A Discussion of Sustainability in site remediation industry in US

Presented by

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Outline

- Definition of sustainability
- Environmental, economic, and social indicator in sustainability
- Site remediation cost analysis
- Remedial methods sustainability analysis
- Case studies: reuse of remediated soil

Definition of sustainability in site remediation

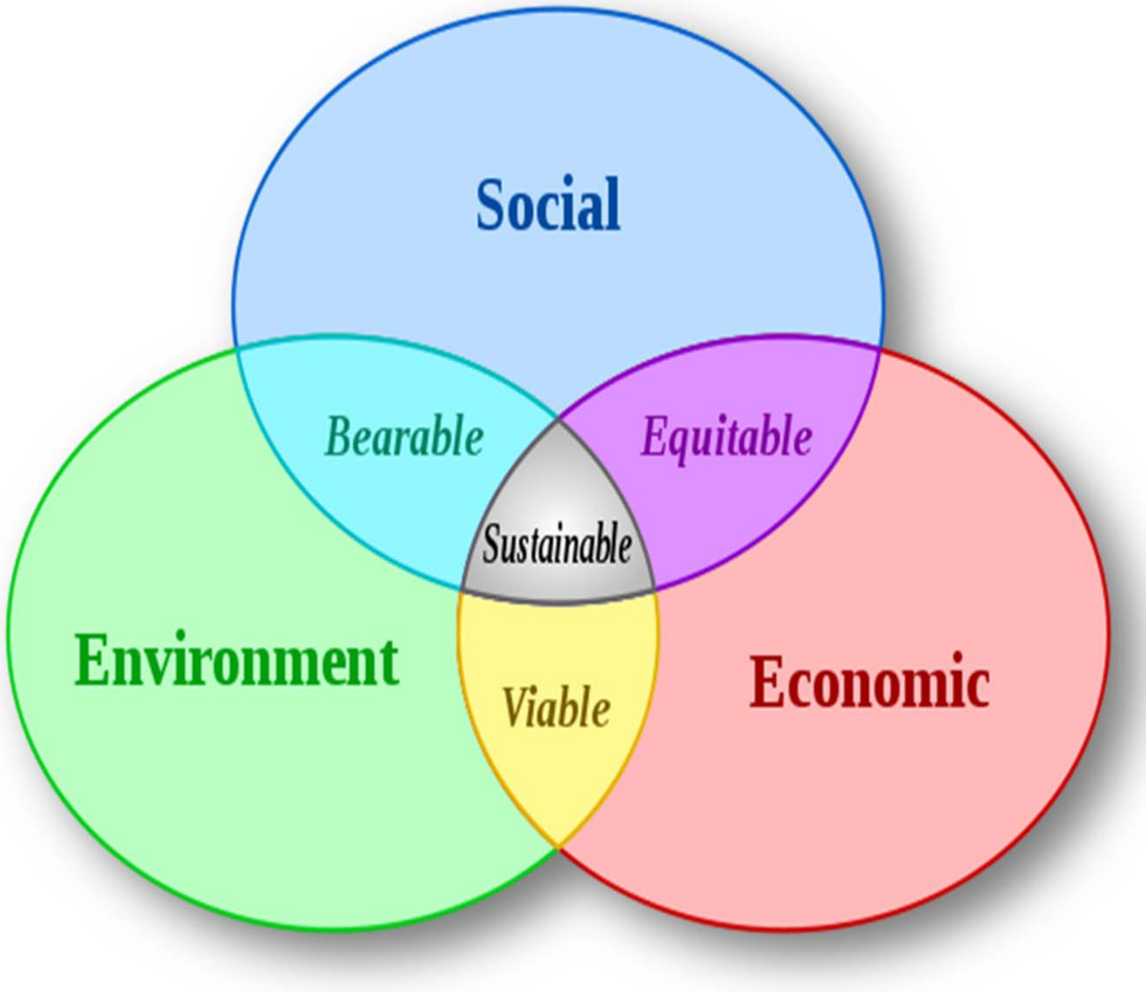
"the practice of demonstrating, in terms of environmental, economic and social indicators, that the benefit of undertaking remediation is greater than its impact, and that the optimum remediation solution is selected through the use of a balanced decision-making process."

Sustainability has 3 points in definition

- Environmental, economic, and social elements
- Benefit of site remediation outweights the impact of the pollution (worth doing it)
- Balanced decision (environment vs. economic growth)

Relations in Sustainability

(Ravi Arulanantham)



Sustainability: Remediation under consideration of lower emission and lower energy consumption

- Energy
- Resources
- Climate change
- Green technology
- Safety/risk
- Cost benefit
- Public acceptance


SIDEWALK CLOSED
12/10/2015

Remediation Model Evolution

Discard	Dig Pump Bury Burn	Recycle Reuse Natural biodegradat ion
60 yrs ago	30 yrs ago	now

Remediation goal vs. sustainability

- Once the remediation goal is set, can we sustain?
- Environmental, economic, and social factors
- Cleanup benefits outweigh pollution impact
- Balanced decision (cleanup vs. economics
- Limited resources
- Current technologies

Cost analysis: case study in L.A.

