



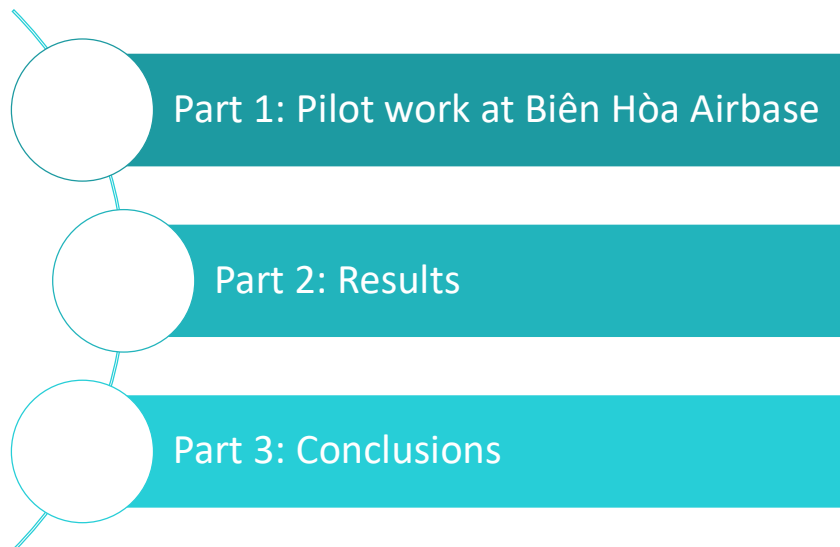
# Ex-Situ Thermal Desorption Treatment of Dioxin-impacted soils

At Bien Hoa Airbase, Vietnam

Jan Haemers, Aurélien Vandekerckhove, Miles Stumbaugh

1

## Summary



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2

2

# Haemers Technology - History



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3

3

# Mobile Thermal Desorption

United States Patent (19)		5,199,354
Wood		Apr. 6, 1993
[54] MOBILE SOIL REMEDIATION SYSTEM		
[57] Abstract:	Wood, Apopka, Fla.	
[52] Appl. No.	847,048	
[51] Int. Cl.	F02B 29/02	



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4

4

# First In Situ projects



Haemers Techno

5

5

# HT TODAY – TECHNOLOGY PROVIDER



Own Lab and R&D facility



Based in Brussels (Belgium)  
55 peoples



Worldwide Operations



Own Smart Burners™  
manufacturing facility



25+ Years in Business

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6

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# Individual Gas Burners – invented 2010



7

7

# Haemers Technology Today

We invent and develop Thermal Desorption Technologies



Award Winning Technologies



Based Brussels (BE) and Rapid City (SD)

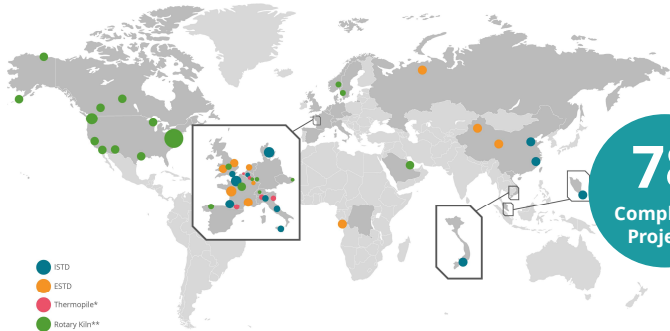


Own Smart Burners manufacturing facility



Own Lab and R&D facility

Worldwide operations through local partners:



Our diverse team:



8

8





9



10

## Site location and history



- US-Vietnam War (1955-1975) – **Operation Ranch Hand**: Rainbow agents sprayed to defoliate jungle, crops and forests
- **Agent Orange** contains **dioxins** that cause severe health issues and are highly toxic for the environment
- Because of its stability, dioxins still affect the inhabitant nowadays
- Contaminated soils are stored on military bases, including **Biên Hòa Airbase**, where HT established its pilot project



11

11

## Scope and purpose

- Demonstrate the **effectiveness of the Smart Burners™** treatment technology and design in order to meet the site-specific dioxins and furans target levels (Agent Orange residues)
- Reach highest circularity levels possible
- **Thermal treatment pilot plant** composed of two main units:
  - The **soil pile** to be heated (ESTD – Ex Situ Thermal Desorption);
  - The **Vapor Treatment Unit (VTU)** where dioxins are destroyed.



