Routes to Successful Phytoremediation of PHC Impacted Soil:
Site Selection and Case Studies

A Practitioners Guide

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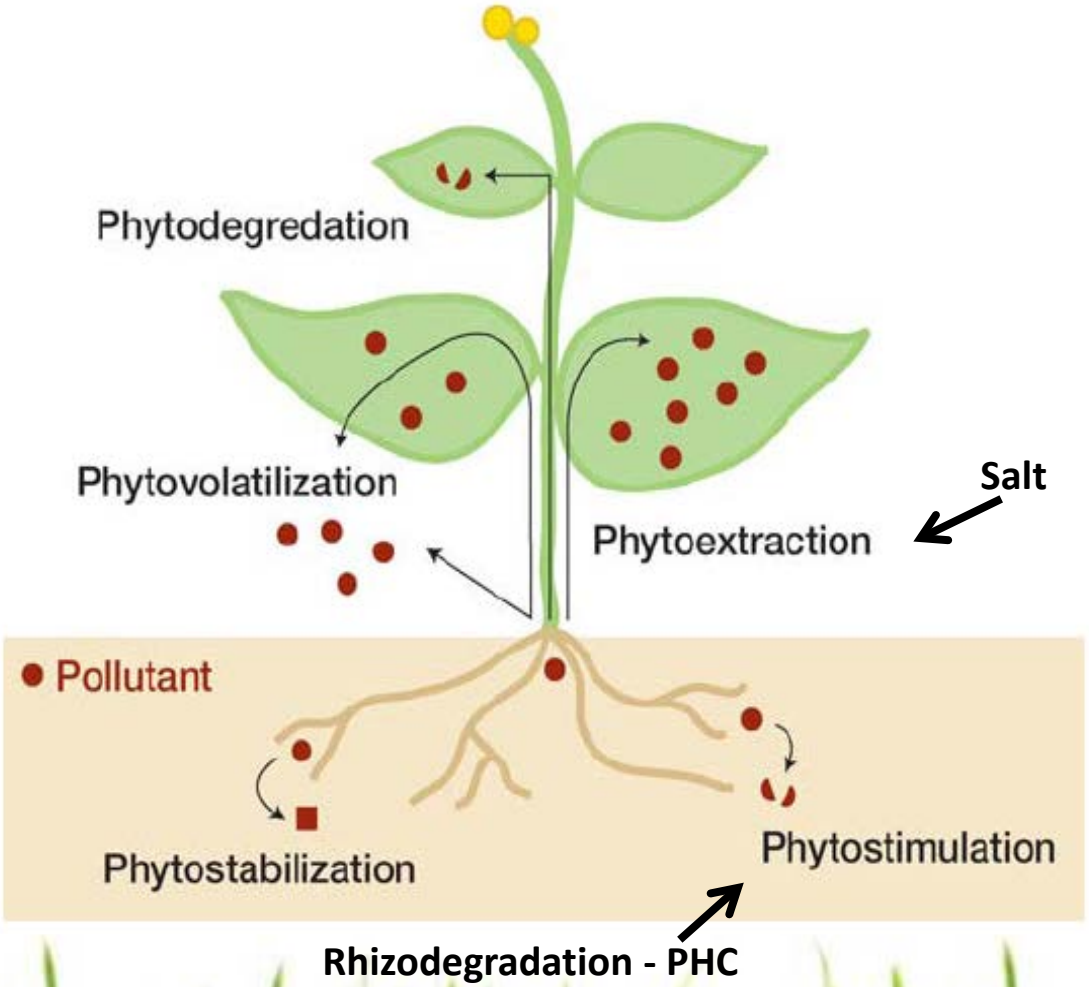
Outline

- Phytoremediation
- PEPS
- Case Studies
  - Red Earth Creek (Boreal Mixedwood)
  - Gregg River (Upper Foothills)
- Commonly Asked Questions

Phytoremediation



- Volatilization
- Phytodegradation
- Plant uptake soil→root
- Rhizosphere processes
- Bioavailability (particle→water)

