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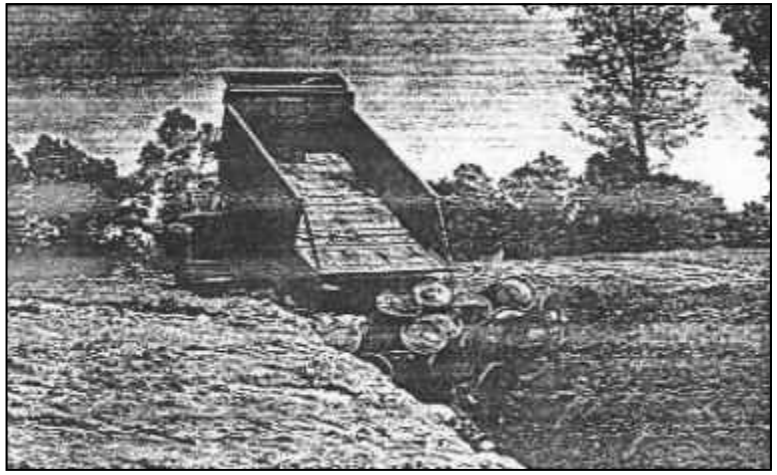
2024 Battelle Chlorinated Conference

Challenges in Soil Vapor Extraction Treatment Design to Deplete Contaminant Mass at the Nation’s Worst Carbon Tetrachloride Landfill Site

Presented by:
Bruce Kennington (Principal) - Ramboll Americas Engineering Solutions, Inc

DISPOSAL OPERATIONS

- Industrial waste disposal operations (1964 to 1973)
- Downgradient residential complaints (1977)
- City water supplied to residents (1979)
- Toxic tort litigation in 1980's



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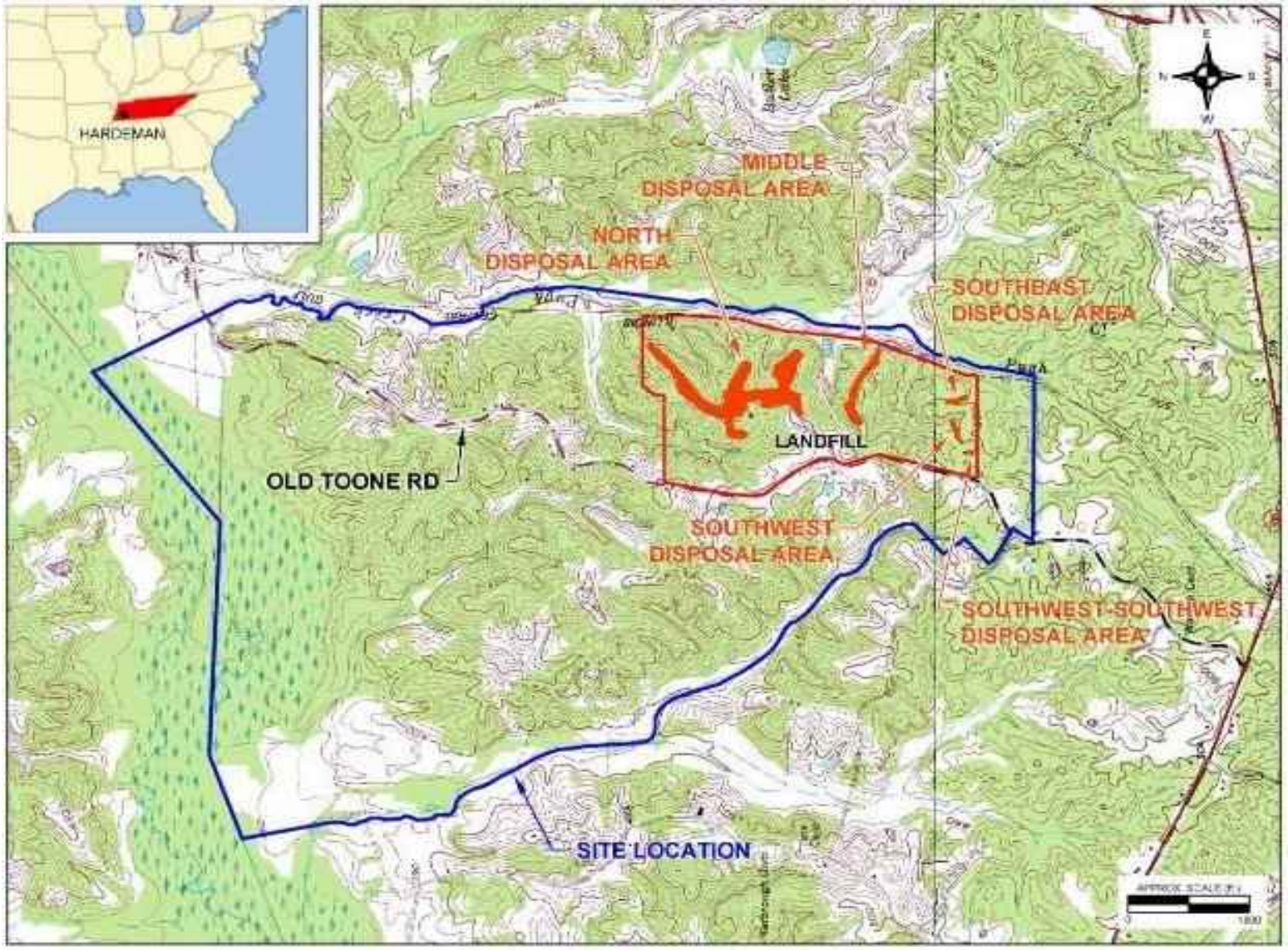
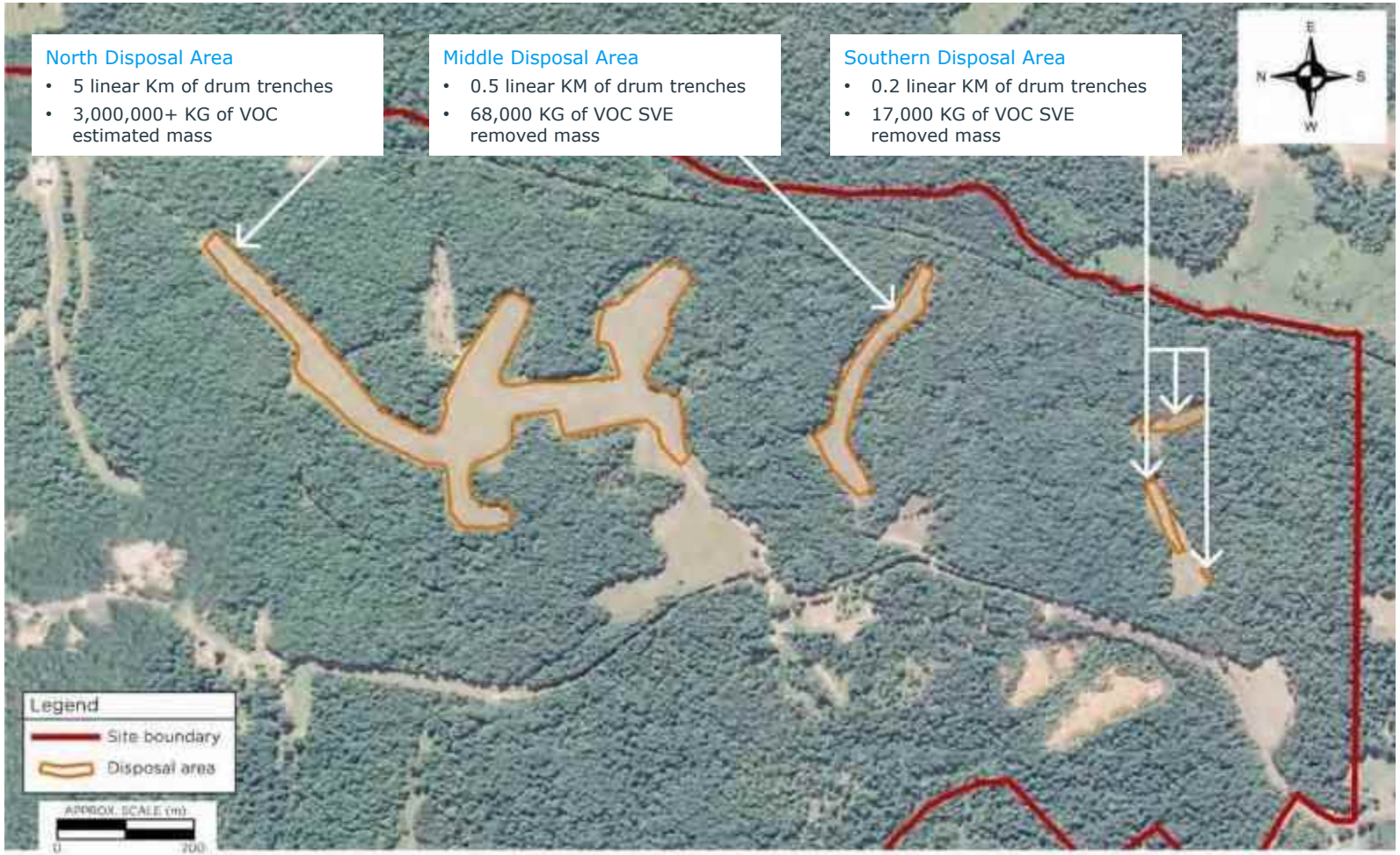
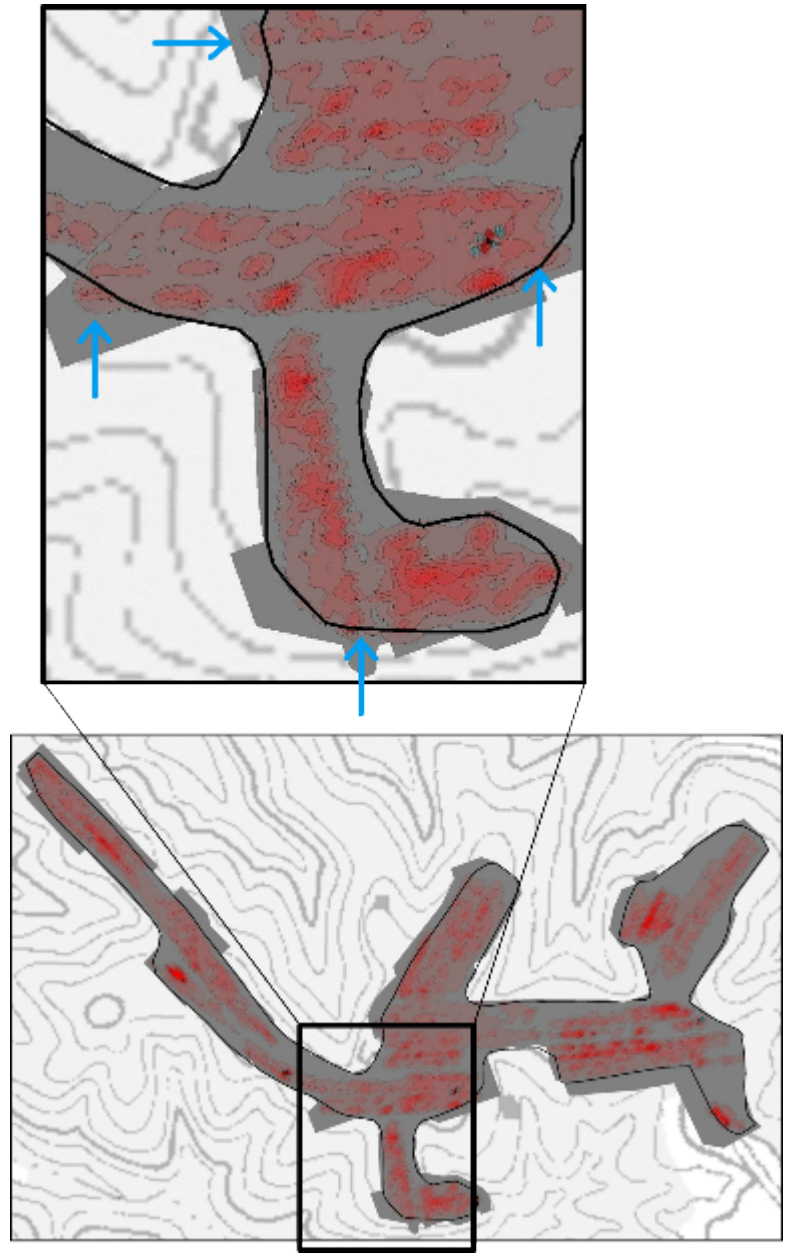
SITE LOCATION & SETTING



