In-Pile Thermal Desorption® (IPTD®) of Dioxin Contaminated Soil and Sediment

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(SheGoTec Japan, Inc., Tokyo, Japan)

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Overview

- IPTD® Background and Concepts
- ISTD/IPTD® Treatment of Dioxins
- SCE - Alhambra ISTD Case Study
- MOE Japan IPTD® Demonstration
- USAID – Da Nang Airport Project
- New IPTD® Patent

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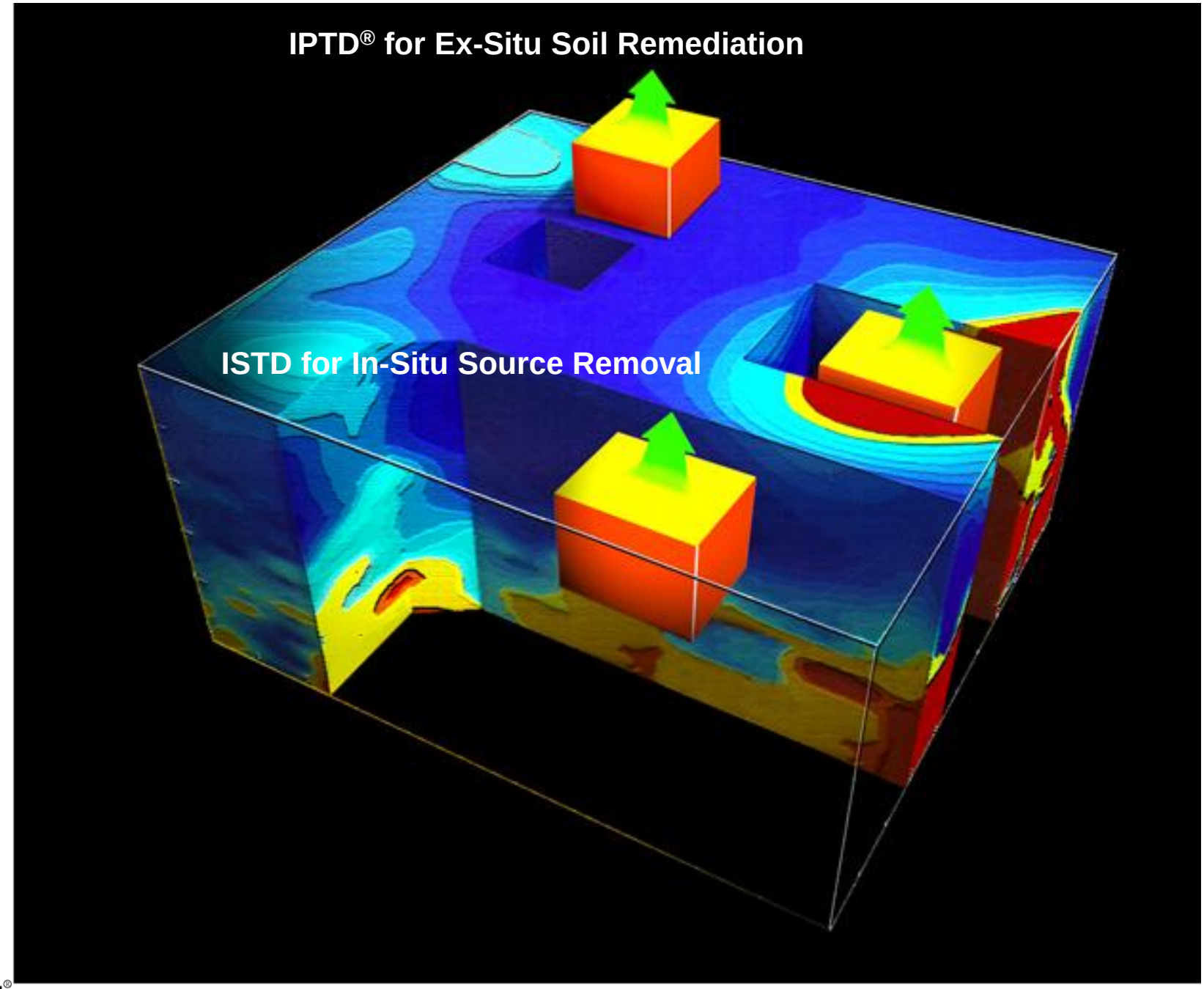
IPTD® for Ex-Situ Soil Remediation
ISTD for In-Situ Source Removal

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In-Pile Thermal Desorption® (IPTD®)

- Like ISTD, uses thermal conduction heating (TCH) and vacuum extraction to provide within-the-soil remediation;
- Can be designed to treat any organic contaminant; and
- Eliminates the need for offsite disposal or incineration of contaminated soils and sediments.

U.S. Patents 6,881,009; 7,004,678; 7,534,926; and 8,348,551; International patents issued and pending.

First IPTD® Application: Saipan (PCBs)

1998 Technology Merit Award - issued by the Army Corps of Engineers for TerraTherm's Saipan ex-situ remediation project.

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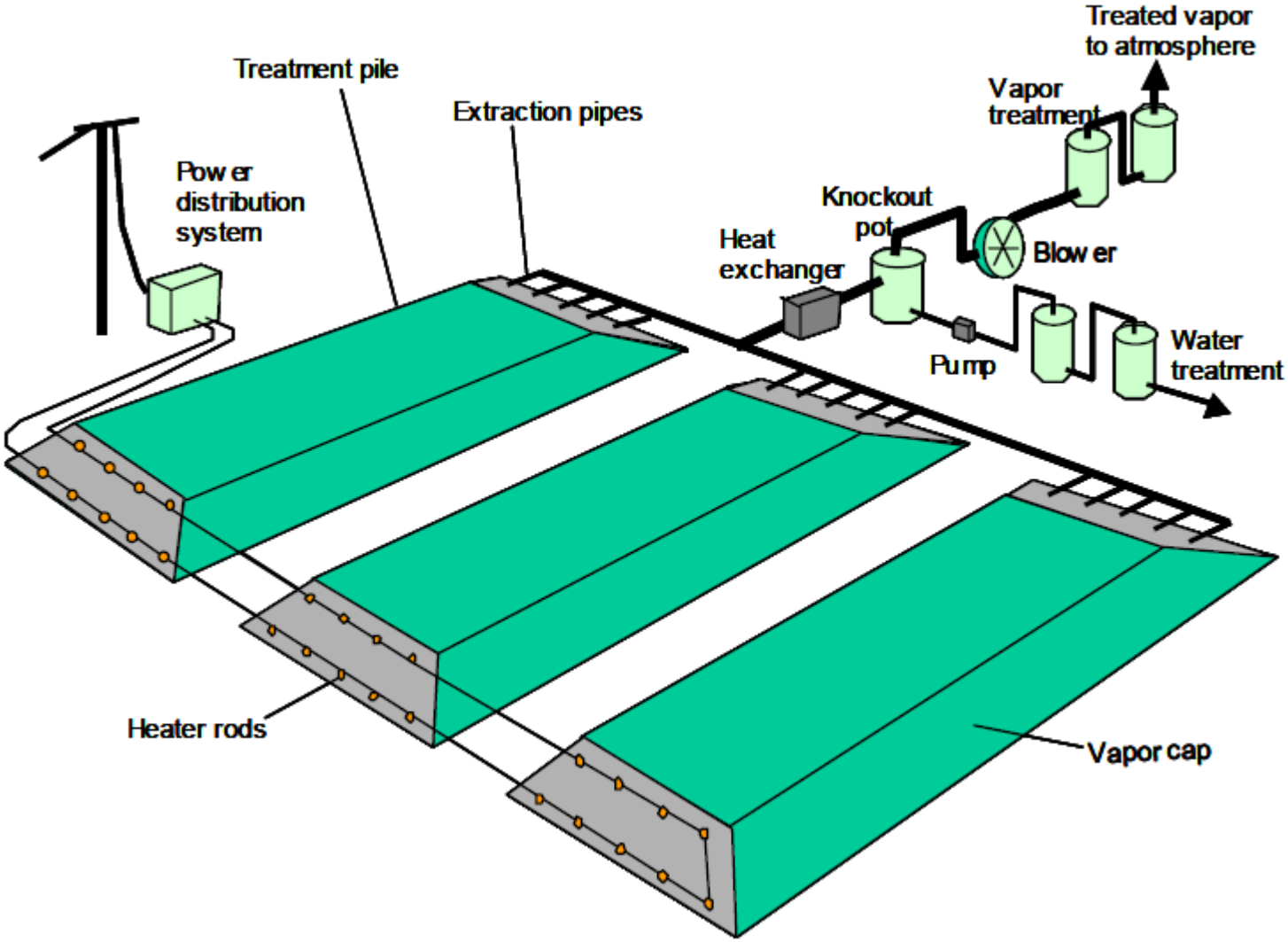
Sketch of IPTD® with Horizontal Wells



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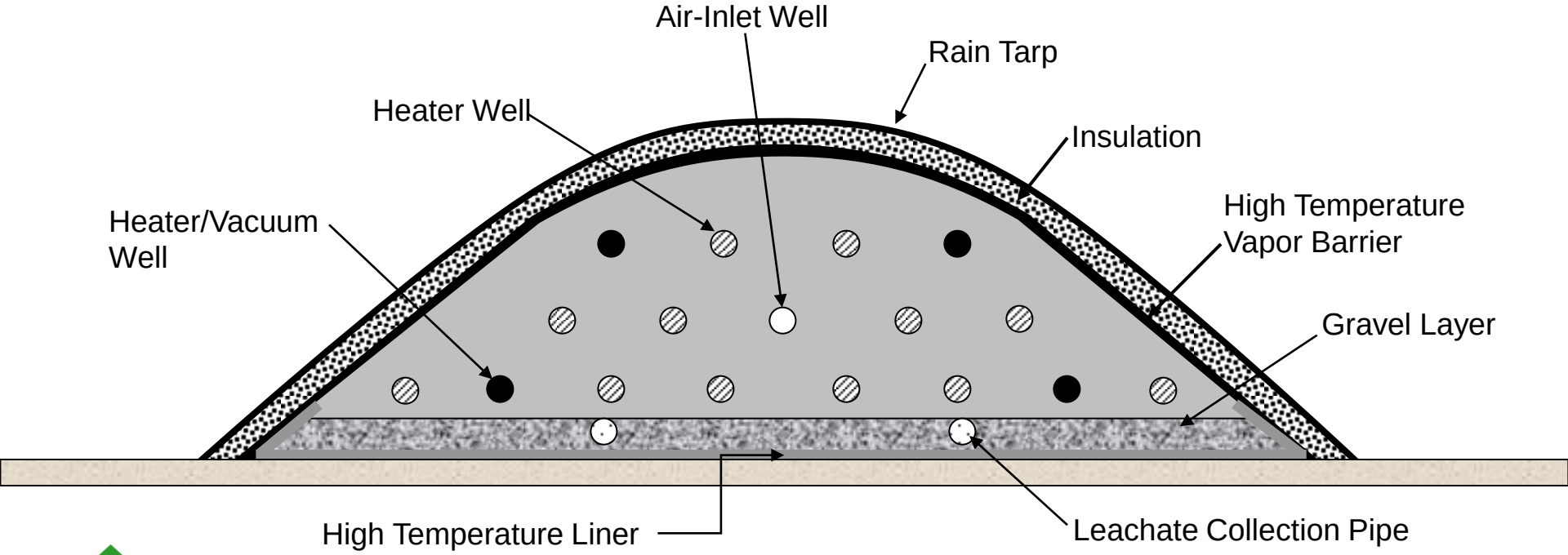
Corinna, ME
(Chlorobenzenes, Dioxins)