PEPS

- PGPR Enhanced Phytoremediation System
- A PROVEN phytoremediation operation:
  - PGPR
  - Soil treatment area management (amendments, seeding, soil manipulation)
  - Performance measures
  - Final site closure
  - Treats all PHCs including F2, F3, F4, PAHs and salts

Red Earth Creek, AB

Pre-Construction

Construction

Construction

Construction

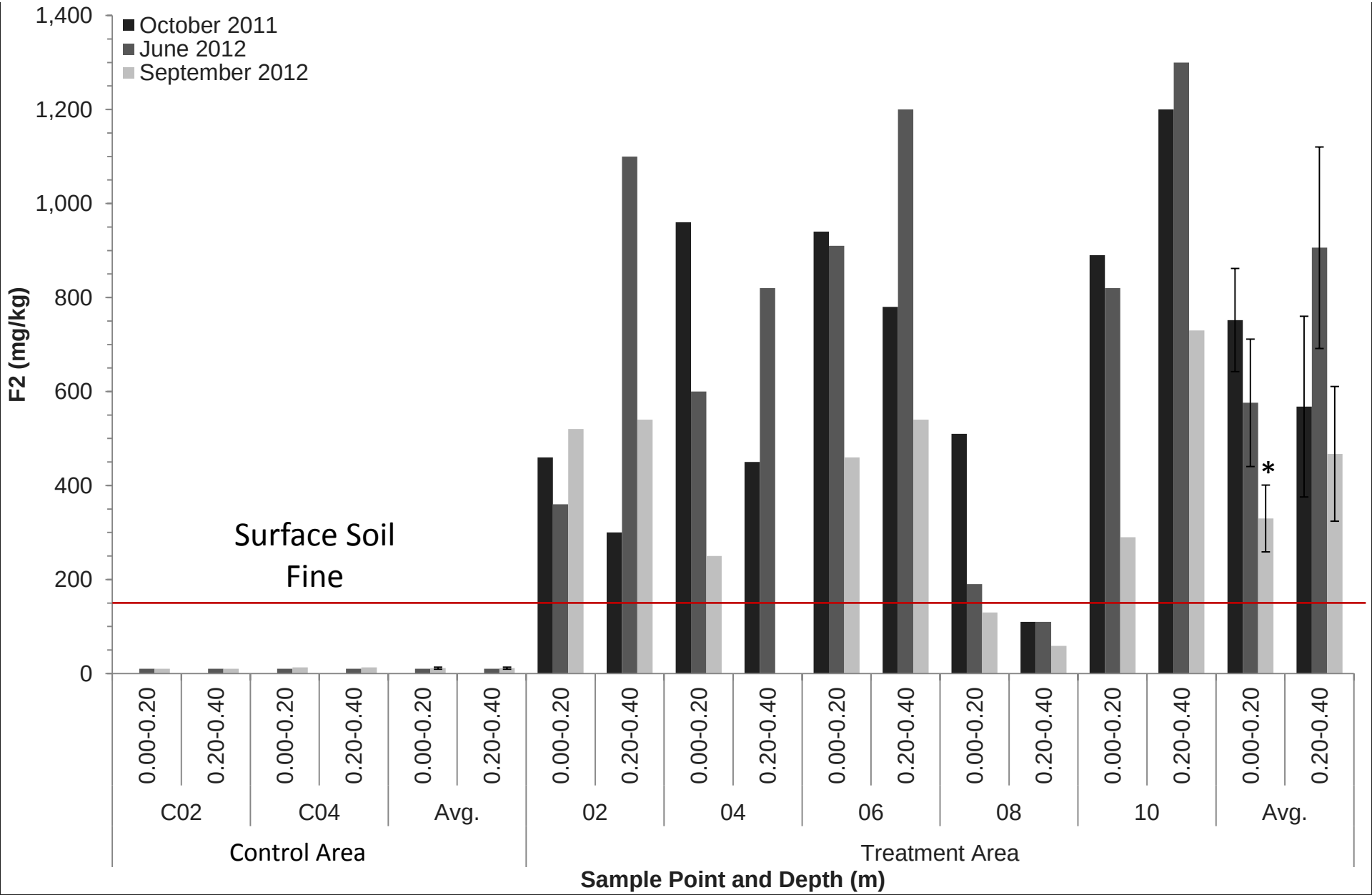
Impacted Soil Placement

Seeding & Fertilizing

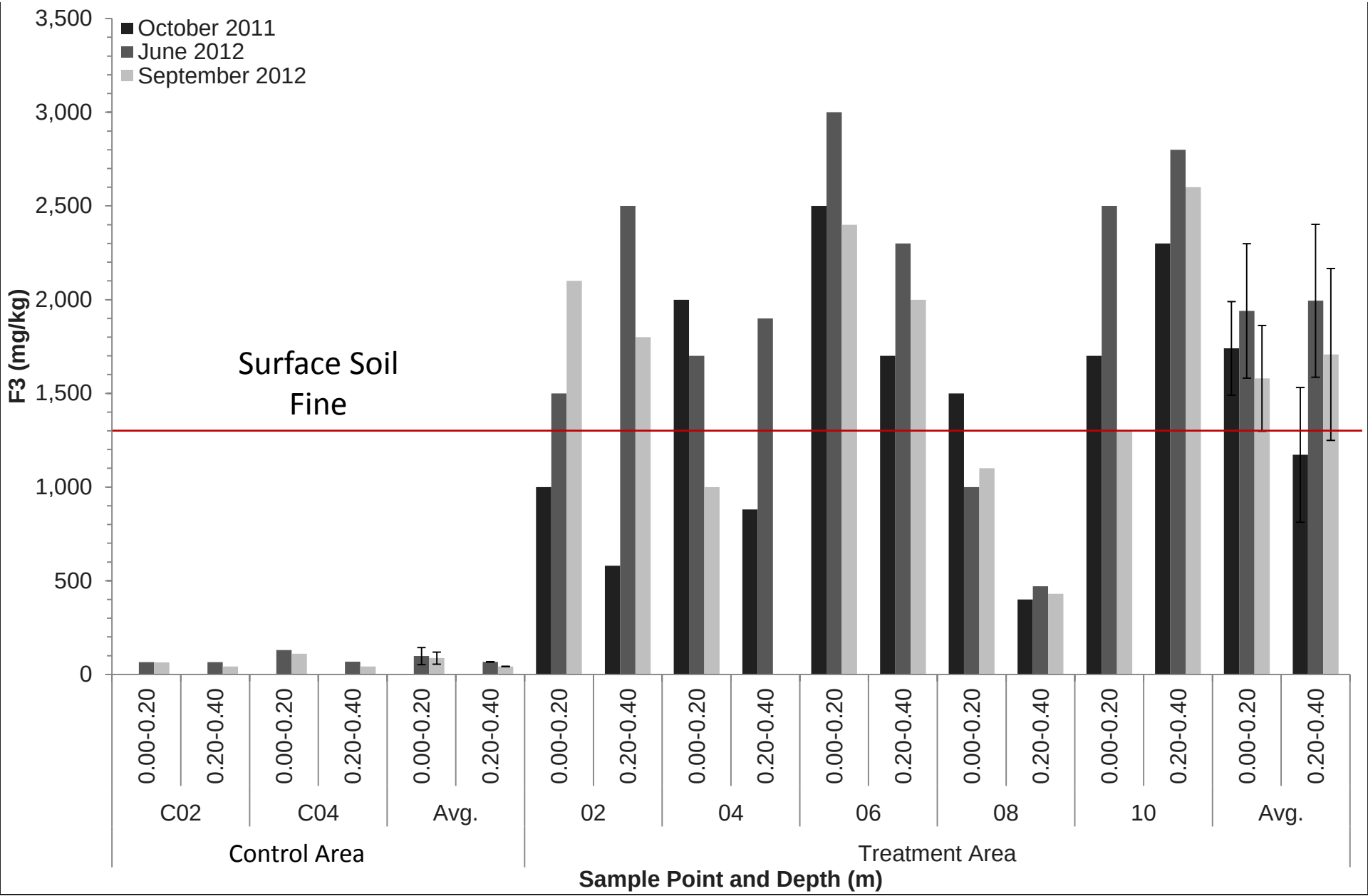
Year One Growth

Harvesting

F2 – Year One Results



F3 – Year One Results



Gregg River, AB

Treatment Pad Construction

Impacted Soil Excavation

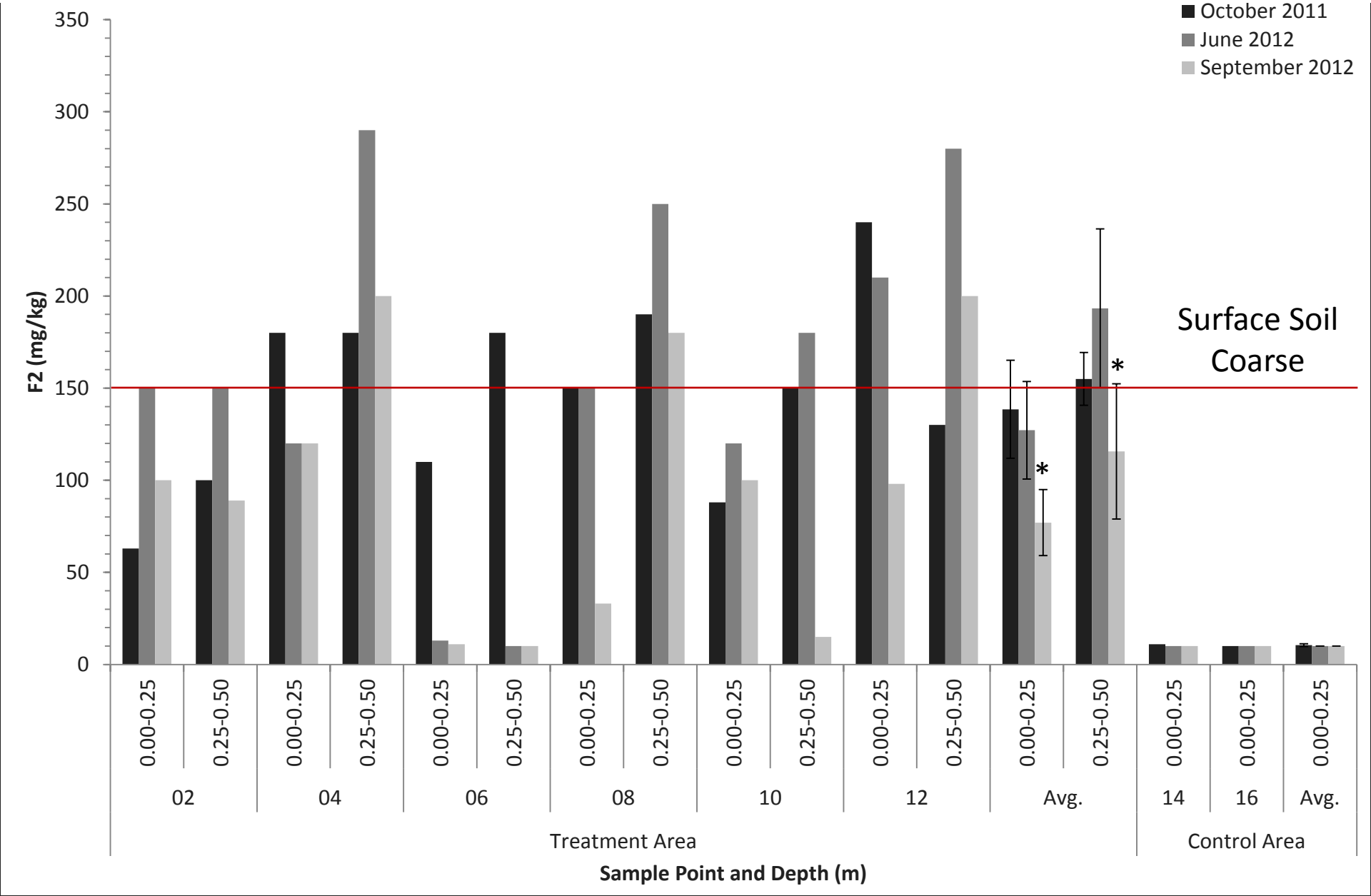
Treatment Area

Seeding & Fertilizing

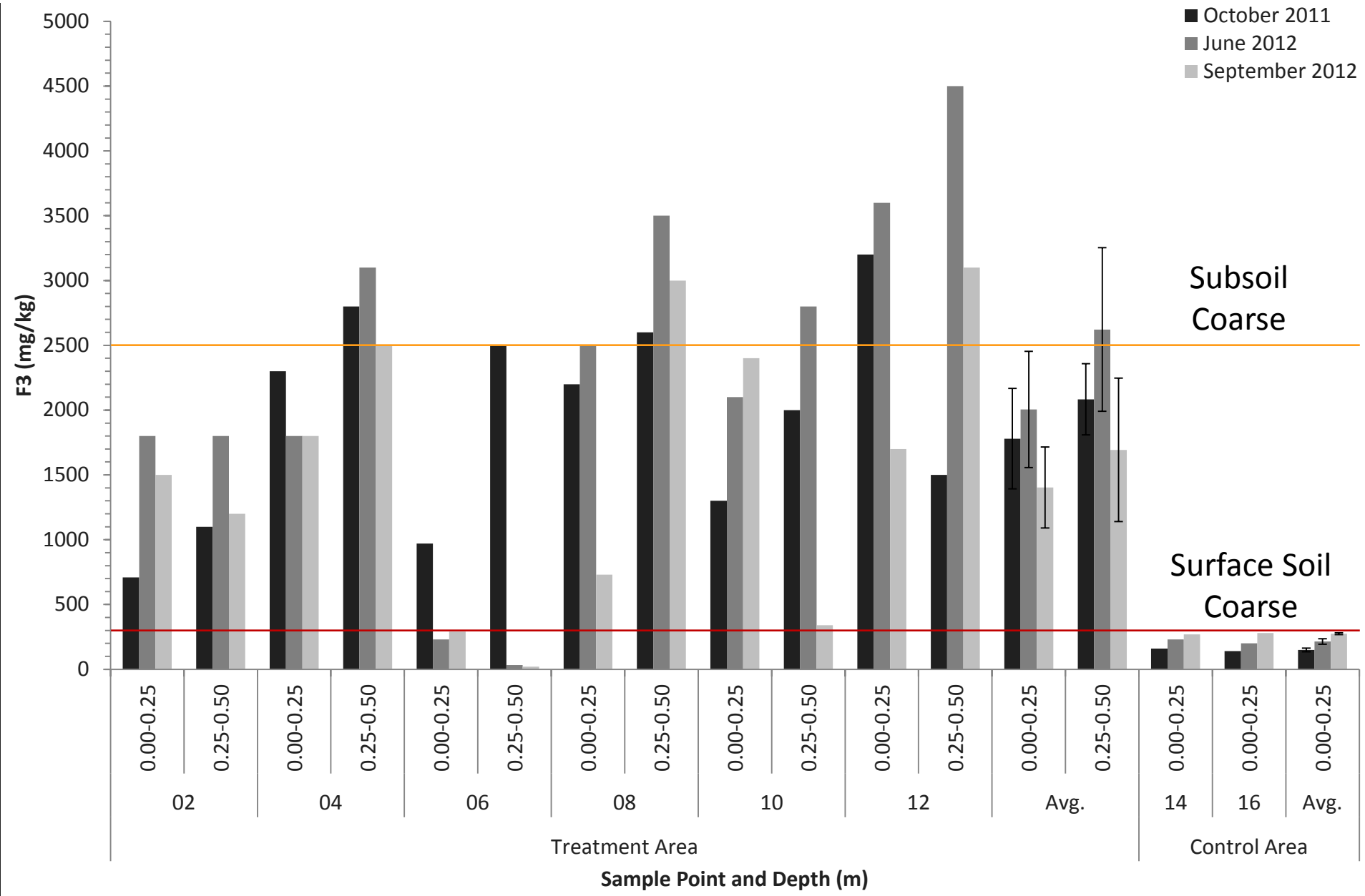
Early Year One Growth

Fall Year One Growth

F2 – Year One Results



F3 – Year One Results



Commonly Asked Questions

