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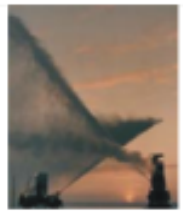
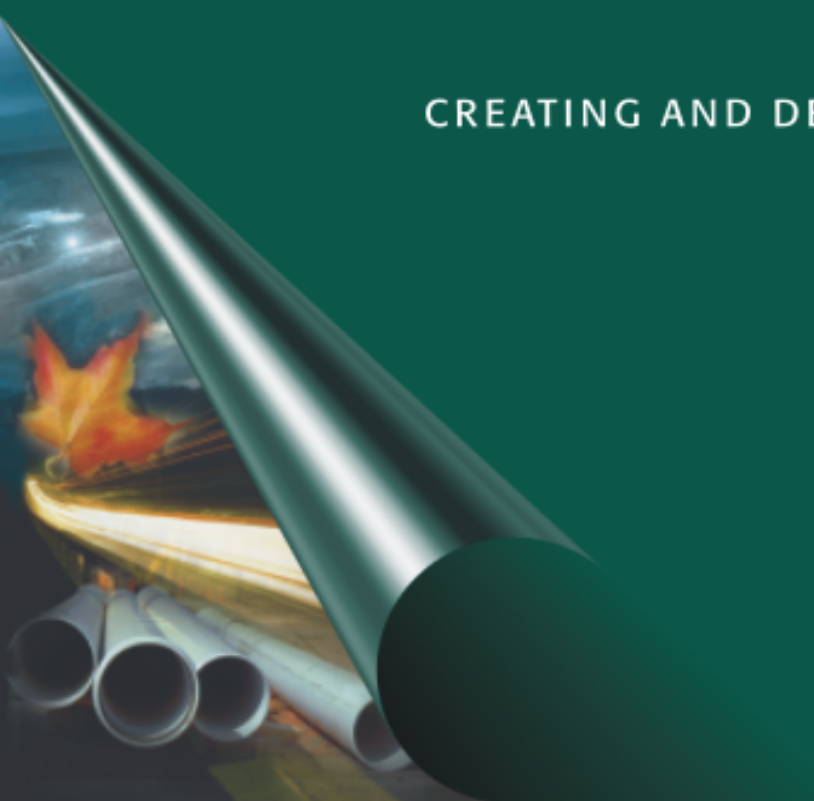





CREATING AND DELIVERING BETTER SOLUTIONS



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Successful Field Trial of a Multi-process Phytoremediation System for Remediation of Petroleum Impacted Soils

Neil Reid, M.Sc., P.Ag.
EBA Engineering Consultants Ltd.
and
Bruce M. Greenberg, Ph.D.
University of Waterloo and
Waterloo Environmental Biotechnology Inc.

OUTLINE

- Technology (General Summary)
- How it works
- Field Study
  - Summary of Study
  - Results Year 1 / 2
  - Conclusions / Expectations

Phytoremediation Technology

- Developed by Dr. Bruce Greenberg

(University of Waterloo and Waterloo Environmental Biotechnology Inc.)

- Rational for Development
  - Low cost
  - Suitable for remote sites
  - Suitable in a wide range of climates
- Four years of field studies Alberta and Ontario

Phytoremediation Technology

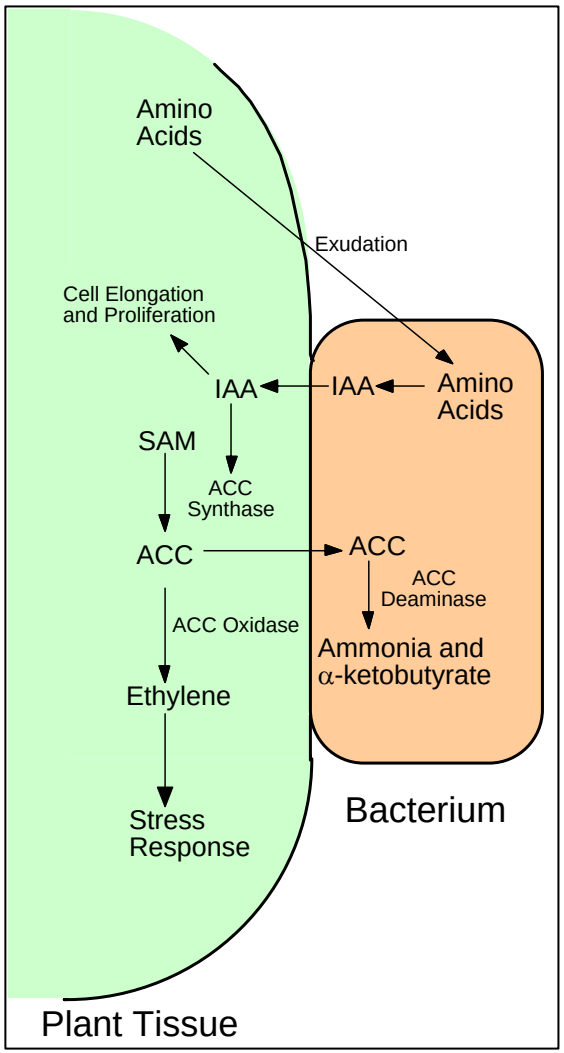
Multi Process Phytoremediation System (MPPS)