12

12

# Circularity - Level 0: Linear

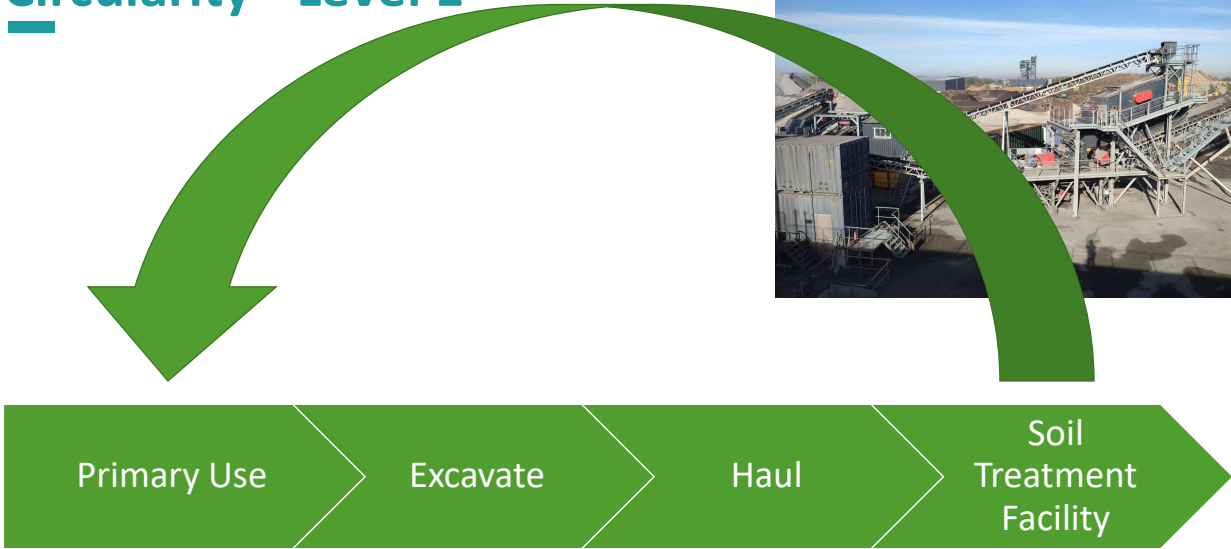


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13

13

# Circularity - Level 1



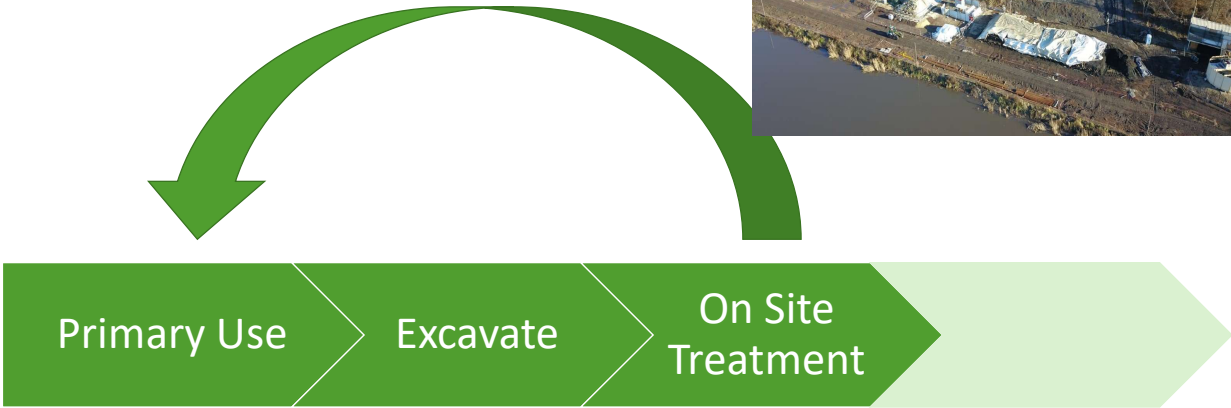
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14