Is it cost effective compared to conventional remediation methods?

- F2 / F3 / F4 / PAH
- The larger the soil volume, the cheaper the unit cost
- $30.00 → $100.00/$m^3$
- Unit costs depend on:
  - Material chemistry and remedial endpoint
  - Site/treatment area conditions
  - Volume
  - Geographic location

How long to complete remediation?

- Typically 2-3 years/50 cm layer of soil to generic criteria

Is available treatment area a limitation?

- Potentially - large volume and small treatment area
  - Treat soil in successive lifts
  - Move soil to adjacent leases (AER notification/approval)

What happens to the vegetation after it is harvested? Is it safe for animal consumption?

- Stockpile and leave to compost – use for organic matter at time of reclamation
- Work into soil
- It is safe as animal feed

Does Earthmaster and WEBi work with other consultants?

- Yes
- We ‘sub’ to project site consultants

Can PEPS be used on wet sites?

- Yes
  - Plant species selection important
  - Create elevated treatment pad
  - Need to dry treatment zone soils to provide oxygen for aerobic PHC degradation
  - Ability to access wet sites (ATV, helicopter etc.)

Are there any guarantees that after phytoremediation all PHC levels will be reduced below guideline values?

- Short answer, No. Similar guarantees to biopile, landfarm or allu/trommel treatments
- Biological systems while they can be predictable are also unpredictable
- Many site specific soil and climate factors affect plants and soil microorganisms
- Tier II risk assessment

Can this technology be used to treat metals and other forms of contamination?

- PEPS effectively remediates soil with PHC (BTEX, PAHs and F1-F4) and salts
- Phytoremediation of trace metals and some pesticides is probable but not yet proven with PEPS

