1,4 Dioxane Groundwater Contamination Remediation Design for Rennie Farm in Hanover New Hampshire

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Abstract

This project was made possible by GZA Geoenvironmental in conjunction with the Civil and Environmental Senior Capstone Design. Throughout the project the design team was tasked with the design of a groundwater remediation program to clean up a 1,4 dioxane contamination. 1,4 dioxane is laboratory chemical that was disposed of improperly near Rennie Road in Hanover, New Hampshire. There have been two projects to clean-up this chemical. The first focused on removing the source of contamination at the main site. The second involved prevention and mitigation of spreading from the site. When beginning this part of the project, the previous one had already been completed and the main site had wells and a treatment system running. Our design team was then tasked with designing a remediation system for the offsite location. This remedial design will focus on containment and treatment of 1,4 dioxane without impacting the existing wetlands. The remediation design consists of a pump and treat system; one pump will be placed in the area with the highest concentrations and two others will be implemented at the southern edge to make sure that the chemical doesn't continue to move north (down gradient). After removing the contaminated water it will be pumped to a small treatment facility where the ambersorb 560 resin will treat the water. Once treated, the groundwater will be reinjected back into the ground.

Scope of Work

Conceptual Design
- Request for Information
- Kickoff Meeting
- Rough Estimate of Calculations for Design
- Conceptual Design Development
- Presentation of Figures of the Conceptual Design

90% Design
- Refine Calculations
- Design of Groundwater Extraction System Components
- Preliminary Cost/Fuel Consumption estimates
- Permitting Approaches
- Pilot Testing Design

100% Design
- Final Design Specs
- Wetland Construction Permit and Groundwater Pumping Permit
- Work plan for Construction
- Final Cost Estimates

