Phytoremediation Case Study
A Growing Solution for Hydraulic Control, Groundwater Treatment and More

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University of Minnesota, St. Paul

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SEH

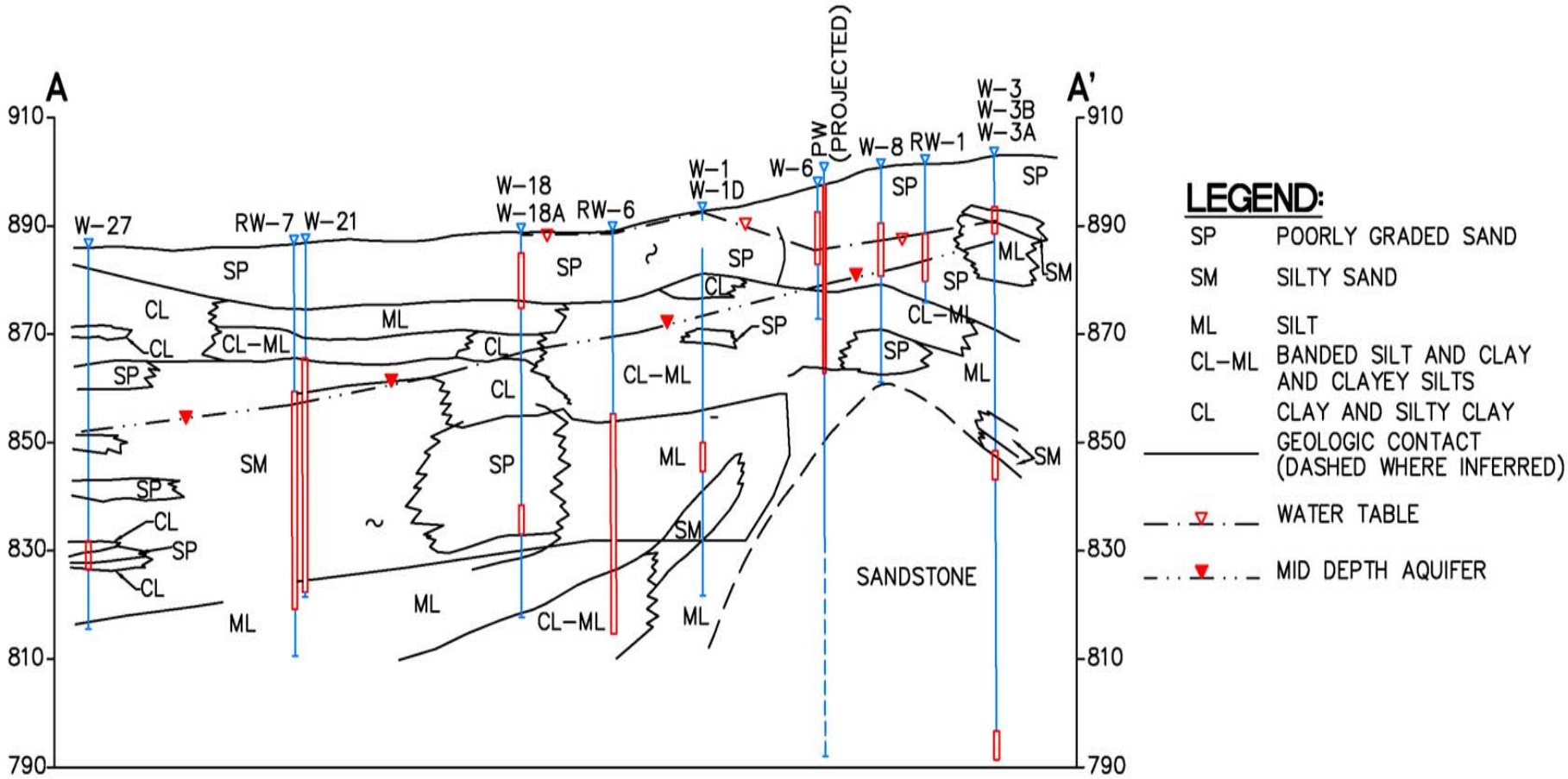
Overview of Presentation

- Project Background
- Treatability Study Phases
- Key Findings
- Recommendations and Options
- Questions and Answers

