Key Engineering Considerations in the Design and Construction of Ditch Plugs and Tile Blocks

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2010 BWSR Academy

Minnesota Board of Water & Soil Resources

Ditch Plugs & Tile Blocks

Key Engineering Considerations

- Location Considerations
- Design/Construction Requirements
- Other Considerations

Keys to Success –
Helpful Tools

Update of Minnesota Wetland Restoration Guide

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Success and Sustainability

Key Engineering Considerations

Maintaining Wetland Hydrology – Preventing/Minimizing Losses

- Ditch Plugs
- Tile Blocks

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Success and Sustainability

Key Engineering Considerations

Maintaining Wetland Hydrology – Preventing/Minimizing Losses

- Ditch Plugs
- Tile Blocks

Ditch Plugs / Embankments

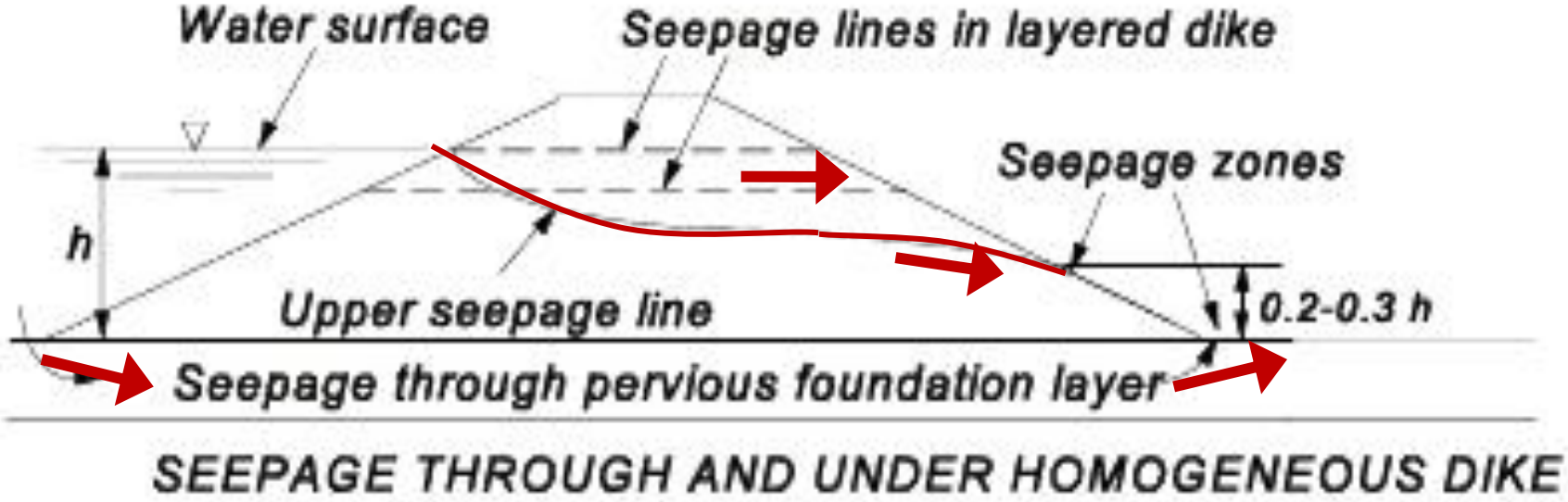
Key Engineering Considerations – *Project Design*

Embankment Seepage & Underseepage

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Embankment Seepage & Underseepage



SEEPAGE THROUGH AND UNDER HOMOGENEOUS DIKE

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Strip Topsoil under Entire Area of Embankment "Footprint"

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Implement Foundation Treatments as Designed "Core or Cutoff Trench"

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Use Suitable Soils for Backfill

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Backfill in Lifts Not to Exceed 9 Inches and Compact each Lift

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Construct with Adequate Top Width and Side Slopes

10 foot Top Width

5:1 Upstream Slope

3:1 Downstream Slope

Ditch Plugs / Embankments

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Topsoil and Properly Seed and Stabilize Constructed Fills as soon as Construction is Completed

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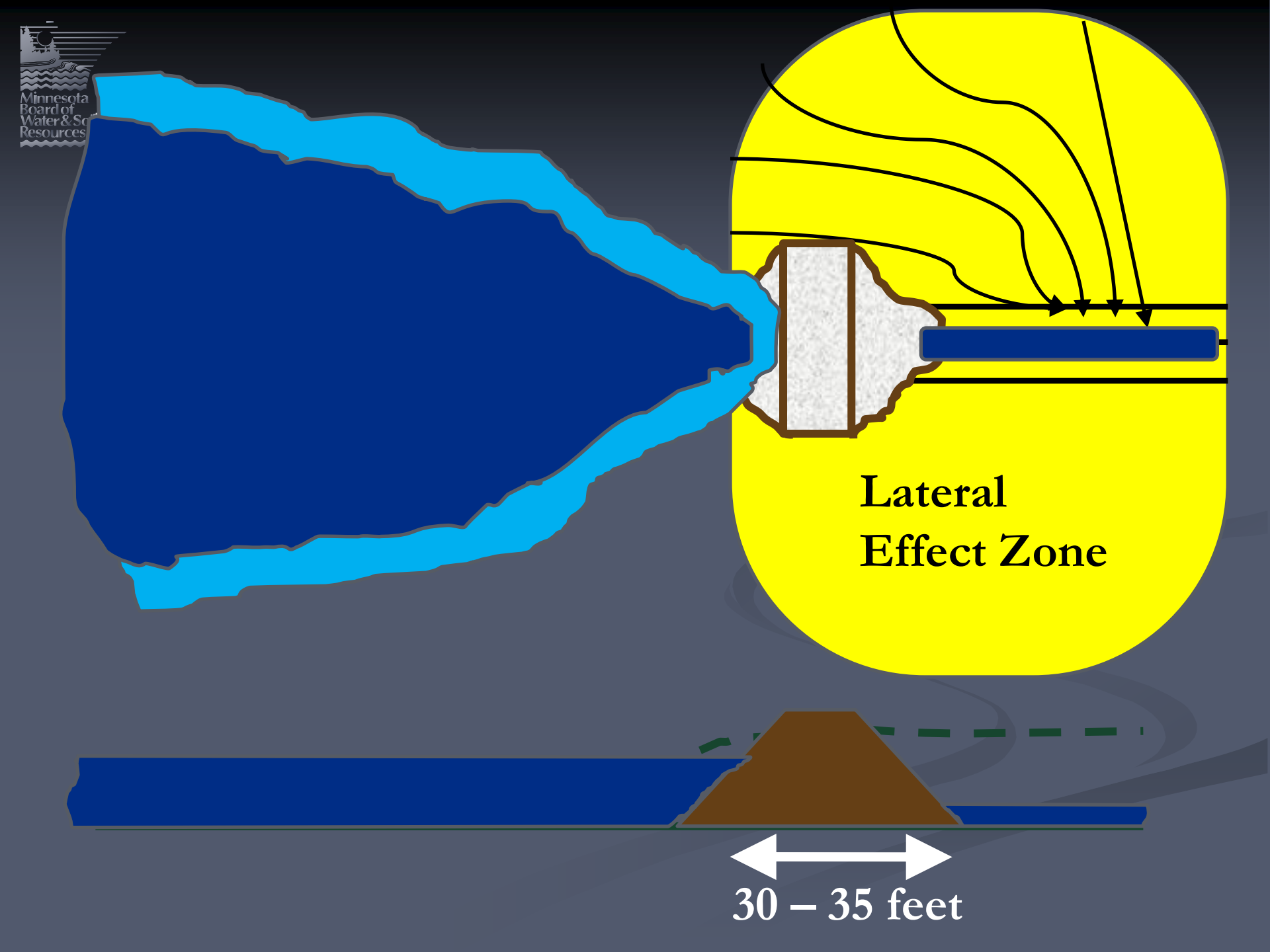
Key Engineering Considerations – *Project Design*

Ditch Plugs

- **Typical Ditch Plug**
  - **Where to Locate?**
  - **How to Construct?**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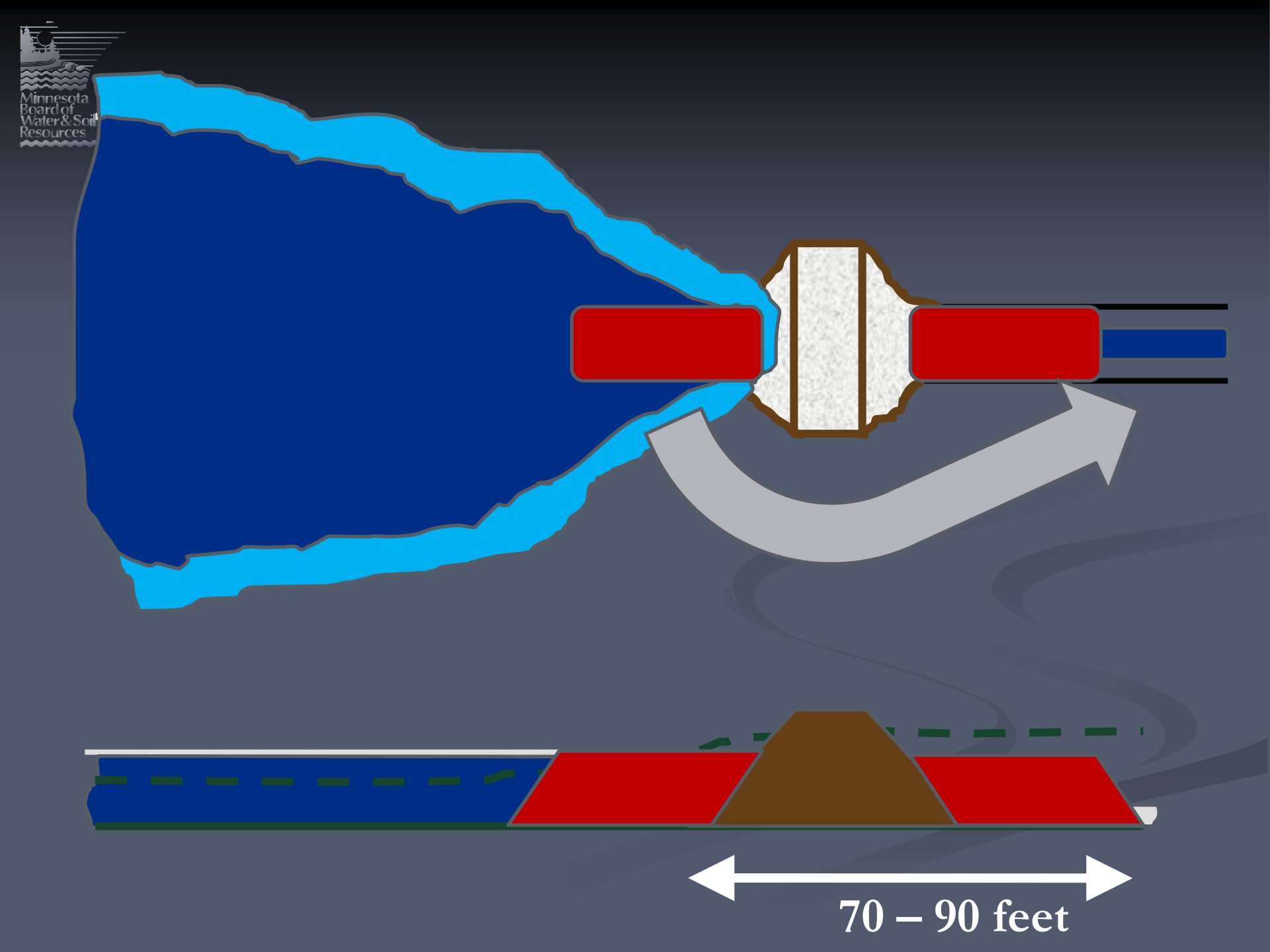
Lateral Effect Zone
30 – 35 feet

Lateral Effect Zone

70 – 90 feet


Minnesota
Board of
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Resources
70 – 90 feet

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Success and Sustainability

Key Engineering Considerations

Maintaining Wetland Hydrology – Preventing/Minimizing Losses

- Ditch Plugs
- Tile Blocks

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Tile Blocks

Key Engineering Considerations – *Project Design*

To prevent undesired hydrologic losses tile blocks should be:

- Properly Located
- of Sufficient Length
- Properly Constructed

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Tile Blocks

- Typical Tile Block
  - Where to Locate?

