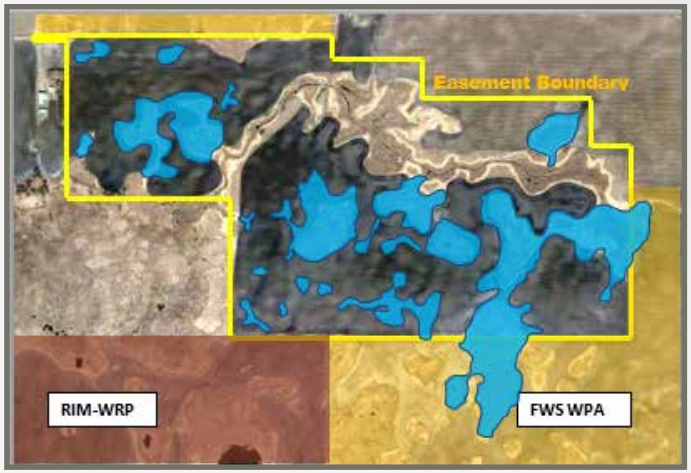
April 2019 – Wetland Banking Training
Overview of Restoration/Construction Strategies

BOARD OF WATER AND SOIL RESOURCES

Shallow/Deep Marshes



Wetland/Wildlife Complexes

Wild Rice Paddies

Sod Farms

Golf Courses

Program Goal

To the extent feasible and practicable, restore drained and altered wetland communities (hydrology and vegetation) to their original pre-manipulation condition.

