

VADOSE ZONE RECHARGE THROUGH SHALLOW HYDRAULIC FRACTURING

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PROJECT DEVELOPMENT

Effective utilization of water is an ever-increasing concern throughout the world. Finding new ways to store and effectively utilize water received from rainfall events is crucial to mitigate flooding and to recharge the Earth's subsurface aquifers. In a growing and changing world, the need for adaptive and cost-effective solutions to water storage and utilization is critical.



Solutions Centered Engineering (SCE) set out to find an economical and environmentally friendly solution to the collection and storage of water. We were specifically searching for ways to reduce runoff and recharge water in the vadose zone. The vadose zone is below the ground surface but above the water table.

ALTERNATIVES

Our team considered four options to face the vadose zone recharge issue:

- Alternative 1: Do Nothing**
- Does not solve the current issue.

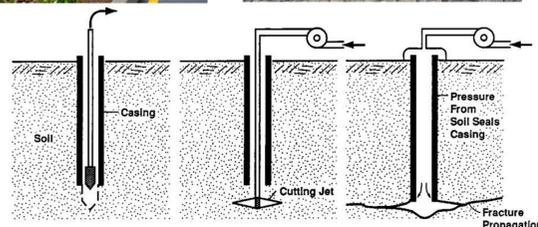


- Alternative 2: Green Infrastructure**
- Environmentally friendly solution.
 - Requires maintenance.



- Alternative 3: A Detention basin**
- Potential to store a large volume of water.
 - Can be expensive to construct.

- Alternative 4: Shallow Hydraulic Fractures**
- Low construction cost
 - Not a common method for groundwater recharge



Method for creating hydraulic fractures in soil
Source: Suthersan, 1997

ALTERNATIVE ANALYSIS

The criteria considered for analyzing the alternatives were cost, storage capacity, client input, runoff reduction, water quality, and operation and management (O&M).

Alternative Comparison									
Criteria	Weight	Detention Basin		Do Nothing		Green Infrastructure		Hydrofracking	
		Rank		Rank		Rank		Rank	
Cost	20%	1	0.20	4	0.80	2	0.40	3	0.60
Storage	5%	4	0.20	1	0.05	2	0.10	3	0.15
Client Input	40%	3	1.20	1	0.40	2	0.80	4	1.60
Runoff Reduction	10%	4	0.40	1	0.10	2	0.20	3	0.30
Water Quality	20%	2	0.40	1	0.20	3	0.60	4	0.80
O&M	5%	3	0.15	4	0.20	1	0.05	2	0.10
Total	100%		2.55		1.75		2.15		3.55

Since this project is research based, client input was the greatest factor in choosing an alternative followed by water quality and cost. SCE ranked the alternatives on a scale of 1 to 4 with 4 being the highest and 1 being the lowest, then multiplied the rank by the weight to produce a score. Based on the criteria, SCE chose the shallow hydraulic fracturing option as the recommended alternative.

WATER QUALITY ANALYSIS

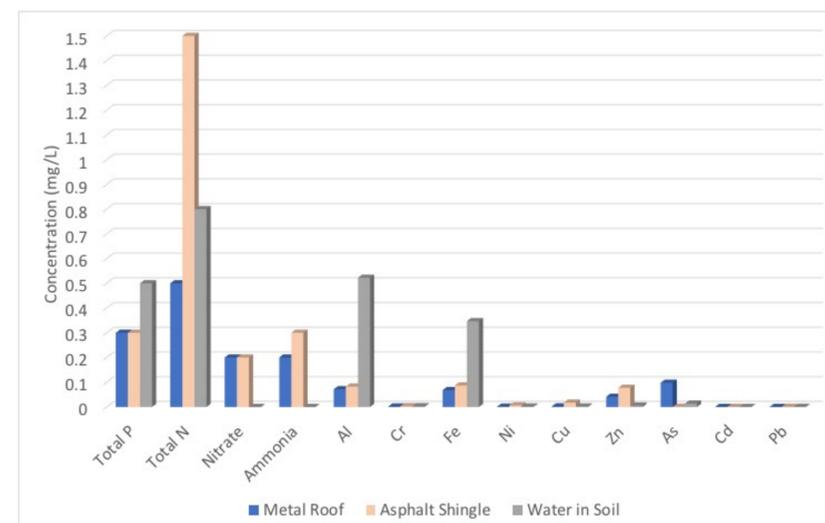
Rainwater runoff will be used to store and recharge the vadose zone. Injections of rainwater into the wells need to be examined for possible pollutants. This study analyzed the quality of rainwater runoff from composite samples of two different types of roofs.

- Roofs sampled:**
- 3 Metal roofs
 - 3 Asphalt Shingle roofs



It was important to evaluate the leaching potential of nutrients and trace elements from the receiving soil. There are primary standards and maximum contaminant levels in place for potable water. The parameters measured were:

- Total Phosphorus
- Total Nitrogen
- Nitrate
- Ammonia
- Total suspended solids
- Total dissolved solids
- pH
- Dissolved Organic Carbon (DOC)
- Electrical Conductivity
- Various Metals



Soil Leaching

- Water in contact with soil after injection can immobilize contaminants
- Concentration increase in aluminum, iron, total N

Roof Comparison

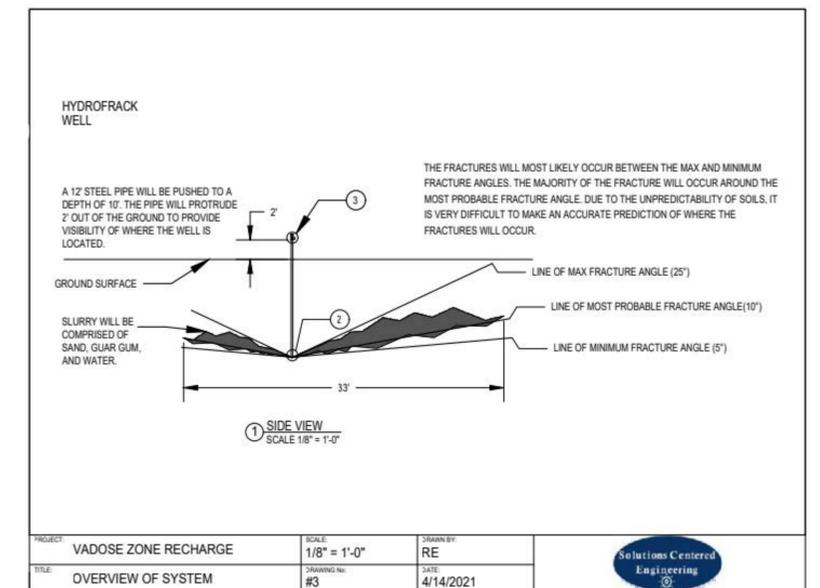
Most of the parameters analyzed were higher for the asphalt shingle roof with exception of a few metals. DOC values for asphalt shingle roof is more than five times higher than metal roof.

- Exceeds Primary Standards
- Arsenic

- Exceeds Secondary Standards
- Aluminum
 - Iron
 - pH

FINAL DESIGN

After significant searching, SCE found a location in Cache Valley that would be suitable to test the methods of hydrofracking. A USU research farm in Wellsville, UT will be used as the testing site. The site consists of fine sands, silty fines, and a deep water table. Low permeable soils are needed to produce effective fractures.



Six wells will be pushed to a depth of 10 ft. A slurry will then be injected into the well at a pressure of 40 psi. The slurry will consist of water, sand or bio-degradable beads, and guar gum. The pressurized slurry will make and keep fractures open in the soil. The fractures can then be filled with water.

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