<u>Method</u>:

1. Use 179 closed cases in L.A. where active remediation took place since 2012
2. Average cost of remediation per site = $887,438/site (n=179)

3. average cost by Individual methods per site

Method	Cost per site
Soil vapor extraction	$926,173 (n=68)
Dual phase extraction	$907,440 (n=21)
Soil excavation	$870,803 (n=80)
Groundwater pump and treat	$639,786 (n=6)
Free product removal	$481,953 (n=1)
Total average	**$887,438 (n=179)**

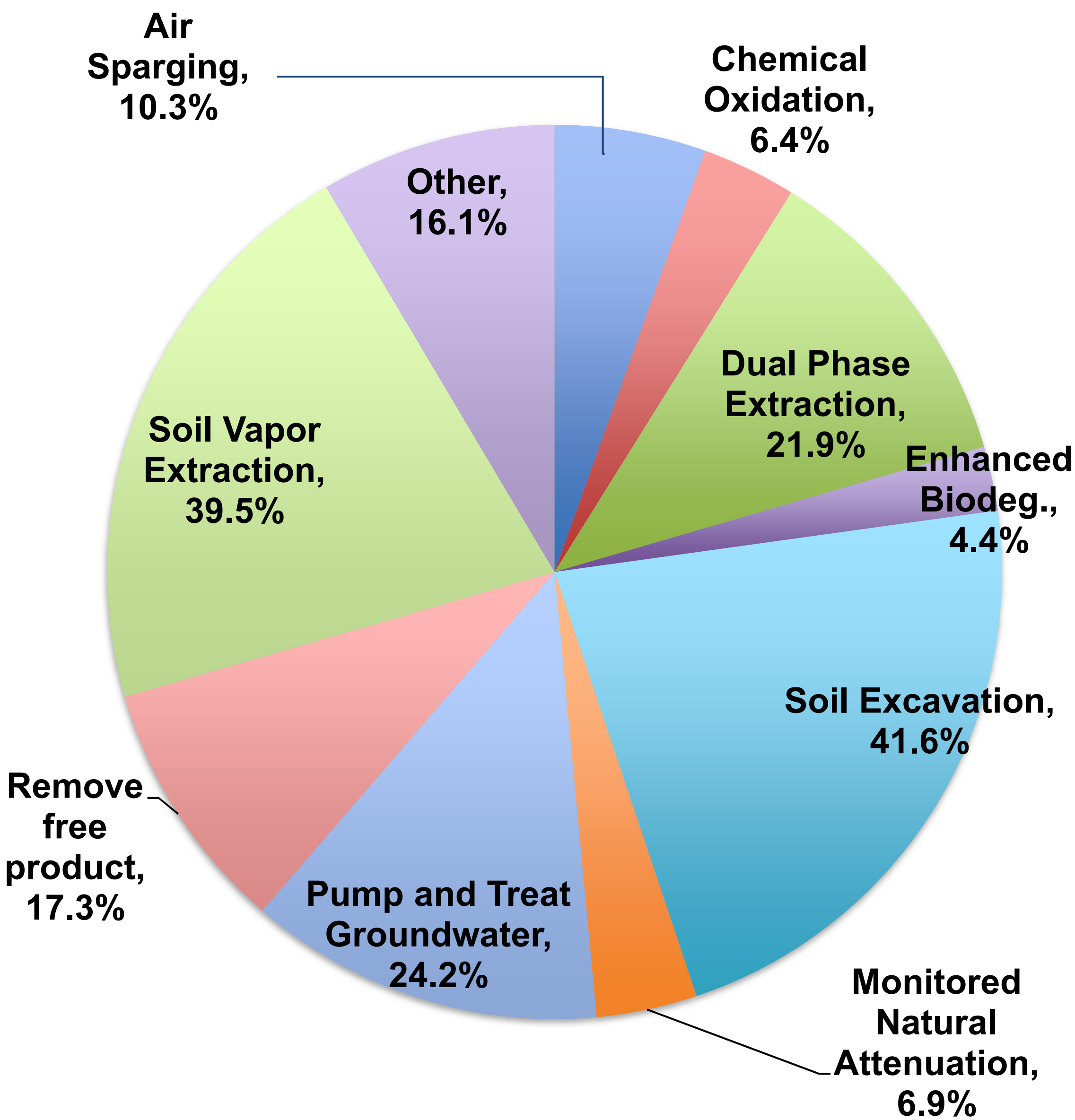
Cost analysis: case study in LA

3. average cost by Individual methods per site

- Total average = $887,438/site (n=179)

- Soil vapor extraction = higher than avg
- Dual phase extraction = higher than avg
- Soil excavation = lower than avg
- Pump and treat = lower than avg
- Free product removal = lower than avg

GeoTracker: Remediation Technologies at California Leaking Petroleum UST Sites



Top 3 Technologies

✓Soil Excavation

✓Soil Vapor Extraction

✓Pump and Treat

Note: Sum of percentages is greater than 100% because some sites had more than one remediation technology.

Source: Matt Lahvis (Shell)

Cleanup method analysis

Method:

- Soil excavation
- Groundwater pump and treat
- Soil vapor extraction
- Dual-phase extraction and air sparging
- Thermal enhancement
- In-situ treatment: chemical and biological
- Monitoring natural attenuation
- Phytoremediation