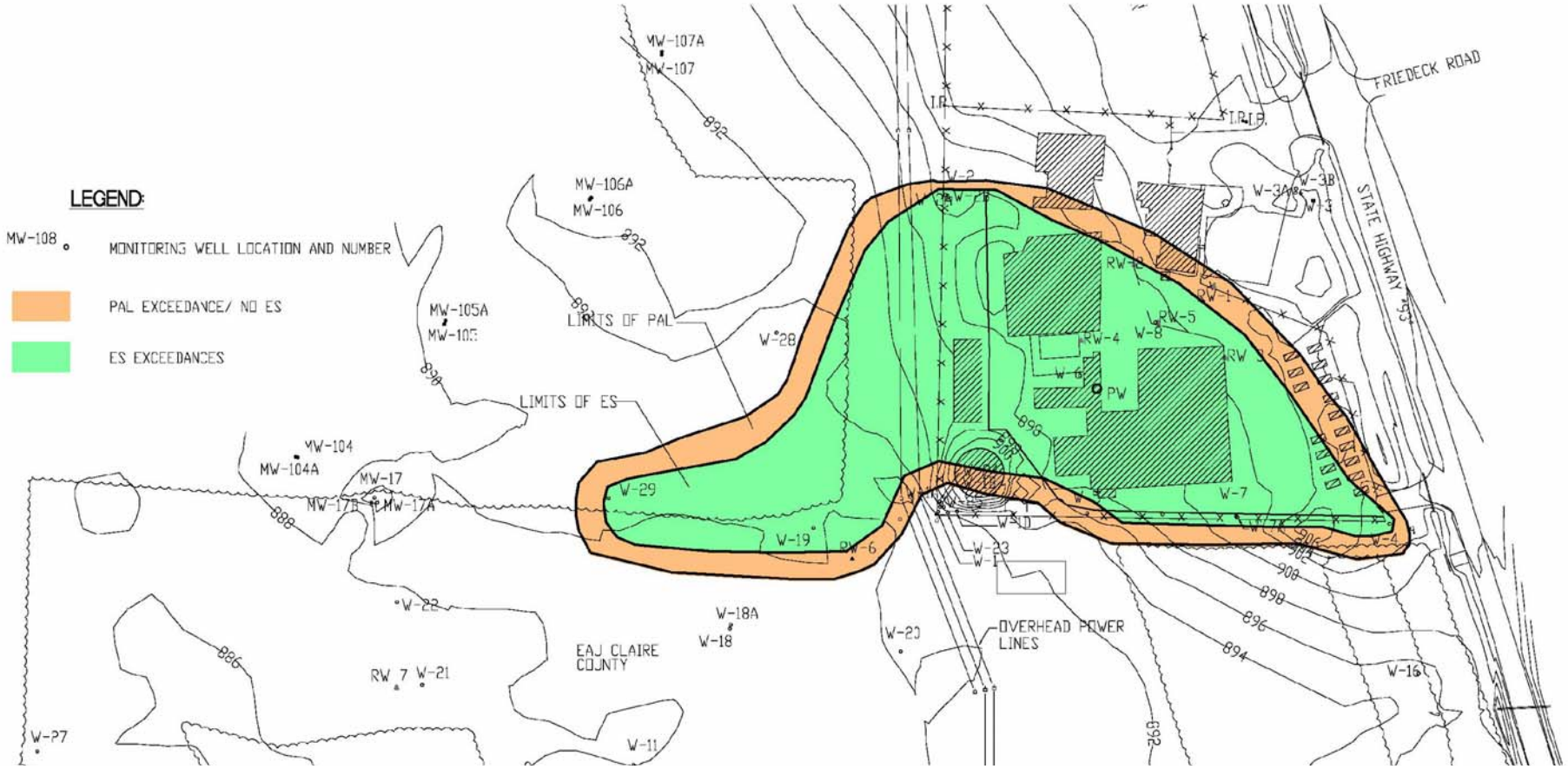
Project Background

- WRR Environmental Services Co., Inc.
  - Waste solvent recycling and wastewater treatment since 1970
- Historical releases to site soils and groundwater
  - Volatile organic compounds (VOCs) detected in groundwater in 1978
