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SAVANNAH RIVER NATIONAL LABORATORY
Operated by Savannah River Nuclear Solutions, LLC

We Put Science To Work

# Detoxification of Outfall Water Using Natural Organic Matter

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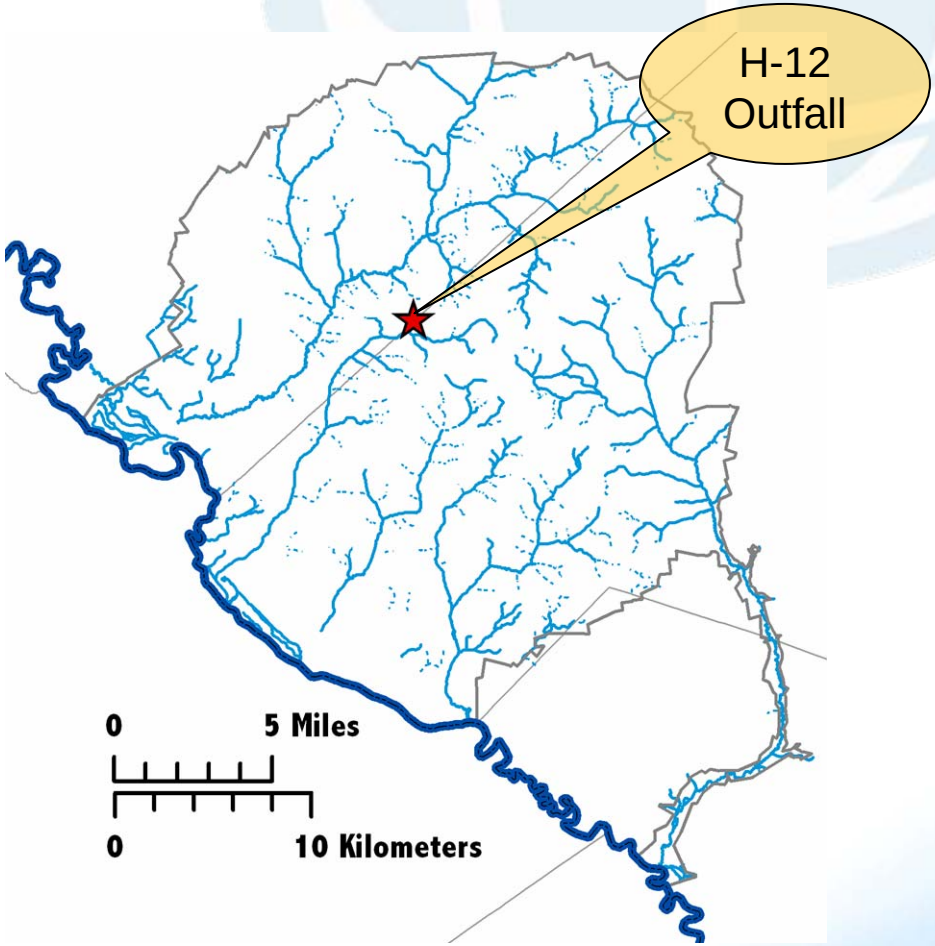
Wilmington, NC

EM Office of Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

# General Location

- **Upper Coastal Plain**
- **Rainfall ~ 45 to 50 in/yr**
- **5 major streams that feed into the Savannah River**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# Problem: Copper in H-12 Outfall