Soil Excavation

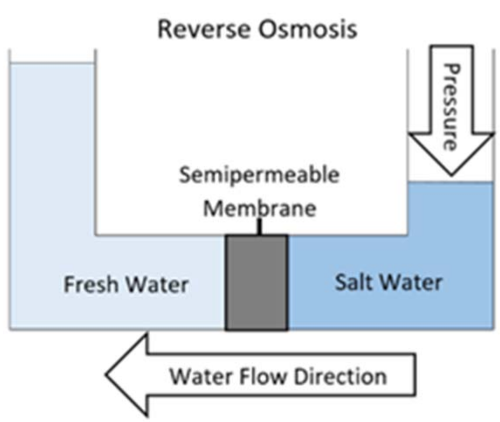
Environmental, economic, social

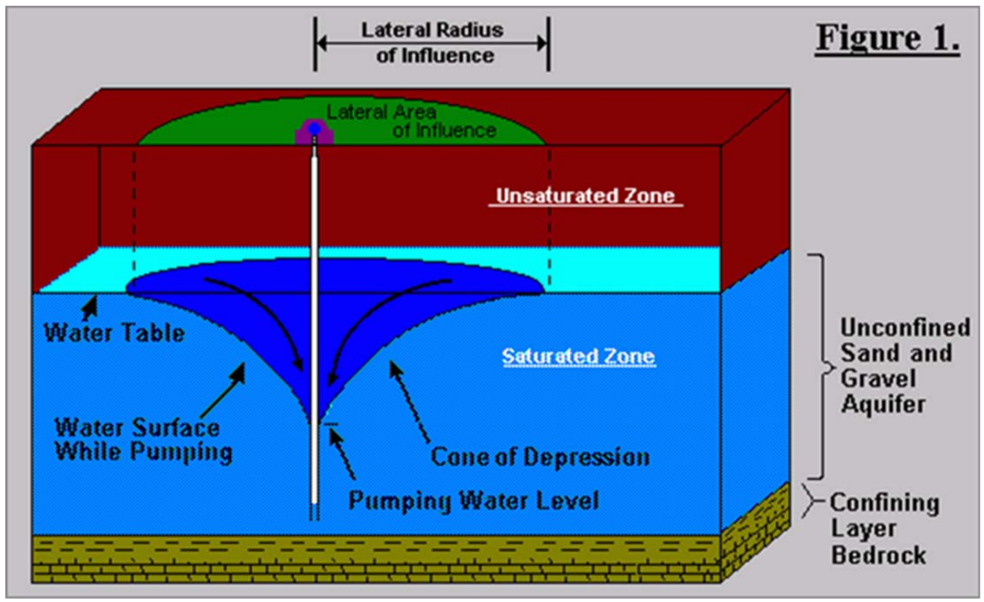
- Quick solution for re-development
- Costly
- Interruptive
- Remove sources
- Good for fine materials

Groundwater pump and treat

Environmental, economic, social

- More treatment methods apply
- Costly, large construction
- No effective for low concentration
- Less interruptive
- Waste water

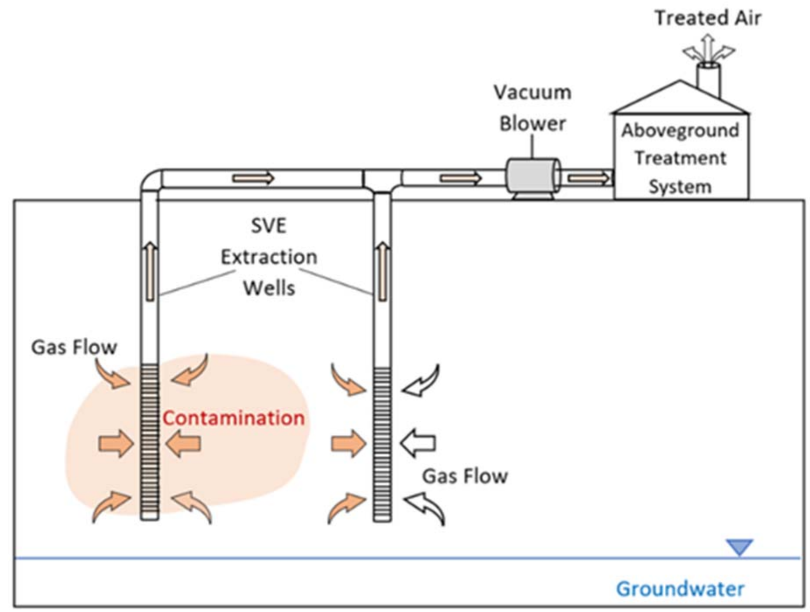




Soil vapor extraction

Environmental, economic, social

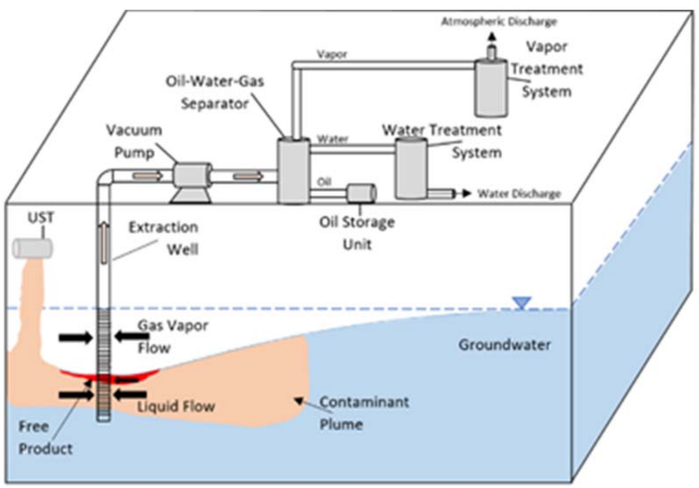
- Effective in coarse materials (ineffective in fine)
- Rebound concentrations
- Large construction area
- Moderate cost
- Noisy

