THERMAL REMEDIATION OF A CLOSED GASOLINE SERVICE STATION

IPEC 13 November 2013

PRESENTATION AND DISCUSSION LED BY:

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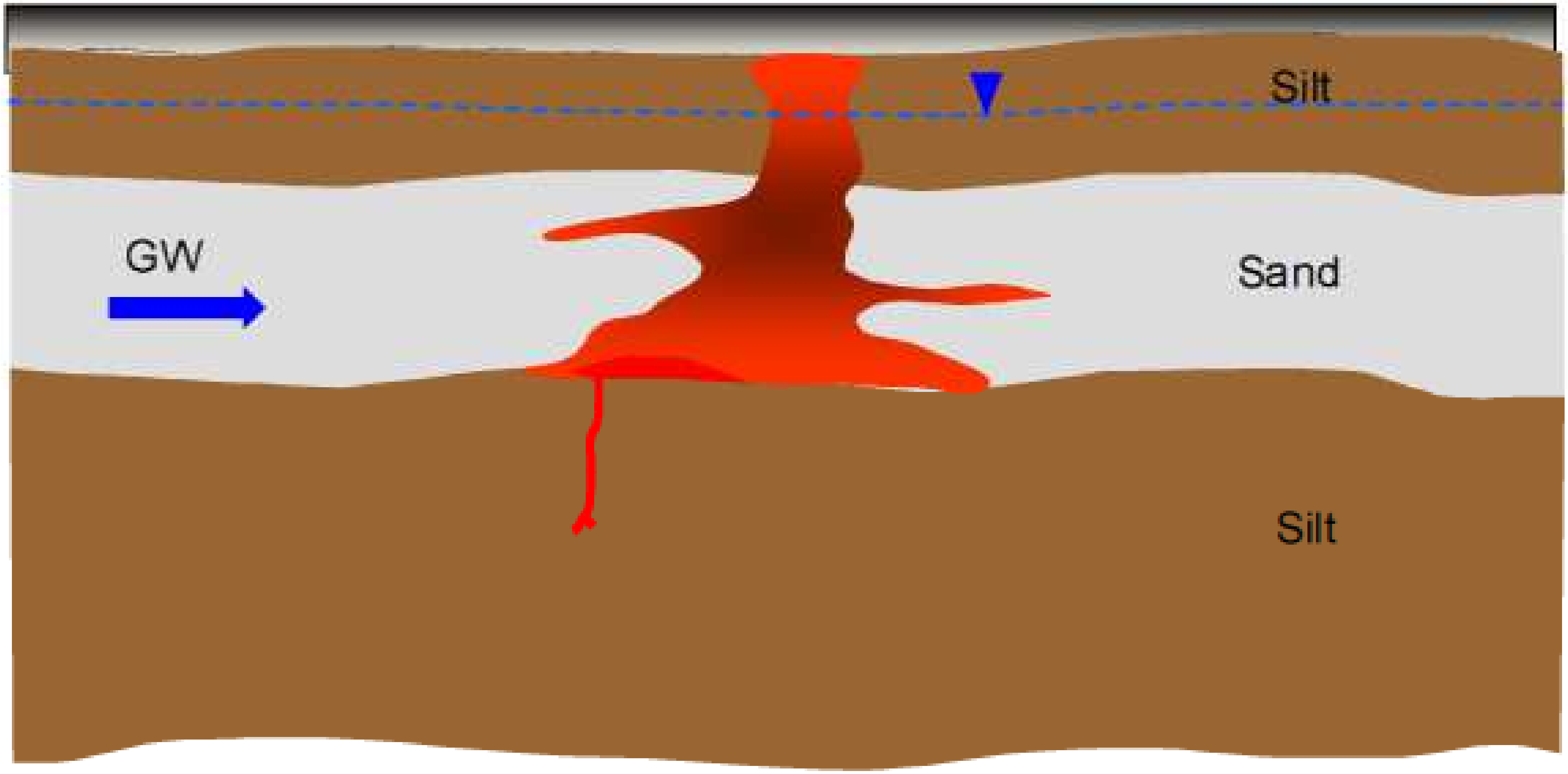
1. IN-SITU THERMAL REMEDIATION
2. CASE STUDY APPLICATION
3. DESIGN & CONSTRUCTION OF ISTR PROJECT IN COLORADO

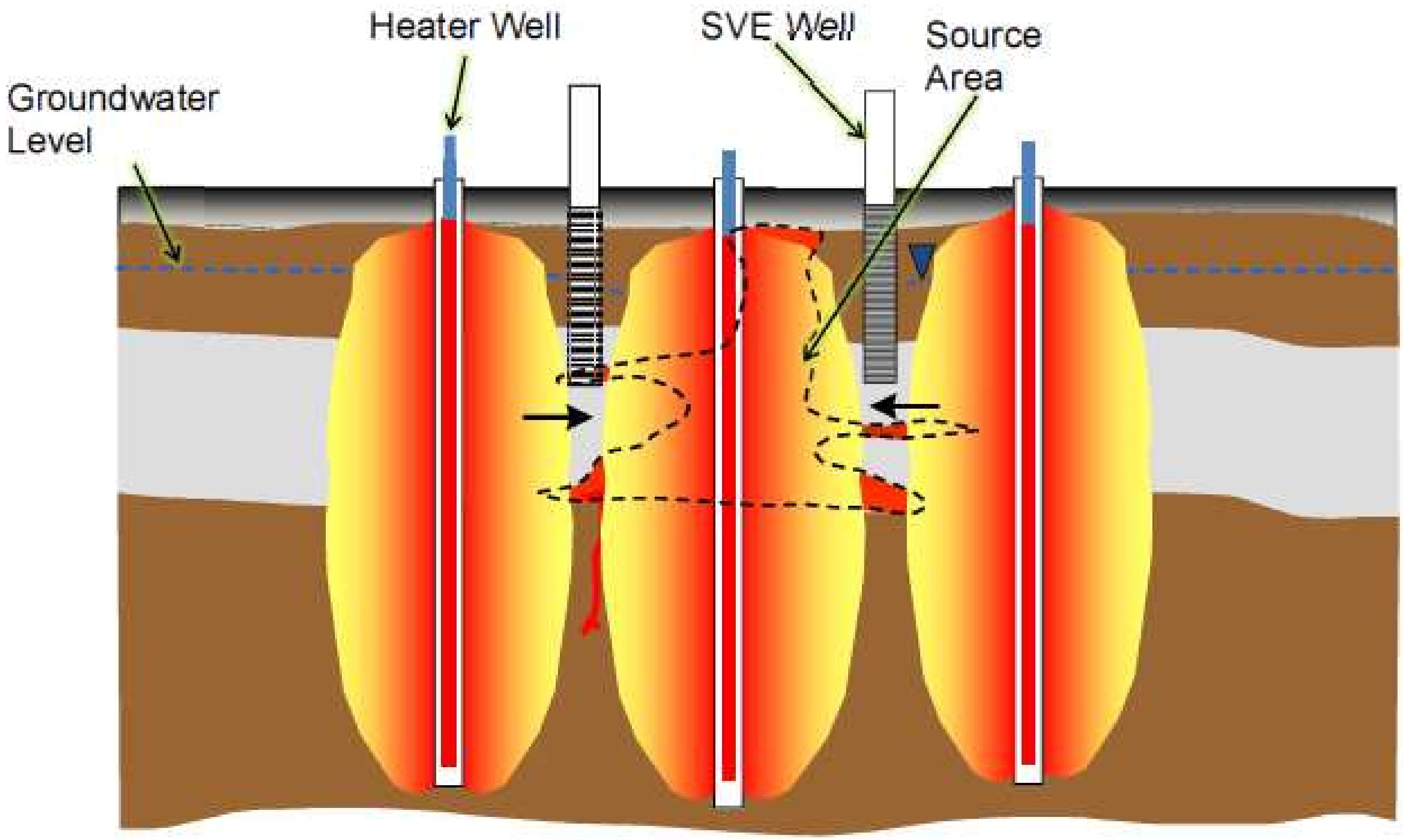
CGRS ENVIRONMENTAL CONSTRUCTION COMPLIANCE