- Multiple phases of investigation and remediation since 1979
  - RCRA Facility Investigation (RFI) process begun in 1988
- Active regulatory agency involvement

Project Background (cont')



Project Background (cont')



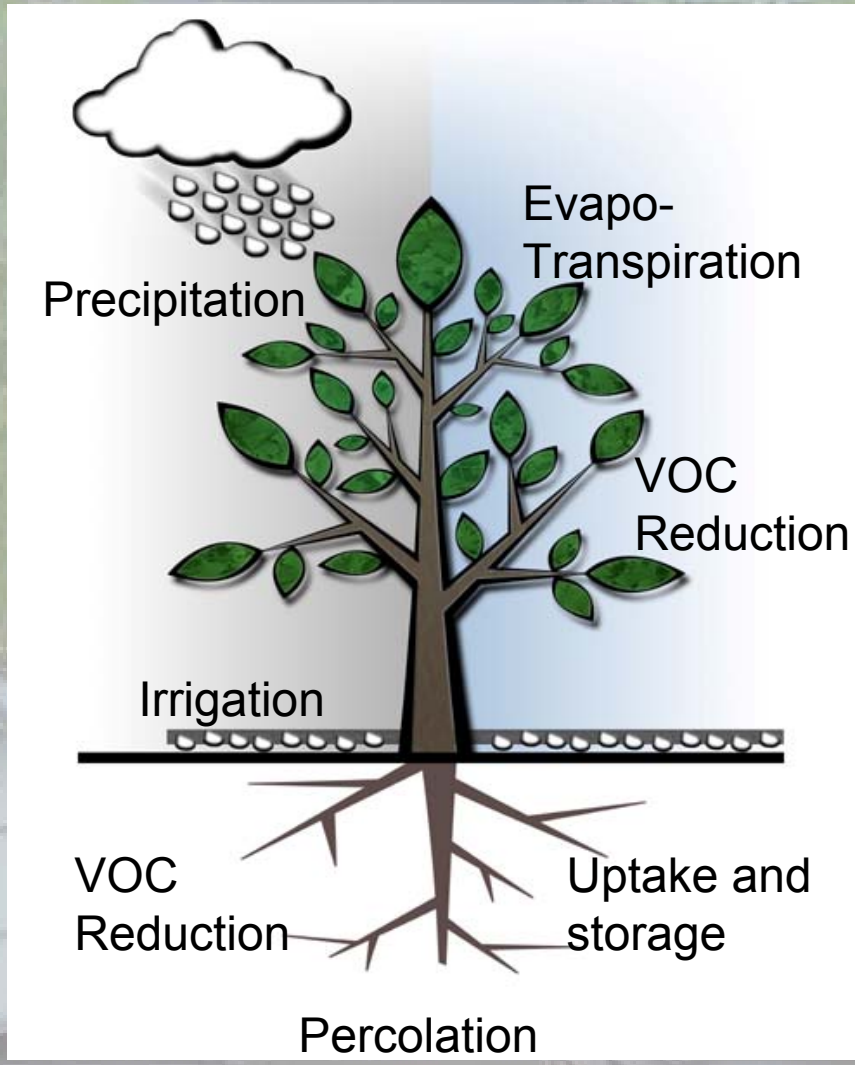
Project Background (cont')