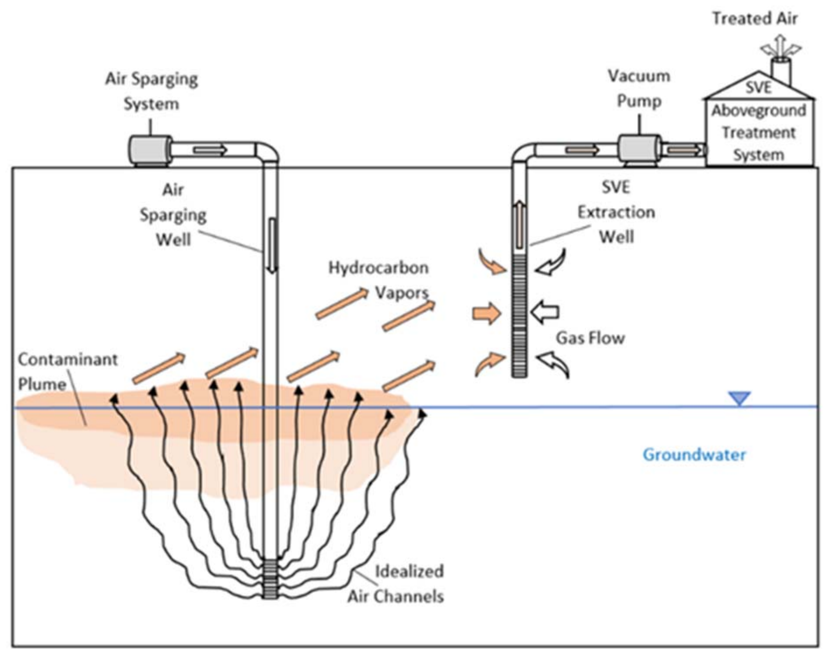


Dual-phase extraction and air sparging

Environmental, economic, social

- Effective in coarse materials, and multi-phase
- Complicated system and construction area
- Moderate cost
- Noisy





Thermal enhancement

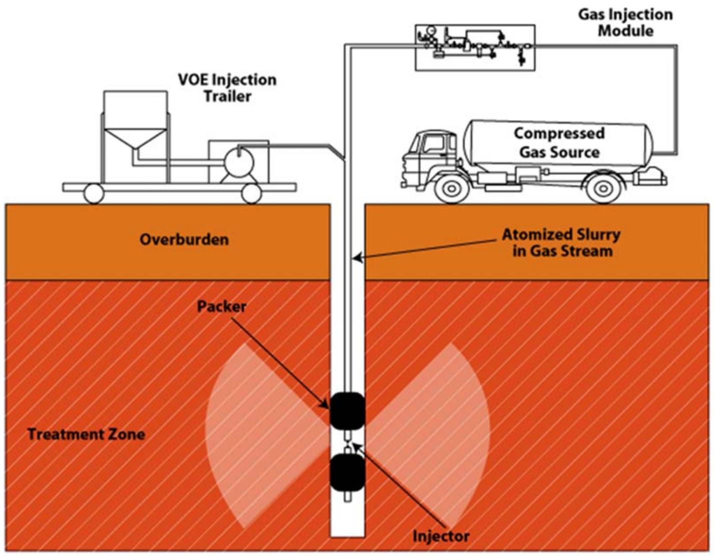
Environmental, economic, social

- Good for fine materials
- Treat semi-volatile contaminants
- Energy consuming
- Quick cleanup time
- Interruptive
- Costly

