

DARTMOUTH

Locus/Site Vicinity Plan



Proactive By Design. Our Company Commitment

Background—Rennie Farm Site

<u>Setting</u>

224-acre undeveloped rural property (Rennie Farm) Acquired by Dartmouth College during 1960s Local topographic relief 130 – 150 feet Depth to bedrock <10 – >100 feet Overburden – glacial till Bedrock – fractured metamorphic <u>Site Use</u>

Agricultural use prior to 1960s <0.5 acres used as medical school waste disposal area 1966 – 1978 Medical school disposed of animal carcasses – radioisotopes Approved disposal method – permitted through NHBRH

Site COC 1,4-Dioxane

Only contaminant of concern at site; VOC; emerging contaminant <u>Properties</u>

Miscible

Limited tendency to attach to soil (organic C partition coefficient 1.23 log Koc)

Limited tendency to biodegrade

Low volatility (Henry's Law Constant 4.80 X 10⁻⁶ atm-m³/mol) Properties allow rapid transport with little retardation or transformation Subsurface attenuation principally due to hydrodynamic dispersion <u>Healt</u>

Reasonably anticipated to be a human carcinogen; EPA cancer risk estimates, based on studies of liver cancer in mice

0.35 µg/L results in 1 excess cancer death in 1,000,000

Assumes a 154-pound man drinking 2 liters of water per day for 70 years No MCL (EPA health based guidance level 0.35 µg/L [ingestion]) NH AGQS = 3 μg/L (ingestion) (0.3 μg/L [MA]; 3 μg/L[CT]; 20 μg/L [VT]) Future NH AGQS 0.32 µg/L

<u>Sources</u>

Solvents (used as a stabilizer; 1,1,1-TCA)

Radiological laboratory use (scintillation fluid) Site (Rennie Farm)

Personal care products, paints, and many more...



Investigation and Remediation of Groundwater Contaminated with 1,4-Dioxane Former Medical Waste Disposal Area, Hanover, New Hampshire



Water Supply Sampling

<u>Sampled</u>

- >140 individual wells
- >400 samples
- 1 municipal reservoir
- 7 surface water locations
- 1 swimming pool

- 1 well with1,4-dioxane detected related to site (3 10 μ g/L)
- 1 well with1,4-dioxane detected not related to site (up to 0.48 µg/L)
- 2 homes supplied with POEs (1 determined to not be site related)

Investigation and Remediation Timeline

2003 - 2011 - Research and investigation

- **2009** Monitoring wells GZ-1 GZ-4 installed, groundwater monitoring begins
- **2011** Excavation of animal carcasses (chemical waste encountered)
- **2012 (April)** 1,4-dioxane detected in well GZ-2
- **2012 2013** Monitoring of wells continues (1,4-dioxane at low concentrations attenuating)
- **2013** Radiological Site Closure
- **2014** Phased site investigation to confirm limits of transport above $3 \mu g/L$
- **2015 (August)** 1,4-dioxane detected (520 µg/L) in sample from well 300 feet from site boundary
- **2015 (August–September)** off-site water supply wells sampled
- **2015 (September)** 1,4-dioxane detected in private water supply well (9 Rennie Road), POE and bottled water provided
- **2015 2016** Source area and off-site investigation and remedial planning
- **2016 (June)** Limited residual animal carcasses identified
- **2016 (August)** Residual animal carcasses removed
- 2016 2017 Remedial system construction
- 2017 (February/May) Remedial system startup
- **2017** Present remedial system operation and water quality monitoring

Site Investigation

<u>Methods</u>

- Geologic mapping
- Surficial and borehole geophysics (ERI, VLF, GPR, OTV, ATV, HPFM, caliper, temperature, and conductivity)
- Soil sampling (borings and excavations)
- Bedrock and overburden monitoring well installation
- Groundwater and surface water sampling
- Hydraulic testing
- **Quantities/Conditions**
- 91 monitoring wells
- 49 soil borings and excavations
- 12 surface water sampling stations
- 12 Groundwater extraction wells
- >4,430 feet of borings (2,027 feet of rock boring)
- Up to 42 feet (18.5 psi) of head above ground surface