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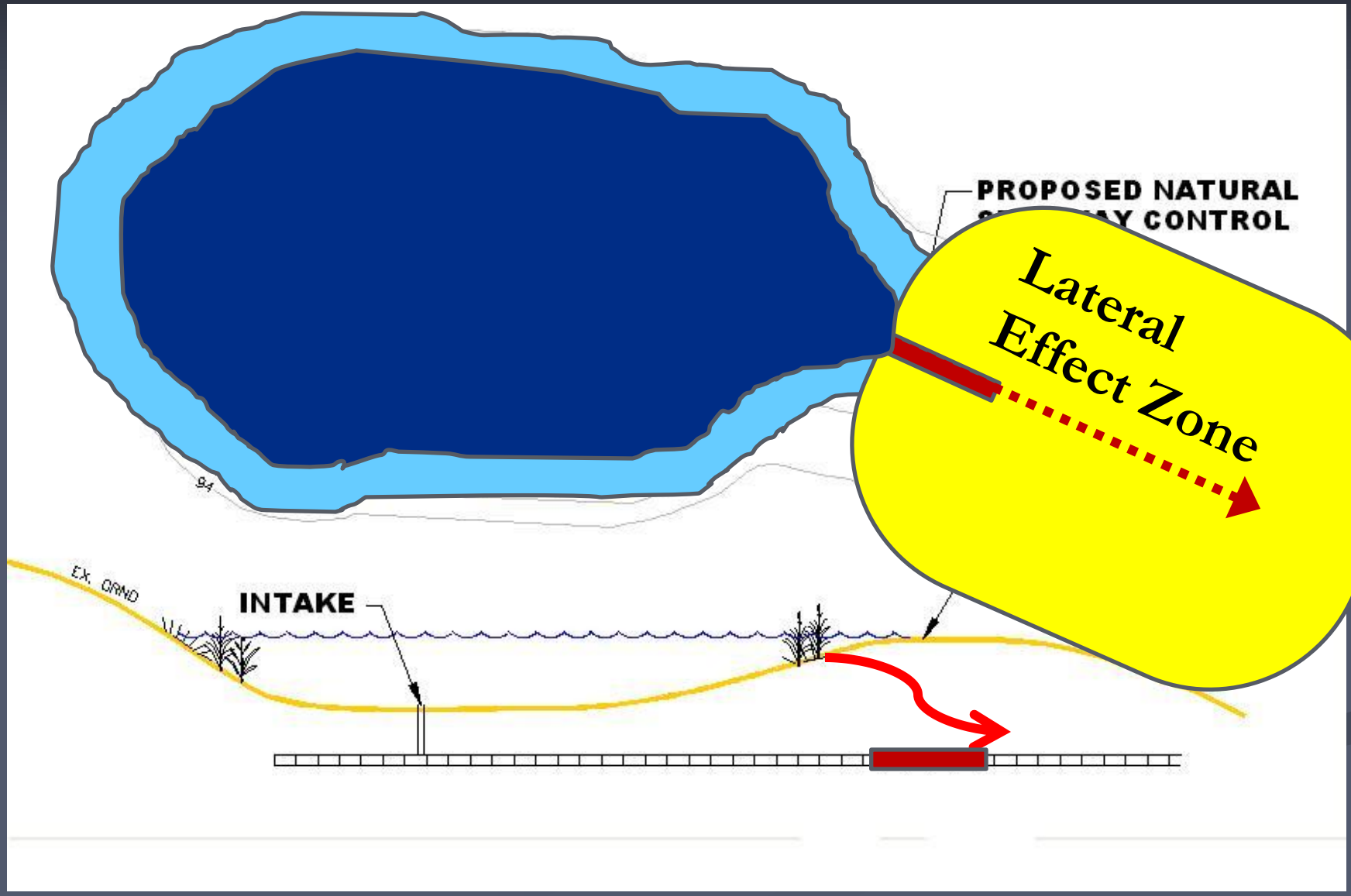
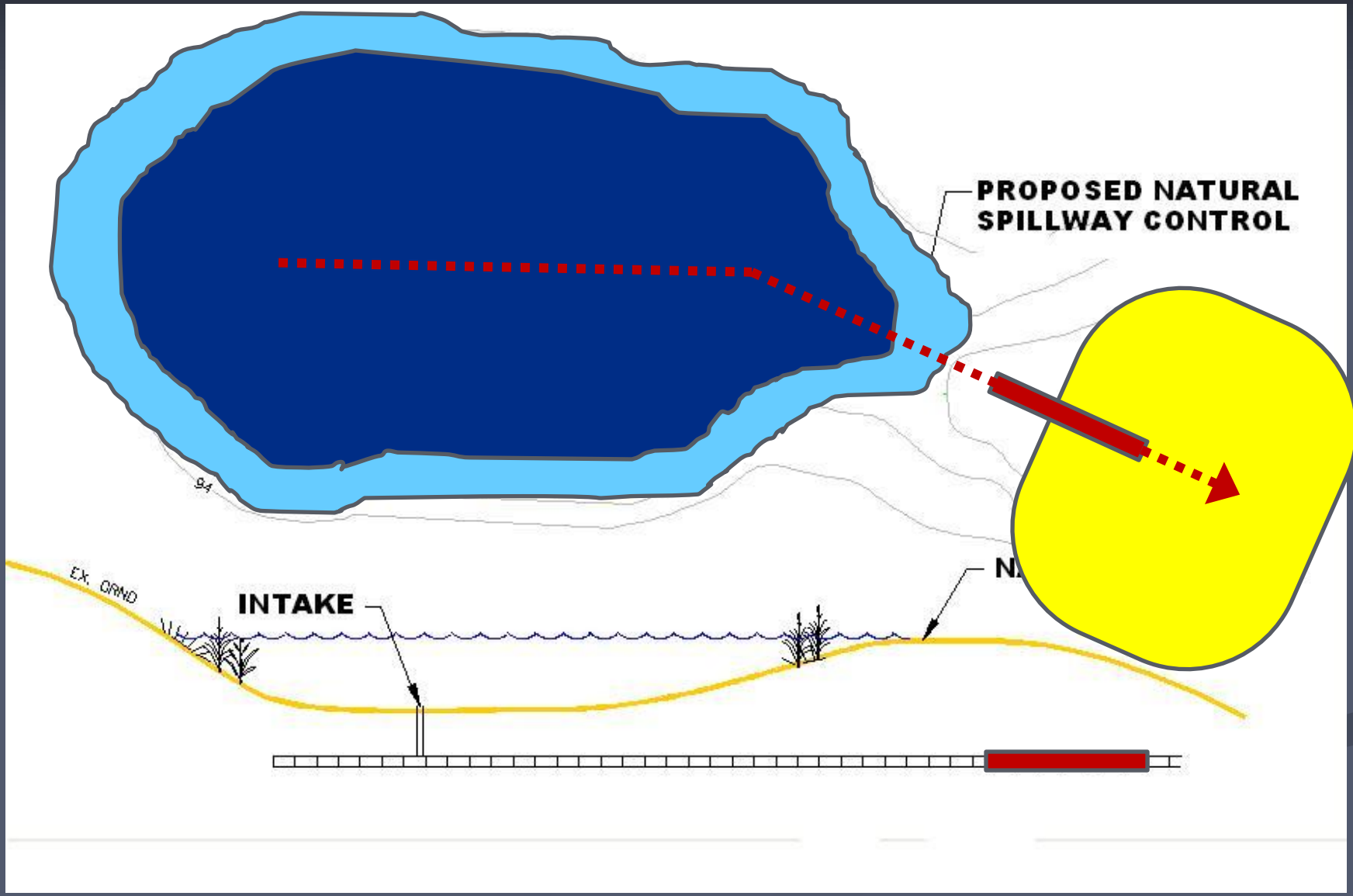
Key Engineering Considerations – *Project Design*

Tile Blocks

- **Typical Tile Block**


PROPOSED NATURAL
Lateral
Effect Zone
94
EX. GRND
INTAKE


PROPOSED NATURAL
SPILLWAY CONTROL
94
EX. GRND
INTAKE

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Key Engineering Considerations – *Project Design*

Tile Blocks

Where to remove? – (depressional wetlands)

Where Possible, Start Block 50 to 100 feet Downstream of Wetland Edge

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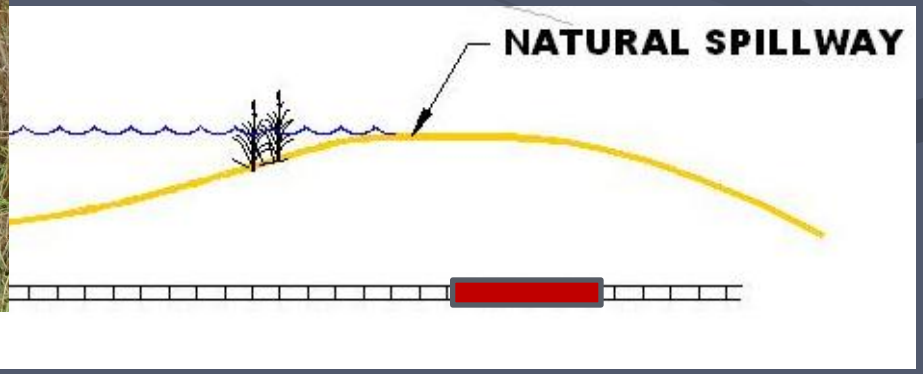
Key Engineering Considerations – *Project Design*

Tile Blocks

Where to remove? – (depressional wetlands)

Avoid Placing Block in Spillway Control Areas (if possible)



Tile Blocks

- **Typical Tile Blocks**

Recommended Removal Lengths:

- **100 Feet – Depressional Wetlands**
- **30 to 50 Feet – Non-Depressional Wetlands**
- **Longer Removal Lengths in Sandy or Organic Soils**

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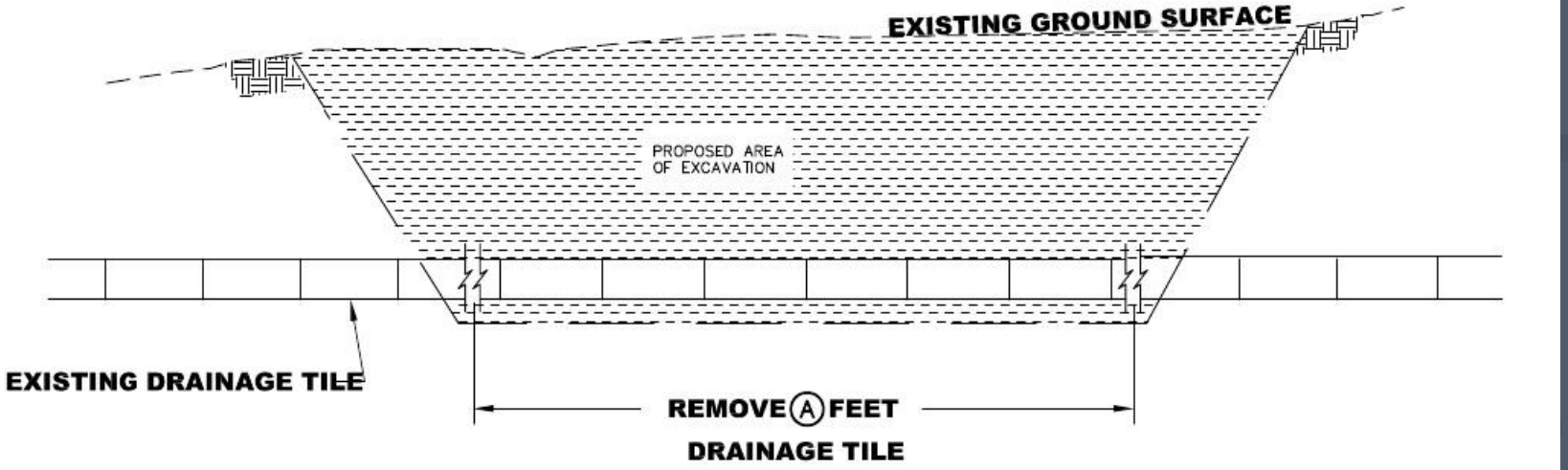
Tile Blocks

Key Engineering Considerations – *Project Design*

- **Typical Tile Removal Length (Block)**



TILE BLOCK/REMOVAL (TYPE "A")

