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Bioremediation of Oil Contaminated Drilling Waste.

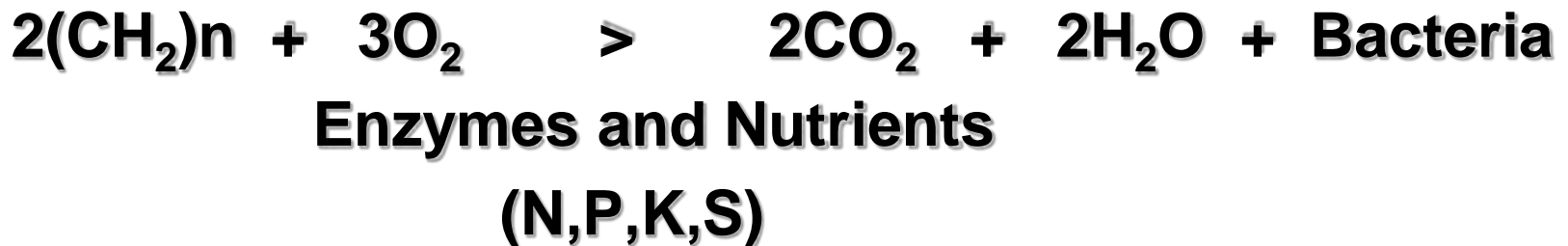


WHAT IS BIOREMEDIATION ?

- In nature, microbes in the soil (in the presence of moisture) are undergoing a process of digestion, respiration, fermentation, synthesis (growth), and reproduction.
- All microbial activities are mediated by the action of organic catalysis or ***enzymes***.

WHAT IS BIOREMEDIATION ?

- Microbial organisms need N & P and trace amounts of K and S to make enzymes, protein and more microbes.



WHY DOES BIOREMEDIATION WORK ?

- It is based on natural biological processes of aerobic and anaerobic nutrient metabolism.
- Many environmental wastes are structurally similar to naturally occurring molecules (e.g. fats, oils, greases, waxes, carbohydrates, etc.) routinely encountered by microbes as natural food.

WHY DOES BIOREMEDIATION WORK ?

- The more closely a compound resembles the naturally occurring metabolic process, the more likely and rapidly it can be degraded by indigenous microbes.
- The more complex the compound, the more difficult it is to degrade.
- Bacteria and fungi are abundant in the soil, and can be exploited favorably.

REQUIREMENTS FOR BIODEGRADATION

- Biodegradable organic waste
- Suitable microbes
- Oxygen
- Moisture
- Nutrients (N,P,K,S)
- Trace elements
- Optimum temperature (68⁰ - 90⁰ F; < 95⁰ F)
- Compatible soil / water chemistry
 - **pH (5-9) - metals - salt - etc.**

ELEMENTS OF BIOREMEDIATION

- Environment
- Contaminants
- Microbes

Understanding and manipulation of these elements are the key to successful bioremediation.

OXYGEN REQUIREMENT

- Biooxidation



3 lbs. Oxygen / lb. Carbon

- Formation of biomass reduces oxygen demand

0.8 to 1.7 lbs. Oxygen / lb. Carbon

- Process inefficiency can increase non-specific oxygen demand

5 lbs. Oxygen / lb. Carbon

BIOREMEDIATION ASSESSMENT

- **Contaminant Characterization**
 - Qualitative
 - Quantitative
 - Biodegradability
 - Nutrient requirements
- **Site Characterization**
 - Surface features, e.g., topography, utilities, etc.
 - Source and extent of contamination
 - Geochemistry, e.g., pH, moisture, background nutrients
 - History of site
 - Regulatory issues

BIOREMEDIATION ASSESSMENT

- **Microbial Characterization**
 - Microbial population
 - Viability
 - Microbial stimulatability
 - Bioaugmentation
 - Biocidal elements?
 - Salts?

NUTRIENT REQUIREMENTS

- N,P,K Requirements

0.5 - 1.0 lb. N / 100 lb. C

0.1 - 0.3 lb. P / 100 lb. C

0.1 - 0.3 lb. K / 100 lb. C

- Micronutrient demand is influenced by:

