Ecological Risk Assessment (ERA) for the City of Greater Sudbury

Public Advisory Committee (PAC) Meeting

November 15, 2005

Presentation Overview

- What is an ERA
  - What did we look for?
  - Where did we conduct the study?
  - What are the next steps?

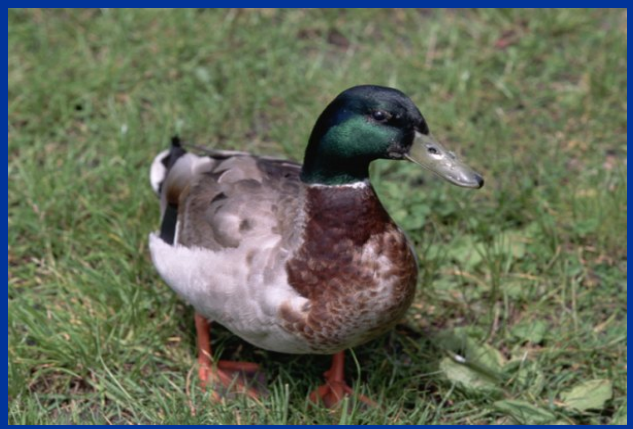
ERA – What is it?

- An established scientific approach to evaluate the existing potential for adverse effects to the natural environment from lifetime exposure to conditions in the environment
  - **Soil, water, air, food**

Sudbury Ecological Risk Assessment

- Estimates potential risks from metals in soils to plants and wildlife
- To support on-going re-greening initiatives in the City of Greater Sudbury

The Sudbury ERA



- Focus on Terrestrial Valued Ecosystem Components
- Detailed aquatic risk assessment outside the scope of this soils study
- Four primary objectives

Focus of the study

Chemicals of Concern (CoCs)

- Arsenic (As)
- Cobalt (Co)
- Copper (Cu)
- Lead (Pb)
- Nickel (Ni)
- Selenium (Se)
- Cadmium (Cd)

ERA Objective 1

1. Evaluate the extent to which COCs are preventing the recovery of regionally representative, self-sustaining terrestrial plant communities;

ERA Objectives 2 & 3

2. Evaluate the risks to terrestrial wildlife populations and communities due to the COCs.

3. Evaluate risks to threatened or endangered terrestrial species due to COCs;

ERA Objective 4

4. Conduct a comprehensive Problem Formulation for the aquatic and wetland environments in the Sudbury area to facilitate more detailed risk assessment in the aquatic and wetland ecosystems.

Different Approach to address each Objective

Objective 4

Problem Formulation for the aquatic and wetland environments of Sudbury

- Collect and review existing information and data on Sudbury area lakes and wetlands
- Determine study area
- Recommend Chemicals of Concern (COCs)
- Recommend Valued Ecosystem Components (VECs)
- Identify data gaps for future study

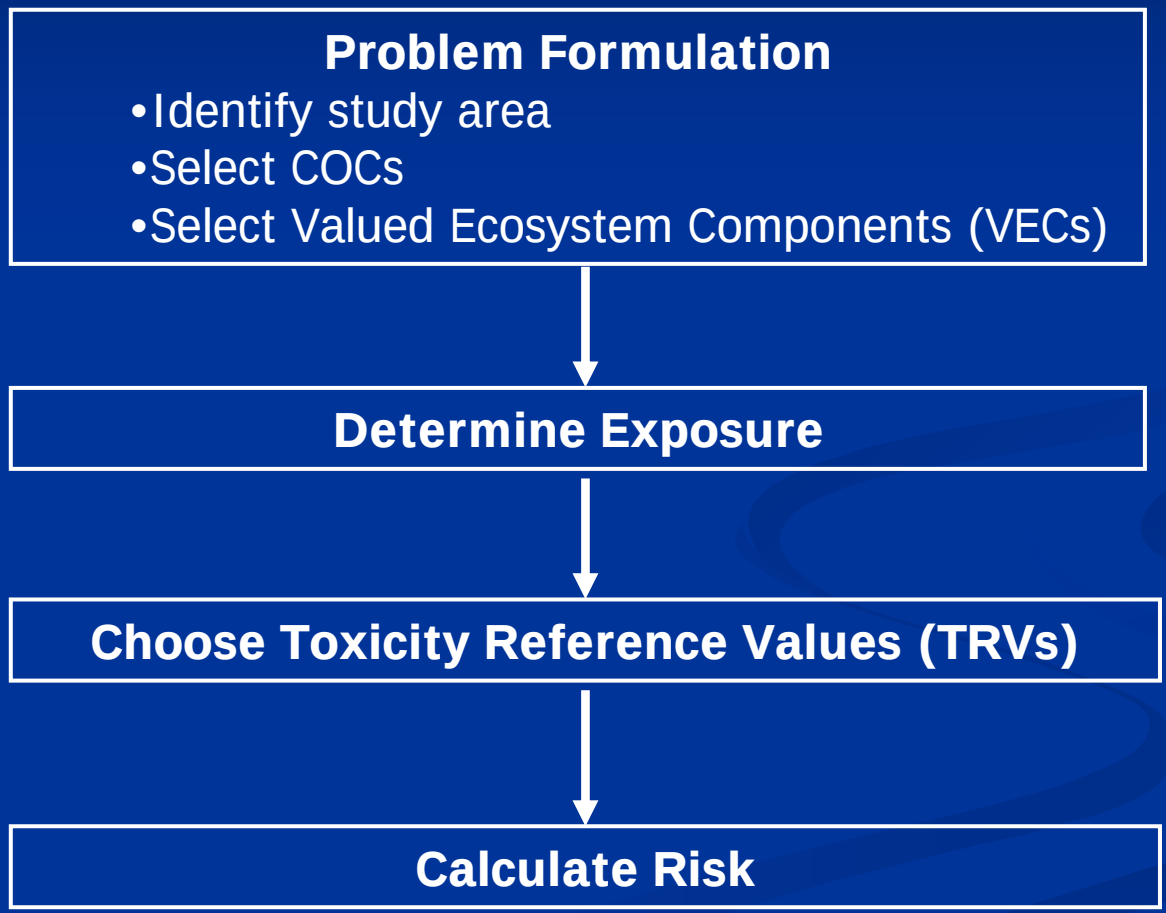
Different Approach to address each Objective

Objectives 2 & 3

Evaluate risks to terrestrial wildlife and terrestrial threatened and endangered species

- Desk top modeling exercise to predict risk based on exposure and toxicity reference values derived from the literature

