Technical Area-V Groundwater Area of Concern

SAND2016-7599PE

presented to the Water Protection Advisory Board

August 12, 2016

Jun Li, Technical Lead

Sandia National Laboratories

Insert SAND number after R&A is complete

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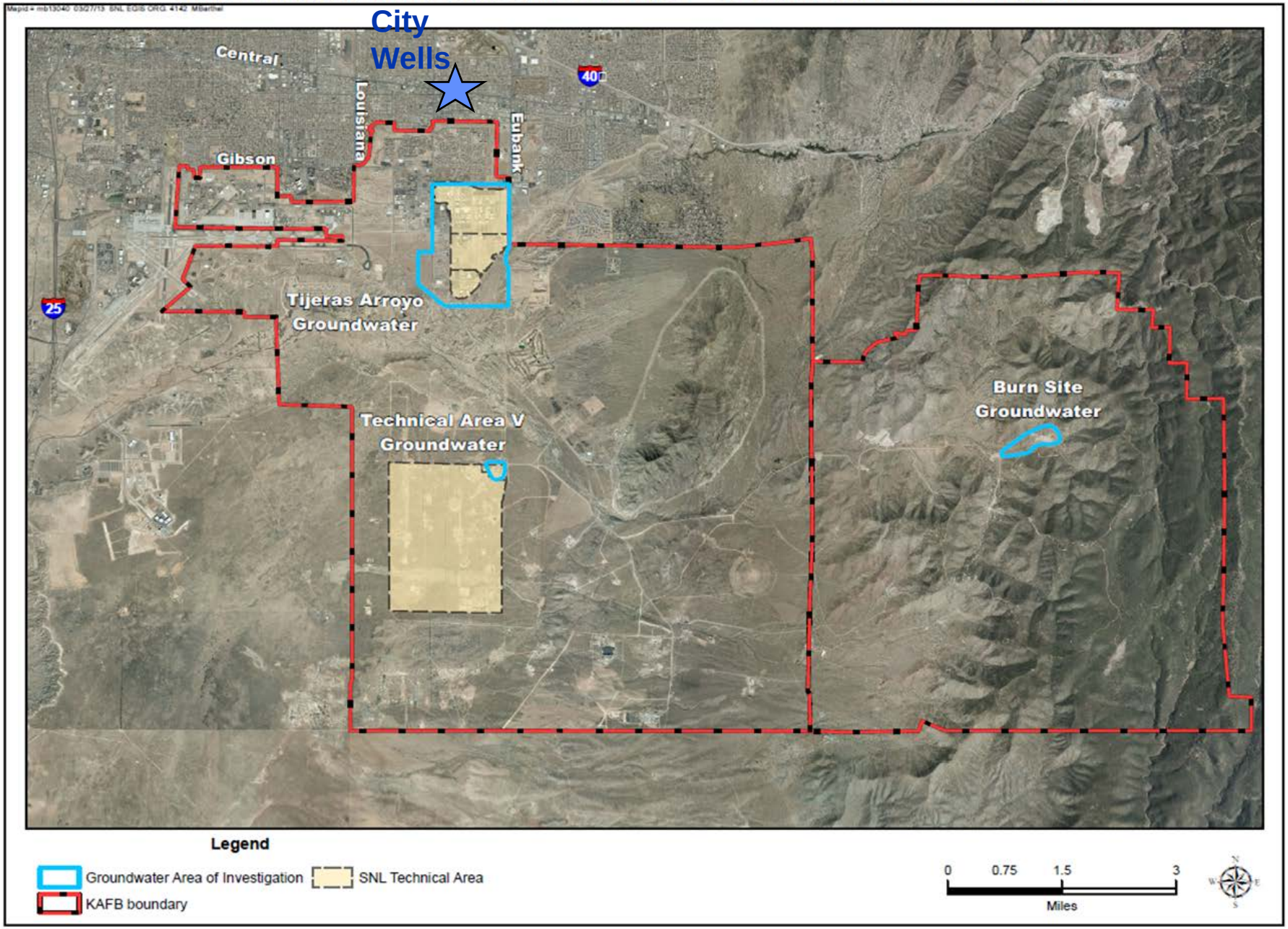
Sandia National Laboratories, New Mexico - Groundwater Areas of Concern

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Sources of Contamination at TA-V Groundwater AOC

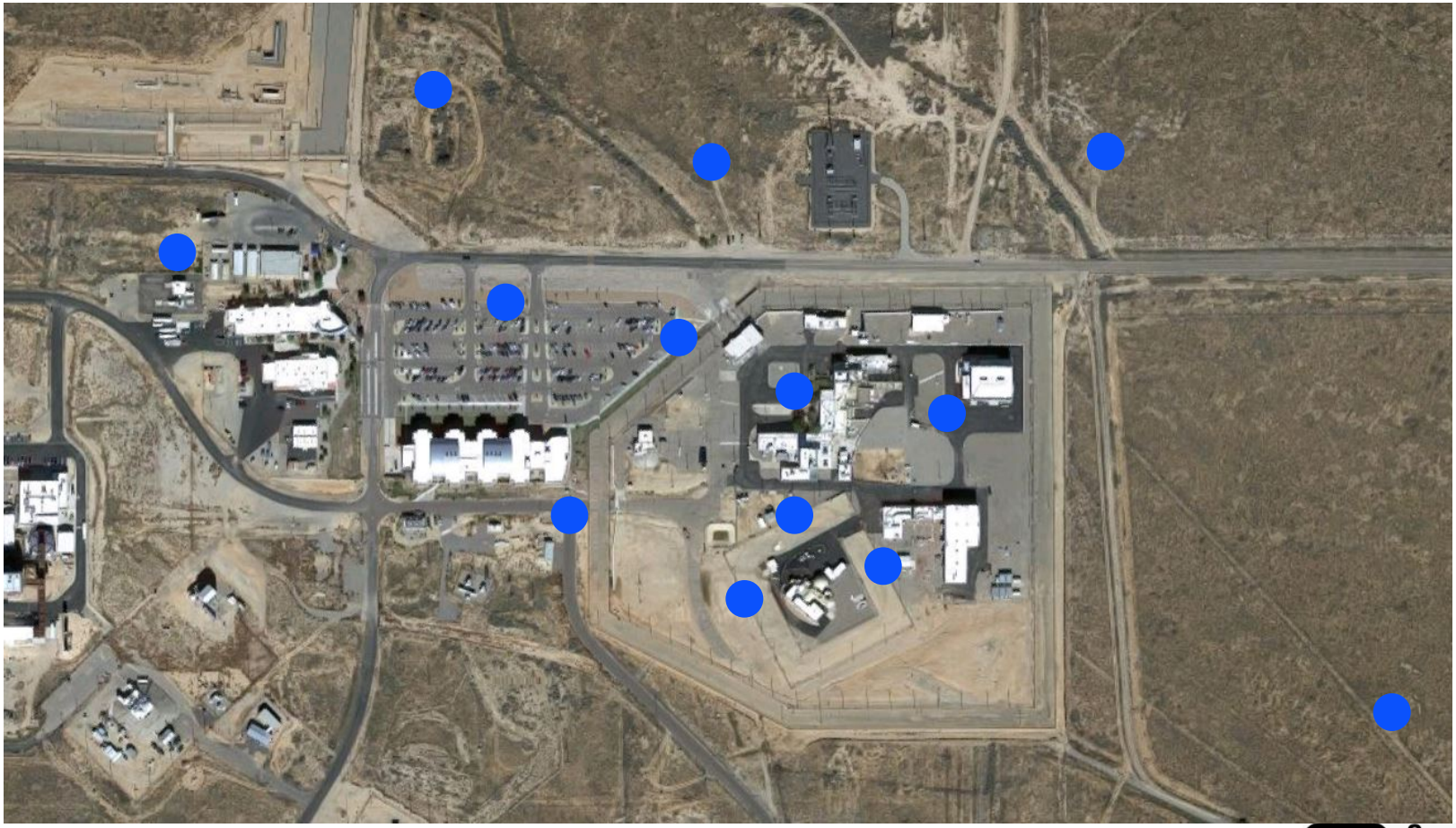
- **Technical Area-V is about 35 acres.**
- **Sources of contamination are wastewater discharges prior to 1992.**

Discharge Site that Impacted Groundwater	Date of Discharge	Estimated Volume	Wastewater
Liquid Waste Disposal System (LWDS) Drain Field	1962 – 1967 (5 years)	6.5 Million Gallons	Industrial waste water
TA-V Seepage Pits	1960s – 1992 (30 years)	30-50 Million Gallons	Septic waste and industrial waste water

Groundwater Monitoring at TA-V

- **Groundwater is at 500 ft below ground surface in low permeability sediments.**
- **Extensively monitored since 1992.**
- **Current monitoring network has 16 wells including three shallow/deep pairs.**
- **Quarterly monitoring for most wells.**

Groundwater Monitoring at TA-V



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Regulating Groundwater Contamination at TA-V

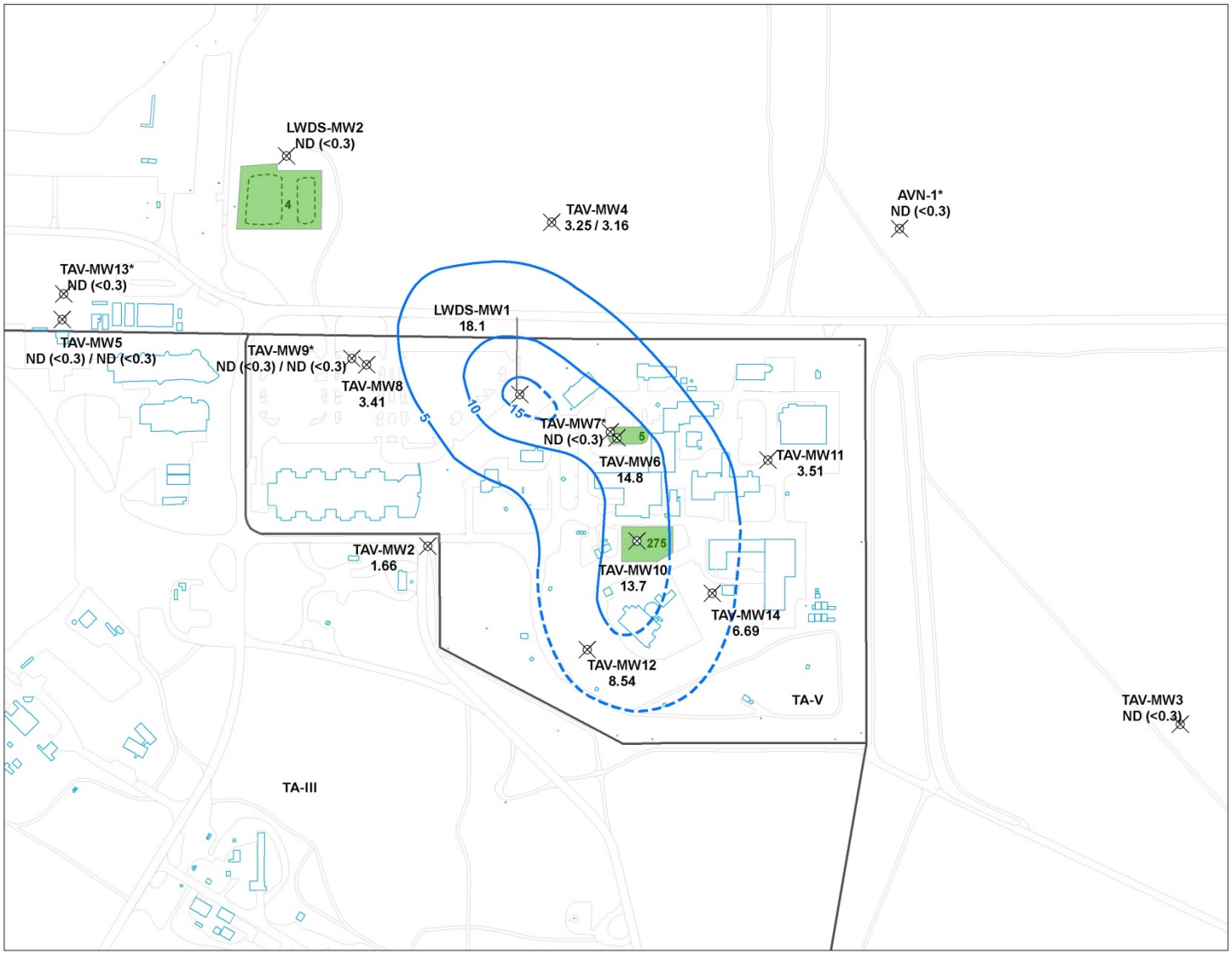
- **NMED Hazardous Waste Bureau regulates the site.**
- **Regulatory standards for groundwater contamination at Sandia are EPA Drinking Water Standards.**