**GOAL: Protect ecosystem in receiving streams from chronic impacts**

**PROPOSED REGULATORY APPROACH: Reduce NPDES permit limit for copper concentration from 25 µg/L to 6 µg/L**


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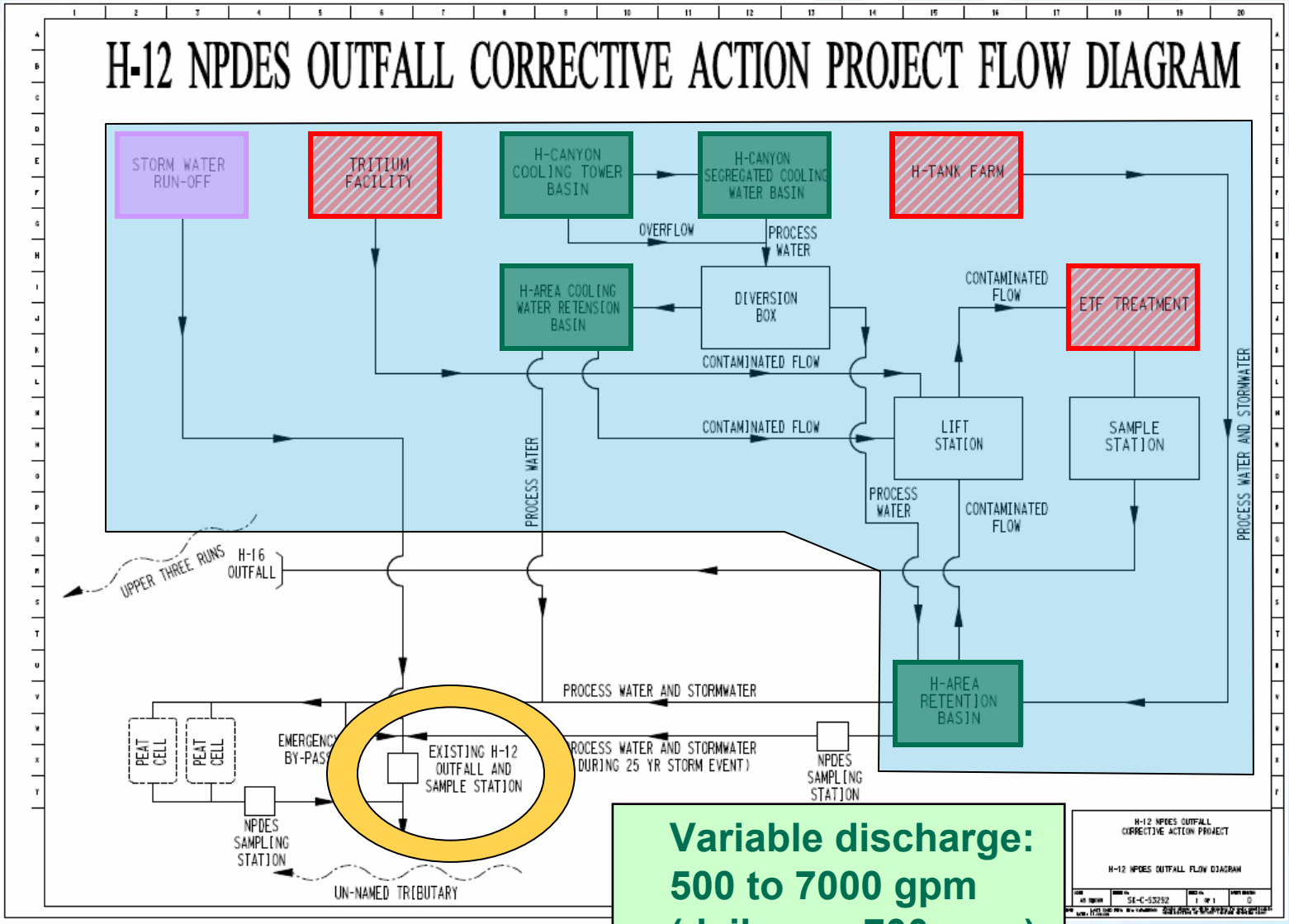
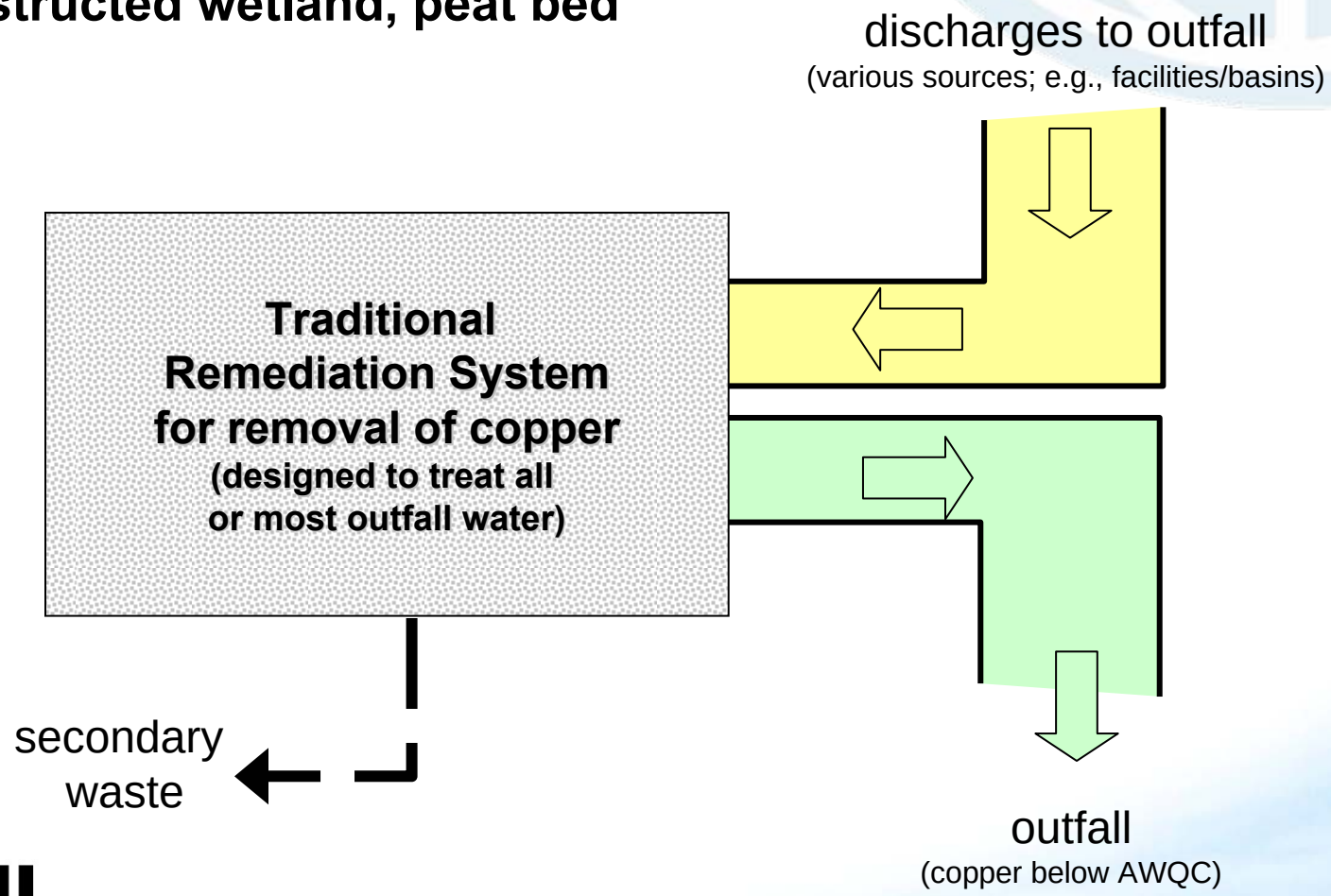
# Multiple & Variable Sources