(Baker et al. 2002)

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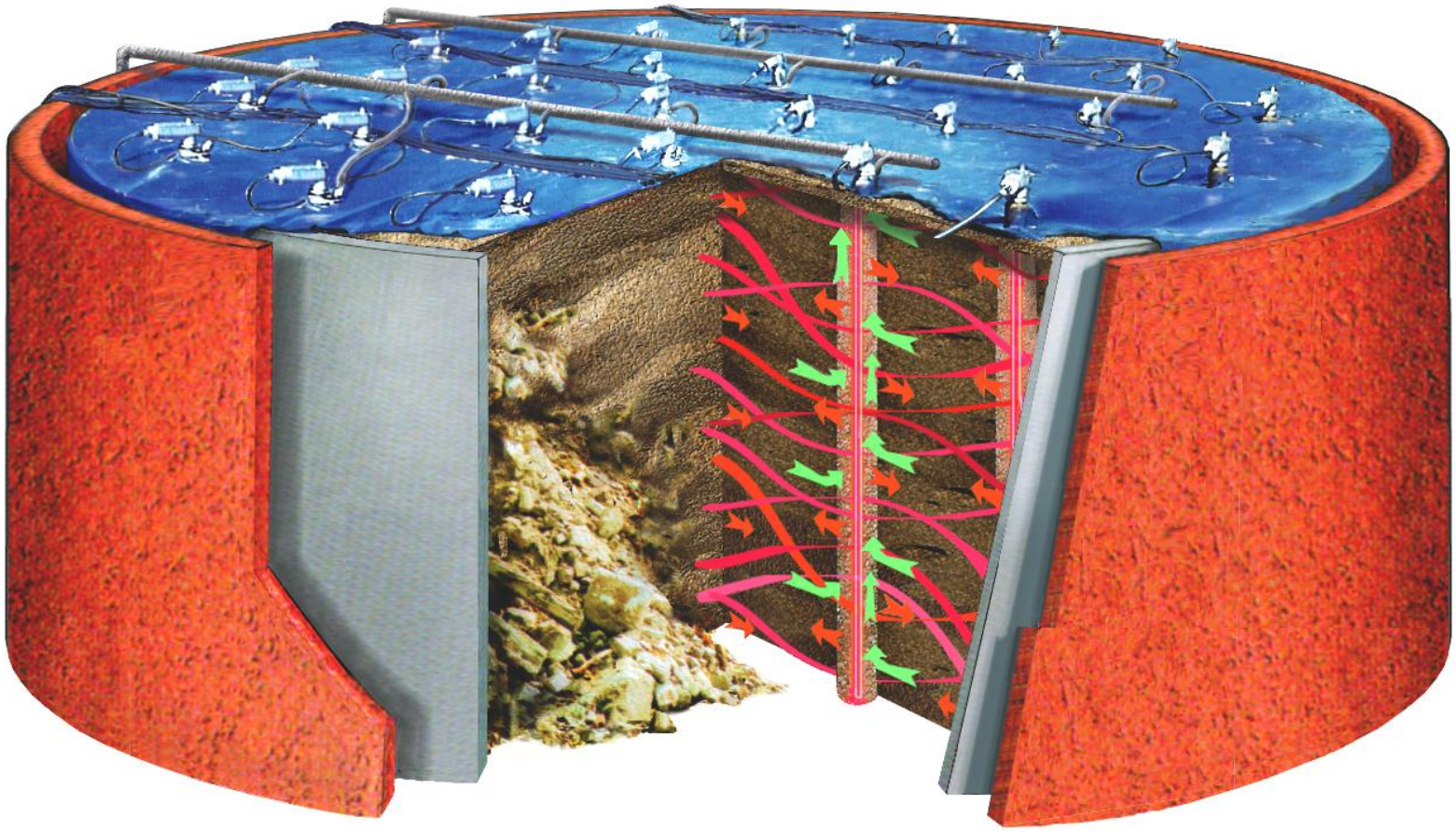
Early IPTD® Concept Utilizing Vertical Wells



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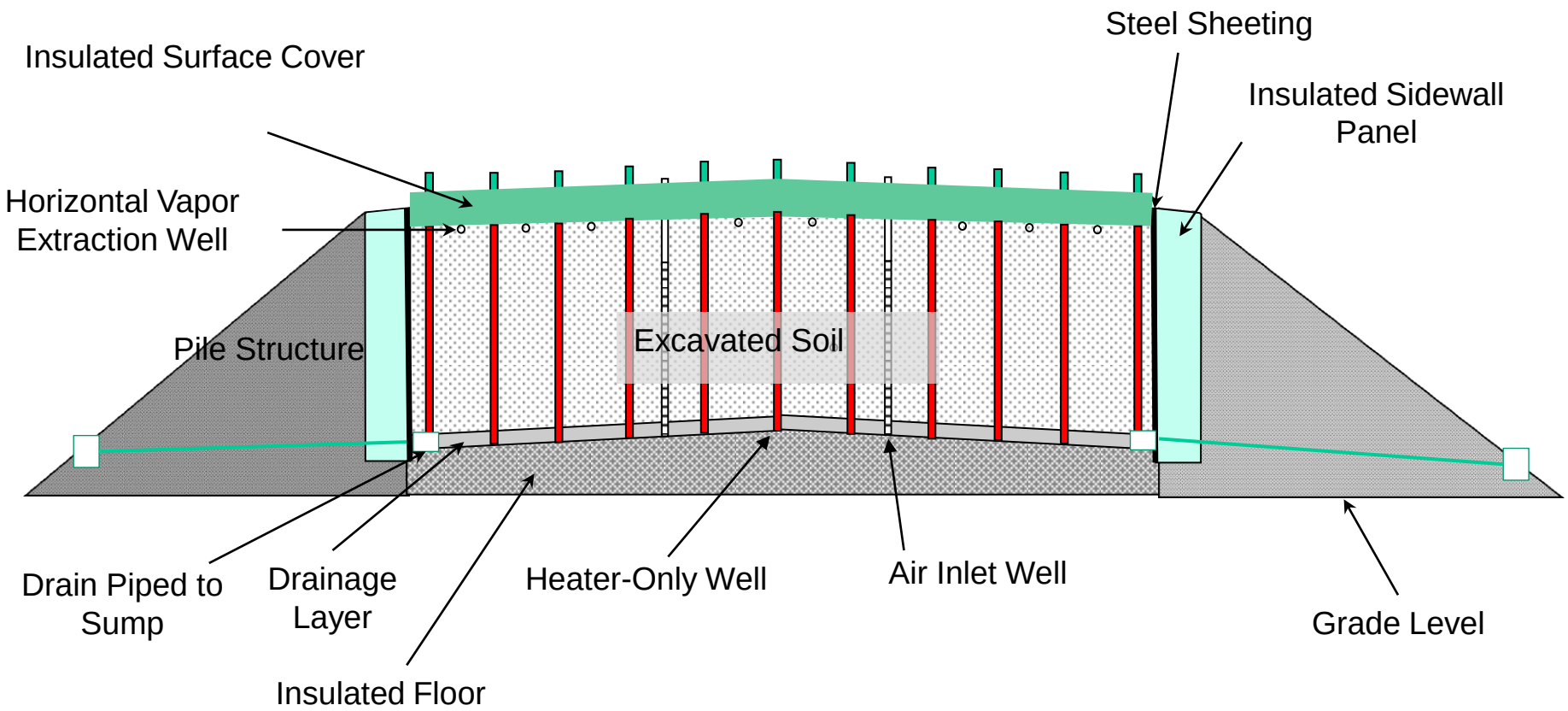
Sketch of IPTD® with Vertical Wells



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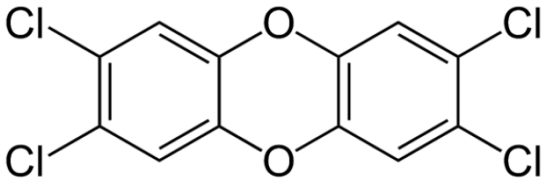
Dioxins and Furans

- Structure, example:



2,3,7,8-Tetrachlorodibenzodioxin (TCDD)

- Low vapor pressure, high boiling point, high log K_{ow}, low aqueous solubility
- Known human carcinogens
- Stable in the environment, highly recalcitrant to most remedial techniques

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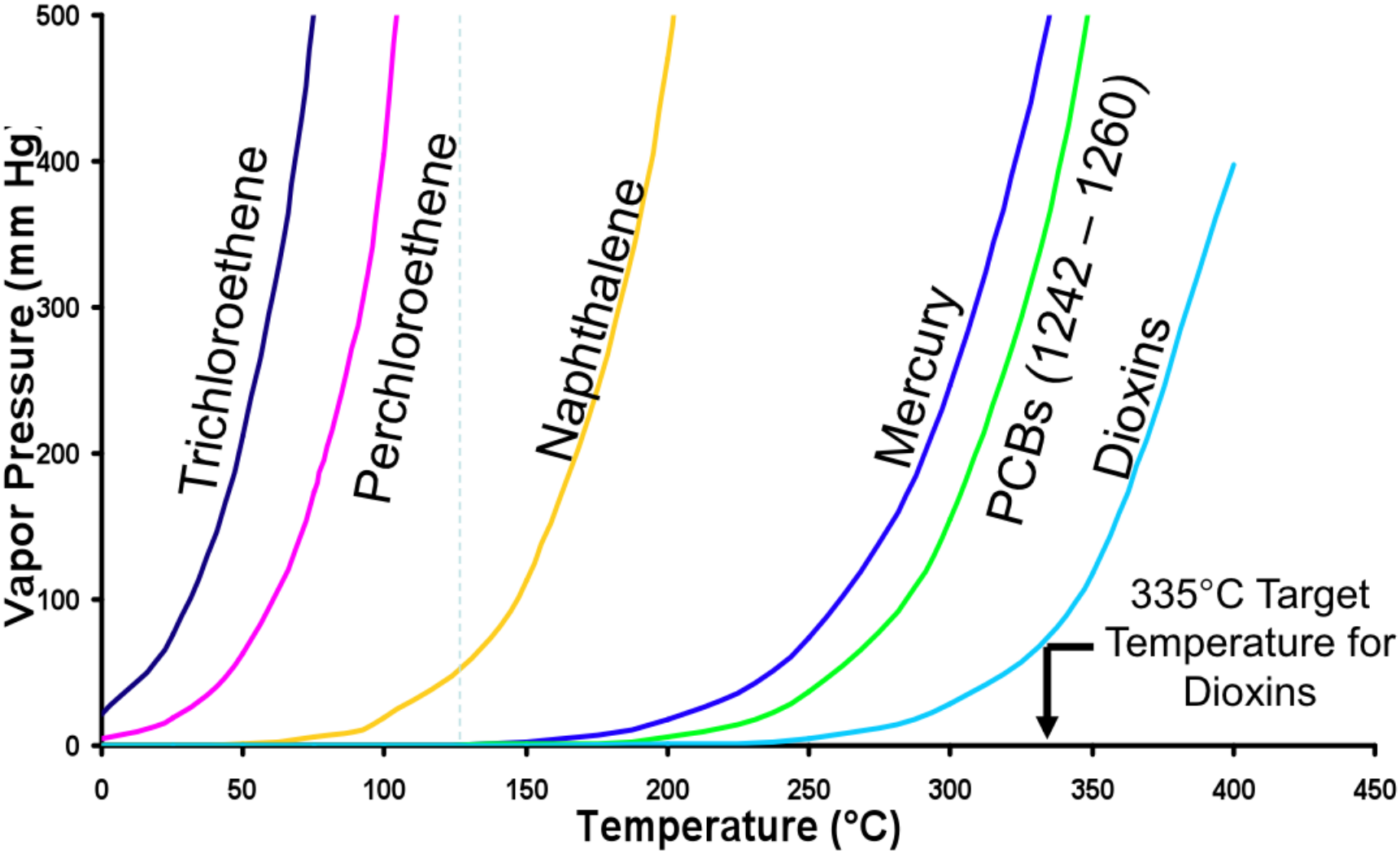