TPSTECH

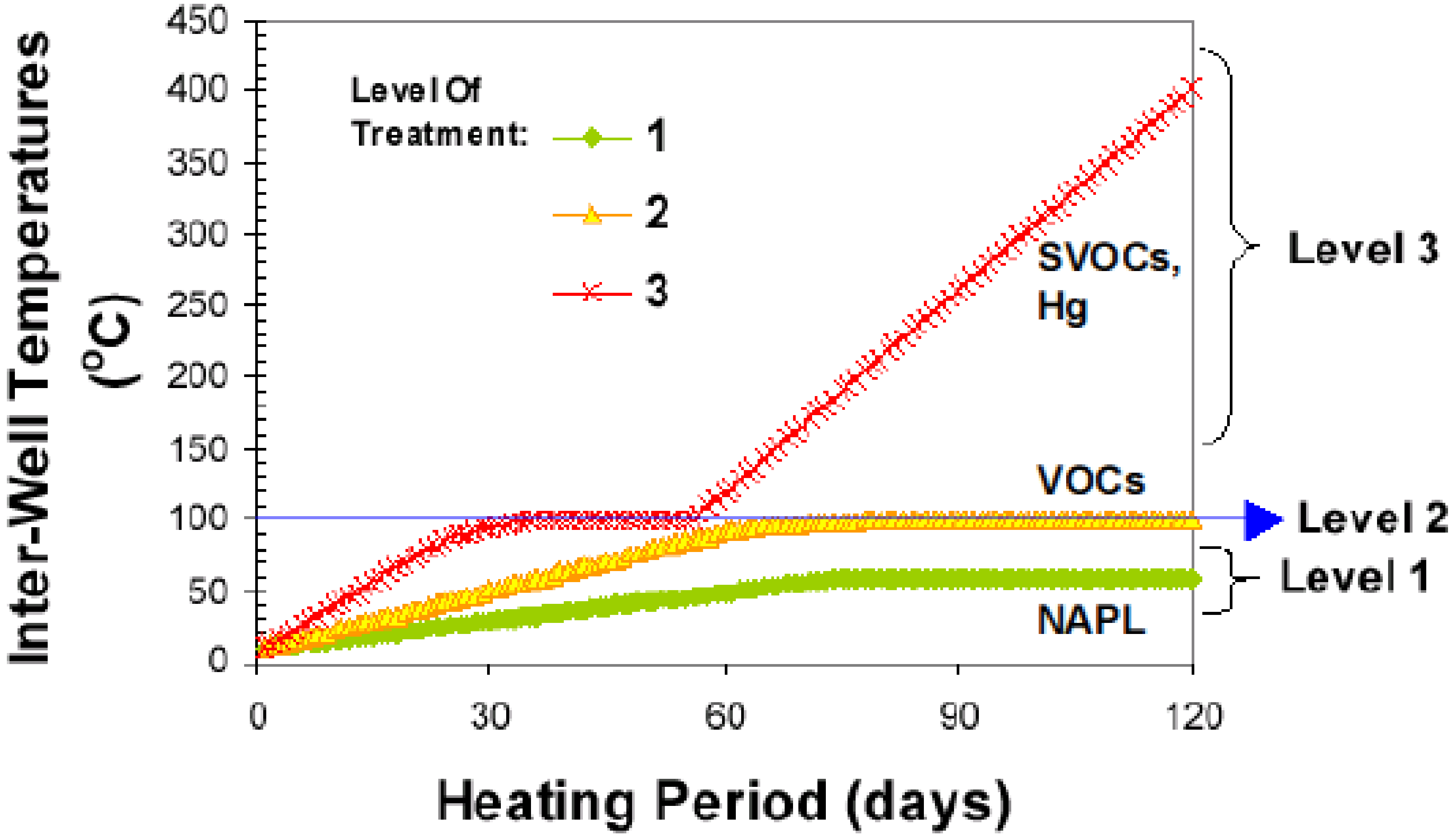
EXAMPLE SOURCE ZONE



ISTD / TCH → Heating governed by thermal conductivity (f~3) nearly uniform

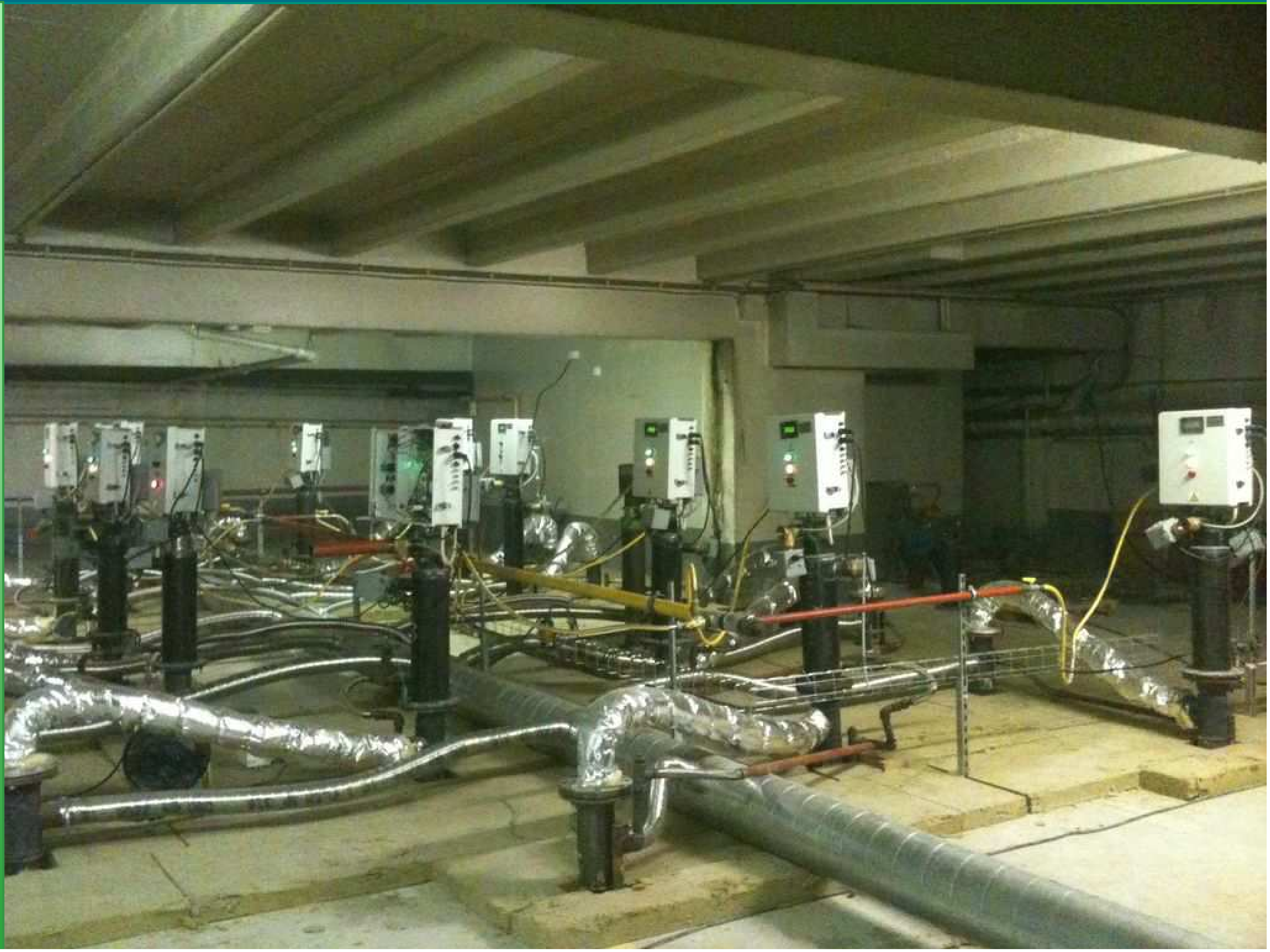


ISTD / TCH → Ability to go above the boiling point of water



ISTD / TCH
LARGE, COMPLEX APPLICATIONS

ISTD / TCH
BENEATH A HIGH RISE APARTMENT BUILDING



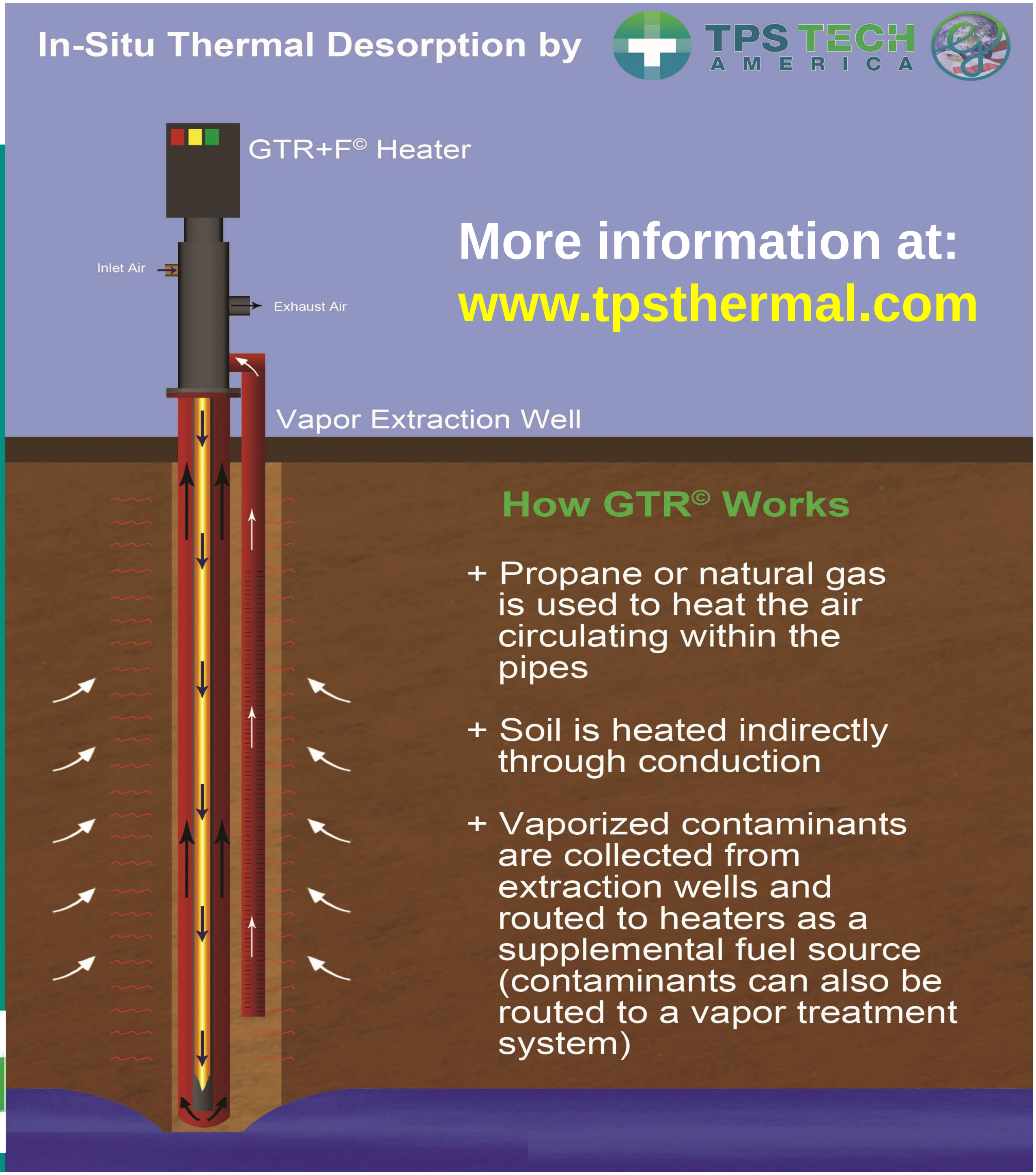
How It Works

Closed-loop in-situ thermal conduction heating system;

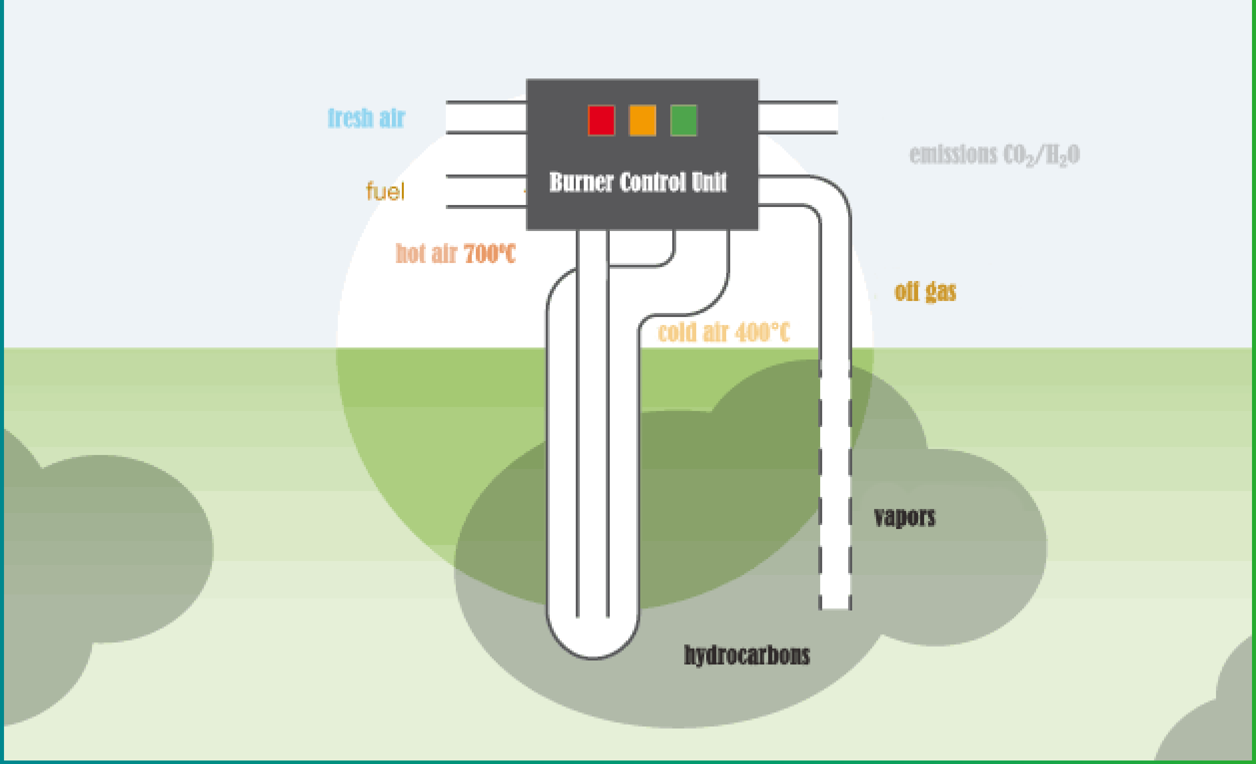
Co-located vapor extraction and heating wells;

Treatment temperatures from ~100°C to >400°C

Some off-gases may be used as supplemental fuel (PAHs and BTEXs), others treated with C3 Technology



How it works: GTR© (Gas-Thermal-Remediation)



Above animation is of GTR+F (+fuel) installation;
Chlorinated applications use separate SVE/DPE wells and/or trenches.

Gasoline: In Situ Thermal Remediation at a Former Service Station Using GTR+F