14



# Circularity - Level 2



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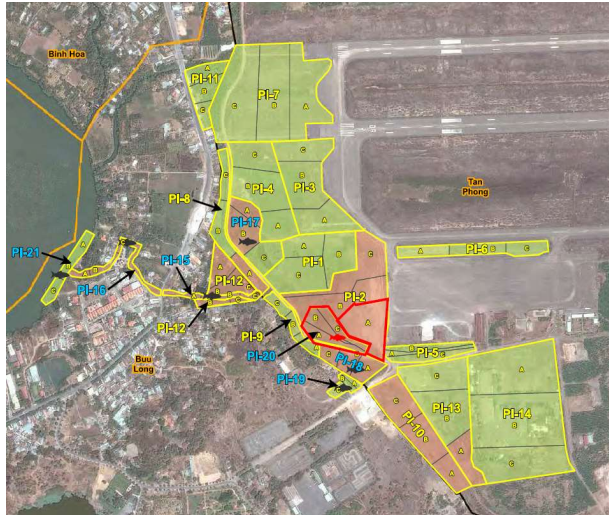
# Circularity - Level 3



16

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## Origin of the contaminated materials

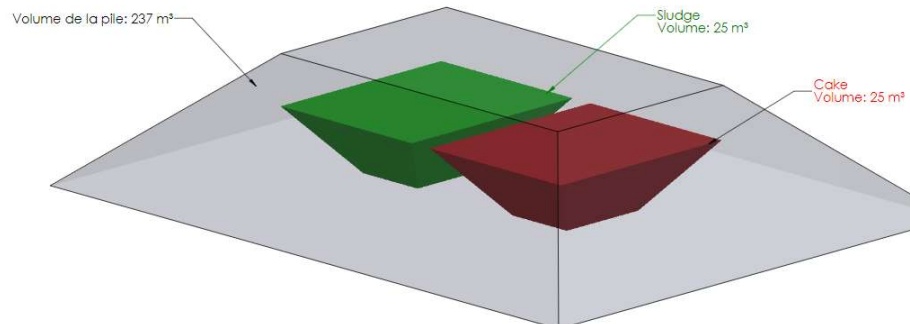


- Contaminated soils : Pacer Ivy-2A
- Contaminated sludges : Pacer Ivy-20
- Washing cake : 2019-2020 Shimizu soil washing installation

## Origin of the contaminated materials



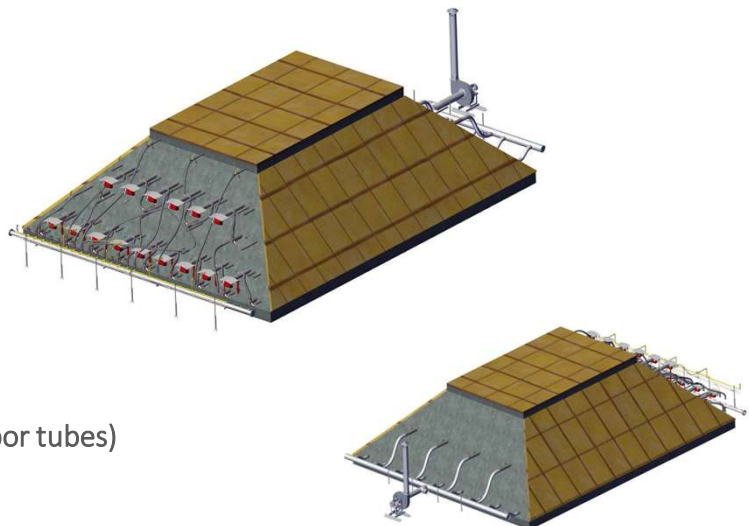
## Thermal Pile Materials



- Thermal Pile of 237m³:
  - 187 m³ of contaminated soils
  - 25m³ of contaminated sludge
  - 25m³ of washing cake