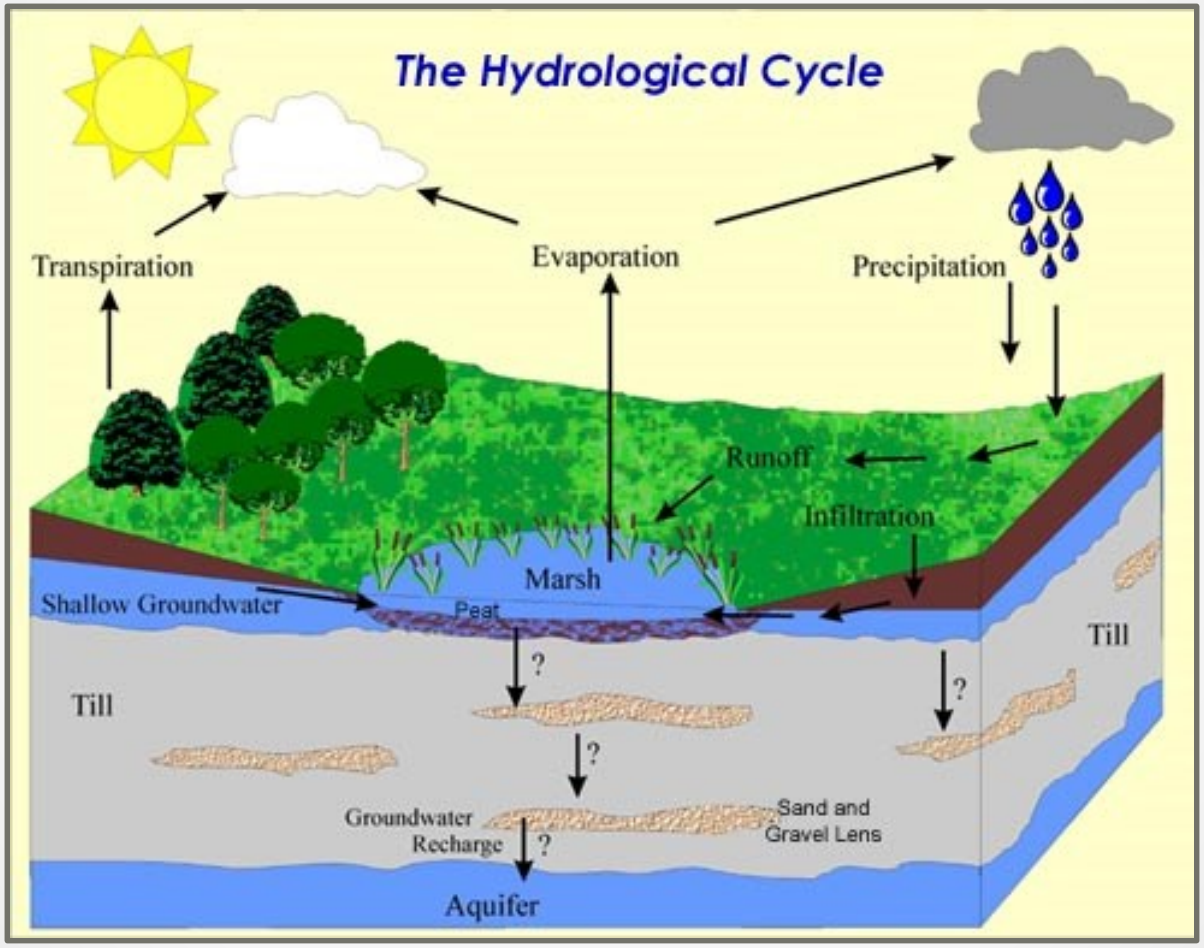
Program Goal

Develop self-sustaining projects

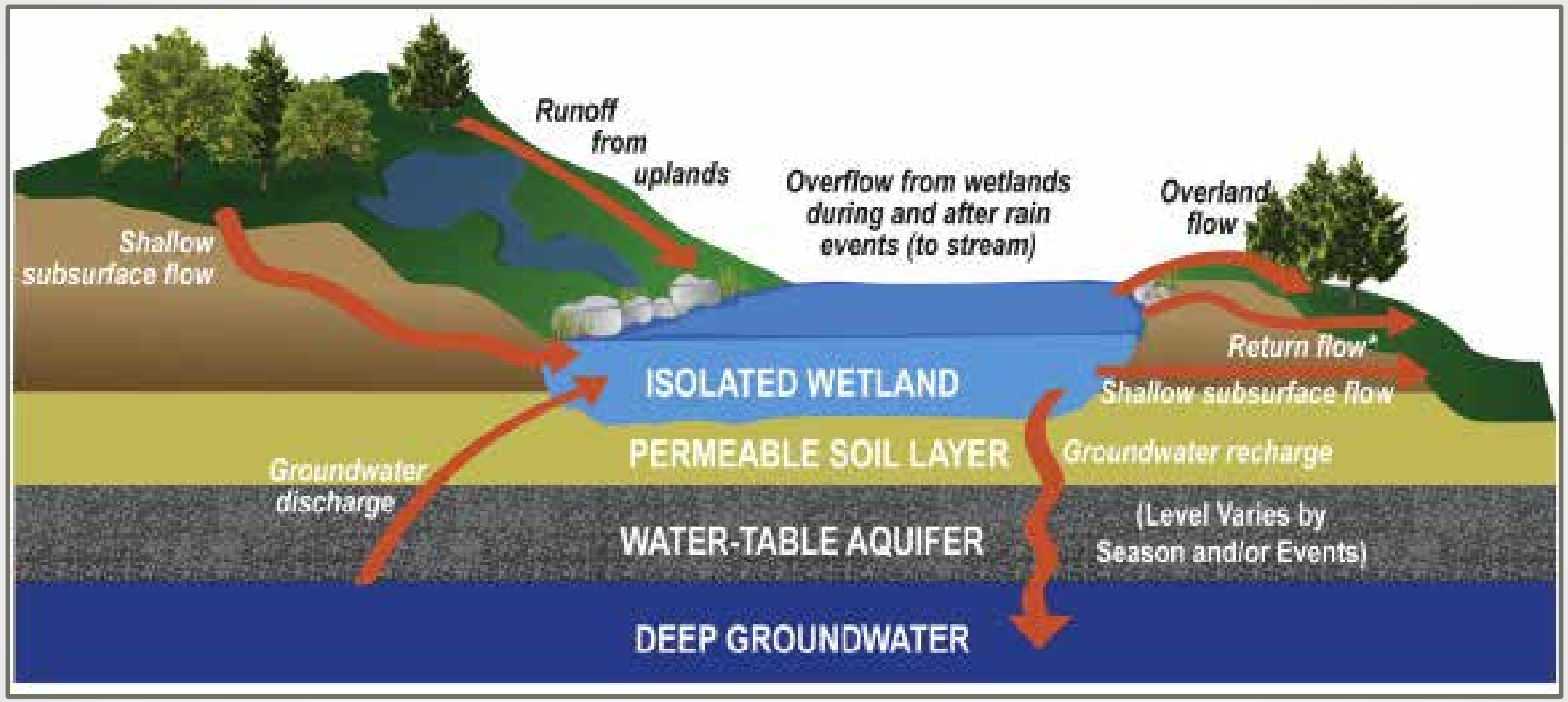
8420.0522 Replacement Standards Subp. 5 – Ecological suitability and sustainability