Contaminant in Groundwater at TA-V	Maximum Concentration	EPA Drinking Water Standard
Nitrate	~ 15 mg/L	10 mg/L
Trichloroethene (TCE)	~ 20 µg/L	5 µg/L

- **There is no pure phase TCE in the groundwater at TA-V.**

TCE Distribution in Groundwater at TA-V

November/December 2015



Legend

- 3.51 — Monitoring well, with November/December 2015 Trichloroethene concentrations (µg/L)
- Isoconcentration contour (µg/L), dashed where inferred
- Road, paved and unpaved
- Building / structure
- Inactive impoundment boundary
- Solid Waste Management Unit (SWMU)
- Technical Area (TA) boundary

Notes:
* Wells AVN-1, TAV-MW7, TAV-MW9, and TAV-MW13 are completed below the water table, and were not contoured.

ND = not detected, method detection limit indicated in parentheses.

0 300 600
Feet

0 100 200
Meters

N

EGIS

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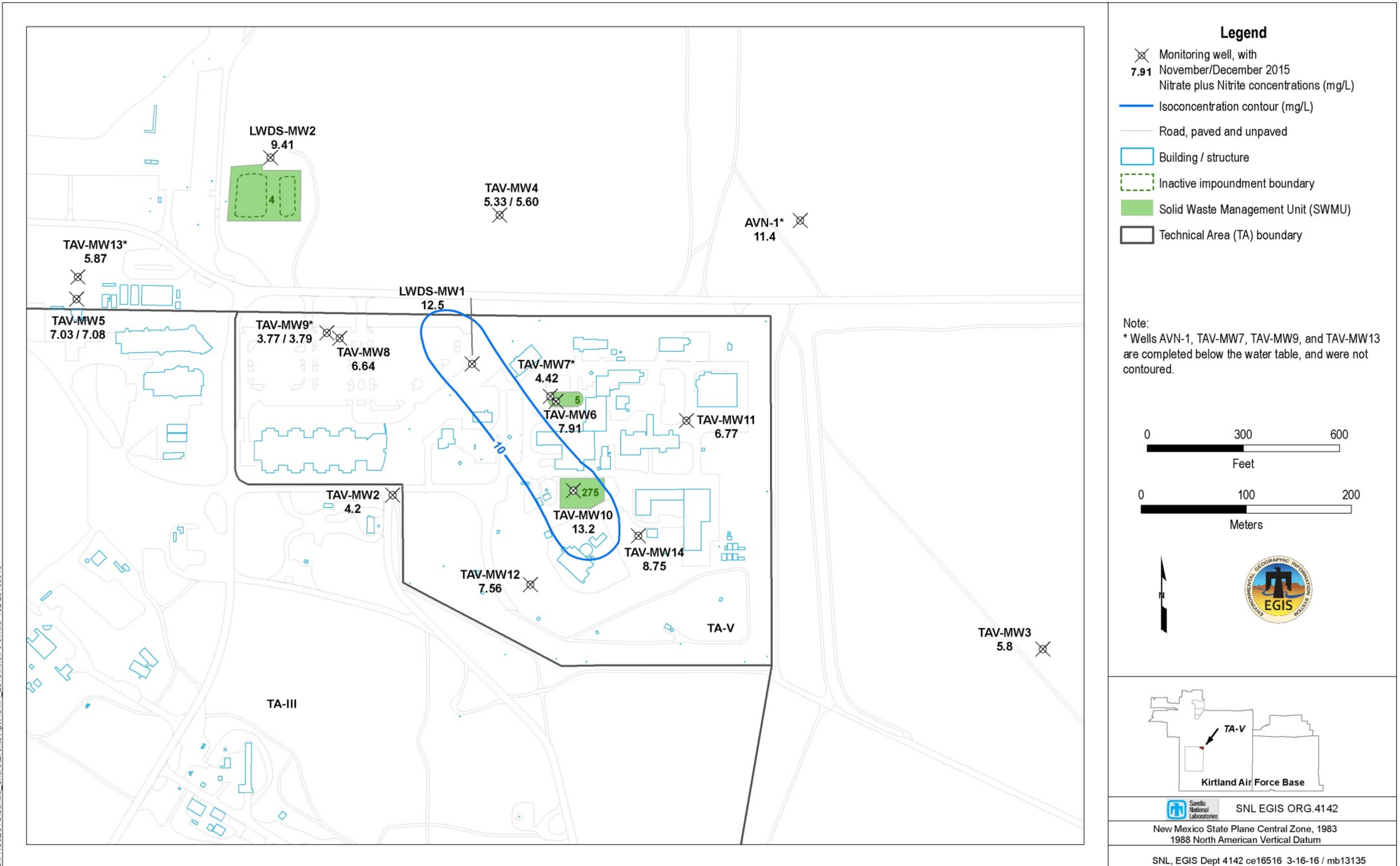
SNL EGIS ORG.4142

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

SNL, EGIS Dept 4142 ce16515 3-16-16 / mb13135

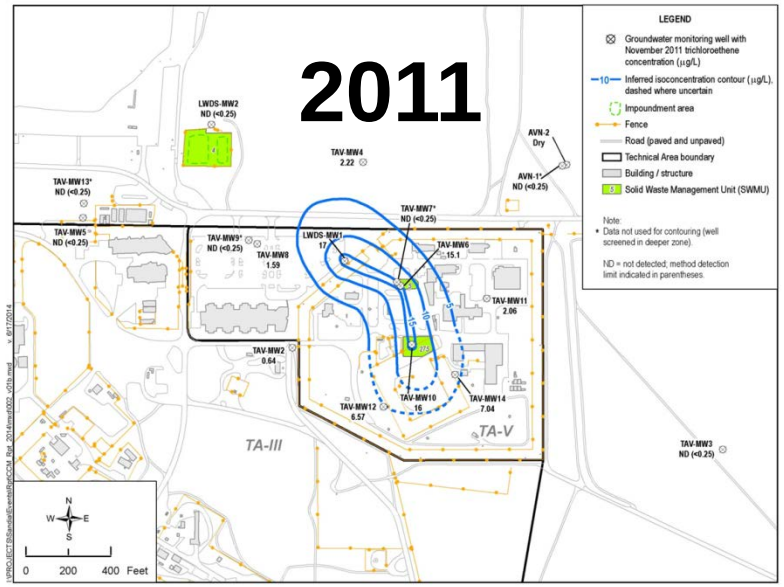
Nitrate Distribution in Groundwater at TA-V