- Physical Soil Treatment
- Inoculation of seed with PGPR
- Phytoremediation growth of plants with PGPR

Physical Soil Treatment

- Aerates the soil
- Photooxidizes PHC by exposing them to the light (reduces thermodynamic barrier to biological oxidation)
- Allows for volatilization

Multi Process Phytoremediation System



Plant Growth Promoting Rhizobacteria

Two natural non-pathogenic strains of ***Pseudomonas putida***

One has high ACC Deaminase
One is an auxin producer

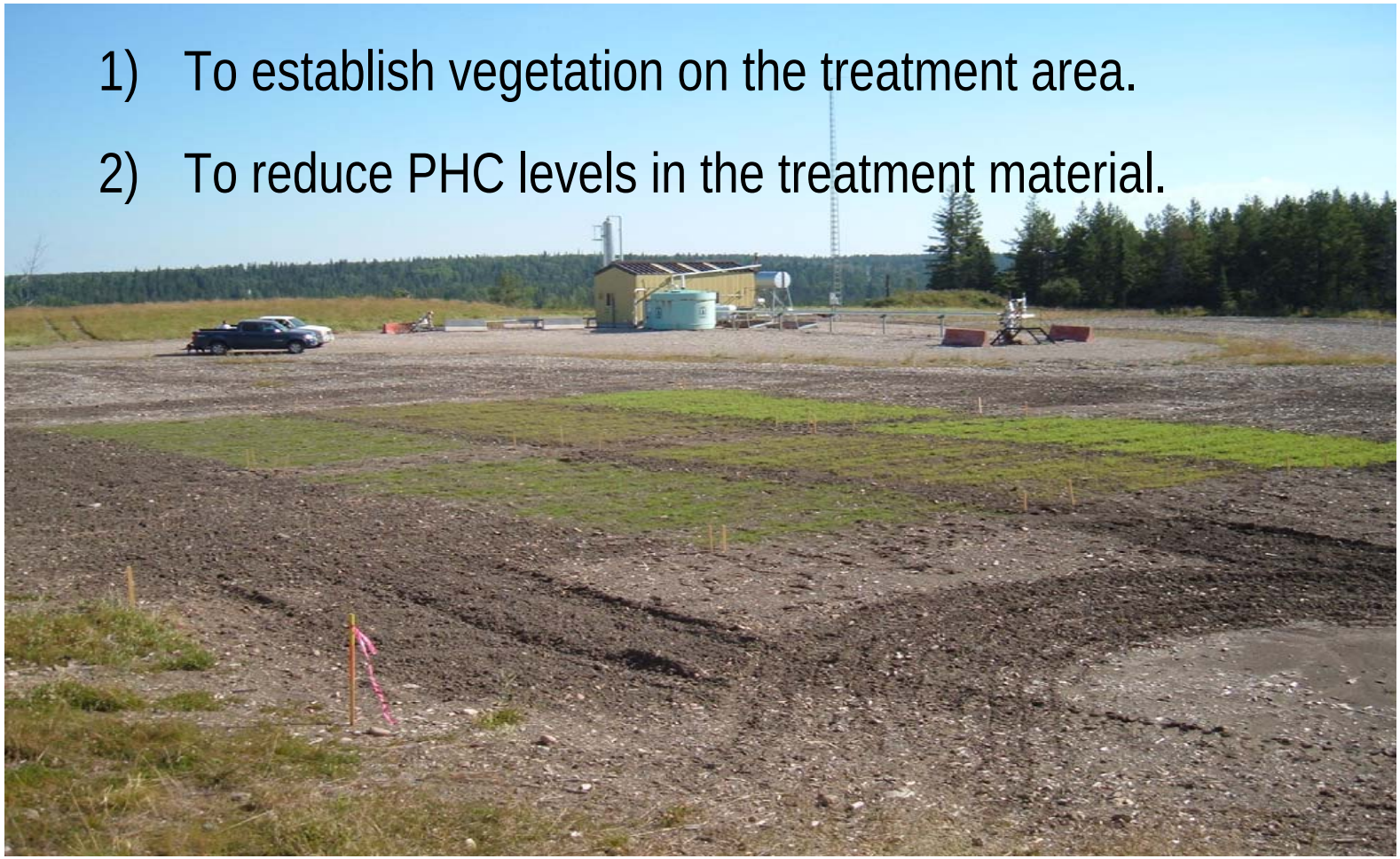
Both PGPR are applied to seeds prior to planting

