER TREATMENT & SLUDGE LAB TESTS (2016)

- Fast sedimentation and filtration rates
- Good supernatant turbidity and suspended solid content, further improved with sand filtration
- Press cake with high dryness >80% and good mechanical properties after filter pressing (density, cohesion, non adhesion to filter clothes)





# WASTEWATER TREATMENT & SLUDGE LAB TESTS (2016)

- Dewatering using Clariant Invoque™ improved overall efficiency compared to conventional anionic polymer technology with:
  - +15-20% in filtration rates
  - +30% in filter press cake density
  - +>2% in filter press cake dryness

**INVOQUE™**

**CLARIANT**

INVOQUE™ is a high-performance sediment dewatering package with substantial ecological benefits. Unlike conventional conditioning/flocculating agents, INVOQUE's modified mineral-based additives provide multiple modes of action: it destabilises, flocculates, precipitates and releases water at the same time as naturally mopping up a number of contaminants from the water phase.

INVOQUE delivers:

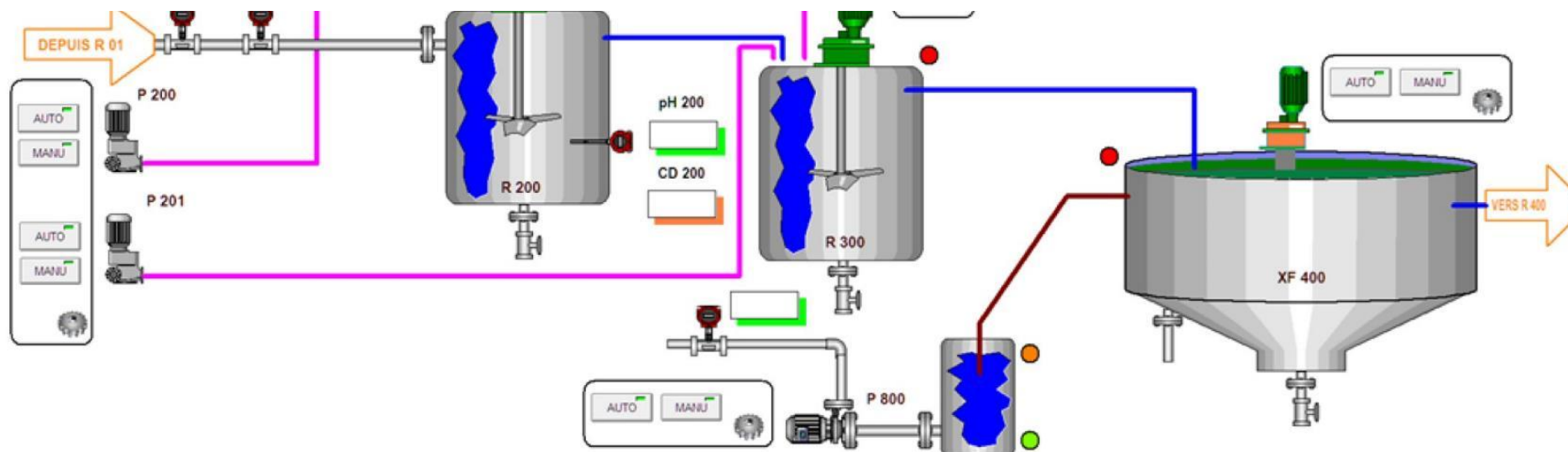
- Higher levels of dewatering performance in the liquid-solid separation process.
- A clearer filtrate that can be returned to nature or more easily reused.
- Drier (up to >90%), more compact and transportable solids.