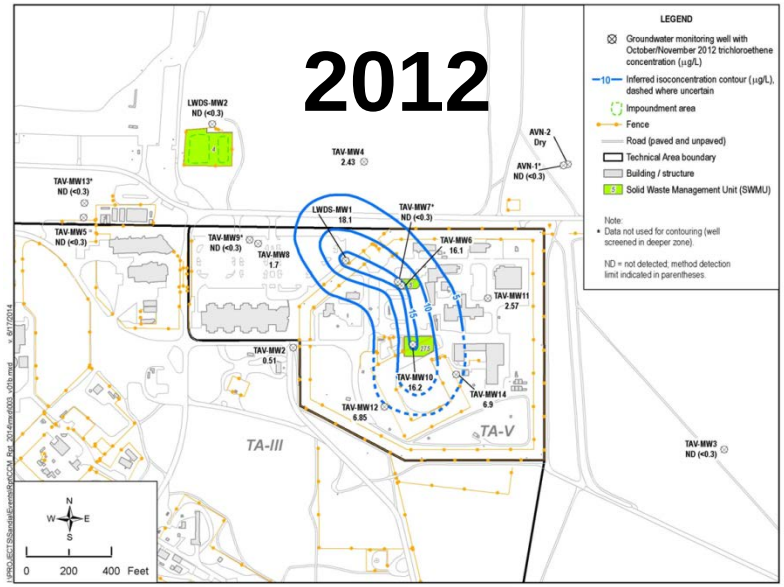
November/December 2015

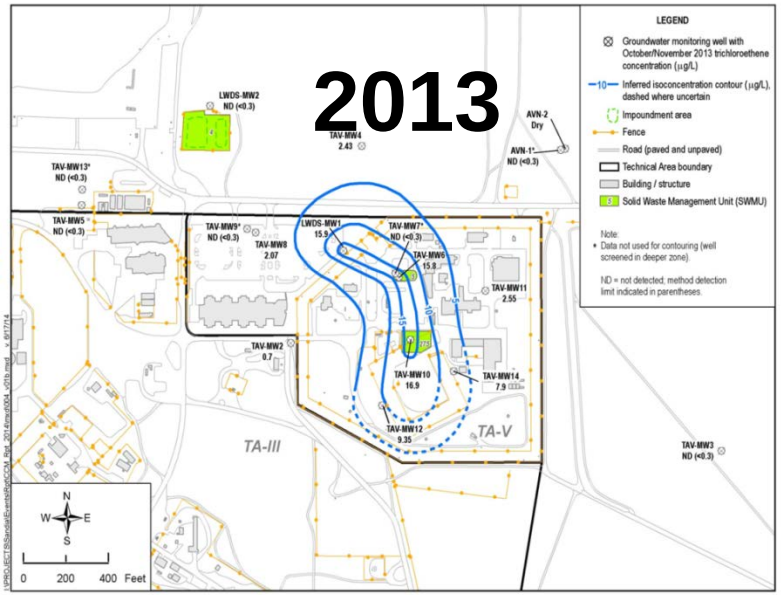


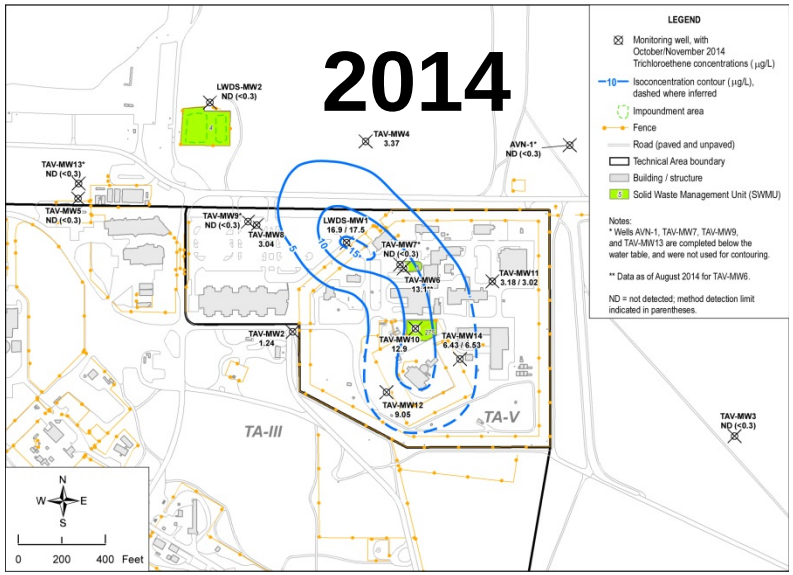
LWDS-MW2
9.41
4
TAV-MW4
5.33 / 5.60
AVN-1*
11.4
TAV-MW13*
5.87
TAV-MW5
7.03 / 7.08
LWDS-MW1
12.5
TAV-MW9*
3.77 / 3.79
TAV-MW8
6.64
TAV-MW7*
4.42
5
TAV-MW6
7.91
TAV-MW11
6.77
10
TAV-MW2
4.2
275
TAV-MW10
13.2
TAV-MW14
8.75
TAV-MW12
7.56
TA-V
TAV-MW3
5.8
TA-III
Legend
Monitoring well, with November/December 2015 Nitrate plus Nitrite concentrations (mg/L)
7.91
Isoconcentration contour (mg/L)
Road, paved and unpaved
Building / structure
Inactive impoundment boundary
Solid Waste Management Unit (SWMU)
Technical Area (TA) boundary
Note:
* Wells AVN-1, TAV-MW7, TAV-MW9, and TAV-MW13 are completed below the water table, and were not contoured.
0 300 600
Feet
0 100 200
Meters
N
EGIS
TA-V
Kirtland Air Force Base
SNL EGIS ORG.4142
New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum
SNL, EGIS Dept 4142 ce16516 3-16-16 / mb13135

TCE Distribution in Groundwater 2011 - 2014

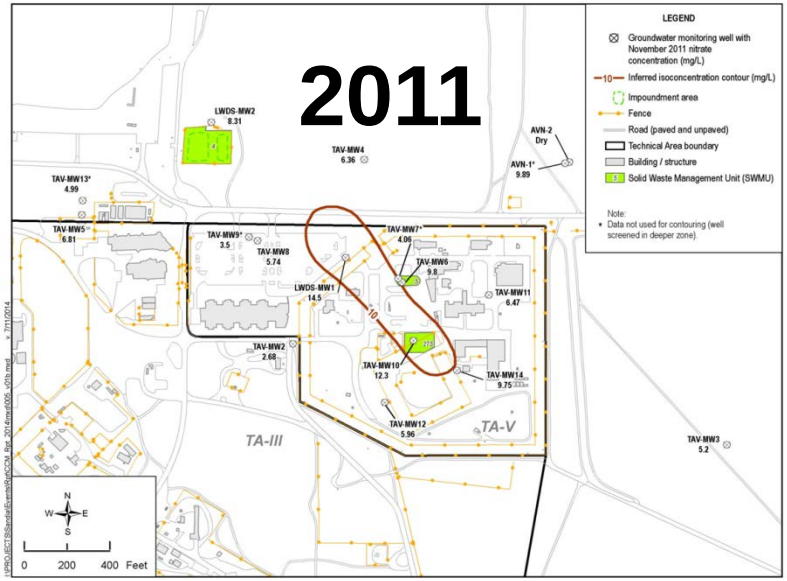


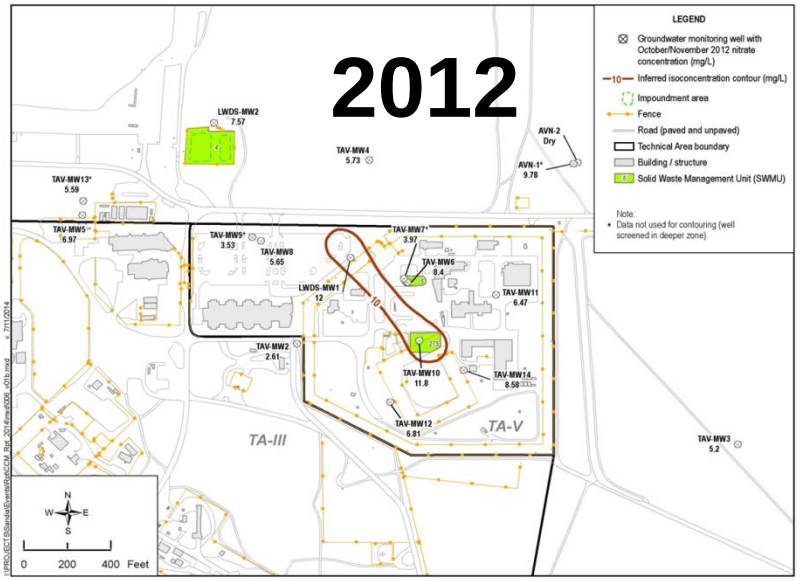


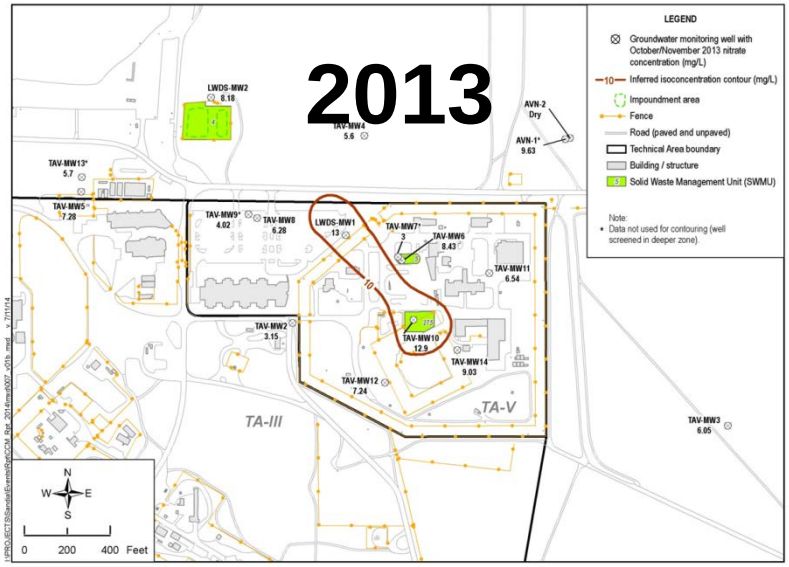


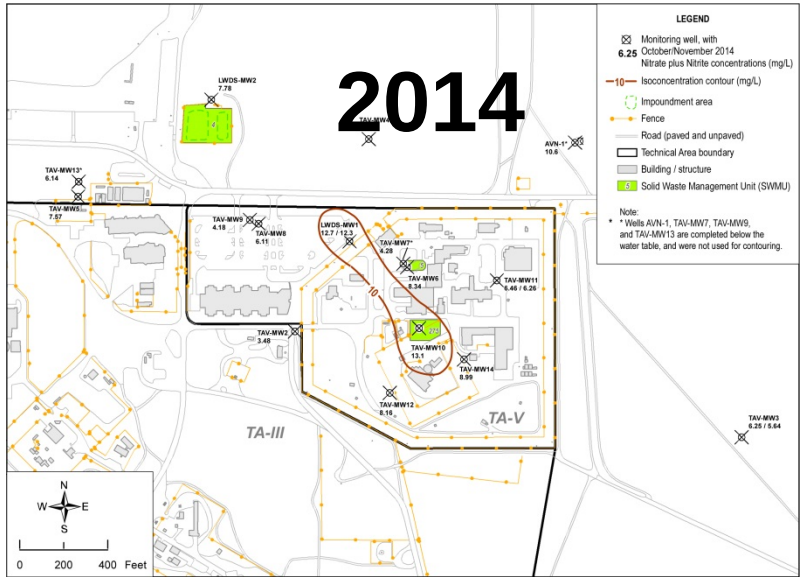


Nitrate Distribution in Groundwater 2011 - 2014



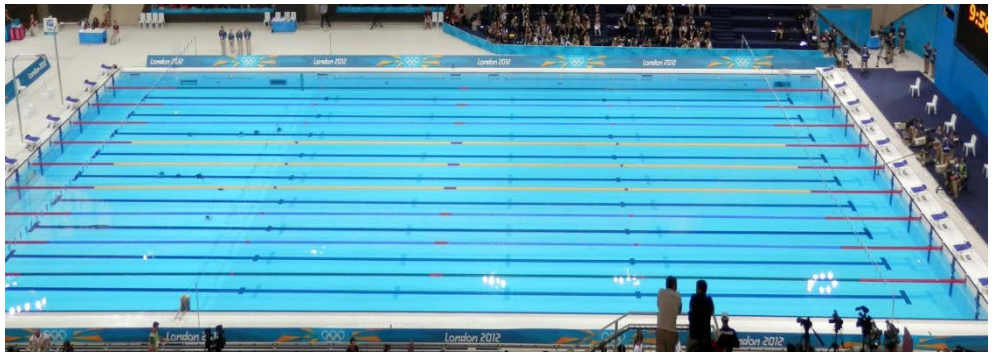






Characteristics of TCE and Nitrate Plumes at TA-V Groundwater AOC

- **Plumes are not moving.**
- **Plumes are approximately five miles south of City drinking water wells.**
- **Plumes are shallow and low concentrations.**
  - **No TCE detected in perimeter wells.**



45 Olympic-Size Swimming Pools

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Path forward: a Phased Treatability Study of In-Situ Bioremediation