C. Replacement projects must be located and designed, to the maximum extent practicable, to be self-sustaining once performance standards have been achieved.

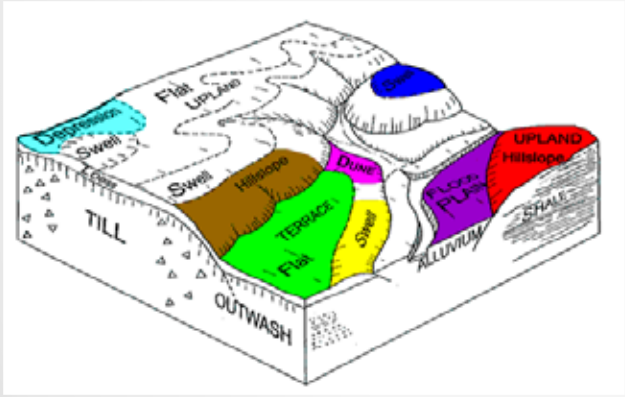
Hydrologic Cycle Within Typical MN Pothole Wetland

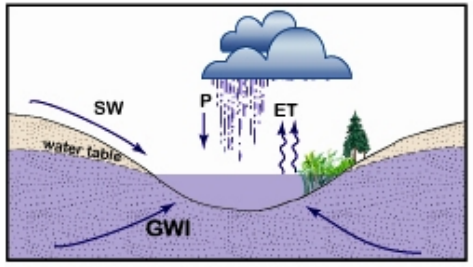
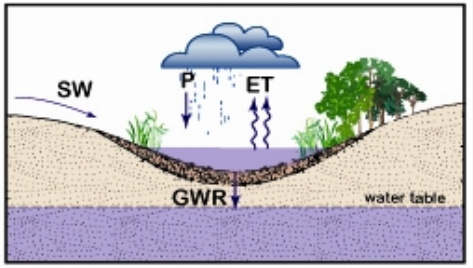
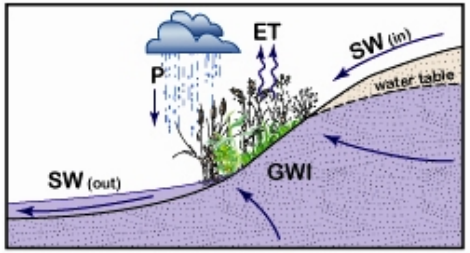
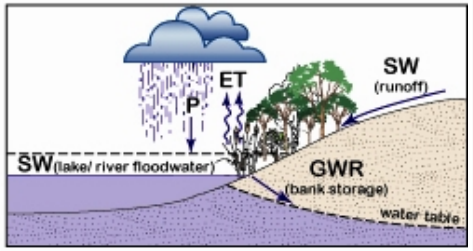
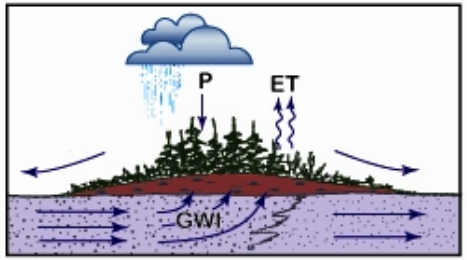
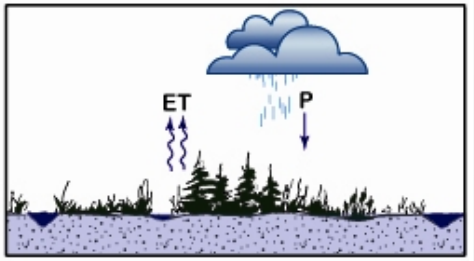