WASTE DISPOSAL AREAS





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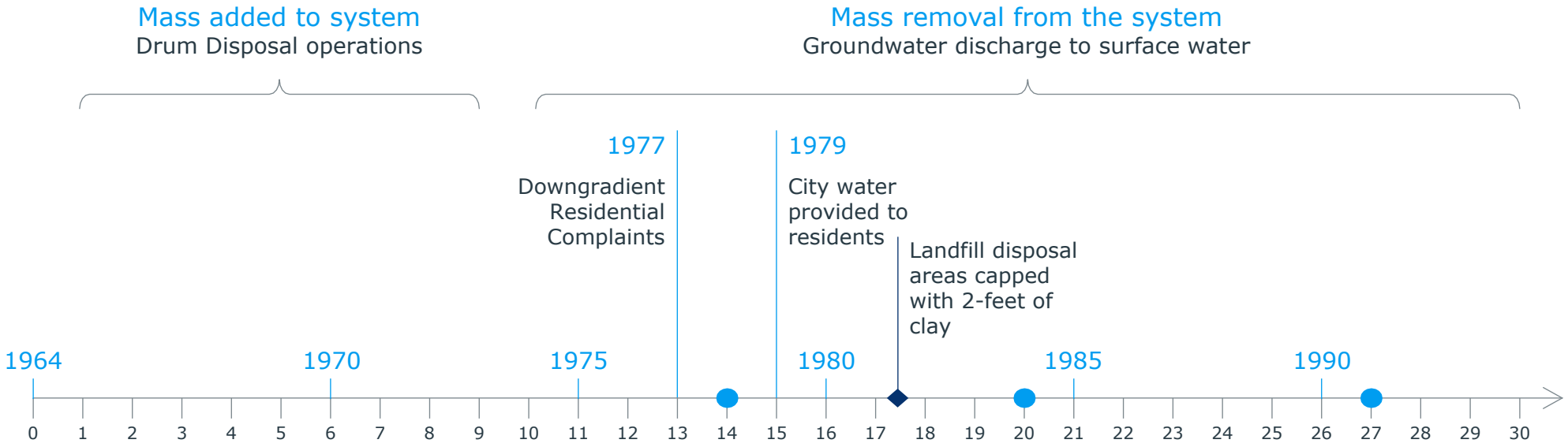
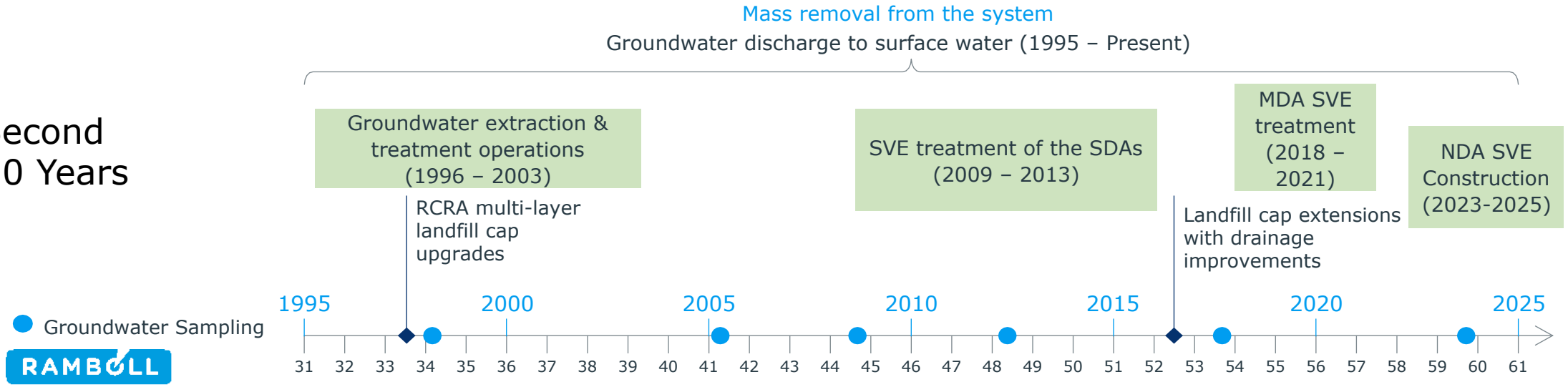
SITE TIMELINE