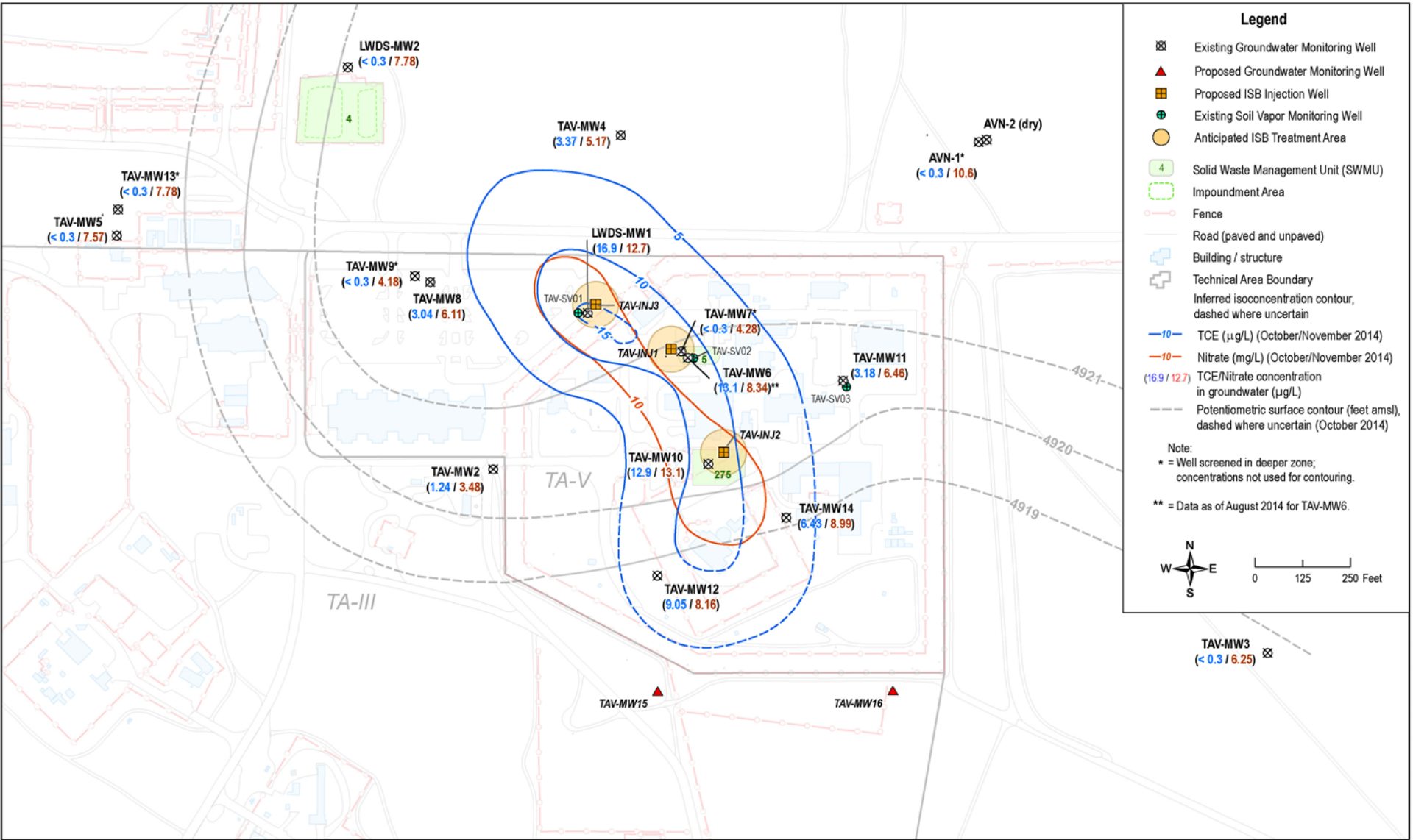
- **“In-Situ” means to treat the contamination in place.**
- **“Bioremediation” means we will make biodegradation happen by supplying the following:**
  - **Dechlorinating bacteria to break down TCE.**
  - **Food and nutrients (i.e., substrate solution) to stimulate the growth of natural bacteria and injected dechlorinators.**

★ Animation video if there is time.

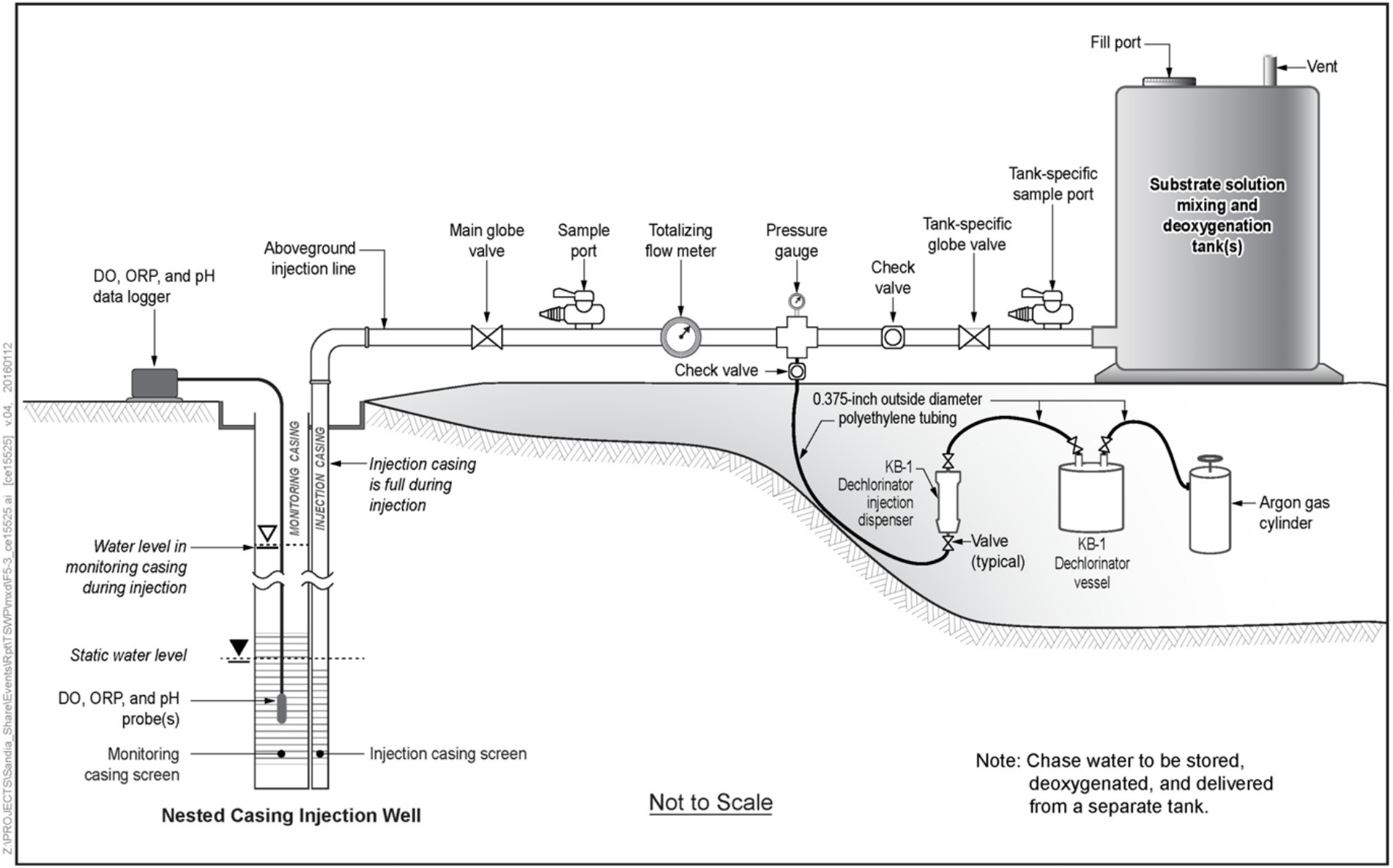
Treatability Study: Target the Heart of the Plume

- **Install up to three injection wells where the highest TCE and nitrate concentrations are detected.**
- **Assemble an aboveground injection system to deliver the dechlorinating bacteria and substrate solution.**
- **“Treatability Study” to test the effectiveness of in-situ bioremediation technology at TA-V.**

Treatability Study:
Install up to Three Injection Wells at Heart of the Plume



Treatability Study:
Assemble an Aboveground Injection System



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Implementation of Treatability Study

- **Phase I Pilot Test.**
  - **Injection volume is 3,700 gallons**
  - **Injection completes in one day**
  - **Performance monitoring for four months**
- **Phase I Full-Scale Injection at the first injection well.**
  - **Injection volume is 530,000 gallons**
  - **Injection occurs for six months**
  - **Performance monitoring for two years**
- **Phase II Full-Scale Injection at the second and third injection wells.**

Progress: Treatability Study Work Plan

- **Treatability Study Work Plan approved May 2016.**

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APPROVED

Sandia National Laboratories, New Mexico
Environmental Restoration Operations

Revised Treatability Study Work Plan for
In-Situ Bioremediation at the Technical Area-V
Groundwater Area of Concern

March 2016

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories

Progress: Discharge Permit Application

- **Discharge Permit Application submitted July 2016.**

Discharge Permit

DP-1845 for Sandia National Laboratories, NM
TA-V Treatability Study Injection Wells

- **NMED Ground Water Quality Bureau is the regulator for Discharge Permits.**

- **NMED and Sandia will put out public notice for 30 days for this DP application.**
- **NMED GWQB will prepare a Draft Permit.**
- **The Pubic and Sandia will have opportunities to comment on the Draft Permit during a 30-day public comment period.**