NOT TO SCALE

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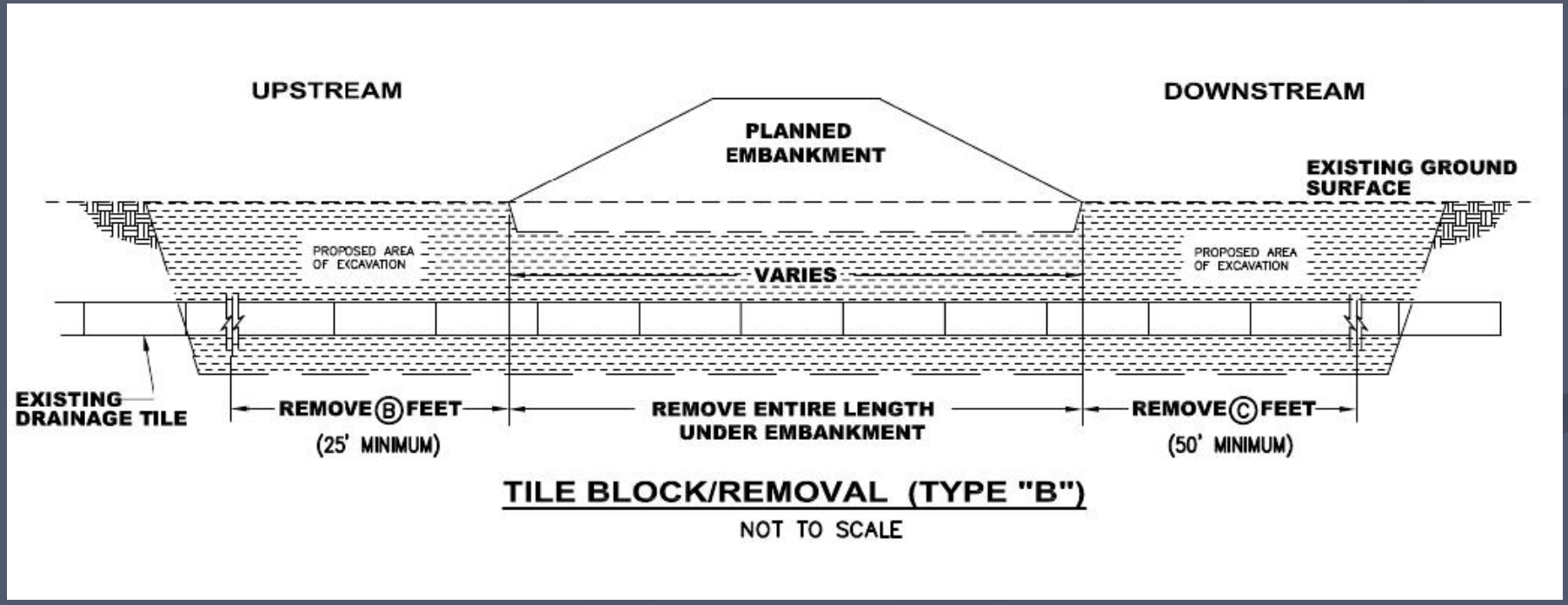
Tile Blocks

Key Engineering Considerations – *Project Design*

- **Typical Tile Removal Length (Block) –**
  Under Embankments



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Tile Blocks

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Remove all Tile Fragments from Excavated Trench

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Tile Blocks

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Excavate Tile Removal Trench to Approximate 1:1 Side Slope Before Backfilling

Especially Under Embankments!

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Tile Blocks

Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

Plug Exposed Tile Ends Before Backfilling

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Tile Blocks

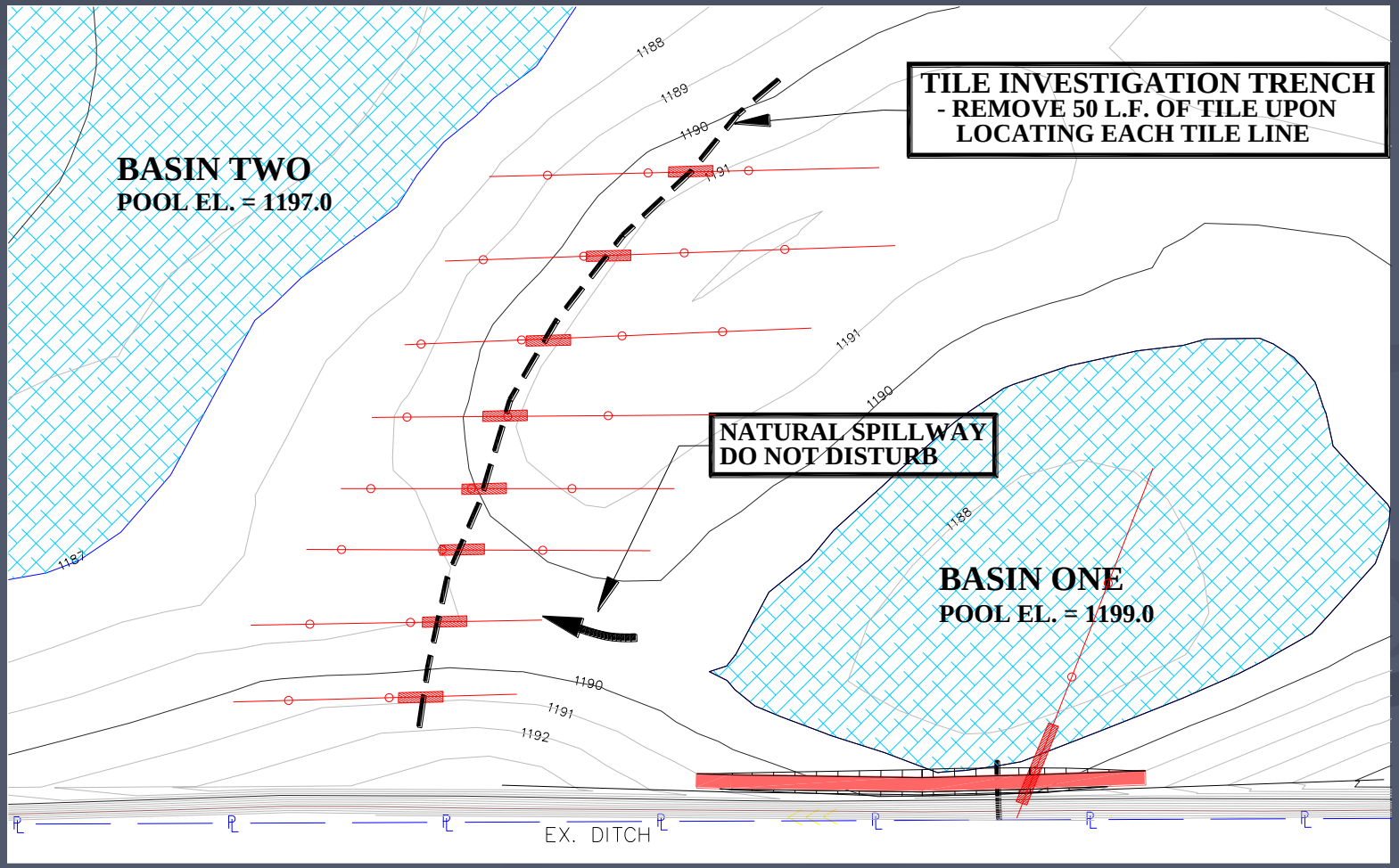
Key Engineering Considerations – *Project Design*

Typical Design/Construction Requirements

- Backfill Trench With Similar Soils
- Compact in Lifts
- Overbuild (fill) to Account for Some Settlement
- Topsoil and Stabilize

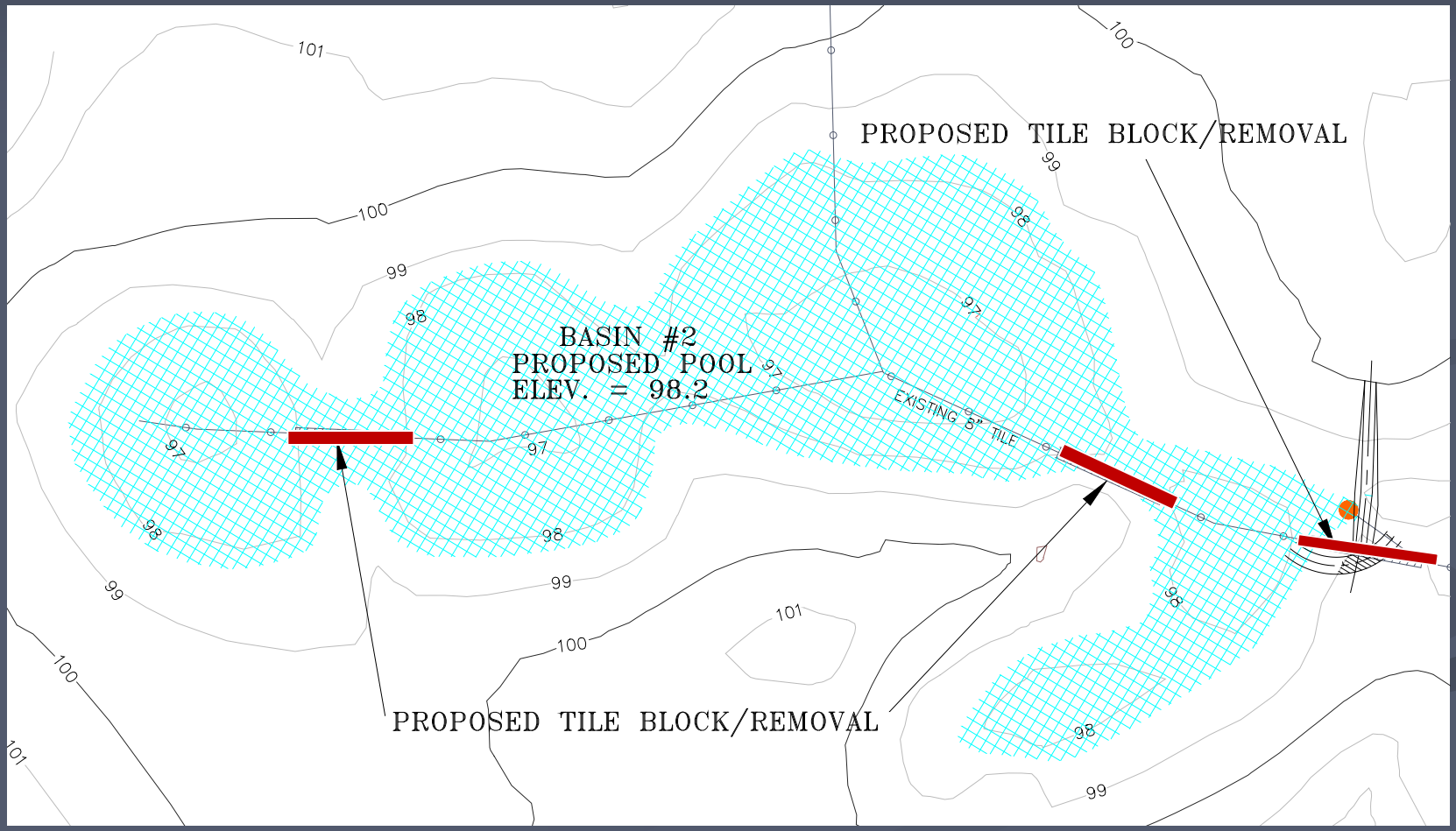
Tile Blocks - *Multiple*

Key Engineering Considerations – *Project Design*



Tile Blocks - *Multiple*

Key Engineering Considerations – *Project Design*



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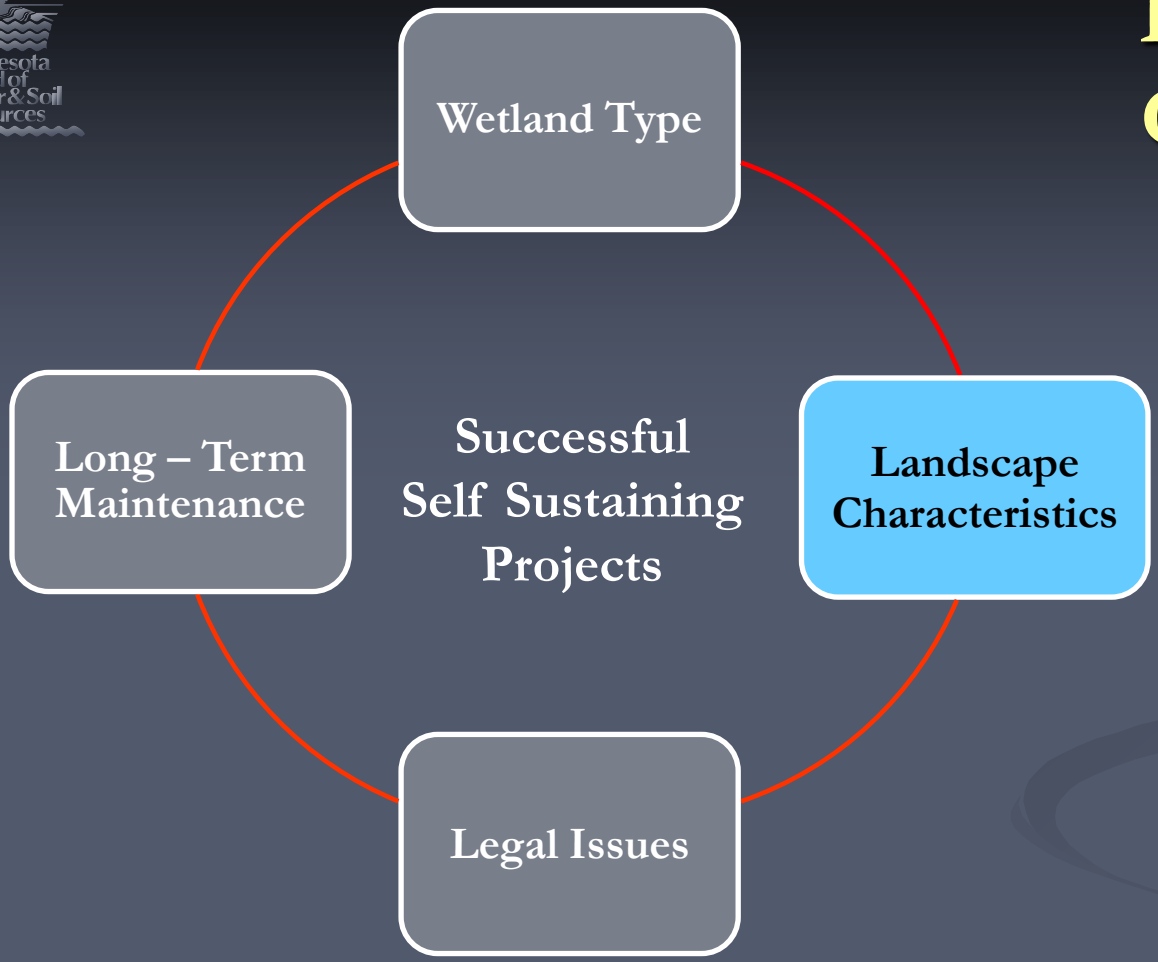
Key Engineering Considerations –