Subsurface (Groundwater) Hydrologic Relationships



Varying Geomorphic Landscape Settings "Wetland Types" Within MN



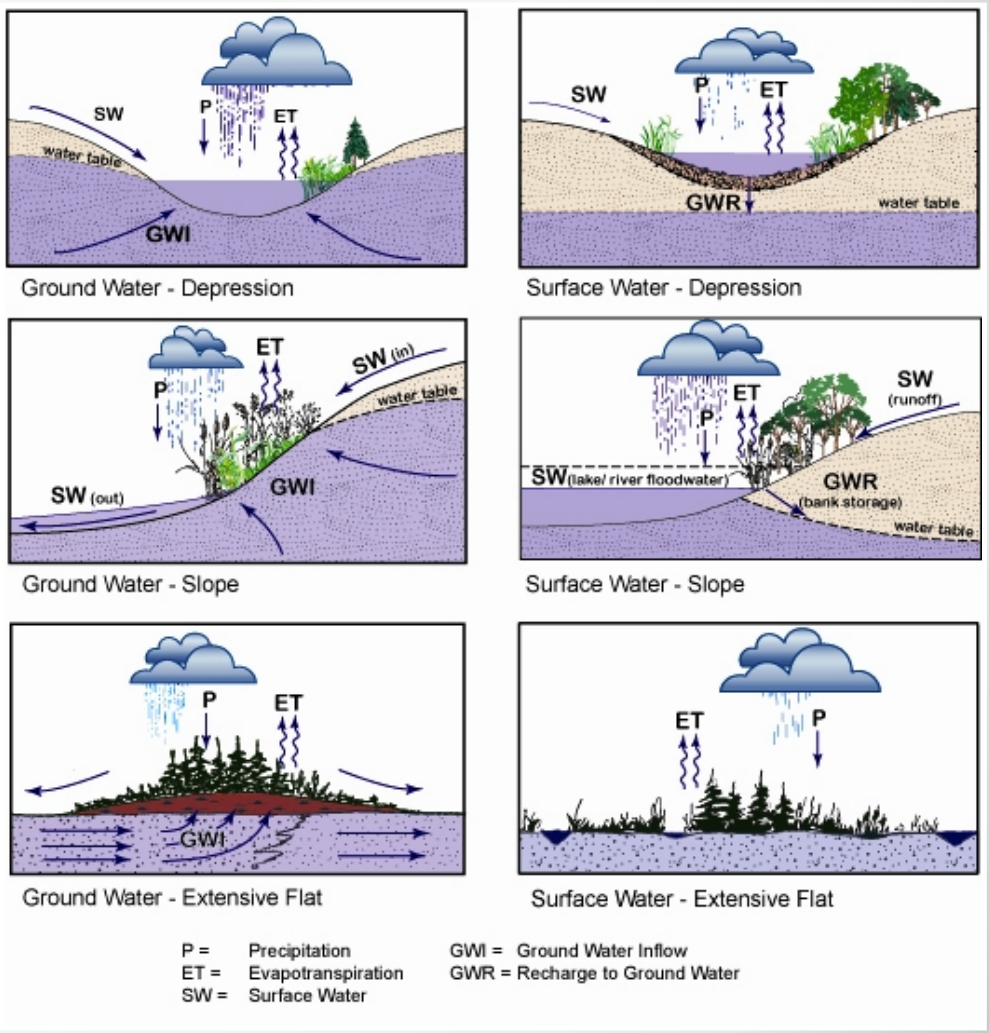
Ground Water Supported Systems	*Surface Water Supported Systems*
	
Ground Water - Depression	Surface Water - Depression
	
Ground Water - Slope	Surface Water - Slope
	
Ground Water - Extensive Flat	Surface Water - Extensive Flat

P = Precipitation
ET = Evapotranspiration
SW = Surface Water
GWI = Ground Water Inflow
GWR = Recharge to Ground Water

Why is it Important to Understand This?