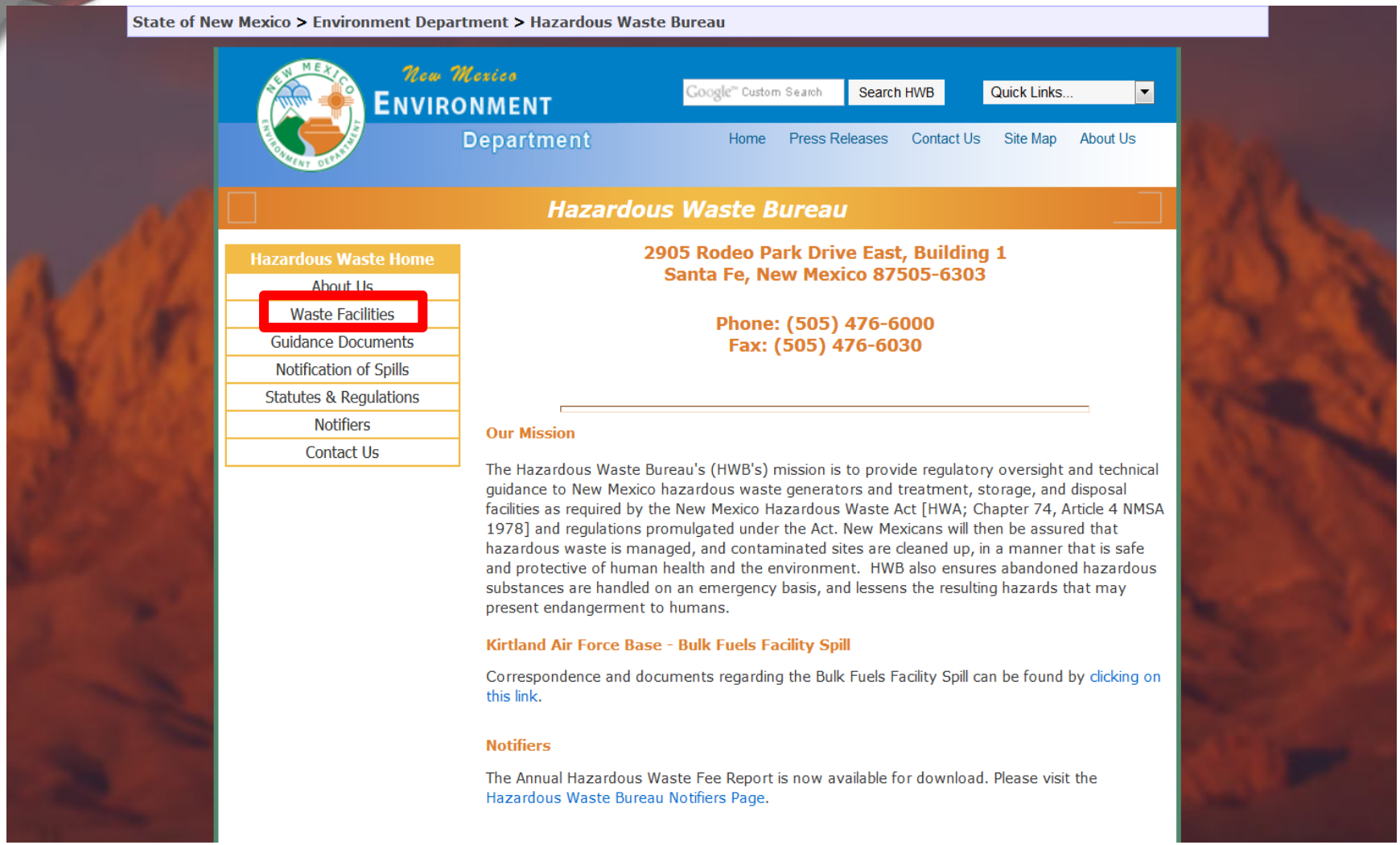
Summary

- **TA-V groundwater AOC is adequately characterized with TCE and nitrate contamination.**
  - **Plumes are stagnant and far from drinking water wells.**
  - **Plumes are of low concentrations.**
  - **No TCE detected in perimeter wells.**
- **NMED HWB regulates the site to drinking water standards.**
- **A Treatability Study of in-situ bioremediation will be implemented.**
- **NMED GWQB regulates the Discharge Permit for injection wells used for Treatability Study.**

Information Available to Public

- **NMED HWB Website, https://www.env.nm.gov/HWB/ ⇗ "Waste Facilities", then ⇗ "Sandia National Laboratories (SNL)":**
  - **Consolidated Quarterly Report (most recent is April 2016)**
  - **CY 2015 Annual Groundwater Monitoring Report**
  - **NMED DOE Oversight Bureau data on groundwater sites at SNL**

- **Physical copies of the Quarterly Reports and the Treatability Study Work Plan are available at UNM Zimmerman library.**



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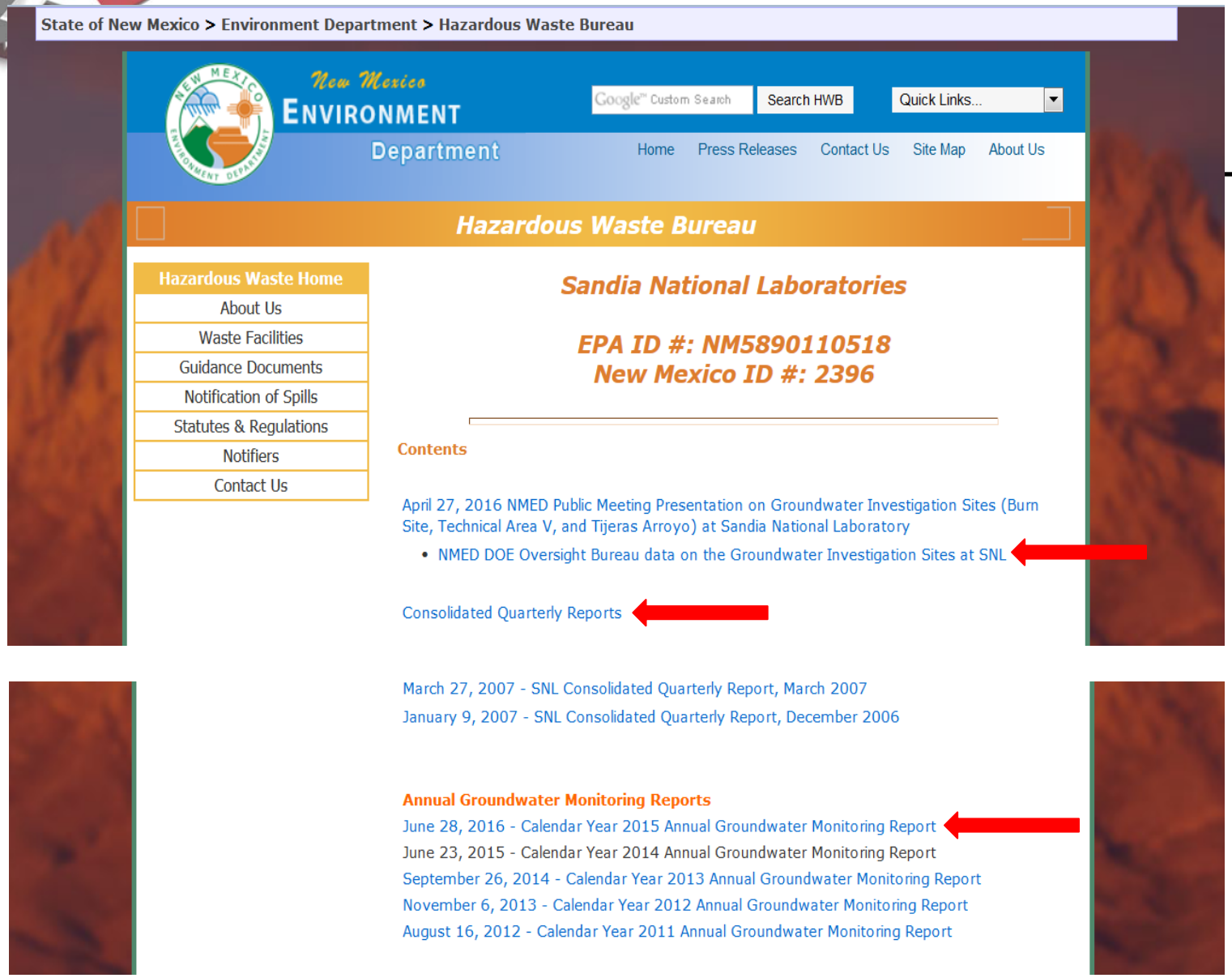
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Press Releases
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Site Map
About Us
Hazardous Waste Bureau
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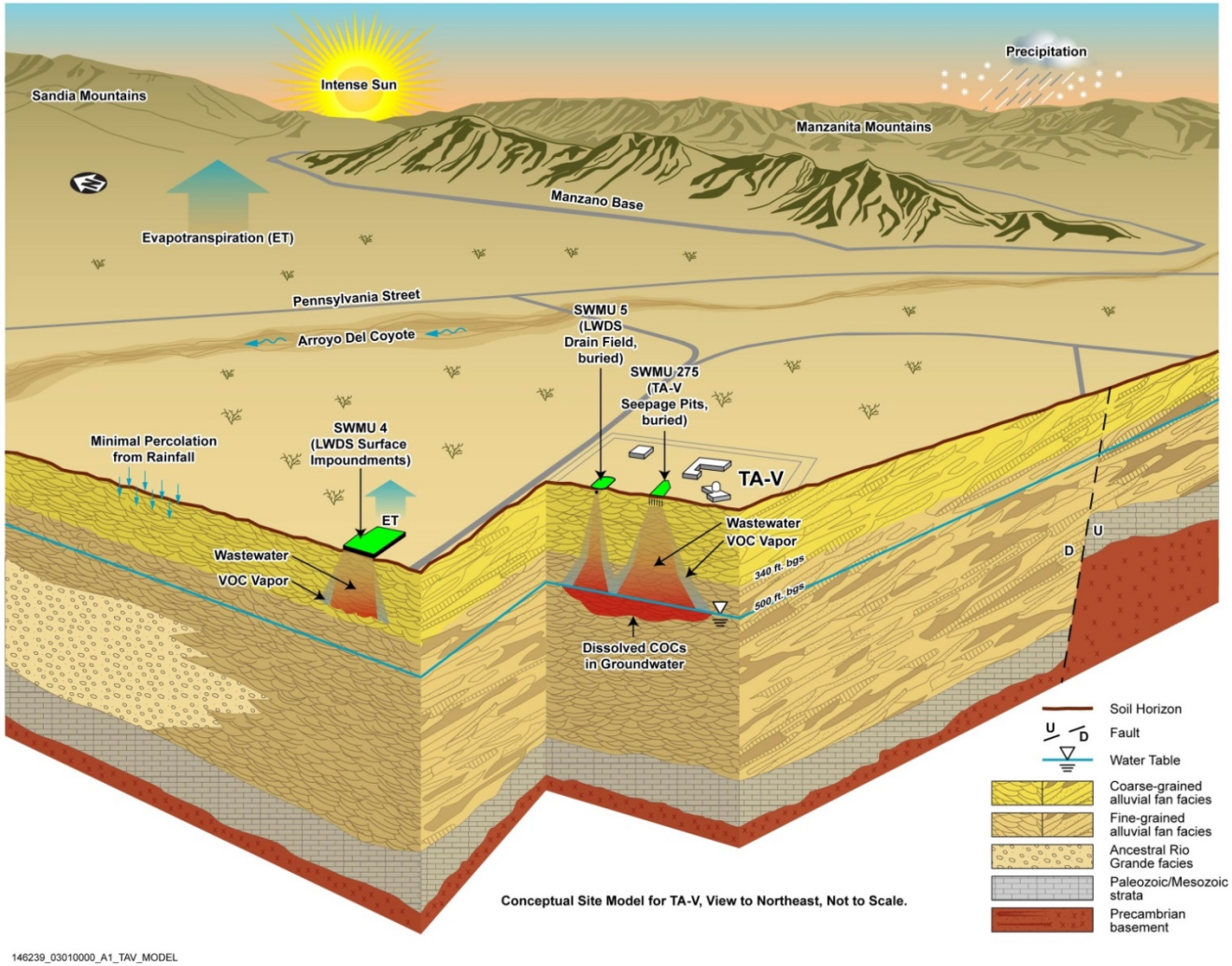
About Us
Waste Facilities
Guidance Documents
Notification of Spills
Statutes & Regulations
Notifiers
Contact Us
Sandia National Laboratories
EPA ID #: NM5890110518
New Mexico ID #: 2396
Contents
April 27, 2016 NMED Public Meeting Presentation on Groundwater Investigation Sites (Burn Site, Technical Area V, and Tijeras Arroyo) at Sandia National Laboratory
NMED DOE Oversight Bureau data on the Groundwater Investigation Sites at SNL
Consolidated Quarterly Reports
March 27, 2007 - SNL Consolidated Quarterly Report, March 2007
January 9, 2007 - SNL Consolidated Quarterly Report, December 2006
Annual Groundwater Monitoring Reports
June 28, 2016 - Calendar Year 2015 Annual Groundwater Monitoring Report
June 23, 2015 - Calendar Year 2014 Annual Groundwater Monitoring Report
September 26, 2014 - Calendar Year 2013 Annual Groundwater Monitoring Report
November 6, 2013 - Calendar Year 2012 Annual Groundwater Monitoring Report
August 16, 2012 - Calendar Year 2011 Annual Groundwater Monitoring Report