- Remediation System Optimization
  - Began in 2002
  - Water balance – increase net groundwater recovery
  - Segregated "hot" well for off-site treatment
  - Used treated groundwater in facility processes
  - Replace shallow pumping wells with trees

→ Phytoremediation

Phytoremediation Processes

- Hydraulic control
- Uptake of VOCs in root zone
- Metabolism of VOCs within plant
- Evapotranspiration of volatiles



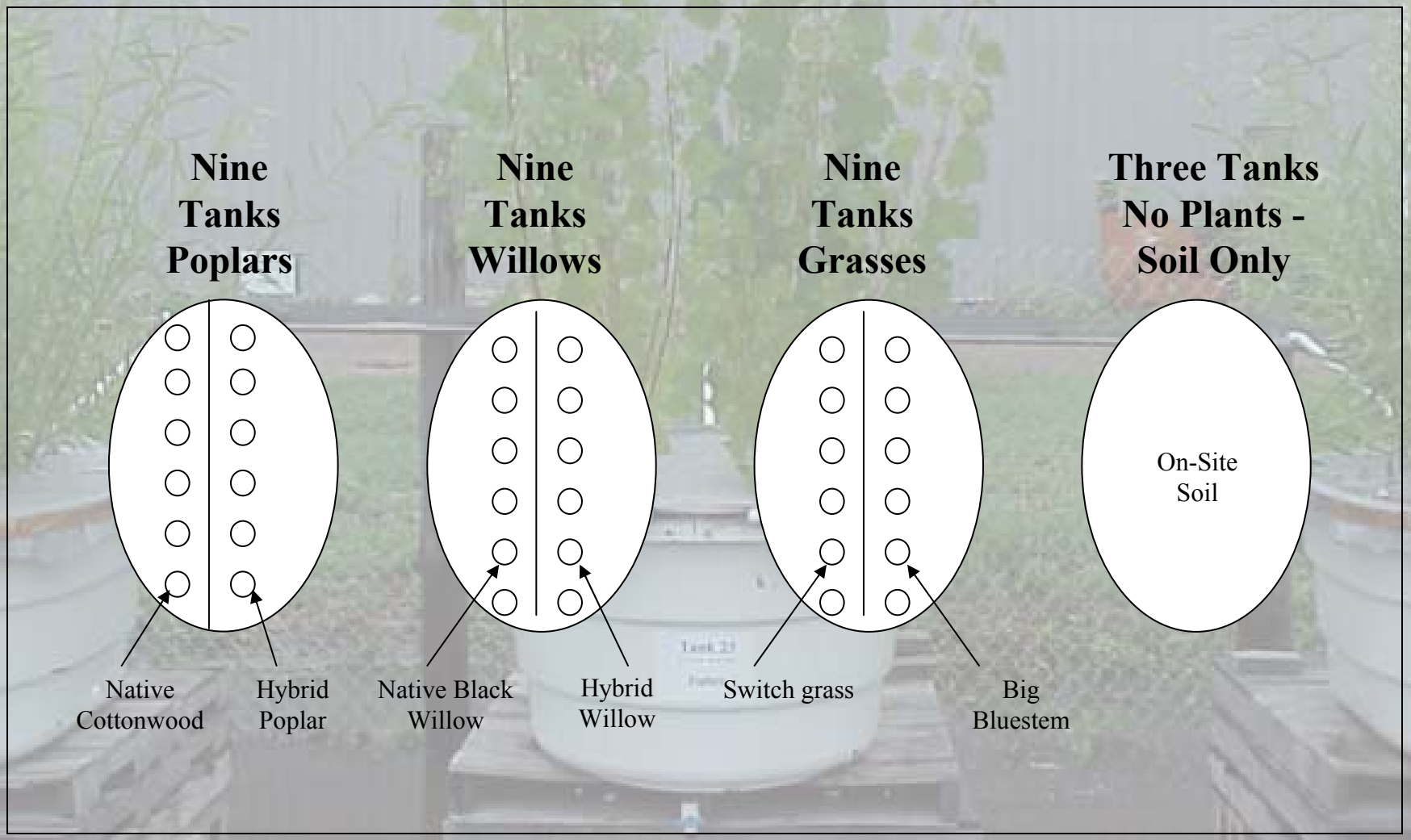
Phytoremediation Processes (cont')