The vapor pressures of contaminants increase exponentially due to thermal conduction heating during the IPTD® process.

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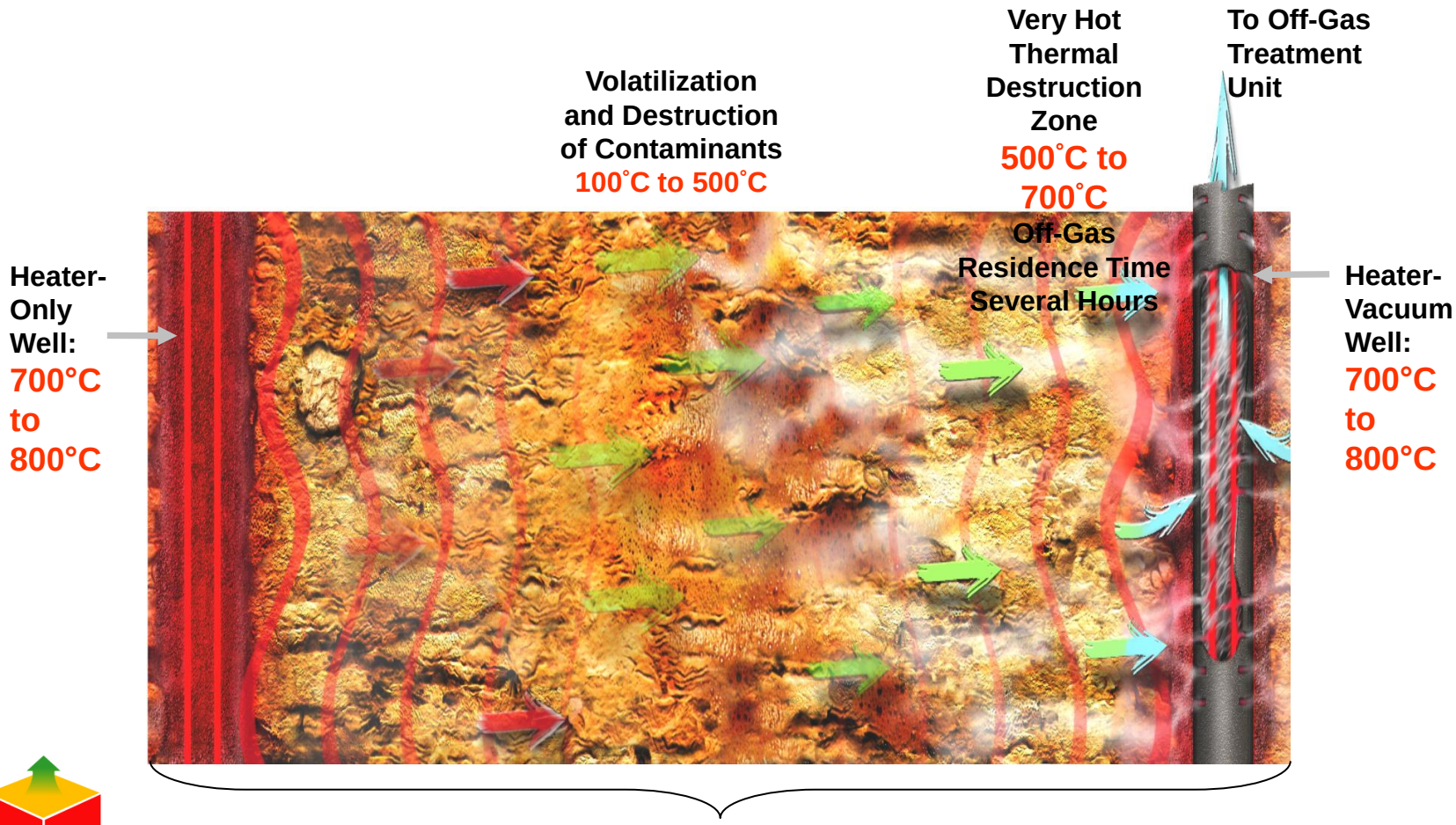
ISTD/IPTD®: Where Does Removal and Destruction Occur?



Vertical cross-section between two thermal wells

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Examples of ISTD and IPTD® field project results for the remediation of dioxin in soil and sediment

Site	Target Media	Average Pre-Treatment Concentration	Average Post-Treatment Concentration	Exhaust Gas Concentration
		pg-TEQ/g	pg-TEQ/g	ng-TEQ/Nm^3
Yamaguchi, Japan	Sediment	1,800	67.75	0.000018
Alhambra, California USA	Soil	18,000	110	0.0071
Cape Girardeau, Missouri USA	Soil	6,500	3.2	0.0029
Ferndale, California USA	Soil	3,200	7.3	0.0055

(Heron et al. 2010; Baker et al. 2007; USEPA 1998; Conley and Lonie 2000)

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ISTD Case Study: Southern California Edison, Former Pole Yard, Alhambra, CA
(PAHs, PCP and Dioxins)

Phase 1

Phase 2

Designed, built, operated by TerraTherm, Inc.

(Baker et al. 2007)

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Alhambra Air Quality Control System

- Continuous Emissions Monitoring (CEM) of Off-Gas
- 4 Stack Tests

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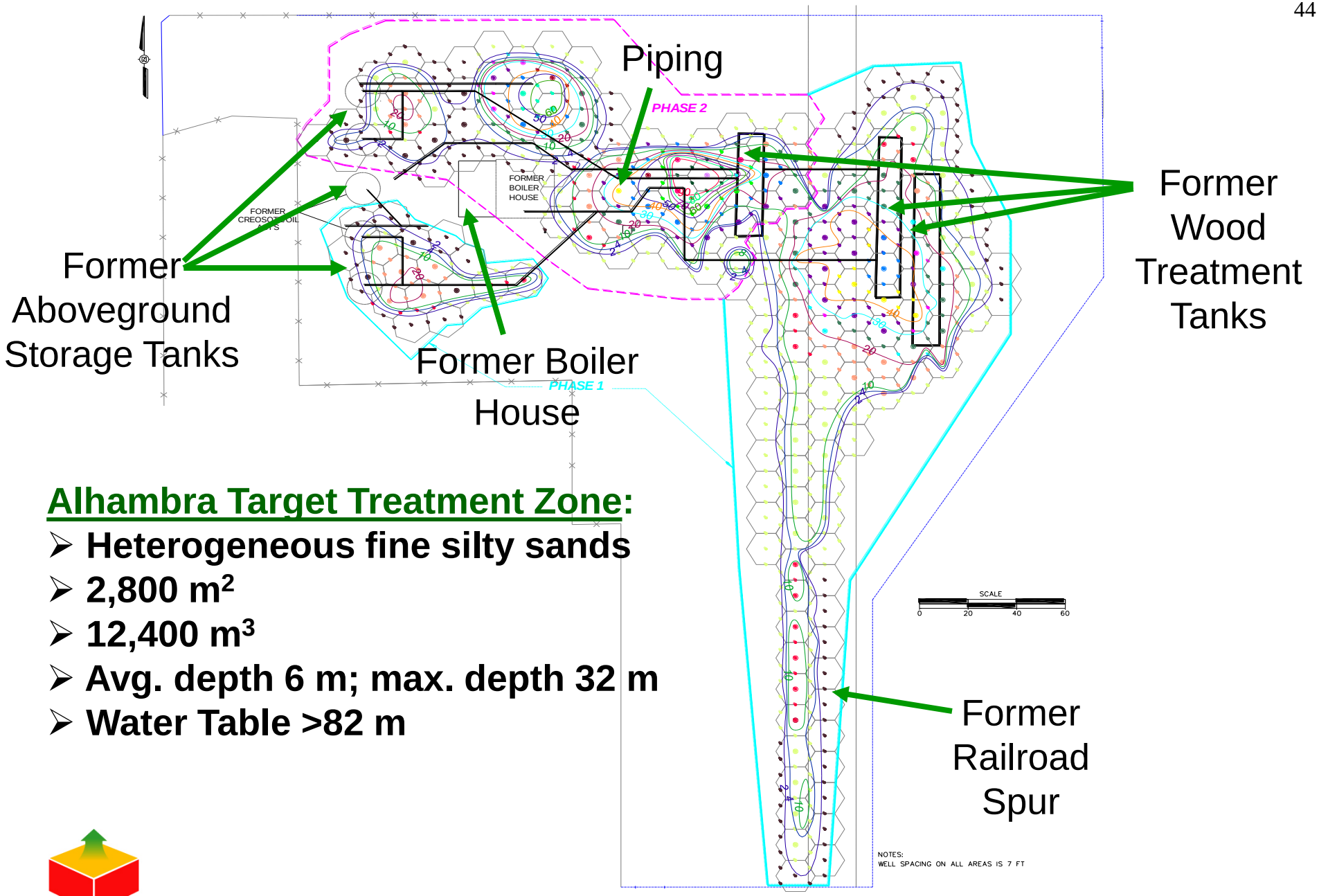

Alhambra Target Treatment Zone:

- **Heterogeneous fine silty sands**
- **2,800 m^2**
- **12,400 m^3**
- **Avg. depth 6 m; max. depth 32 m**
- **Water Table >82 m**