Site

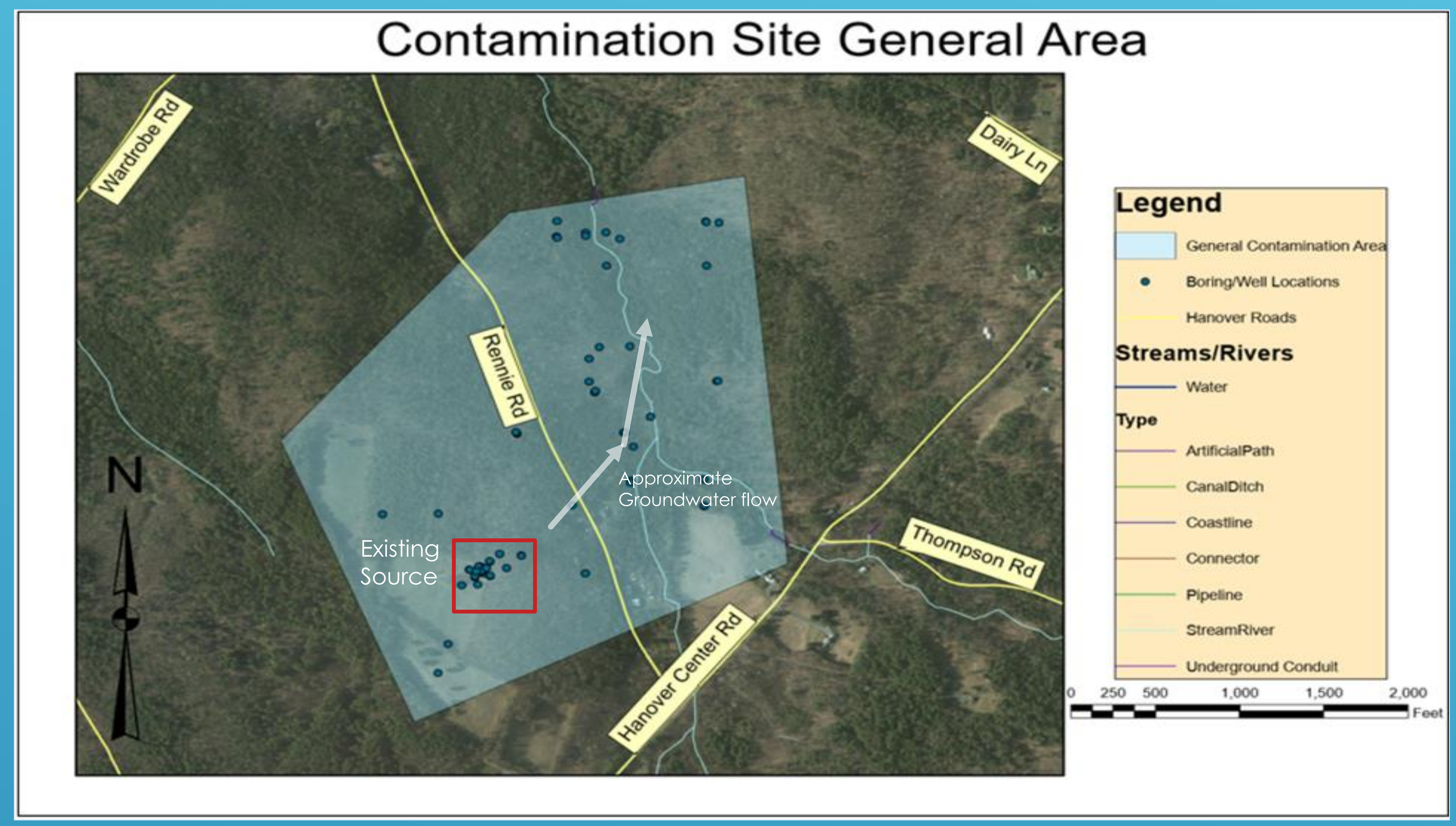

Figure #: General Site Boundary and Layout

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Permitting

PERMIT	REASONING
Alteration of terrain	Road construction
Pump installation	Installation of pumps for treatment system
NPDES surface water discharge	Needed to protect the stream and marsh within the GMZ
Groundwater discharge	Needed for discharging treated effluent back into groundwater
Treatment	Required for treatment system operation
Stormwater site design	Site erosion will change as a result of road construction
Wetlands	The GMZ is in a wetland area

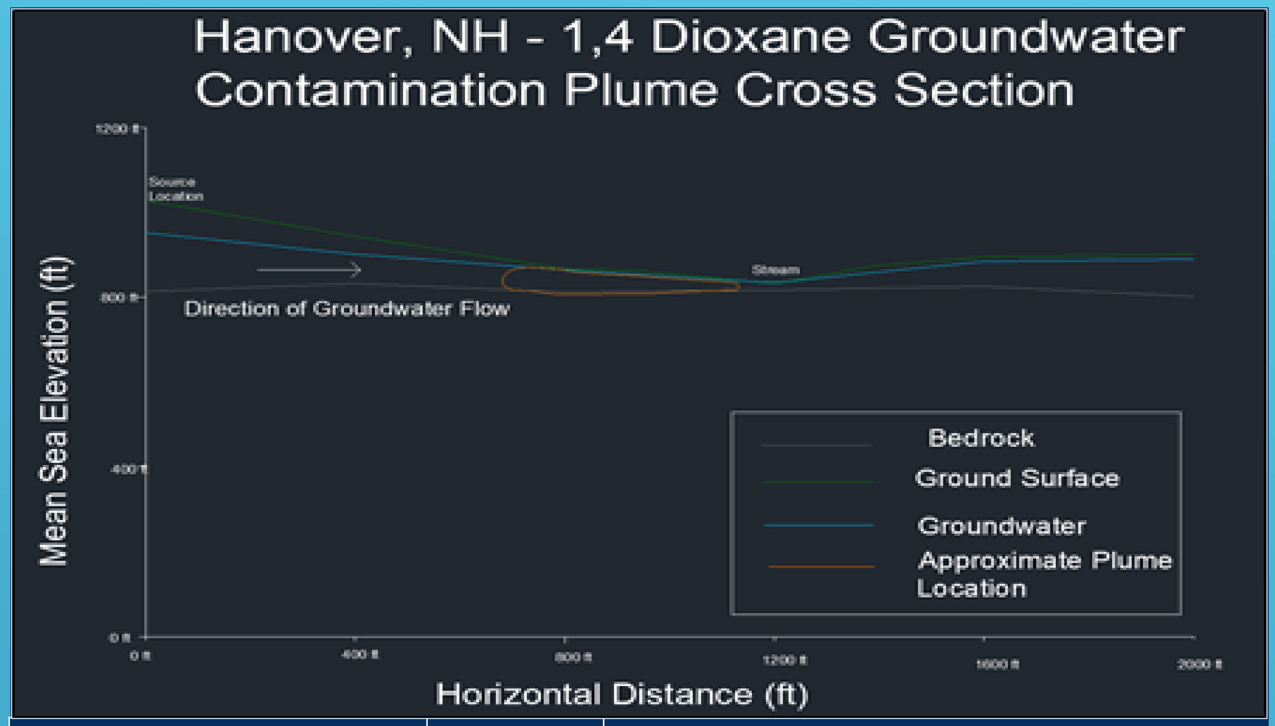
Feasibility Study

Remediation Alternative	Cost (Scale 1-5)	Implementation	Short Term Effectiveness	Long Term Effectiveness	Reliability
Excavate	5	Soil removal	Poor	Poor	Unreliable
Pump and Treat	3	Horizontal and vertical pumping distance	Ok	Good	Reliable
In-Situ – Chemical Oxidation (injection)	1	Injection wells	Ok	Good	Less Reliable
In-Situ – Chemical Oxidation (PRB)	2	Oxidation material	Ok	Good	Average Reliability
Ex-Situ – Bio-remediation	4	Pumping	Ok	Good	Unreliable