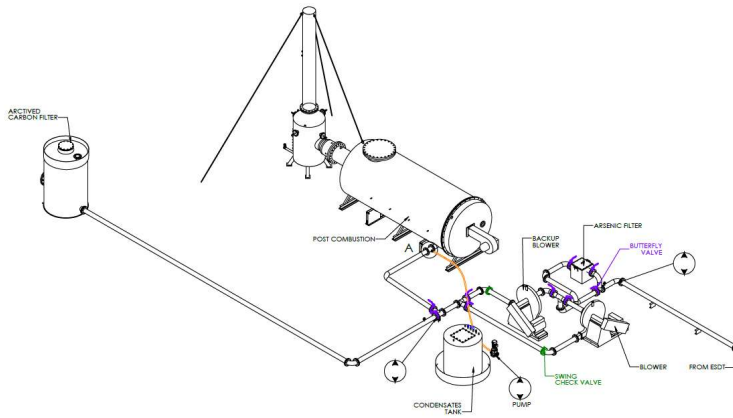
## Thermal Pile Design

- Combustion network
  - 15 burners -15 heating tubes
  - 13 exchanger tubes
  - 1 fan
- Vapor network
  - Vapor tubes
  - Secondary vapor tubes
- Cover of the pile
  - Layer of gravel (+ secondary vapor tubes)
  - Concrete
  - Thermal insulation





## Vapor Treatment Unit (VTU)



- Thermal Oxidizer:
  - $T^{\circ} > 1100^{\circ}\text{C}$  ;
  - $t > 1\text{ s}$  ;
  - High turbulence ( $Re \gg 2500$ )
  - $\text{O}_2$  content  $> 6\%$
- Quench Tower
  - Rapid cooling ( to  $T^{\circ} < 180^{\circ}\text{C}$ )
  - Avoid reformation
- Back-up Activated Carbon



21

21

## Vapor Treatment Unit (VTU)



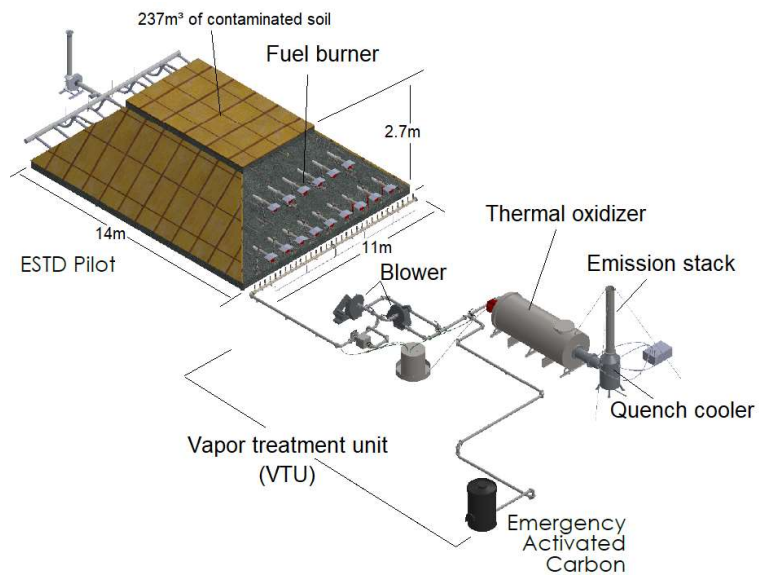
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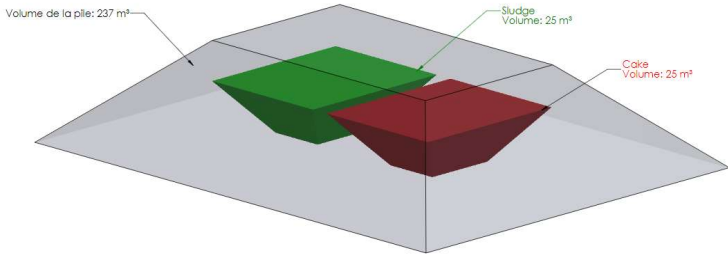
# General layout