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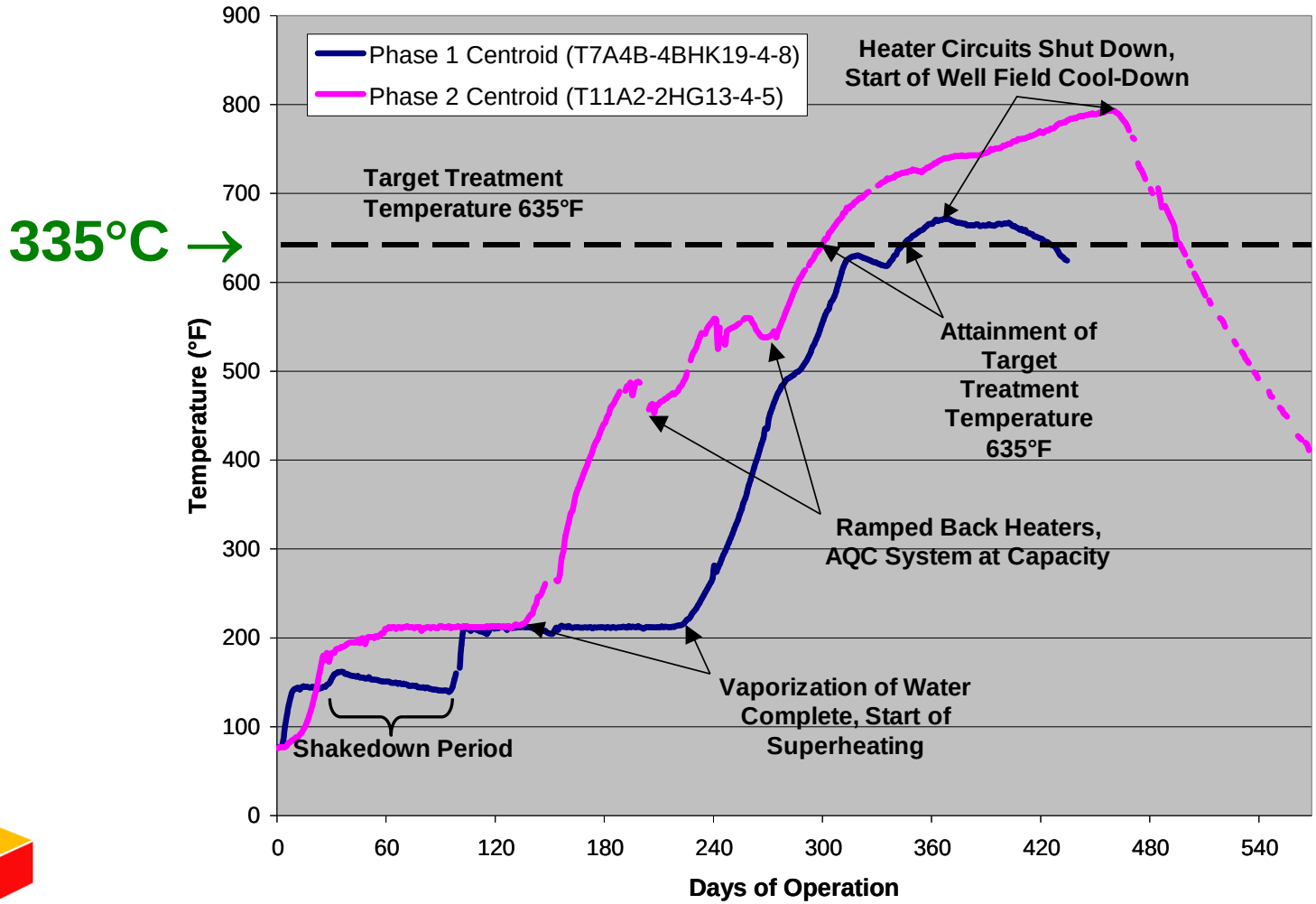
Alhambra ISTD Design Features

- Target temperature (treatability results) of 335°C, maintained for 3 days
- 2.1-m thermal well spacing
- 785 thermal wells, total (131 heater-vacuum and 654 heater-only wells)
- Insulated surface seal
- Two treatment phases

Attainment of Target Temperature (Phases 1 and 2)



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Confirmatory sampling in well field

Auger cuttings oxidation vs. pyrolysis

Coke from product zone

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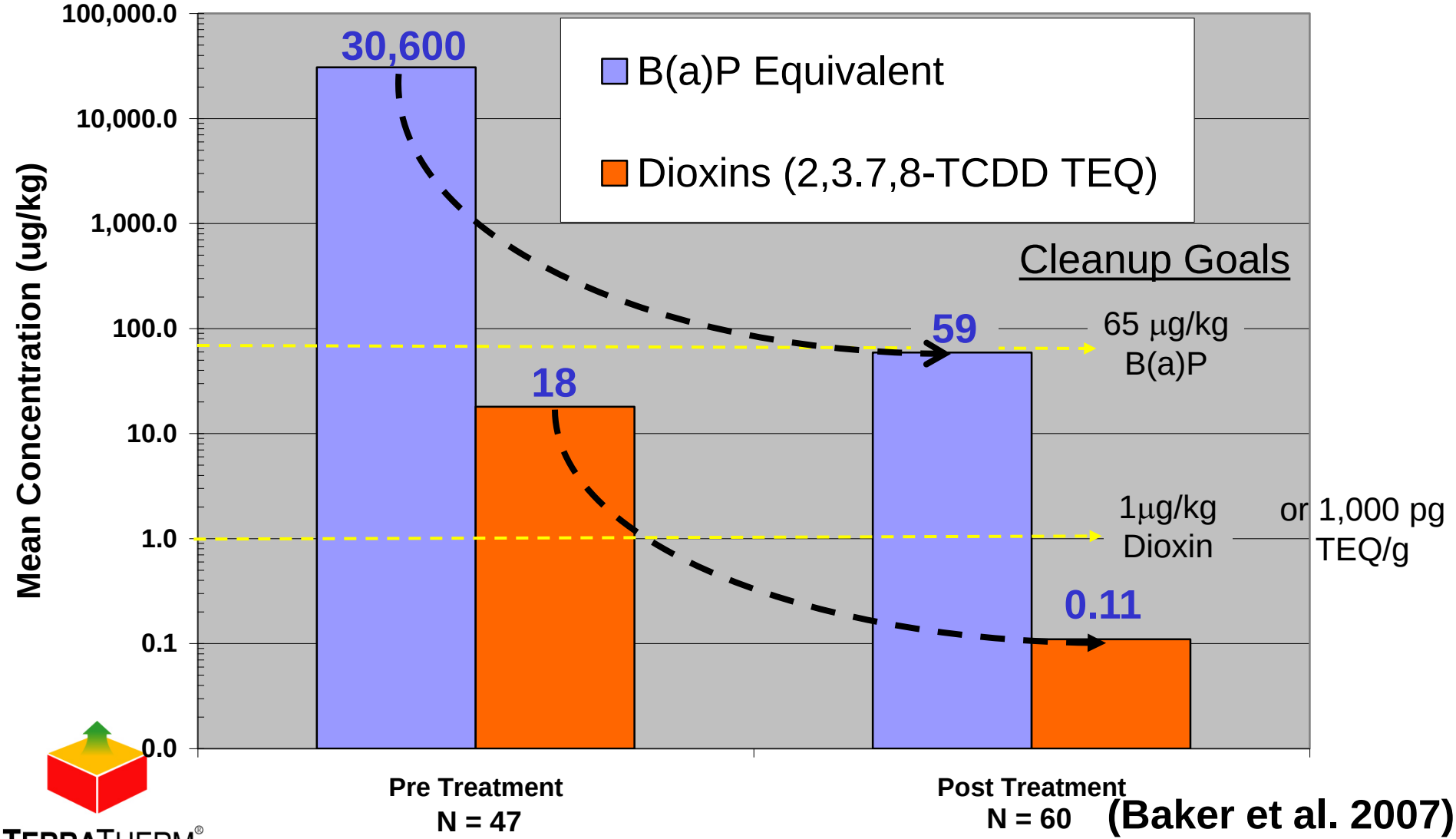
Alhambra Confirmatory Soil Sampling

Alhambra Treatment Results



(Baker et al. 2007)

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Alhambra No Further Action Letter:

"DTSC has determined that the AOC-2 portion at this Site has been remediated to allow for unrestricted land use and that No Further Action is required."

Department of Toxic Substances Control

Linda S. Adams
Secretary for
Environmental Protection

Maureen F. Gorsen, Director
1011 North Grandview Avenue
Glendale, California 91201

Arnold Schwarzenegger
Governor

February 8, 2007

Ms. Jennie King
Project Manager
Environmental Affairs
Southern California Edison
2244 Walnut Grove Avenue
Rosemead, California 91770

REMEDIAL ACTION COMPLETION REPORT APPROVAL AND AOC-2 CERTIFICATION, SOUTHERN CALIFORNIA EDISON (SCE) ALHAMBRA COMBINED FACILITY, ALHAMBRA, CALIFORNIA

Dear Ms. King:

The Department of Toxic Substances Control (DTSC) has reviewed the subject Remedial Action Completion Report (Report) for AOC-2 at the SCE Alhambra Combined Facility submitted by TerraTherm. The Report documents the treatment of approximately 16,500 cubic yards of soil at AOC-2 contaminated with polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), dioxins and furans.

DTSC approves the Report and certifies that it meets all of the conditions of the approved Remedial Action Plan developed pursuant to Health and Safety Code Section 25356.1 for the contaminated soil remediation. DTSC has determined that the AOC-2 portion at this Site has been remediated to allow for unrestricted land use and that No Further Action is required.

Thank you for your efforts in remediating this Area of Concern. If you have any questions please contact Mr. Tedd Yargeau, Project Manager, at (818) 551-2864 or myself at (818) 551-2822.