In-situ treatment: chemical and biological

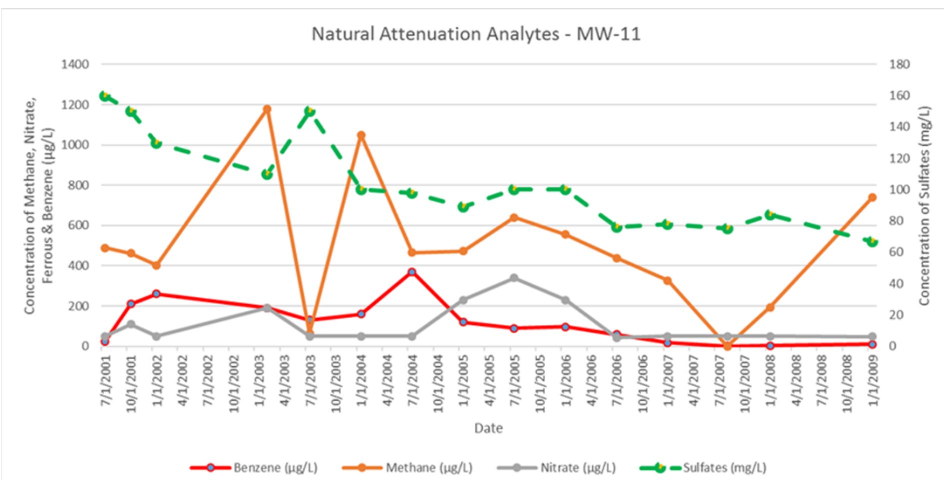
Environmental, economic, social

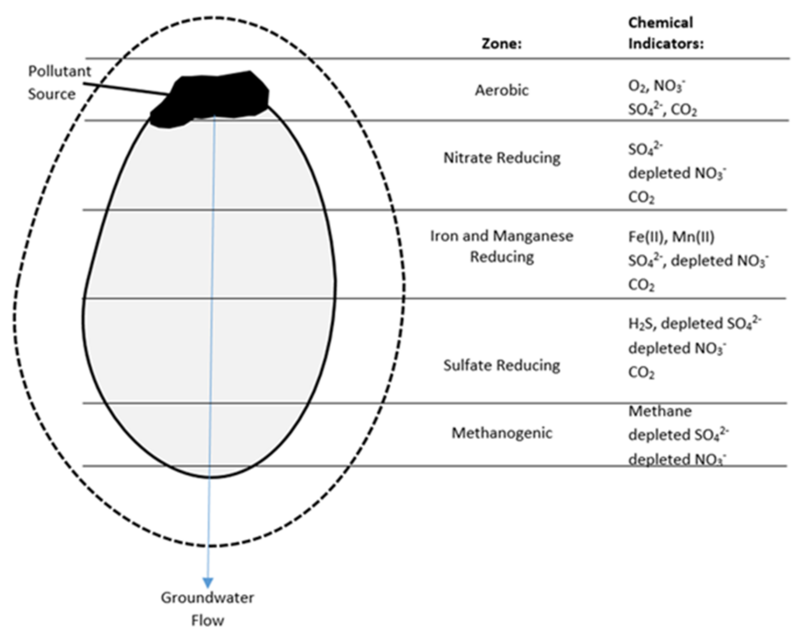
- Hard for high concentrations
- Low cost
- Less interruptive
- Small impact area
- Water conservation
- Good for polishing
- Hard to verify results
- Biological agent concern
- How to estimate mass removal?



Monitoring natural attenuation

- Good for physical constrained sites
- Hard to verify results
- How to estimate mass removal?
- Good for polishing
- Less interruptive
- Low cost
- Long period



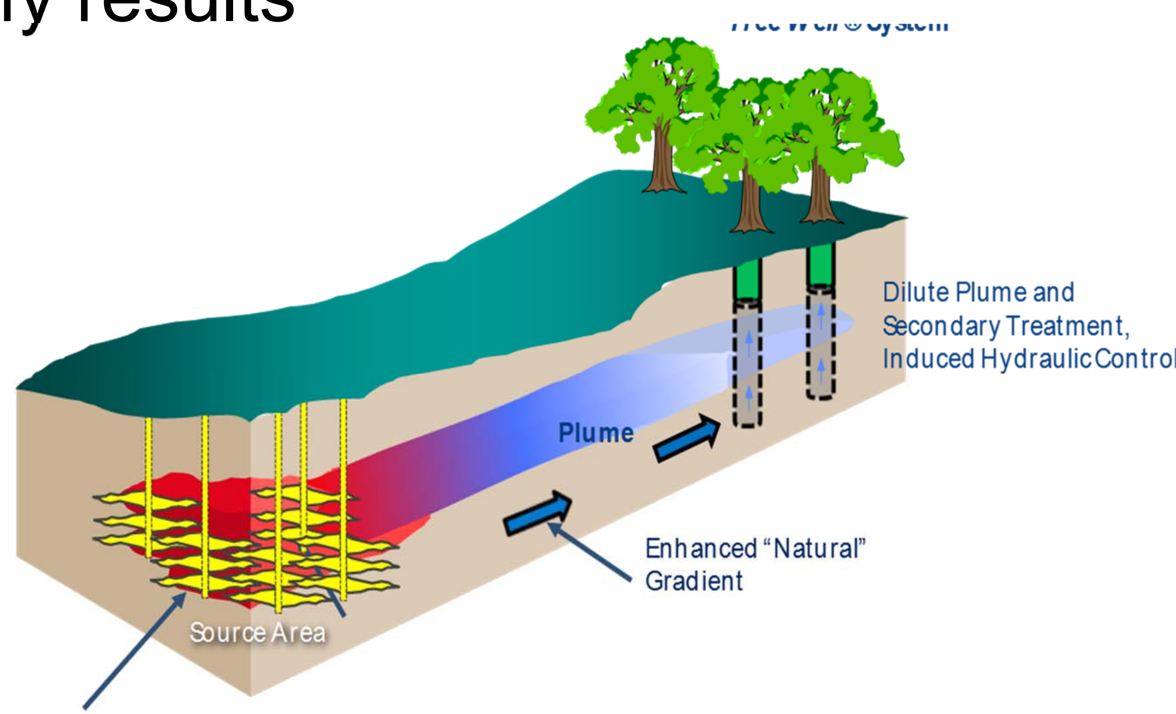


Phytoremediation

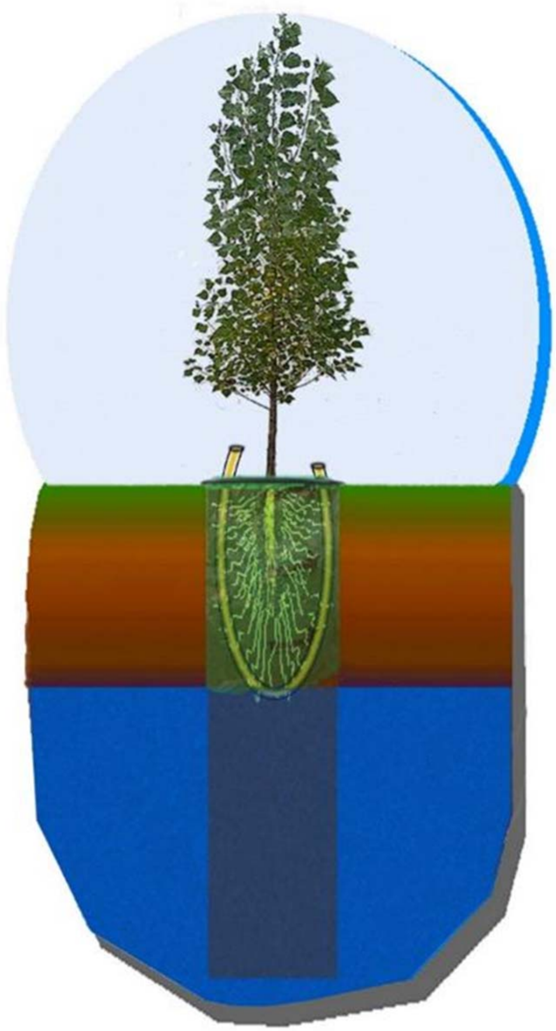
(Edward Gatliff & Doug Riddle 2018)