Ground Water Supported Systems

Surface Water Supported Systems



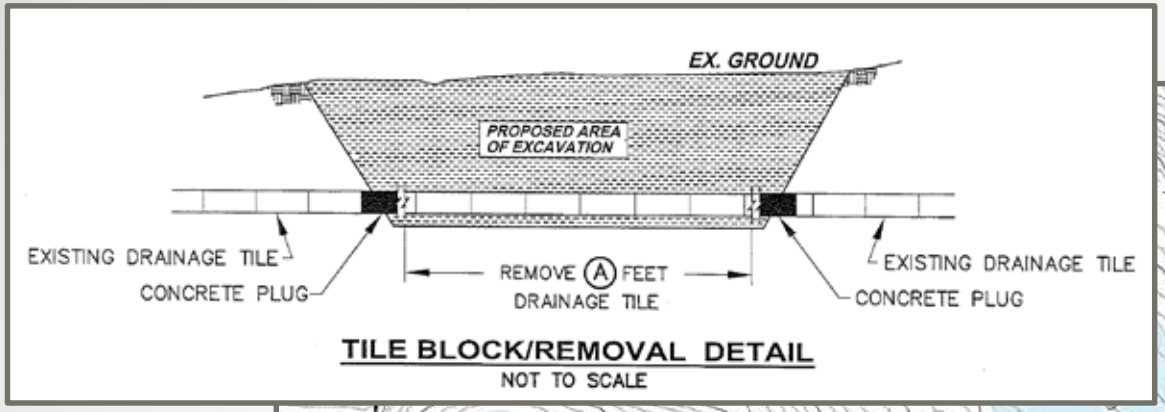
Because it influences how and to what extent wetlands are (were) drained

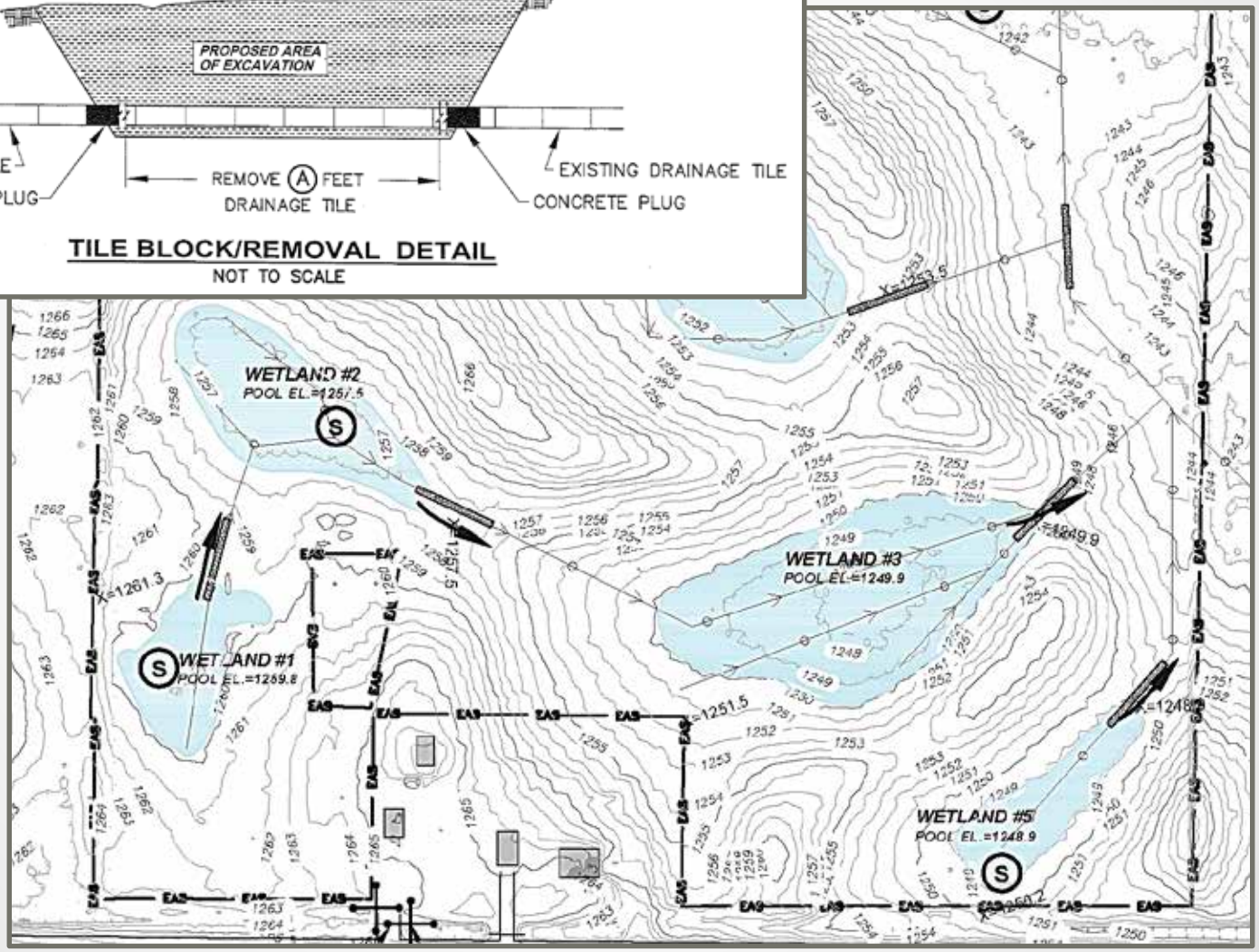
And it influences strategies used to effectively restore them