23

23

# Soil Treatment Objectives



Material	Unit	Initial concentration	Treatment goal	Target DRE
Soil	ppt TEQ	11.400	300 (Urban residential)	97,3 %
			1200 (Industrial)	89,5 %
Sludges	ppt TEQ	5.410	150	97,2 %
Washing cake	ppt TEQ	17.200	300	98.2%



24

24

## VTU Objectives

- Demonstrate Vapor treatment process
  - Emissions at stack compliant with VN, EU and US standards  
 $<0.1\text{ng TEQ/Nm}^3$
  - No increase in dioxins in ambient air
- Zero waste concept



## Activities in 2019-2020

- Arrived on site end of November 2019
- Installation complete in February 2020
- Testing the Installation
- Start of the treatment: 17 march 2020
- Interruption of the project due to COVID-19





## Resuming activities in 2022

- Resume activities on 28th of December 2021
- Restoration of the site and installation testing
- Treatment start: 2<sup>nd</sup> of February 2022
- Treatment phase end: 14<sup>th</sup> of March 2022 – 40 days of treatment



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27

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## 02 Results of the pilot

28

## Treatment Performance Report

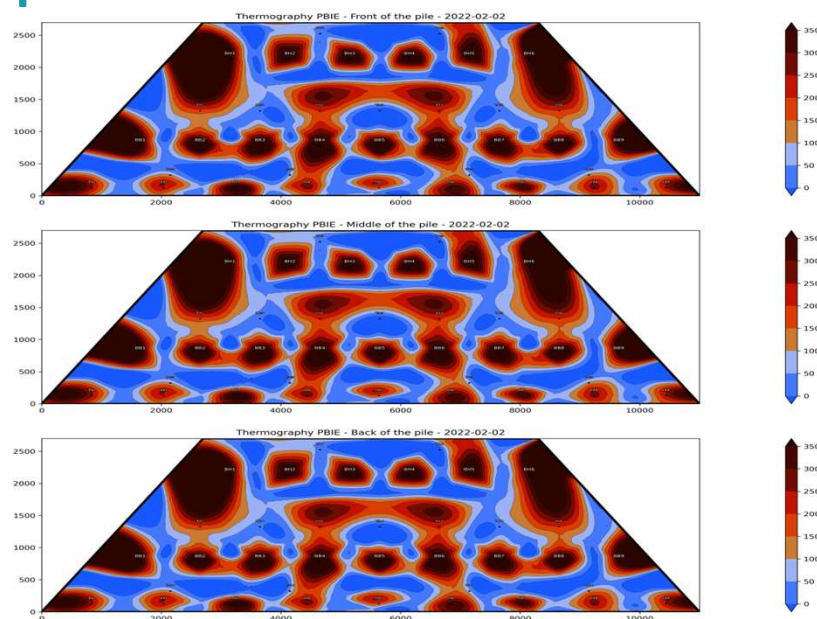
- The effectiveness of the thermal treatment is evaluated by various parameters:
  - Soil temperature;
  - Pressure monitoring;
  - Temperatures in the VTU;
  - Emission control;
  - Ambient air monitoring;
  - Treated Soil analysis;
  - Concrete analysis;



29

29

## Soil Temperature evolution



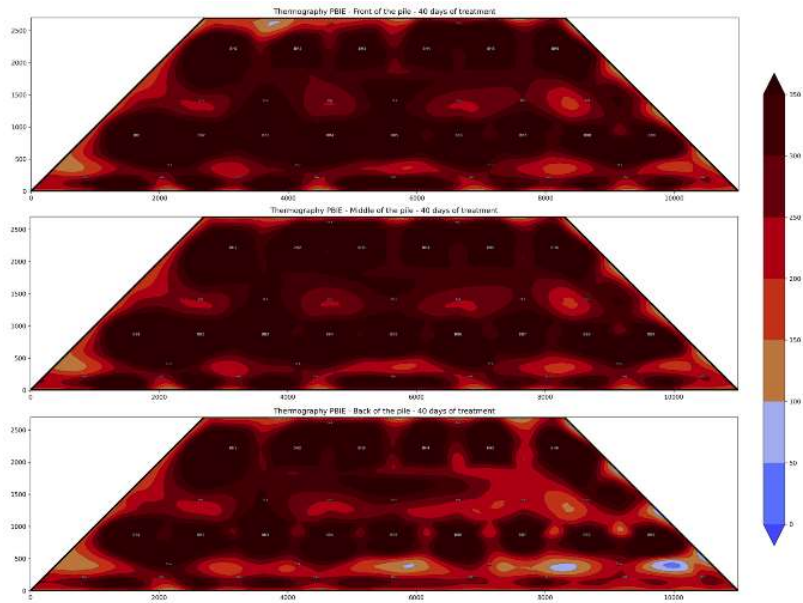
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# Soil Temperature after 40 heating days