Environmental, economic, social

- Green technology
- Limited in shallow zone (root zone)
- Hard to verify results
- Low cost
- Effective
- interruptive



Phytoremediation

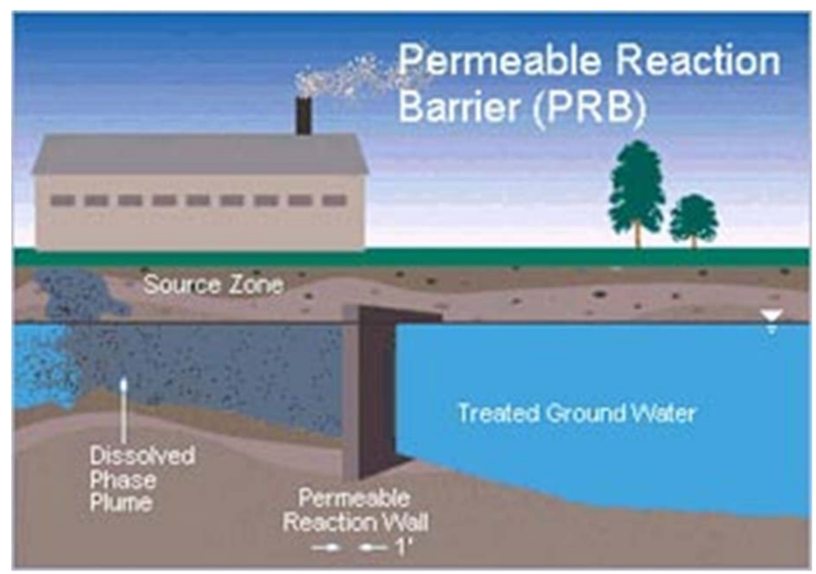


Phytoremediation

We can also evaluate other cleanup methods in the same principles

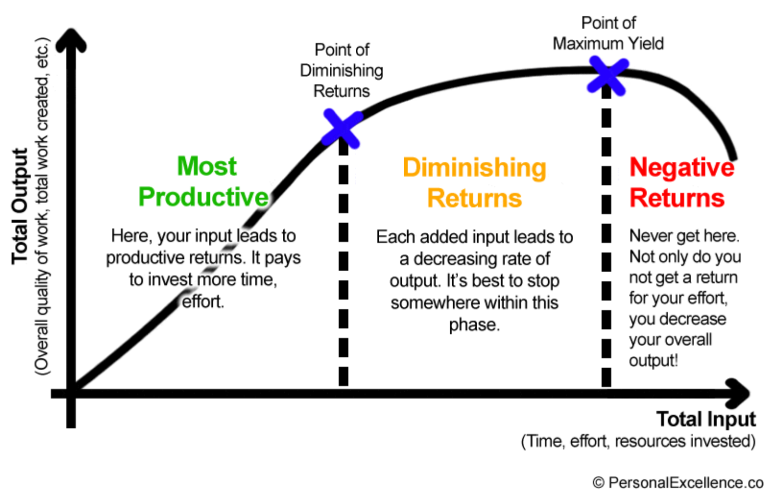
<u>Other Methods</u>:

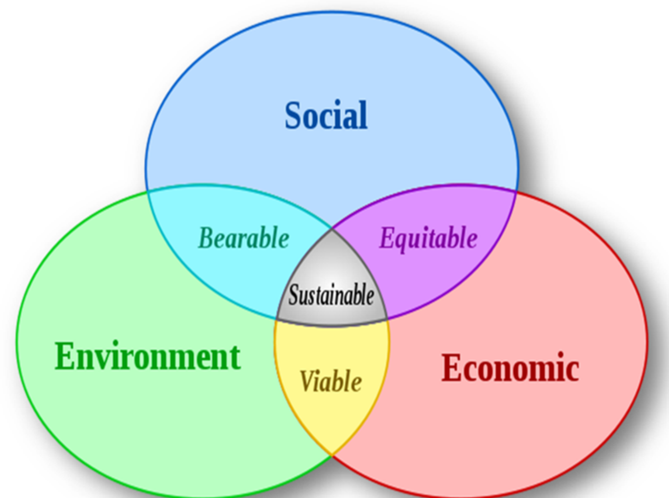
- o Permeable Reactive Barriers (PRBs)
- o In-situ oxygen and bio venting
- o Incinerator (burn out)
- o Soil washing