First 30 Years



Second 30 Years



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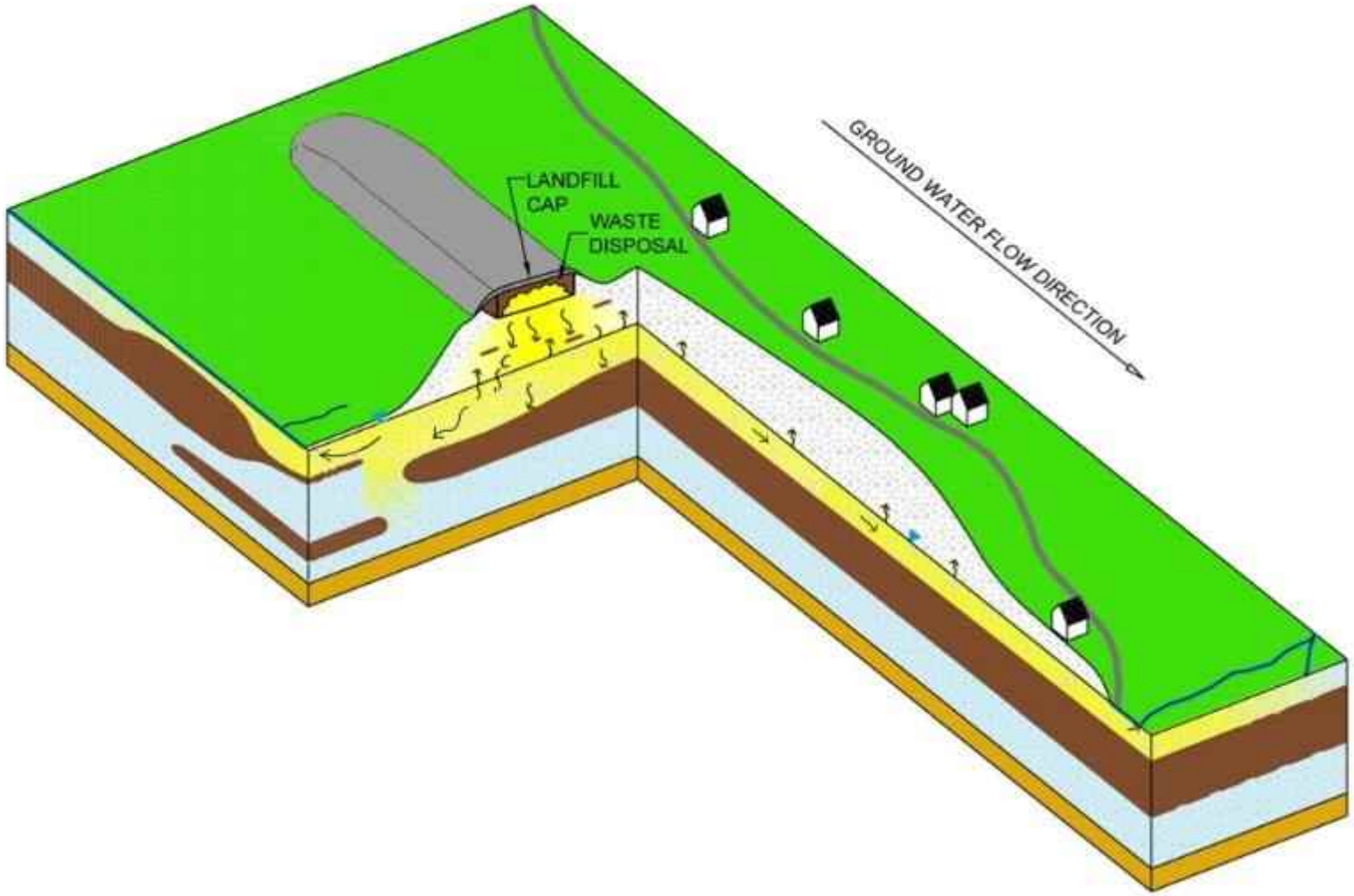
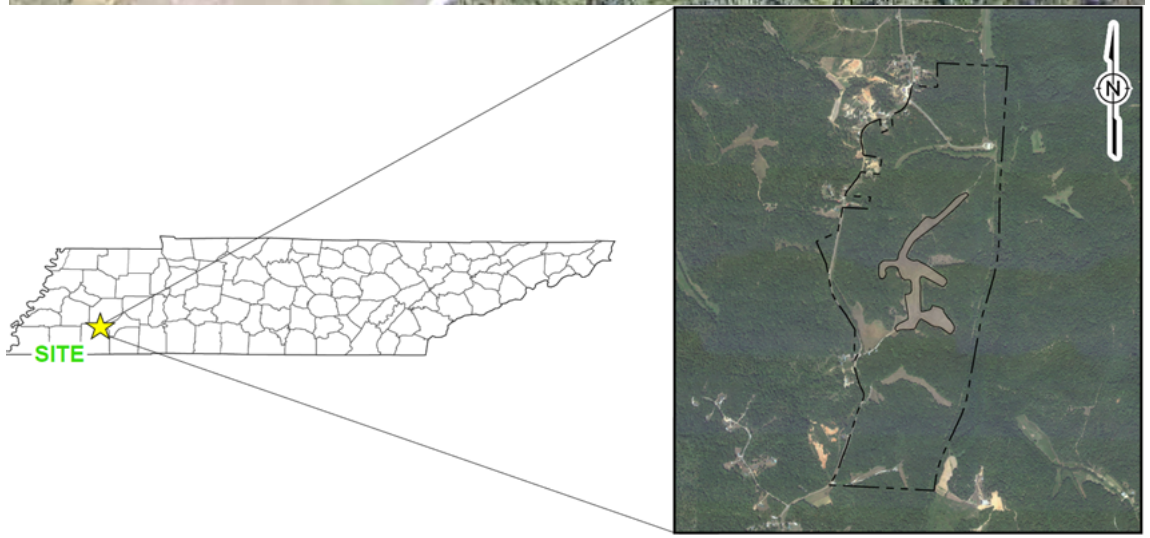
PROBLEM STATEMENT

- Mega-superfund site with 200,000 drums of buried pesticide manufacturing waste with carbon tetrachloride as carrier solvent
- Mississippi embayment unconsolidated sediments with multi-hydrostratigraphic units
- Multi historically flawed CSMs lead to failed source area and groundwater remedies
- Updated CSM used for new source area remedy design and implementation
- New Groundwater Remedy - To be Determined



SITE BACKGROUND - REMEDIAL ACTIONS

- Landfill Clay Caps constructed in 1980; upgraded with geo-membranes in 1997; cap upgrades to improve drainage and address erosion completed in 2015
- 1991 ROD for groundwater included a P&T system for hydraulic containment (operated from 1996 to 2003); Shutdown due cross-contamination from highly impacted unconfined aquifer to an underlying semi-confined aquifer
- Turnkey design/build of a pilot SVE system at the 1-acre Southern Disposal Areas (SDA) in 2008. Based on these results, EPA issued an Amended ROD for the Site in 2012
- Full-scale SVE treatment system implemented at 3-acre Middle Disposal Area (MDA) in 2015



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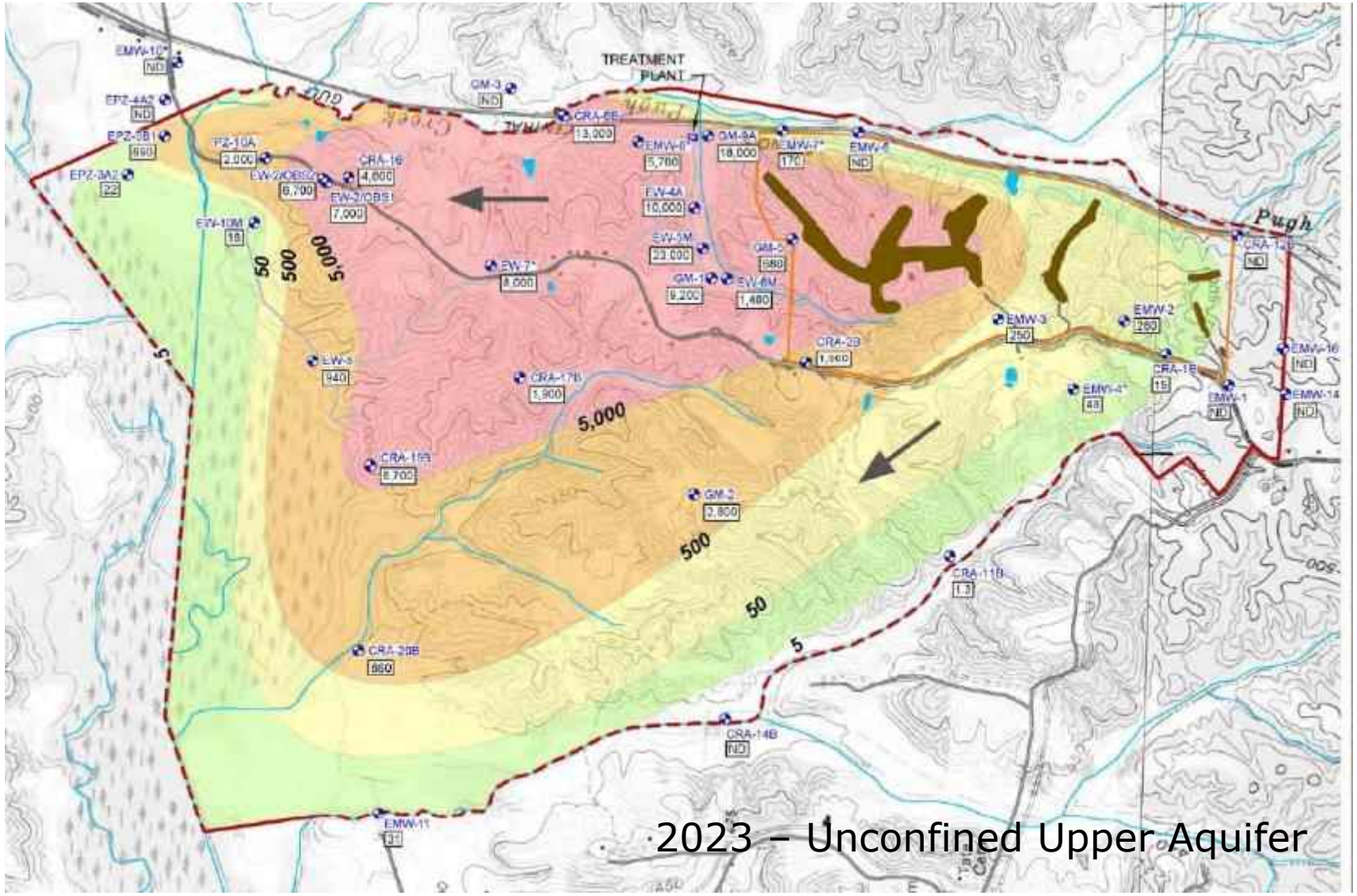
COUNTRY'S WORST CARBON TETRACHLORIDE PLUME



