Sustainable Application of Combined Remediation Technologies: Integration of DPE and DGR for Chlorinated Contaminants in a Short-Term Project

2024 Battelle Chlorinated Conference

June 2024

Agenda

1 The Problem

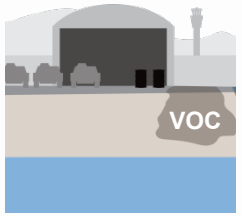
2 The Approach

3 Remediation Strategy

4 Optimizations

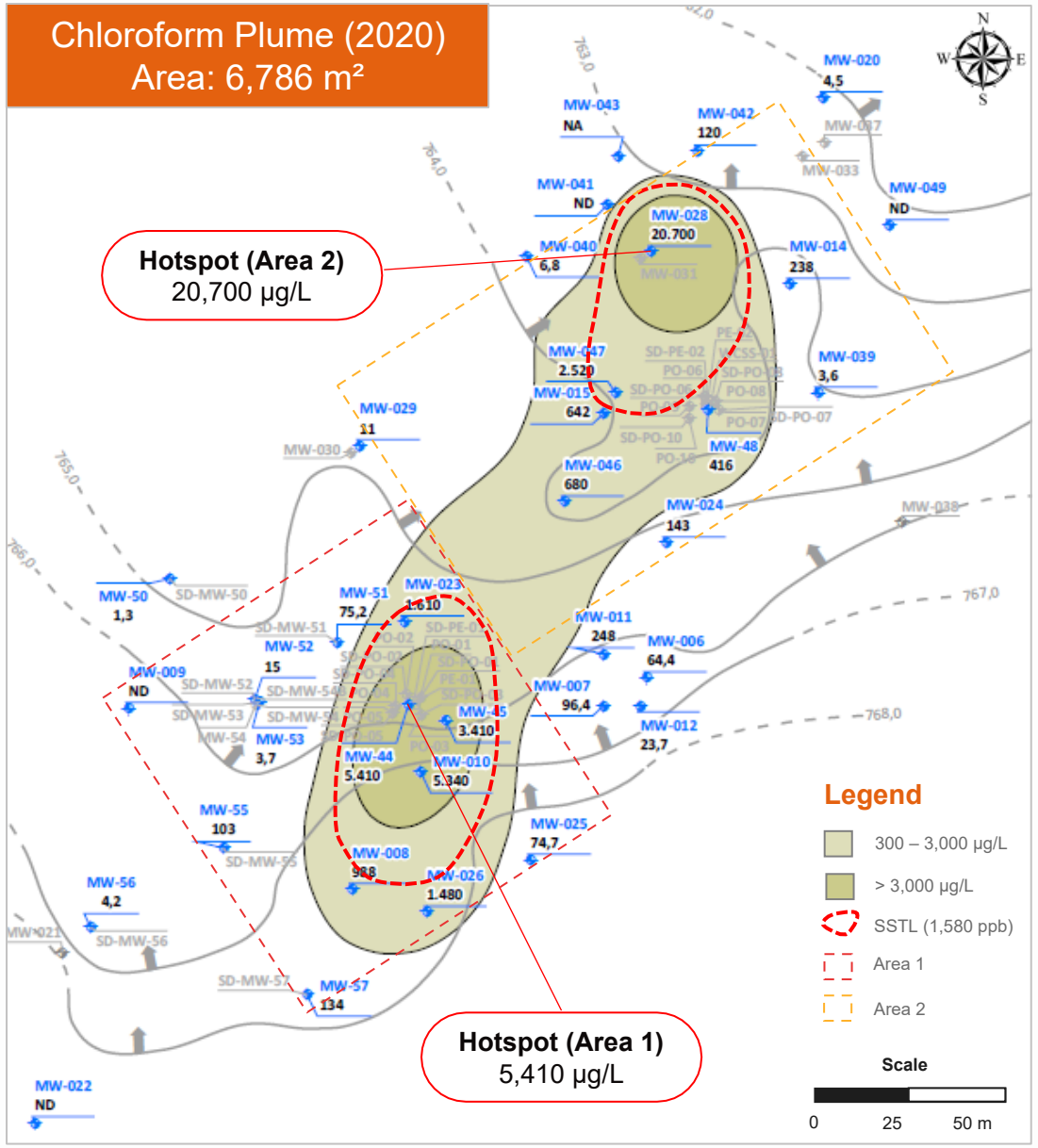
5 Results and Conclusions

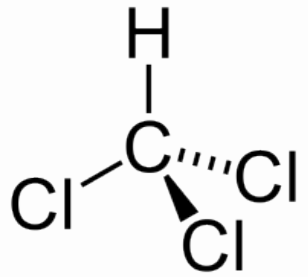
The problem



1969

Chloroform Plume (2020)
Area: 6,786 m²





Information	Data
CASRN	67-66-3
Empirical formula	$CHCl_3$
Molecular weight	119.38
Density	1.483 g/mL
Vapor pressure	197 mm Hg at 25°C
Henry's constant	3.00E-03 atm-m³/mol
Solubility in water	7.95 g/L at 25°C
Log Kow	1.97

The problem

Previous Consultancy

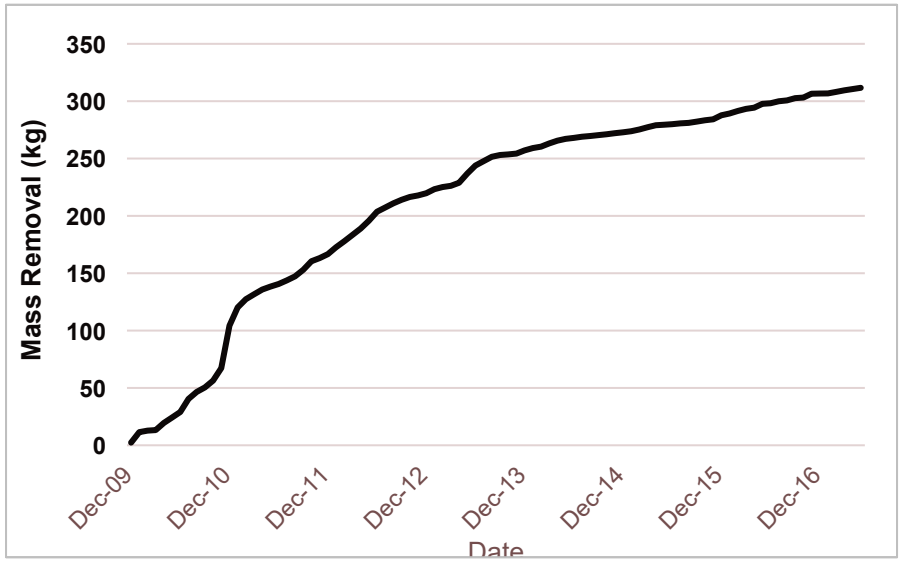
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Investigations, HHRA, Monitoring