Sincerely,

Sayareh Amir, Chief
Site Mitigation and Brownfields Reuse Program – Glendale Office

cc: See next page

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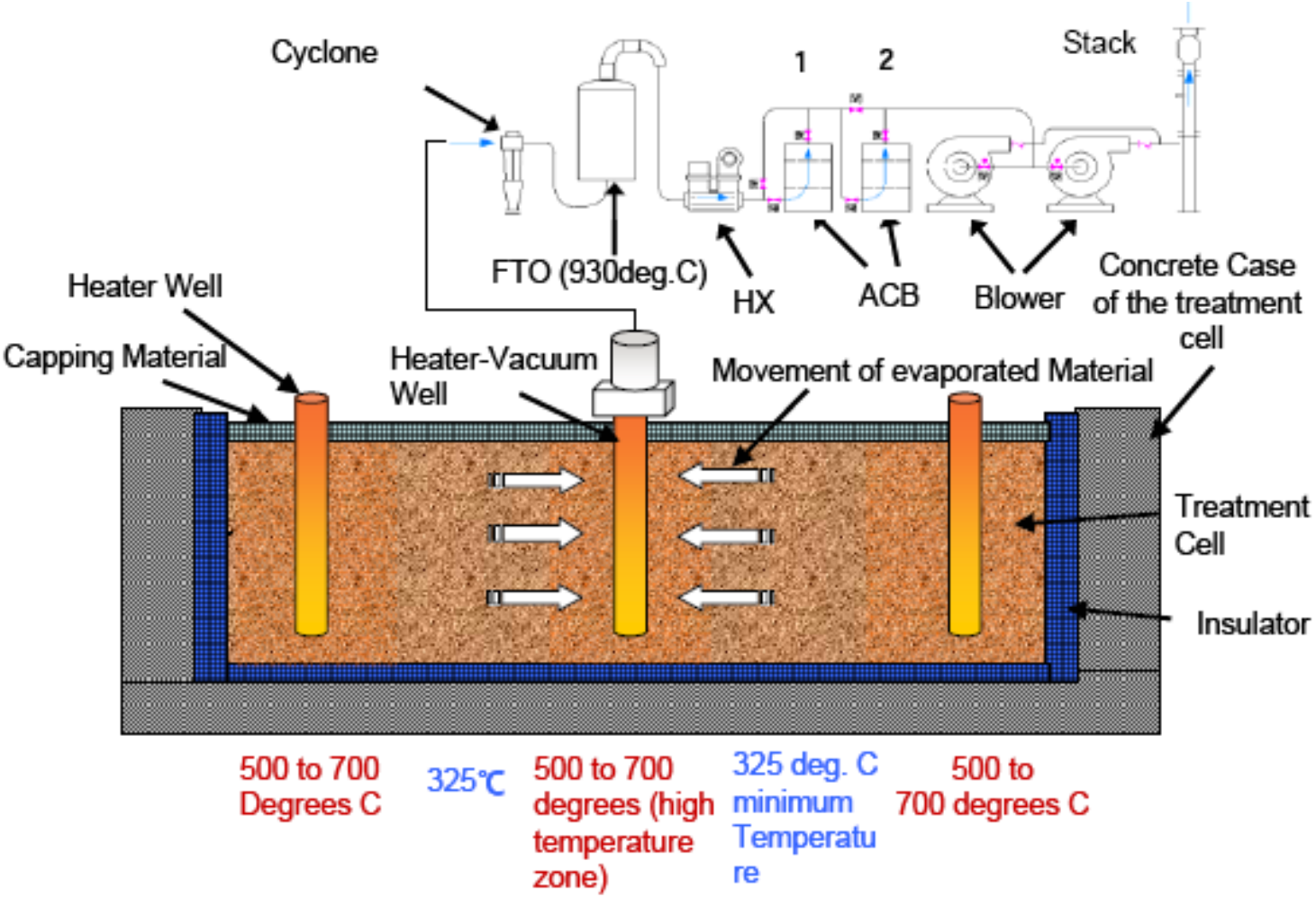
⇒ **Unprecedented outcome for an in-situ remediation technology!**

⇒ **Also, less expensive than excavation.**

IPTD® Demonstration 2009

Sponsored by Ministry of Environment (MOE), Japan



A joint project of TerraTherm, Inc. and SheGoTec Japan, Inc.

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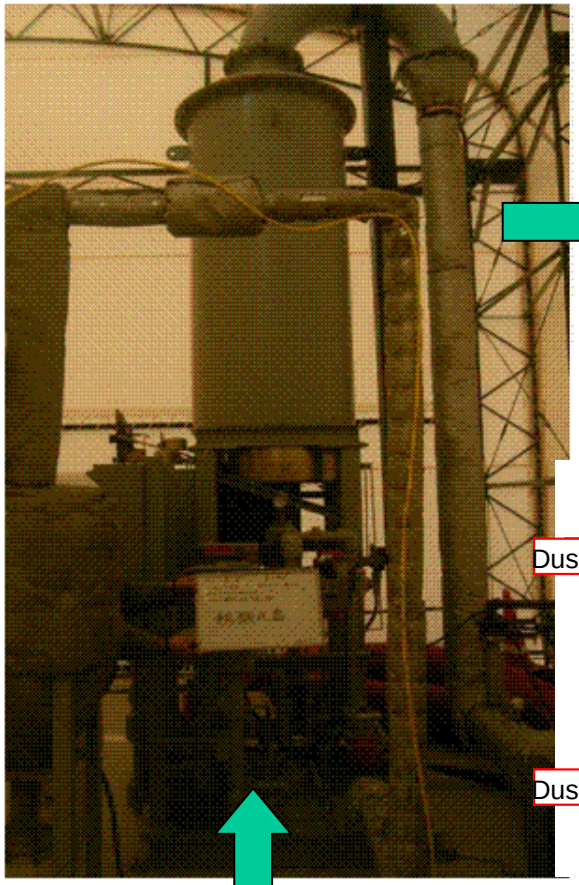
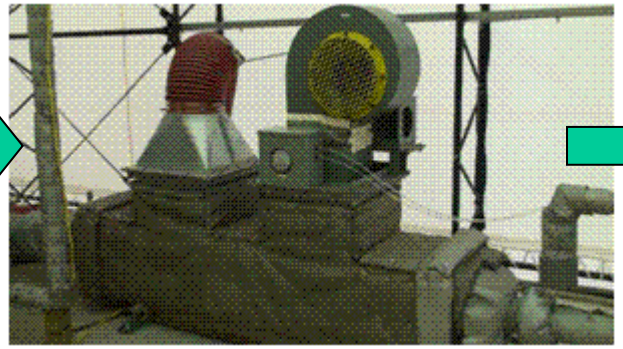
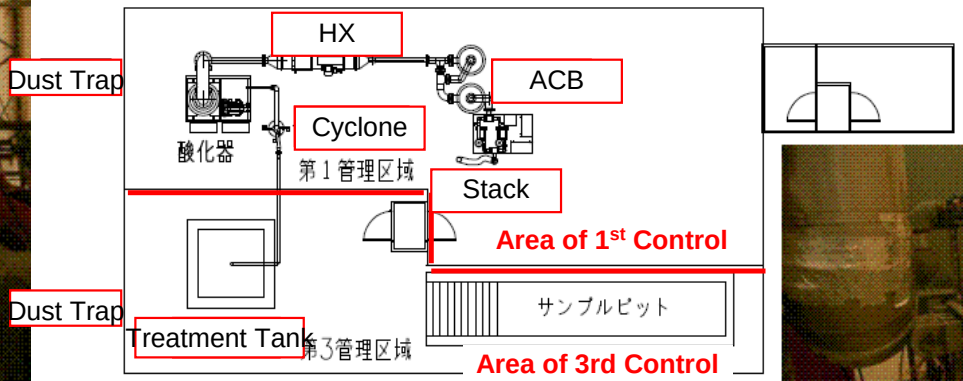
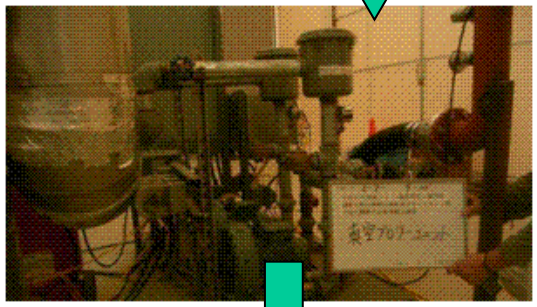
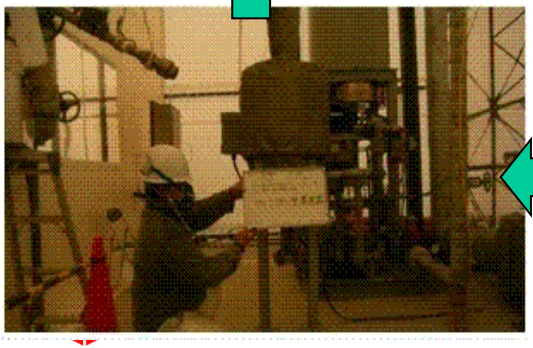
(Heron et al. 2010)



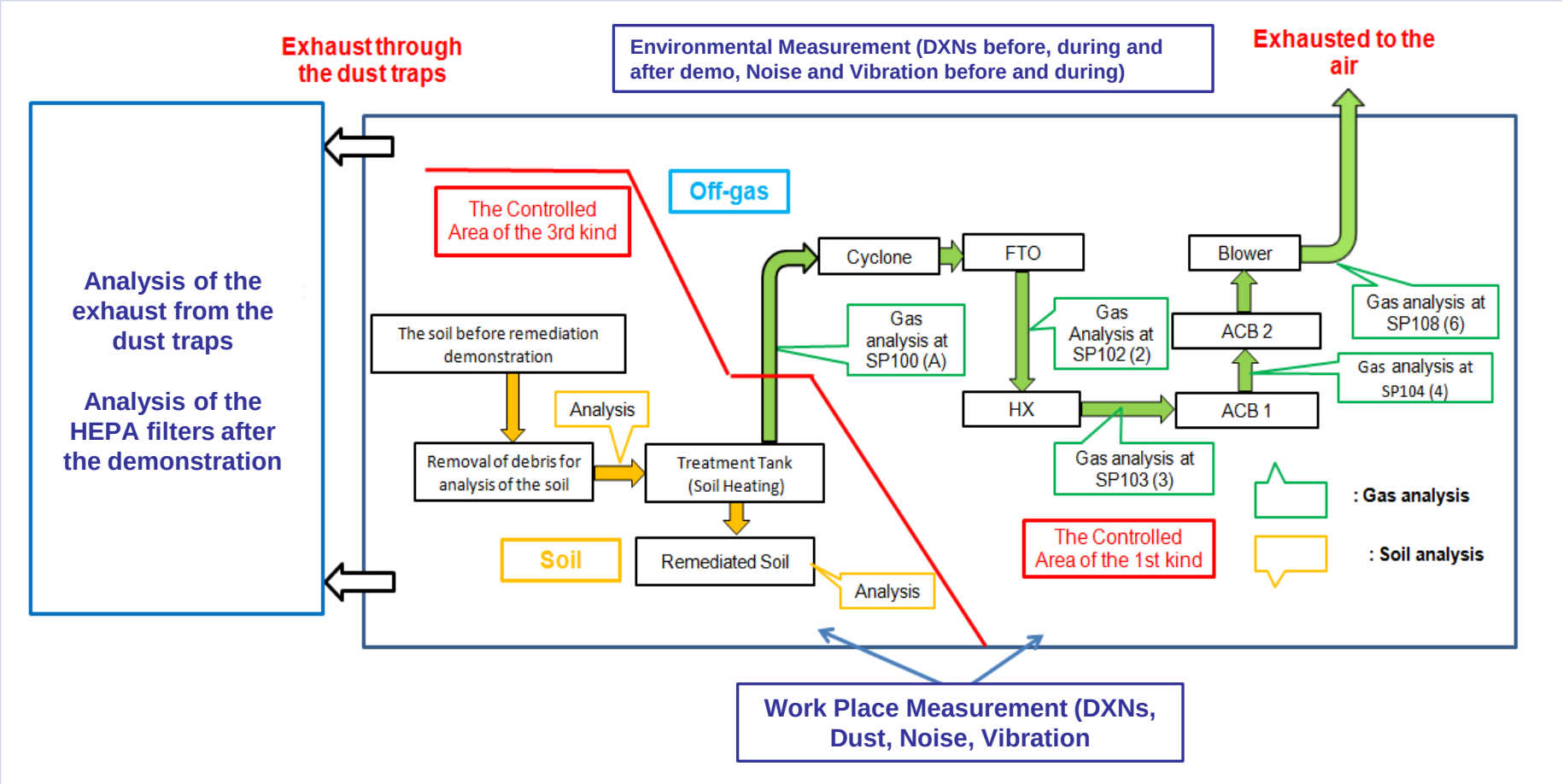



HX
Dust Trap
ACB
Cyclone
酸化器
第１管理区域
Stack
Area of 1st Control
Dust Trap
サンプルピット
Treatment Tank
第３管理区域
Area of 3rd Control