Approach to Objectives 2&3



Valued Ecosystem Components (VECs)

- Conditions in Sudbury are very specific
- Impossible to look at every species of plant, animal or fish
- Chose representative species from the Sudbury area

VEC Selection Process

List of Candidate VECs

Obtained from public input, local naturalist groups, reviews of previous studies in the Sudbury area

↓

Screened against criteria

Special protection, important to residents, important to food chain,

↓

VECs identified

VECs for the Sudbury Soils Study

- Common Loon
- Mallard Duck
- American Robin
- Peregrine Falcon
- Ruffed Grouse (Partridge)
- American beaver
- White-tailed deer

- Mink
- Meadow vole
- Blueberries
- Moose
- Red fox
- Forest communities
- Northern short-tailed shrew
- Soil-dwelling invertebrate communities (earthworms)

Potential Risk is Estimated for each VEC and for each COC

Risk (HQ) = Exposure/Reference Dose

If HQ < 1.0 – no predicted risk

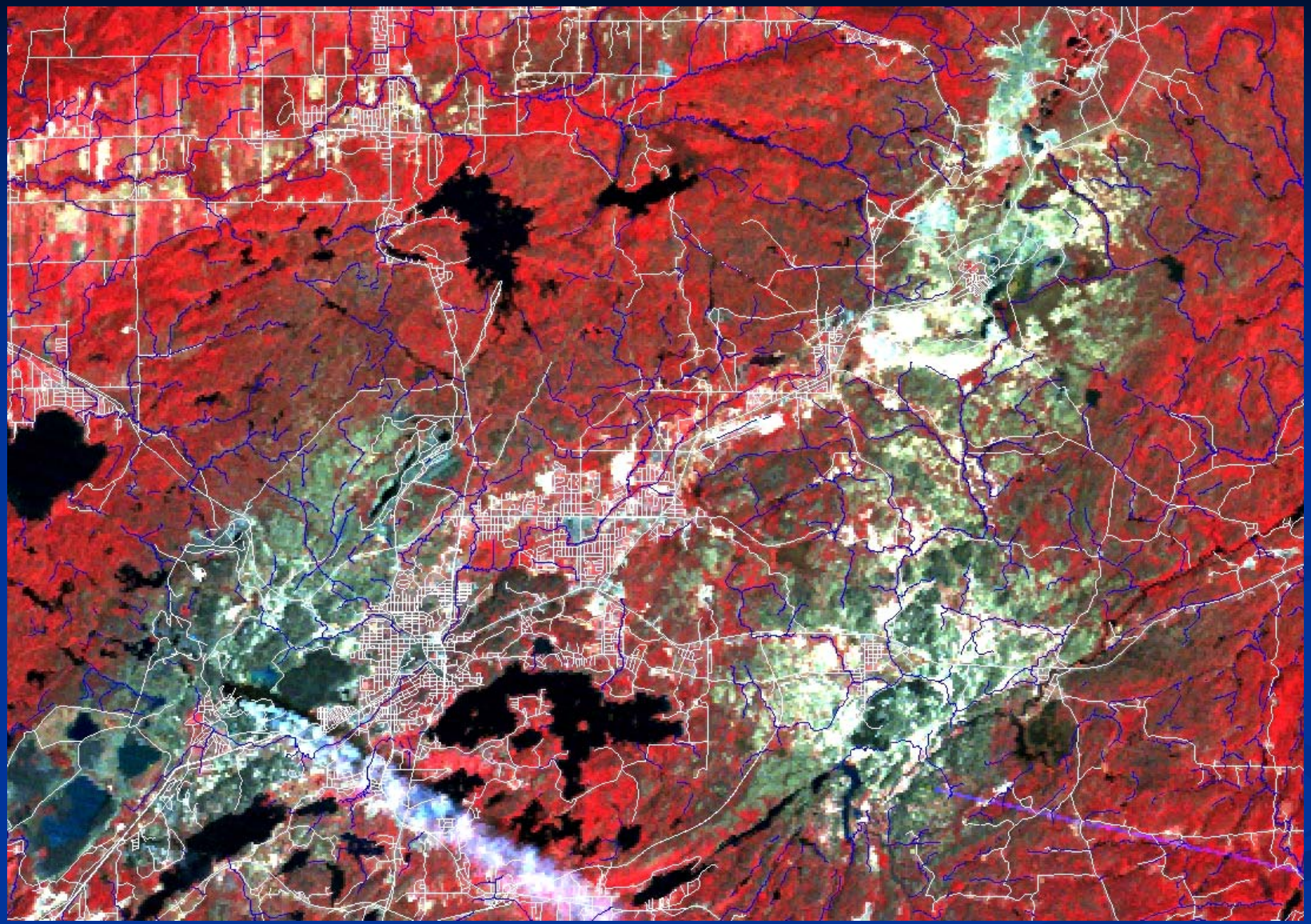
If HQ > 1.0 – potential risk; need for further analysis