Does a shorter growing season (Northern Canada) increase the normal time period to phytoremediate a site?

- No - Shorter growing season – longer days – same daylight hours

Is the PEPS technology proprietary?

- The technology is in the public domain – all scientific and research information published in peer reviewed scientific journals
- Earthmaster/WEBi have the practical application knowledge to make it work. Significant time and money spent to develop our procedures and methods

What can be done if a site has contaminated hot spots?

- Homogenize the soil so can reach remedial endpoint at same time on all areas of site
- Excavate and landfill small hot spot volumes and phytoremediate remainder

Are we introducing non-native bacteria into the ecosystem?

- No
- We isolate our bacteria from Canadian soils
- They are ubiquitous in nature
- Biohazard safety level 1 – non-pathogenic and not GMOs

When a site is ready for reclamation is there an invasive and viable agronomic seed population in the treated soil?

- Non-invasive species are used
- Plants can be eradicated after phytoremediation is complete
- Annual harvest before seed set can eliminate seed production

What makes PEPS better than other phytoremediation systems in Western Canada?

- Proven, efficient and >13 years of experience
- Extensive research → proven effective in the field
- Seed treatment with PGPR proven to significantly enhance phytoremediation
- Commercial projects successfully completed – no failures
- Practical process – use of conventional and available equipment and amendments
- Significant investment to develop methods and process for successful field application

Questions?

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