Monitoring Program



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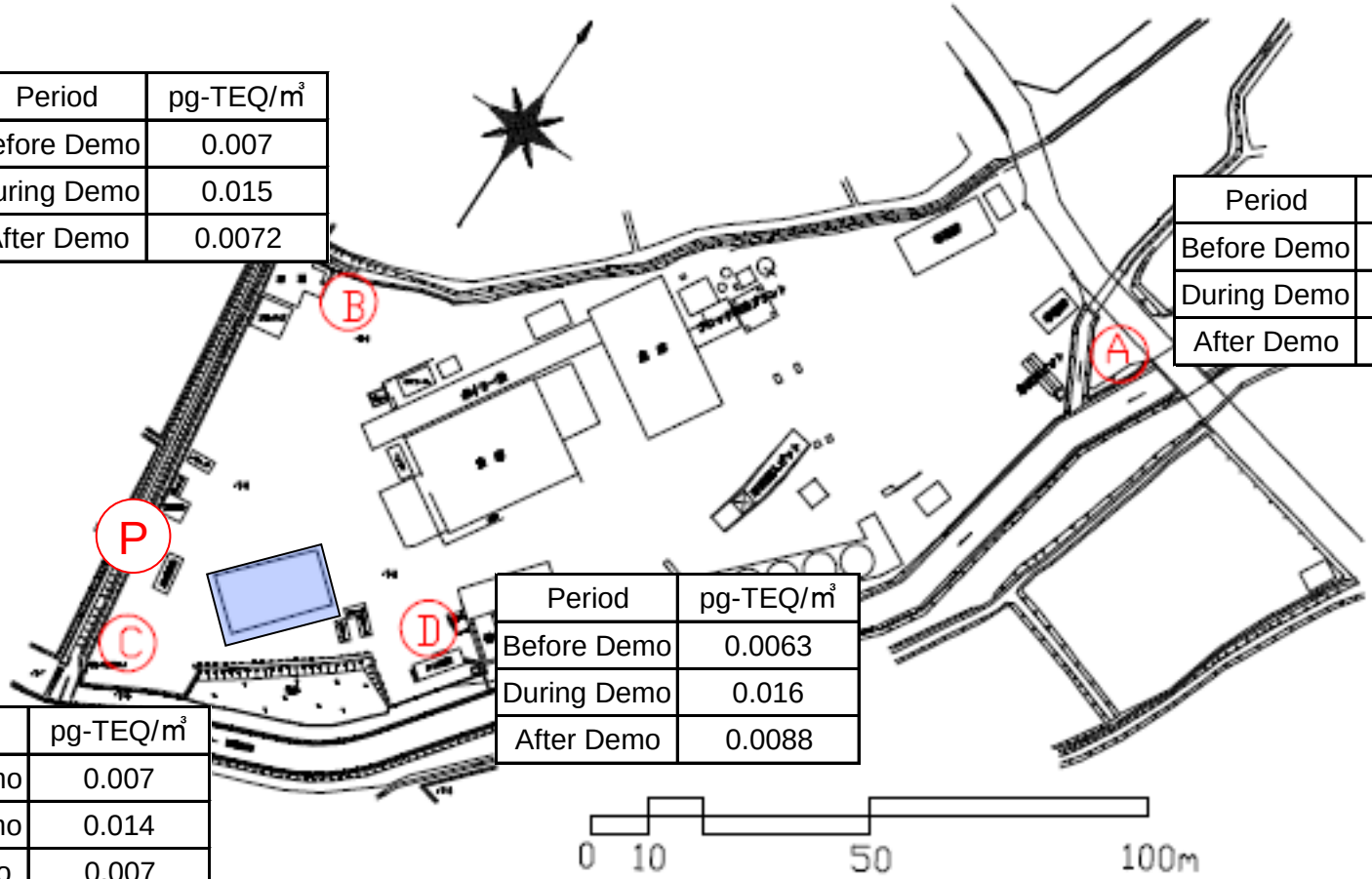
Monitoring the Surroundings



Period	pg-TEQ/m³
Before Demo	0.007
During Demo	0.015
After Demo	0.0072

Period	pg-TEQ/m³
Before Demo	0.0053
During Demo	0.015
After Demo	0.009

Period	pg-TEQ/m³
Before Demo	0.0063
During Demo	0.016
After Demo	0.0088

Period	pg-TEQ/m³
Before Demo	0.007
During Demo	0.014
After Demo	0.007

: Demonstration Tent

Ⓐ to Ⓓ : DXN monitoring Points

Ⓟ : Noise/Vibration monitoring Points

Environmental Std.: 0.6pg-TEQ/m3

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Effectiveness of the IPTD® Technology

Values expressing the effectiveness		Basis for the calculation	
Removal Ratio	%	DXNs concentration before remediation (pg-TEQ/g)	DXNs concentration after remediation (pg-TEQ/g)
	96.24	1,800	67.75
Decomposition Rate	%	Total amount of DXNs in the treatment tank before remediation (ng-TEQ)	Total amount of DXNs in the treatment tank after remediation (ng-TEQ)
	96.48	5,597,219	197,260
Decomposition Rate in the soil	%	Total amount of DXNs removed from the tank (ng-TEQ)	Total amount of DXNs evolved from the tank (ng-TEQ)
	99.98	5,399,959	852

No changes in soil characteristics were observed

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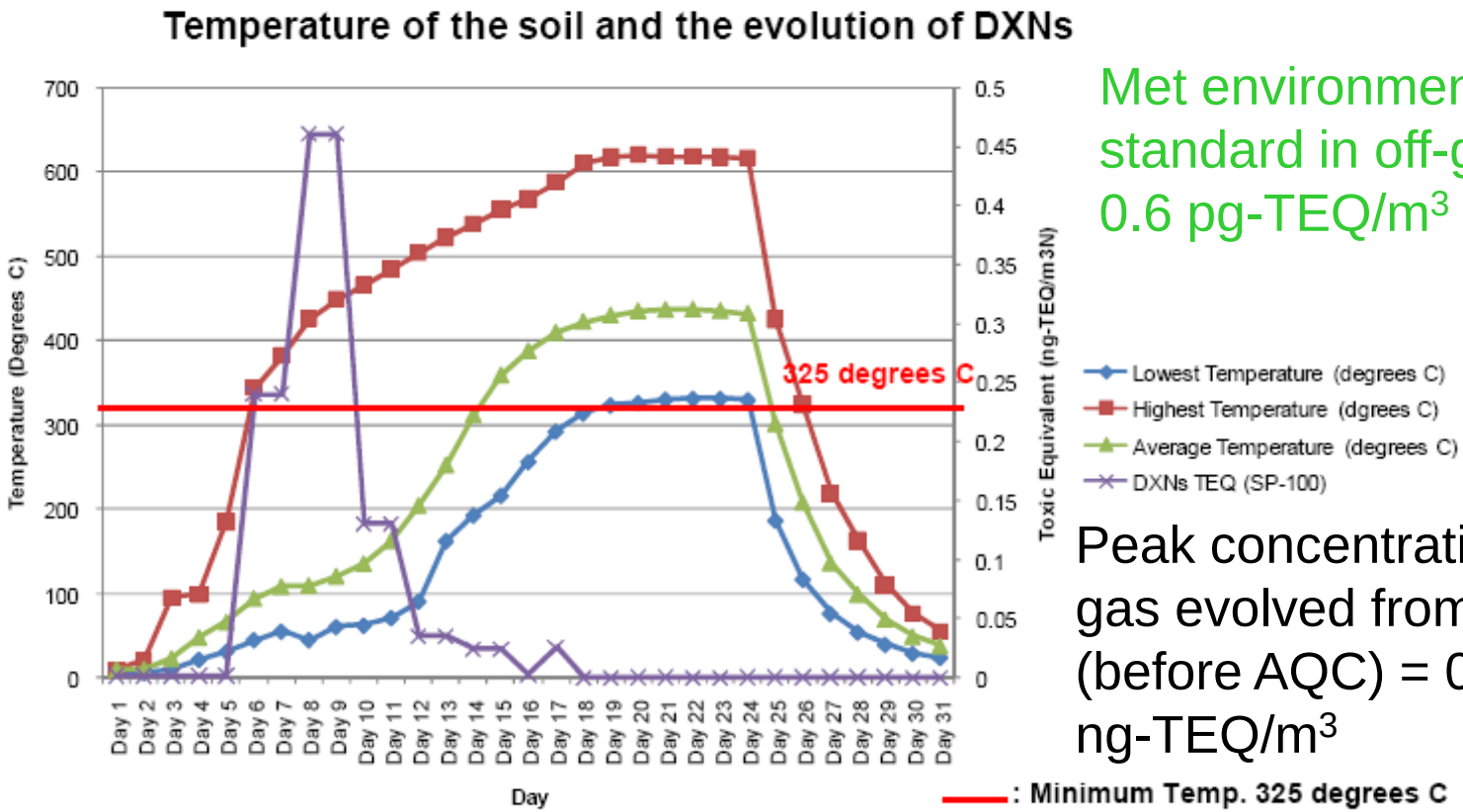
MOE IPTD® Demonstration Results



Met environmental standard in off-gas: 0.6 pg-TEQ/m^3

Peak concentration in gas evolved from soil (before AQC) = 0.46 ng-TEQ/m^3

Average TEQ in soil after treatment: 68 pg-TEQ/g (standard = 1,000 pg/g) relative to pre-treatment concentration of 1,800 pg-TEQ/g