Multi Process Phytoremediation System

Phytoremediation
growth of plants with PGPR

- Creates soil conditions favorable for biodegradation of PHC **(oxygen, drainage, structure)**
- Preserves natural soil structure and texture
- High levels of microbial biomass in the soil can be achieved

EBA Field Study (Hinton, Alberta)



EBA Field Study (Hinton, Alberta)

- Compost Invert Drilling Mud (CIDM)
- Biopile / Land Treated Unsuccessfully
- F2 (130 – 1,400 mg/kg) and F3 (1,100 – 6,100 mg/kg).
- Ecotoxicity

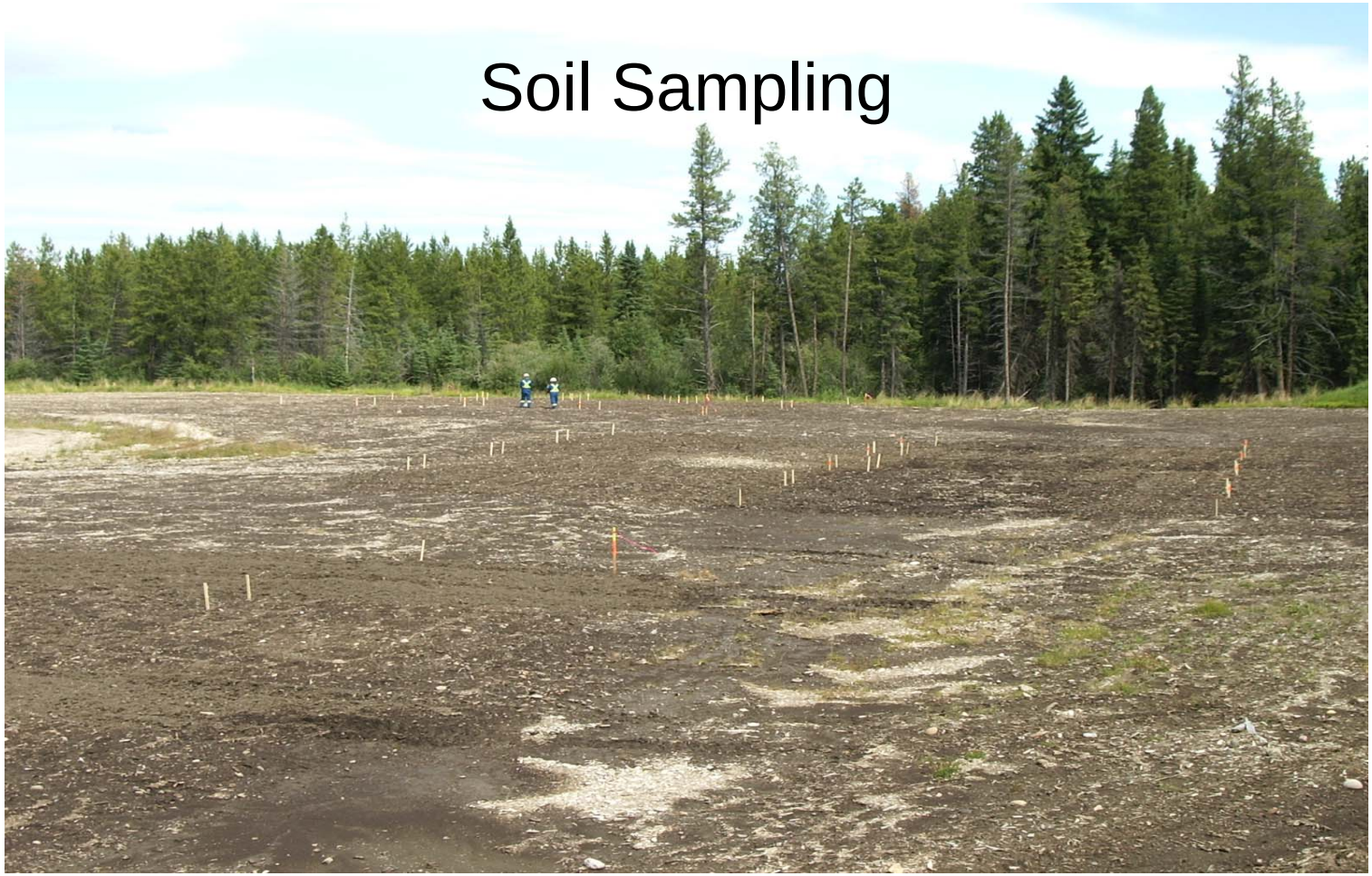
EBA Field Study (Hinton, Alberta)