Summary: A former petrol station in a predominately residential neighborhood was closed for a major petrol marketing company. Two former 5,000 gallon USTs were excavated and removed. The soil and groundwater beneath the USTs was still heavily impacted by BTEX contaminants. Excavation near surrounding homes was not desired. The client elected to treat the groundwater and soil onsite using in situ thermal treatment (as opposed to chemical oxidation or bio-treatment). TPS TECH exceeded all remedial and scheduling goals.

Gasoline: In Situ Thermal Remediation at a Former Service Station Using GTR+F

Contaminants: Benzene (TPH-g)

Maximum Concentration: > 30,000 mg/kg (LNAPL)

Remediation Goal: > 90% removal of BTEX compounds

Treatment Volume: 2,750 cubic yards

Hydrogeology: Silty sand and gravel; vadose and shallow groundwater

Heating Wells: 39

Target Temperature: 100°C (120 hours)

Project Duration: 50 days

Confirmation Sampling: > 95% RE

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Drivers for In Situ Thermal Remediation

Alternatives: Excavation and offsite disposal; In situ bio; Soil vapor extraction plus air sparging

Regulators: Originally favored excavation

Residents: Preferred in situ cleanup (no trucks, no dust)

PRP: Cost and "no further action" were main drivers

Certainty: Negotiated residential goals for soils and site; redevelopment in negotiation

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Energy Sources for In Situ Thermal Remediation

Energy Sources: Natural Gas and Volatized BTEX (off-gas)

Energy to Subsurface: Average of 124 kWh per ton of soil treated

Energy Balance: Natural Gas accounted for 84% of utility consumption; remaining energy balance was electricity required for vapour extraction and controls