Remediation by DPE

ISCO and DPE

Mass Removal by the DPE System in combination with ISCO



Remediation Goals achieved between 2009 and 2016

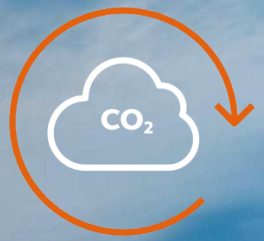
0%

A **Thermal System (ISTR)** had been proposed to solve the case

The approach:
Remedial Process Optimization as a tool for a Sustainable Project

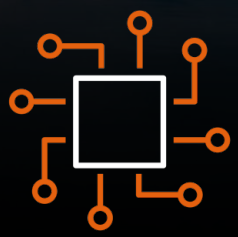
Exit Strategy

Monitoring



Sustainability

Conceptual Site Model

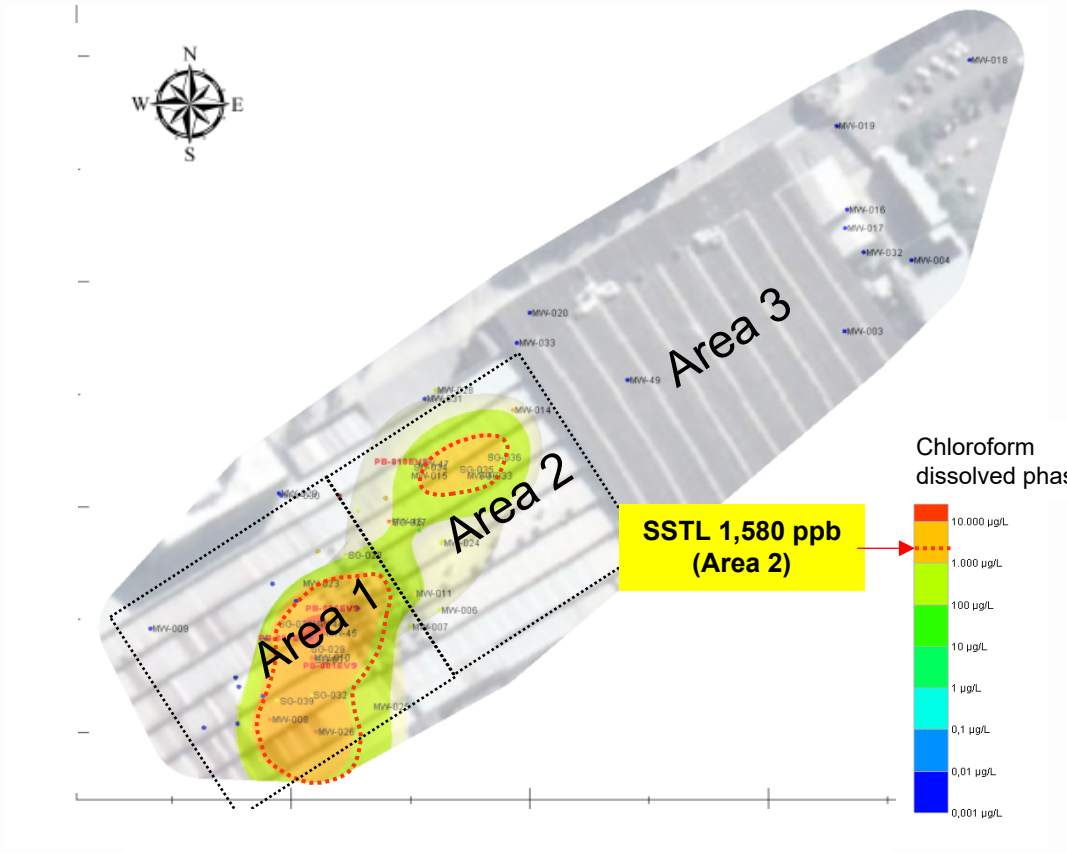


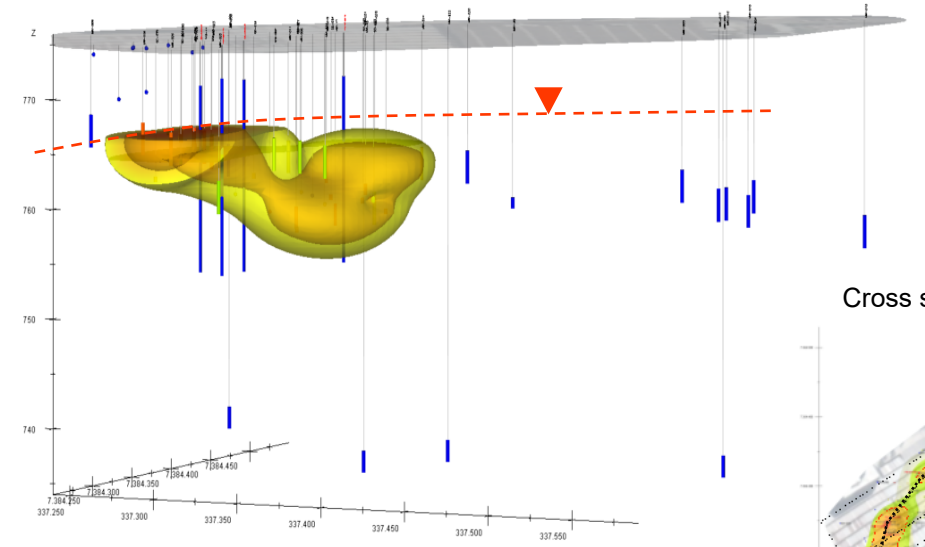
Data Management

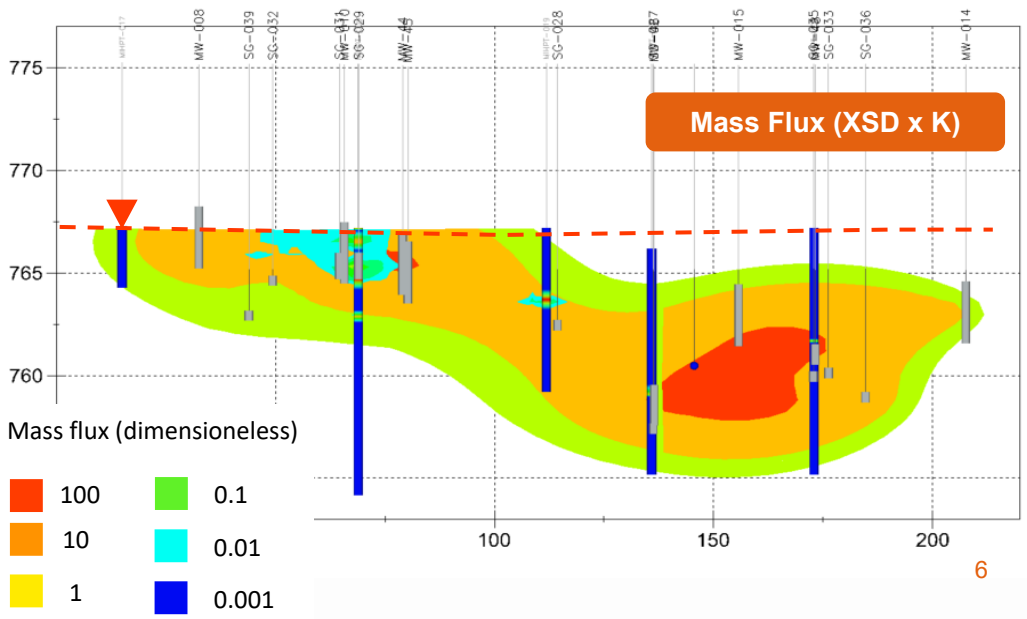
Remedy Components

Triad Approach

Rethinking the CSM

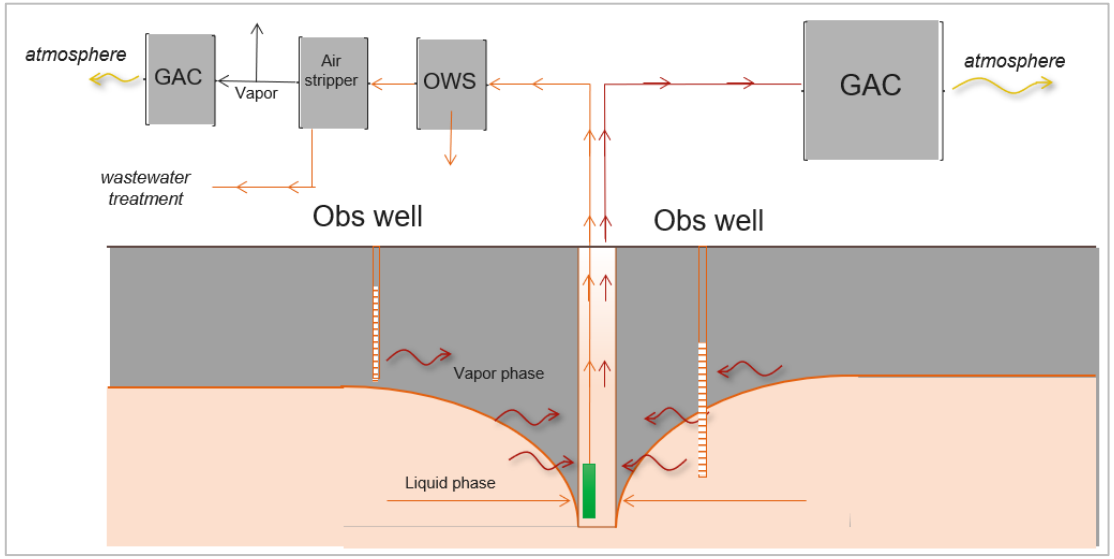






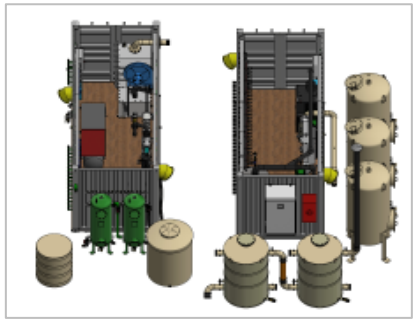
- Hot spot mapped in lower "k" zones and in relative higher "K" zone
- Higher hydraulic conductivity zones mapped by HPT results shows high heterogeneity
- The **relative mass flow of Organochlorines** was identified in the range of **14.0 m to 18.0 m**, corresponding to 99% (7.0 g/m²/day) of the entire mass flow verified in the profile.

Remediation Strategy

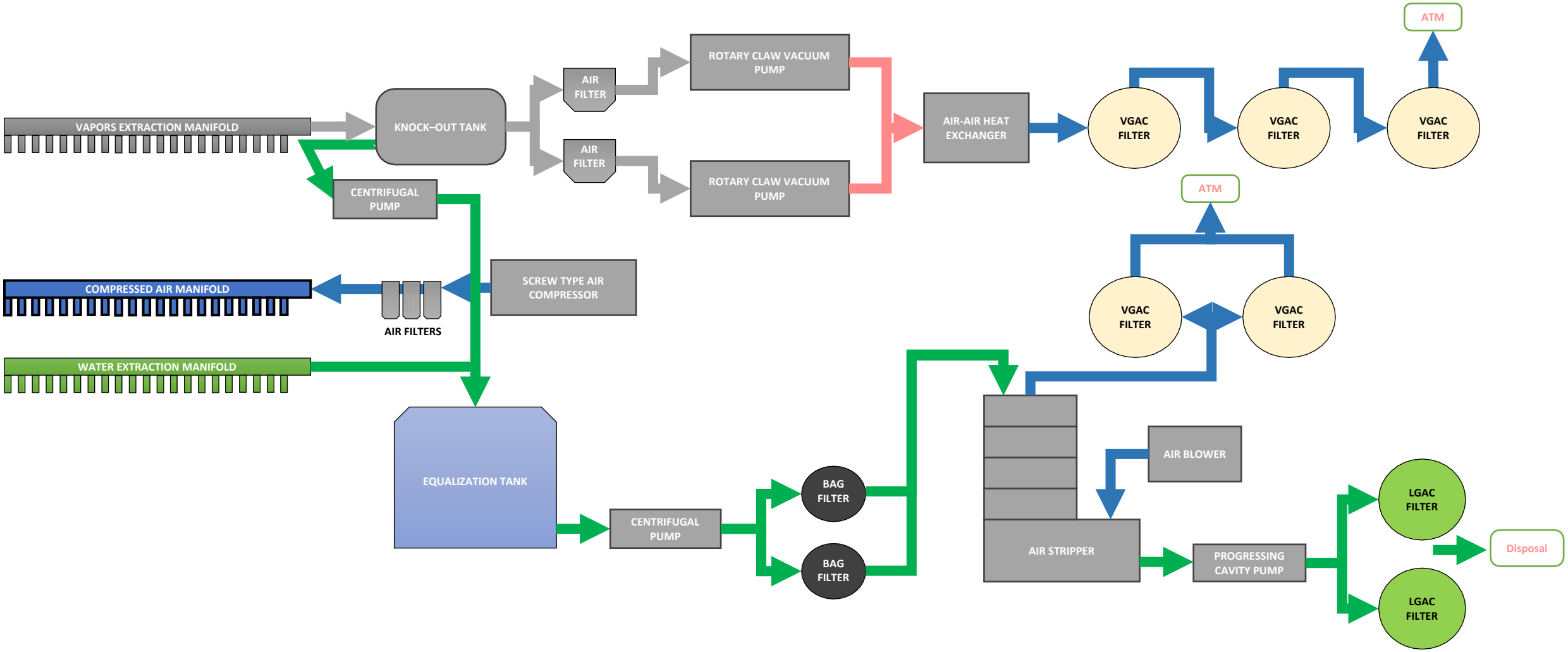


Remediation Technique

- Well-defined objectives and metrics
- Flexible structure
- Adjustable operation