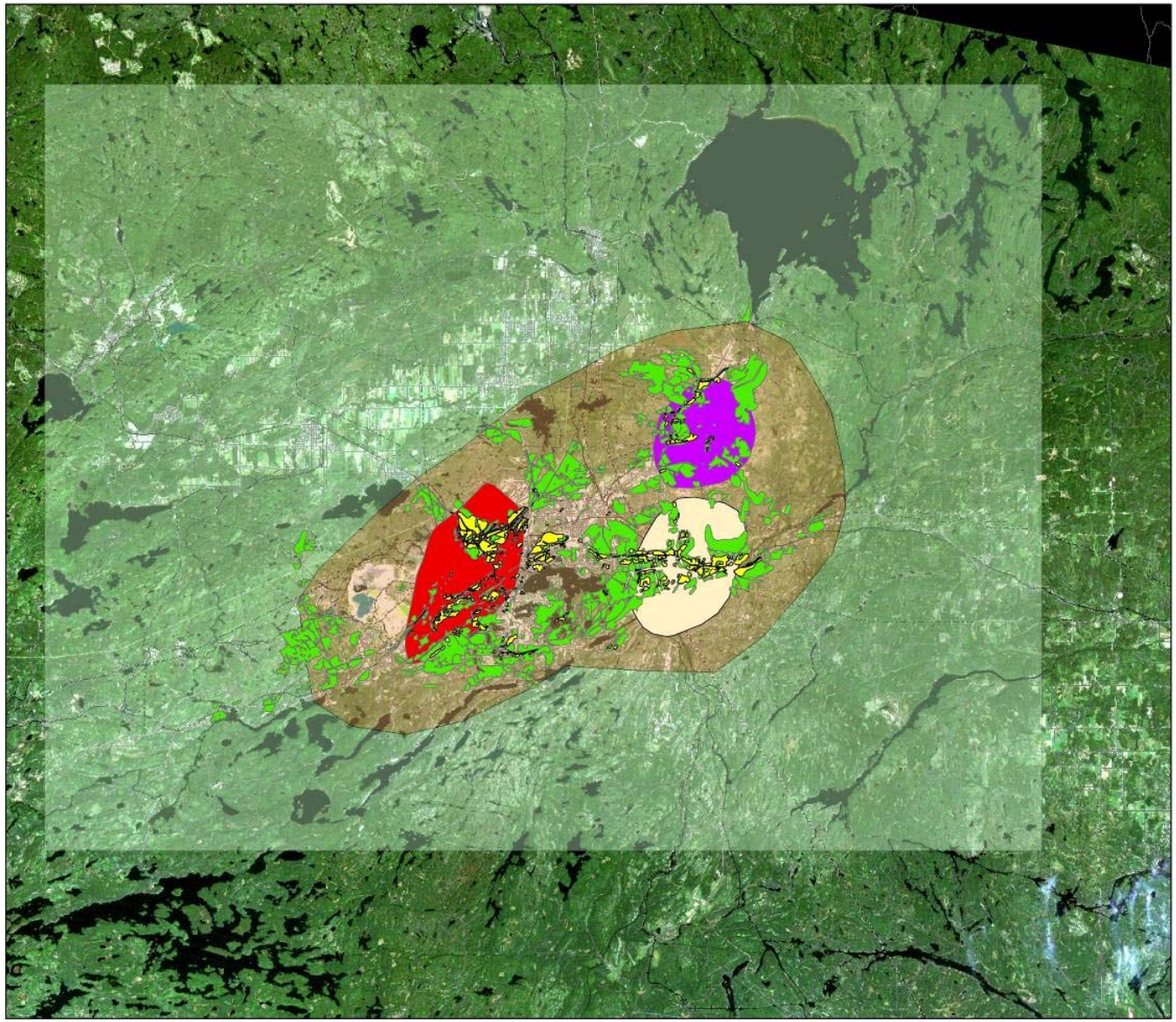
Different Approach to address each Objective

Objective 1

Determine the extent to which COCs are preventing self-sustaining ecosystems:

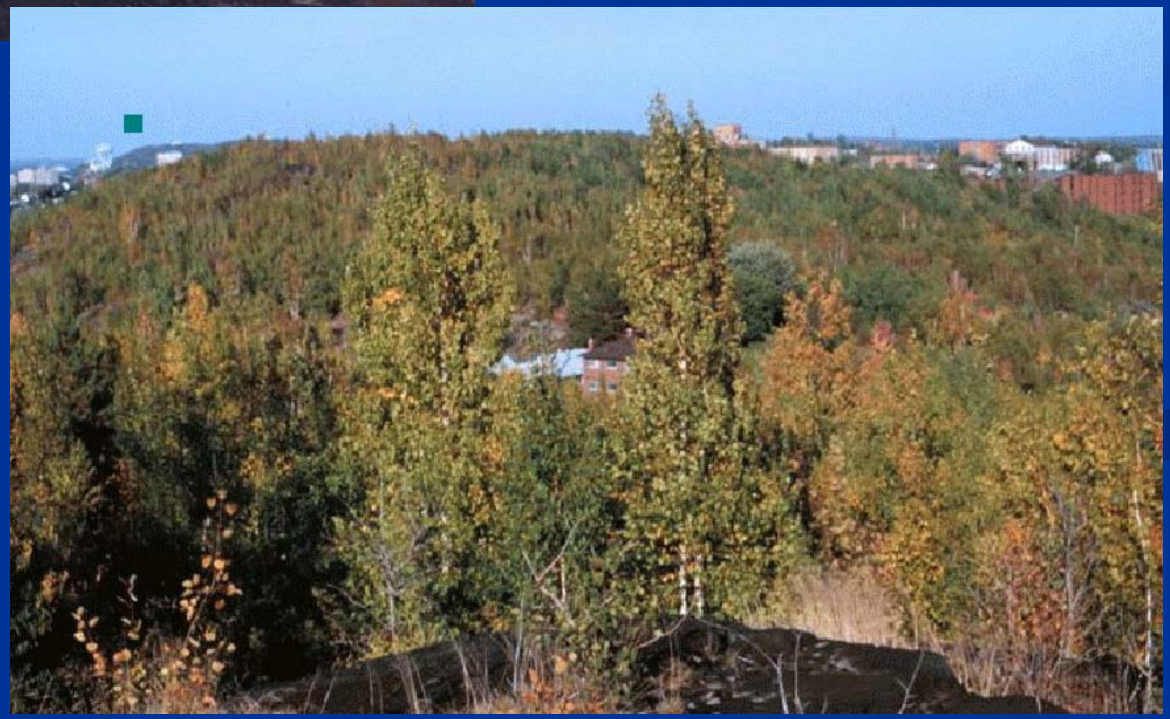
- Detailed field ecological surveys
- Laboratory toxicity studies with Sudbury soils




Legend
NaturalArea
Semi-Barren Area
Coniston Barren
Copper Cliff Barren
Falconbridge Barren
Entire Recovery Area
Concentrated Recovery Area

Significant Regreening Efforts Initiated since the 1970s

1970



2001

However…

Designed and Initiated field and lab studies during 2004 and 2005 to address Objective #1.

