Bioremediation of Hydrocarbon Impacted Soils in Central Alberta

Remediation Technologies Symposium

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Presentation Overview

- Review of Bioremediation
- Background on Petroleum Hydrocarbon Impacts
- Case Studies Scenarios
  - Soil characterization
  - Treatment technique
  - Confirmatory analyses

Summary-

- Benefits of land treatment;
- When is bioremediation appropriate

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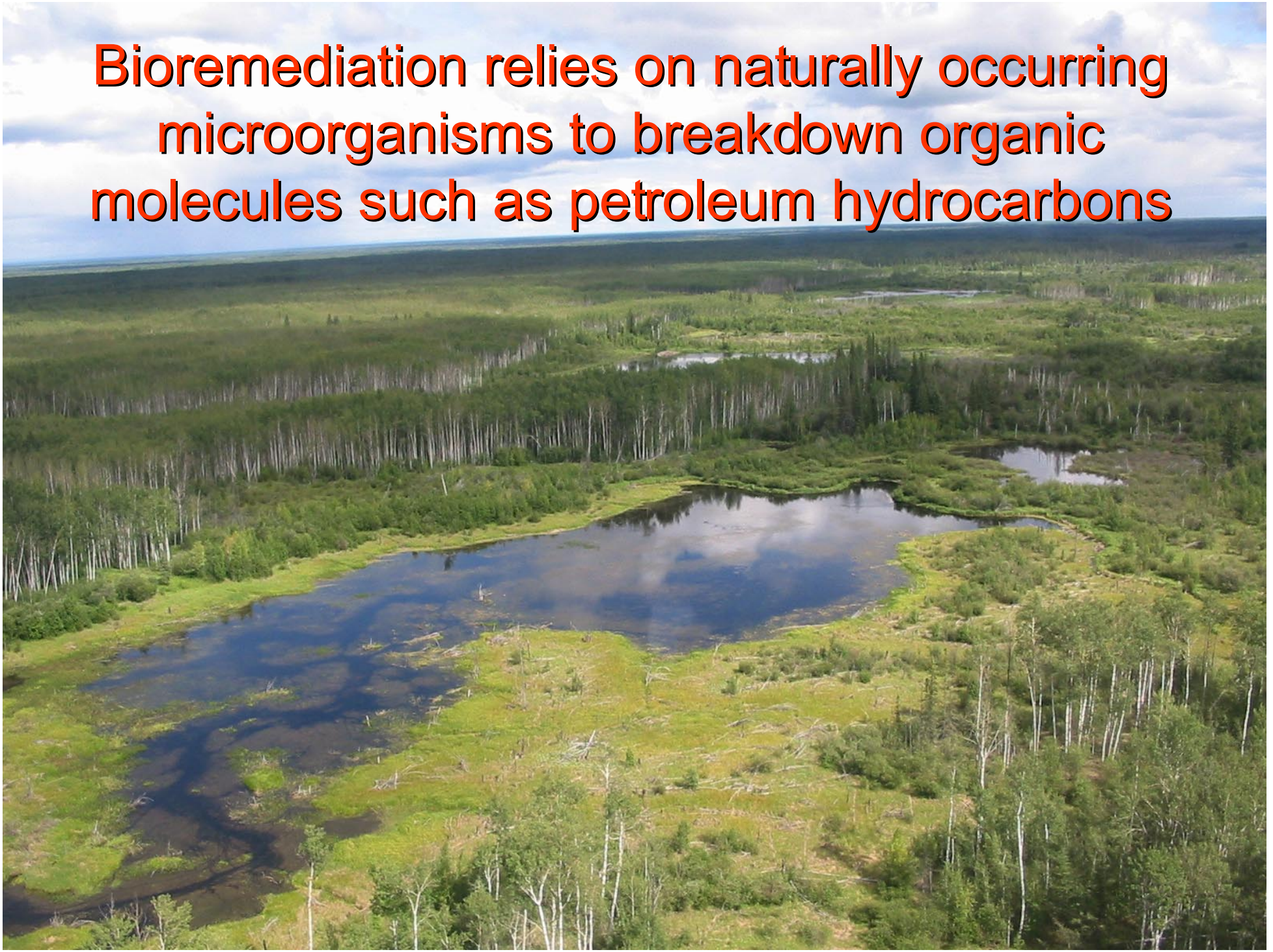
Bioremediation relies on naturally occurring microorganisms to breakdown organic molecules such as petroleum hydrocarbons