**Variable discharge:**
**500 to 7000 gpm**
**(daily avg 700 gpm)**

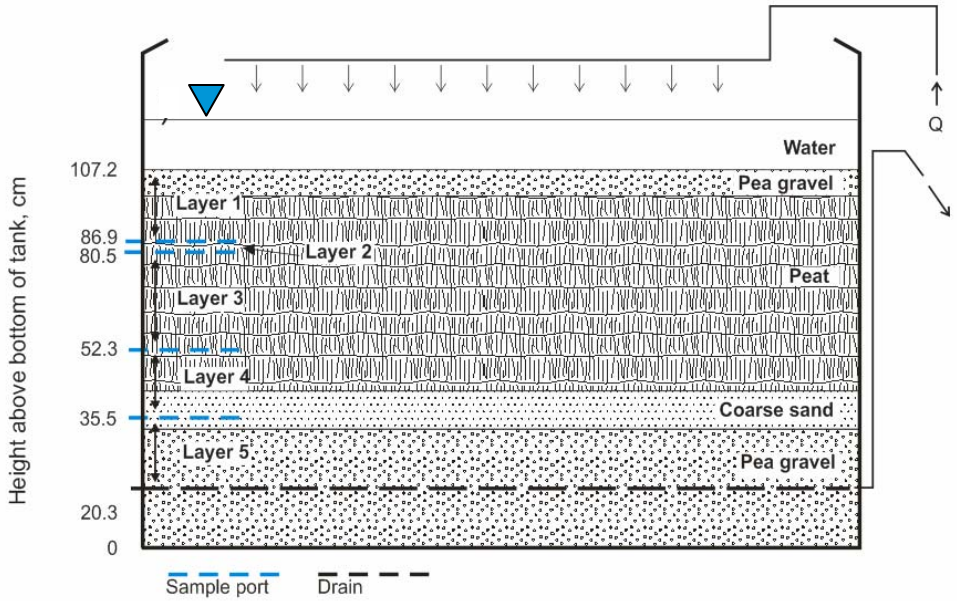
# Traditional Technology Approach

- **Water treatment – e.g., metals removal using ion exchange, flocculation, or innovative methods such as constructed wetland, peat bed**



# Peat Bed (identified as promising "traditional" approach)

- Vertical flow
- Natural ion exchange
- 11 acres
- $9M – $12M
- Waste generation

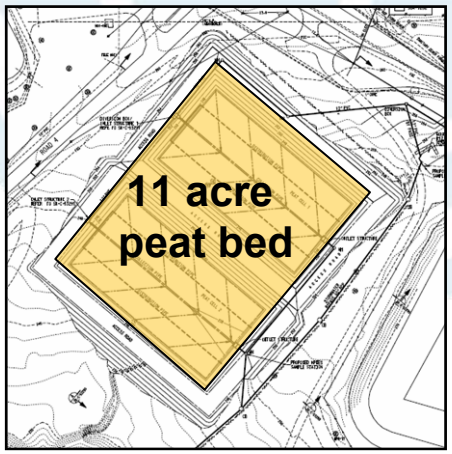



**Low target concentrations and variable conditions challenge the viability of traditional treatment technologies.**

# Thinking Differently

- **Traditional Approach**
  - Construct treatment system to reduce copper to acceptable levels

- **Alternative Approach**
  - Objective – Protect ecosystem…
  - Can objective be met differently?
    - Prevent copper toxicity (e.g., prevent from sorbing to gill tissue)
  - *Detoxify* copper (rather than remove)
    - Make copper unavailable for biological uptake




VS

?