DPE System


VAPORS EXTRACTION MANIFOLD
KNOCK–OUT TANK
AIR FILTER
AIR FILTER
ROTARY CLAW VACUUM PUMP
ROTARY CLAW VACUUM PUMP
AIR-AIR HEAT EXCHANGER
VGAC FILTER
VGAC FILTER
VGAC FILTER
ATM
CENTRIFUGAL PUMP
COMPRESSED AIR MANIFOLD
SCREW TYPE AIR COMPRESSOR
AIR FILTERS
ATM
VGAC FILTER
VGAC FILTER
WATER EXTRACTION MANIFOLD
EQUALIZATION TANK
CENTRIFUGAL PUMP
BAG FILTER
BAG FILTER
AIR BLOWER
AIR STRIPPER
PROGRESSING CAVITY PUMP
LGAC FILTER
LGAC FILTER
Disposal

DPE at a glance

3 m³/h
Average water extraction flow

5 m
Lowering the aquifer's water level

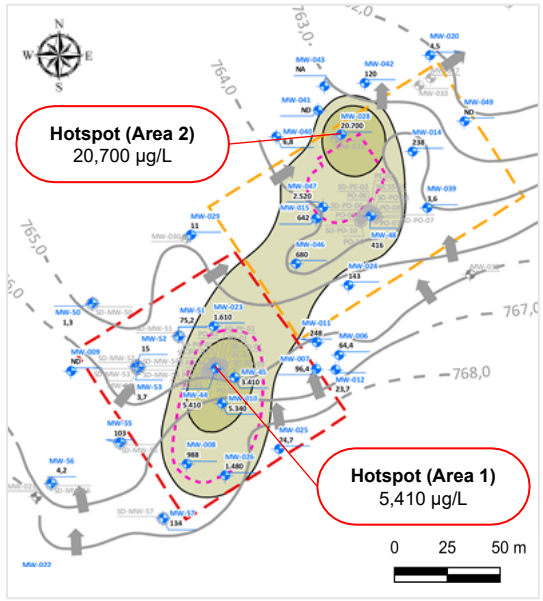
800 m³/h
Average vapor extraction flow

-14 inHg
Medium vacuum

-20 inH_2O
Vacuum influence

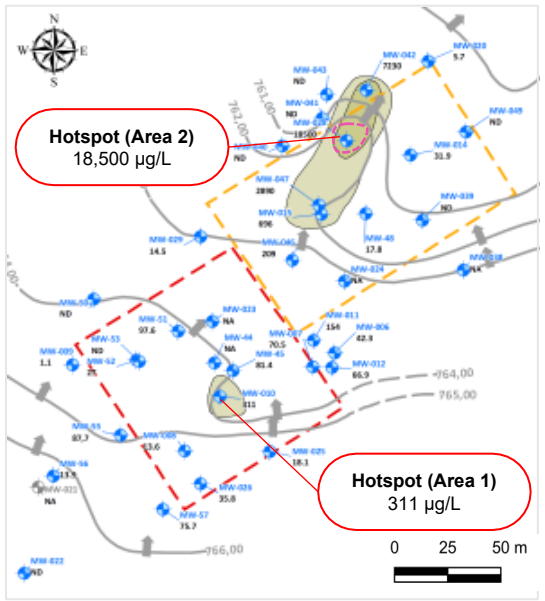
After 6 months...

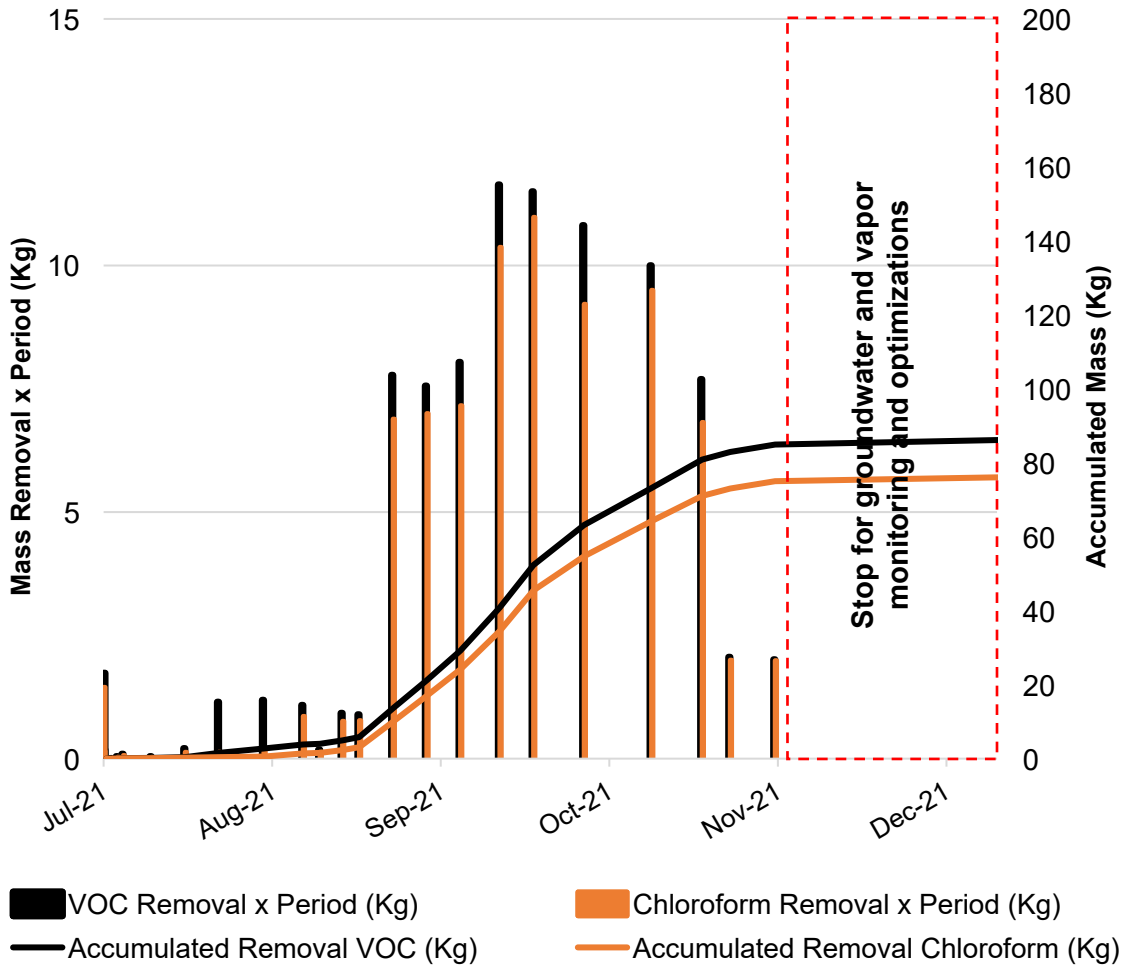
Baseline (dec/20)