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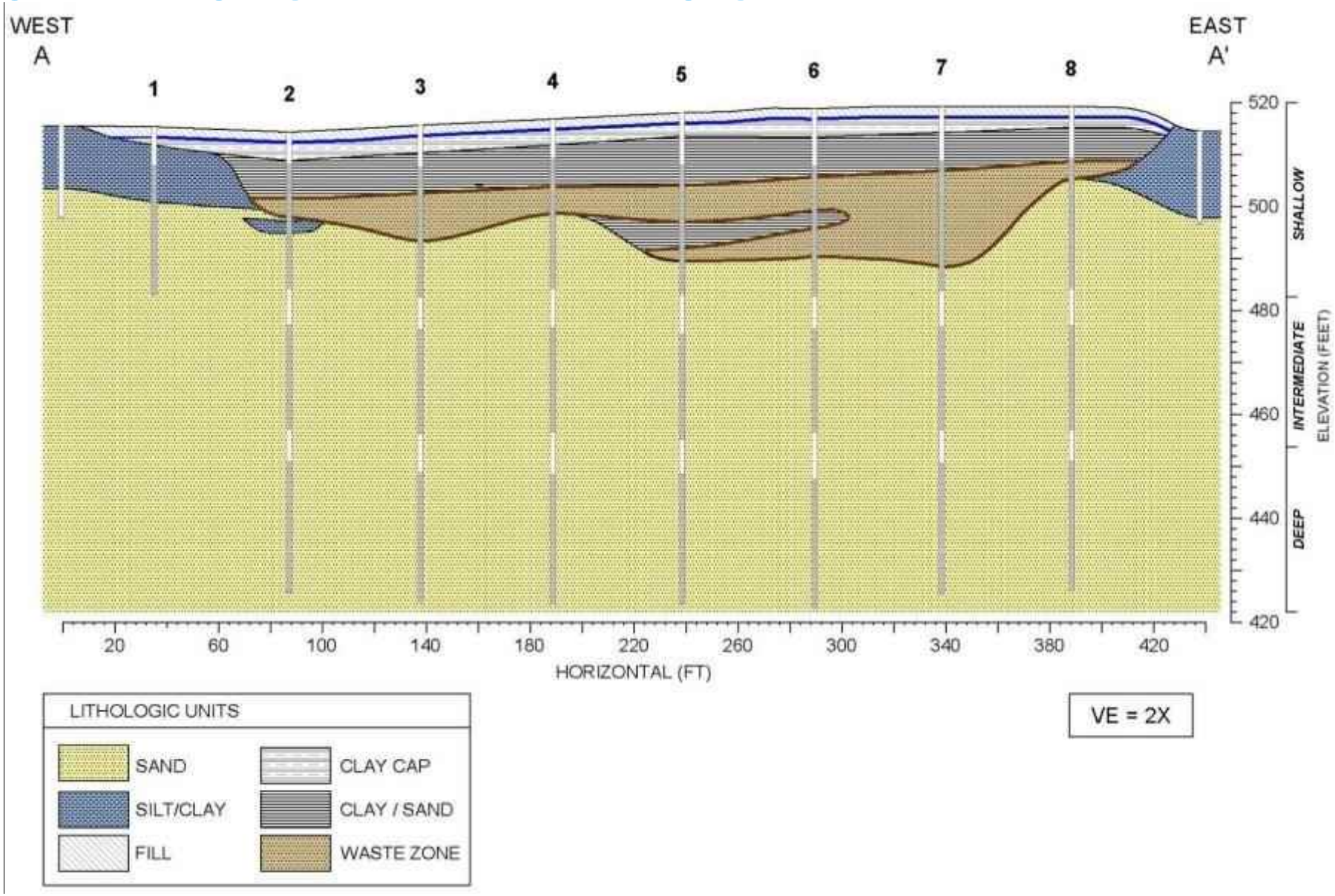
SITE CONDITIONS AMENABLE TO SVE



SVE WELL INSTALLATION - LEVEL B DRILLING

- 2009 to 2013 – Turnkey design, installation and operation of a pilot Scale SVE system at the 1-acre South Disposal Areas (SDA); Vented over 1,400 pore volumes and ~40,000 lbs of VOCs
- 2018 to 2021 – Design, installation and operation of full-scale SVE system at the 3-acre Middle Disposal Area (MDA)
- Achieved over 97% net reduction from baseline conditions of mean VOC soil gas concentrations

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IMPACT OF SVE REMEDIAL ACTIVITIES AT SOUTH AND MIDDLE DISPOSAL AREAS

August 2008

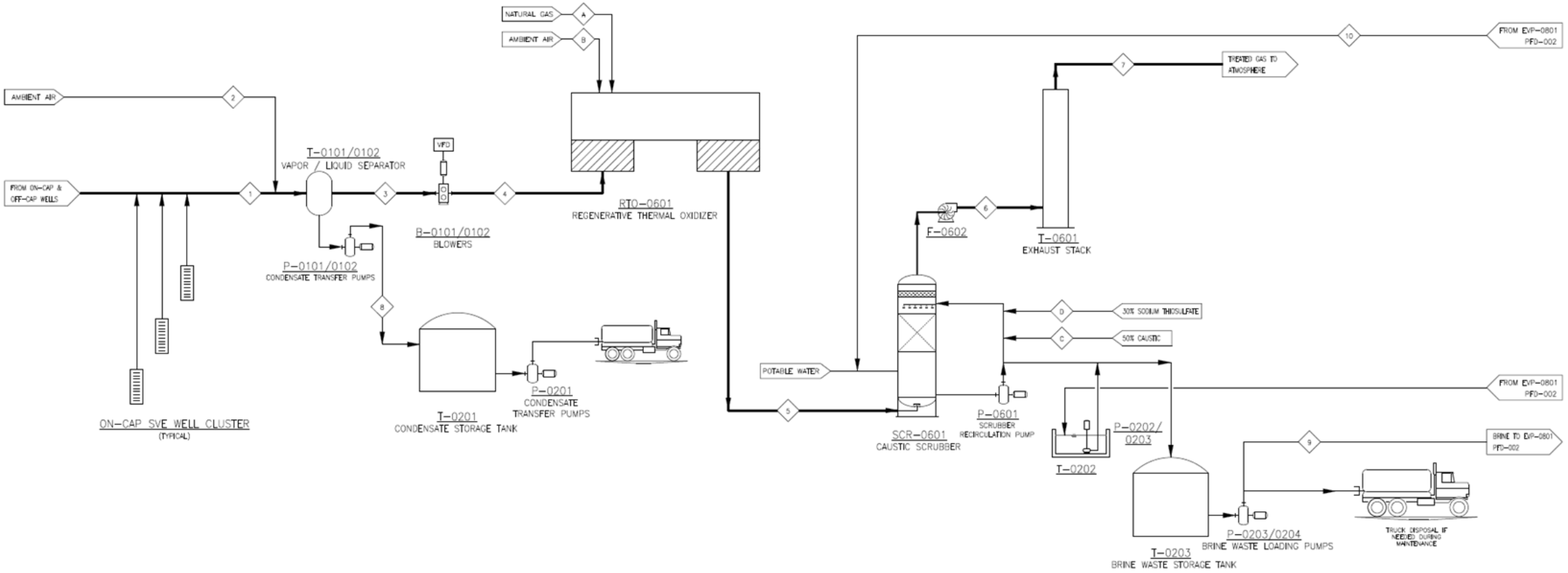
July 2012

August 2017

August 2023

Following SVE remedial activities at the SDA in 2008 and at the MDA in 2018, groundwater concentrations of CCl_4 in monitoring wells located 500, 1,000 and 1,600 feet downgradient decreased by one to two orders of magnitude.