⇒ IPTD® approved for treatment of dioxin-contaminated soil or sediment in Japan

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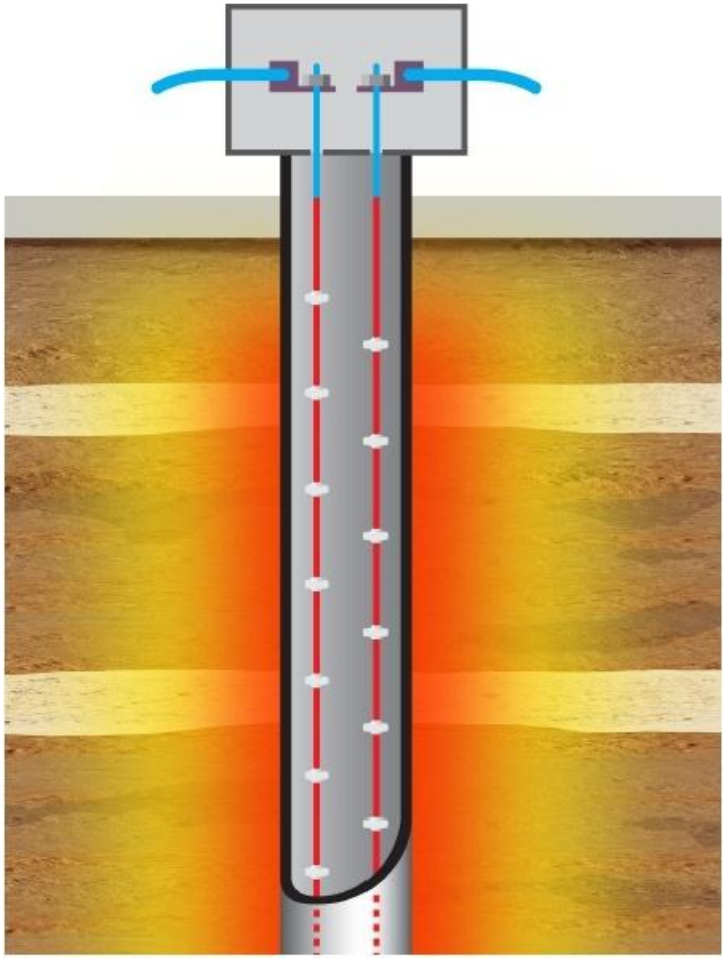
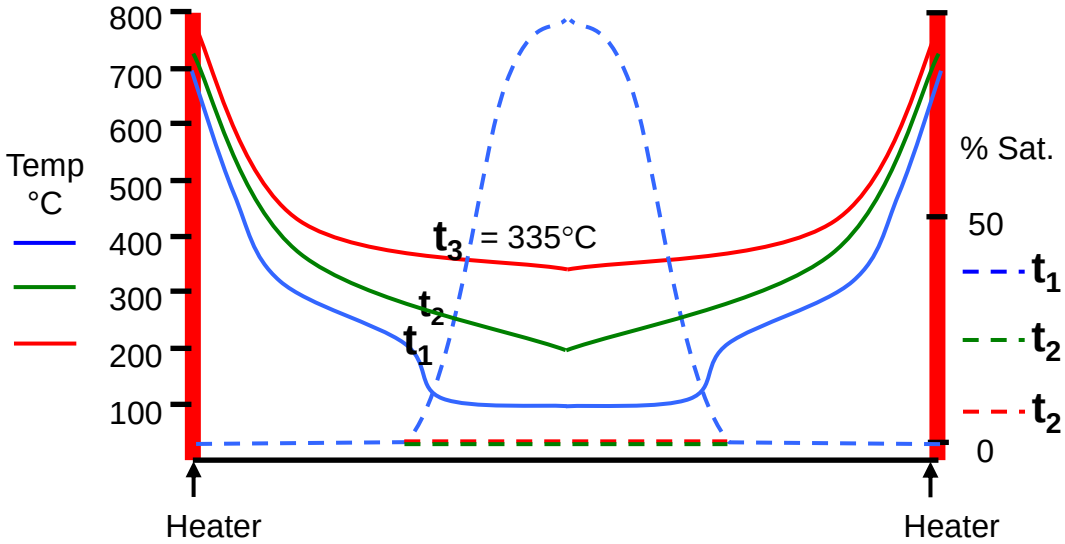
ISTD and IPTD® without Heater-Vacuum Wells





$t_{1,2,3}$ = temperature progression

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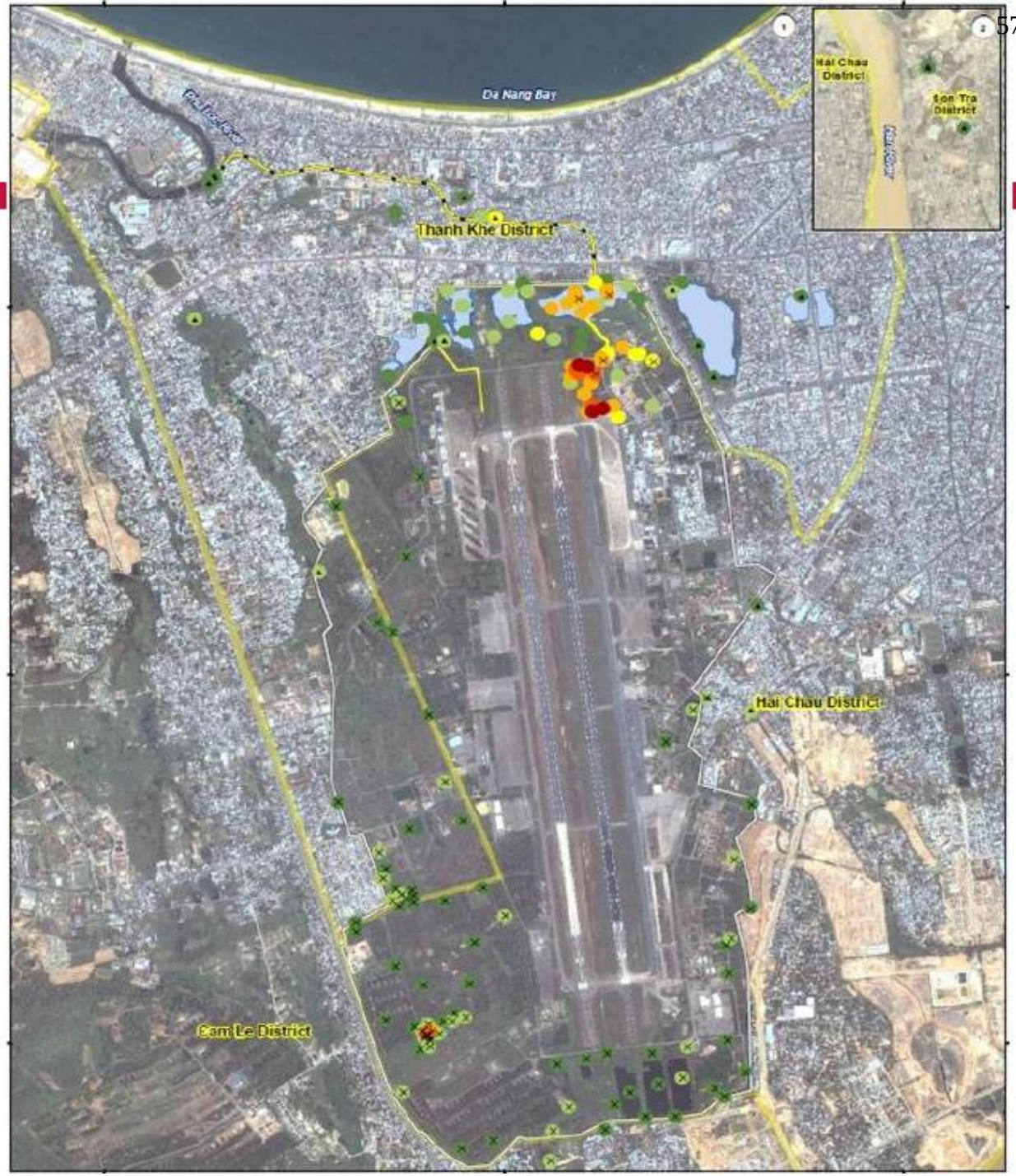
Da Nang Airport

(Sorenson et al. 2011)



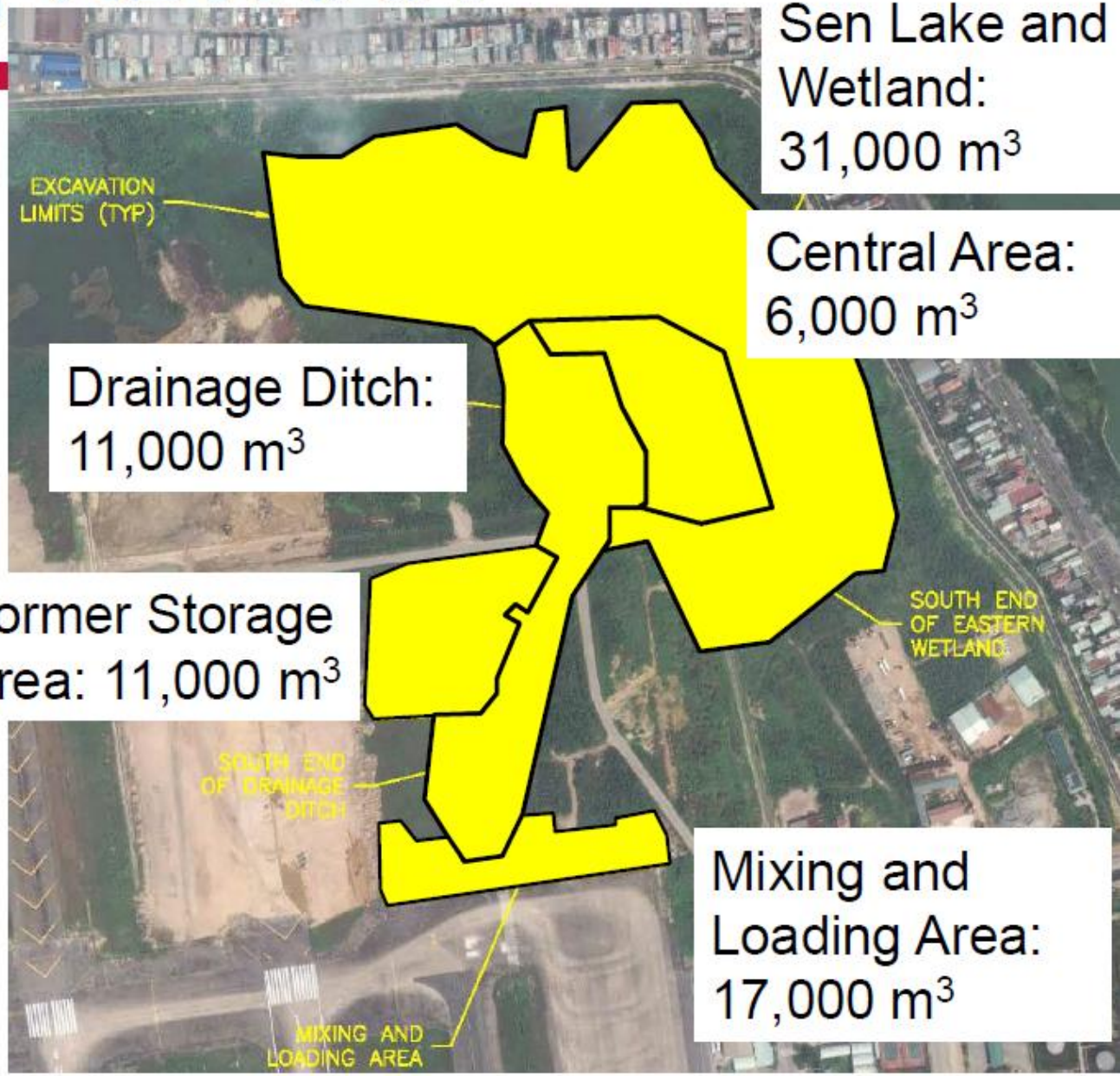
USAID | VIETNAM (Sorenson et al. 2011)