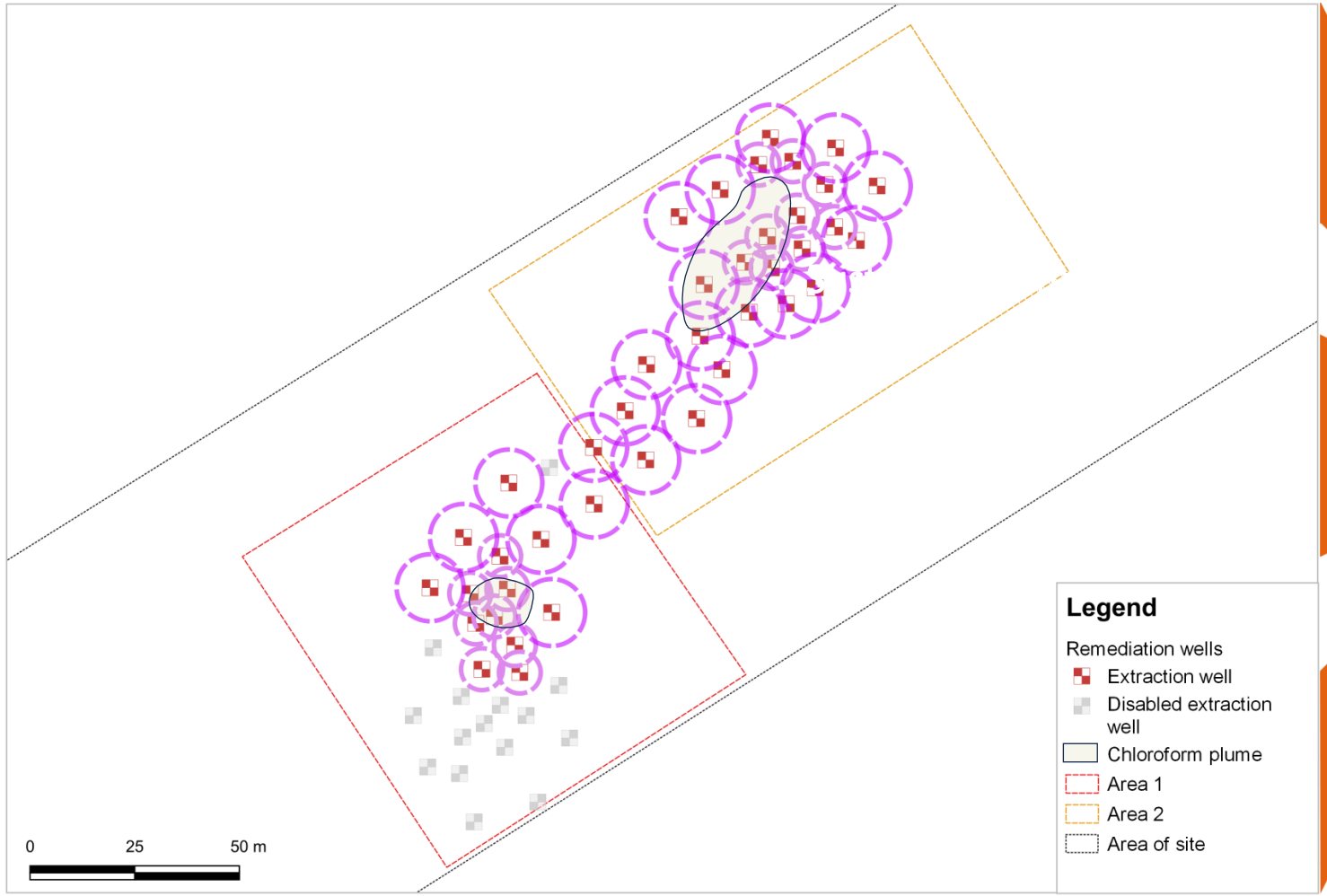
Start up DPE (jul/21)

6 months (dec/21)





DPE System - Optimized Layout



15 EW
Wells disabled

41 EW
Wells in operation

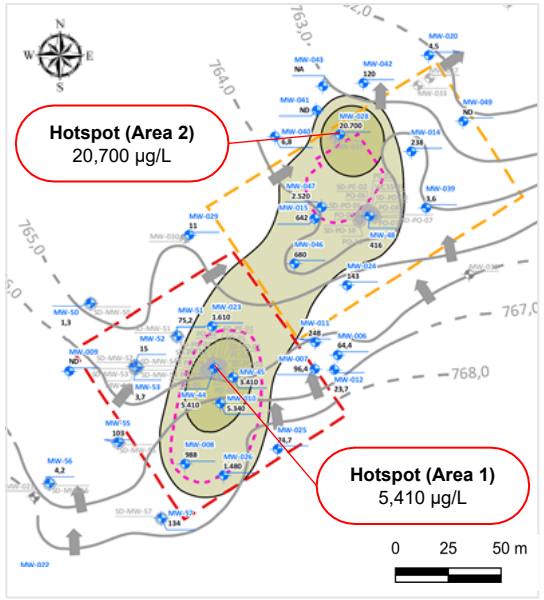
Sustainable project choice

Asset Optimization

Early assessment of rebound potential

After 12 months...

Baseline (dec/20)



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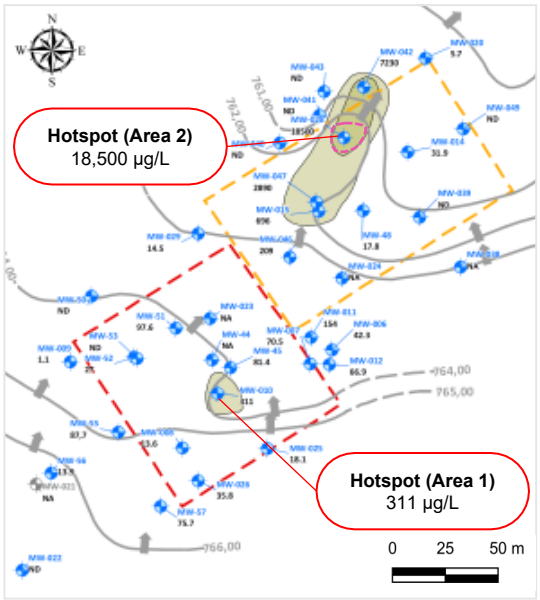
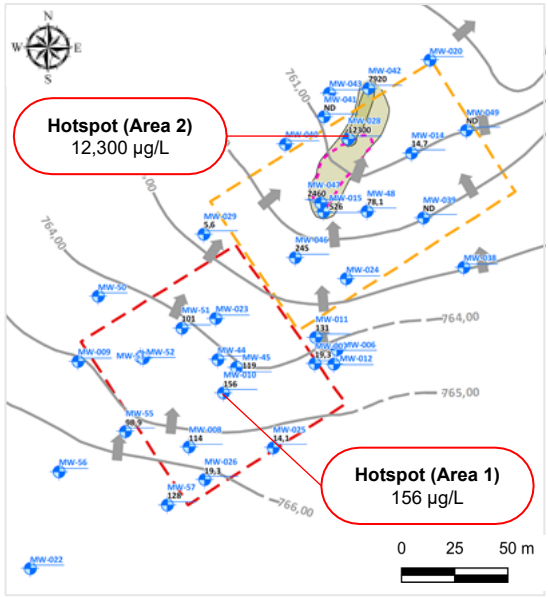
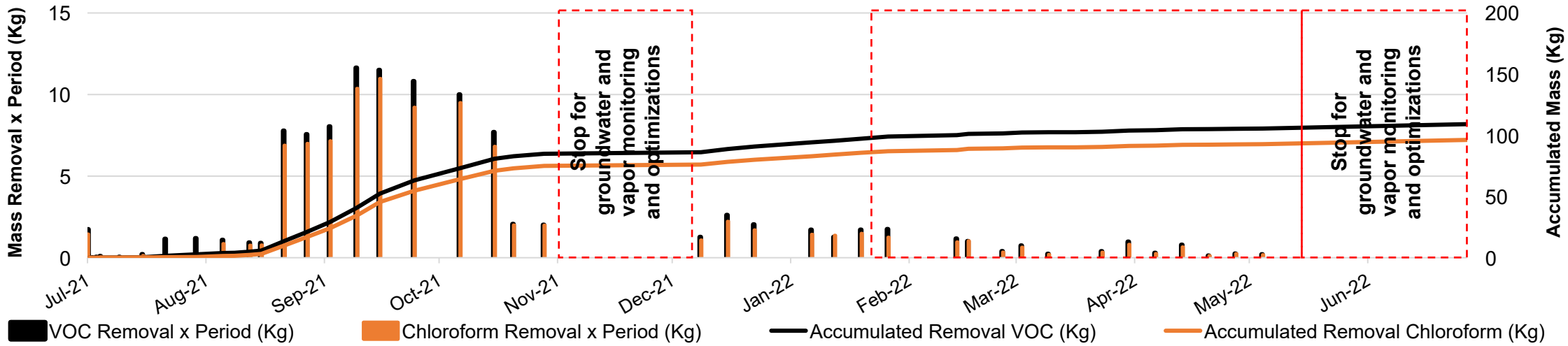
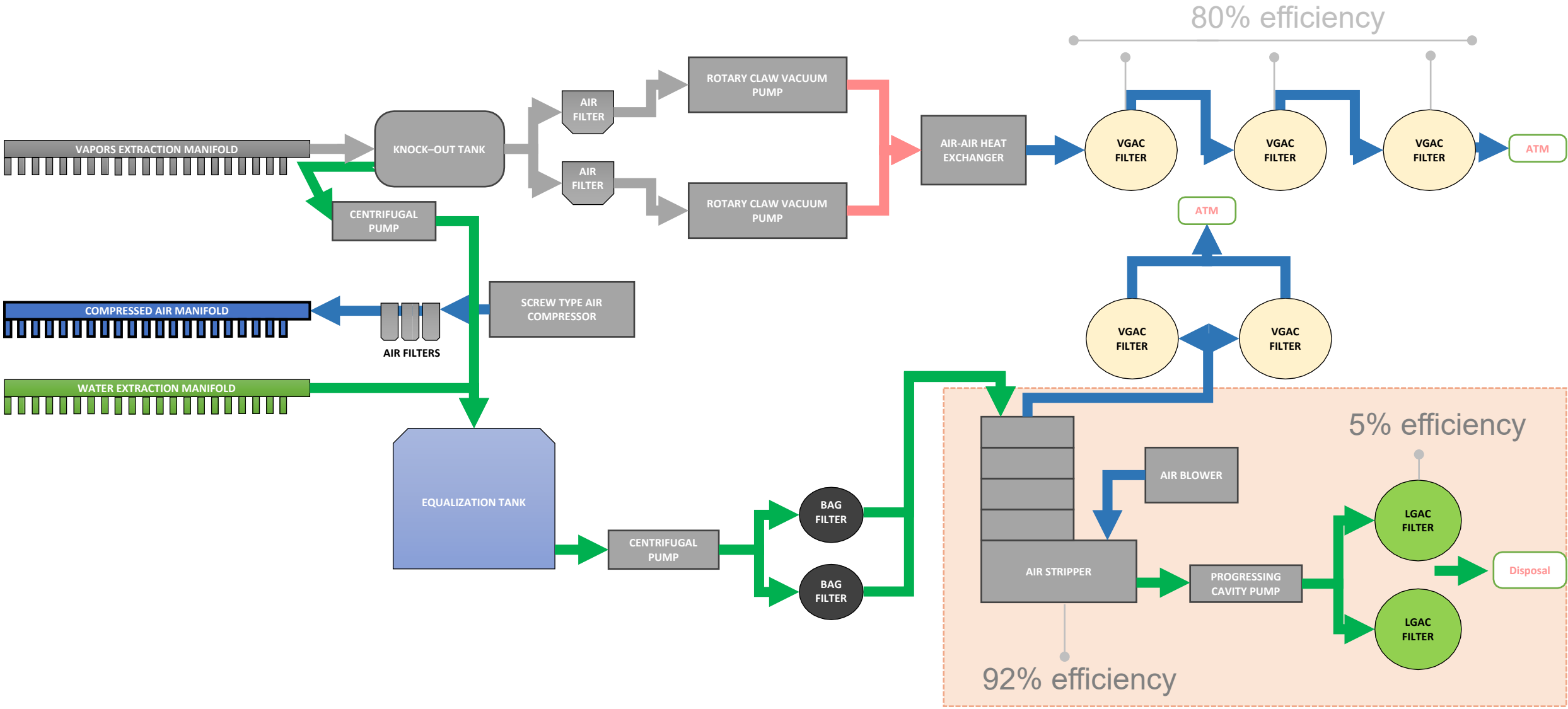