SVE SYSTEM PROCESS FLOW – NORTH DISPOSAL AREA



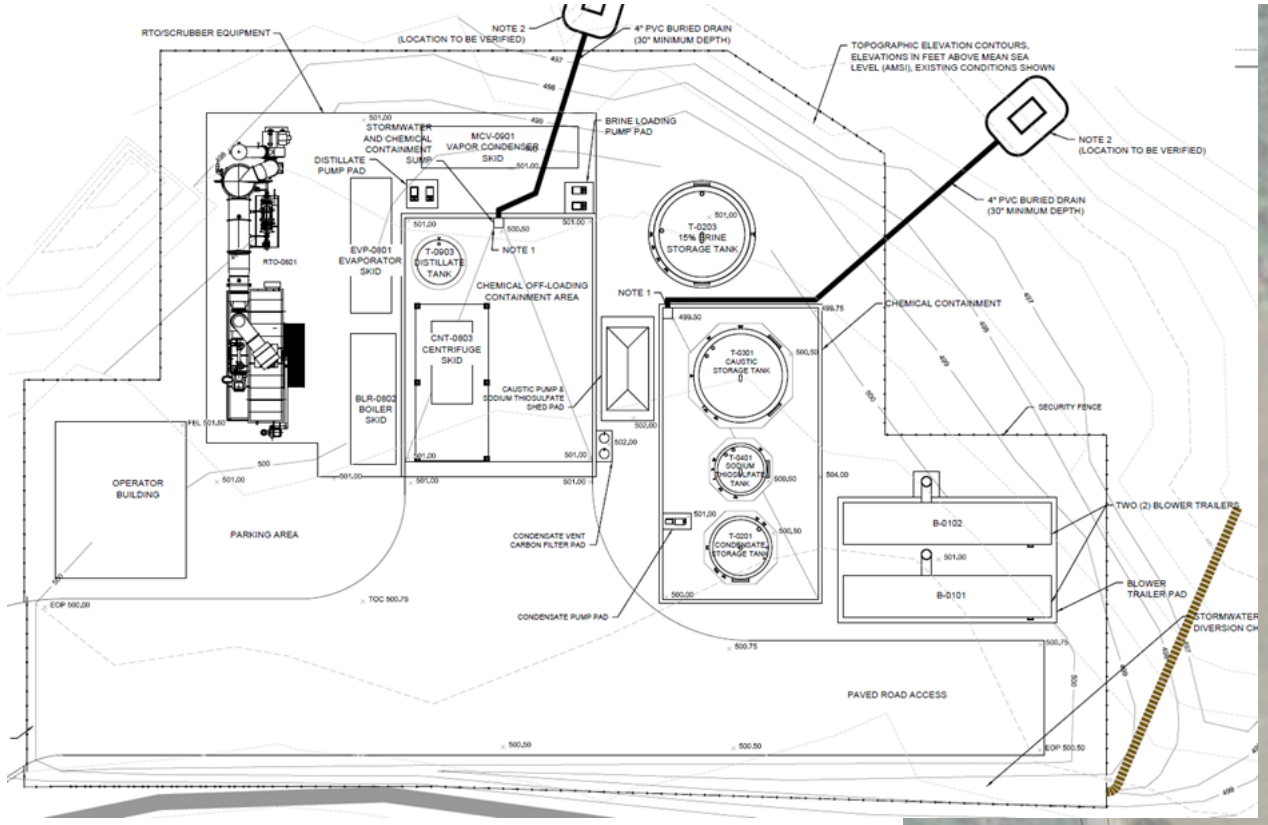
DESIGN CHALLENGES

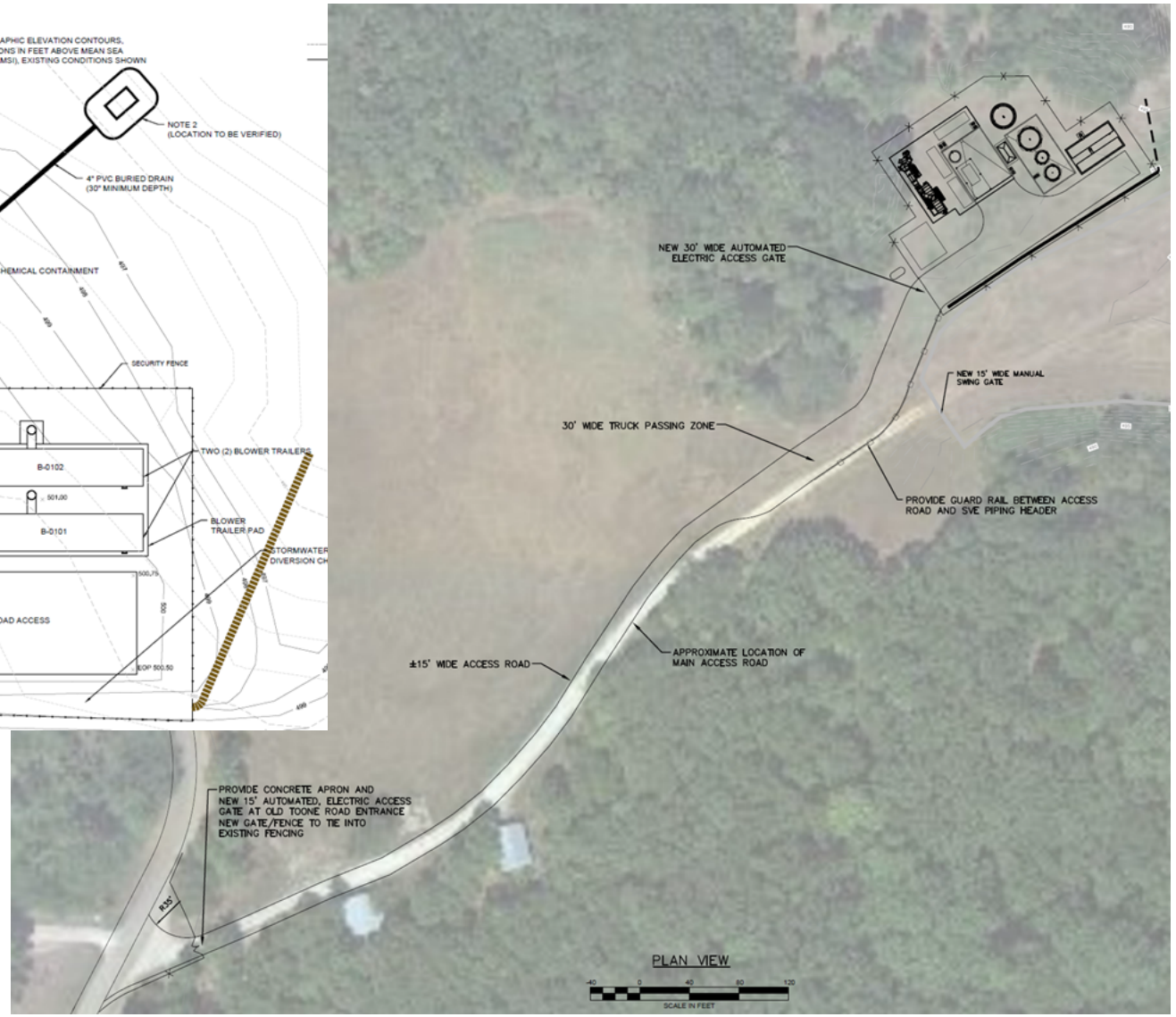
- Presence of free product and residual non-aqueous phase liquids (NAPL) within a vadose zone thickness of 90 to 110 feet
  - ➢ Employment of a robust network of SVE wells for venting of soils beneath the engineered cap
    - Selection in the alignment of the SVE swell network based on geophysical surveys of historic disposal trenches and pre-design results of soil vapor monitoring studies
    - Spacing of SVE wells with a minimum overlap of 25% (or 50 ft) resulting in a well spacing of ~150 ft
    - Use of SVE well couplets and triplets to provide vertical coverage
    - Incorporation of passive inlets to enhance treatment to enable alternate flow paths during venting
- Explosive nature of the extracted vapors
  - ➢ Incorporation of explosion protective equipment (Class 1 / Div 2)
  - ➢ Use of sensors to detect explosive vapors and automated controls and interlocks to safeguard the system

DESIGN CHALLENGES (CONTINUED)

- Sheer mass of residual contamination (upwards of 10M lbs of VOCs) projected to be removed during the anticipated 16 to 20-year operation of the treatment system
  - Division of the NDA treatment area into 3 separate phases of operating SVE wells
  - Design and sizing of treatment system components based on projected peak CVOC loading
  - Incorporation of packaged system components to facilitate replacement of system lifetime
- Copious amounts of chlorine gas generated from thermal destruction of CVOCs
  - Incorporation of sodium thiosulfate to keep chlorine in solution
- Considerable volume of acid off-gas scrubber blowdown liquids generated
  - Addition of a Brine Reduction System (BRS) to reduce the brine to a crystalline solid for off-site disposal

SVE SYSTEM - TREATMENT PLANT LOCATION





BRINE REDUCTION SYSTEM

- Peak organic loading to SVE treatment system will result in a maximum Brine Generation Rate of ~ 29,000 gpd (or 8 tanker trucks/day) for off-site disposal.
- June 2013: City of Memphis written acceptance for brine disposal to the Onsite Environmental Facility in Memphis, TN.
  - 2013 Memphis Brine Disposal = $0.35 per gallon ($0.13 disposal / $0.22 transportation)
  - April 2020: City of Memphis declined to allow brine disposal.
- April 2020: Disposal facility in Nashville that discharges to the City of Nashville sanitary sewer system was contacted.
  - 2020 Nashville Brine Disposal = $0.52 per gallon ($0.19 disposal / $0.33 transportation)
  - 18-year Brine Disposal Estimate to Nashville = $12.1 M.
- Brine Reduction System alternative incorporated into the distong for the SVE treatment system for the NDA.
  - Estimated CAPEX: $4.1M to $14.7M / OPEX: $4.6M to $16.9M / Total Lifetime cost of $11.3M to $22.8M