1. Evaluate the extent to which COCs are preventing the recovery of regionally representative, self-sustaining terrestrial plant communities;

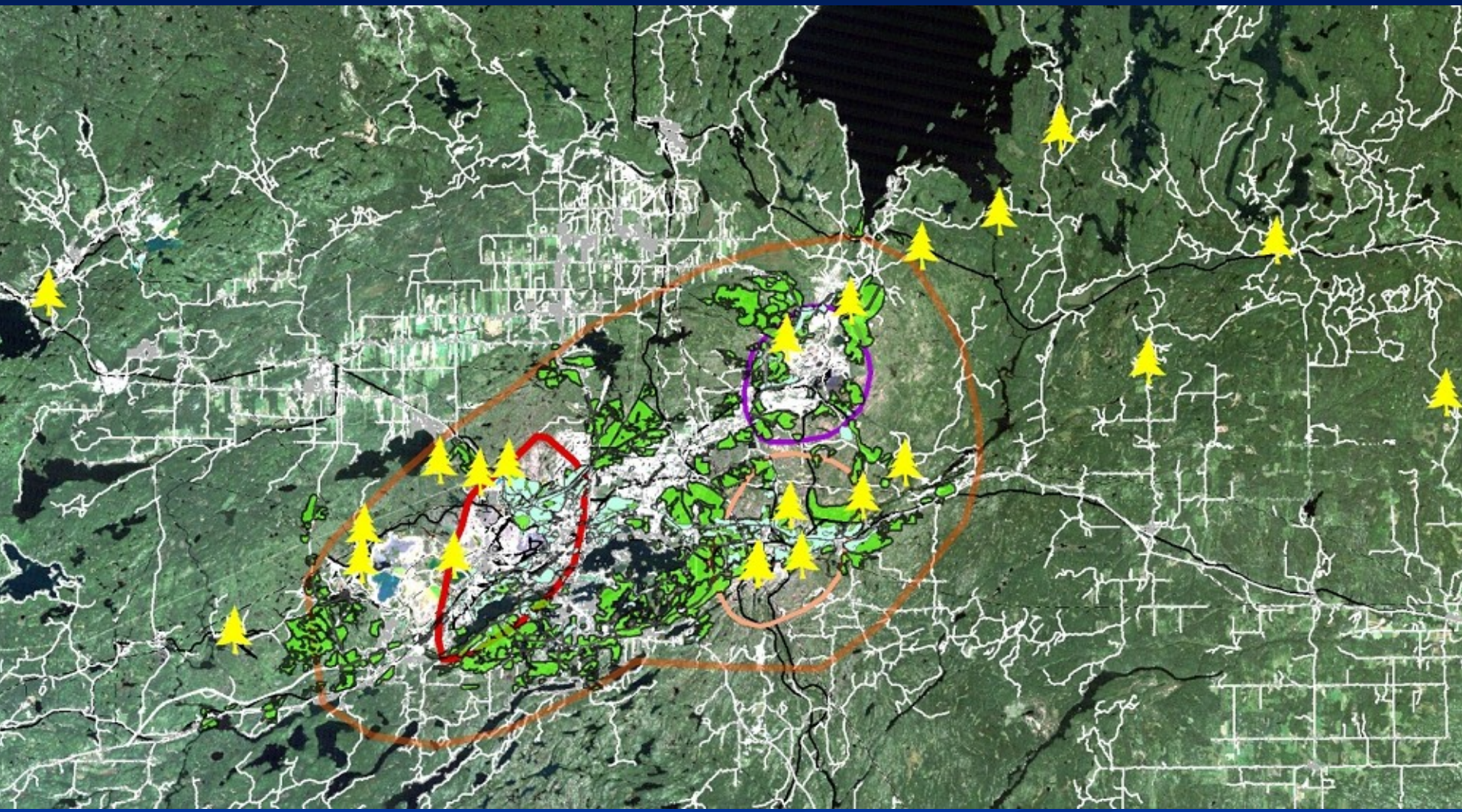
Field and Laboratory Studies ERA 2004-2005