12 months (jul/22)

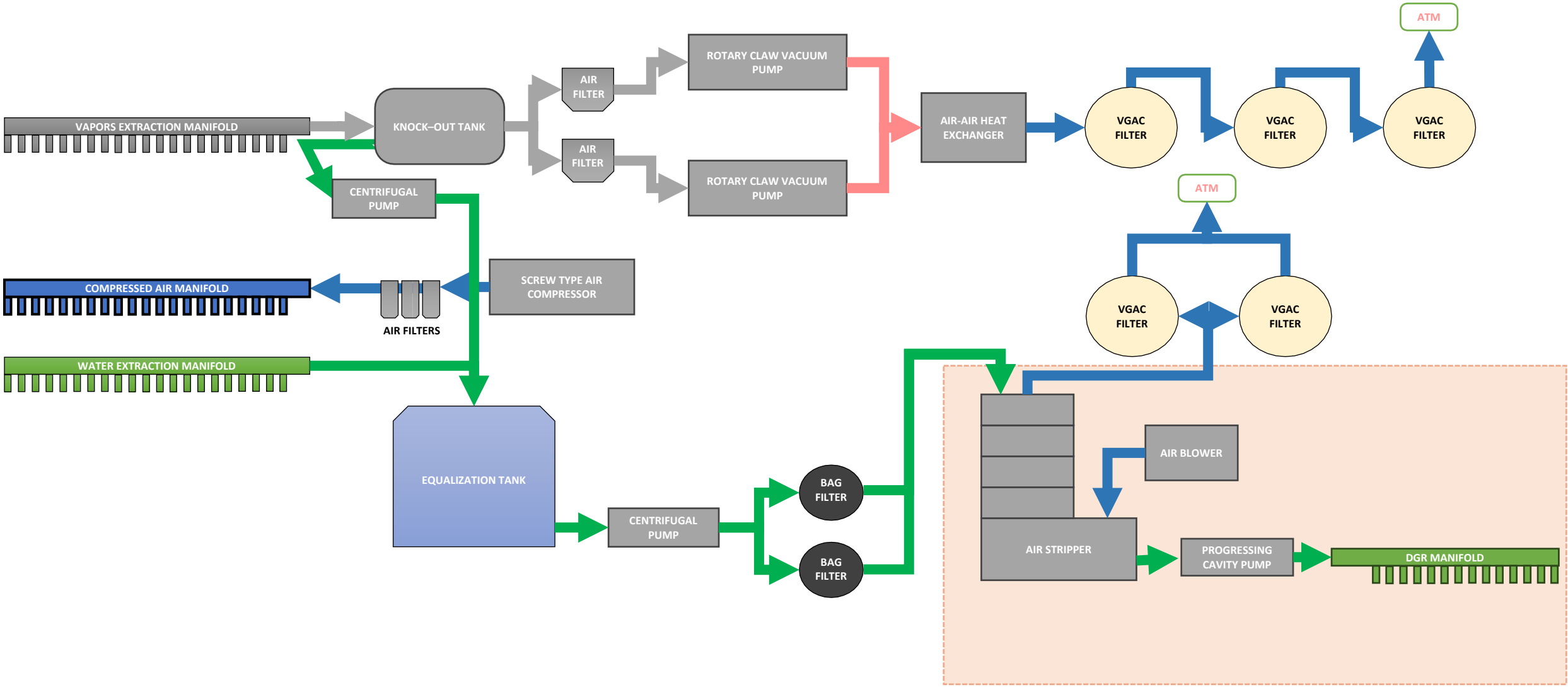




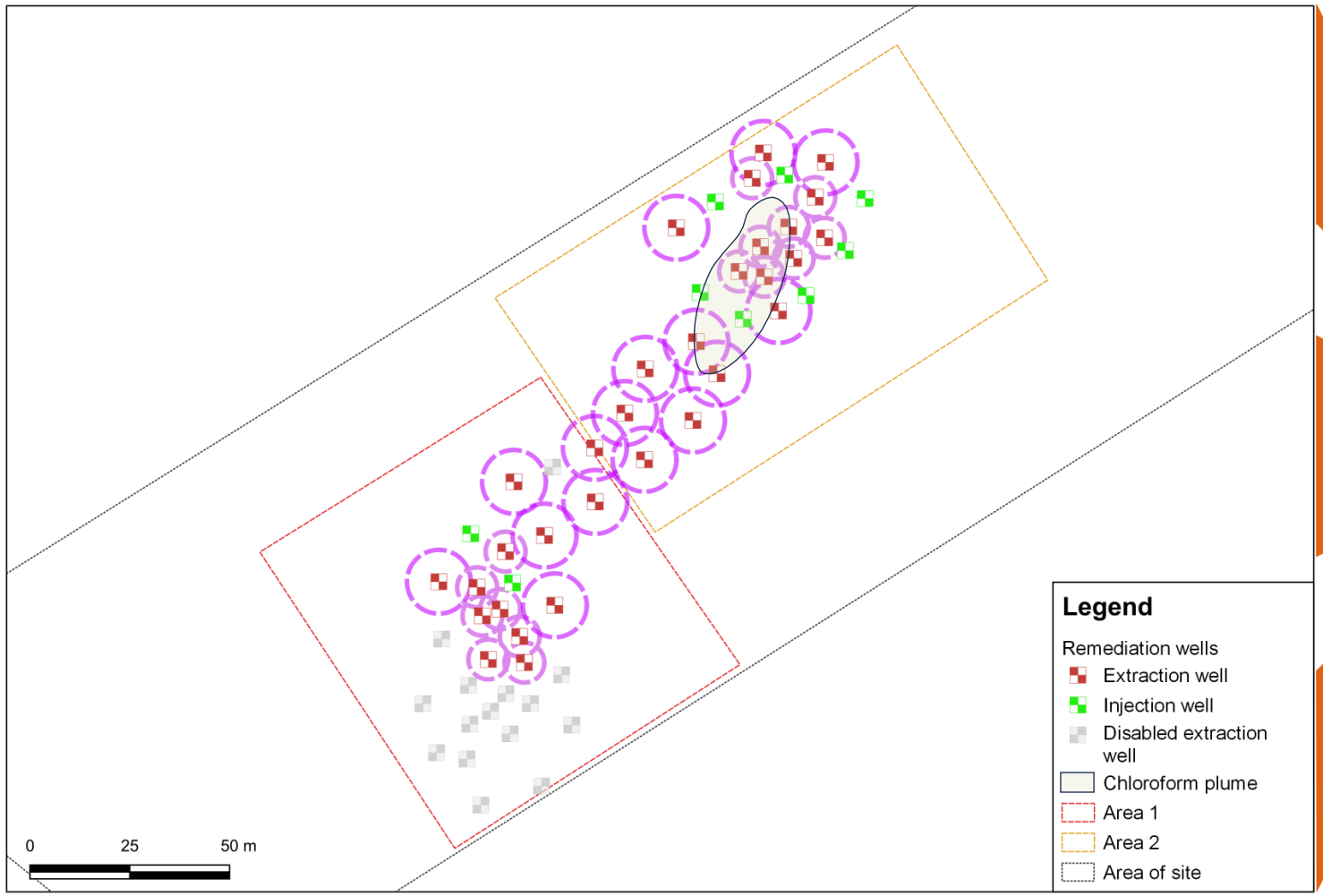
Remediation Optimization



Remediation Optimization



Remediation Optimization – DPE & DGR - Layout I



15 EW
Wells disabled

32 EW
Wells in operation

9 IW
Wells in operation

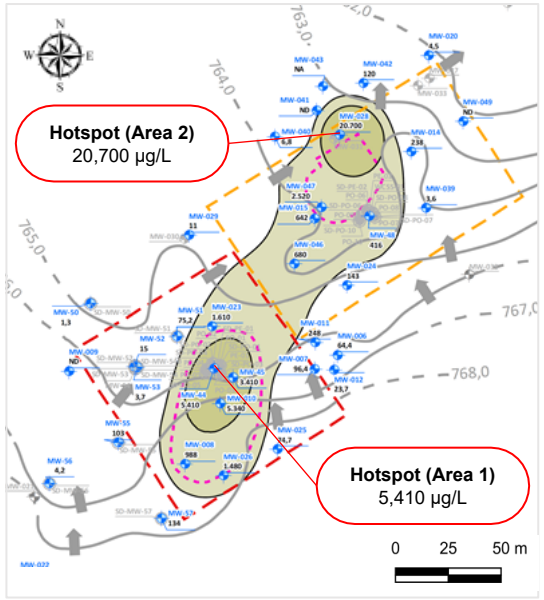
Soil flushing

Increase of mass removal

Groundwater reinjection

After 18 months...