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# Calculating AWQC for Cu

- **Past/Traditional method**
  - Water hardness calculation
  - Water effects ratio (WER) tests
- **EPA's Biotic Ligand Model (BLM)**
  - Metal bioavailability model
  - Recently developed for copper (EPA, 2007)
  - Uses receiving water chemistry to develop site specific AWQC

Downstream of H-12 Outfall

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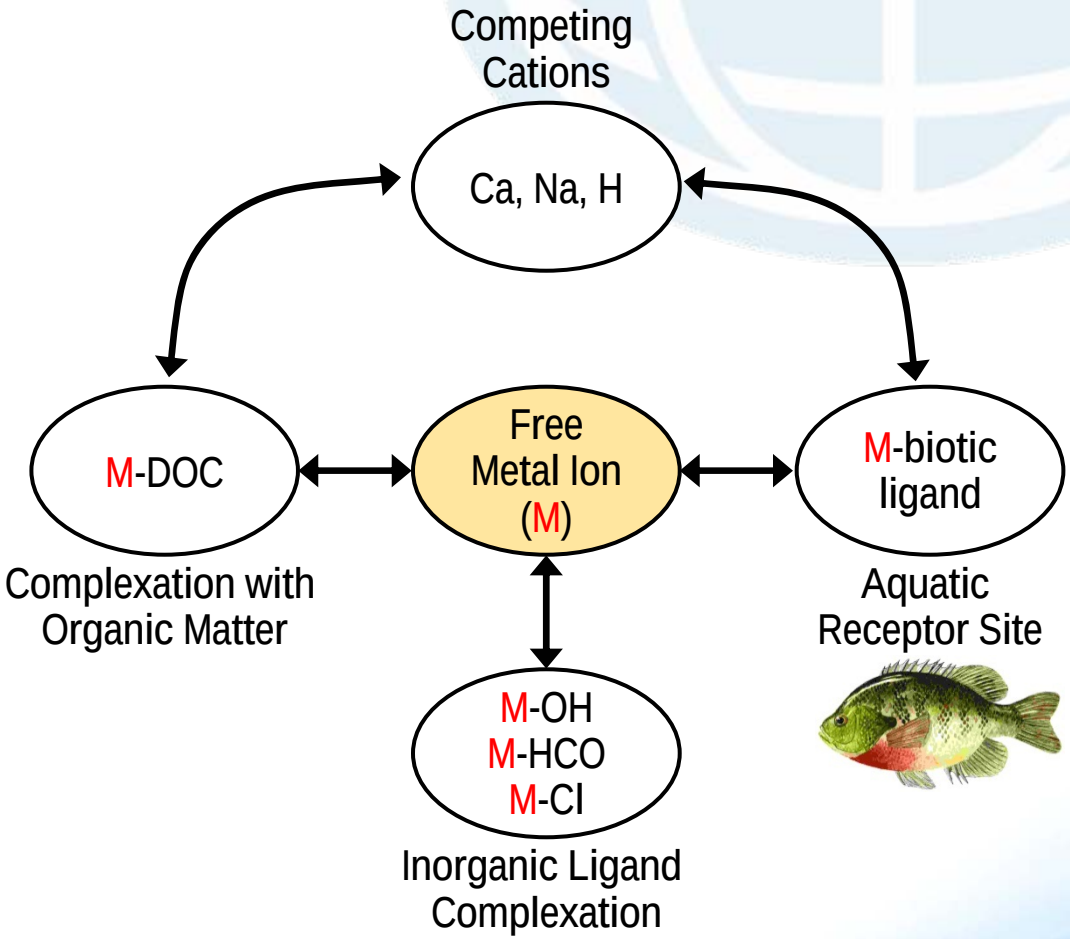
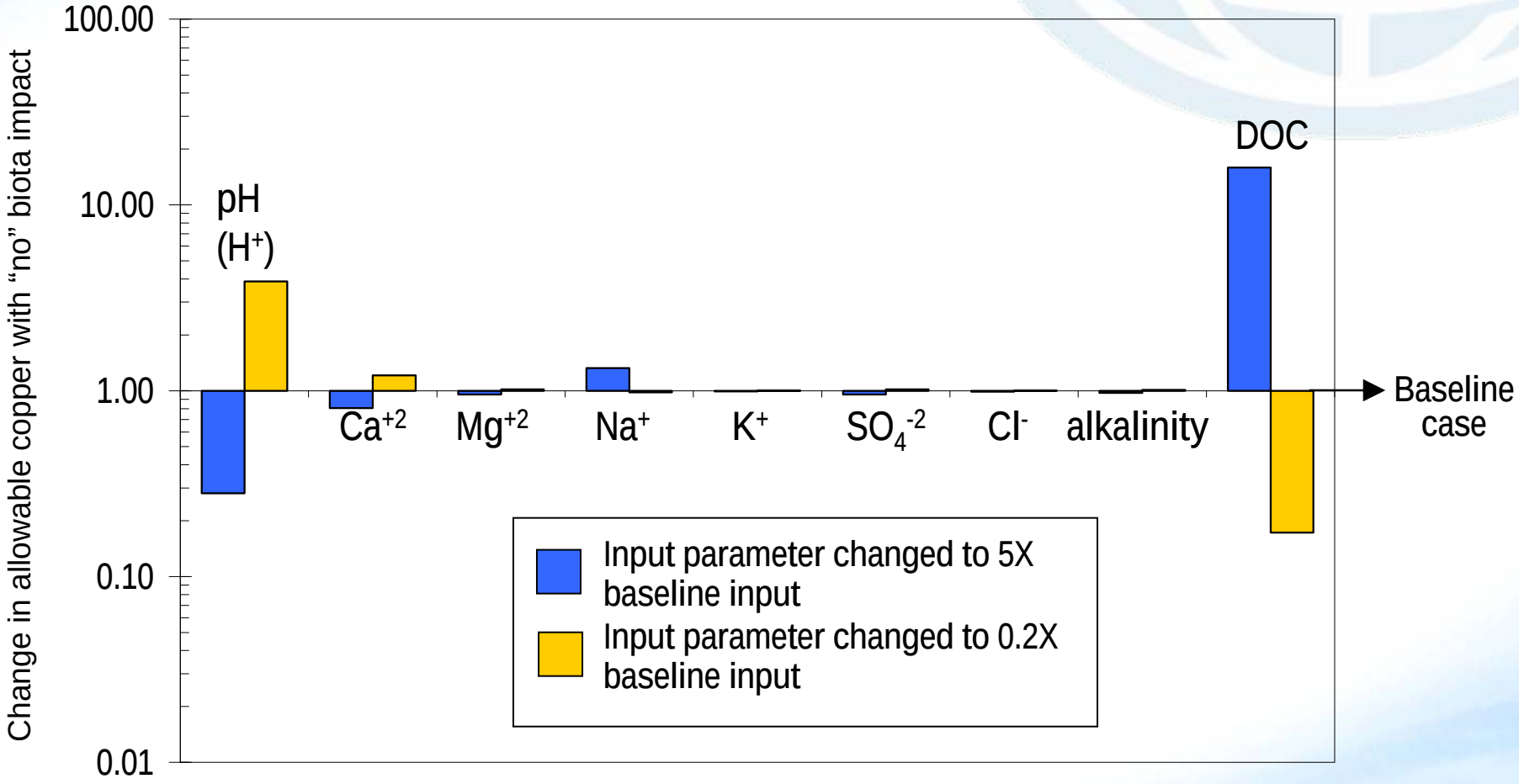
# Biotic Ligand Model