Common Restoration Strategies

- Tile Blocks
- Outletting Incoming Drainage Tile
- Rerouting Tile and Ditch Systems
- Removing, Relocating, and Installing Drainage Lift Stations
- Sediment/Vegetation Removal
- Ditch Blocks and Fills
- Earthen Embankments
- Wetland Outlets

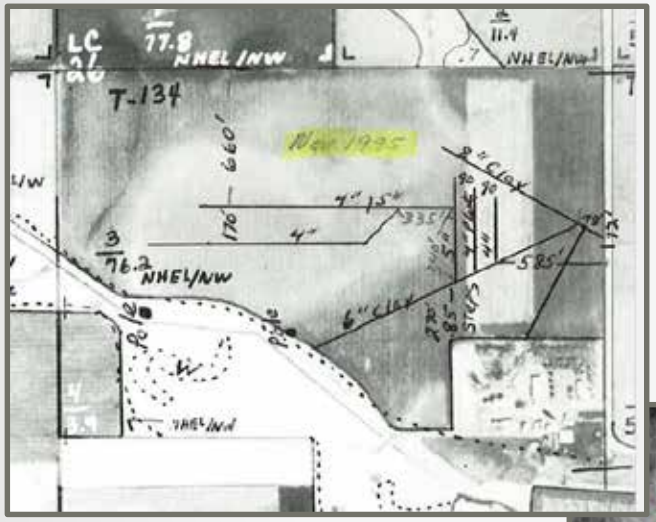
Tile Blocks

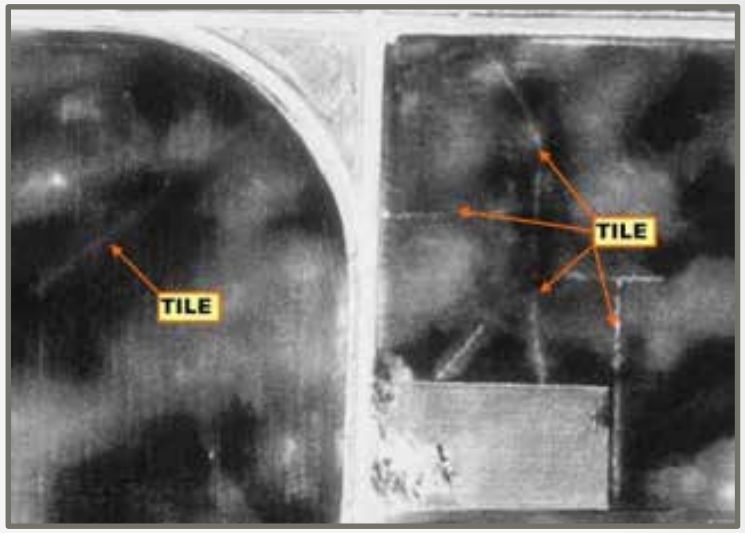

EX. GROUND
PROPOSED AREA OF EXCAVATION
EXISTING DRAINAGE TILE
CONCRETE PLUG
REMOVE (A) FEET
DRAINAGE TILE
EXISTING DRAINAGE TILE
CONCRETE PLUG
TILE BLOCK/REMOVAL DETAIL
NOT TO SCALE