- Hydrology
- Topography
- Drainage
- Soils
- Land Use

Ditch Plugs & Tile Blocks

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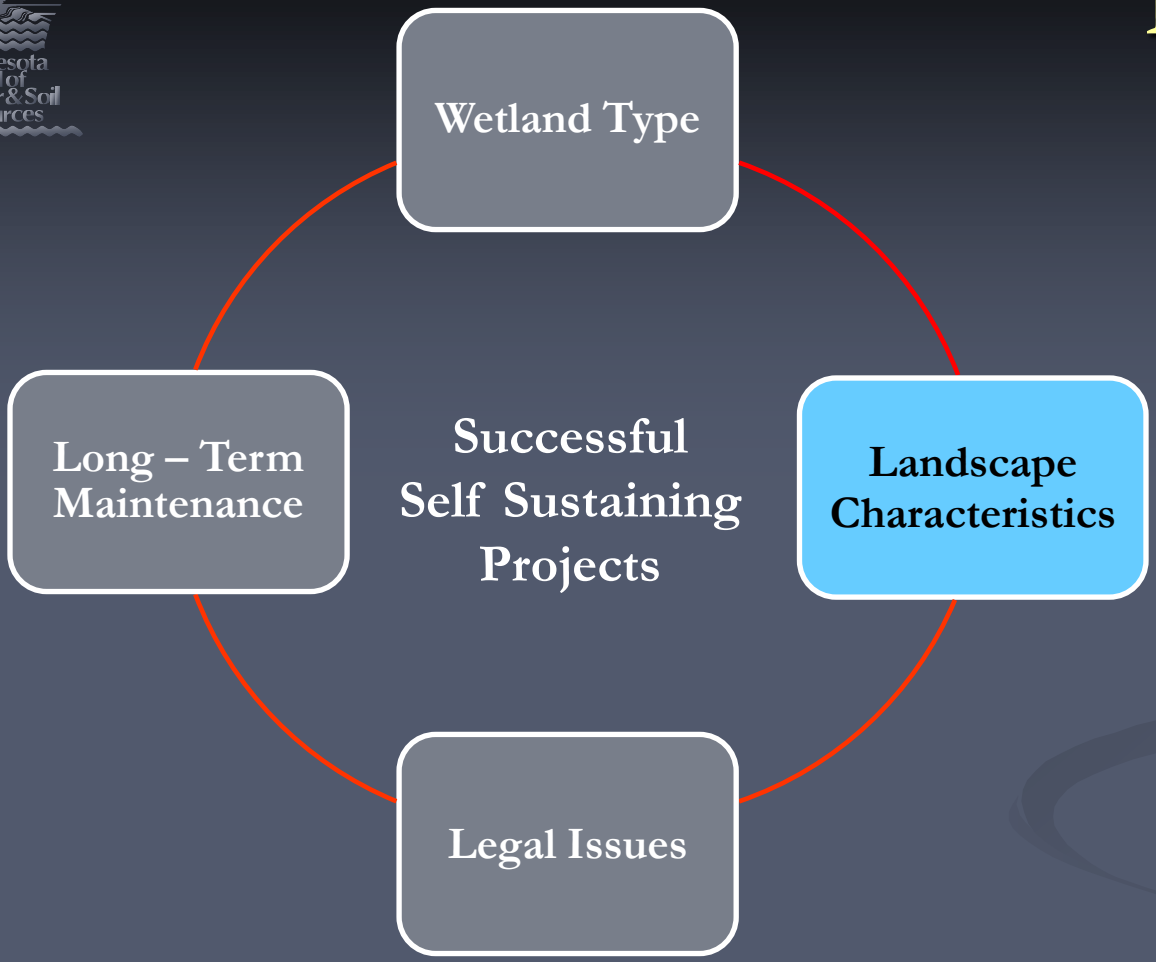


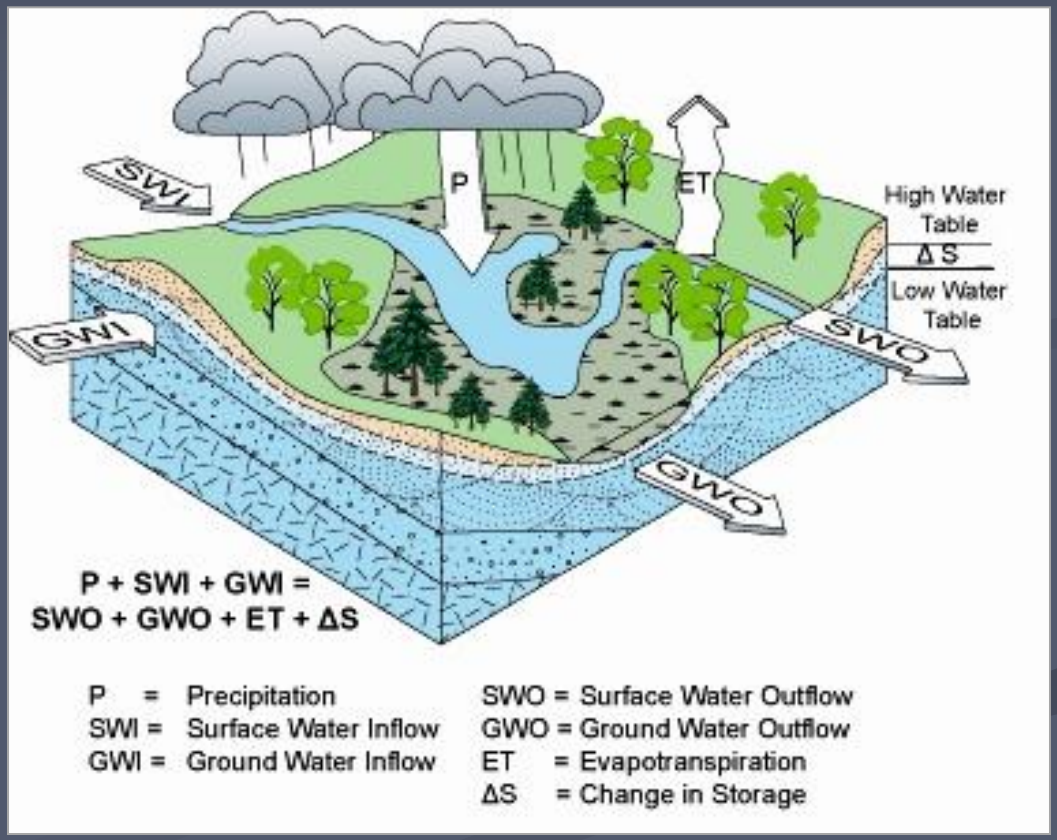
Ditch Plugs & Tile Blocks

Key Engineering Considerations

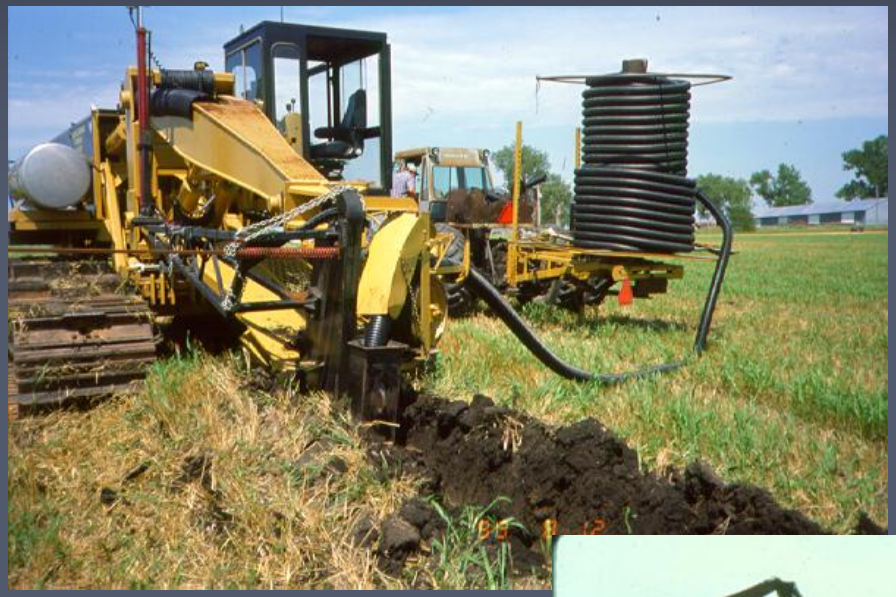
- **Hydrology**
- Topography
- Drainage
- Soils
- Land Use

Wetland Hydrology

- Wetland Hydrology is Complex!
- It Varies
- Why is this Important?



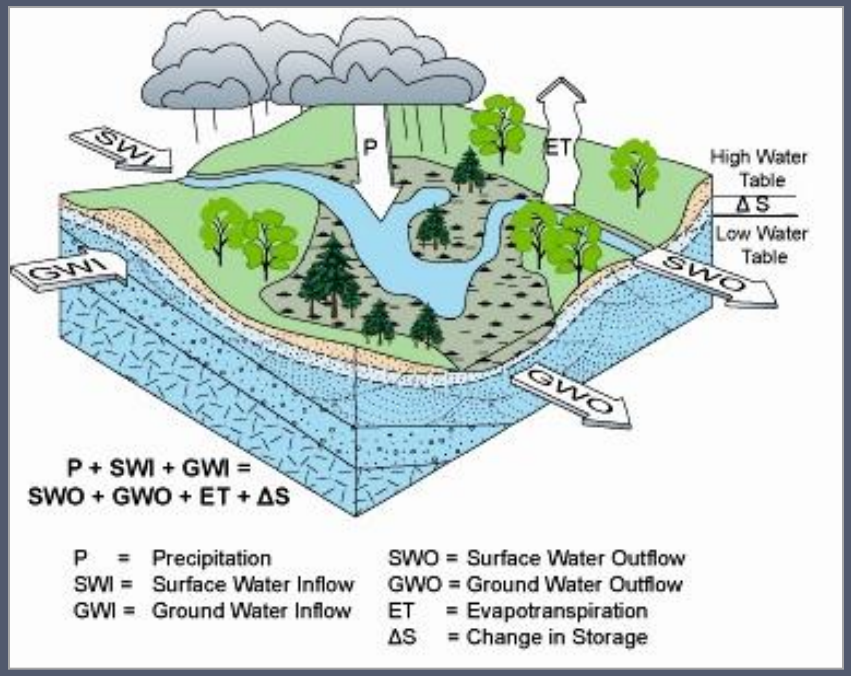
Because it influences how and to what extent wetlands are drained