- Consider Phytoremediation at the site for:
  - Hydraulic uptake and control
  - Water quality improvement
  - Development of beneficial natural resource
    - County Park → Arboretum
- Phased treatability studies from May to December in both 2002 and 2003

Phase I (2002)

- **Objectives:**
  - Evaluate use of plants to improve hydraulic control at site
  - Evaluate possible VOC removal by using plants
  - Evaluate hybrid and naturally occurring species of poplars, willows and grasses
  - Select best plant materials

Phase I (2002) (cont')

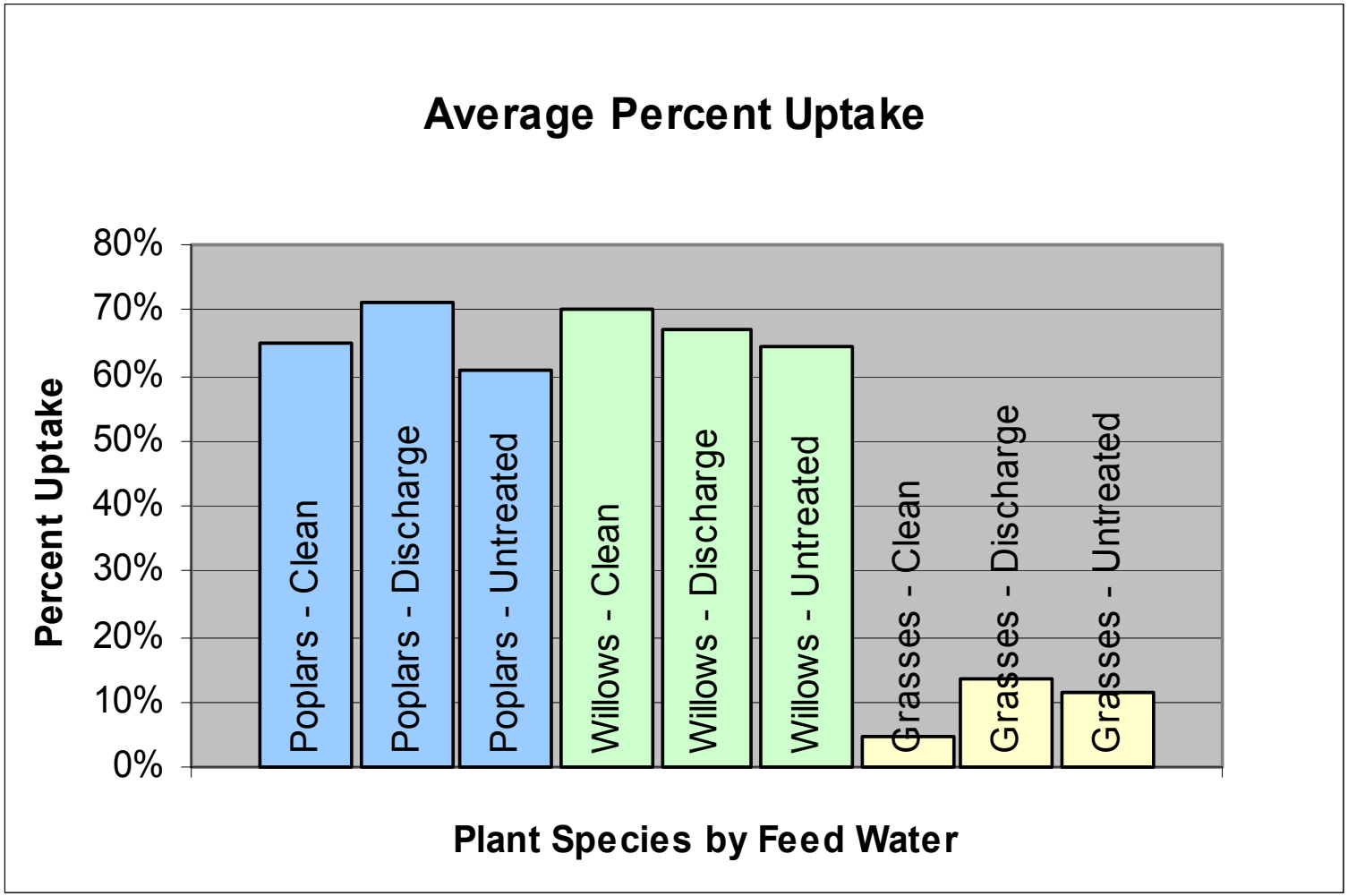


Phase I (2002) (cont')

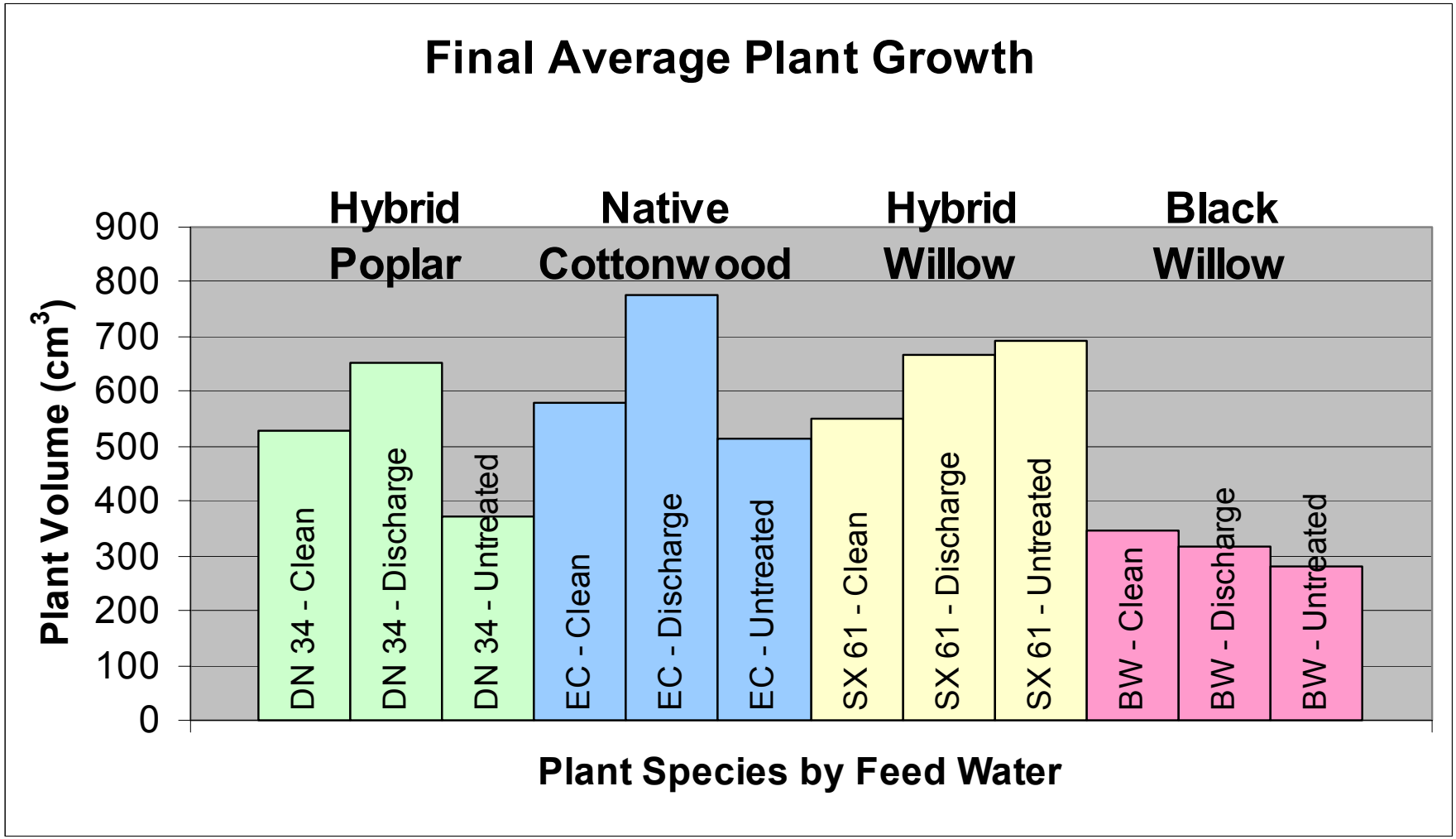
Phase I (2002) (cont')