**INVOQUE™**



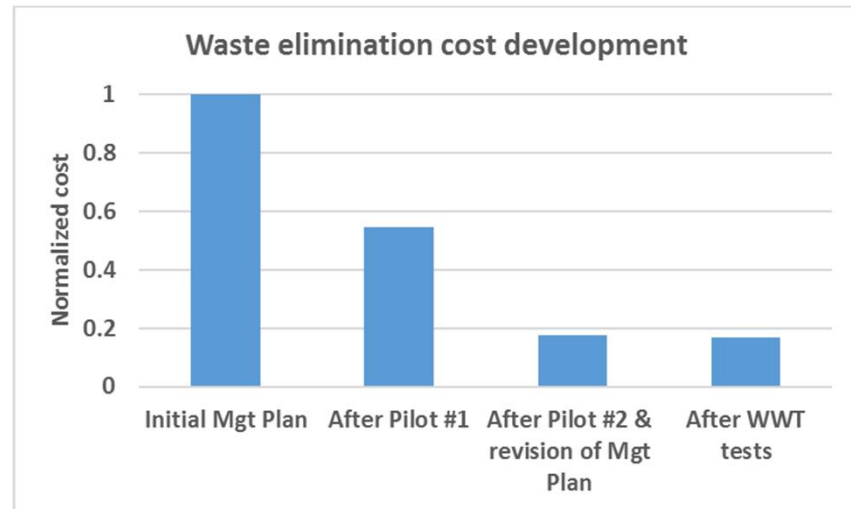
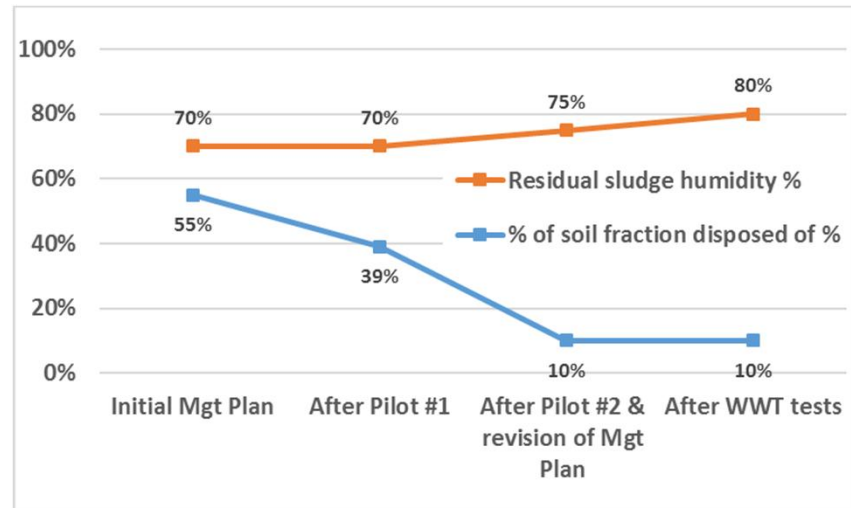
[www.clariant.com/sediment](http://www.clariant.com/sediment)