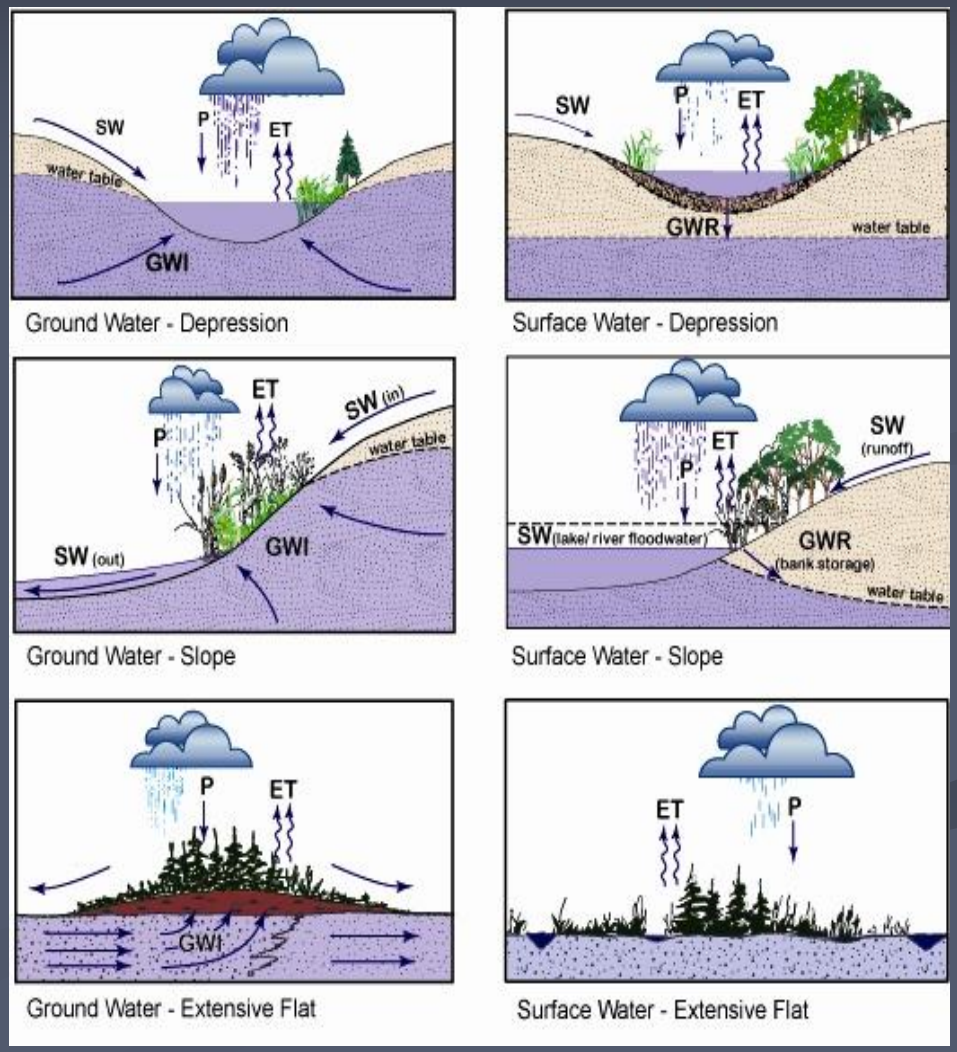


And therefore what strategies we need consider to effectively restore them

Landscape Characteristics - *Hydrology*

Key Engineering Considerations





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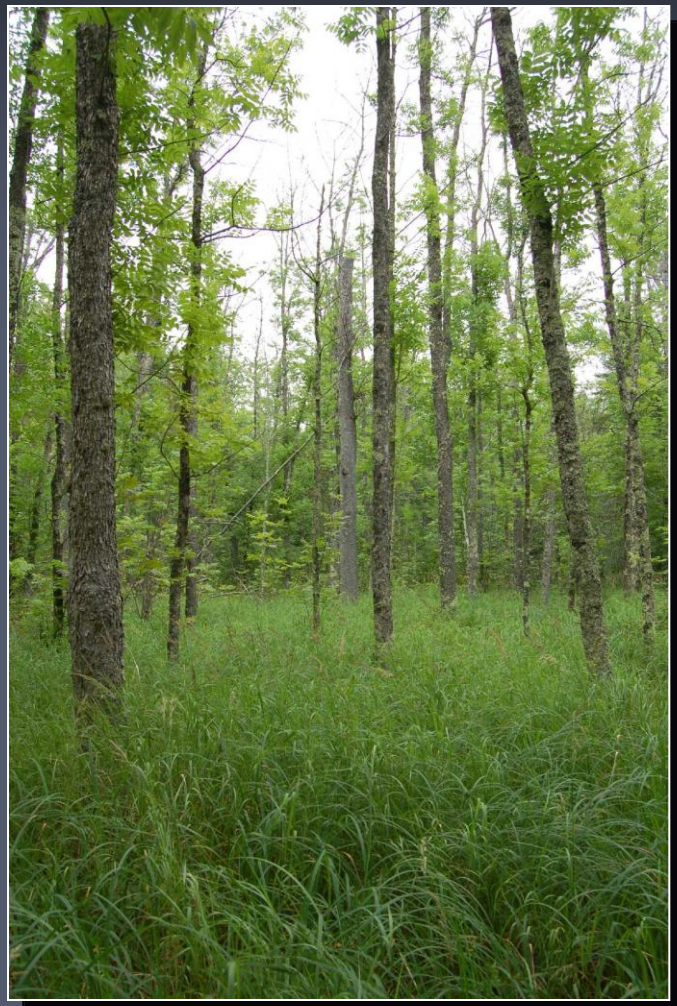


Extensive Wetland Flats

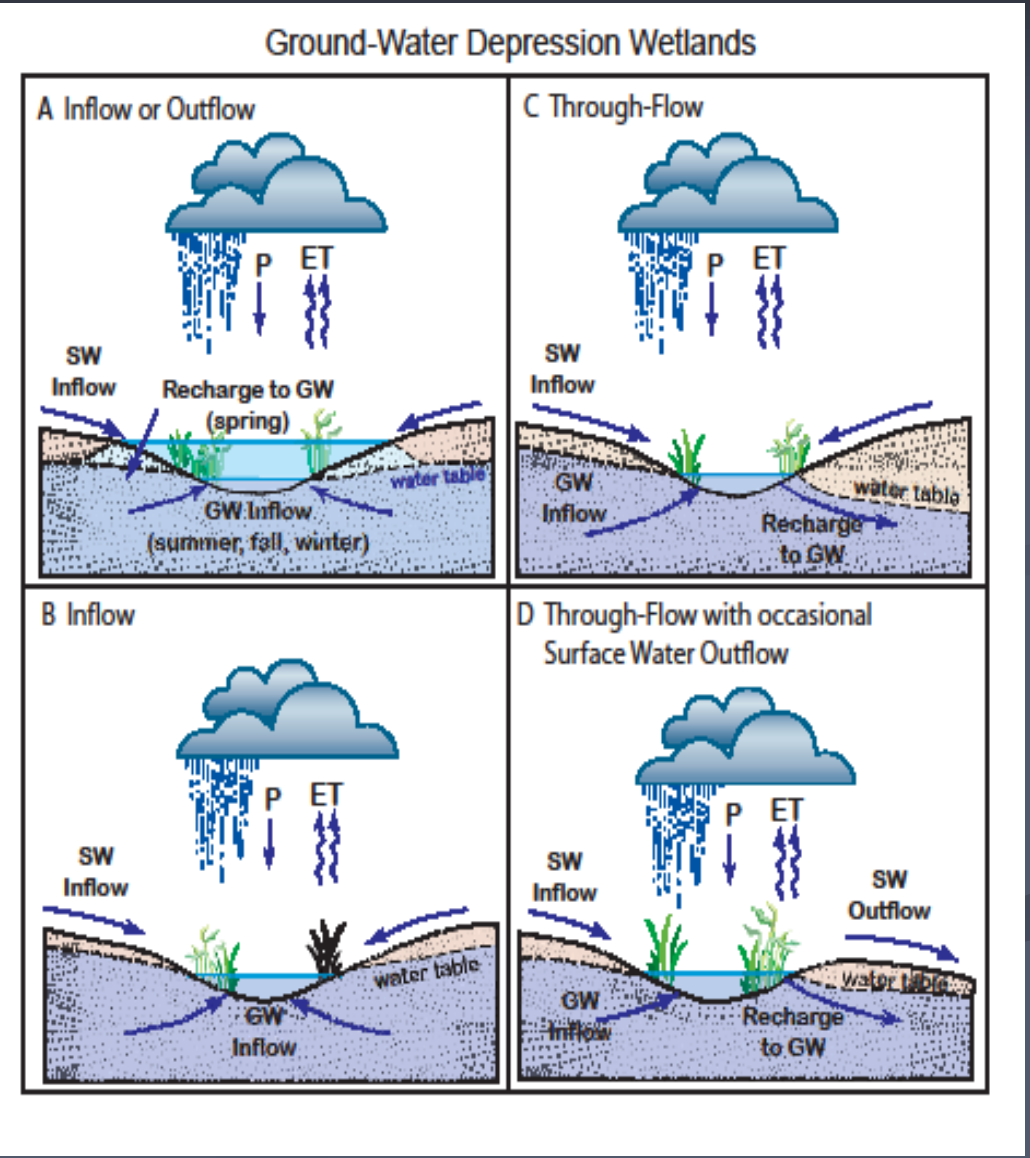
Depressional Wetlands

Slope Wetlands

Depressional Wetlands

Ground Water Supported – (Recharge)

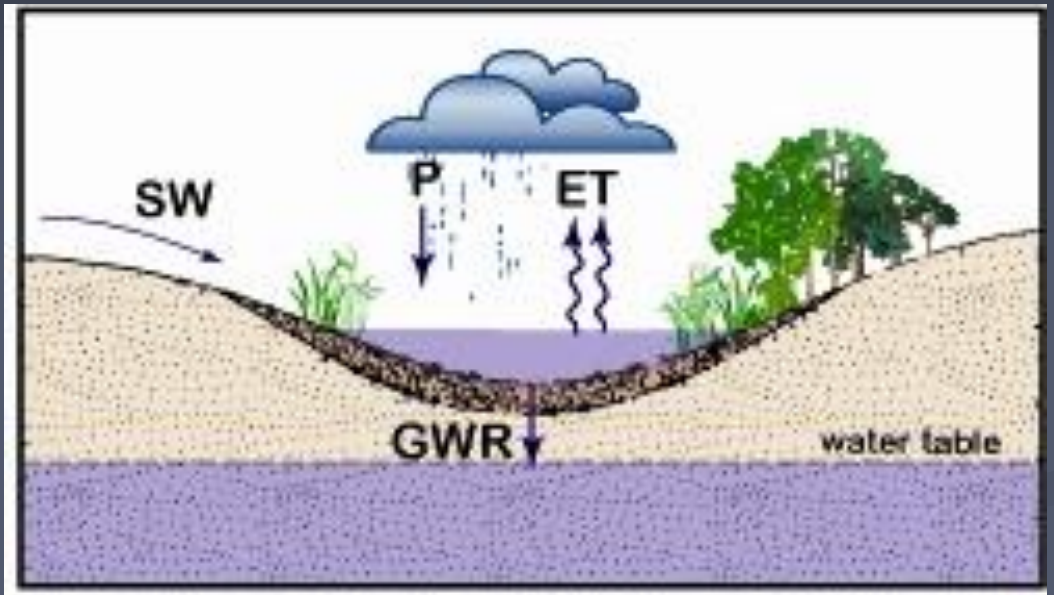
- *Marshes*
- *Sedge meadows*
- *Fens*



Depressional Wetlands

Surface Water Supported – (Discharge)

- ***Seasonal Wetlands***
- ***Sedge Meadows***
- ***Marshes***

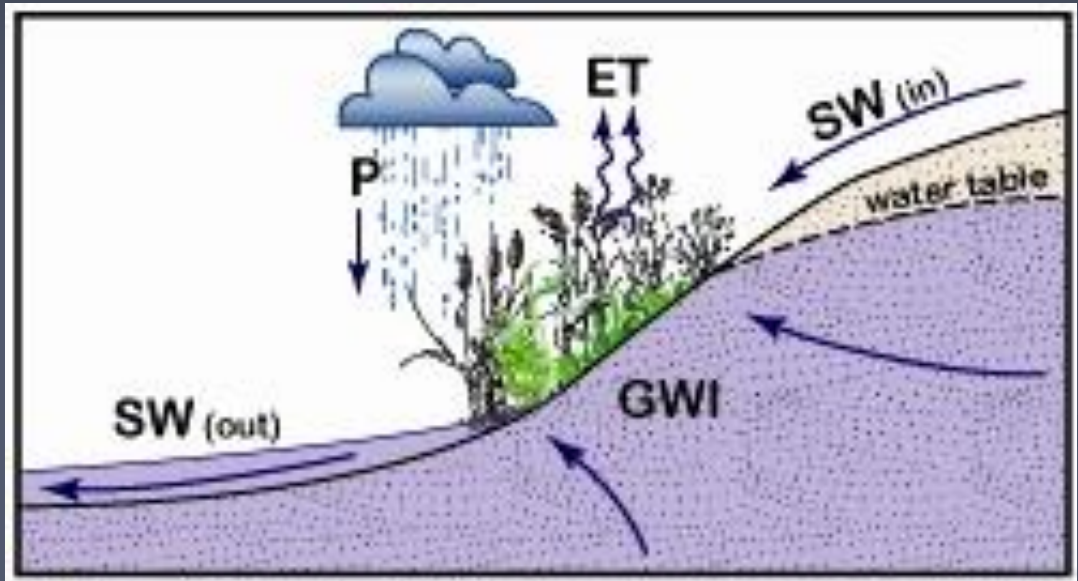


Surface Water - Depression

Slope Wetlands

Ground Water Supported – (Recharge)