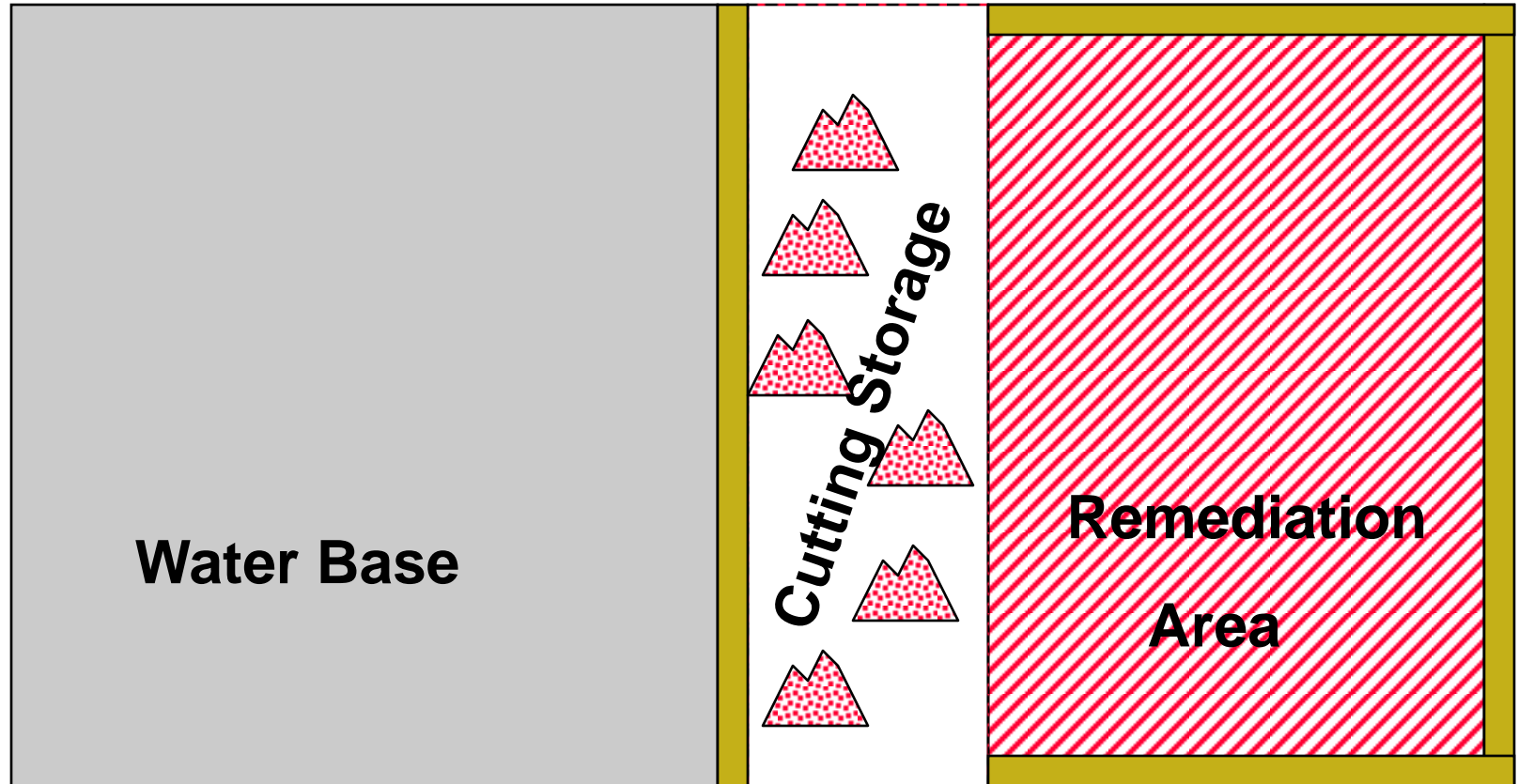
- Mineralogical composition of soil

- Background levels

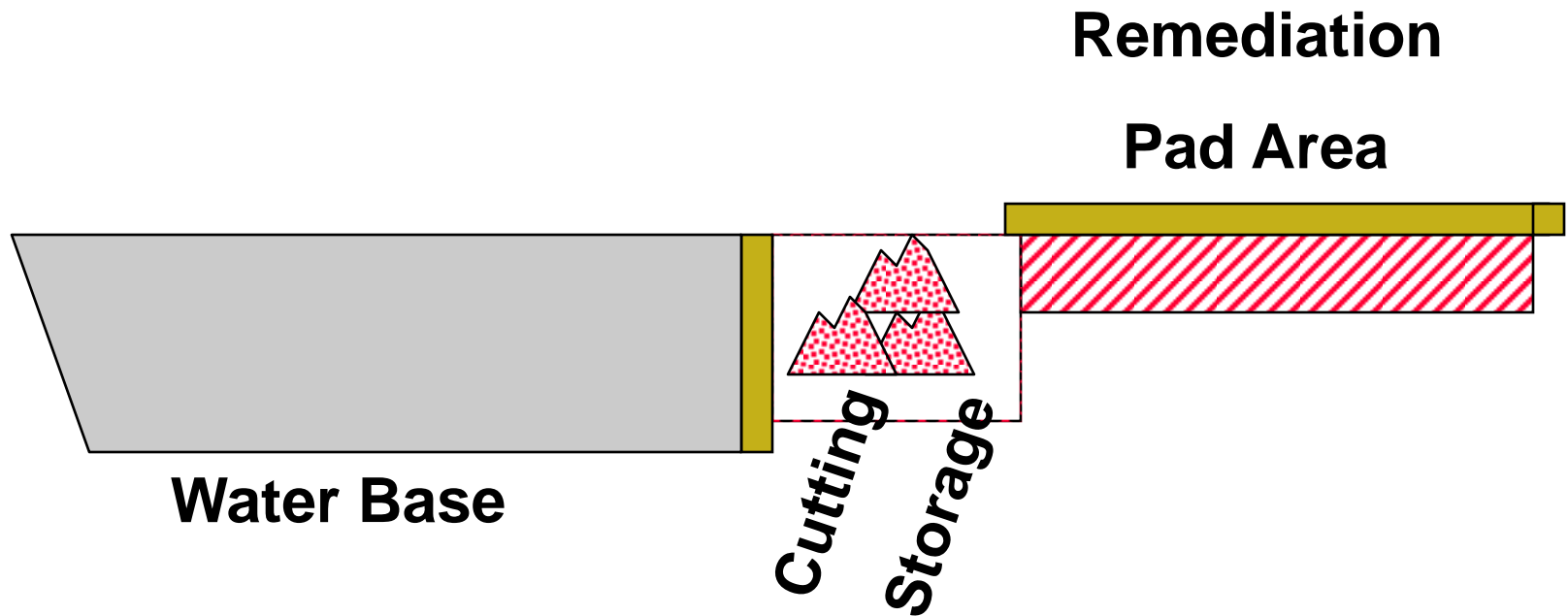
In-Situ Bioremediation of Hydrocarbon Containing Cuttings

- Controls & limits environmental liability
- Fast cost effective pit closures
- No hauling of drill cuttings
- No land farm risk

Pit Layout



Pit Layout



Pit Construction



Pit with Cuttings & Mud



In-Situ Bioremediation



Pit Closure



New Growth Appearing



Treatment Procedure

- Treat cuttings with **BioWash™** in storage area to minimize contamination
- Spread cuttings and blend with clean soil (dilutes TPH and introduces indigenous microbes)
- Plow or till area, adding bulking material if required (mulch or hay)
- Apply **MicroBoost™**
- Till - keep damp - monitor TPH
- Repeat until ready for closure

WHAT IS **BioWash™** ?

BioWash™ is a highly concentrated organic aqueous based cleaner and breaker for the removal of petroleum hydrocarbons from soils and surfaces. **BioWash™** is biodegradable and helps promote microbe growth.

ROLE OF **BioWash™** IN BIOREMEDIATION?

- Minimizes amount of contamination
- Improves microbe availability to contaminants
- Promotes the growth and activity of microorganisms present in the soil
- Non-toxic and non-hazardous
- Cost-effective
- Environmentally safe
- Easy to apply

WHAT IS *MicroBoost*™ ?