Bedrock Geology







of Bedrock Fractures

Number of Bedrock Fractures Plotted = 142 Contour Interval = 2

2011 Animal Carcass Removal

<u>Removed</u>

- 10 tons of animal carcasses and soil
- 26 tons of radiological soils 4 tons of laboratory waste
- 100 tons of chemically contaminated soil (not anticipated



Remedial System Design/Construction/Results

<u>Constraints</u>

- Dissolved source Glacial till/fractured bedrock
- **Remote location**
- Single-phase electrical service
- Accelerated schedule to limit liability (winter construction) Public trust
- Remedial Alternatives Considered
- In-situ AOP
- Ex-situ
- GAC
- AOF

DATE(S) SURVEYED: November 23 & 24, 2015

of Bedrock Fractur

Dip Histogram (Count)

Counts: 142.00

HAGER-RICHTER FILE: 15J101

ORIENTATION REFERENCE: True North

MAGNETIC DECLINATION: 15° West

Stereogram - Lower Hemisphere Dip Azimuth Rose Diagram Dip Angle Histogram

of Bedrock Fractures

Azimuth - Absolute (Count)

5.00 355.00

- Resin
- **Remedial Alternative Selected**

Resin/GAC

- Capture of source area and on-site plume
- Average 40 % reduction in 1,4-dioxane concentration after 8 months of full operation Treatment system meeting 0.25 μg/L effluent limit under EPA Region One RGP

Investigation Summary



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Groundwater Extraction and Treatment Process Diagram





Remedial System Layout



ENVIRONMENTAL HEALTH & SAFETY

safety | Laboratory Safety | Radiation Safety | Laser Safety | Occupational Safety | Waste Management | Emergency Planning | Environm

Office From the mid 1980s-1978, Dartmouth used less than a ½ acre portion on the 223-acre Rennie Farm, to dispose of animal remains used in medical research, under State and Federal licenses. In addition, the remains of donated human cadavers were buried in a 10-foot by 10-foot site adjacent to the animal burial area, after the bodies had been used in medical school classes.

Dartmouth is committed to complete the cleanup of a scientific waste burial site on our Rennie Farm property a expeditiously and effectively as possible.

ndwater and other conditions on the property have been monitored for years. In 2011, the state approved viation and remodiation of the animal burial site. While working there in November 2011, we found hazardou mical waste at the animal burial site. We notified the state, and the waste was removed.

continued to monitor the site, and in April 2012 we found that for the first time a chemical compound called 1,4-ane was detected in groundwater samples near the site of the 2011 excervation. 1,4-Dioxane is a synthetic jstance used primarily as an additive in solvents and is "reasonably articipated to be a human carcinogen" by 5 U.S. Department of Health and Human Services, according to the federal Centers for Disease Control.

now have an understanding of the complex site geology and the contaminant's path of travel. Based on the that we have collected—and with the state's approval of our work plans—we plan to focus our remedial work introlling the further movement of groundwater contamination from the site, while monitoring the water quality Dartim.

About Rennie Farm:



Challenges/Lessons Learned/Solutions

<u>Challenges</u>

- **Technical** 1,4-dioxane properties limits remedial alternatives
- **Unrelated Sources** Prevalence of 1,4-dioxane in consumer products and manufacturing create low level sources that must be evaluated and communicated
- Schedule Rapid response required due to neighbor concerns
- Location Limited site access in rural location; topography; limited infrastructure
- Weather Winter construction necessary due to aggressive schedule **Communication** - Limited public knowledge = fear/anger
- Lessons Learned/Solutions
- Rapid response is best Concurrent investigation and remediation Frequent communication is essential
- Formal public meetings
- Informal drop-in meetings
- System tours
- Dartmouth Rennie Farm website
- Summaries
- Periodic updates
- Document access
- Email updates
- Individual communication
- Low concentration (unrelated) sources must be identified Swimming pool liner
- Subsurface disposal system
- **Neighbor Concerns Addressed (Good Neighbor Policy)** Water supply well sampling
- Bottled water supplied Property value concerns addressed through value assurance plan including purchase of properties Technical
- Resin combined with GAC can be an effective combination

GAC can be effective for a residential POE when 1,4-dioxane is primary contaminant