- ***Fens***
- ***Marshes***

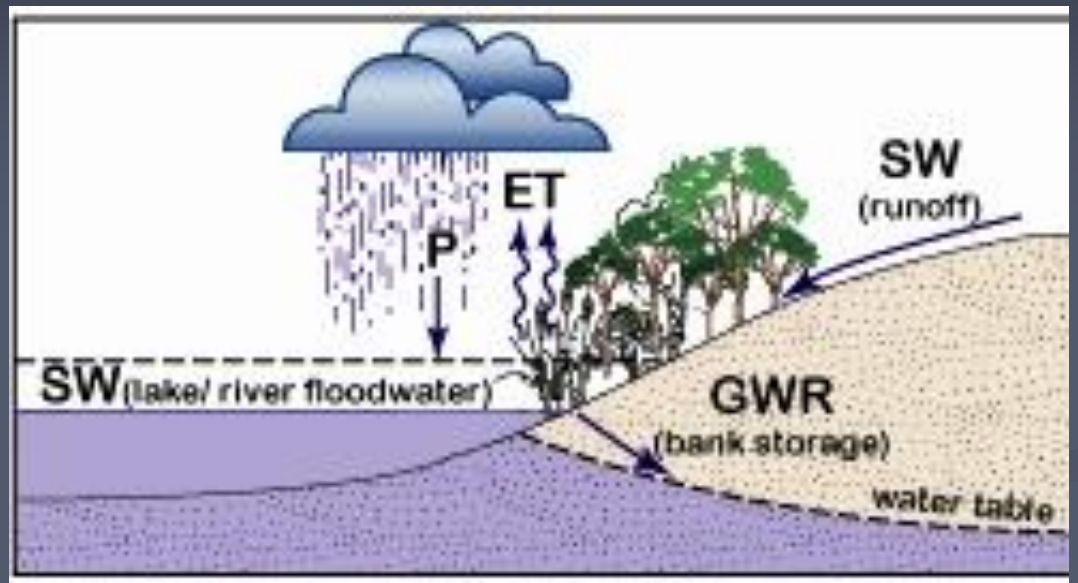


Ground Water - Slope

Slope Wetlands

Surface Water Supported – (Discharge)

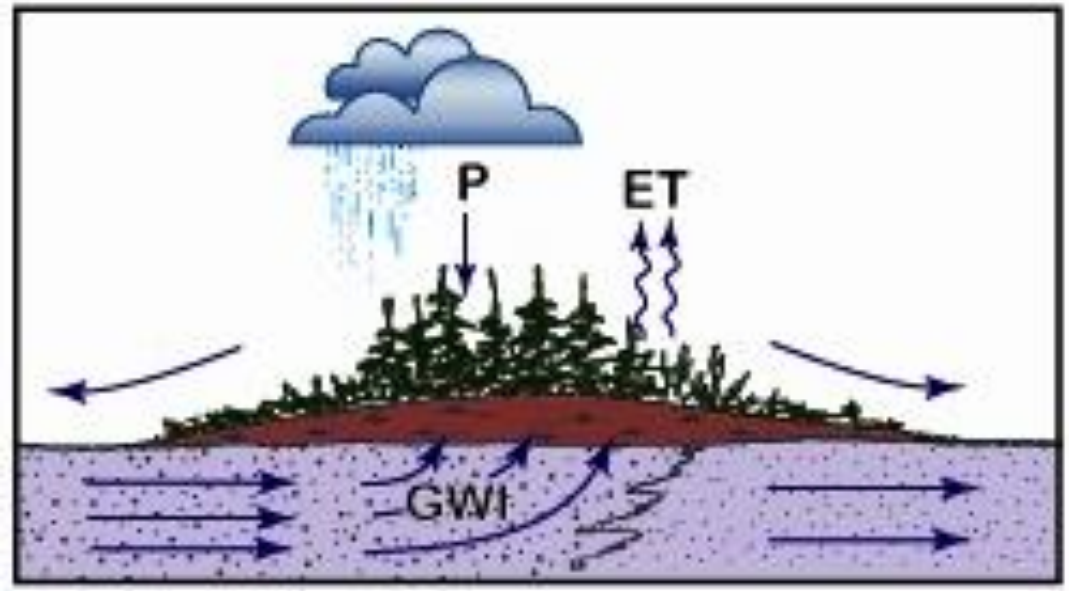
- *Marshes*
- *Shrub Swamps*
- *Riverine Wetlands*
- *Floodplain Forests*



Surface Water - Slope

Extensive Flat Wetlands

Ground Water Supported – (Recharge)

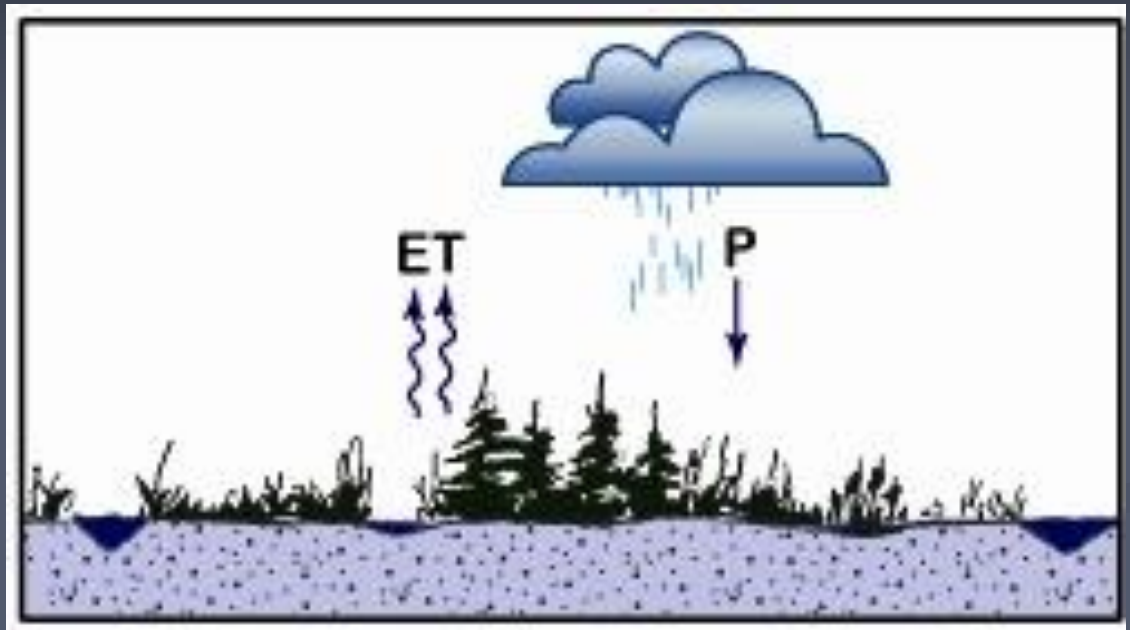


Ground Water - Extensive Flat

- *Occur on large, relatively flat plains and lake bottoms (ex. Lake Agassiz region*
- *Mucklands and Peatlands (bogs)*

Extensive Flat Wetlands

Surface Water Supported – (Discharge)



Surface Water - Extensive Flat

- *Areas along shallow, low gradient streams*
- *Mucklands and Peatlands (bogs)*

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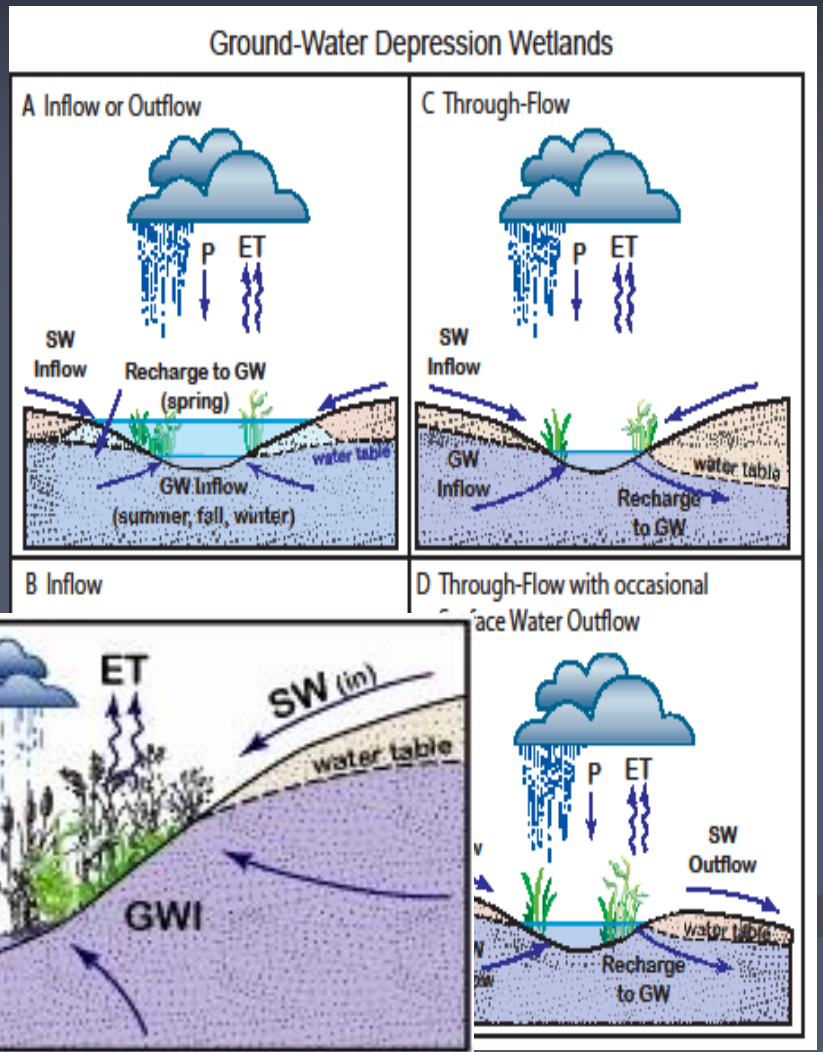
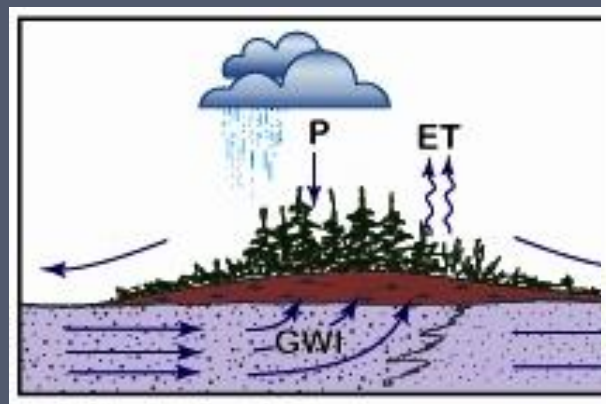
Examples

Ground Water Supported Wetlands - *(Recharge)*

Have a net <u>in-seepage</u> water budget where groundwater flows into and provides hydrology to the wetland