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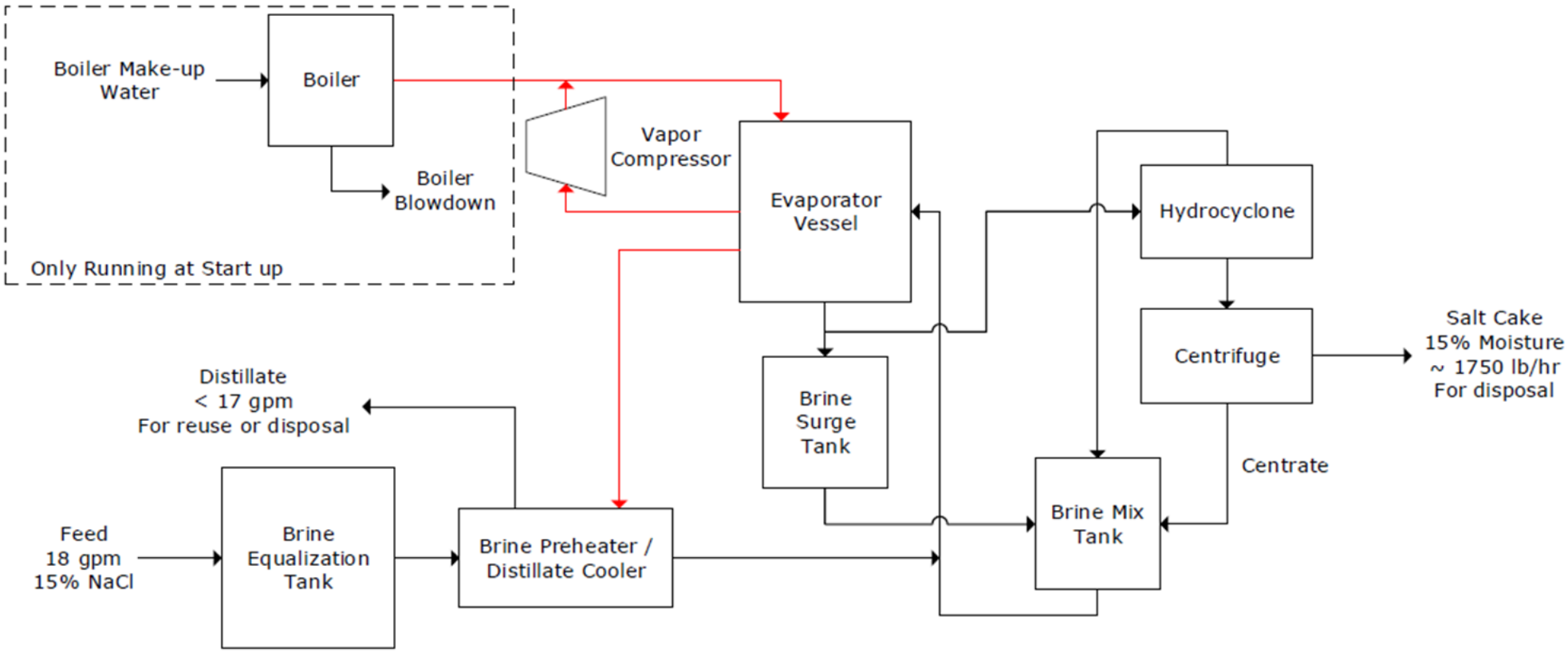
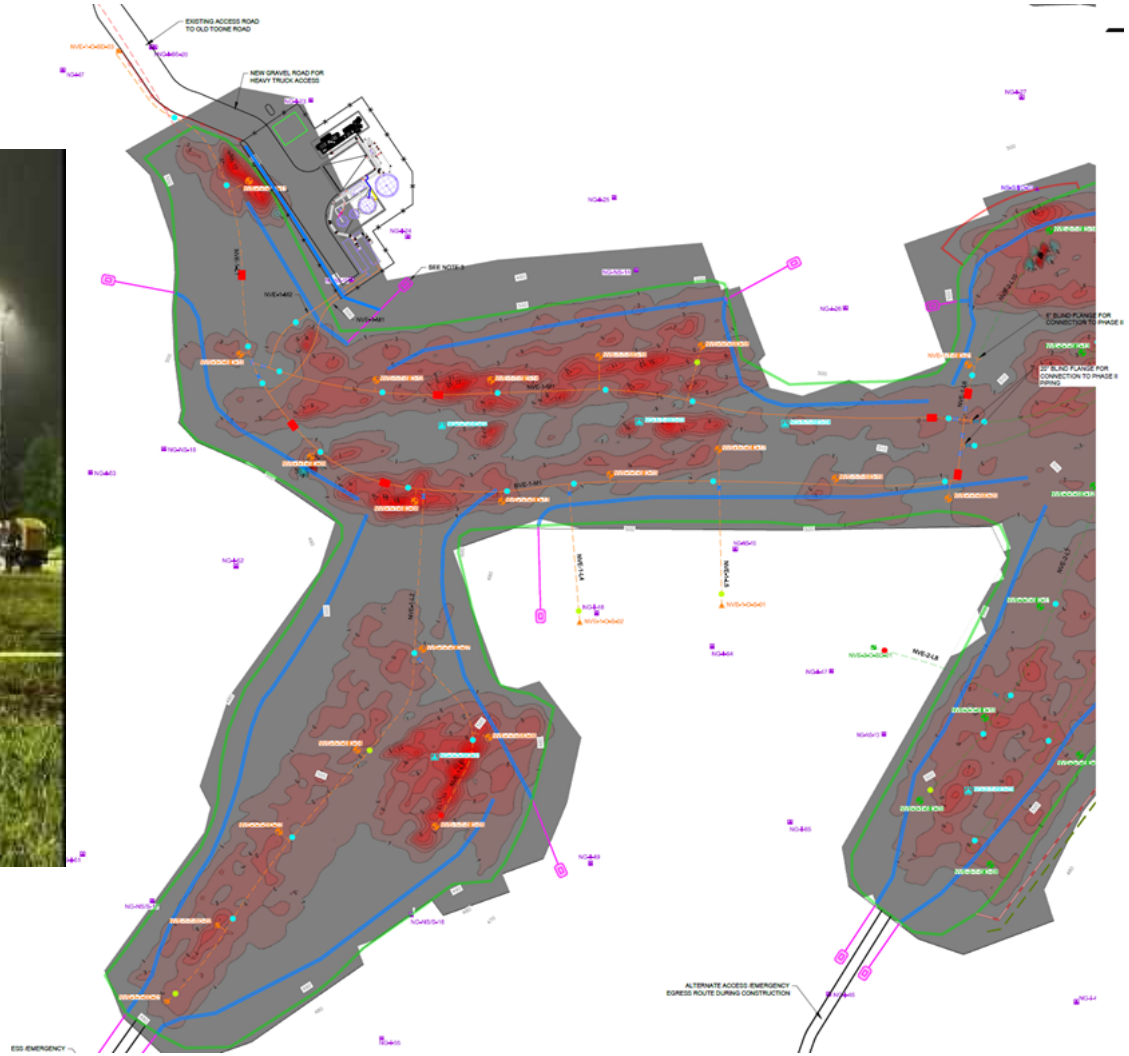
BRINE REDUCTION SYSTEM



- A mature Technology with longstanding history in wastewater treatment
- Typically used to treat highly contaminated and/or highly saline industrial wastewaters
- Produdes a concentrated brine slurry of solid cake and a clean distillate/condensate stream

GEOPHYSICAL INVESTIGATION & SVE WELL PLACEMENT



- ~200,000 drums (carbon tetrachloride, chloroform with pesticides) buried in 3.3 miles of unlined trenches.
- SVE well placement aligned to geophysical survey results of historic drum trenches now situated beneath and engineered low permeability cap
- Recent installation of Phase 1 SVE wells identified significant residual DNAPL throughout