- Operation, Maintenance and Monitoring
  - Plant inspection and spraying
  - Water balance three times per week (uptake)
  - Sampling and analysis (VOC reduction)
    - Feed water each event, drain water monthly
- Plant Measurements and Harvest
  - Height and diameter measurements
  - Mortality
  - Soil samples

Phase I (2002) (cont')



Phase I (2002) (cont')



Phases II and III (2003)

- Objectives
  - Refine design under more representative field conditions
  - Obtain additional performance data on uptake and VOC reduction/removal
  - Perform side by side tank study and in-ground plantation
  - Discharge water only

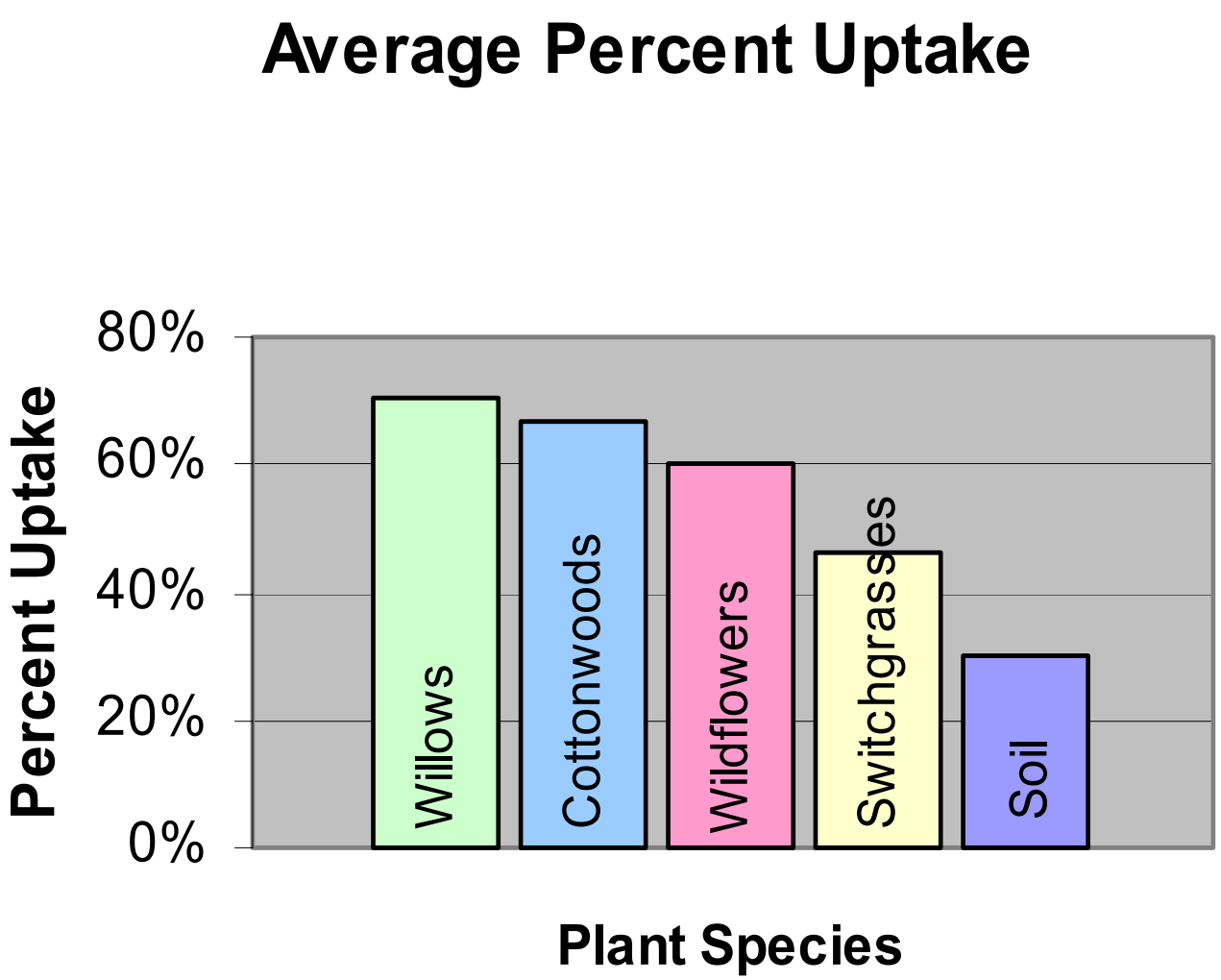
Phase II Tank Study (2003)