Bioremediation builds on techniques used in composting and agriculture

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Microbial Activity

- Suitability of biodegradation of soils is based on characteristics including:
- Low to medium salinity
- Metal content below regulatory criteria
- pH between 5 and 9
- Moisture content approximately 60% field capacity (20-40% moisture)
- Carbon: Nitrogen: Phosphorus (100:10:1)

Composting and Bioremediation

Compost Systems

- Available Carbon and Nitrogen from fresh residues
- Microbial population is diverse
- Wide array of feedstock that can be used in recipe

Bioremediation Challenges

- Hydrocarbons may be unavailable
- Lack of hydrocarbon degraders;
- Naturally occurring hydrocarbons in amendments

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Hydrocarbon impacted soils originated and were treated at active upstream oilfield sites.

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Soil Characterization to Evaluate Treatment Potential

- During a phase II assessment, soil analytical data compared to generic criteria (AENV TIER I)
- Consideration to build a treatment cell –background location evaluated;
- Site evaluated for environmental receptors;
- Impacted soil characterized for
  - Recalcitrant compounds;
  - Salts and metals;
  - Organic halides and polyaromatic hydrocarbons;

Case Study 1 Former Flare Pit Impacted Material Treated On Lease Using A Bulldozer Equipped With A Cultivator

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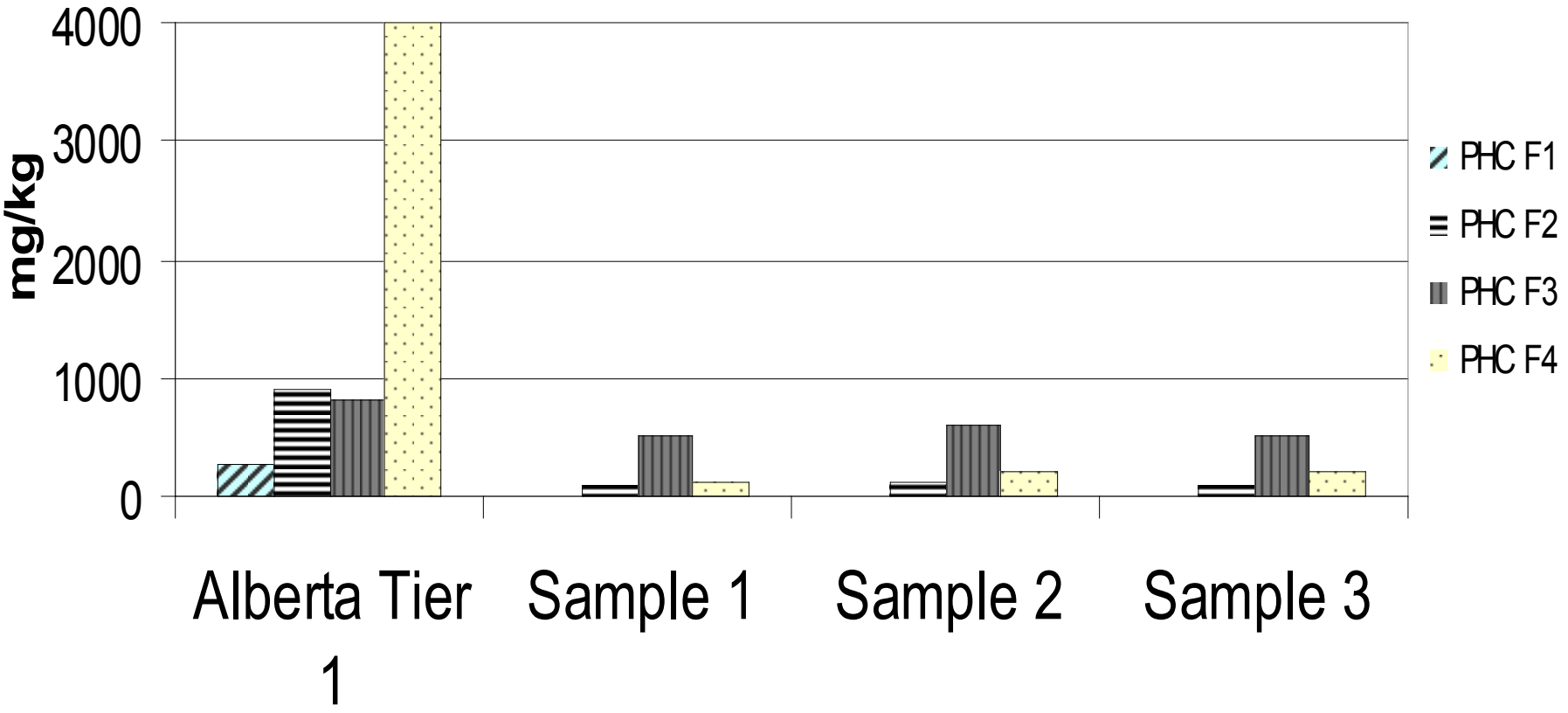
Soil Quality Compared to AENV 1994 Criteria