Baseline (dec/20)



Start up DPE (jul/21)

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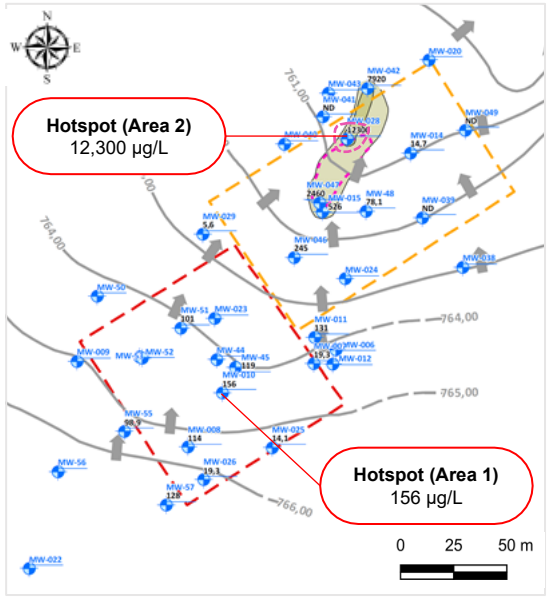
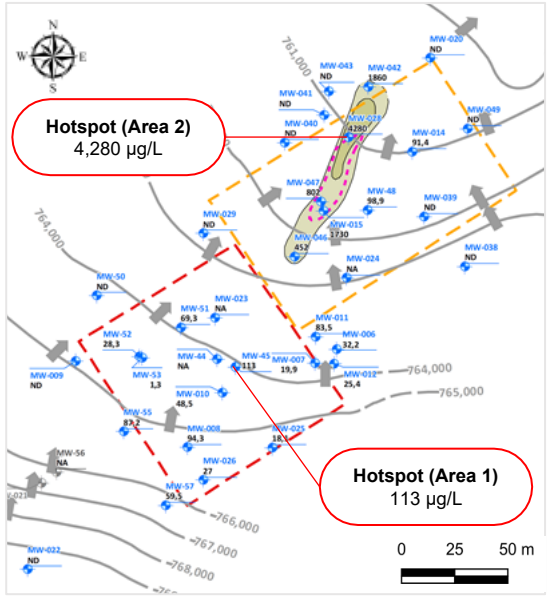
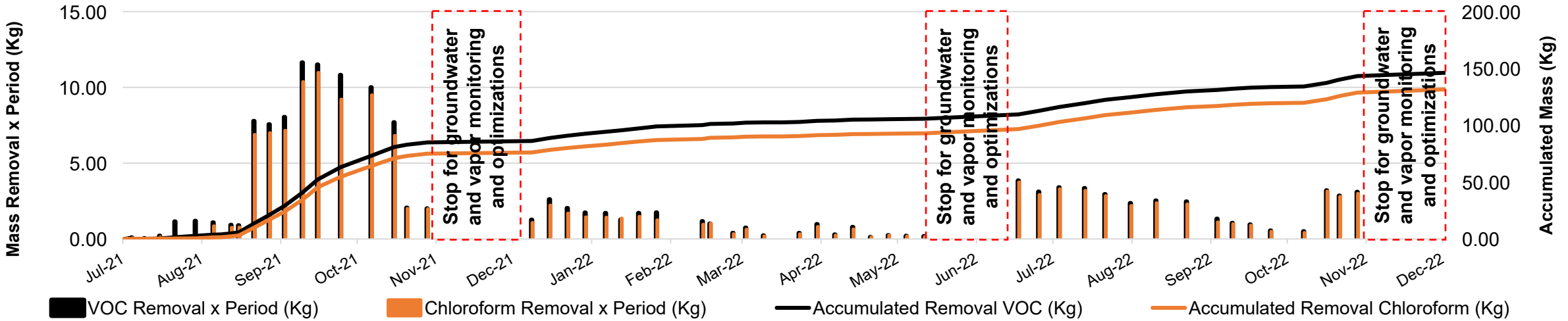
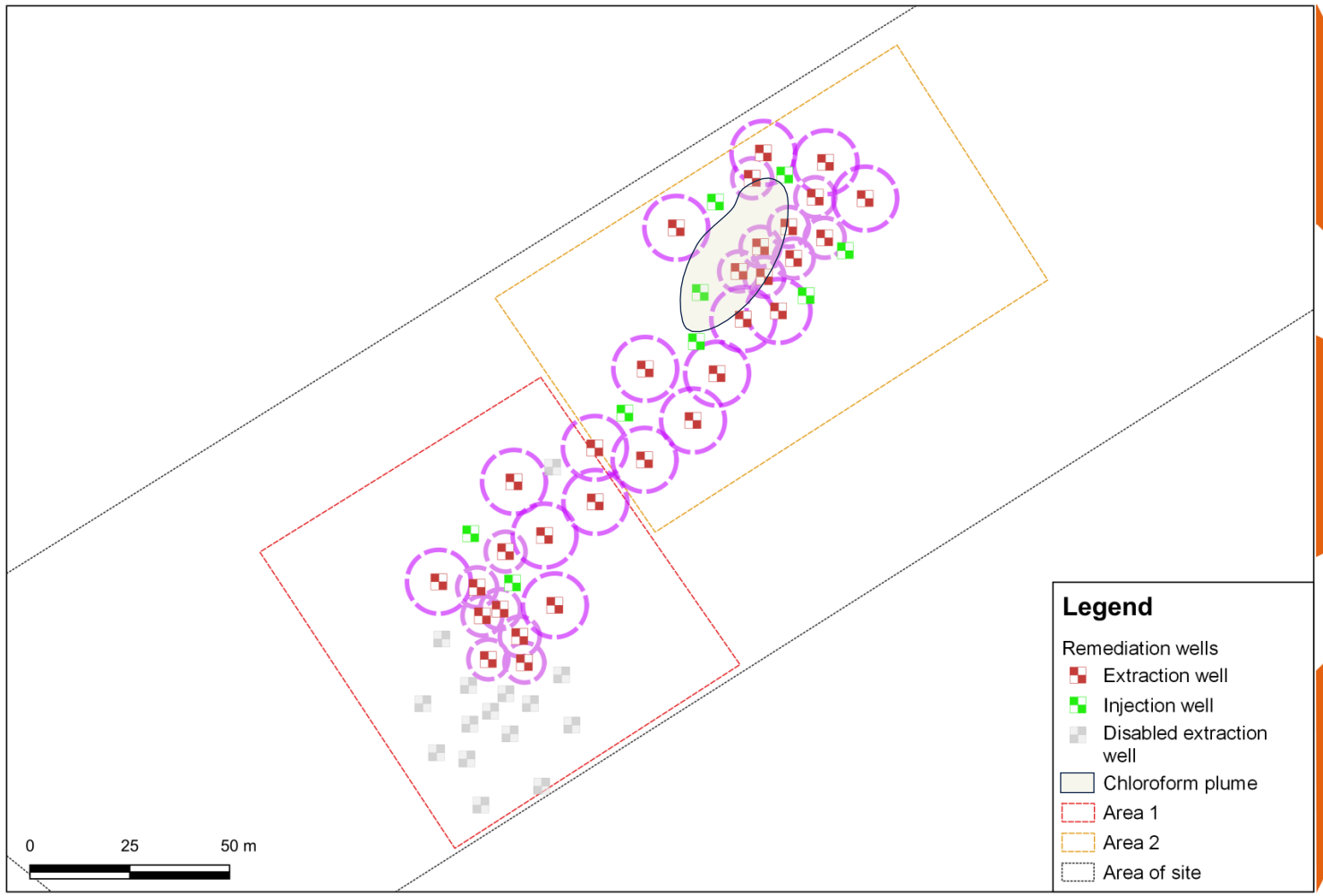


18 months (dec/22)