Soil Collection

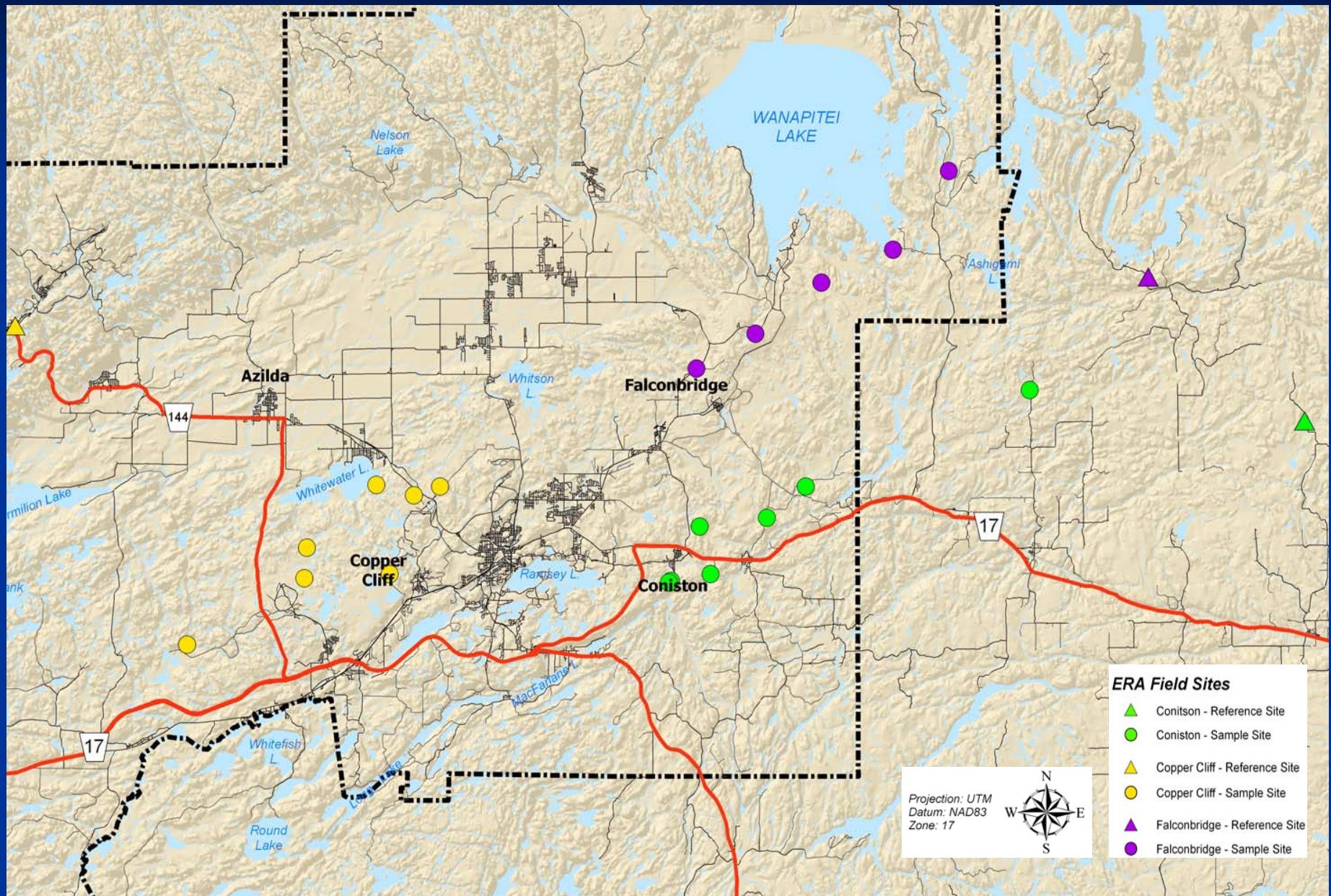
Soils for Toxicity Testing

Site Ecological Characterization

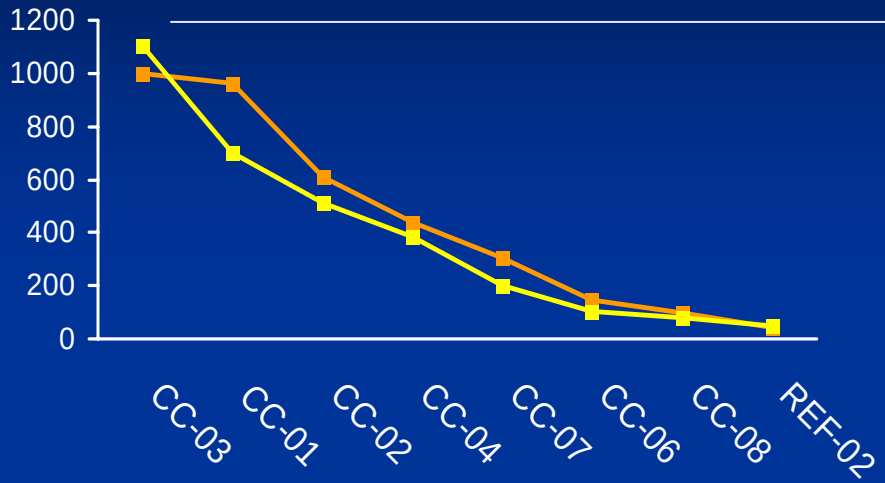
Toxicity Tests

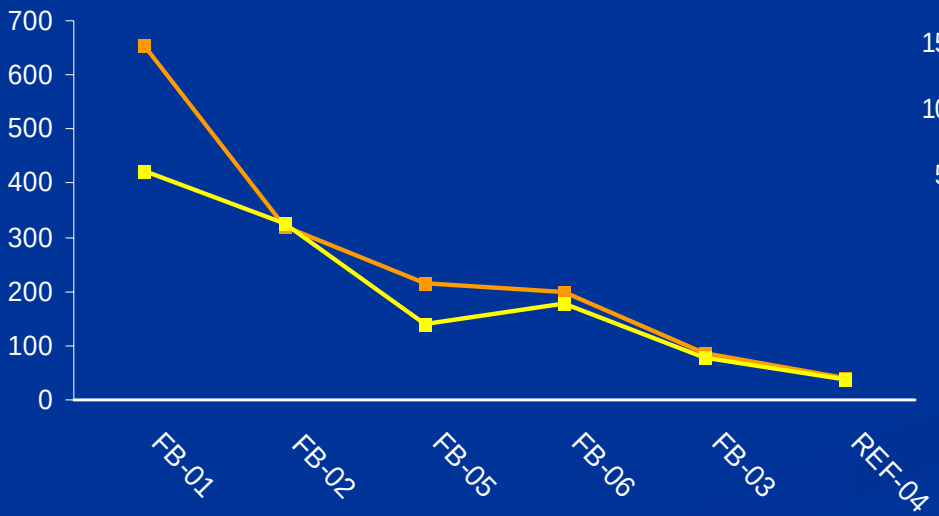


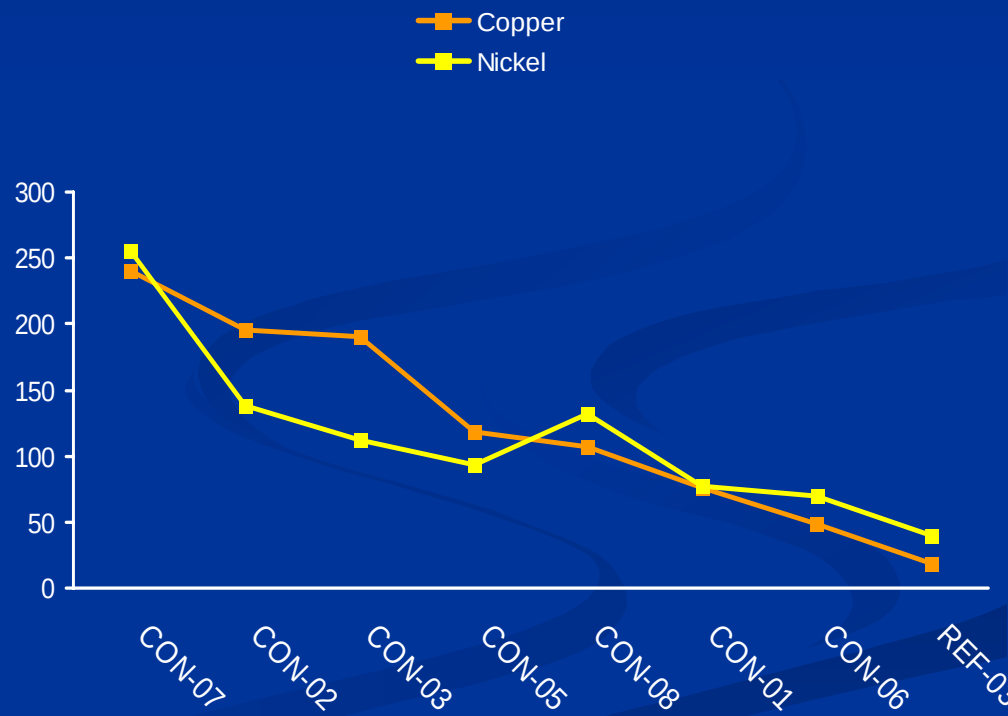
Site Locations on 3 Transects



Cu and Ni Metal Gradient Achieved







Site Soil: Physical and Chemical Parameters

- **Composite 0-5 cm core sample**
  - "Total" metals
  - Plant available metals (water leach)
  - Total nitrogen
  - Nitrate/nitrite
  - Total sulfur
  - Ammonia
  - Conductivity
  - pH (water slurry and $CaCl_2$)
  - CEC (analysis of Ca, Mn, Mg, K, Na)
  - Carbon (total, inorganic, organic)
  - Available Fe and Mn
  - **Particle Size**
- **Bulk Density**