- Soil parameters reported hydrocarbon impacts including:
- Benzene 0.15 mg/kg soil;
- Toluene 1.56 mg/kg soil,
- Ethylbenzene 2.17 mg/kg soil;
- Xylenes 9.91 mg/kg soil; and,
- Total Petroleum Hydrocarbons up to 6170 mg/kg soil.

Figure 1. Case I Comparison of Alberta 2001 Criteria and PHC Fractions After Land Treatment Complete.



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Land Treatment Using Bulldozer with Cultivator

- *Approximately 3,000 m^3 were treated in a period of 18 months*
- *Petroleum hydrocarbons were below criteria*
- *Land treatment pad was reclaimed*
- *No additional land was required for on site treatment*

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Case Study 2: Biopiles Aerated with Mixing Unit

- Petroleum hydrocarbon impacted soil:
- Benzene 0.14 to 0.23 mg/kg soil;
- Toluene below criteria,
- Ethylbenzene 2.17 mg/kg soil;
- Xylenes 1.36 mg/kg soil; and,
- Total Petroleum Hydrocarbons up to 1,600 mg/kg soil.

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Track hoe can be equipped with mixing unit

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Mixing heavy clay soil and cobbles

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Treatment Summary

- Build treatment pad on site
- Use track hoe equipped with mixing unit to aerate biopiles
- Add amendments NPK to stockpile
- Stockpile soil in biopiles 1.5 m high;
- Conducted confirmatory sampling in sections of treatment pad

Confirmatory Analyses

- Benzene, Toluene, Ethylbenzene, Xylene, were all below AENV 2001 Criteria
- PHC Fractions (F1 to F4) were below AENV 2001 Criteria
- Addition of nutrients raised the EC above 2.0 dS/m;
- Loss of hydrocarbons through volatilization and degradation was not quantified

Extractable Hydrocarbons

Carbon Chain	Boiling Range	Before Turning	After Turning
	ºC	mg/kg soil	mg/kg soil
C11-C12	196 to 216	17	<1
C16-C17	271- 287	38.9	16
C30-C31	441 to 449	25.5	27

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Bioremediation works with some of the oldest organisms on earth

Summary

- On site land treatment in central Alberta conducted in active oil field sites using two different technologies;
- Both achieved PHC levels below regulatory criteria;
- Land treatment is based on one time application
- Several other equipment types are available including windrow turners, roto-tillers, allu-bucket

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Benefits of bioremediation

- Reduced transportation and disposal fees; soils are handled more due to turning;
- Soils can be treated and used as industrial fill;
- Cost are about \$50-60 /m^3;
- Suitable for remote sites where trucking cost can be quite expensive