Remediation Optimization – DPE & DGR - Layout II



15 EW
Wells disabled

32 EW
Wells in operation

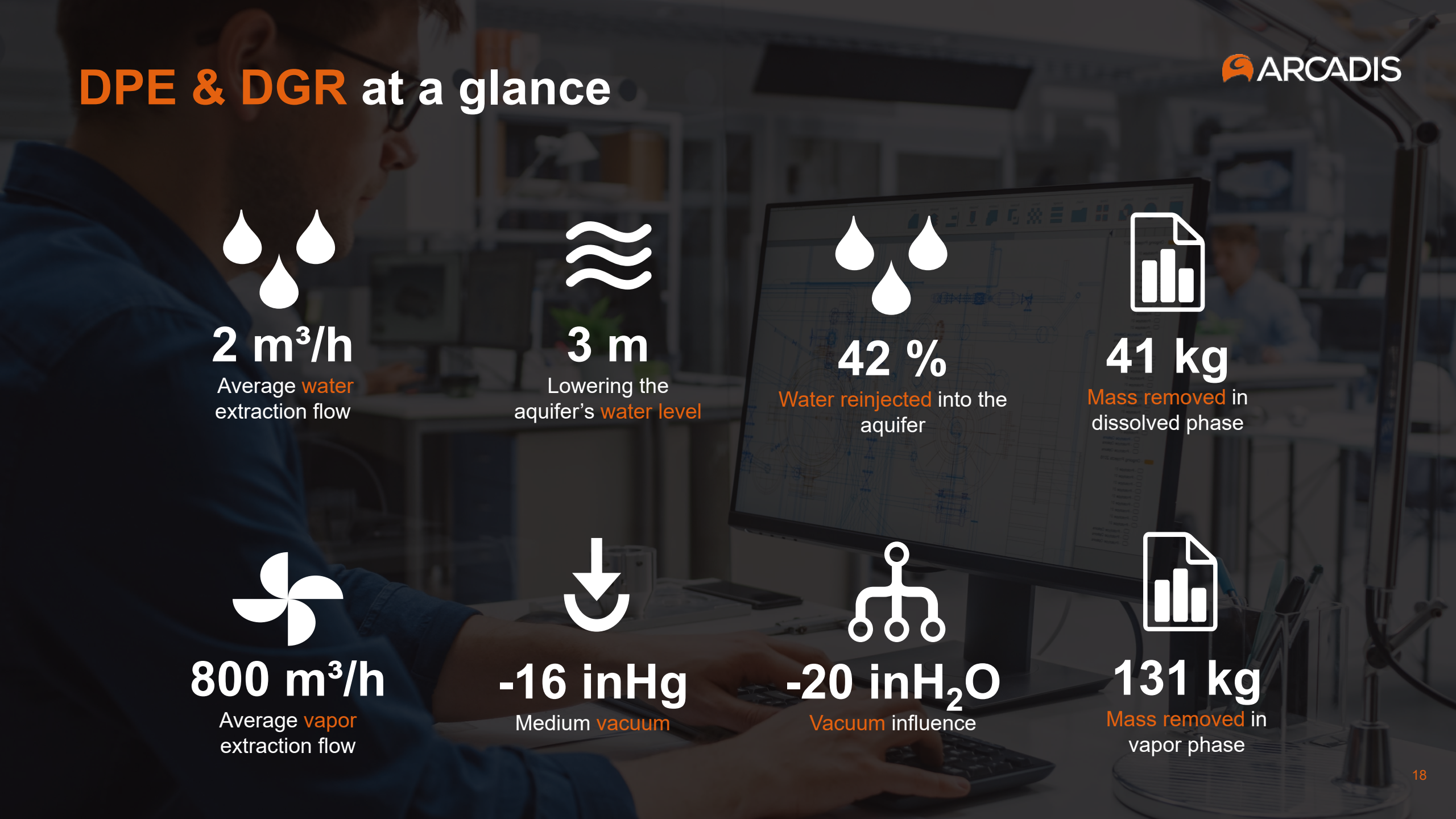
9 IW
Wells in operation

Soil flushing

Increase of mass removal

Groundwater reinjection

DPE & DGR at a glance



2 m³/h
Average water extraction flow

3 m
Lowering the aquifer's water level

42 %
Water reinjected into the aquifer

41 kg
Mass removed in dissolved phase

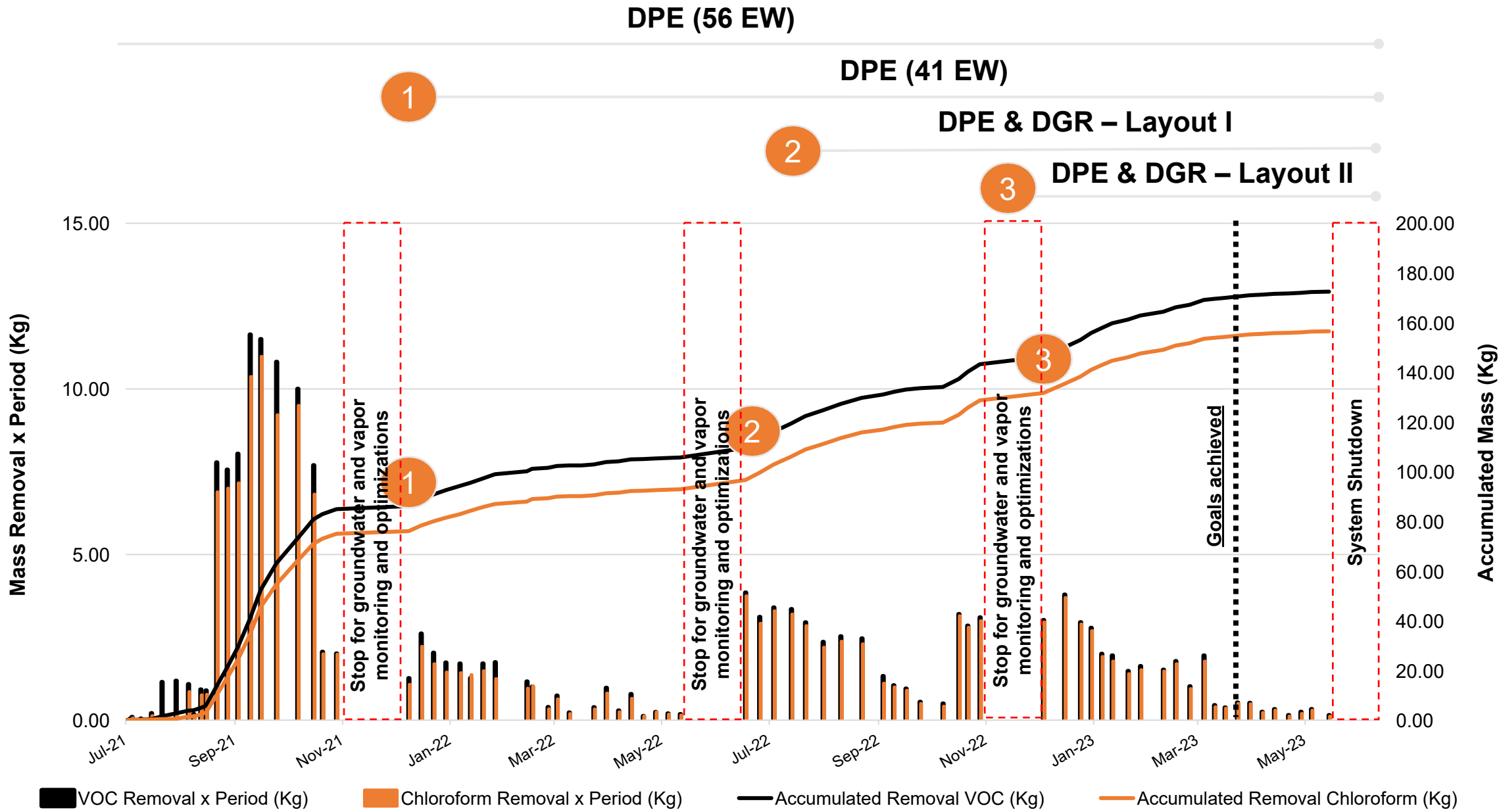
800 m³/h
Average vapor extraction flow

-16 inHg
Medium vacuum

-20 inH_2O
Vacuum influence

131 kg
Mass removed in vapor phase

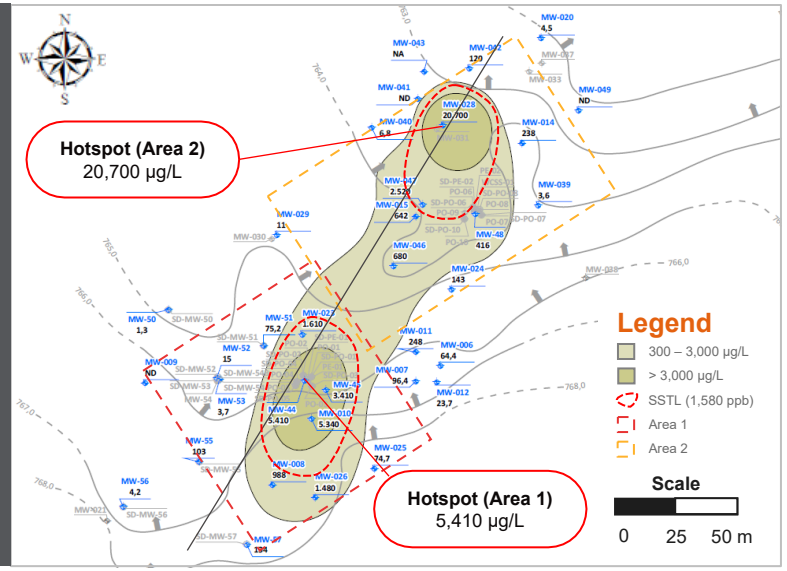
After 24 months...