EBA Field Study (Hinton, Alberta)

- Three blocks of three species + / - PGPR
- Physical Treatment
- Soil Sampling
- Planting
- Fertilizer
- Soil / Vegetation Sampling

EBA Field Study (Hinton, Alberta)

EBA Field Study (Hinton, Alberta)

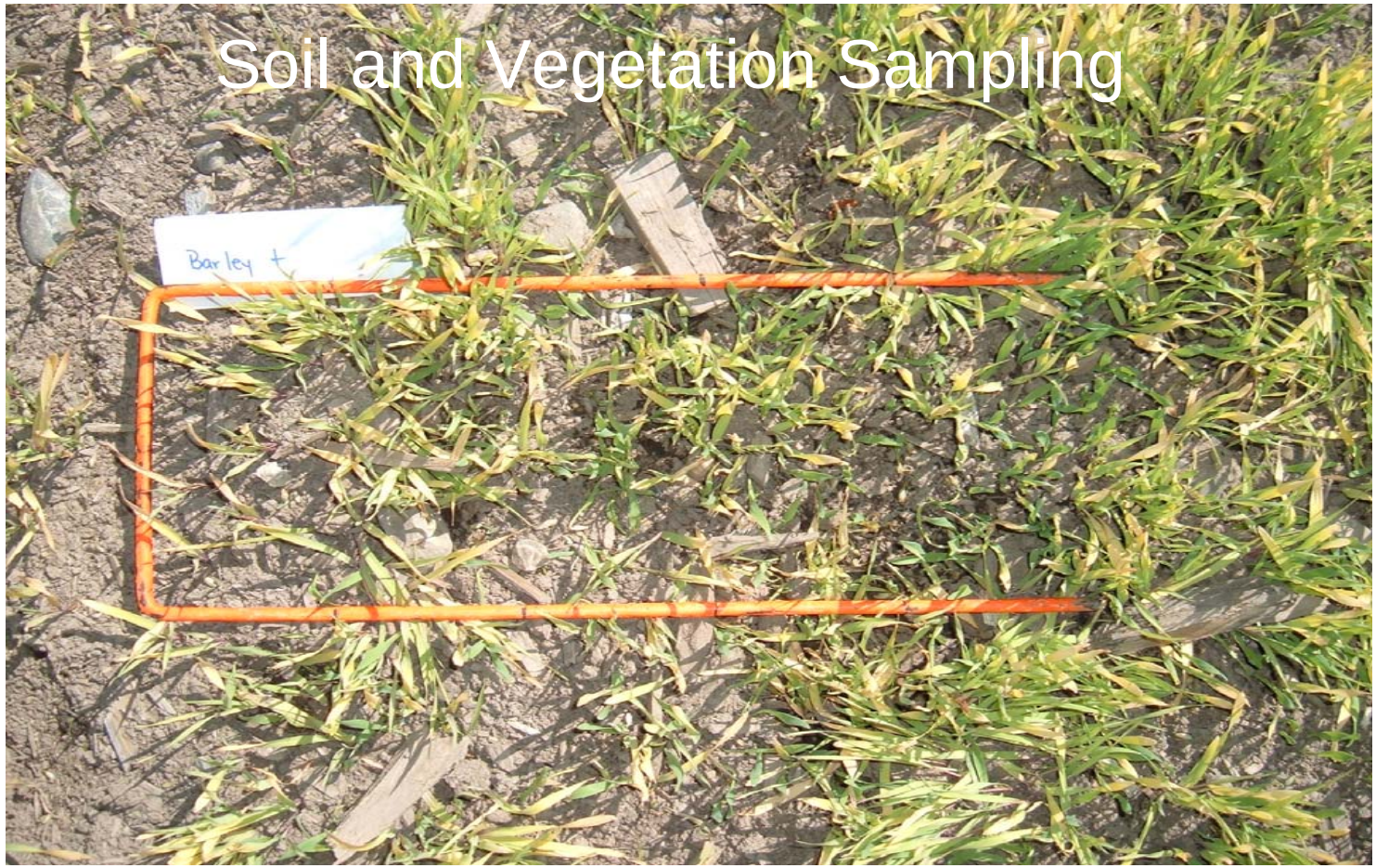


EBA Field Study (Hinton, Alberta)

Seeding / Fertilizer

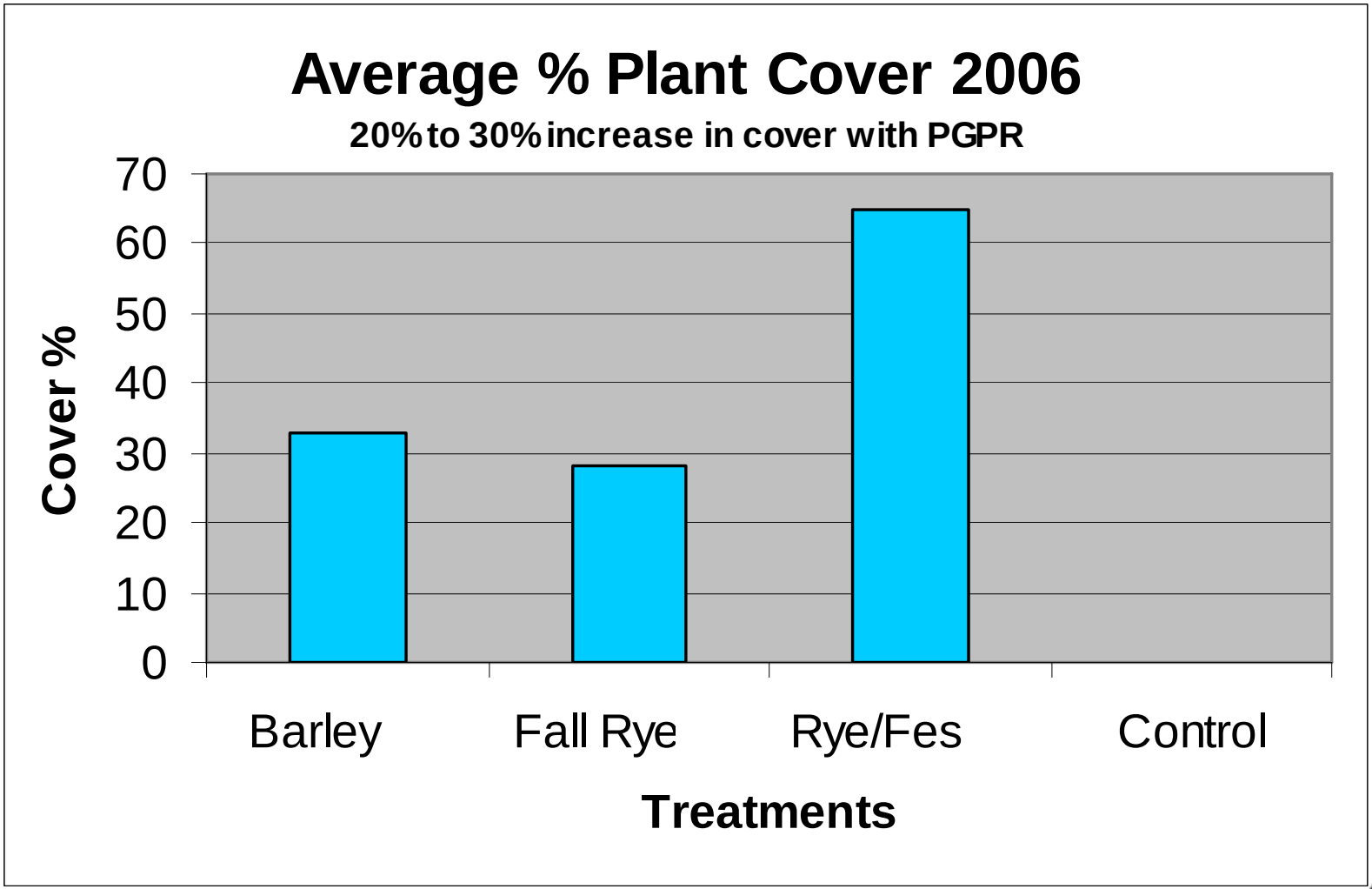
EBA Field Study (Hinton, Alberta)

