Remediation

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1st Jan, 2025

created in Curvenote

Keywords Spiritual Safety, Process Safety, Chemical Engineering, Risk Assessment

Learning Outcomes

- Identify and detail various environmental remediation processes, such as soil washing, vitrification, pump and treat, and bioremediation.
- Understand the fate and transport of contaminants through environmental cycles like the hydrologic cycle.
- Discuss the relationship between environmental remediation principles and spiritual "cleaning" through the Atonement of Jesus Christ.

Reading

- Foundations of Spiritual and Physical Safety: with Chemical Processes; Section X11.5
- https://www.churchofjesuschrist.org/study/general-conference/2006/10/the-atonement-can-clean-reclaim-and-sanctify-our-lives?lang=eng

1 Spiritual Healt

The Atonement of Jesus Christ Can Clean, Reclaim, and Sanctify Our Lives

https://www.churchofjesuschrist.org/study/general-conference/2006/10/the-atonement-can-clean-reclaim-and-sanctify-our-lives?lang=eng

2 Fate and Transport

2.1 Thought Experiment - Tree Leaves

What happens to tree leaves?

Do they not just keep building up in layers?

Wouldn't the tree's just eventually be buried in leaves?

2.2 Thought Experiment - Tire Tread

Wear does all the tire tread go from use of millions of tires?

Why doesn't it build up on the highway's or surroundings?

How are those pieces transported?

2.3 Hydrologic Cycle

Water moves through the air, on the ground, and in the ground. It rains, water flows downhill on the surface, and water infiltrates into and out of the ground (aquifers).

Water is a universal solvent, and it can dissolve many substances. Water can also carry substances in solution, suspension, or as a colloid. Some of those substances are toxic.

We depend on water for drinking, agriculture, and industry.

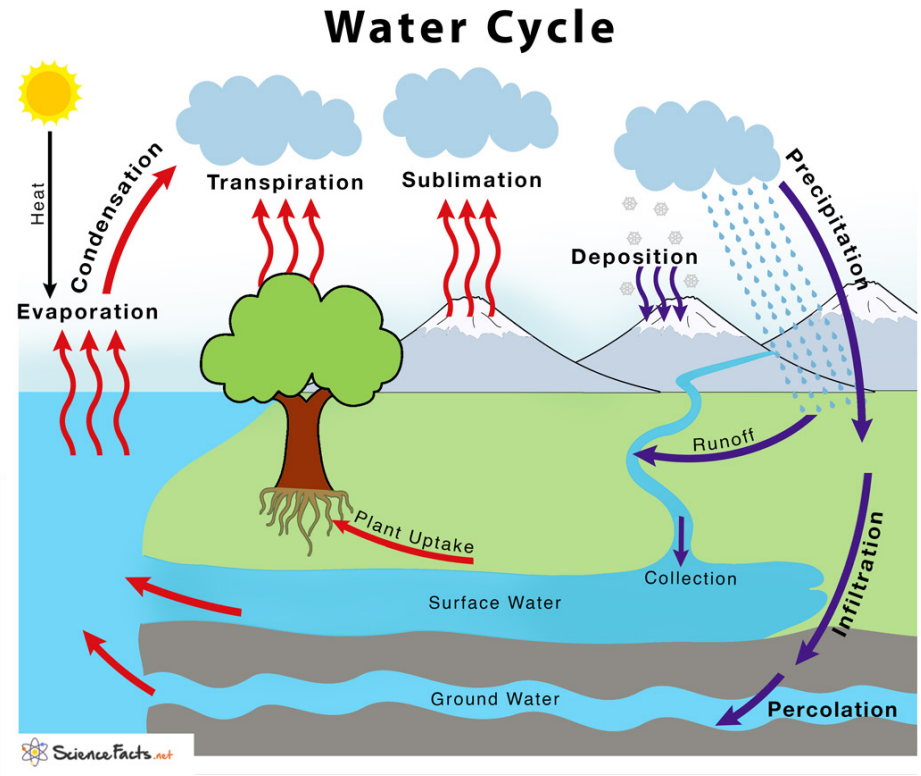

Figure 1: Image of the water cycle. See also the USGS website at https://water.usgs.gov/edu/watercycle.html.

Image source: https://www.sciencefacts.net/water-cycle.html

2.4 Fate Processes

3 Environmental Remediation

Remediation: the action of reversing or stopping environmental damage.

3.1 Soil Washing

The soil is excavated and washed with water or other solvents to remove contaminants. The water is then treated to remove the contaminants.