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Loveland Sinclair Station

Retail fueling station since 1972

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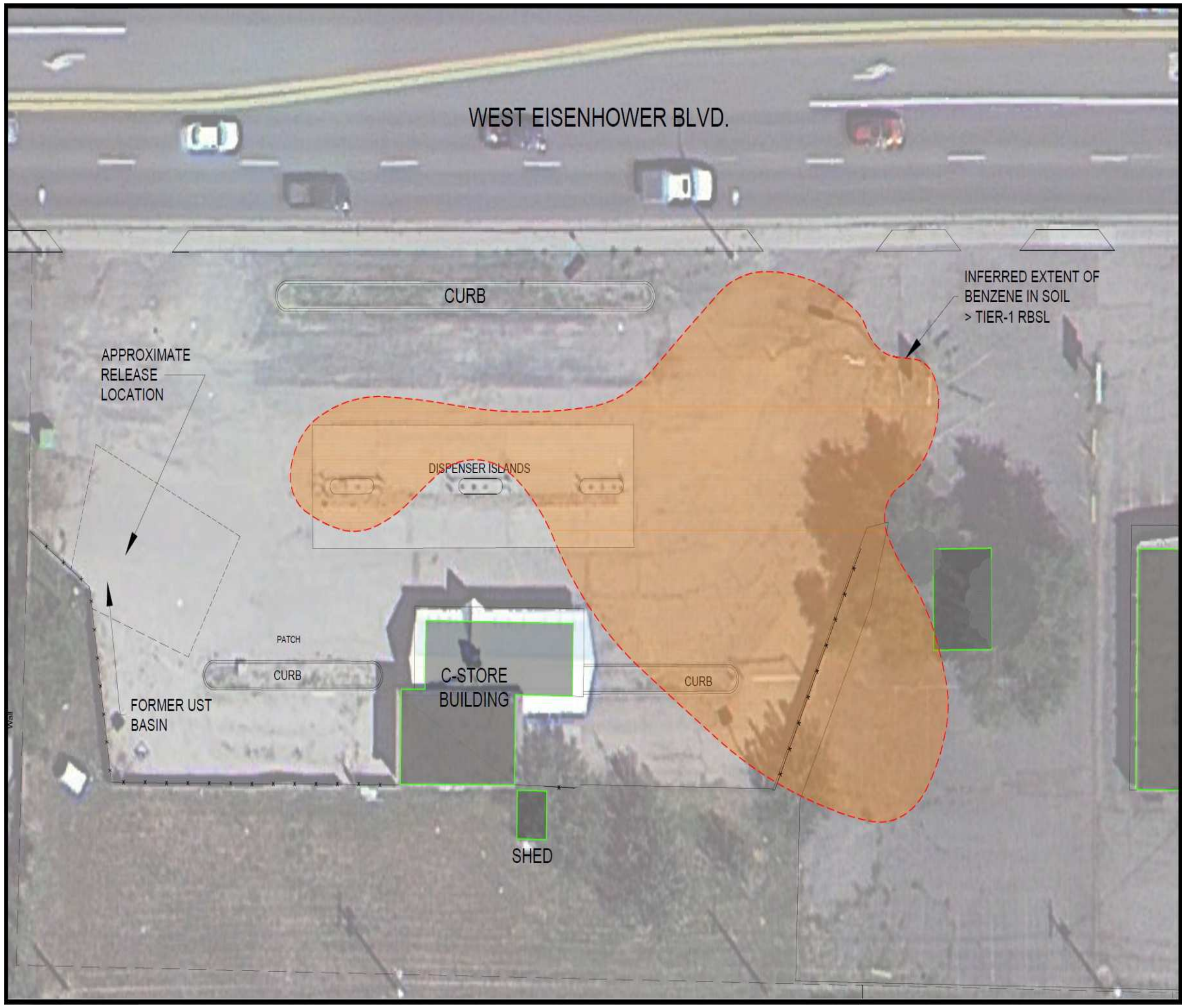
Loveland Sinclair Station - Soil Impacts



The inferred extent of the benzene plume in **soil** exceeding the Tier-1 RBSL for the groundwater exposure pathway covers an area of approximately 12,000 ft^2.

Benzene and TPH-G impacts detected in soil at concentrations up to 6.68 mg/Kg and 5,058 mg/Kg, respectively.

Soil impacts exist primarily between 8 feet to a depth of approximately 14 feet bgs.

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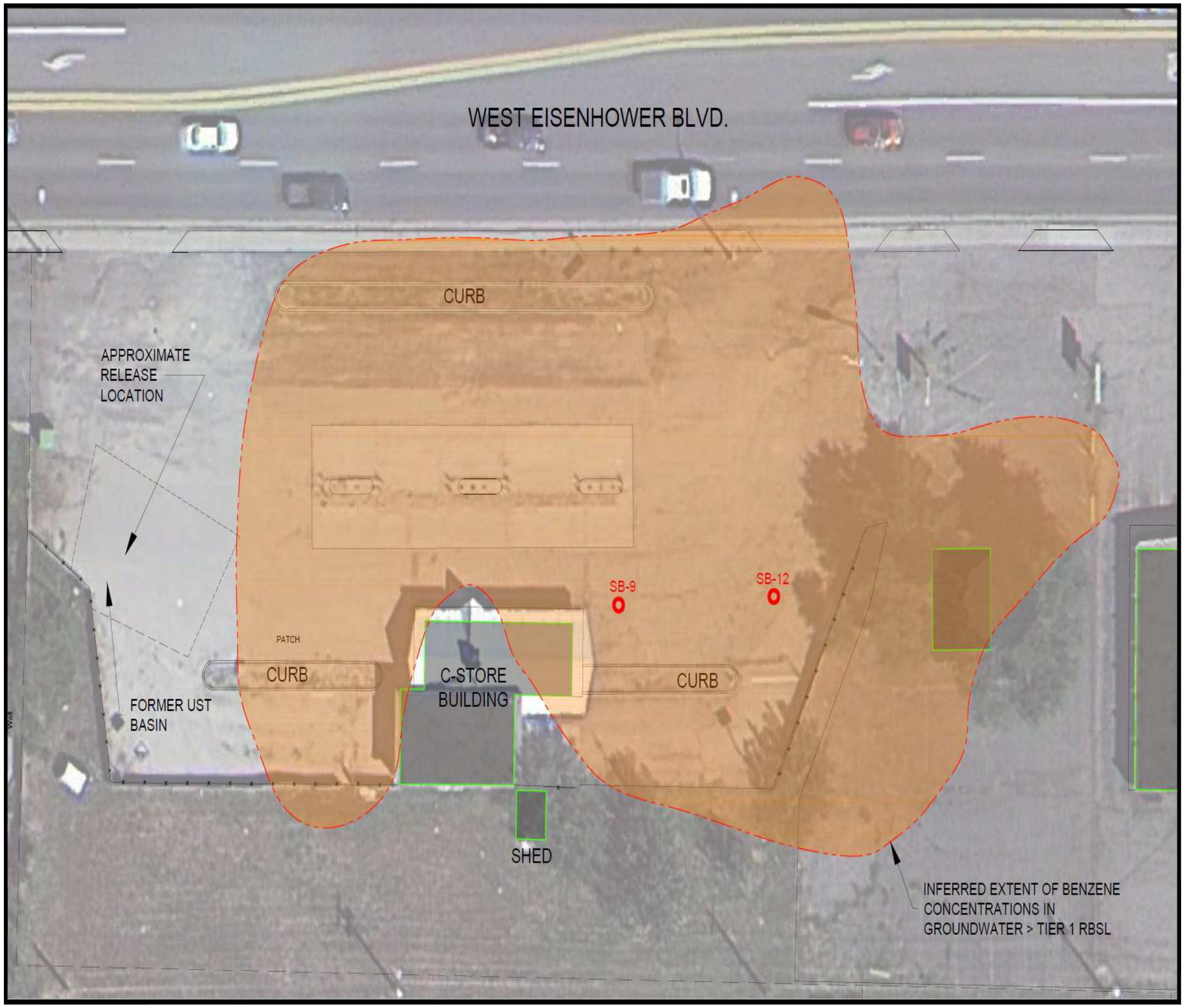
Loveland Sinclair Station – Groundwater Impacts