Sustainability dilemma:
how to set up a cleanup goal

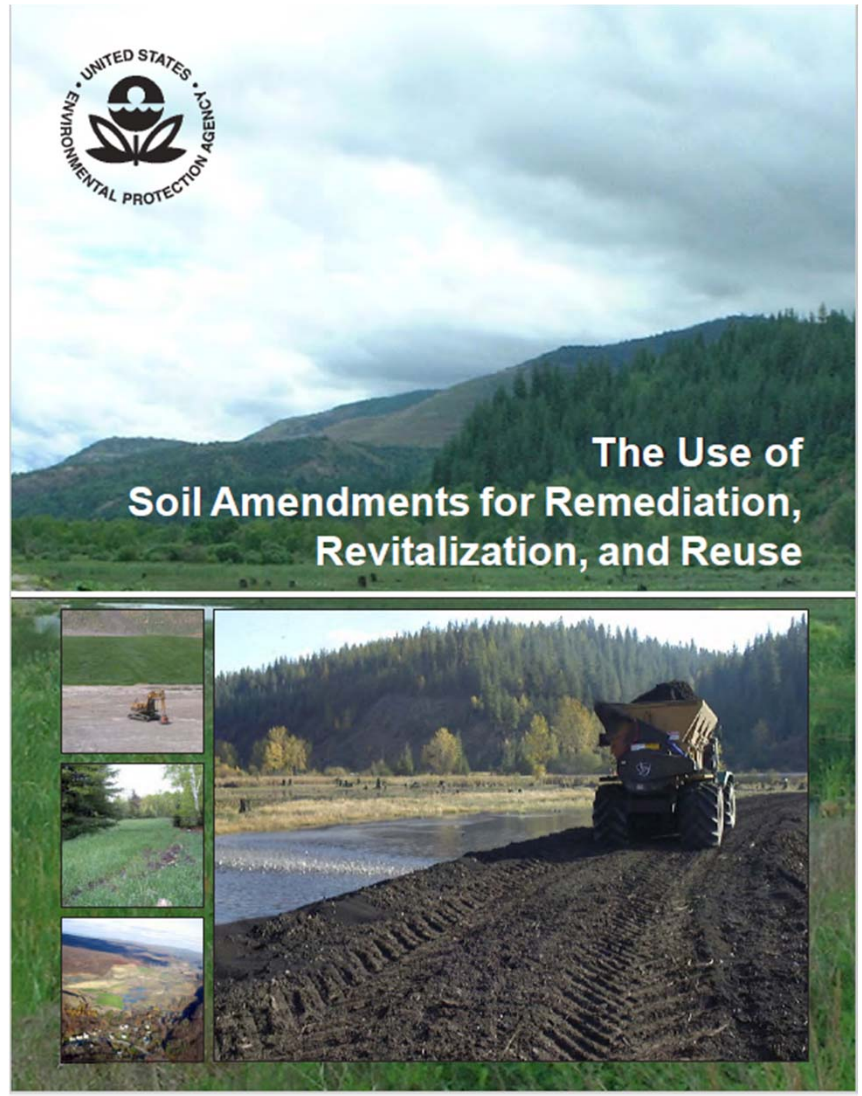
- Clean it up to background level
- Cost effective
- Risk-based management with consideration of sustainability
- Public acceptance





Case Study 1: reuse of remediated soils

1. USEPA guidelines
2. Soil cleanup completion
3. Confirmation sampling
4. Reuse of remediated soil for road pavement
5. Permitting/approval



Case Study 1: reuse of remediated soils

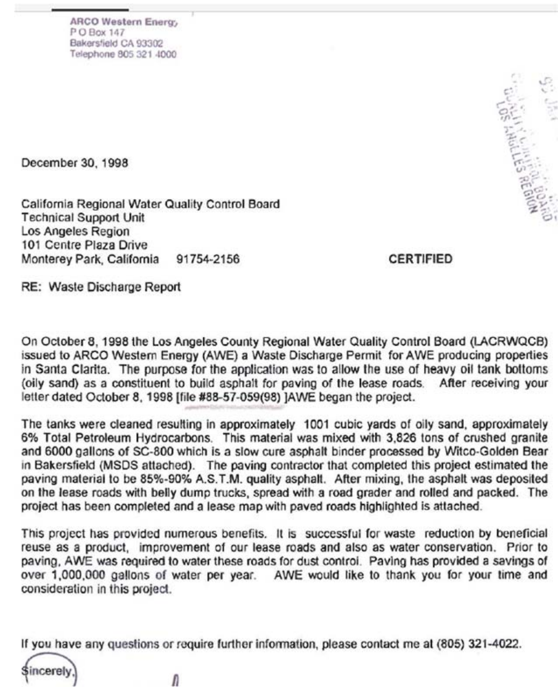
USEPA guideline contents

1. Type of soil contamination (petroleum, metals, volatiles)
2. Exposure pathway evaluation
3. Soil type and ecosystem function
4. Reuse proposal (cleanup goal)
5. Permitting (cleanup goal)
6. Operation
7. monitoring

Case Study 1: reuse of remediated soils

Reuse oily sand for road
Pavement materials

- 1001 yard^3 oily sand
- From oil storage pond bottom
- Mixing with asphalt
- Concentration=6% TPH
- Mixing with other materials
- Use for pavement of a road
- Asphalt materials for the road=90%
- Permitting (regulatory agency approval)



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Telephone 805 321 4000

LOS ANGELES REGION

December 30, 1998

California Regional Water Quality Control Board
Technical Support Unit
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, California 91754-2156

CERTIFIED

RE: Waste Discharge Report

On October 8, 1998 the Los Angeles County Regional Water Quality Control Board (LACRWQCB) issued to ARCO Western Energy (AWE) a Waste Discharge Permit for AWE producing properties in Santa Clarita. The purpose for the application was to allow the use of heavy oil tank bottoms (oily sand) as a constituent to build asphalt for paving of the lease roads. After receiving your letter dated October 8, 1998 [file #88-57-059(98)]AWE began the project.