14/03/22  
40 heating days

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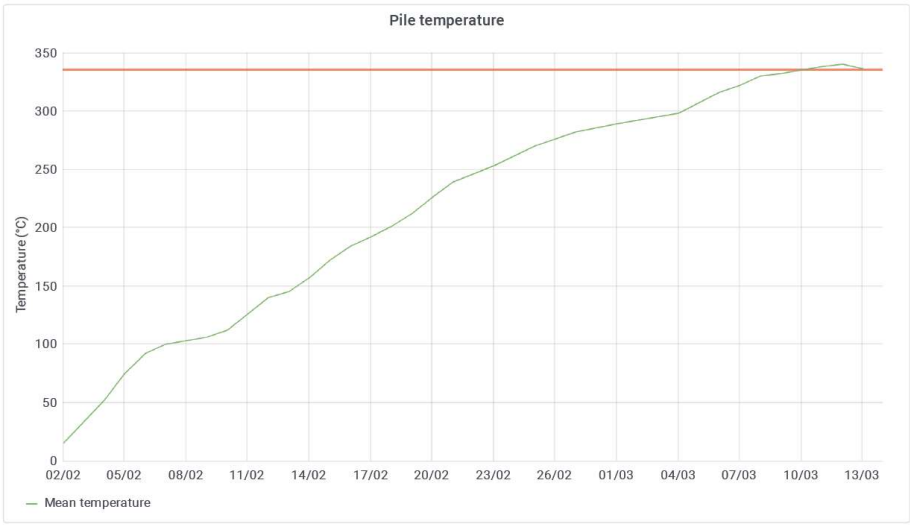


31

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# Soil Temperature: average temperature

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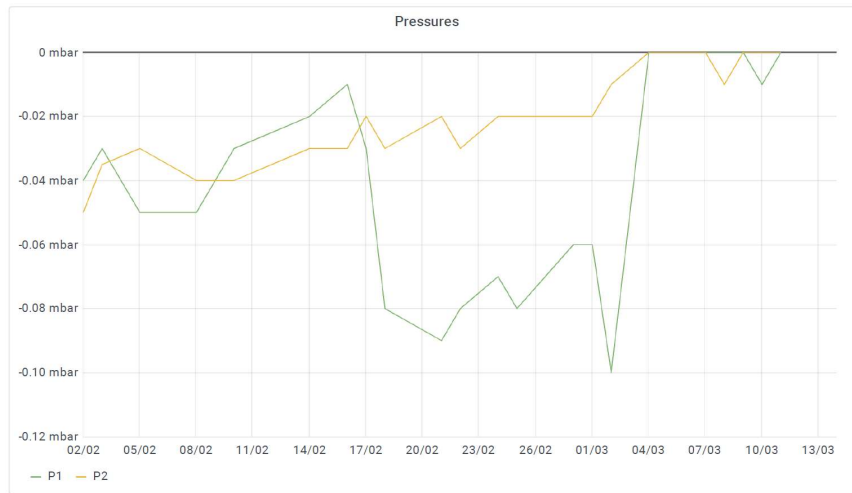