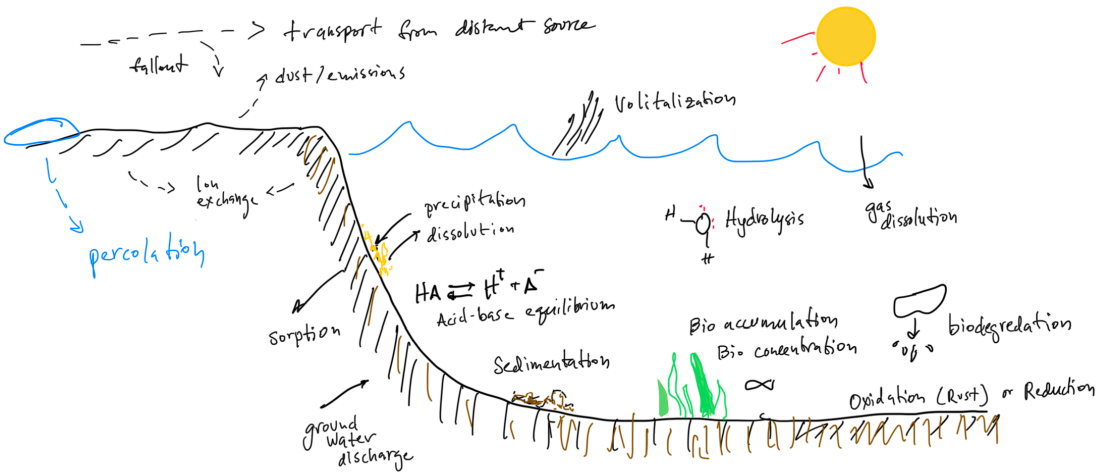

Figure 2: Image of fate processes.

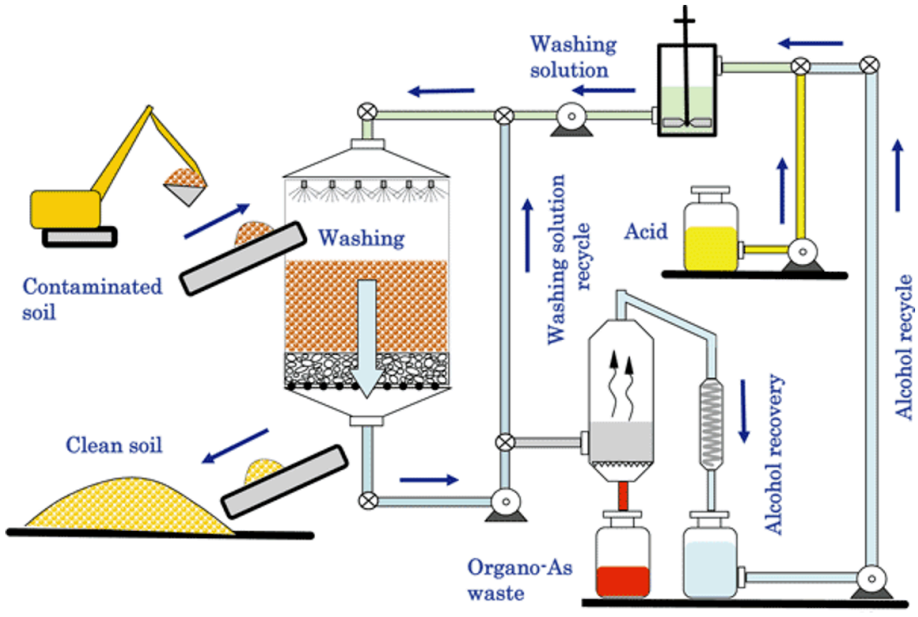

Figure 3: Remediation process with washing and scrubbing of gases.

3.2 Demonstration

500mL syring and a makeshift sand charcoal filter showing how large particles are screened but smaller molecules like dyes are not or that those smaller molecules can be washed or eluded out of the makeshift filter.

3.3 Soil Roasting/ Incineration

Soil roasting is a thermal treatment process that uses heat to remove contaminants from soil.

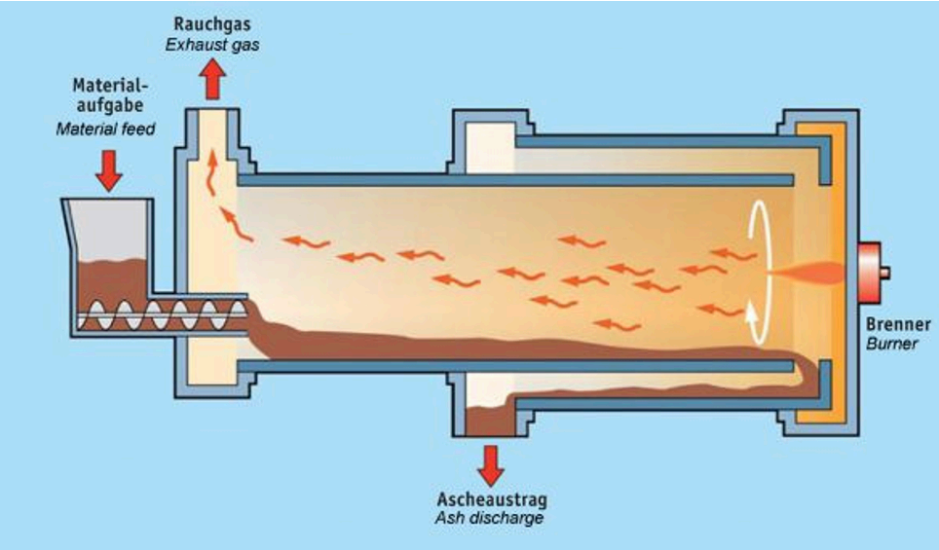

Figure 4: Image of aa soil roasting process.