# CONCLUSIONS

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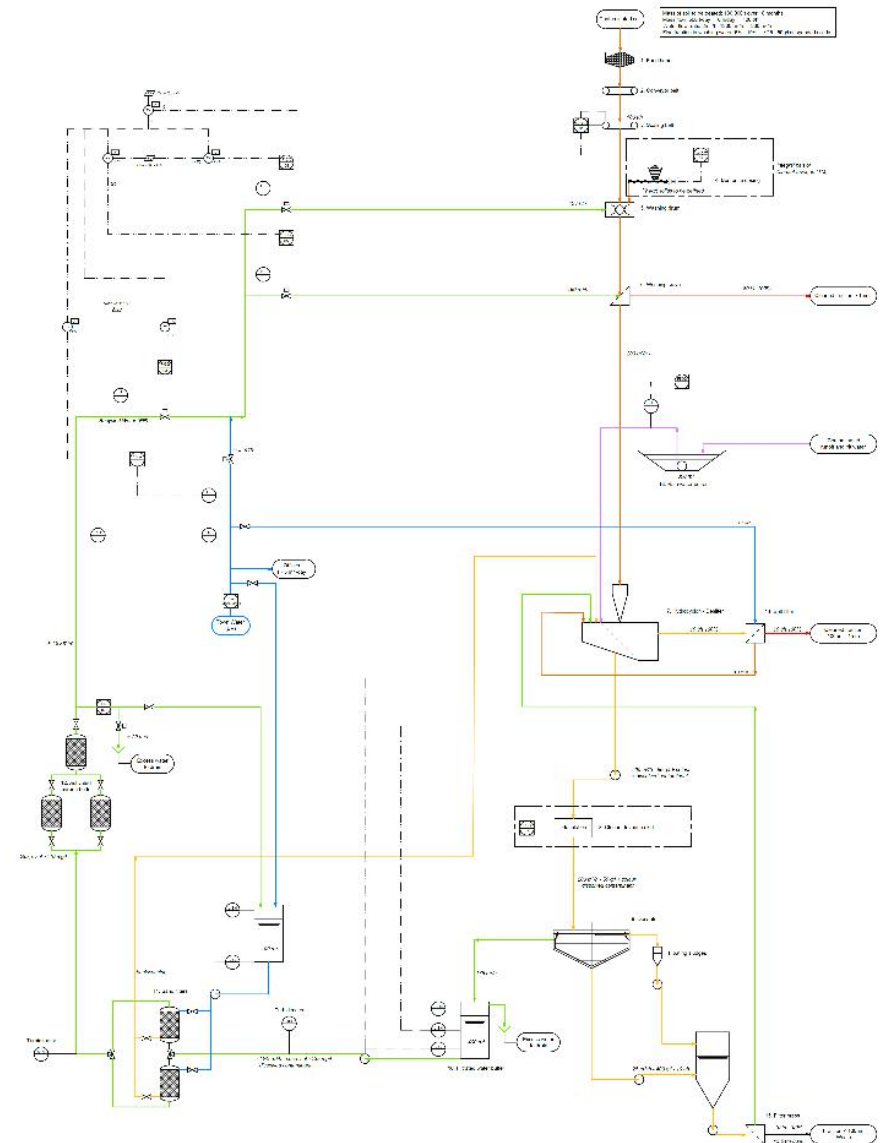
- Validation of the technical and financial feasibility of soil washing at full scale for the remediation of the site:
  - Major optimization of soil reuse for backfilling: >95% (all fractions > 0.1mm)
  - 100% recycling of soil washing waters (no discharge)
  - Ultimate waste with high disposal costs reduced to minimum
- Major technical and operational learnings obtained from the trials (choice and sizing of equipment, recirculation rates, fluxes, ...), valuable for the remedial works bidding process.
- Substantial cost optimization and financial securing for client





# CONCLUSIONS

- Comprehensive approach implemented several years ahead of the 2017 update of French methodology on contaminated sites and soils!
- Fully in line with the 2017 formalized approach of “PCT” (Plan de Conception de Travaux / Work Design Plan ) whose objectives are:
  - *Is the proposed remedial technique appropriate considering the contamination and the media ?*
  - *What are the expected performance of the technique and what are the information required for the installation design ?*
- All the results and learnings from the pilot and lab tests were included in the remedial works bidding process





# NEXT STEPS – REMEDIAL WORKS

## NEXT STEPS – REMEDIAL WORKS

- Start of remedial works mid-2017 for 2 years in a challenging context :
  - demolition of all remaining infrastructures
  - removal of all underground networks
  - excavation of 300,000 tons of materials (>70% under confinement tents) down to -11 m
- Expected mass removal of >80% with:
  - Washing of 130,000 tons of impacted materials
  - Reuse as backfill of 90 to 95% of cleaned materials
  - Offsite disposal of 10,000 tons of high dryness (>80%) sludge dewatered using Clariant Invoque™
  - 100% recycling of soil washing waters (no discharge)





## NEXT STEPS – REMEDIAL WORKS













# THANKS

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