Preventing Columbia/Potomac Aquifer Cross Contamination in the Decommissioning of an In-Ground Frozen Earth Propane Storage Facility, Delaware City Refinery, Delaware

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In-Ground Frozen Earth Propane Storage

Project Objectives

1. Re-establish a low permeability horizon that will separate the Columbia Fm from the Potomac Fm
2. Protect against groundwater cross contamination between Columbia and Potomac Fm
3. Implement groundwater screening to identify baseline groundwater conditions and monitor groundwater compositional and microbiological changes during and after the decommissioning process

Monitoring Objectives

1. Authenticating cross contamination from the Columbia Fm to the Potomac Fm
2. Authenticating cross contamination from the Potomac Fm to the Columbia Fm
3. Authenticating cross contamination in the vicinity of the FES before, during, and after the decommissioning process

Re-establishing the Cavern

Grout Specifications

- Hydraulic conductivity must be less than 10-9 cm/sec
- Minimum cement content of 30 lbs/ft³
- Minimum fine content of 2% by volume

Grout Testing

- 1,000 psi confinement test
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Grout Emplacement

- 1-inch diameter inner pipe within 4.5-inch diameter outer pipe over 165 feet in diameter and 128 feet deep, with a capacity of about 495,000 barrels

Sand Source Evaluation

- 60 feet thick, from cavern borehole, crushed sandstone to an average size of 0.068 inches
- Foundry sand mixes

Groundwater Investigation

- On-site source: nearby Dredge Material Storage Area (DMSA)
- Off-site source: foundry-supplied sand

Groundwater Results

- Major measured ions: Na, K, Al, Ca, Mg, Fe, Mn, Cl, NO3, Br, CO3, SO4, S, HCO3, SiO2, pH, ORP, conductivity
- Major contaminants: petroleum hydrocarbons and metals

Monitoring Results

- Bacteria and fungi present in groundwater

ABANDONING THE FREEZE PIPES

Freeze Pipe Abandonment

- Freeze pipe abandonment
- New Potomac Fm Well
- Columbia Fm Well

Sand Backfill Specifications

- Multi-layered freeze pipe and sand backfill method selected as most protective and cost-effective backfill

GROUNDPWATER MONITORING Documenting the Decommissioning

- Columbia Fm wells
- Potomac Fm wells

Historic Conditions

- Import groundwater cross contamination from the Columbia Fm to the Potomac Fm
- Import groundwater cross contamination from the Potomac Fm to the Columbia Fm
- Import groundwater cross contamination in the vicinity of the FES before, during, and after the decommissioning process

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Hydrogeologic Conditions

- Sand content distribution
- Water quality before, during, and after the decommissioning process

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