WETLAND #2
POOL EL.=1257.5
WETLAND #1
POOL EL.=1259.8
WETLAND #3
POOL EL.=1249.9
WETLAND #5
POOL EL.=1248.9

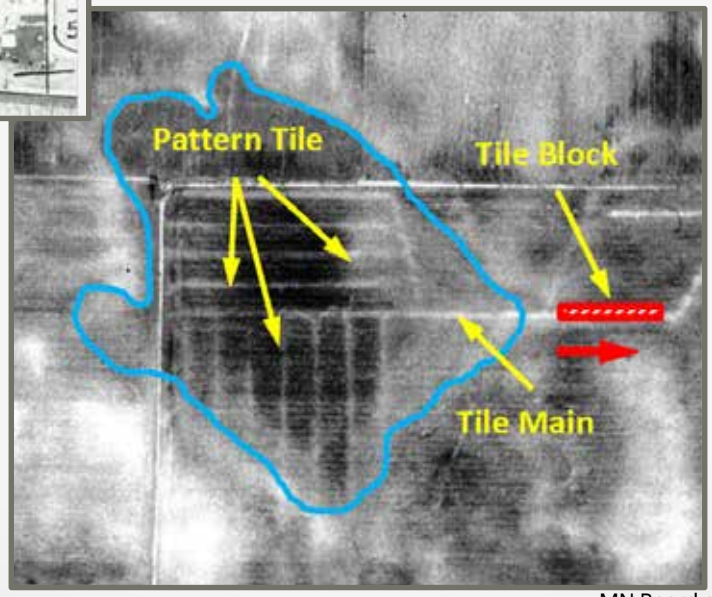
Tile Blocks

Tile Maps