- Design and Construction
  - 14 uncovered tanks
  - Cottonwood, willow, switchgrass, wildflowers and soil
  - Planted 10-inch long cuttings or rooted plugs

Phase II Tank Study (2003) (cont')

- Operation, Maintenance and Monitoring
  - Plant inspection and spraying
  - Water balance three times per week
  - Sampling and analysis
    - Feed water each event, drain water monthly
- Plant Measurements and Harvest
  - Height and diameter measurements
  - Soil samples
  - Aboveground and belowground biomass samples

Phase II Tank Study (2003) (cont')



Phase II Tank Study (2003) (cont')

Plant Material	Average Height (cm)	Average Diameter (cm)	Average Volume (cm^3)
Cottonwoods	167.85	1.42	353.84
Willows	212.41	1.43	443.24
Switchgrasses	98.35	N/A	N/A

Phase III In-Ground Plantation (2003)

- Design and Construction
  - Two each 7 x 7 plots of cottonwood, willow and switchgrass
  - Trickle (drip) irrigation system

Phase III In-Ground Plantation (2003) (cont')

- Operation, Maintenance and Monitoring
  - Plant inspection, spraying and weed control
  - Watered three times per week
    - Up to 3,000 gallons per watering event
- Plant Measurements and Harvest
  - Height and diameter measurements
  - No plants harvested

Phase III In-Ground Plantation (2003) (cont')

Plant Material and Plantation Location	Average Height (cm)	Average Diameter (cm)	Average Volume (cm^3)
Cottonwoods (NW)	157.72	1.58	460.20
Cottonwoods (SE)	184.10	1.83	763.70
Willows (SC)	160.24	1.30	308.34
Willows (NE)	159.95	1.22	274.18
Switchgrasses (NC)	102.11	N/A	N/A
Switchgrasses (SW)	95.20	N/A	N/A

Phytoremediation Treatability Study Key Findings

- Excellent plant growth
- Low mortality
- Effective hydraulic control
- Effective VOC removal or reduction for plant/soil system
- Improve the environment through use of natural resources
- It's much more than just "Plant them and they will grow"

Recommendations and Options

- 2004
  - Expanded in-ground treatability study with established plants
  - Partner involvement
    - Objectives, agreements and permits
    - Site locating
  - Plan, prepare and obtain plant materials
- 2005
  - Full-scale implementation

Thank You!

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