EBA Field Study (Hinton, Alberta)

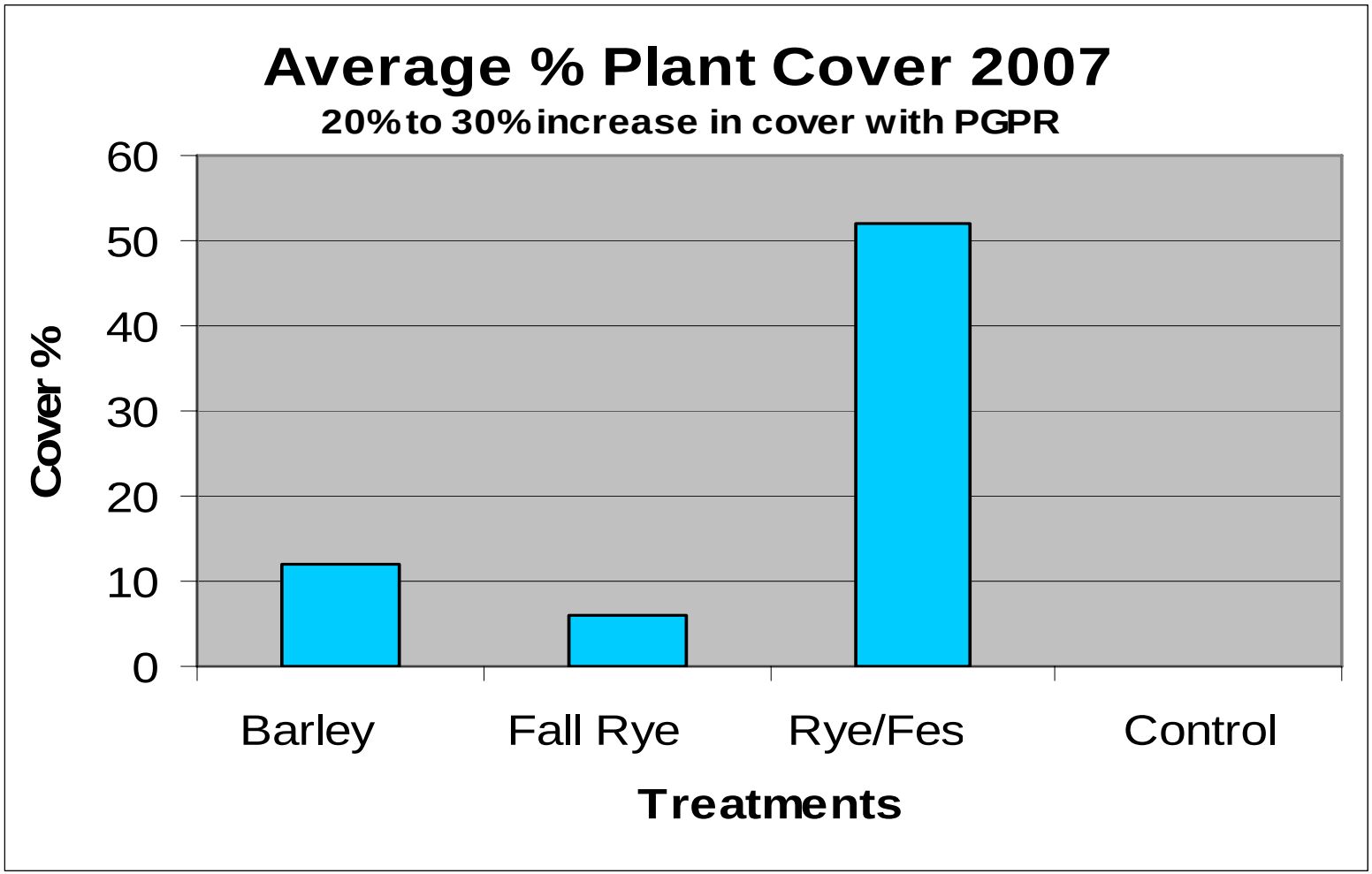


EBA Field Study (Hinton, Alberta)