- **Inputs**
  - Temperature
  - pH
  - Alkalinity
  - DOC
    - Humic acid content
  - $Ca^{+2}$, $Mg^{+2}$, $Na^{+}$, and $K^{+}$
  - $SO4^{-2}$, and $Cl^{-}$
- **Outputs**
  - Copper speciation
  - Site-specific criteria



# BLM Sensitivity

- **Controlling parameters: DOC and pH**



# Primary DOC Amendments Tested

- Used in agriculture/soil conditioners
- Humates (humic acid)
  - Extracted from natural materials
  - OMRI certified
  - Available as dry flake or as liquid
- Lignosulfonate
  - Byproduct of pulp and paper processing

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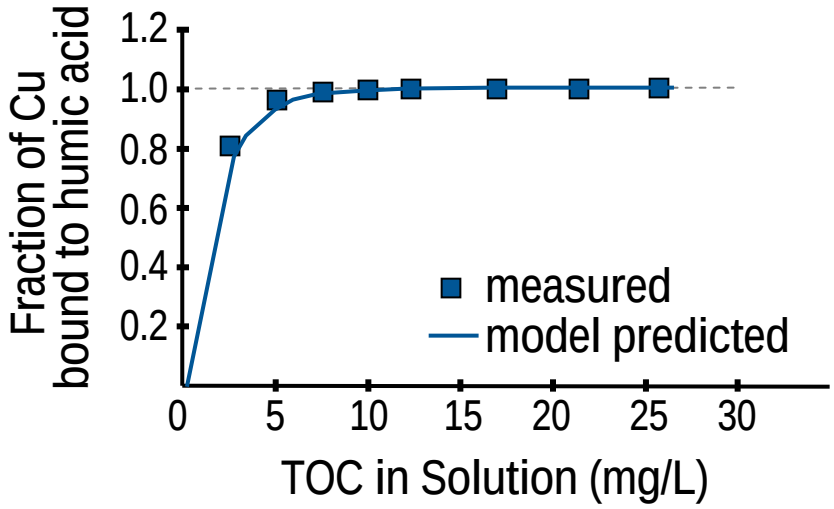
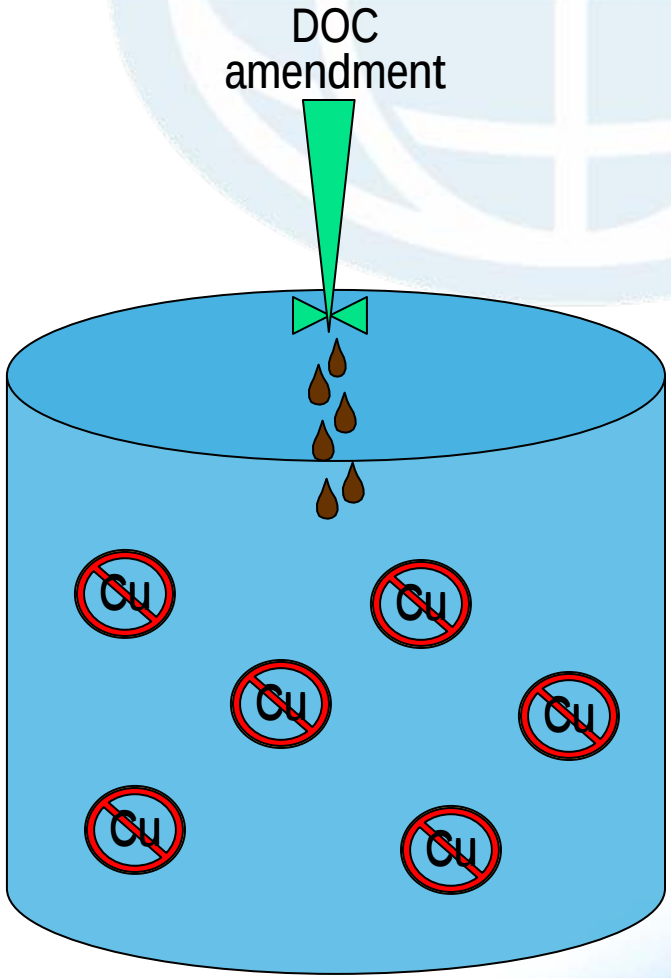
# Lab Tests with Different DOC Amendments