**NUTRIENT ADDITIVE SOLUTION
FOR EXCELERATED TREATMENT OF
PETROLEUM HYDROCARBON WASTES**

ROLE OF *MicroBoost*™ IN BIOREMEDIATION

- Promotes the growth and activity of microorganisms present in the soil
- Provides concentrated nutrition to microorganisms
- Improves oxygen and water supply to microbes
- Improves microbe availability to contaminants
- Non-toxic and non-hazardous
- Cost-effective
- Environmentally safe
- Easy to apply

MicroBoost™ REQUIREMENT

Influenced by:

- Soil composition
- Hydrocarbon and organic contents
- Nature and degree of inorganic contents of soil

Optimization of the MicroBoost™ ***function:***

- Tilling for aeration of soil
- Irrigation
- Temperature
- Complimentary additives

MicroBoost™ REQUIREMENT

Analytical information on soil:

- Total Petroleum Hydrocarbons
- Total Organic Carbon
- Cation Exchange Capacity
- Exchangeable Sodium Percentage

MicroBoost™ APPLICATION GUIDELINES

- Sample soil to establish existing contaminant levels (TPH 413.1 or 418.1)
- Remove excess free oil and treat sodium damaged soil
- Determine extent of damage in soil to be treated (depth and surface area)
- Establish proper ***MicroBoost***™ application rate.
- Till or disc soil
- Apply ***MicroBoost***™ solution onto the contaminated area (spray, till, or inject)
- Note and adjust soil pH
- Irrigate the site heavily with fresh water
- Monitor site periodically (samples, etc.)