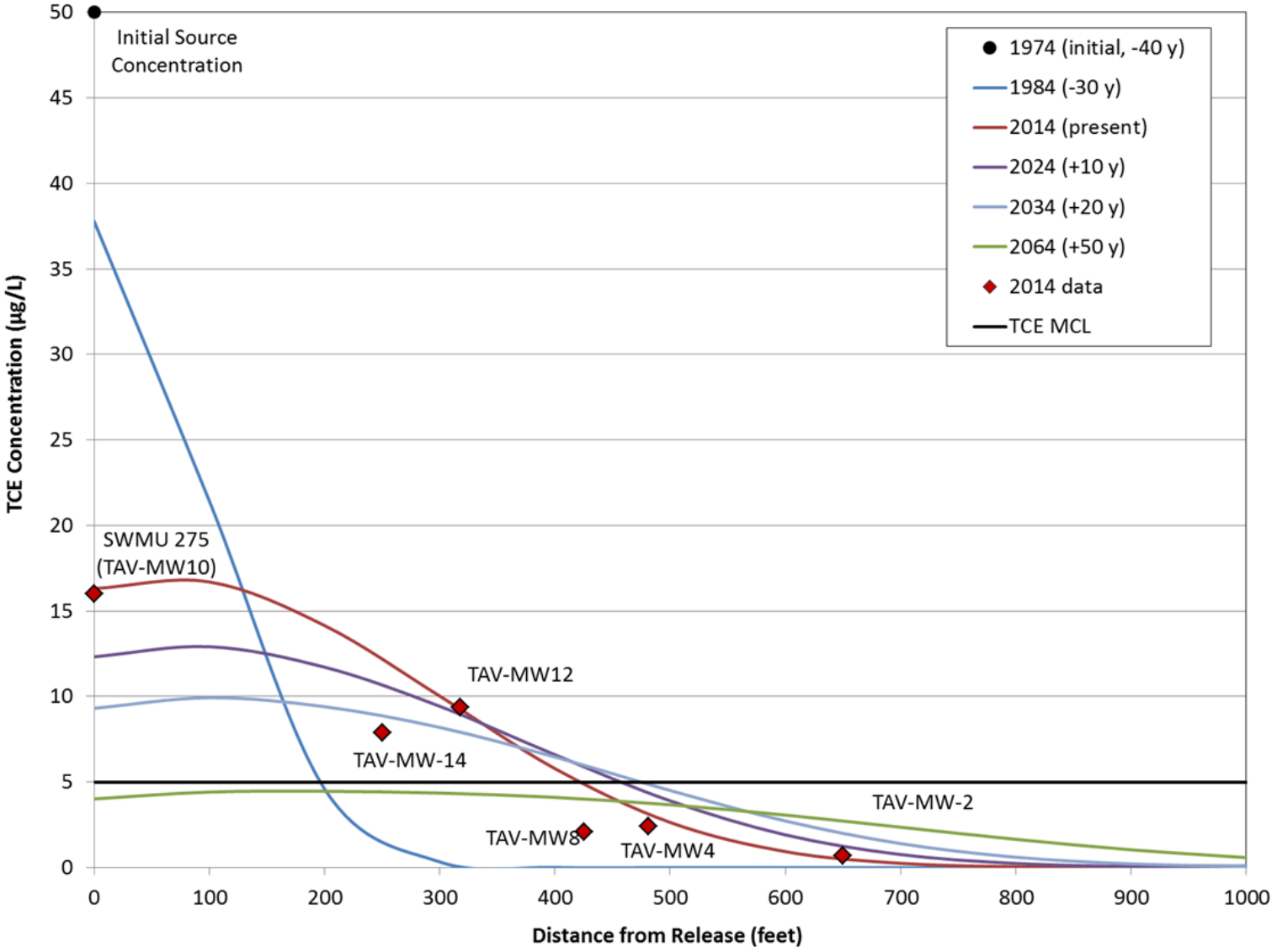
Back Up Slides

Conceptual Site Model for TAVG AOC

- Surface Impoundments, Drain Field, and Seepage Pits
- Regional aquifer is ~500 ft below ground surface

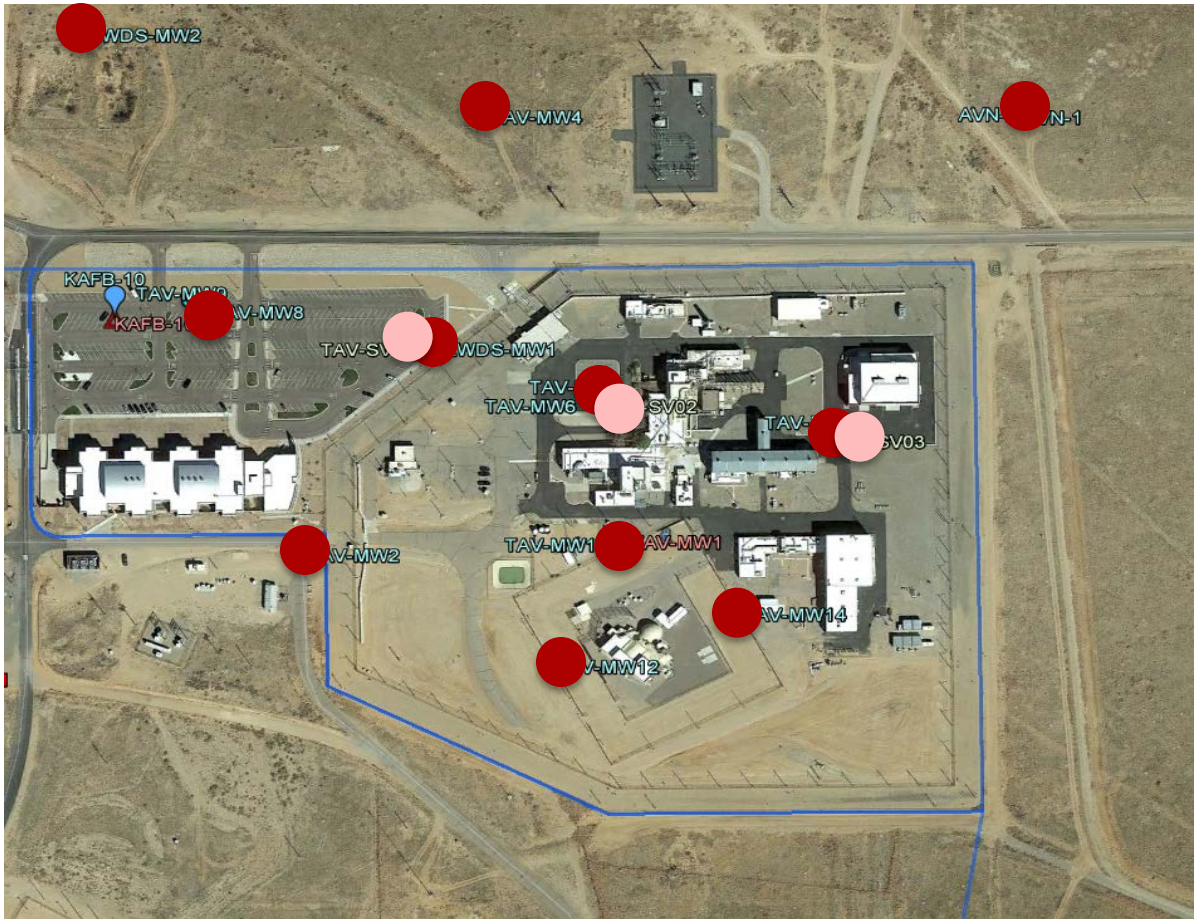


BIOCHLOR Modeling of TCE Concentration Profile



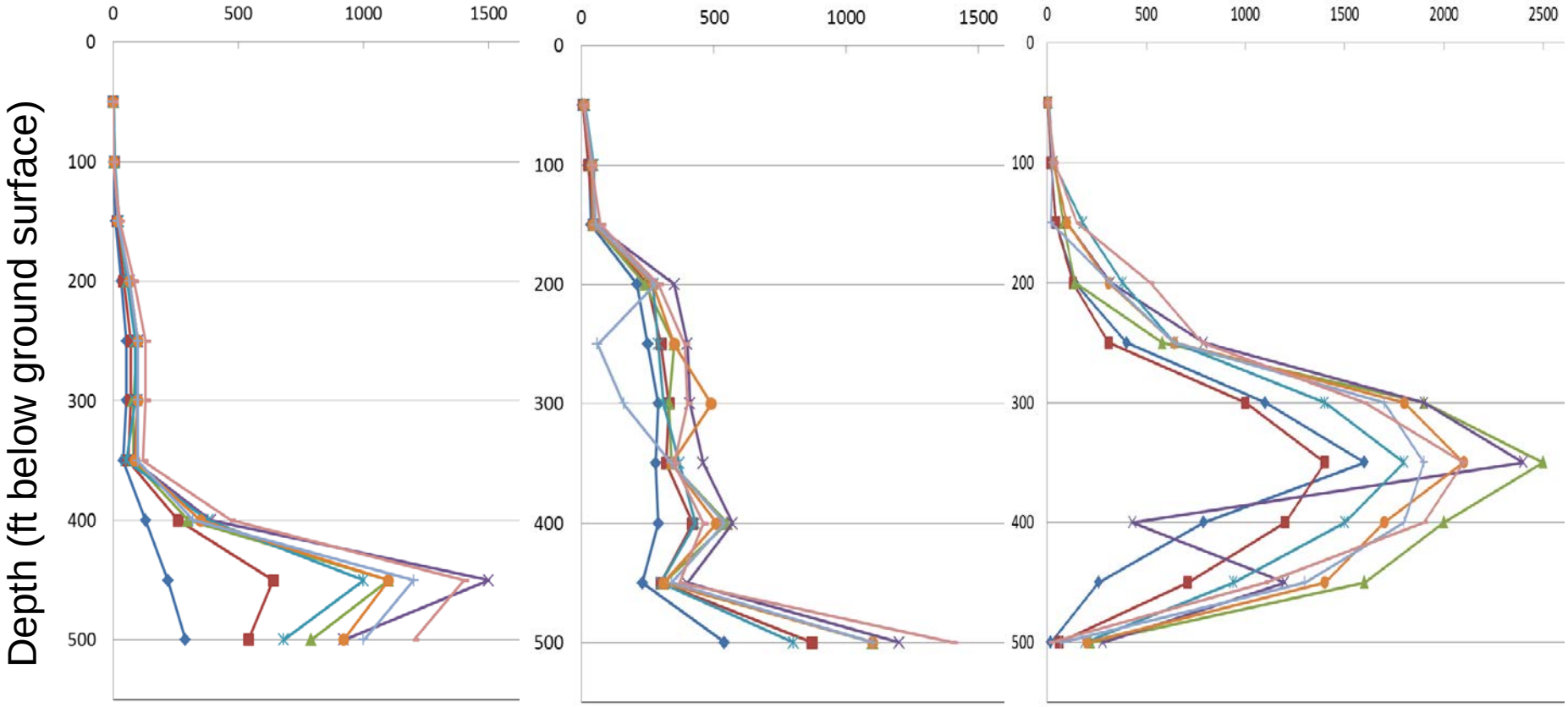
Technical Area V

- 18 Groundwater monitoring well installed from 1992 – 2010 (**currently 16-well network**)
- 3 Soil Vapor monitoring wells installed in 2011