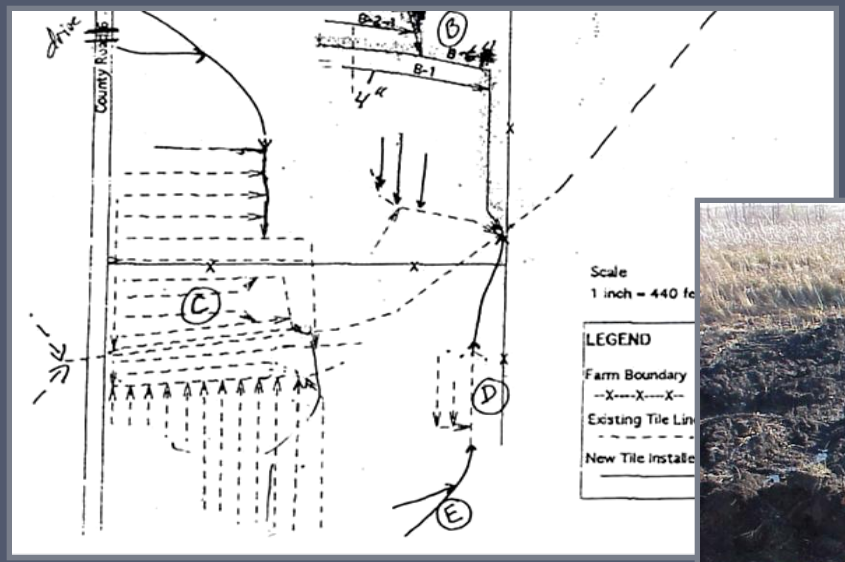


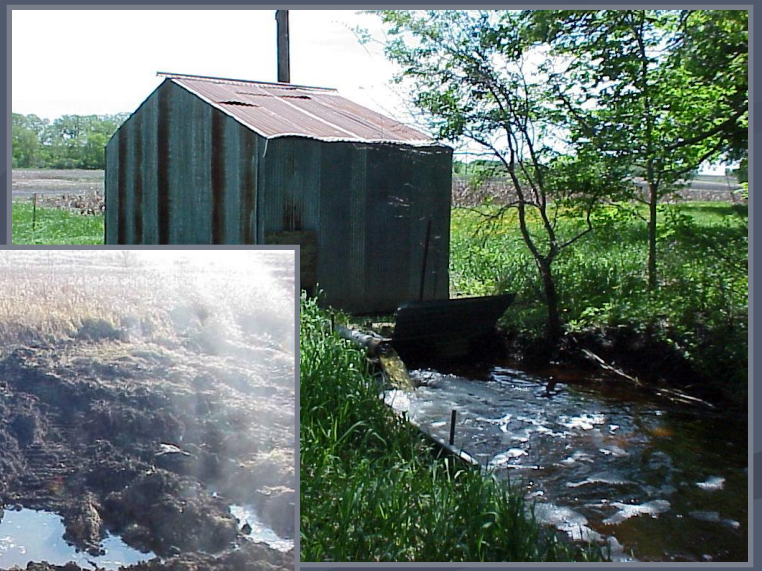
Ground Water - Extensive Flat

Ground Water - Slope

Ground Water Supported Wetlands - *(Recharge)*

Will typically have high water-tables and be drained by extensive drainage systems (pattern tile, extensive ditches, pumps, etc.)





Ground Water Supported Wetlands - *(Recharge)*

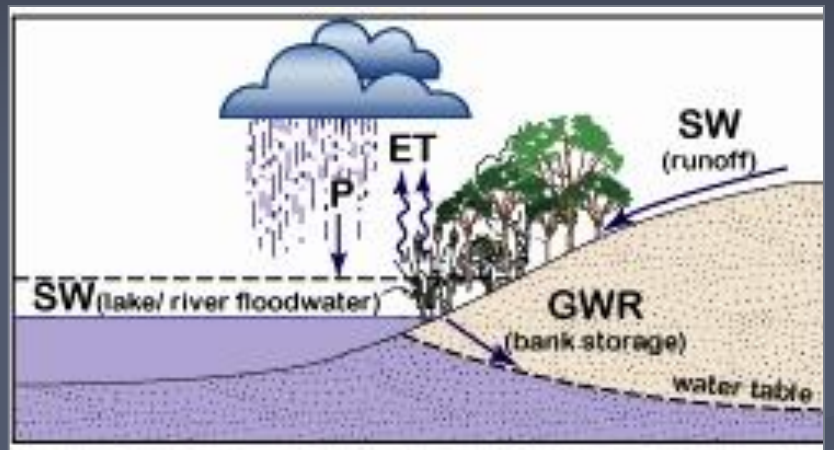
The goal for restoring hydrology should be the abandonment or blockage of the site's drainage at the wetland's outlet

Tile Blocks

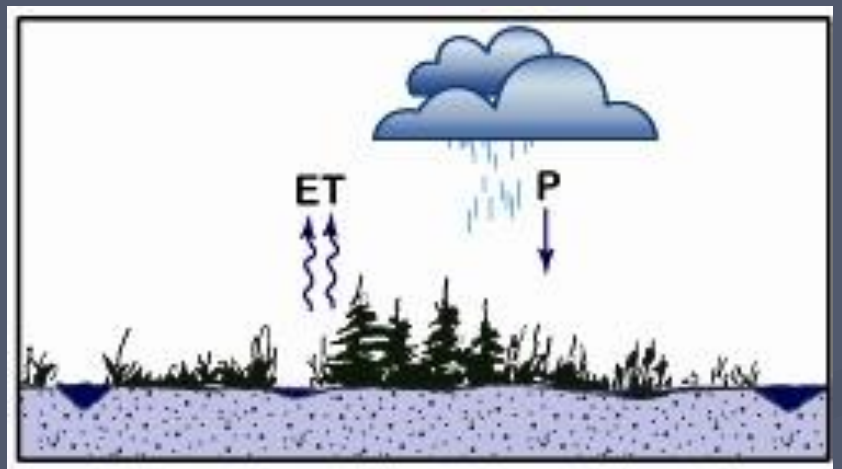
Ditch Plugs

Surface Water Supported Wetlands - *(Discharge)*

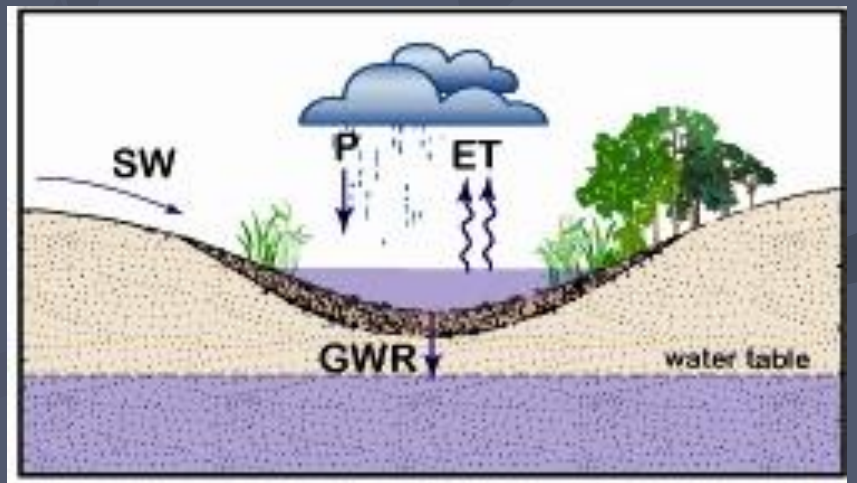
Have a net <u>out-seepage</u> water budget where outflows are predominantly from the surface into the groundwater



Surface Water - Slope



Surface Water - Extensive Flat



Surface Water - Depression

Surface Water Supported Wetlands - *(Discharge)*

Will typically be drained by simpler drainage systems (single string of tile, shallow ditch, etc.)

Surface Water Supported Wetlands - *(Discharge)*

The goal for restoring hydrology is similar to recharge wetlands – includes the abandonment or blockage of the drainage at the wetland's outlet

Tile Blocks

Ditch Plugs

Surface Water Supported Wetlands - *(Discharge)*

In addition, restoration may also require sealing off breaches through the wetland's substrate. If not sealed, the wetland's ability to retain hydrology could be limited

Surface Water Supported Wetlands - *(Discharge)*

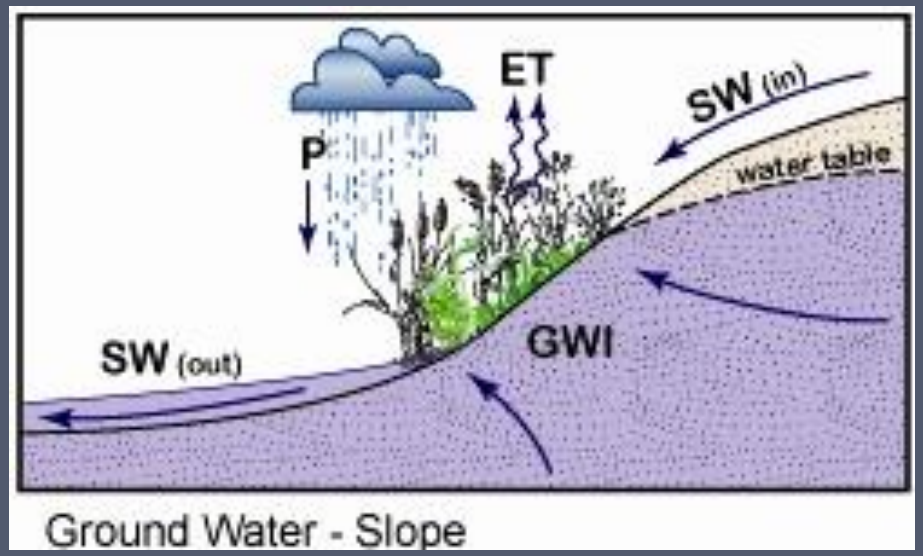
An example might be a complete filling-in of a drainage ditch where penetration through the wetland's impervious bottom stratum has occurred via the ditch construction

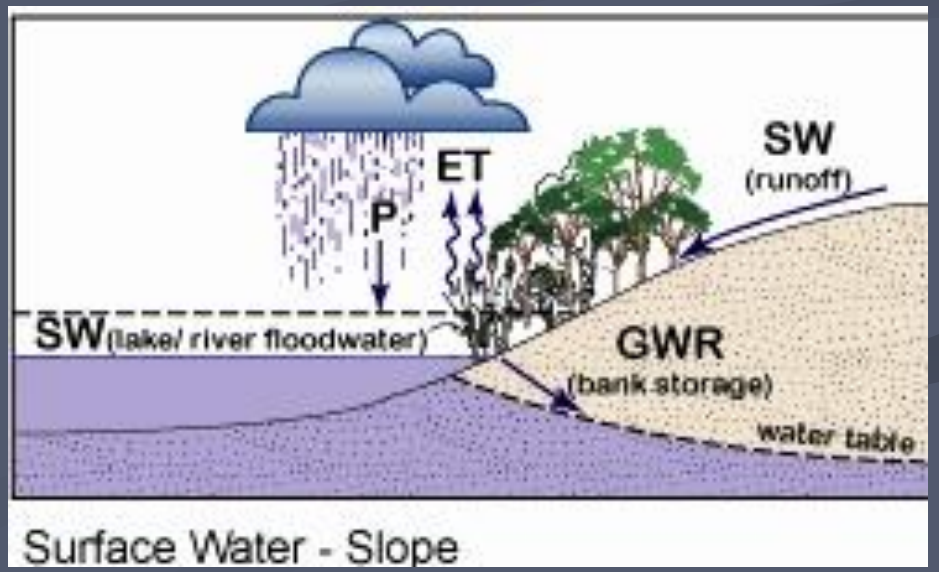
Surface Water Supported Wetlands - *(Discharge)*

Negative impacts via a substrate breach may also result from any excavations that may be planned within the wetland as part of the restoration work

Sloped Wetlands

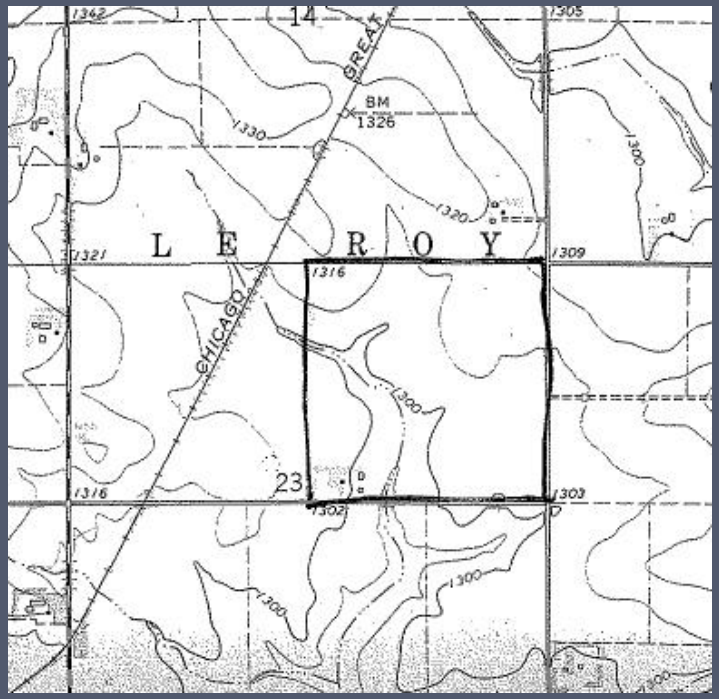
Sloped wetlands provide other restoration challenges as they are usually pattern tiled or extensively ditched and are on a grade