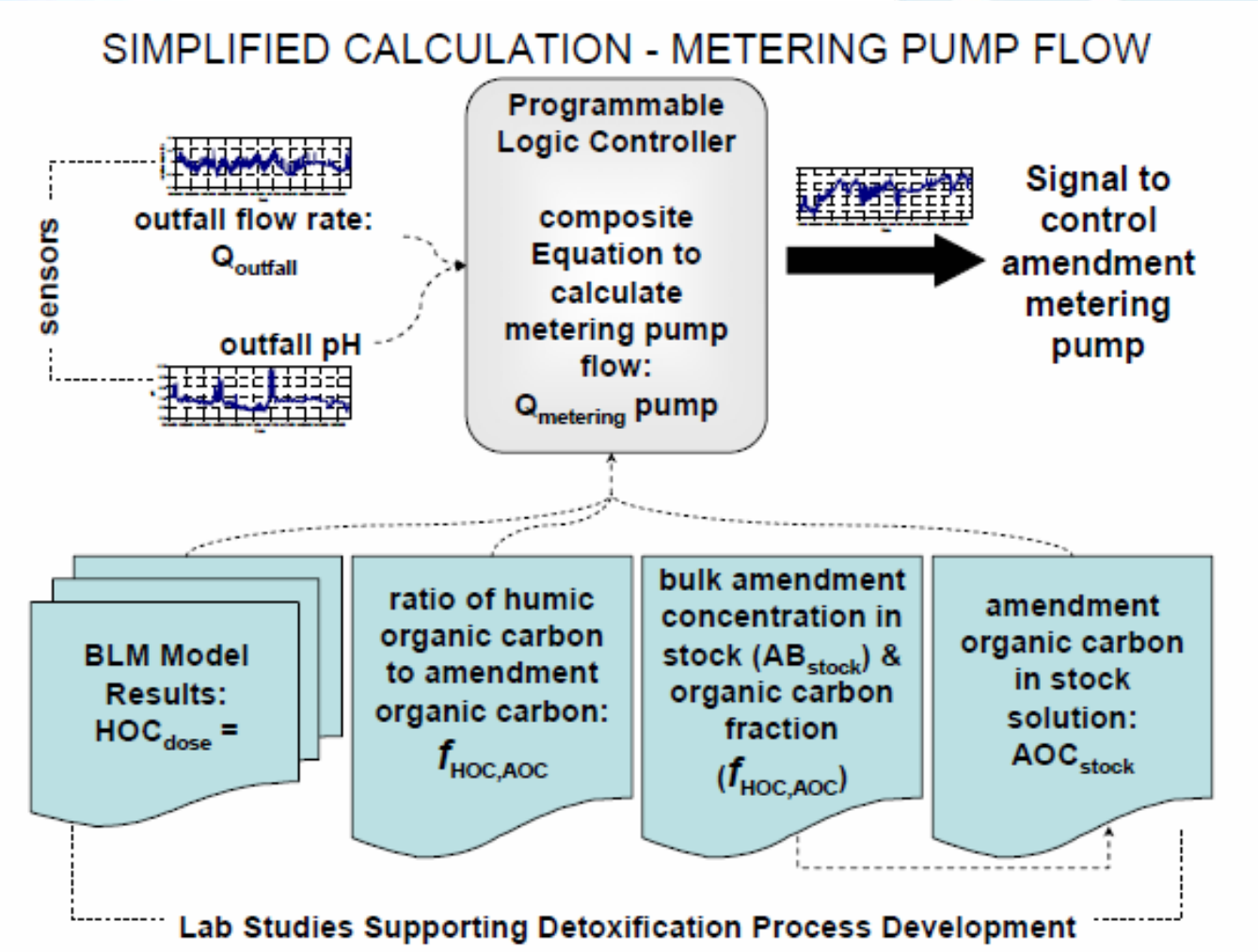
- **Used Cu electrode (ISE) to measure free (uncomplexed) Cu**
- **Cu electrode = surrogate for ecological receptors (e.g., gill tissue/ "biotic ligands")**