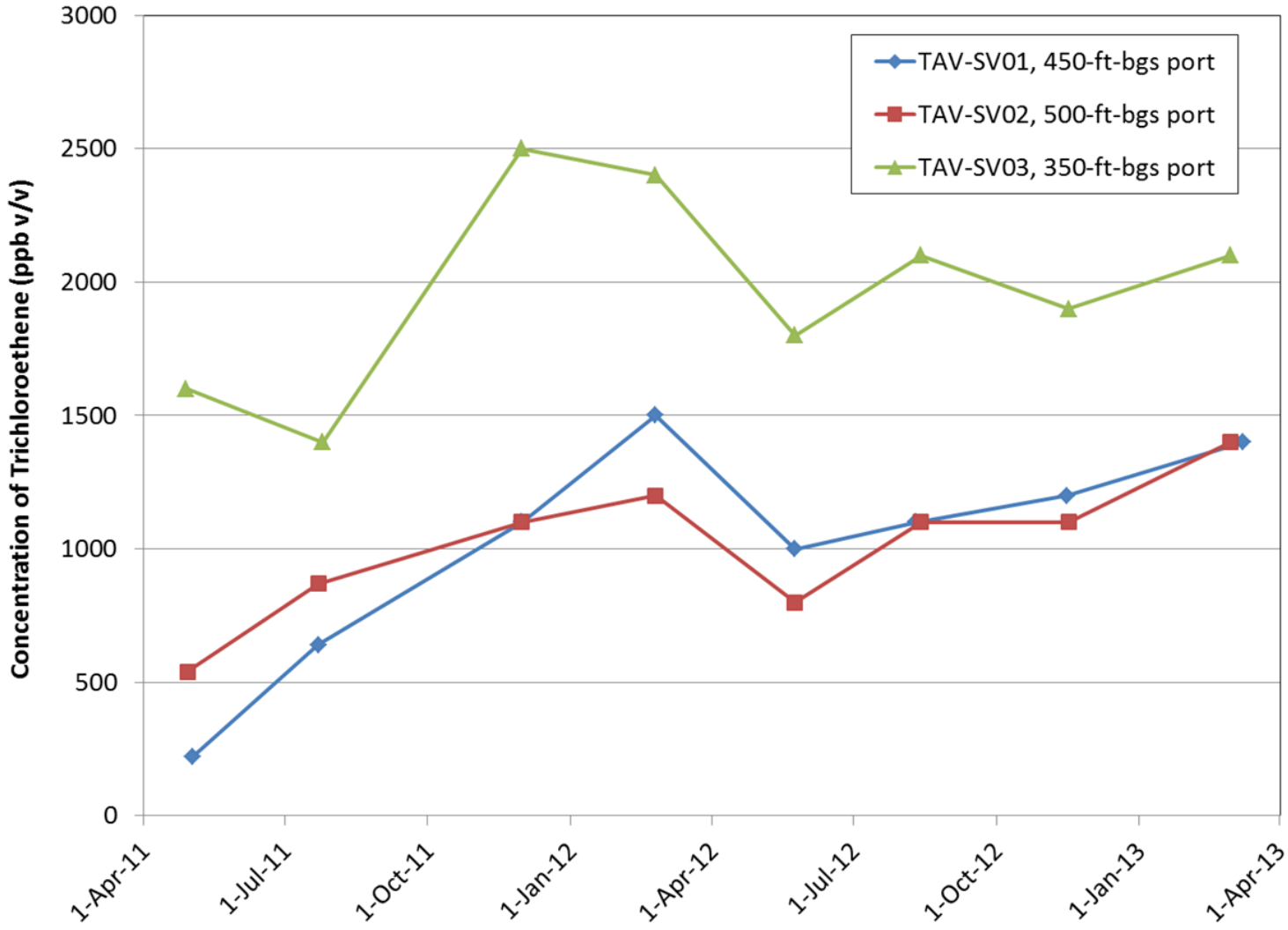
Vadose Zone Monitoring April 2011 to March 2013

Concentrations of TCE in soil vapor (ppb v/v)



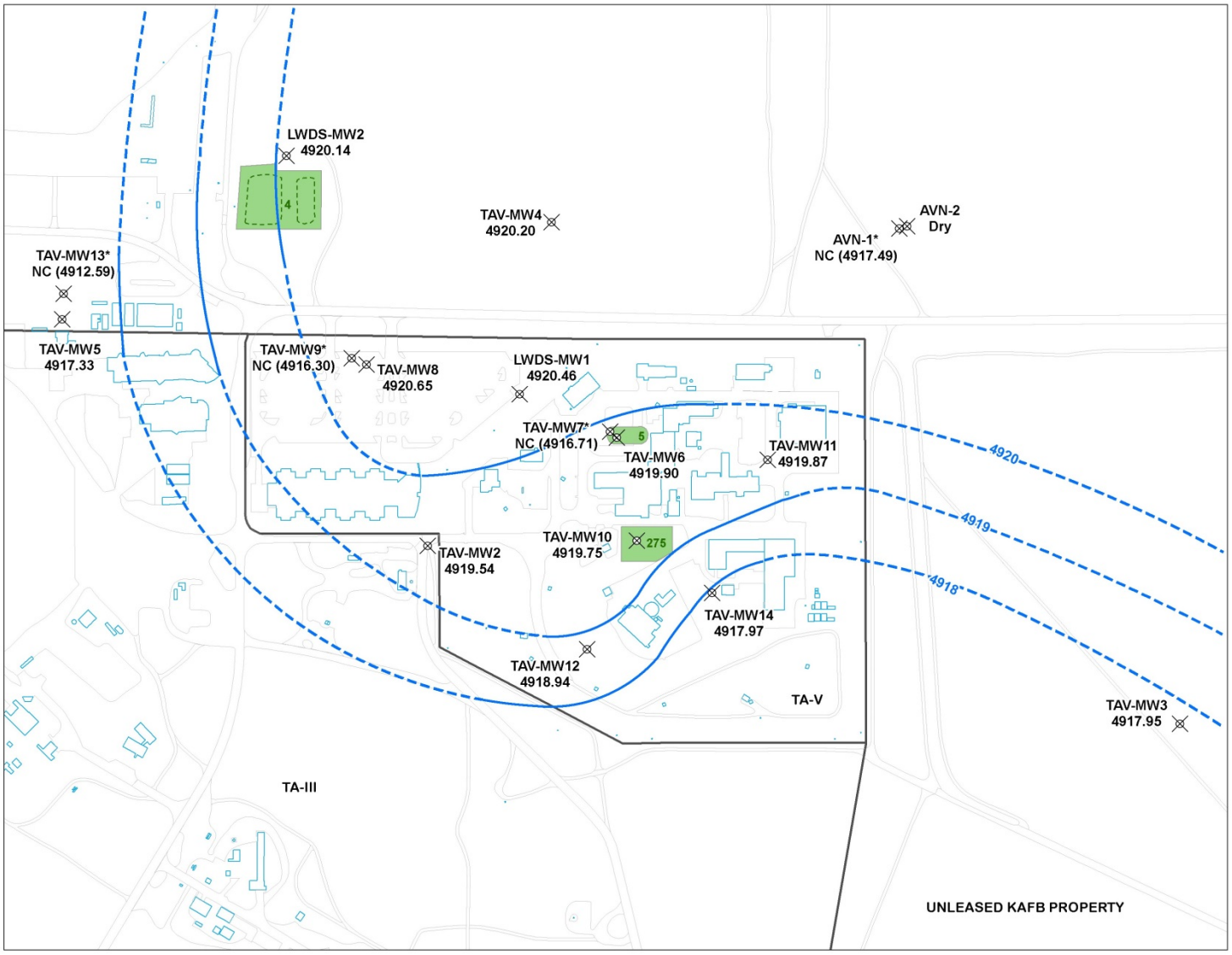
TAV-SV01 TAV-SV02 TAV-SV03

Vapor-Phase TCE Concentrations over Time at Maximum Concentration Ports of the Three Soil-Vapor Monitoring Wells



Potentiometric Surface at TA-V

October 2015



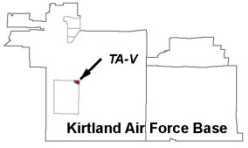
Legend

- Monitoring well, groundwater
- 4920.46 Groundwater elevation (ft amsl) October 2015
- Potentiometric surface contour (ft amsl), dashed where inferred
- Road, paved and unpaved
- Building / structure
- Inactive impoundment
- Solid Waste Management Unit (SWMU)
- Technical Area (TA) boundary

Note:
* Wells AVN-1, TAV-MW7, TAV-MW9, and TAV-MW13 are completed below the water table, and were not contoured (NC).