3.4 Vitrification or Encapsulation

Vitrification is the process of converting a material into a glass-like substance

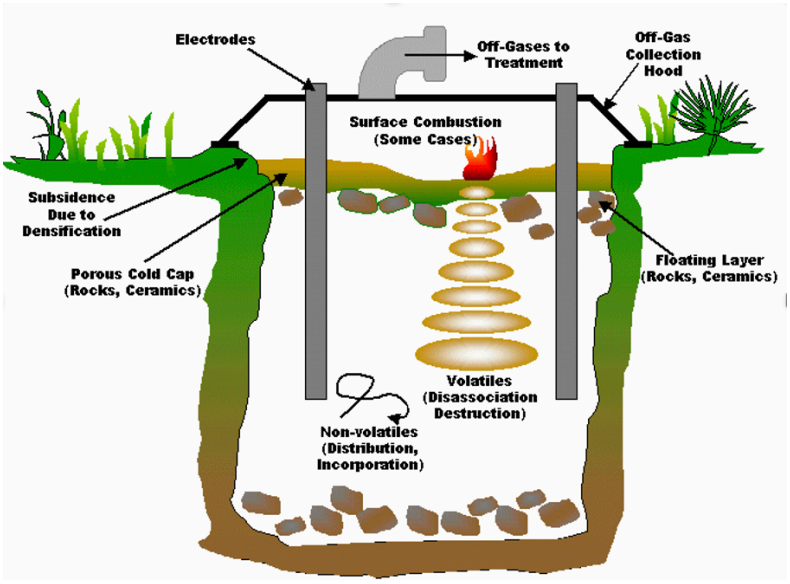

Figure 5: Image of a vitrification process.

3.5 Video on Vitrification at PNNL

https://www.youtube.com/watch?v=I-3we_QTK24

3.6 Landfilling

Contaminated soil is excavated and placed in a landfill.

Figure 6: Image with layer details and barriers at a landfill.

Double lining with FML (Flexible Membrane Liners) and a dense clay layer is common practice to prevent leachate from contaminating groundwater.

3.7 Pump and Treat

Groundwater is pumped to the surface and treated to remove the contaminants.

3.8 Volatilization

Volatilization is the process of converting a solid or liquid into a gas.

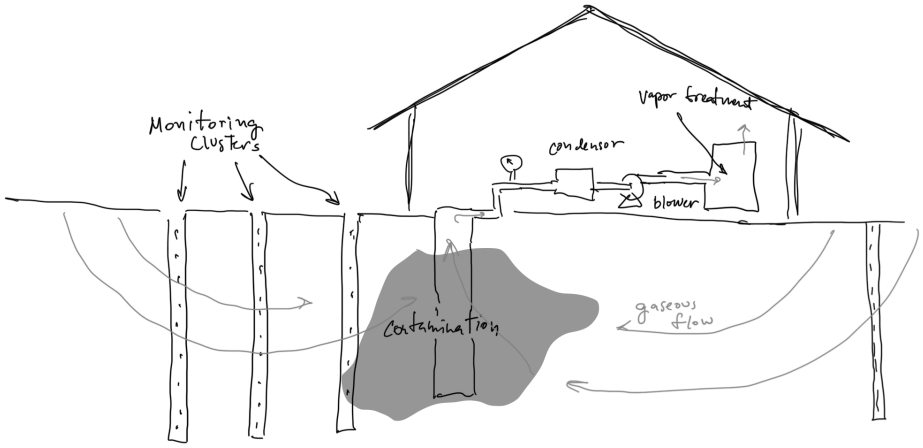

Figure 7: Drawing of a volatilization process.

3.9 Bioremediation

Bio-remediation is the use of living organisms to clean up contaminated soil and water. The organisms can be bacteria, fungi, or plants. For example, some bacteria can break down oil into carbon dioxide and water.

4 Remediation Example

Mt. Trashmore in Virginia Beach, Virginia, is a former landfill that has been turned into a park. The park is built on top of the landfill, which has been capped with a layer of soil and grass. The park has a lake, playgrounds, and walking trails.

5 Example Problems

Which of the following methods would you choose to remediate a gasoline leak from an underground storage tank that has reached a water aquifer? Explain your reasons.

- a. Soil washing
- b. Soil roasting/incineration
- c. Bioremediation/landfarming
- d. Stabilization and solidification, e.g., vitrification
- e. Landfill
- f. Pump and treat
- g. Volitalization (soil vapor extraction or in situ air sparging)

Which of the following methods would you choose to remediate heavy metal contamination of a small volume of soil? Explain your reasons.

- a. Soil washing
- b. Soil roasting/incineration
- c. Bioremediation/landfarming
- d. Stabilization and solidification, e.g., vitrification
- e. Landfill
- f. Pump and treat
- g. Volitalization (soil vapor extraction or in situ air sparging)

Action Items

1. Research a Superfund site near your home and provide a brief summary of the hazards and the cleanup progress achieved. Include a cleanup method that could be used in addition to the one being used.
2. How could Jesus Christ act as a Remediator to clean up the contamination (or provide comfort in the struggles) in your life?