The inferred extent of the benzene plume in **groundwater** exceeding the Tier-1 RBSL for the groundwater exposure pathway covers an area of approximately 24,000 ft^2

Average groundwater table elevation is approximately 10 feet bgs.

BTEX concentrations have increased, and free-product has been detected in wells SB-9 & SB-12 at a thickness up to 0.8 feet

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Loveland Sinclair Station

Remediation Technology Evaluation

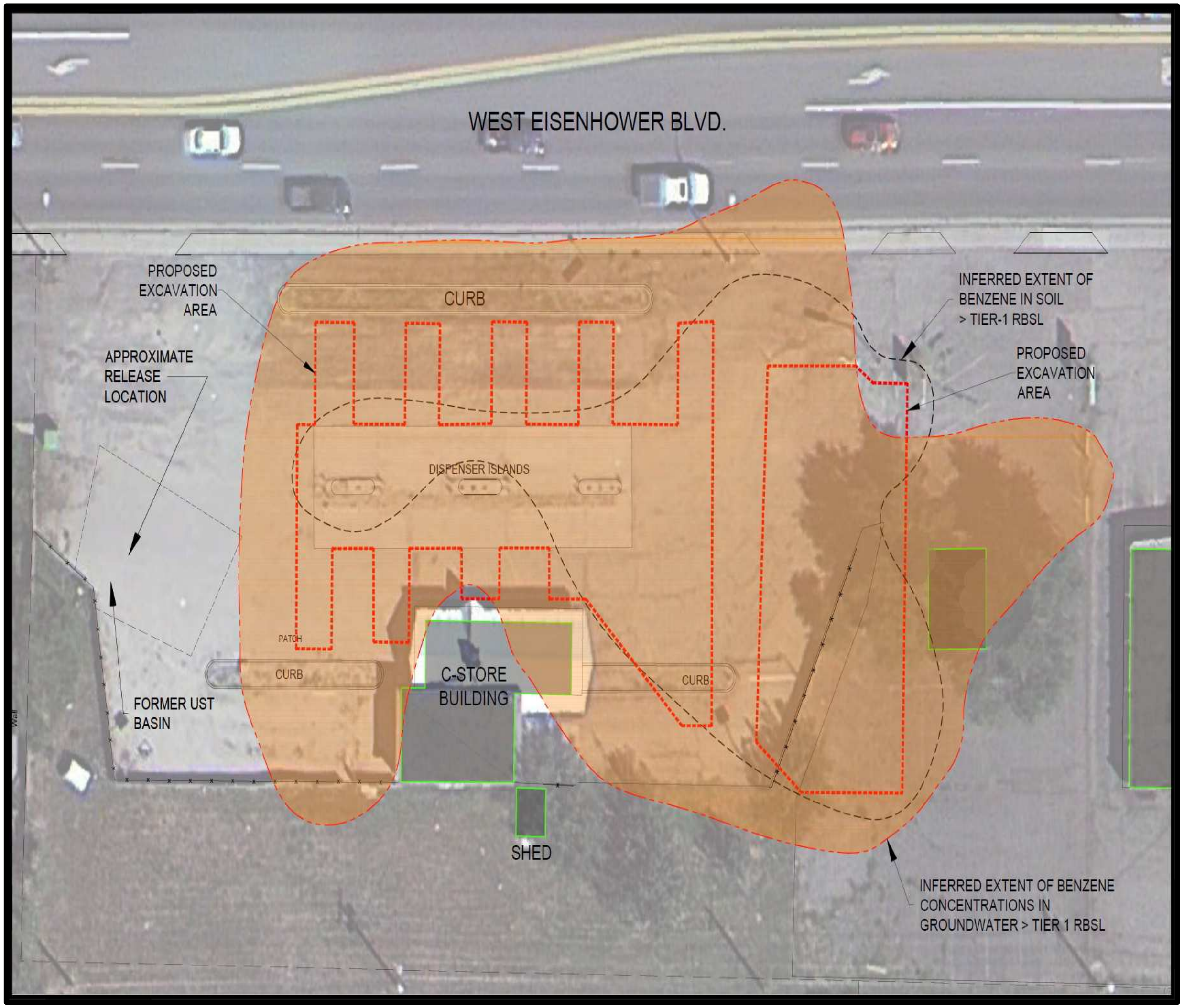
Conventional Remediation Methods & Bio Augmentation

Pilot test data, combined with low permeability of clay soil, and expansive plume size rule out feasibility of soil vapor extraction and air sparge remediation methods

MNA data suggest conditions along the leading edge of the plume may be conducive to natural attenuation.