CON-07 and CON-08

- Sparse groundcover
- Metal levels slightly lower than Con-07
- pH below 5

- Groundcover abundant
- Earthworms present
- pH 7.19

Ecological Survey

- Broad plant survey
- Detailed plant list of herbaceous and tree species
- Percentage cover
- Coarse and down woody debris
- Photographs of transects and plots

Herbaceous Cover Estimate

- % cover:
  - low shrubs
  - herbs
  - grasses
  - sedges
  - ferns
  - club-mosses
  - mosses
  - lichens
- % groundcover:
  - bedrock
  - gravel/cobbles
  - soil
  - woody debris (<7.5cm diameter pieces)
  - other (e.g. buried wood)

Soil Collection for Toxicity Tests in laboratory

Toxicity Testing Objective

Establish whether the metal mixture present in the site soils is toxic to a battery of test species

Soil Toxicity Testing - Required to address specific issues

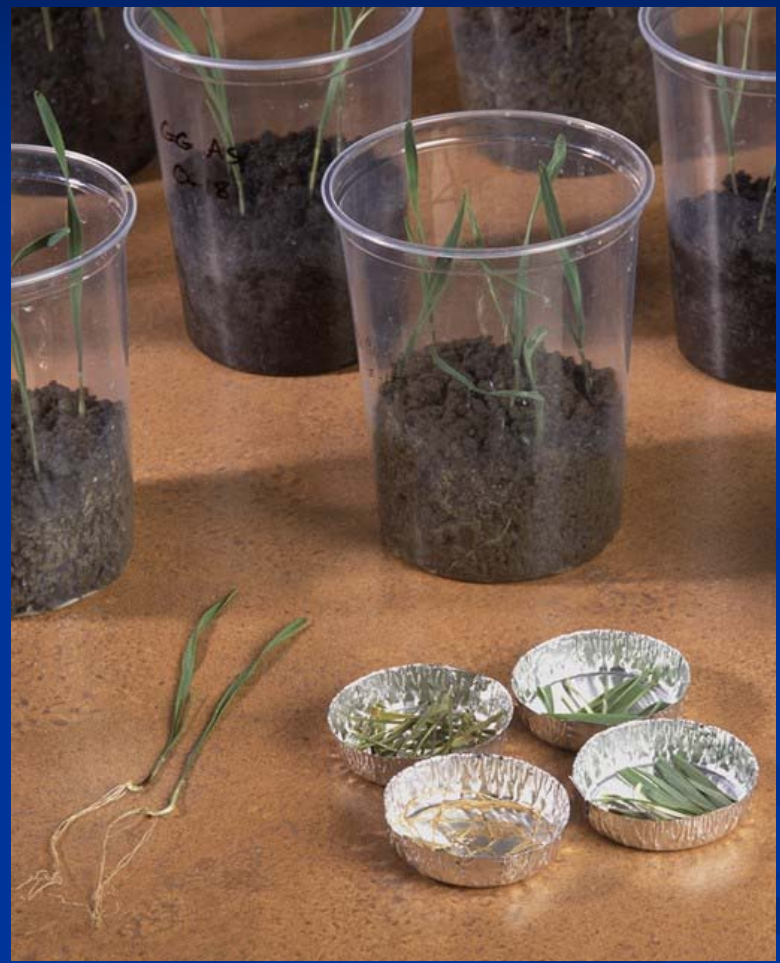
- Low soil pH
- Multiple metals in soil
- Species relevant to Sudbury area
- Better quantify toxicity

Final Toxicity Test Species

- Soil invertebrate
  - Earthworm – *Eisenia andrei*
- Plants
  - Monocot: Northern Wheatgrass
  - Dicot: Red Clover and Canada Goldenrod
  - Tree: White Spruce