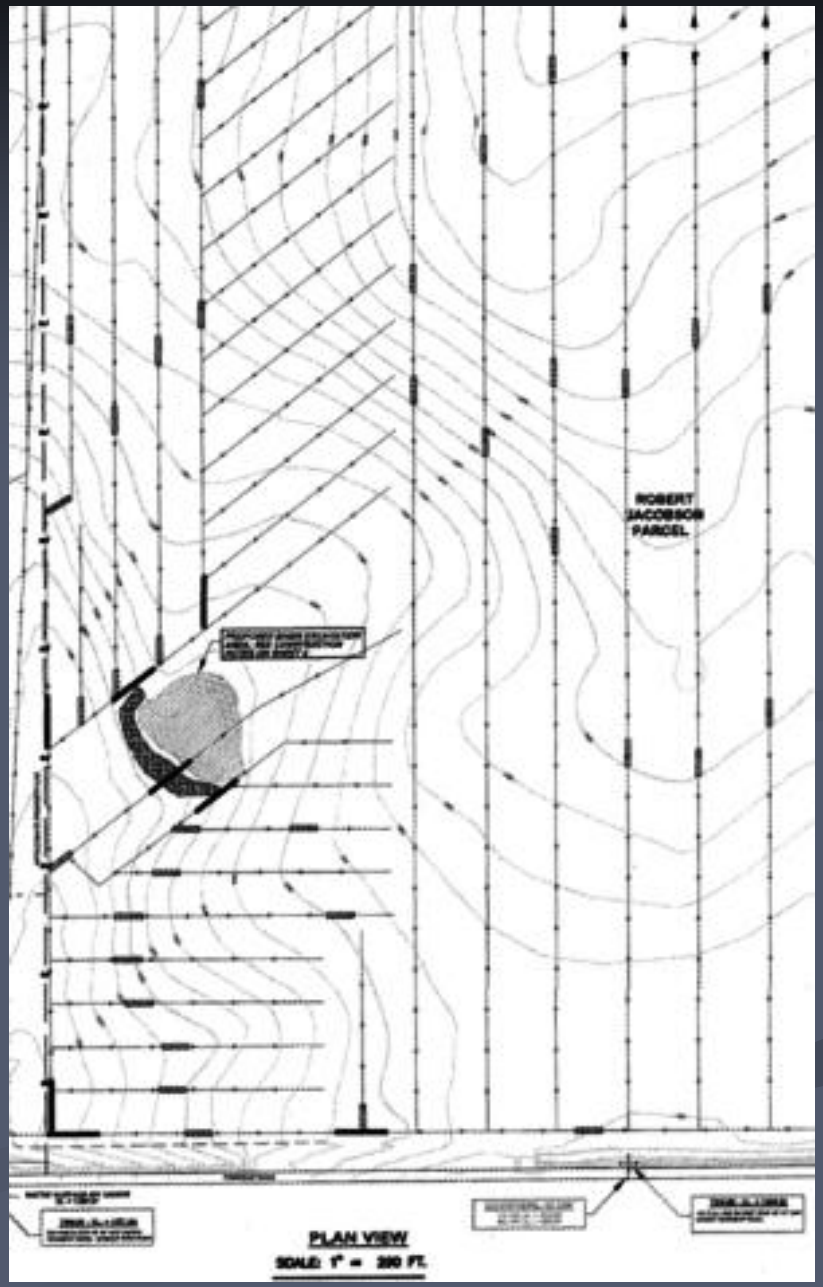




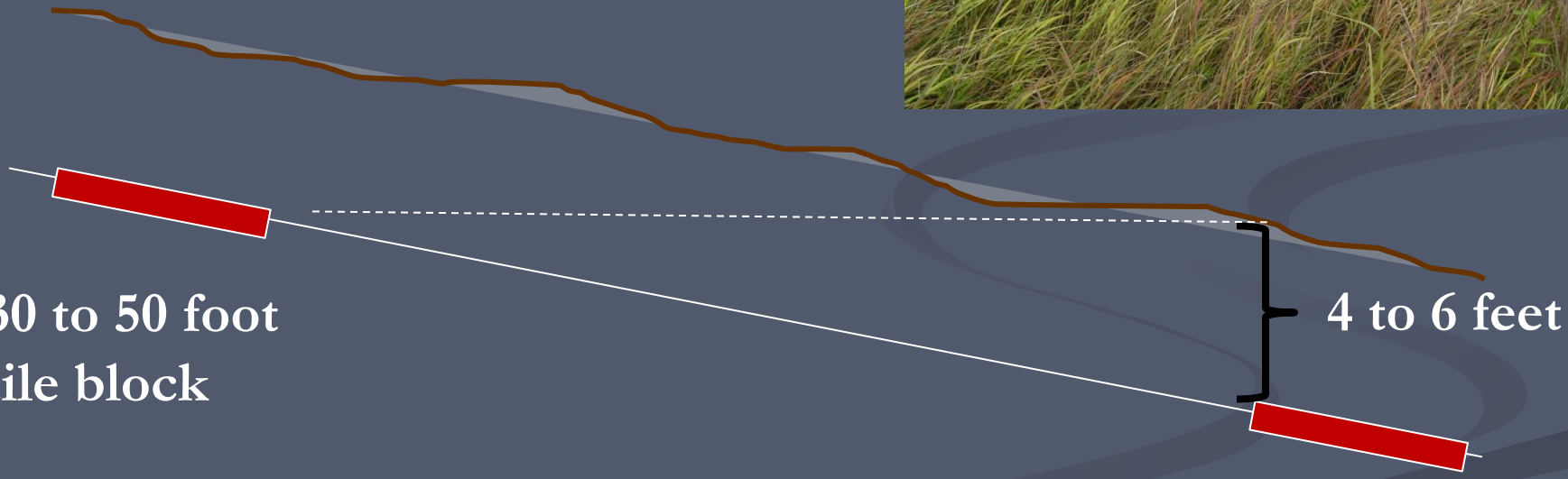
Sloped Wetlands

Multiple tile blocks are usually needed to render the drainage system ineffective





Sloped Wetlands



All Wetlands

The wetland's outlet needs to accommodate all excess discharges from surface water runoff and for recharge wetlands base flows from groundwater contributions

Keys to Success – Helpful Tools

Update of Minnesota Wetland Restoration Guide

Keys to Success –
MN Wetland Restoration Guide

Restoration Guide Goals:

- Create a comprehensive wetland restoration resource for conservation and mitigation projects

- Create an interactive format to assist wetland professionals (practitioners) with planning and design

Keys to Success –
MN Wetland Restoration Guide

Restoration Guide Goals:

- Summarize current research and field experience from a wide range of partners – keep information updated

Keys to Success –
MN Wetland Restoration Guide

Section 1 – Introduction
Section 2 – Identifying and Planning a Project
Section 3 – Site Assessment and Evaluation
Section 4 – Engineering Design and Construction
Section 5 – Vegetation Establishment
Section 6 – Site Monitoring and Management

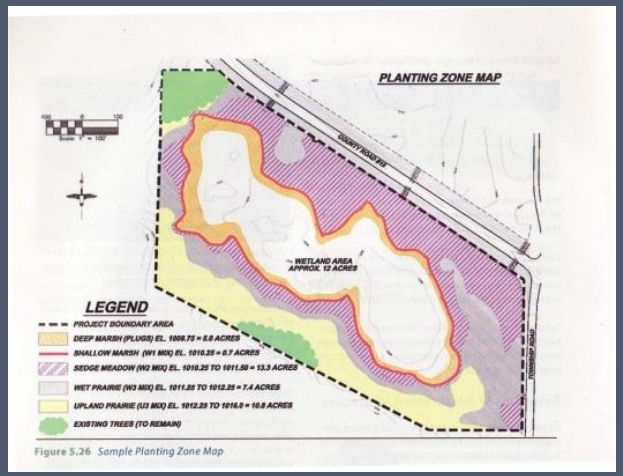


Figure 5.26 Sample Planting Zone Map

Keys to Success –
MN Wetland Restoration Guide

SECTION

3 Site Assessment and Evaluation

All wetland restoration and creation projects depend on the suitability o
intended purpose. Successful projects take advantage of the distinct q
and overcome the drawbacks or obstacles that become evident during eva

Before the evaluation can occur, a comprehensive site assessment needs to be made. This includes the collection and assessment of maps, photos, and other reference materials along with site specific information relating to soils, hydrology, drainage, vegetation, topography, and other surrounding landscape issues.

Figure 3.1 *Drained Wetland Landscape*

3-1 Defining the Project Scope
3-2 Ownership, Land Use and Legal Issues
3-3 Site Soils
3-4 Site Hydrology
3-5 Site Drainage
3-6 Conditions for Vegetation Establishment
3-7 Site Topography
3-8 Surrounding Landscape and Reference Wetlands
3-9 Analysis and Interpretation of Site Assessment Data

Keys to Success –
MN Wetland Restoration Guide

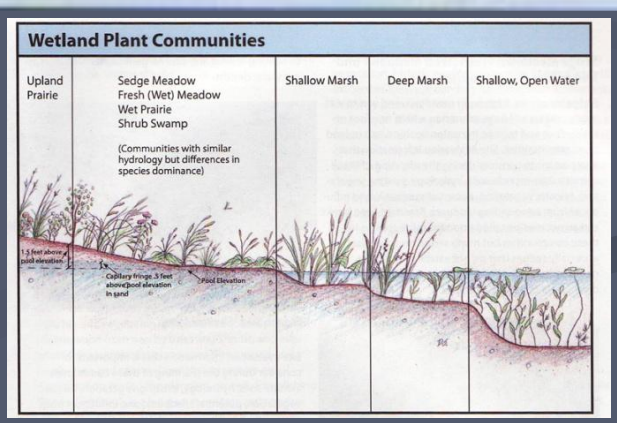
5 Vegetation Establishr

The Vegetation Establishment Section of the Minnesota Wetland Restoration Guide provi
hensive approach to establishing native vegetation in restored and created wetlands ar
ing upland areas. The chapters in this section of the Guide provide detailed information abo
involved in establishing plant communities from developing a vegetation plan to project im
and maintenance.

The establishment of wetland vegetation has been occurring since wetland restoration became a common practice in the 1970s and 80s. Goals for many earlier project focused on restoring hydrology and the creation of habitat for waterfowl. The restoration of vegetation typically relied on species that would establish from native seedbanks or natural colonization. In recent years, there has been an increased emphasis on establishing diverse wetland plant communities that create wildlife habitat for a larger number of species including birds, animals, and insects, increasing competition with invasive species, and providing greater plant community stability. The increased emphasis on these functional goals has led to new techniques to remove invasive species, plant wetland species, and provide long-term care.

Figure 5.1

5-1 Vegetation Establishment Considerations
5-2 Developing a Vegetation Plan
5-3 Site Preparation
5-4 Establishing Upland Vegetation
5-5 Establishing Wetland Vegetation
5-6 Selecting Seed Mixes and Plant Materials
5-7 Vegetation Plan Implementation
5-8 Maintenance for Vegetation Establishment



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Section 4 – Engineering Design and Construction

4-1 Introduction
4-2 Wetland Hydrology
4-3 Drainage System Modifications
4-4 Spillways and Outlet Structures
4-5 Earthen Embankments
4-6 Sediment Removal, Scrapes, and Other Excavations
4-7 Other Design Strategies
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4-10 Construction Implementation

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Section 4 – Engineering Design and Construction Appendices (will include)

Technical Guidance Documents

- **Drainage Manipulation Strategies**
- **Outlet Structures**

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BLOCKING – REMOVING DRAINAGE TILE

TECHNICAL GUIDANCE DOCUMENT

Document No.: WRG 2010-XX
Publication Date:

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INTRODUCTION

Blocking and removing subsurface drainage tile is a strategy that is commonly used to restore tile drained wetlands. The excavation and removal of a portion or segment of drainage tile along with capping or plugging the exposed tile ends is generally referred to as "blocking" the tile.

Figure 1 Removing Subs

APPLICATION

The complexity of restoring tile drained wetlands varies and is dependent on many factors including the extent, size, material, location, flow direction, elevations, and grades of the tile system, site topography, ownership, and type of wetland to be restored. It will be necessary to considers all of this information to prepare a that will provide long-term hydrologic restoration success for the wetland.

DESIGN

To successfully restore long-term, functional hydrology to tile drained wetland systems, it render the subsurface tile drainage system that drains the wetland inoperable. To accomp not necessary to remove the entire length of tile within the wetland. Instead, designing str blocks of sufficient length and with proper blocking, backfilling, and compaction methods that is needed to abandon the desired reach of drainage tile and achieve full restoration o

To accomplish this, one needs to first understand the basics of tile drainage and lateral aff blocks, a reach of existing tile will continue to function downstream of the block (**Figure 2**) to ensure the upstream end of that functioning reach of downstream tile is located far enc

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Target Completion Date – Spring 2011

Minnesota Board of Water & Soil Resources

Questions?