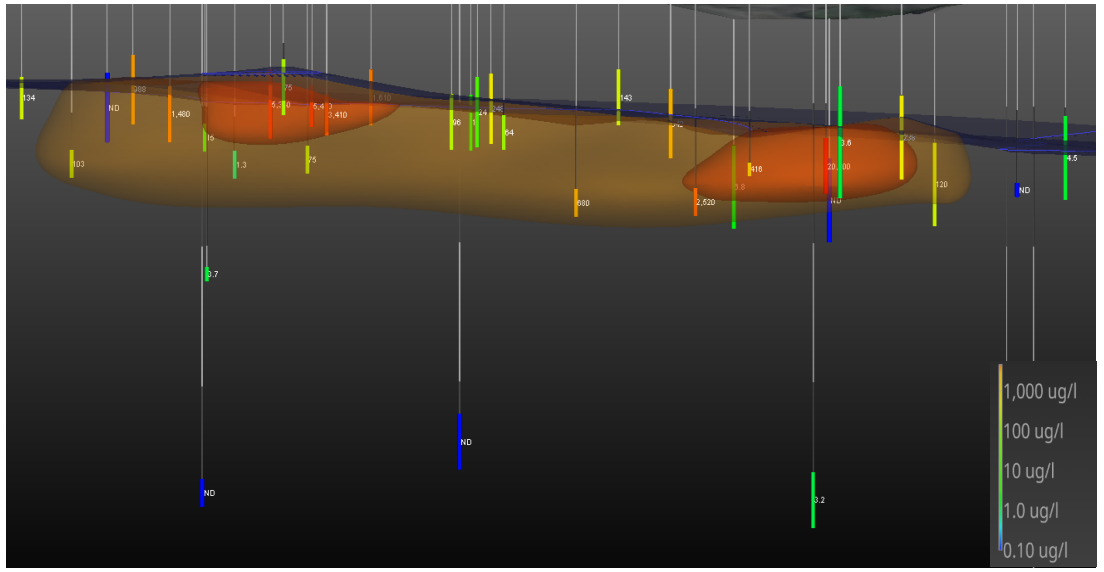


Results

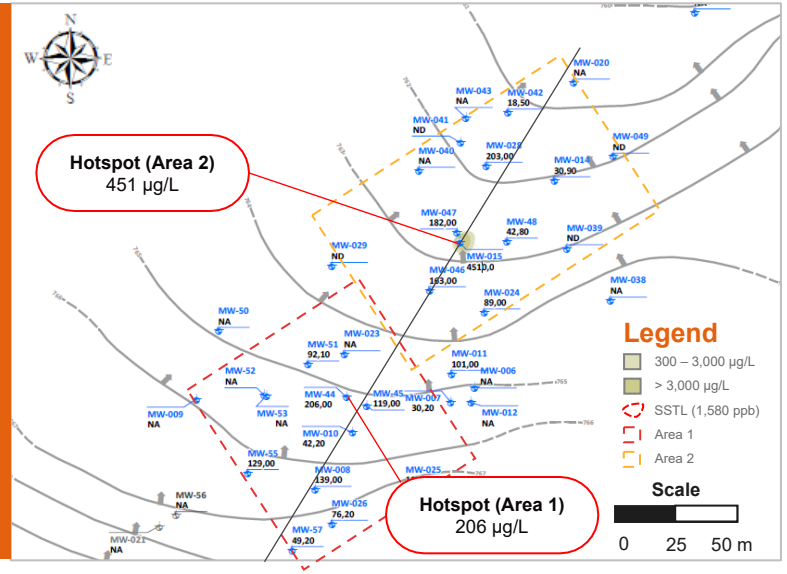
ARCADIS

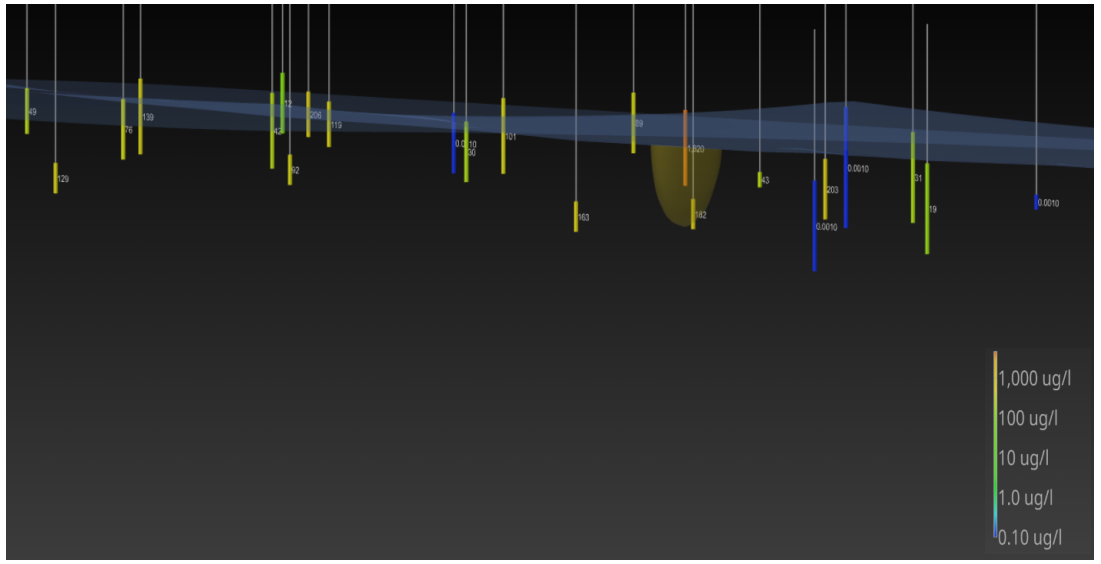
Baseline
December 2020





24 months of
Remediation
July 2023



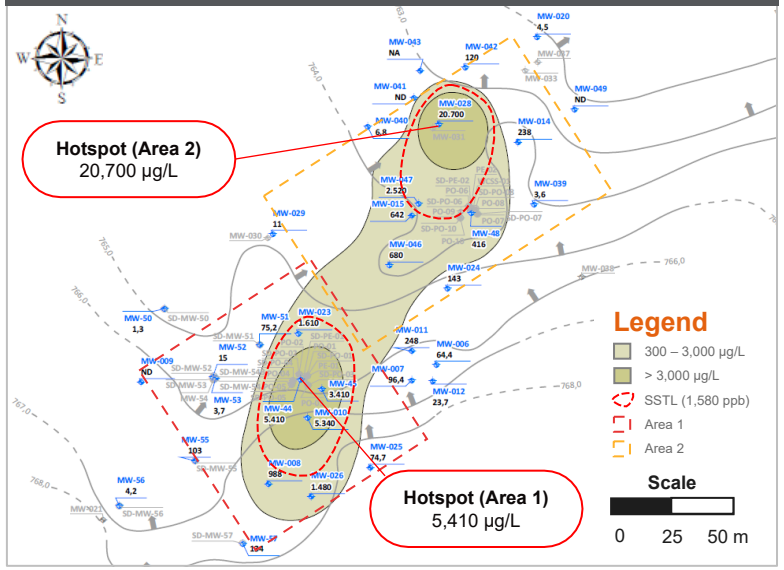


Achieving goals

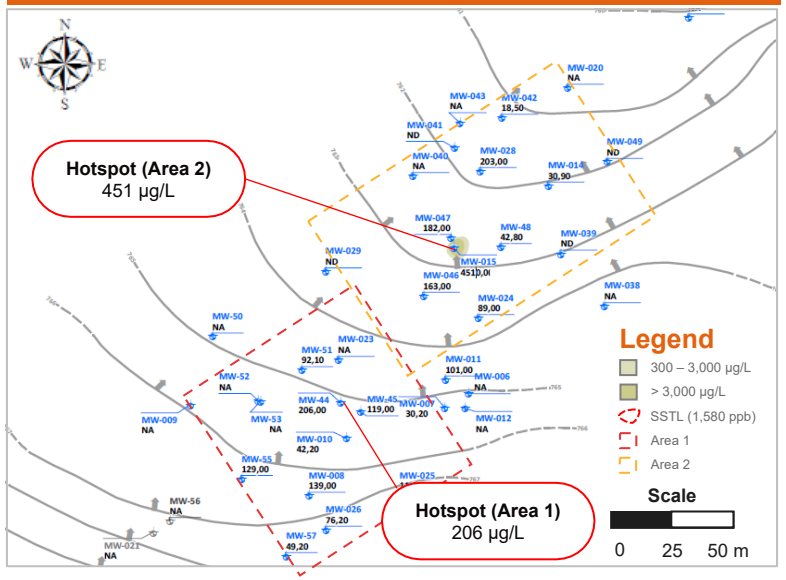
100%

Results

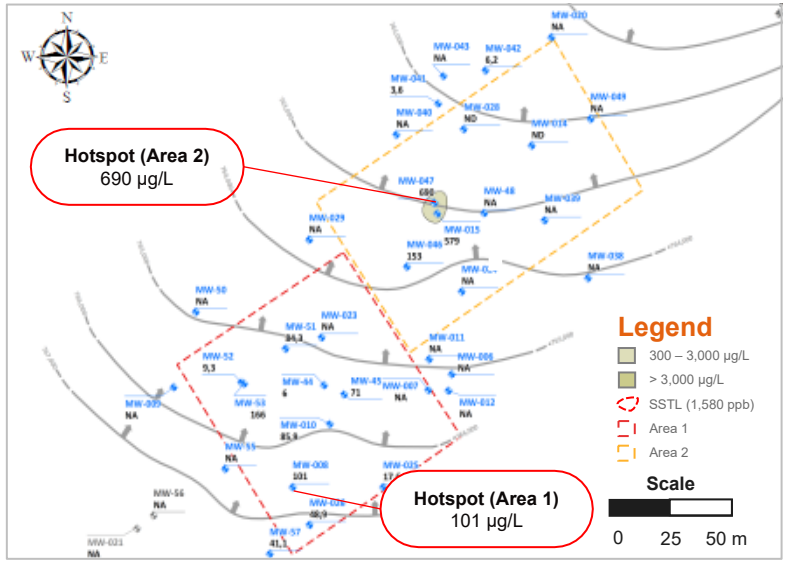
Baseline December 2020



24 months of Remediation June 2023



1st monitoring campaign for closure - December 2023



Conclusions

Project Overview

Timeframe	Financial	Sustainability
Former Consultancy (Remediation by DPE and ISCO and ISTR's simulation)		
10 years	14M ~US$	2,100 tons of CO_2 equivalent
Arcadis Project (Remediation by DPE & DGR)		
2 years	1M ~US$	89 tons of CO_2 equivalent

20%

20% of the time Arcadis managed to achieve remediation goals

7%

With 7% of the investment consumed and projected, Arcadis was able to achieve the remediation goals

-95%

Arcadis managed to reduce emissions by 95%

Contact Us

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