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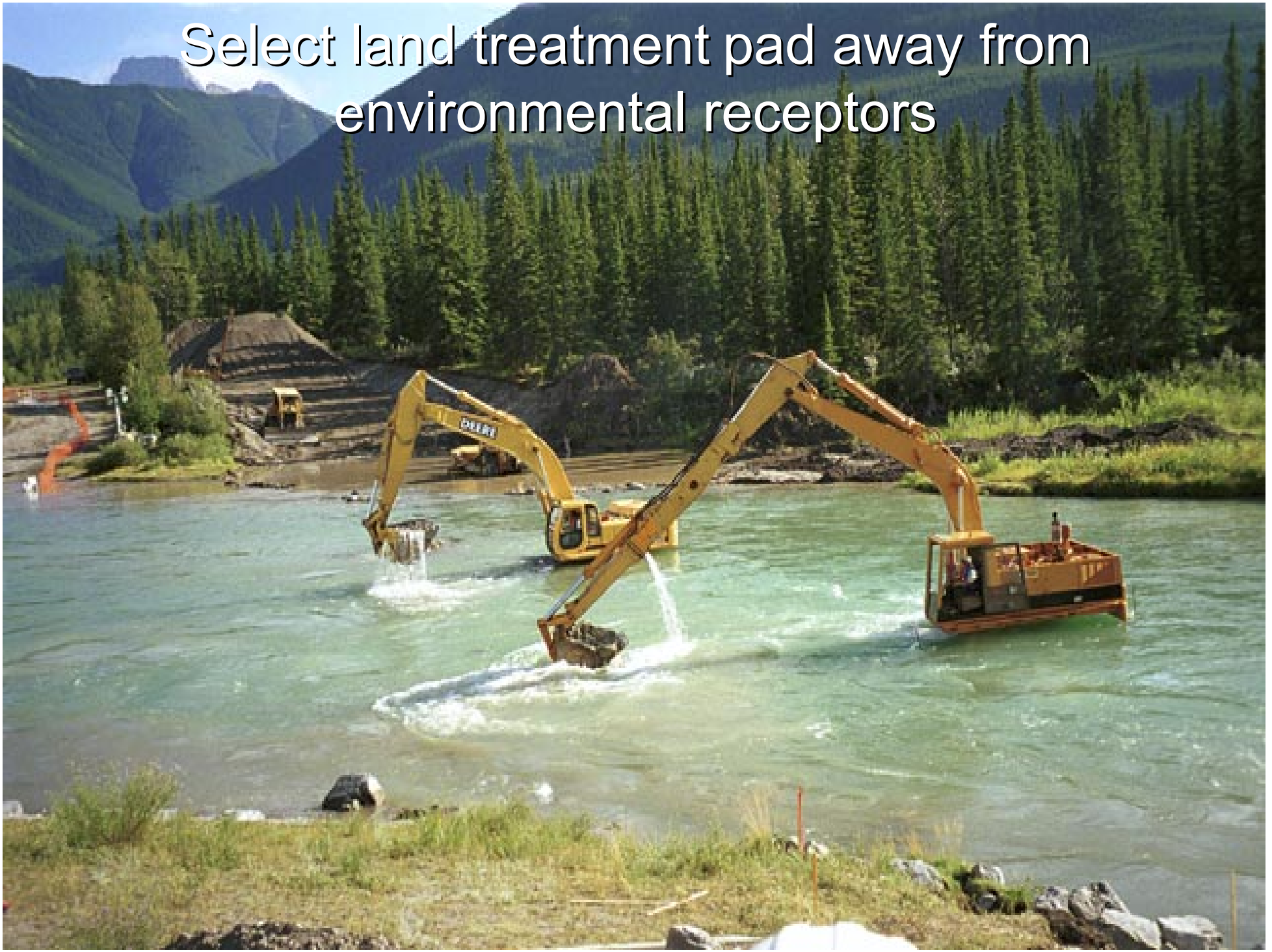
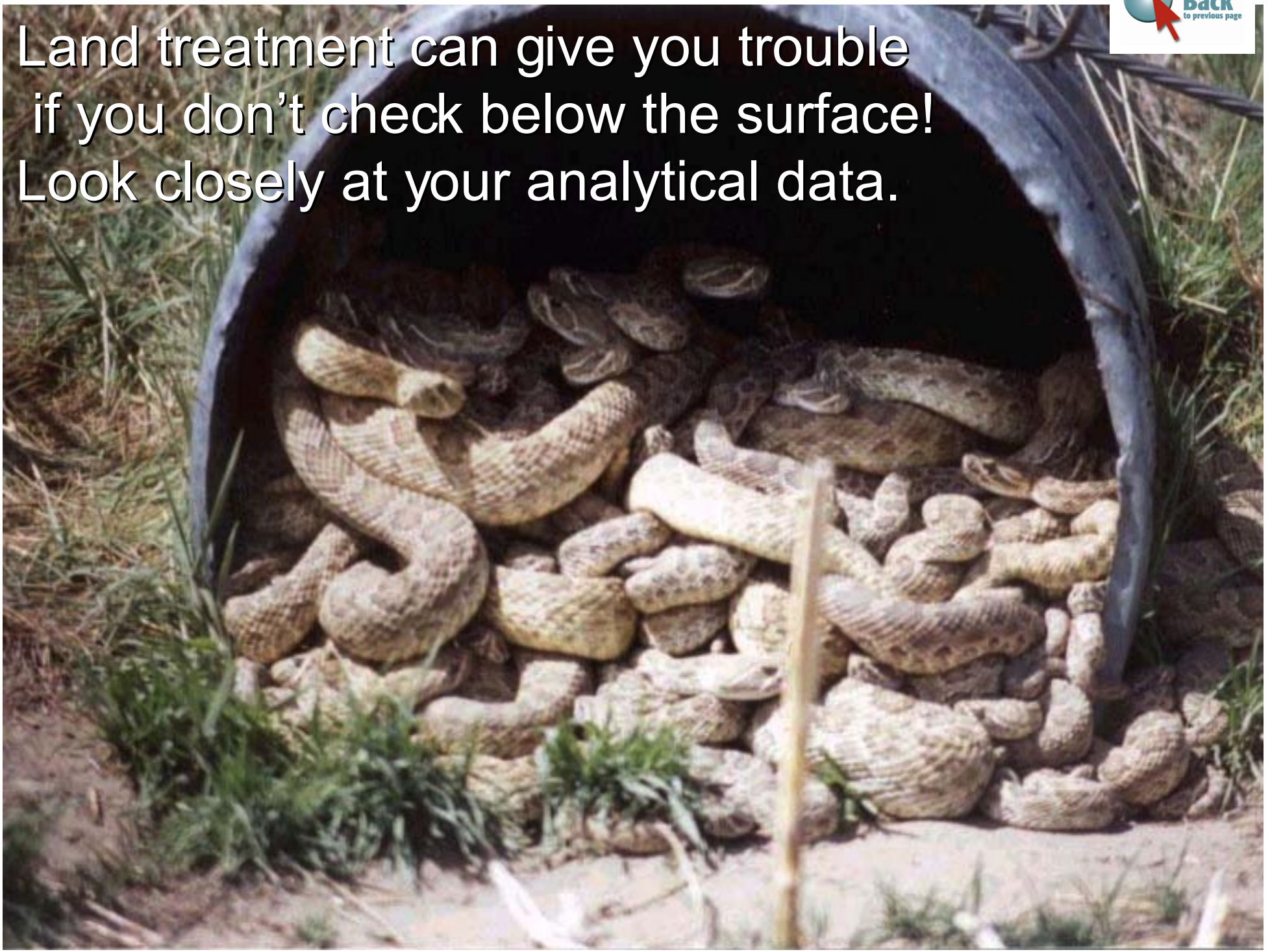
Bioremediation is appropriate if

- Amount of soil can be treated within existing lease or additional land is available;
- Treatment can be done within 2-3 years;
- Treatment pad can be located away from sensitive environmental receptors


Select land treatment pad away from environmental receptors


Land treatment can give you trouble
if you don't check below the surface!
Look closely at your analytical data.