Cu concentration (low) & ISA solution

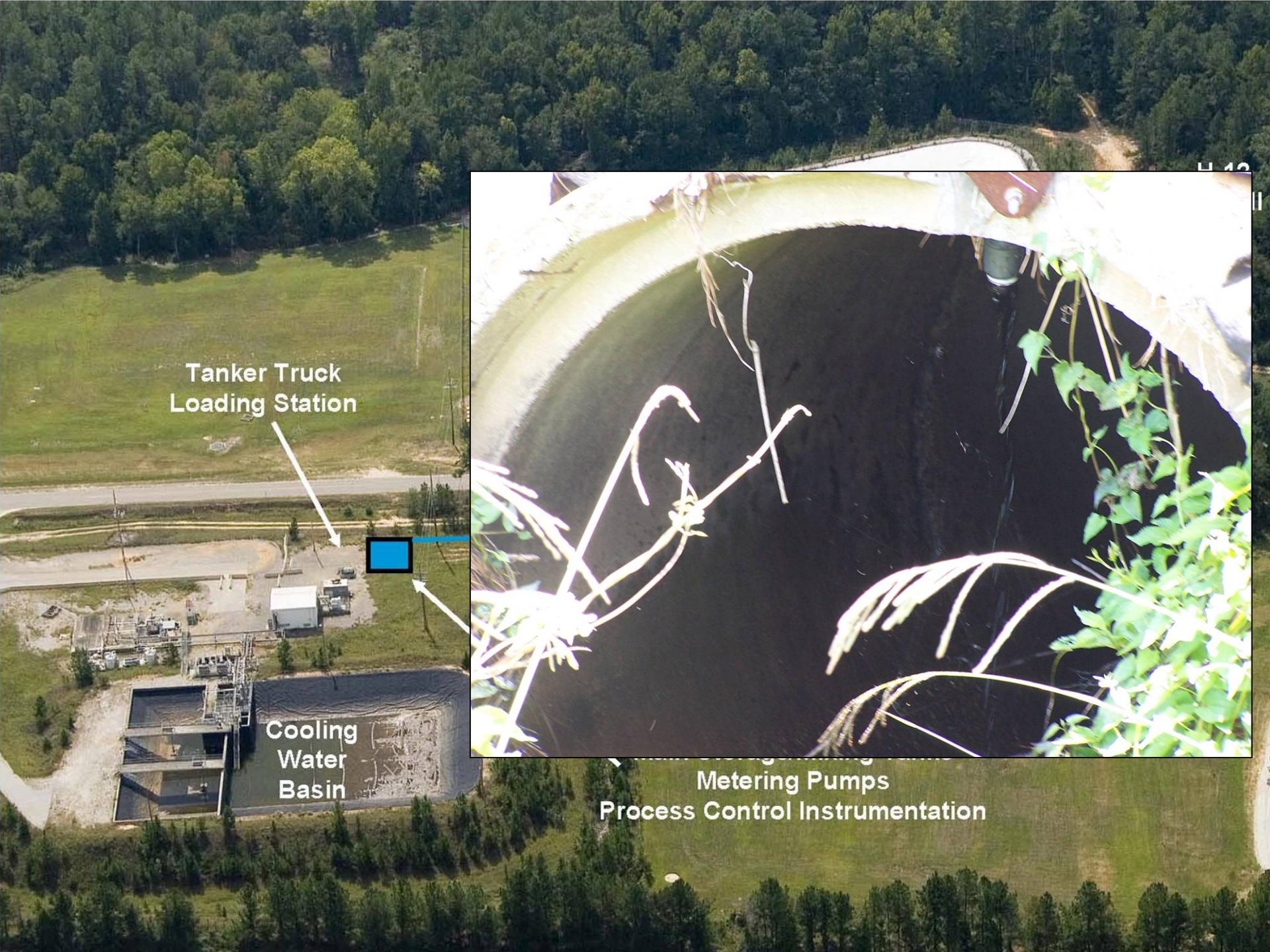
# Process Control Equation



# DOC System

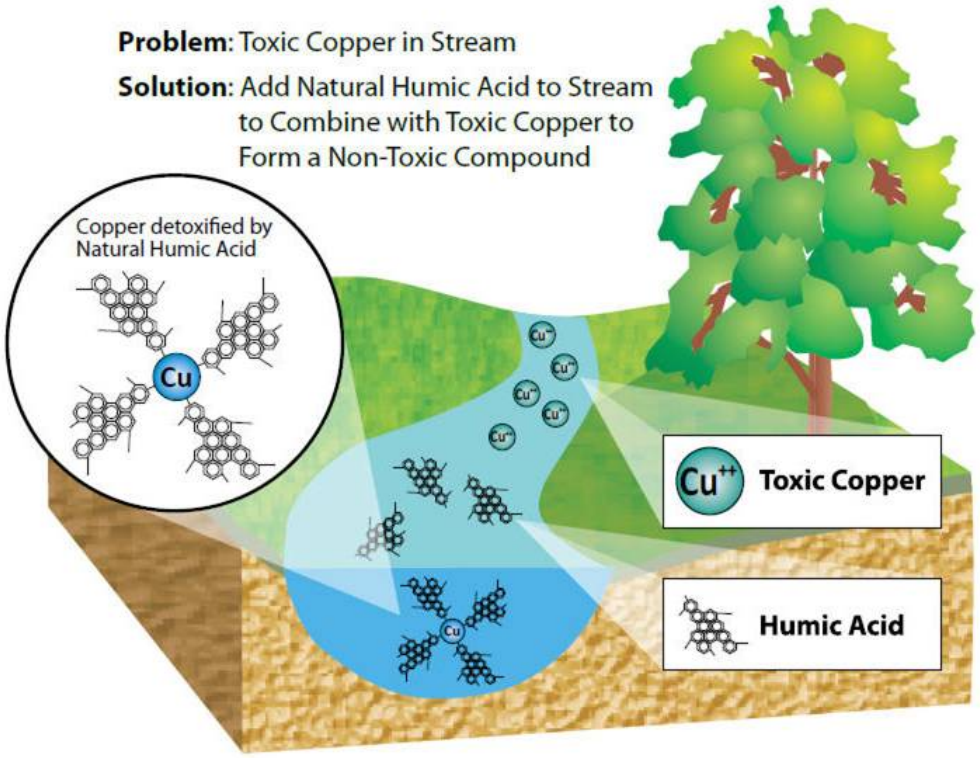
- 2 double-walled 5,500 gal storage tanks with recirculation pumps
- pH meters, flow meters, PLC for addition of amendment
- Tanker to deliver humate stock solution




Tanker Truck
Loading Station
Cooling
Water
Basin
Metering Pumps
Process Control Instrumentation

# End Results

- **Lab results confirmed adding moderate amounts of DOC would reduce Cu toxicity in outfall by making it less bioavailable.**
  - **≤ 22 mg/L DOC renders 25 µg/L copper non-toxic at all outfall pH values ≥ 5.9**
  - **Higher pH requires less DOC**
- **Meets NPDES objective even with Cu >> 6 µg/L in outfall. Revised final permit to reflect detoxification.**
- **DOC Addition System online in June 2009.**

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