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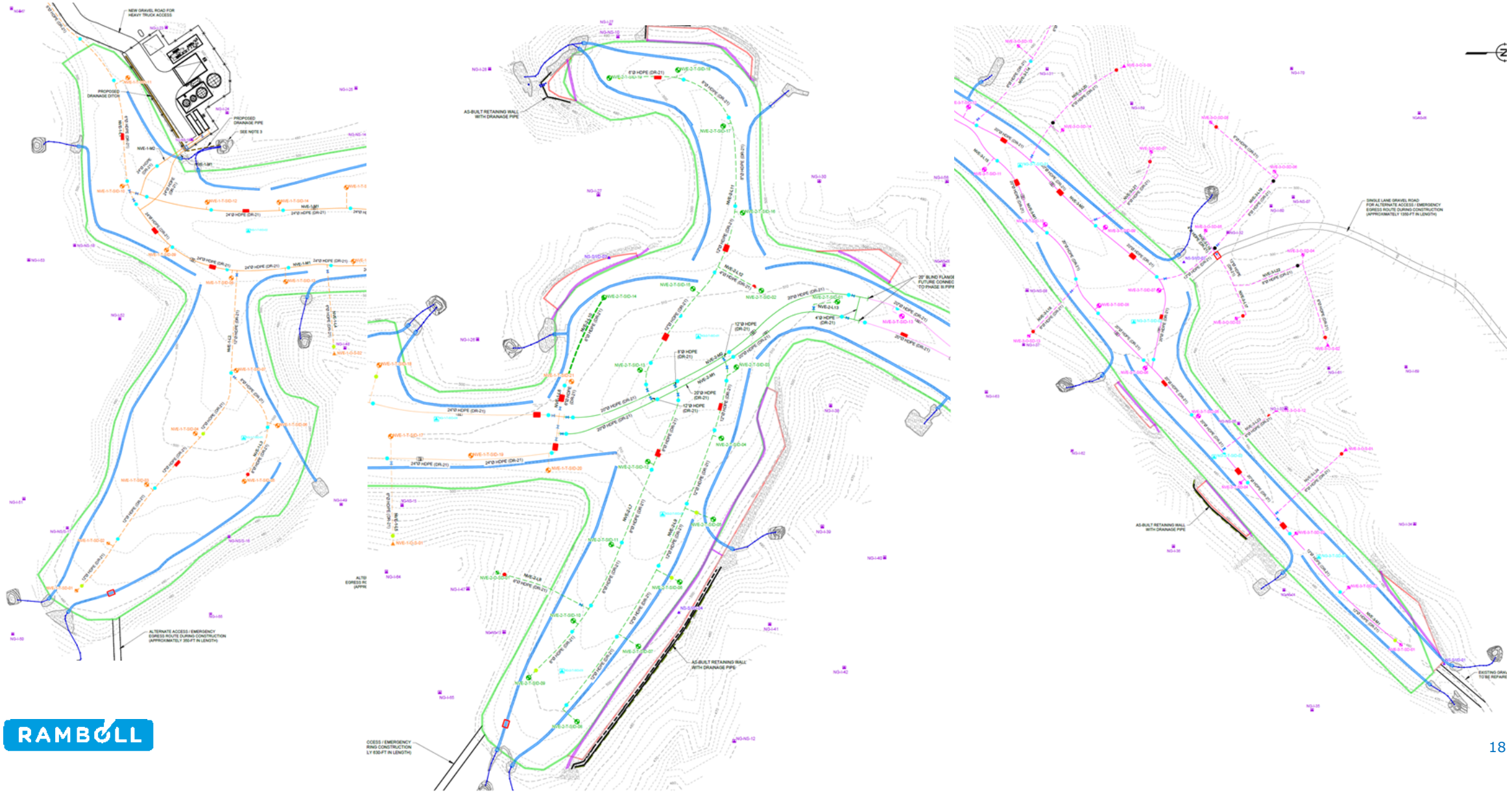
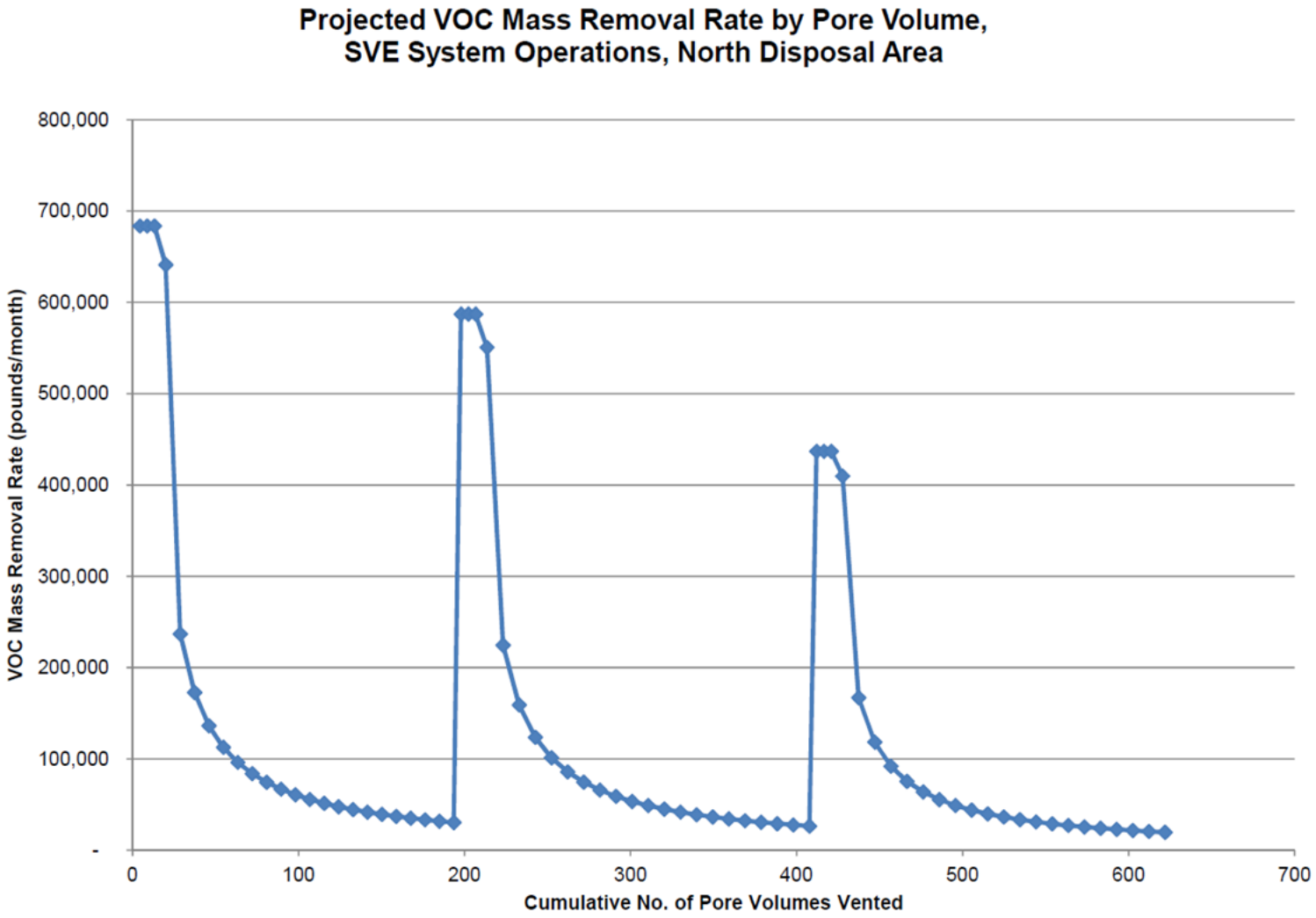
PHASED OPERATION: 192 SVE WELLS OVER 12 TO 16 YEARS



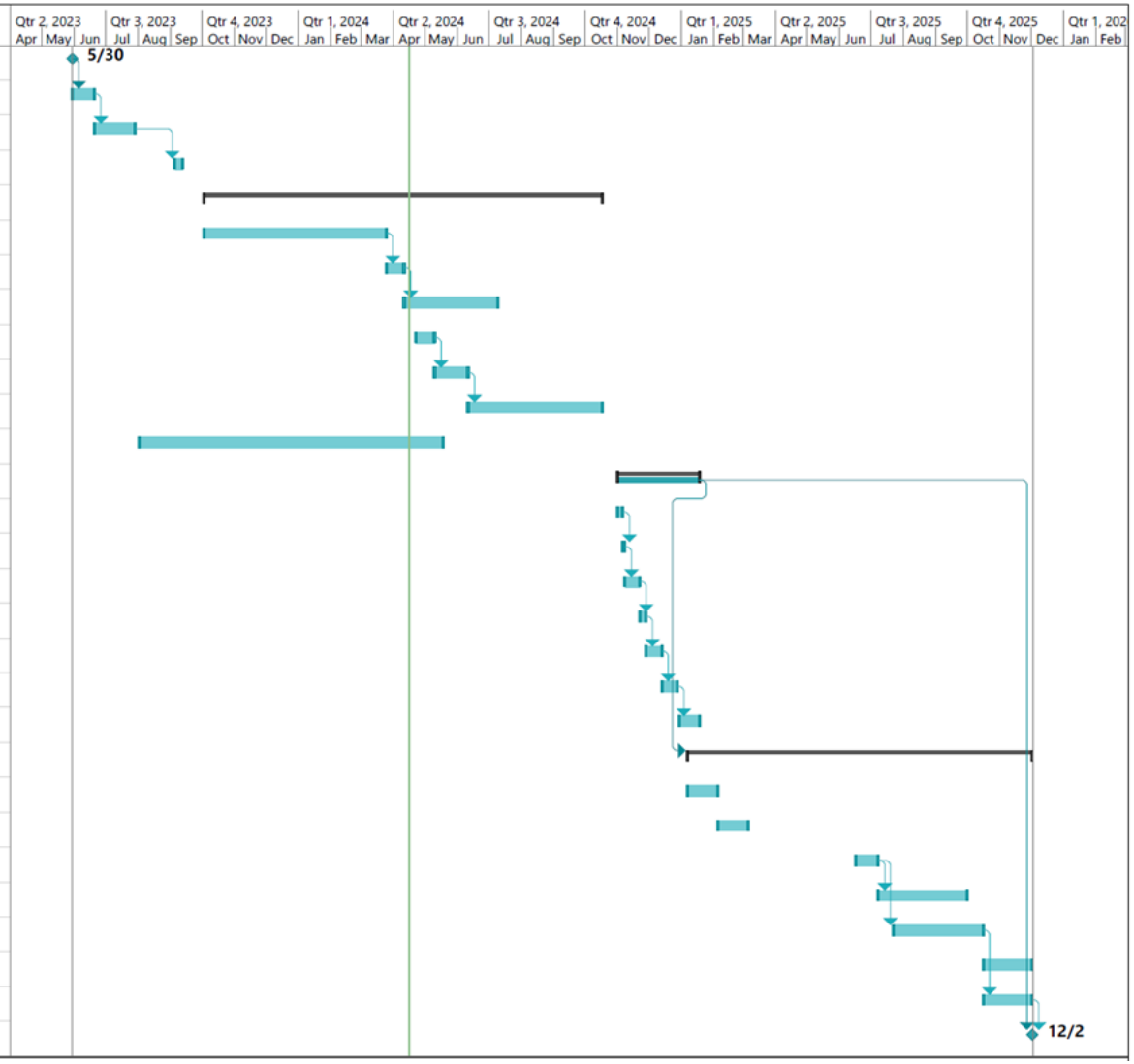
PROJECTED VAPOR CONCENTRATIONS OVER TIME