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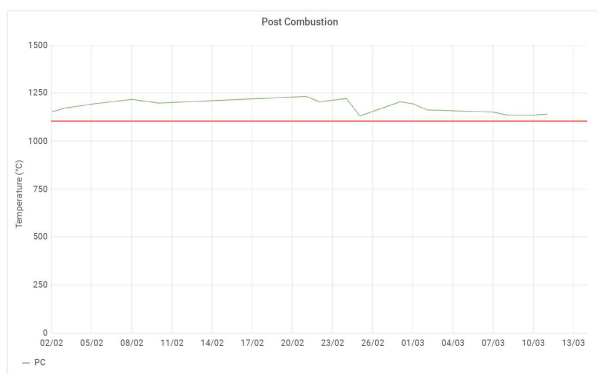


## Pressure monitoring

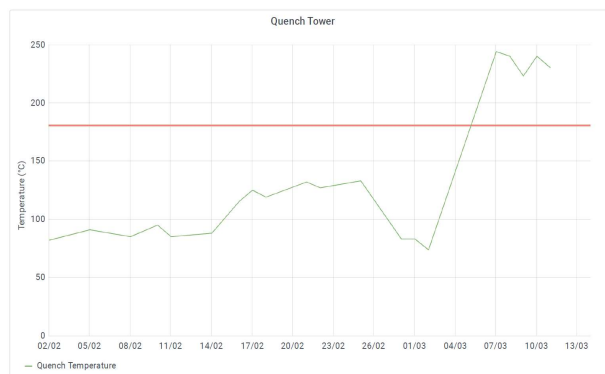


Continuous vacuum ( $P < 0$  mbar) in the pile -> **No fugitive emissions**

## VTU Temperatures

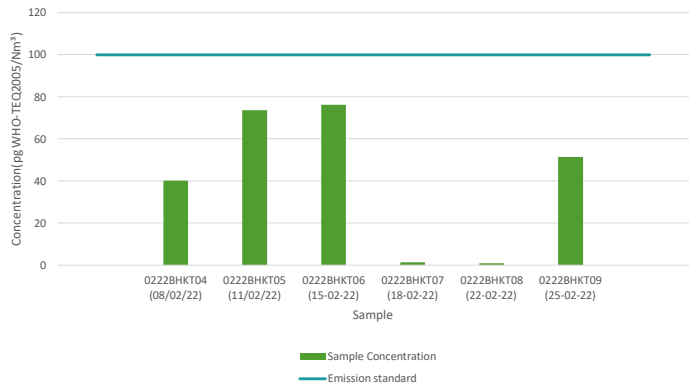


**Thermal Oxidizer > 1100°C**



**T° at the stack < 180°C**  
(for 30 days of treatment, then <240°C)

# Emission control



Compliant emissions (< 0,1 ng TEQ/Nm³)

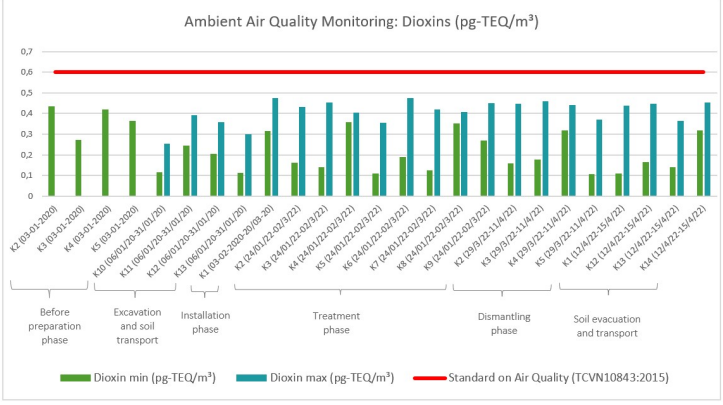


Source: VRTC



# Ambient Air monitoring

During excavation works (2020) → Compliant  
During treatment (2022) → Compliant  
During demobilization (2022) → Compliant



Source: CF/CTET (Chemical Force)