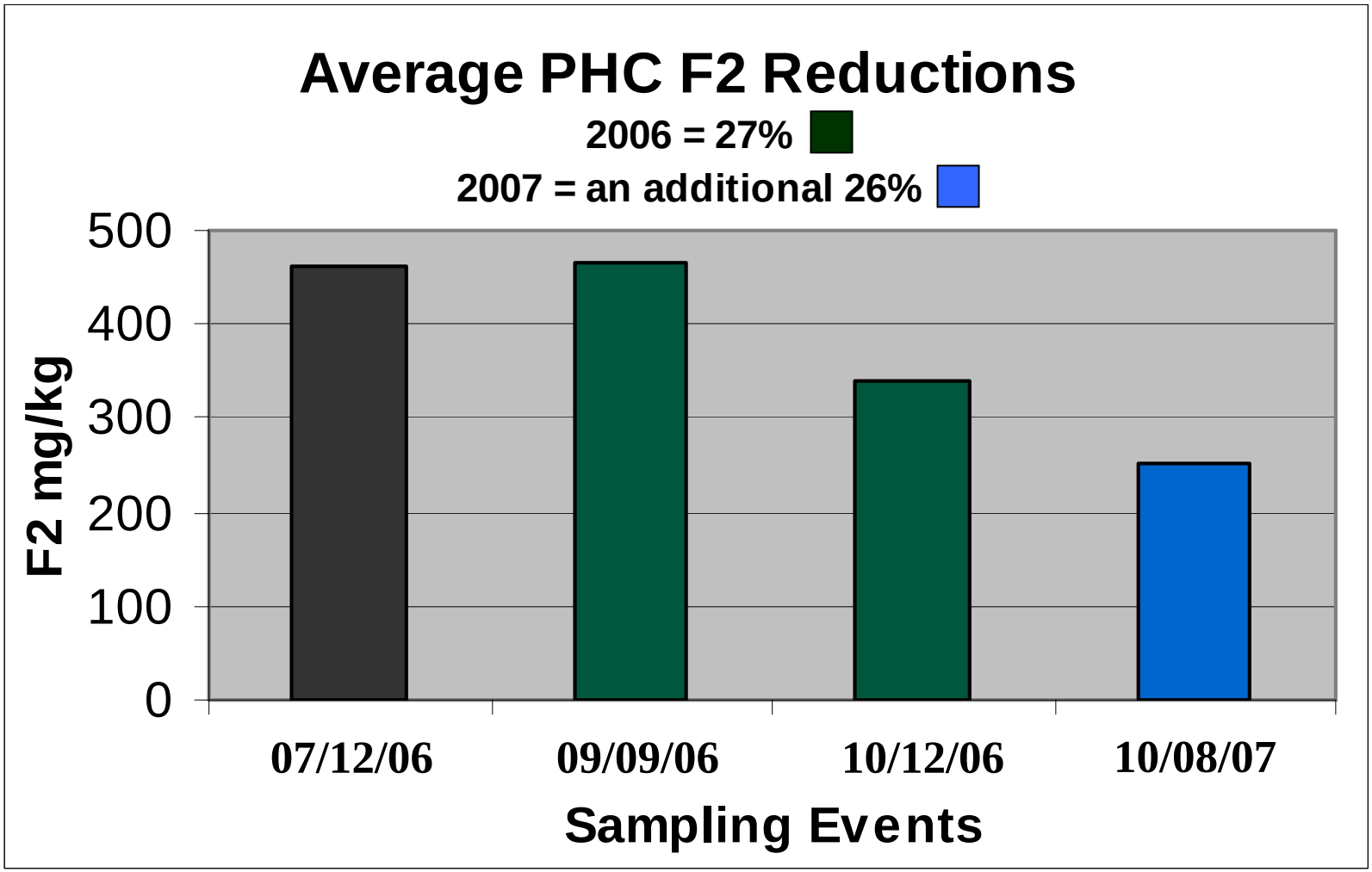
Field Study Results 2006



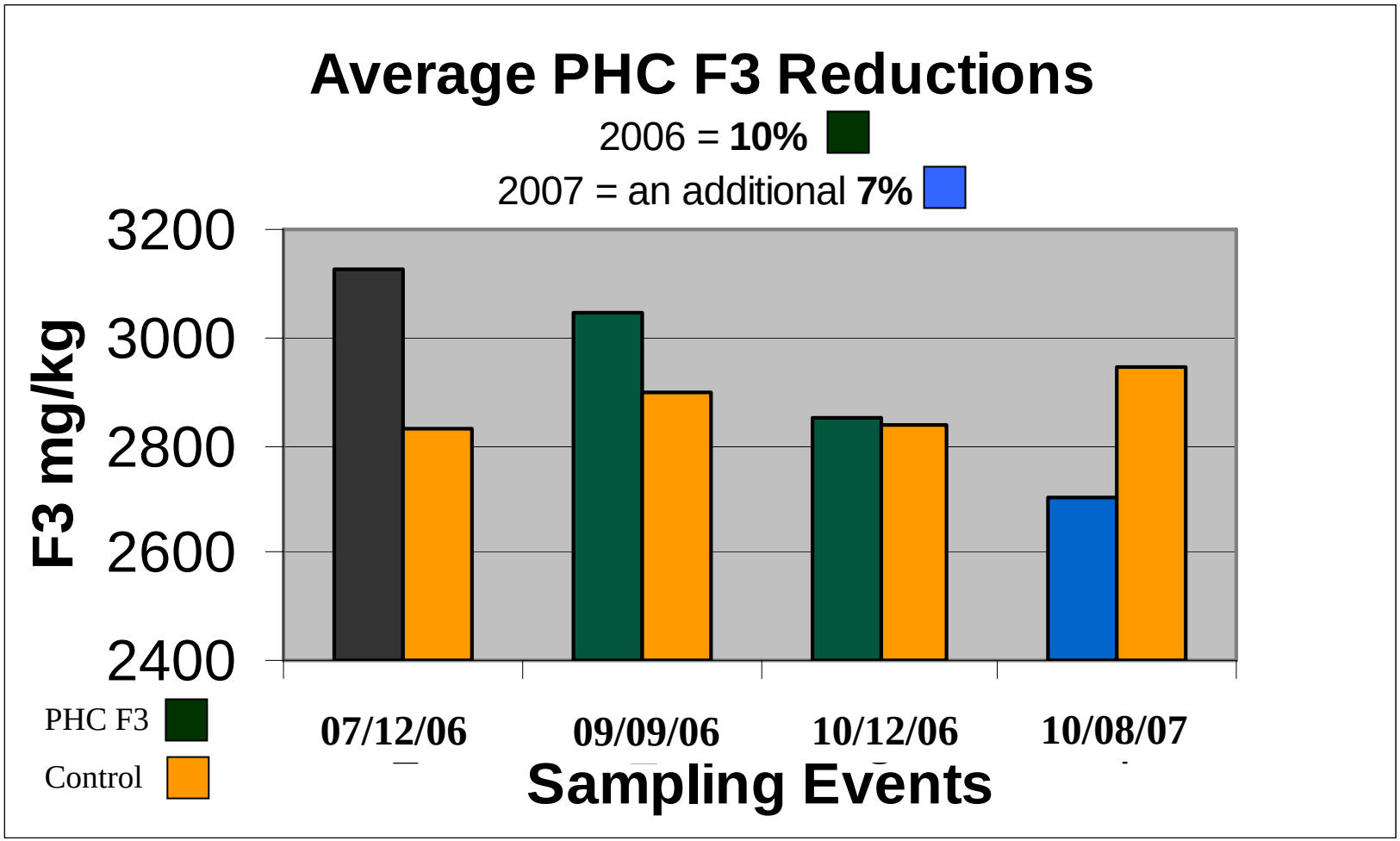
Field Study Results 2007



Field Study Results 2006 / 2007



Field Study Results 2006 / 2007



Field Study Summary

- Good establishment and growth of vegetation
- Winter survival of perennial species
- Reduction of hydrocarbon levels in the CIDM material over two growing seasons
  - 17% reduction of F3
  - 53% reduction of F2

Full Scale MPPS, 2007

Full Scale MPPS, 2007

Phytoremediation Expectations

- Vegetation cover will be sustainable with minimal inputs
- Continued reduction of hydrocarbon levels in the CIDM material
- With long-term monitoring remediation / reclamation of the site can be achieved

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