In-plume conditions are anaerobic, and electron receptors such as nitrate and sulfate appear to have been depleted.

Soil lithology (clay) and large plume area present limitations to bio-augmentation and/or chemical oxidation injection methods



Dig and Haul / Chemical Oxygen Enhancement / Bio Sparge

Initial Corrective Action proposed excavating impacted soil exceeding Tier-1 RBSLs within an area ~9,490 ft^2 in order to remove the most elevated hydrocarbon sources in the soil

After excavation application of chemical oxygen enhancement amendments and installation of a bio sparge remediation

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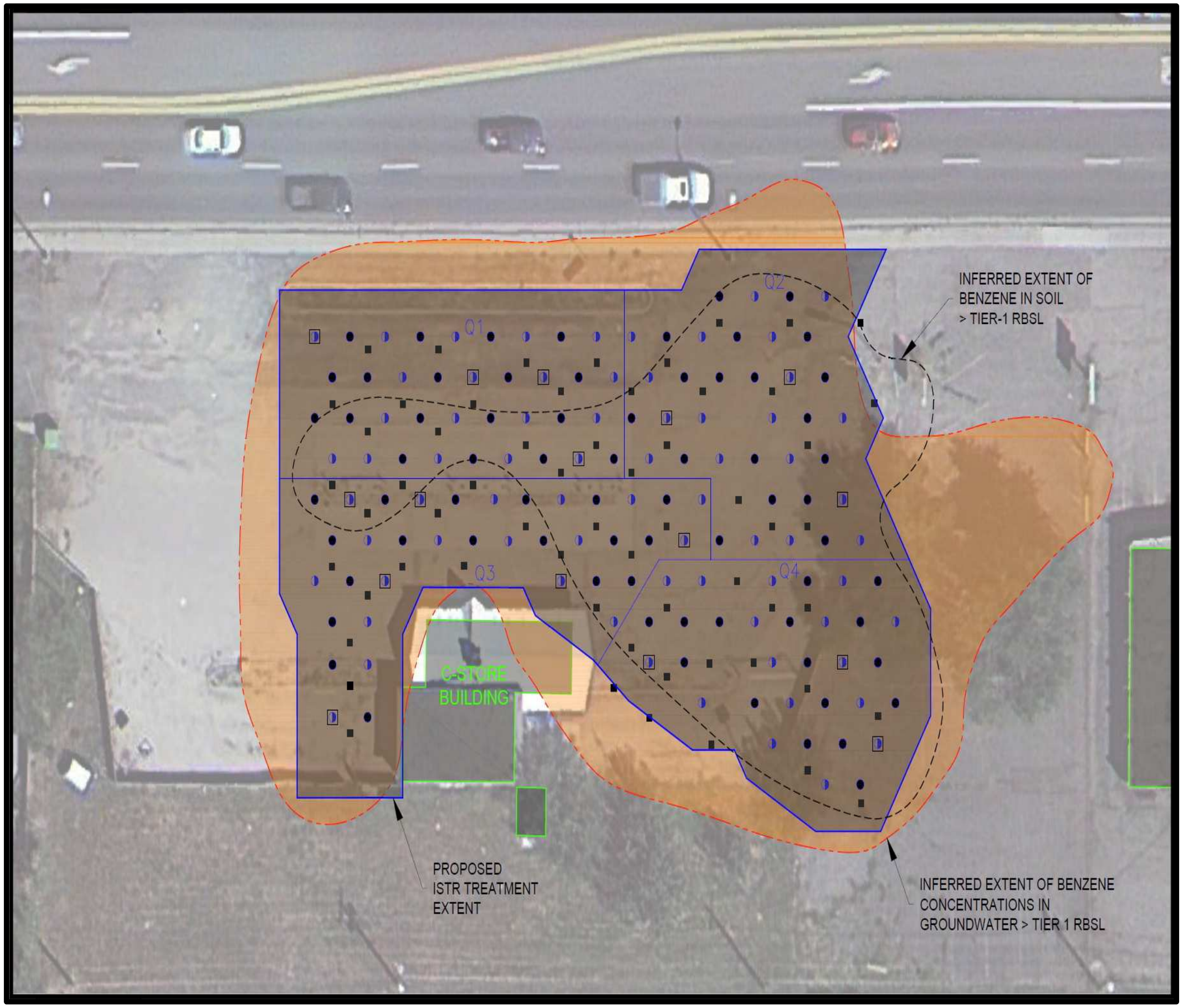

In-Situ Thermal Remediation

ISTR targets a treatment area of 14,065ft^2 and includes a total treatment volume of 3,126yds^3

The target treatment temperature required to remediate soil and groundwater to Tier-1 RBSLs is 100^{o}C

Estimated time to reach TTT is 76 days, time TTT is 7 days, cool down period of 17 days – total project time of 100 days