## Treated Soil Analysis

Material	Unit	Initial concentration	Treatment goal	Treated soil Results	Destruction Rate Efficiency
Soil	ppt WHO-TEQ <sub>2005</sub>	11.400	300 (Urban residential)	<b>4,84</b>	99,96%
			1.200 (Industrial)	<b>96,29</b>	99,16%
Sludges	ppt WHO-TEQ <sub>2005</sub>	5.410	150	<b>ND</b>	> 99,99%
Washing cake	ppt WHO-TEQ <sub>2005</sub>	17.200	300	<b>6,7</b>	99,96 %

The Destruction Rate Efficiency is **over 99%** for all samples



37

37

## Concrete analysis

Sample	Unit	Concentration
Concrete 1 (top of the pile)	pg WHO-TEQ <sub>2005</sub> /g	6,31
Concrete 2 (side of the pile)	pg WHO-TEQ <sub>2005</sub> /g	14,11

No cross contamination of the concrete



38

38

# Performance report conclusions

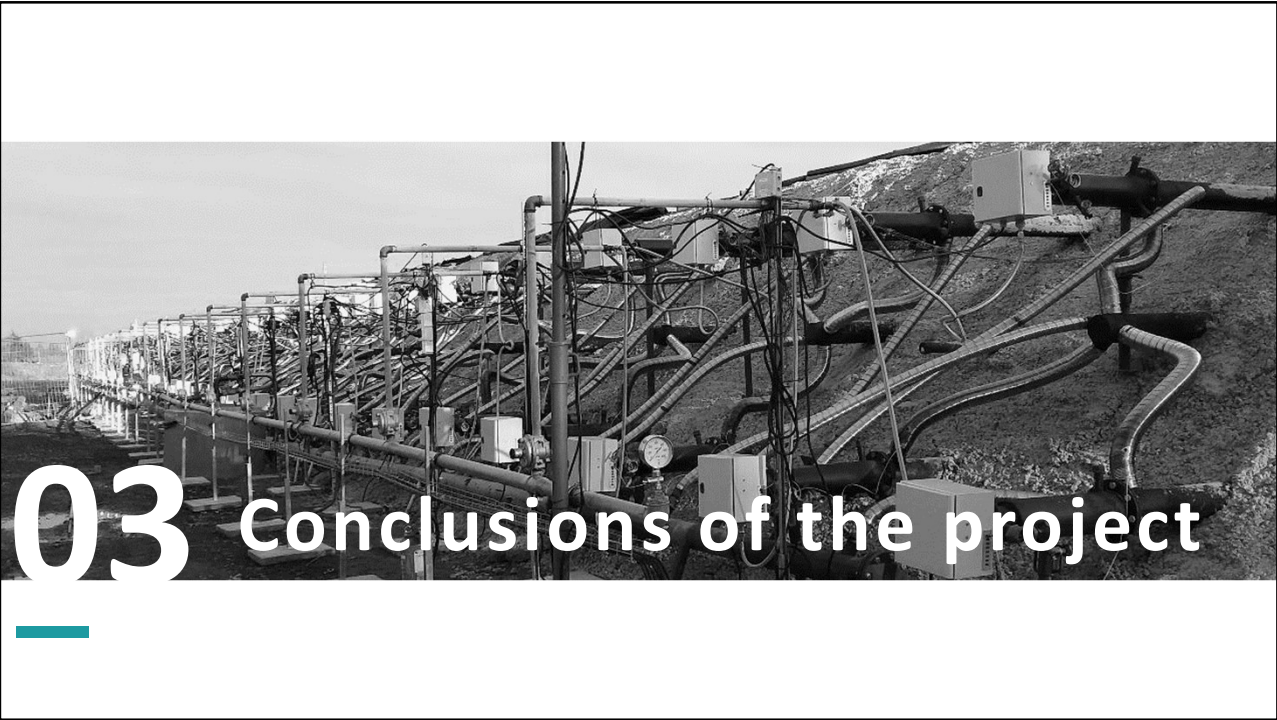


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39

39



40



## Conclusions

This project demonstrates an improved and effective thermal treatment technology for the remediation of dioxin contaminated soils where all toxic components are destroyed, and soil is recycled.

Technology is ready for full scale

- Cost effective
- No material environmental impact
- Sustainable (zero waste – full destruction)



41

41



42