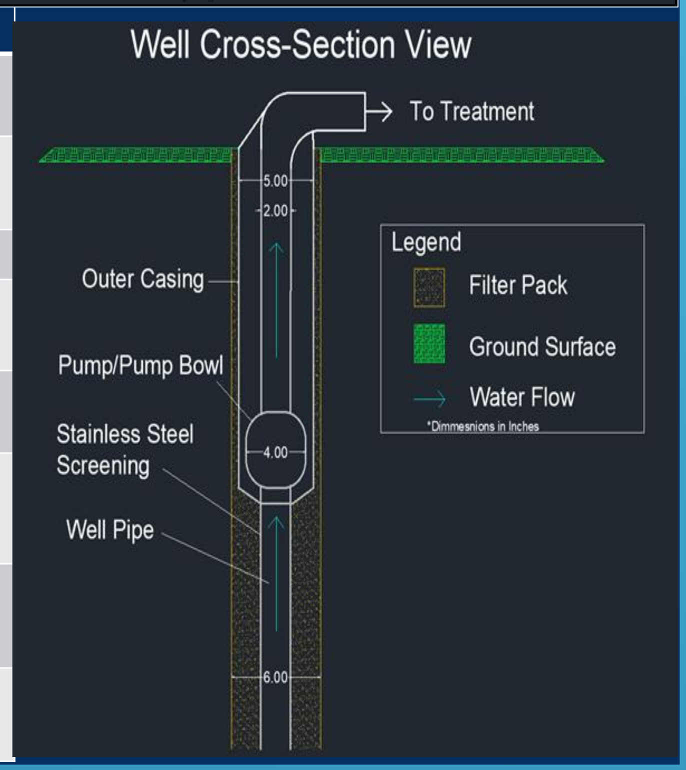
When conducting this feasibility study the design team looked at 5 different treatment options they were; Excavation, Pump and Treat, In-Situ Chemical Oxidation (injection), In-Situ Chemical (PRB), and Ex-Situ Bio remediation.

From the five choices researched Pump and Treat was the option chosen. It was chosen because comparatively it was the most reliable out of them all and the design team felt that the cost feasible for the scope of the project.

Soil and Well Design



Pump Rate (gpm)	0.1
Upper Casing/Pump Housing	
Nominal Diameter of Pump Bowl (inches)	4
Casing Diameter (inches)	5
Screening	
75% of plume thickness screened	
Slot Width (inches)	0.008
Well Filter Outer Diameter (inches)	2
Well Filter Inner Diameter (inches)	1.75



Well Placement

Treatment Choice

Treatment Method	Pros	Cons
Hydrogen peroxide with UV Radiation	• Proven to treat 1-4 Dioxane as well as other contaminants • Moderate Capital Cost	• Expensive O&M cost • Must be pretreated to deal with turbidity • Hydrogen peroxide residuals can pose safety risk
Hydrogen peroxide with Ozone	• Proven to treat 1-4 Dioxane as well as other contaminants • Moderate Capital Cost	• Expensive O&M cost • Hydrogen peroxide residuals can pose safety risk • Bromide will oxidize to bromate requiring further treatment
Resin Treatment	• Very Low O&M cost • Modular/easily sized based off influent flow • Small changes to influent flow will not affect levels of treatment • Simple operation/will not require expensive employees	• Expensive capital cost

When choosing a treatment system for the 1,4 dioxane the group chose three widely used methods to compare and then choose the best option. The three options were Hydrogen peroxide with UV radiation, Hydrogen peroxide with ozone, and Resin Treatment.

The treatment system chosen was resin treatment, the team felt that this was the best option based on location and water chemistry data. The other two options would have caused more treatment to be needed since the hydrogen peroxide would reacted with some of the chemicals in the water. Using resin treatment, we wouldn't have to worry about those new compounds being created as it more filtration oriented. The team also felt that the higher capital cost was offset by the much lower O&M cost when being compared to the other two.