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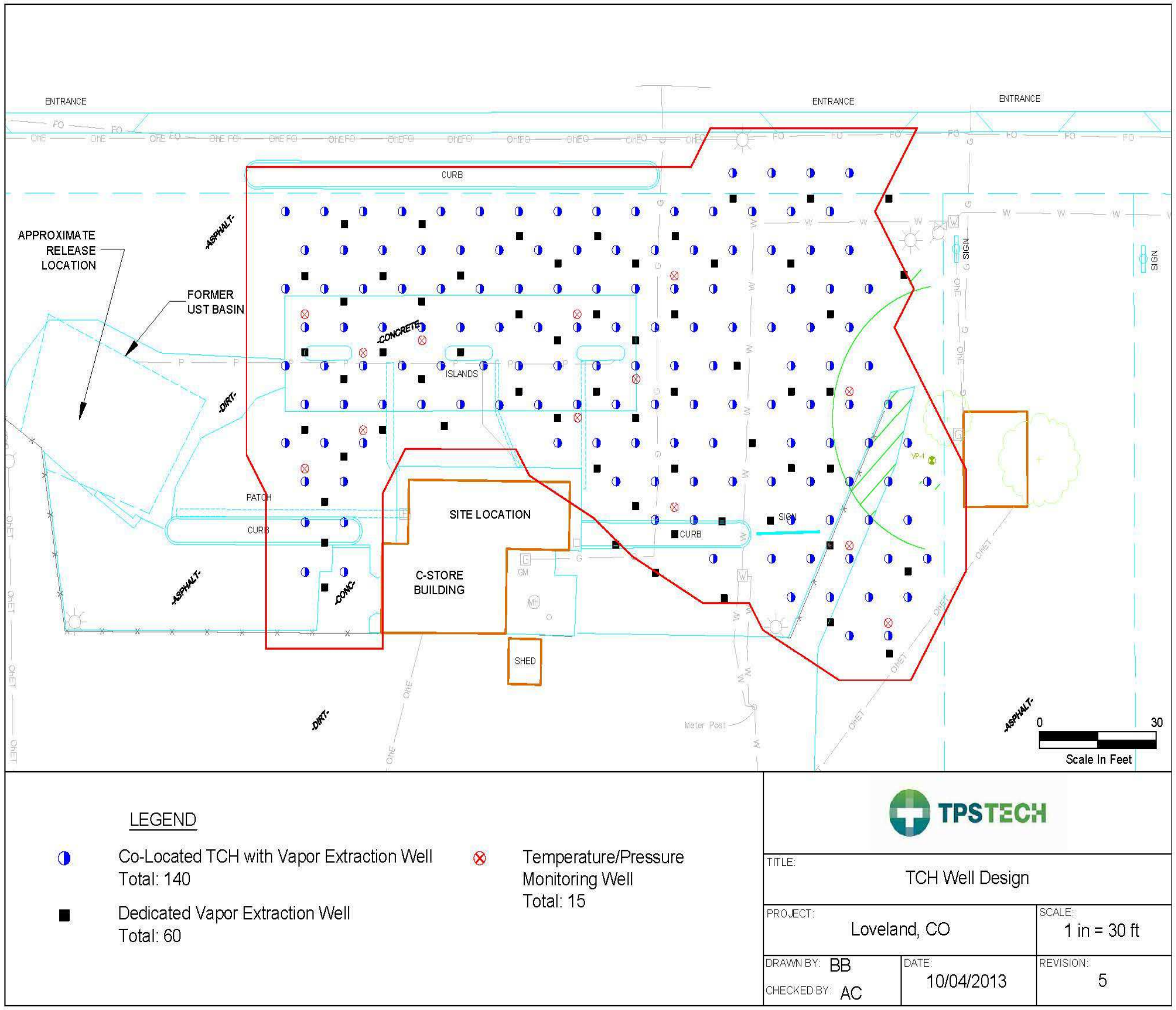

System design includes 140 Thermal Conductive Heating (TCH) wells to supply heat to 14 feet bgs. 70 wells are GTR + F™ re-heat wells. 140 co-located and 60 dedicated SVE wells. 16 temperature and pressure monitoring points.

Estimated **natural gas** requirement - 7.2E6 1,000 ft^3

Estimated **electrical** requirement – 1.5E5 kWh

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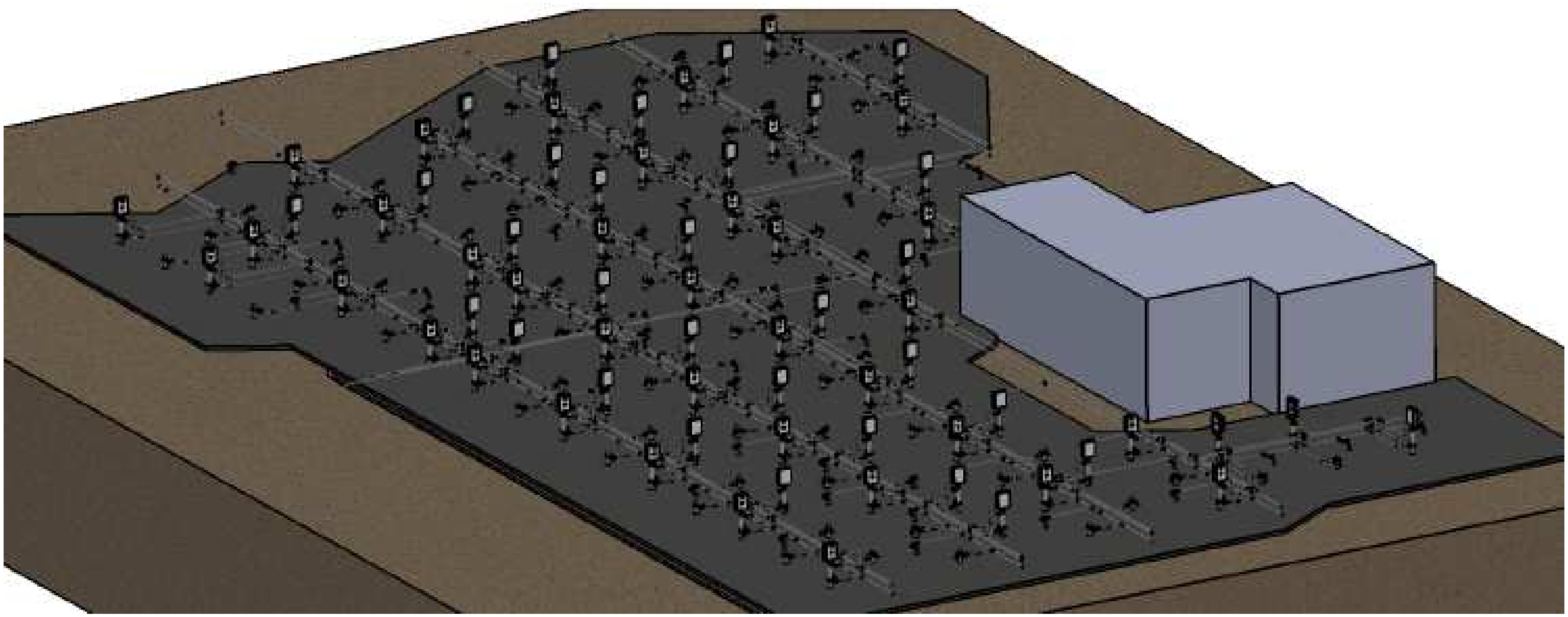
Loveland Sinclair Station: In-Situ Thermal Remediation

•Subsurface water utilities limit a portion of the treatment area to both excavation and ISTR, however ISTR increases the area of treatment in the vicinity of the water lines

•Plan includes a treatment area in excess of 14,000 ft^2 *(33% larger area than excavation)*

•No supplemental remediation anticipated within the treatment area after thermal remediation is completed

•ISTR project completed within 100 days from system start-up *(4 times faster than excavation/bio-augmentation)*



Contact Information

Technical Information & Case Studies Available at:
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