FROM THE AMERICAN PEOPLE

Areas Requiring Excavation

Total Area: approximately 190,000 m^2

Total Volume (with Pacer Ivy Storage Area to the south): 77,000 m^3



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(Sorenson et al. 2011)

DETAILED EVALUATION: SUMMARY OF EA FINDINGS

Alternative	Final Remedy to Meet Clean Up Goals	Implementable	Potential Environmental Impact	Estimated Cost
No Action	No	Yes	Highest	Externalized
Active Landfill	Uncertain	Yes with challenges	Second highest	$31M
Passive Landfill	No	Yes with challenges	Third highest	$36M
ISTD/IPTD	Yes	Yes with challenges	Lowest	$34M

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Da Nang Airport Treatability Testing

(Sorenson et al. 2011)

- Samples collected in August 2010 from MLA and Sen Lake
- Pre-treatment 2,3,7,8-TCDD concentrations
  - Soil: 130,000 ppt to 157,000 ppt (VN standard = 1,000 ppt)
  - Sediment: 5,970 ppt to 7,480 ppt (VN standard = 150 ppt)
- Post-treatment 2,3,7,8-TCDD concentrations
  - MLA Soil below soil cleanup goal after 10 days
  - Sen Lake Sediment below sediment cleanup goal after 7 days

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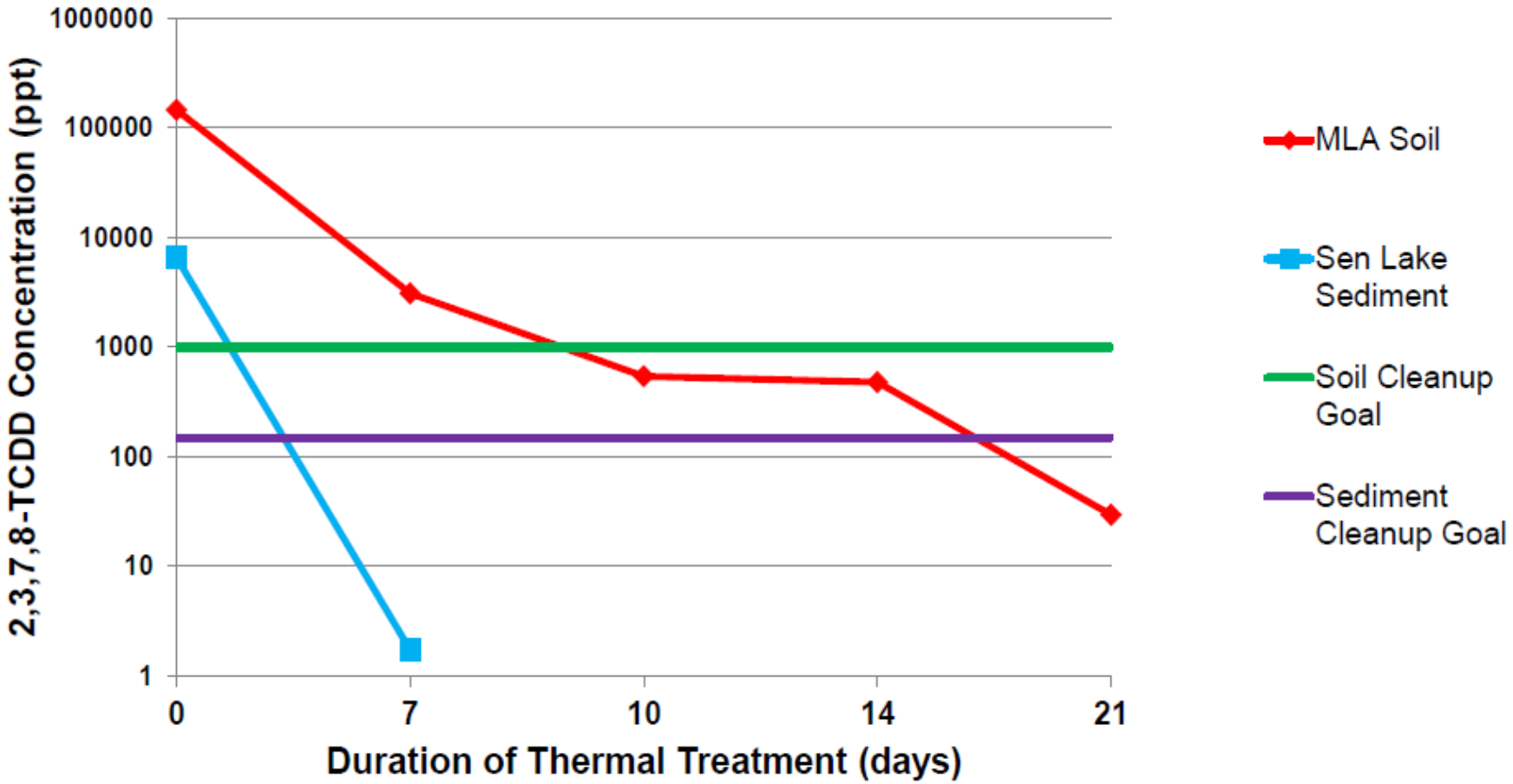
Treatability Testing Results (Sorenson et al. 2011)



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IPTD Pile Location (Sorenson et al. 2011)

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Vietnam: Environmental Remediation of Dioxin Contamination at Danang Airport

Progress Report: November 1, 2012 to November 30, 2012

Test pits in pile structure
(Photo: CDM Smith)

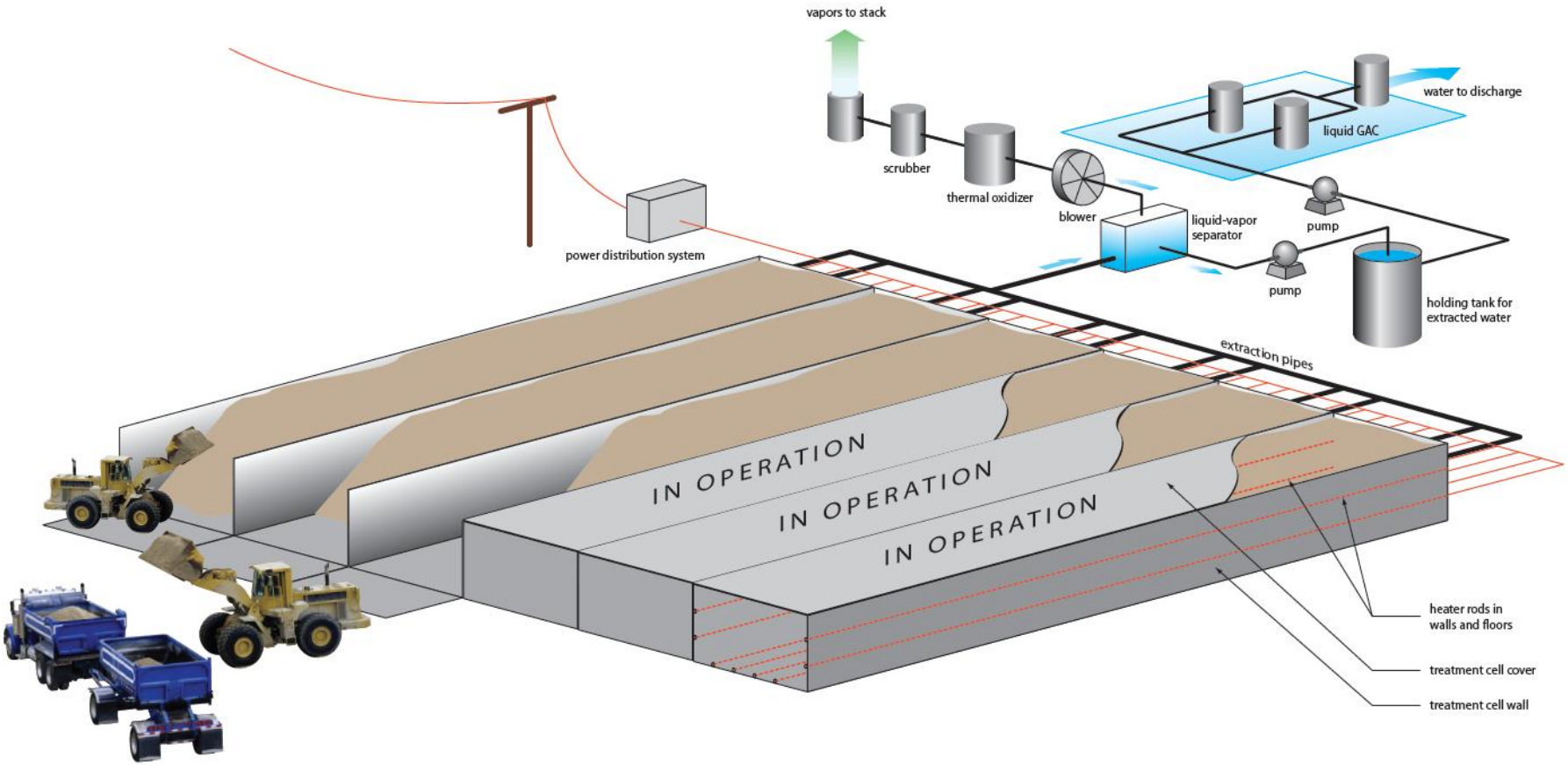
Importing fill material for the pile structure foundation *(Photo: CDM Smith)*

CONSTRUCTION ACTIVITIES

Clearing and grading continued, and USAID contractors began importing fill material at the location for the thermal desorption treatment pile containment structure. Test pits were dug to ensure the integrity of the foundation below the pile containment structure. Contractors also began casting concrete masonry unit (CMU) blocks for construction of the pile structure – 644 of the eventual 33,000 CMU blocks were produced as of November 30, 2012.

http://vietnam.usaid.gov/progress-reports-environmental-remediation-dioxin-contamination-danang-airport

IPTD® Adapted for Mobile or Fixed Ops



Drive in / Drive out capability. Load / unload with no obstructions!

U.S. Patent 8,348,551 issued Jan. 8, 2013.

International patents pending.

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