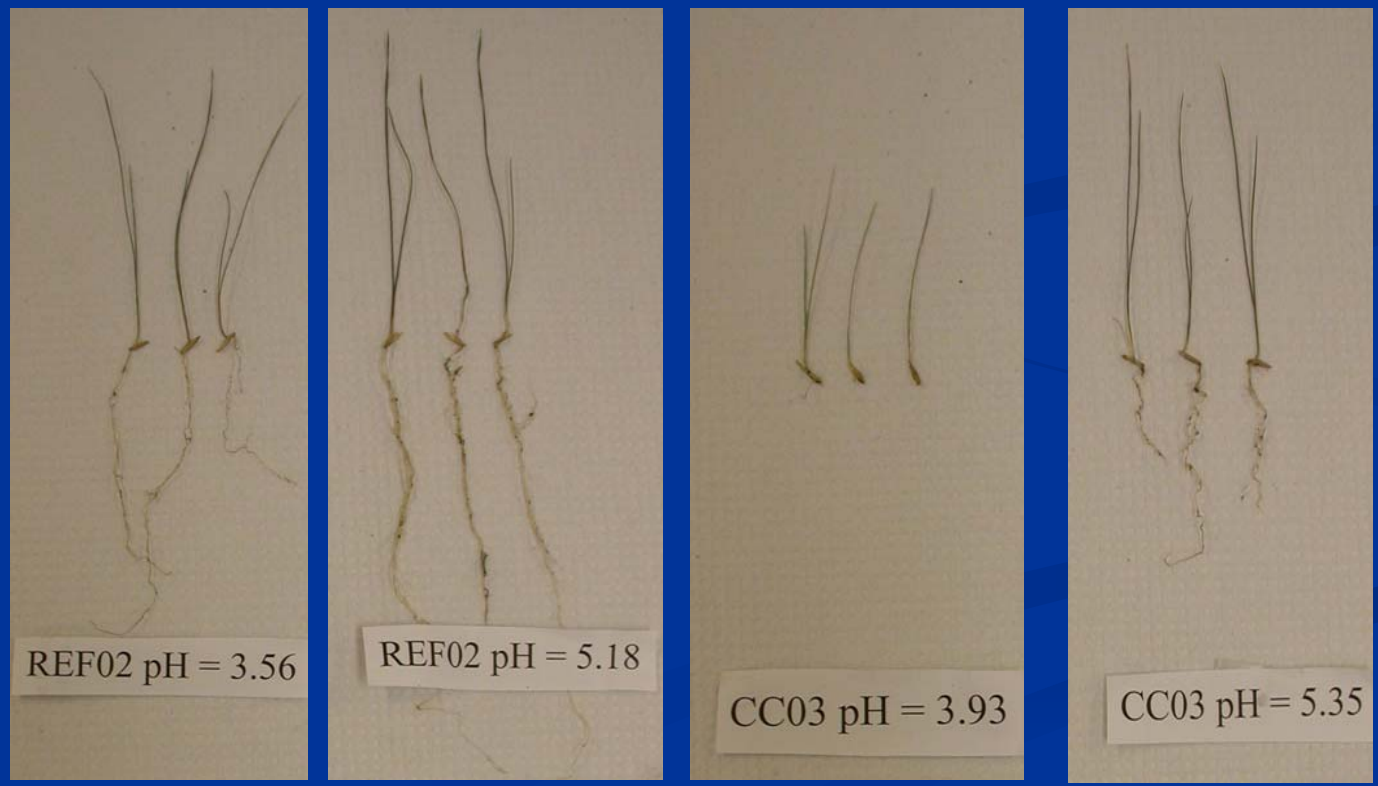
Endpoints

- Invertebrates
  - Survival
  - Number of juveniles
  - Mass of juveniles
- Plants
  - Emergence
  - Root length
  - Root mass
  - Shoot length
  - Shoot mass

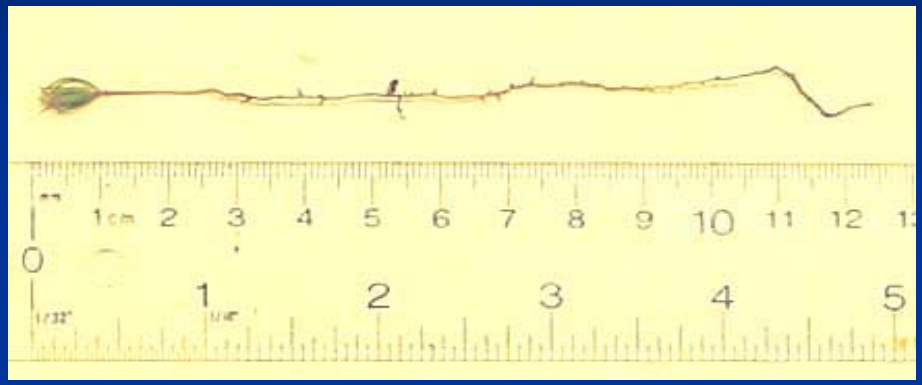


Preliminary Screening Results: Plants

- All plants had some endpoints which were affected between high and low metal sites