0 300 600
Feet

0 100 200
Meters



SNL EGIS ORG.4142

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

SNL, EGIS Dept 4142 ce16500 3-16-16 / mb13135

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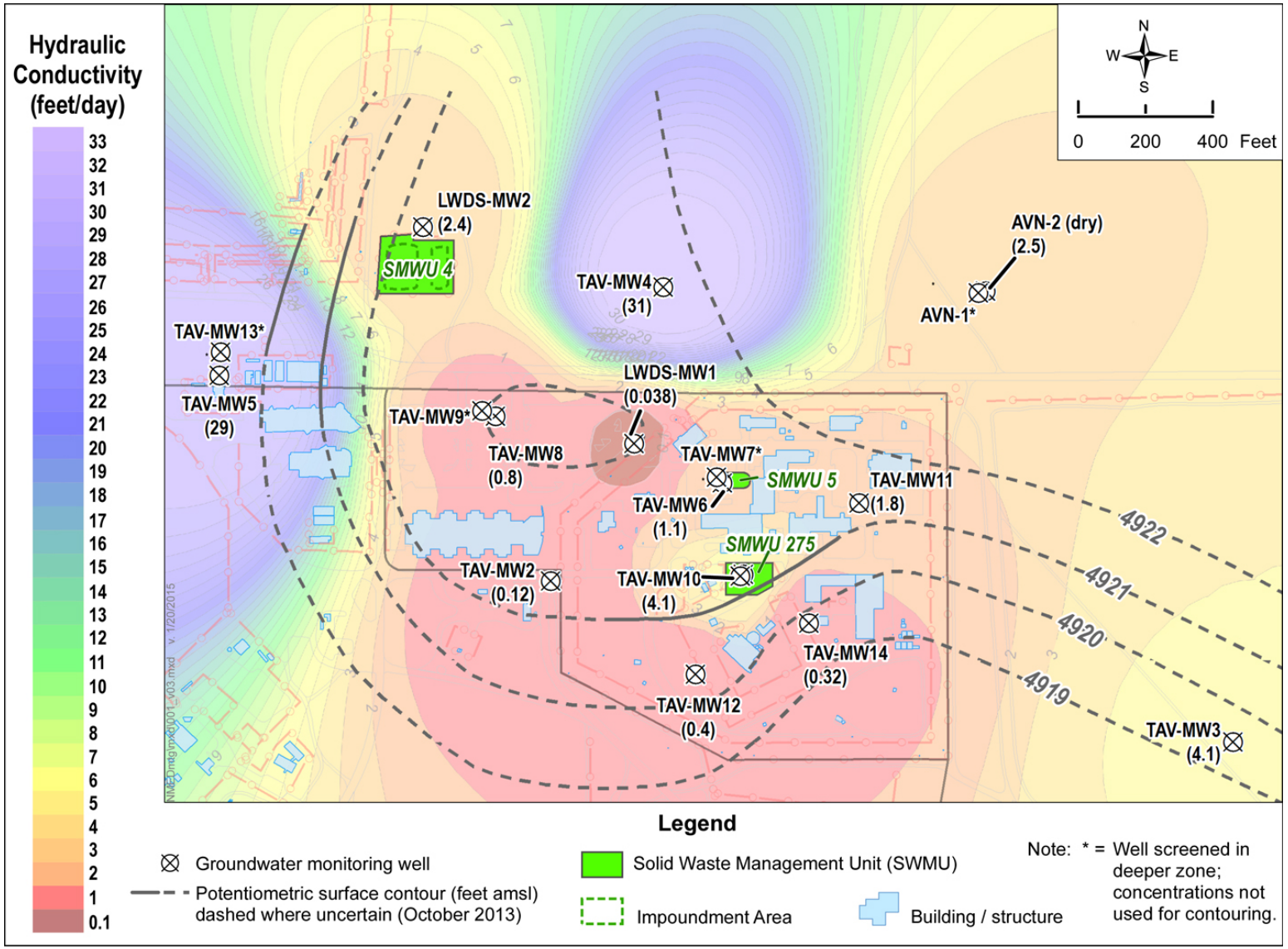
Hydraulic Conductivity (ft/day) at TA-V



TCE and Nitrate in Groundwater

- Five wells with TCE above the MCL of 5 µg/L.
  - LWDS-MW1, TAV-MW6, and TAV-MW10 have been within the 15 µg/L isoconcentration contour.
  - TAV-MW12 and MW14 have TCE below 10 µg/L.
- Stable TCE isoconcentration contours for the last 4 years.
  - The maximum TCE concentration in groundwater at TA-V is considerably dilute at more than four orders of magnitude less than the water solubility of TCE (1,100 mg/L at 25ºC), indicating no NAPL TCE could be present.
- 10 mg/L Nitrate contour co-located with highest TCE concentrations.
- Nitrate detected in deeper upgradient well (AVN-1) at similar concentrations as the shallower upgradient well (AVN-2).
- Besides sanitary wastewater, sources of nitrate could also include contributions from upgradient sites and natural conditions.

Mechanisms for Contaminant Transport & Natural Attenuation

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- Contaminant fate & transport mechanisms in groundwater include advection, dispersion, diffusion, sorption, and biodegradation.
  - Insignificant advection.
  - Limited anaerobic reductive dechlorination.
  - Potential aerobic cometabolism, but insignificant to reduce mass.
  - The stable concentration contours can be attributed to the relatively slow processes of dispersion and diffusion, and the reversible sorption process.
- Dominant natural attenuation mechanisms for TCE at TAVG AOC include dispersion, diffusion, and sorption.

In-Situ Bioremediation: Biostimulation

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Substrate Solution Components	Function	Per 1,000 Gal. of Water
Ethyl lactate	Electron donor	~9 lbs
Diammonium phosphate	Nutrient and pH buffer	~2 lbs
Yeast extract	Nutrient	~0.3 lb
Sodium bromide	Inert tracer	~0.2 lb

Project Total:
~ 530,000 gallons of potable water mixed with ~ 4,700 pounds of ethyl lactate, *per* injection well

In-Situ Bioremediation: Bioaugmentation

Bioaugmentation Culture
KB-1® Dechlorinator (*Dehalococcoides*)
~ 0.5 lb per 1,000 Gal. of Water

Naturally occurring, non-pathogenic microbial culture

Project Total:
> 200 lbs of KB-1® Dechlorinator, *per* injection well

Substrate Solution and Bioaugmentation Bacteria to be Injected

Components	Function	lbs per 1,000 Gal. of Water
Ethyl lactate	Electron donor	~9
Diammonium phosphate	Nutrient and pH buffer	~2
Yeast extract	Nutrient	~0.3
KB-1 Primer • Amino acid • Potassium bicarbonate • Sodium sulfite	Substitute for above three components to accelerate initial batch deoxygenation	~5
Sodium bromide	Inert tracer	~0.2
KB-1 Dechlorinator (*Dehalococcoides*)	Bioaugmentation culture	~0.5

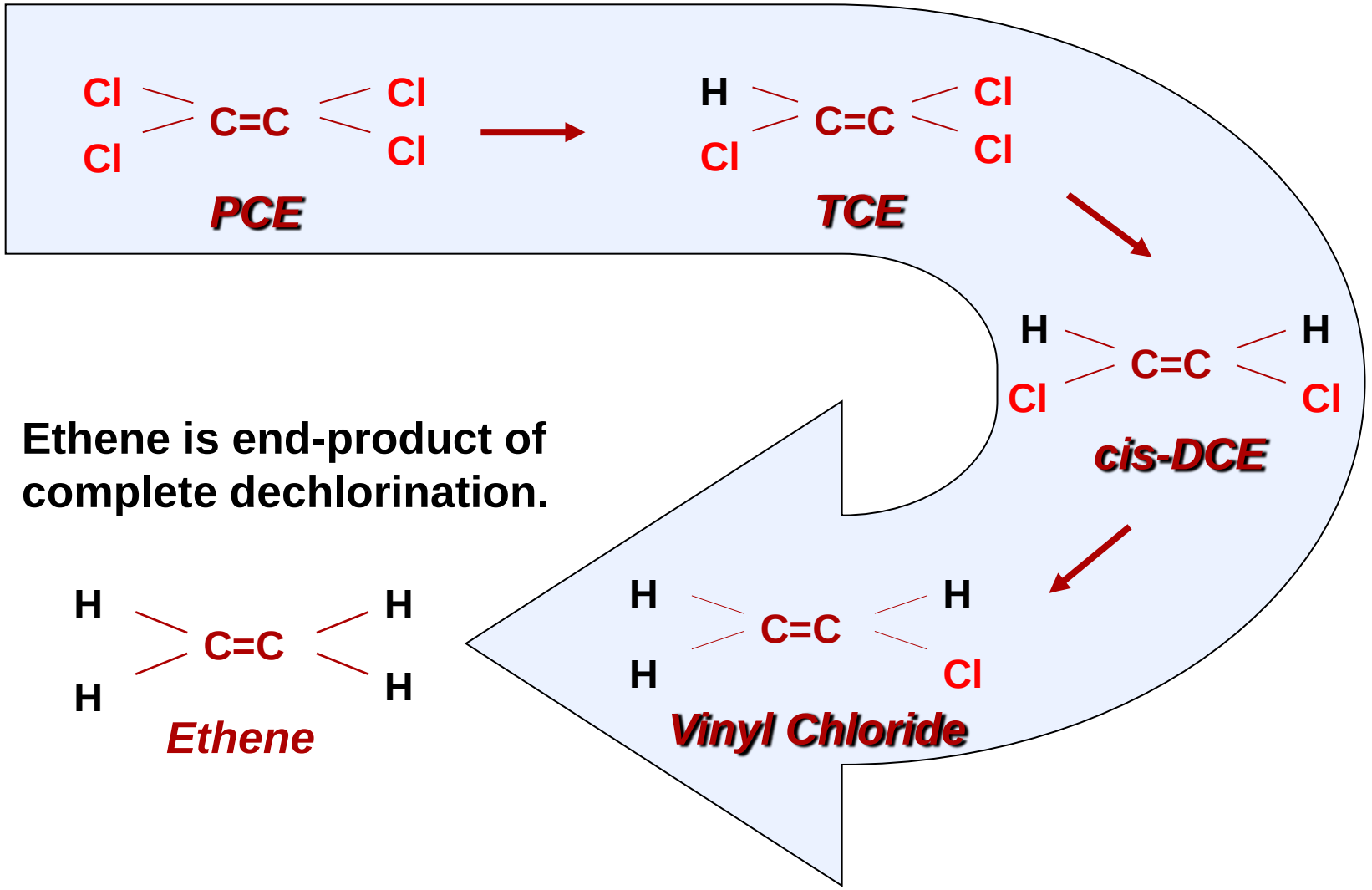
Biodegradation of Nitrate

Denitrification ultimately generates innocuous nitrogen gas:

$$NO_3^- \rightarrow NO_2^- \rightarrow NO + N_2O \rightarrow N_2(g)$$

Denitrification occurs first, followed by anaerobic reductive dechlorination of TCE

Biodegradation of TCE



Ethene is end-product of complete dechlorination.

Ethyl Lactate

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High transportability which is essential at TA-V.

- High water solubility
- Low viscosity
- Low retardation factor
- Lacks particulates
- Fully utilized by microbes
- Demonstrated success for VOCs and nitrate

Note:

- Partially-used containers must be stored under inert conditions to prevent oxidation.
- Combustible (but this characteristic is eliminated upon dissolution in water).

Decision Points Criteria

1. Injection rate, volume, and timeframe.
2. Conditions established and maintained in groundwater to degrade COCs.
3. Establishment of sufficient *Dehalococcoides* population.
4. COC concentration reduction, daughter product generation, and possible COC concentration rebound.
5. Tracer concentration trends.
6. Metals/metalloid concentrations (Fe, Mn, As).
7. Influence on deep monitoring well (TAV-MW7).