The tanks were cleaned resulting in approximately 1001 cubic yards of oily sand, approximately 6% Total Petroleum Hydrocarbons. This material was mixed with 3,826 tons of crushed granite and 6000 gallons of SC-800 which is a slow cure asphalt binder processed by Witco-Golden Bear in Bakersfield (MSDS attached). The paving contractor that completed this project estimated the paving material to be 85%-90% A.S.T.M. quality asphalt. After mixing, the asphalt was deposited on the lease roads with belly dump trucks, spread with a road grader and rolled and packed. The project has been completed and a lease map with paved roads highlighted is attached.

This project has provided numerous benefits. It is successful for waste reduction by beneficial reuse as a product, improvement of our lease roads and also as water conservation. Prior to paving, AWE was required to water these roads for dust control. Paving has provided a savings of over 1,000,000 gallons of water per year. AWE would like to thank you for your time and consideration in this project.

If you have any questions or require further information, please contact me at (805) 321-4022.

Sincerely,

Cal-EPA soil stockpile sampling guidelines

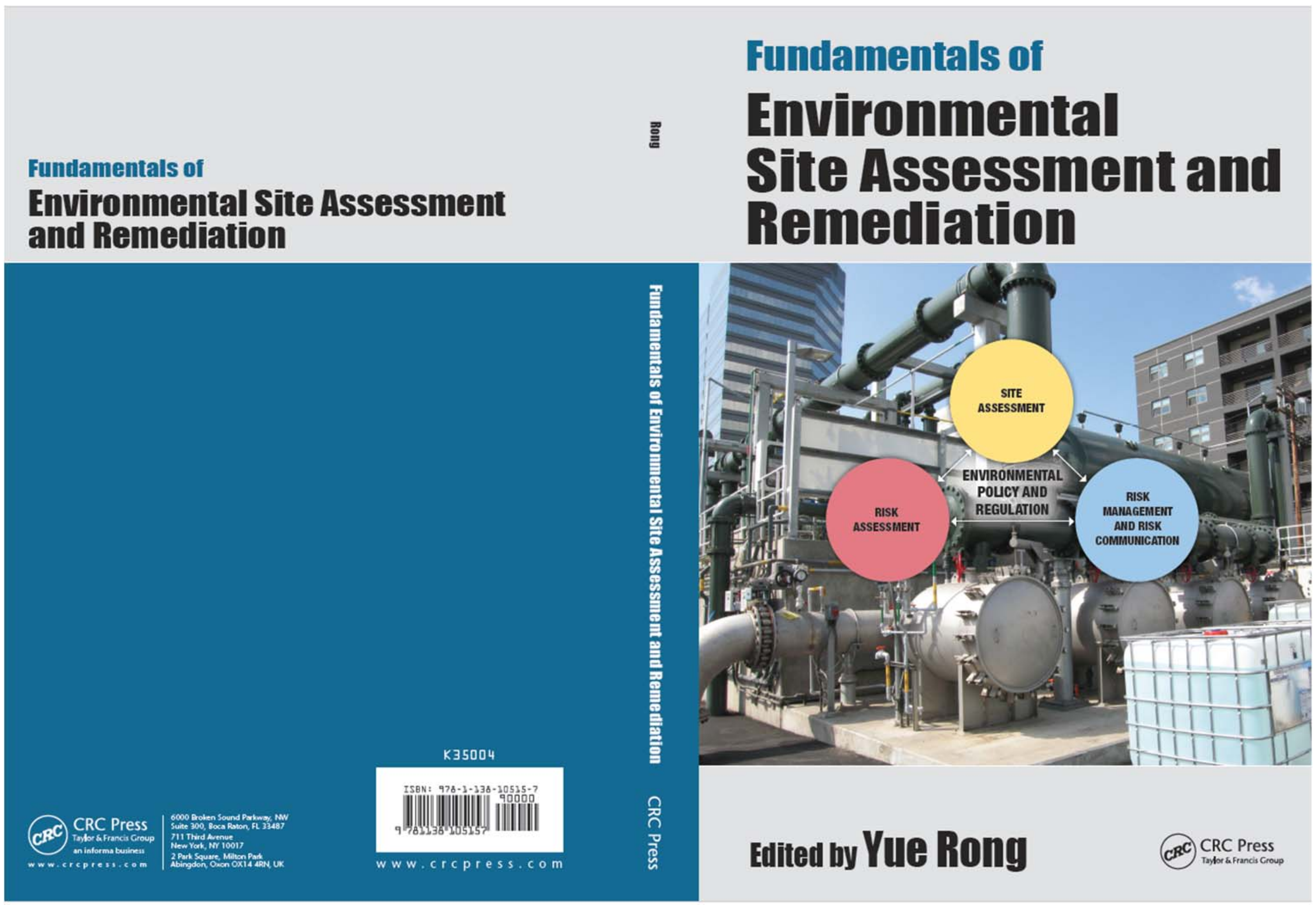
Volume of stockpile	**Samples per volume**
Up to 1000 $yard^3$	4
1000 – 5000 $yard^3$	4 + 1 every 500 $yard^3$
> 5000 $yard^3$	12 + 1 every 1000 $yard^3$

Recommendations

Choice of remedial methods should consider:

1. Sustainable?
2. Reuse
3. Cost effective
4. Resource conservation
5. Reduce emission
6. Green technology
7. Public acceptance

New book: (Yue Rong, editor 2018)
Fundamentals of Environmental Site Assessment and Remediation



Questions?