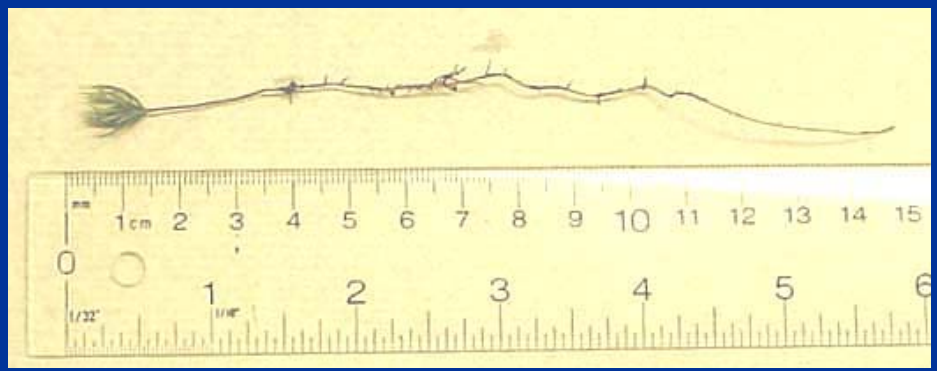


Preliminary Screening: Trees

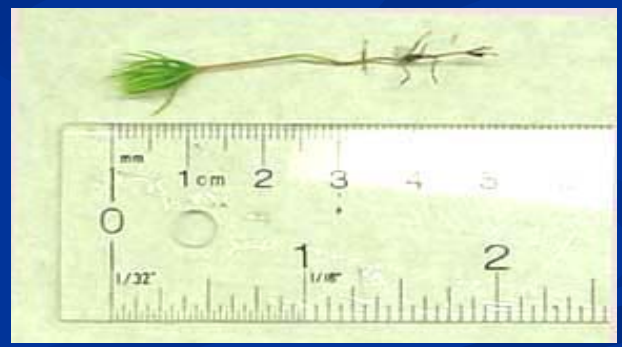


Ref-02 Straight Soil

CC-03 Straight Soil



Ref-02 pH Adjusted Soil



CC-03 pH Adjusted Soil

Litter Bags

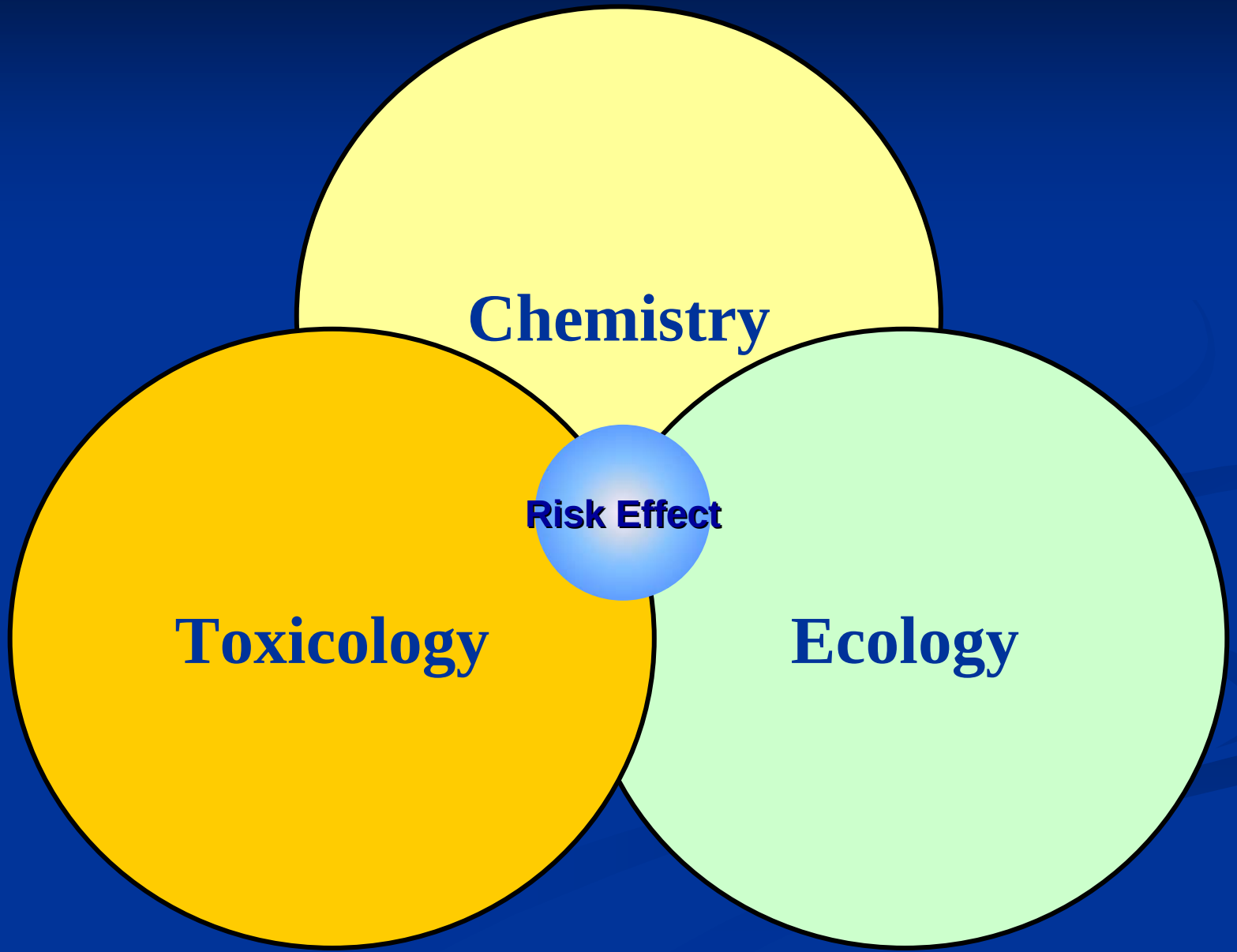

Sudbury Soils Study
-REF-03
Litter Bag 9


Sudbury Soils Study
-FB-03
Litter Bag 25

Weight of Evidence Approach

- Collect multiple lines of evidence
  - Detailed site chemistry
  - Soil toxicity testing with multiple species and multiple endpoints
  - Detailed ecological surveys with several dozens of field metrics at each of 22 sites
  - Litter bags to measure rates of microbial decomposition

Integration of Data



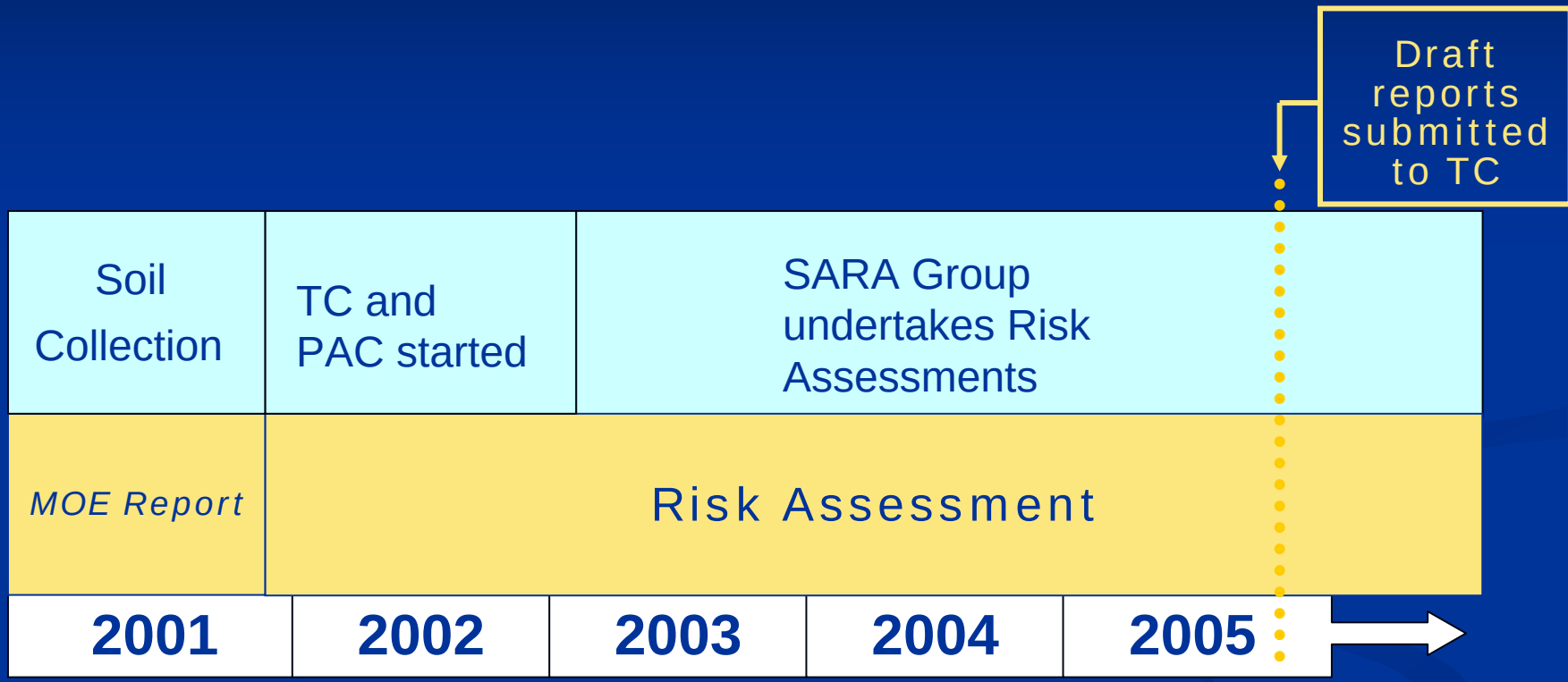
Weight of Evidence Approach for Objective #1

- Apply statistics and professional judgement to determine which sites are “damaged” relative to reference sites, and
- Identify, if possible, what factors may be inhibiting a self-sustaining natural ecosystem

Final ERA Report –
will be divided into discrete chapters plus appendices

- Multiple lines of evidence to address Objective #1
- Detailed risk analysis for Objectives #2&3
  - Evaluation of Objectives #1-3 will identify areas of damage or potential risk to terrestrial receptors
- Comprehensive Aquatic Problem Formulation for Objective #4

Where are we now?



Projected dates are based on current information and may be subject to change

Where are we going?

Projected dates are based on current information and may be subject to change