- Brine generation rate proportional to the VOC mass loading to the SVE treatment system
- Maximum estimated brine generation of 29,000 gpd at peak loading at startup of each phase;
- Decreasing to a rate of 6,000 gpd within 6 to 8 months of operation



TIME SCHEDULE

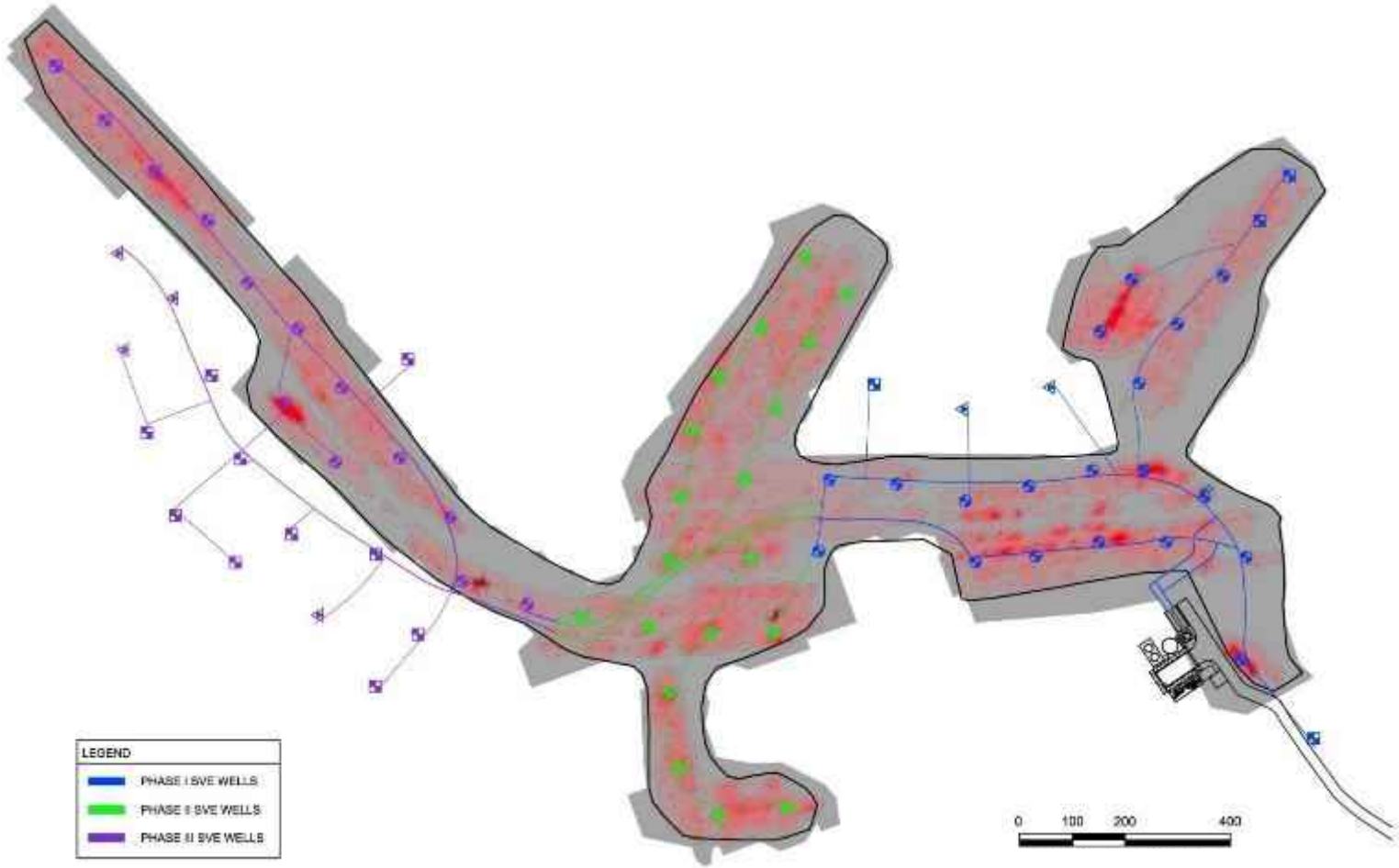
ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Tue 5/30/23	Tue 5/30/23
2	Pre-Mobilizartion Planning	15 days	Tue 5/30/23	Mon 6/19/23
3	Site Preparation	29 days	Tue 6/20/23	Fri 7/28/23
4	Site Mobilization	5 days	Tue 9/5/23	Mon 9/11/23
5	**SVE Wells, Wellheads & Piping Construction**	**272 days**	**Tue 10/3/23**	**Wed 10/16/24**
6	Phase 1 - Well Construction	125 days	Tue 10/3/23	Sun 3/24/24
7	Phase 1 Wellhead Construction	13 days	Mon 3/25/24	Wed 4/10/24
8	Phase 1 - SVE Piping Installation	64 days	Thu 4/11/24	Tue 7/9/24
9	Phase 2 - Well Construction	14 days	Mon 4/22/24	Thu 5/9/24
10	Phase 2 Wellhead Construction	22 days	Fri 5/10/24	Mon 6/10/24
11	Phase 2 - SVE Piping Installation	92 days	Tue 6/11/24	Wed 10/16/24
12	Shop Drawings Preparation & Approval	208 days	Wed 8/2/23	Fri 5/17/24
13	**Civil Construction**	**56 days**	**Fri 11/1/24**	**Fri 1/17/25**
14	Erosion Controls	3 days	Fri 11/1/24	Tue 11/5/24
15	Survey Controls	2 days	Wed 11/6/24	Thu 11/7/24
16	Construction Entrance	10 days	Fri 11/8/24	Thu 11/21/24
17	Clearing & Grubbing	4 days	Fri 11/22/24	Wed 11/27/24
18	Utilities (water, gas, electric)	11 days	Thu 11/28/24	Thu 12/12/24
19	Earthwork and Grading	11 days	Fri 12/13/24	Fri 12/27/24
20	Concrete (Building & Equipment Pads)	15 days	Mon 12/30/24	Fri 1/17/25
21	**Treatment System Construction**	**235 days**	**Tue 1/7/25**	**Mon 12/1/25**
22	Control Building	21 days	Tue 1/7/25	Tue 2/4/25
23	Tank Installations	21 days	Wed 2/5/25	Wed 3/5/25
24	Packaged Component Installation	16 days	Mon 6/16/25	Mon 7/7/25
25	Process Piping	61 days	Tue 7/8/25	Tue 9/30/25
26	I&C / Electrical Installation	62 days	Tue 7/22/25	Wed 10/15/25
27	Asphalt/ Concrete Pavement	33 days	Thu 10/16/25	Mon 12/1/25
28	System Testing, Shakedown & Commissioning	33 days	Thu 10/16/25	Mon 12/1/25
29	**Commence Phase 1 SVE Well Treatment**	0 days	Tue 12/2/25	Tue 12/2/25



20-Acre NDA SVE System Under Construction

Projected Remediation Timeframe: 2026 – 2038+

Projected VOC Mass to be Removed: 3,000,000+ Kg (3,300+ tons)



THANK YOU

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Questions and Acknowledgements

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