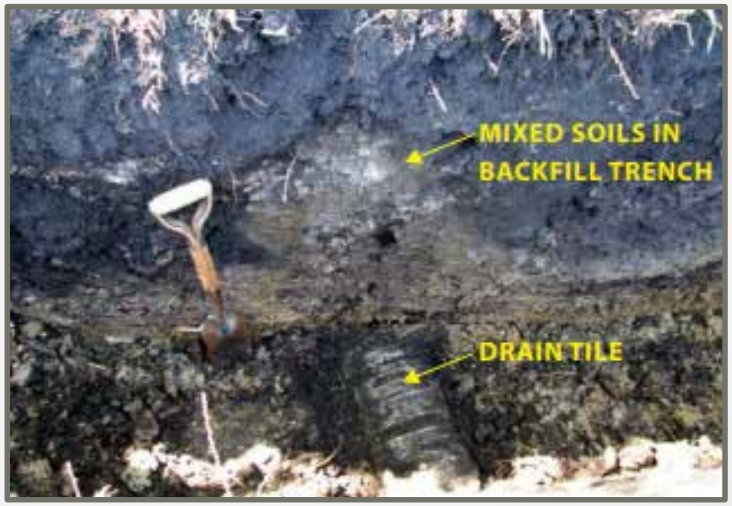


Aerial Photo Signatures

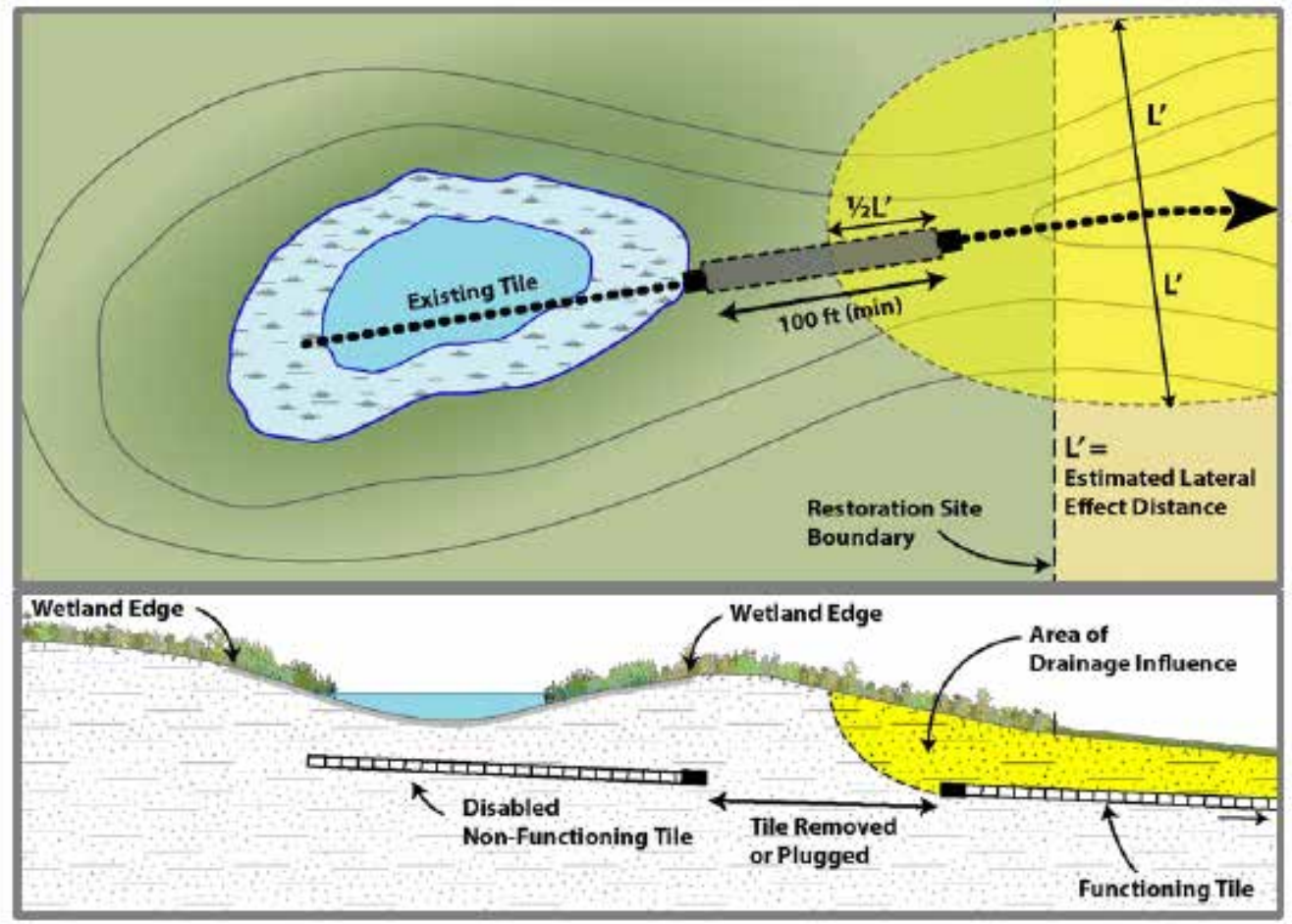


Tile Blocks

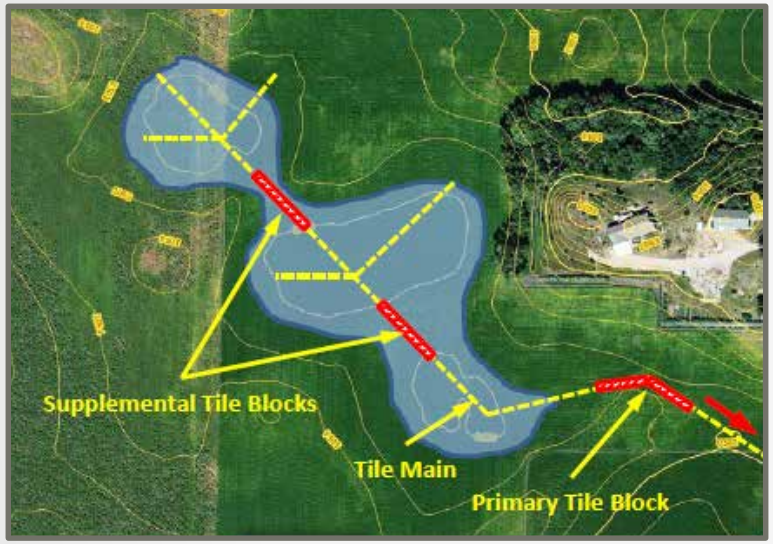
On-Site Investigations

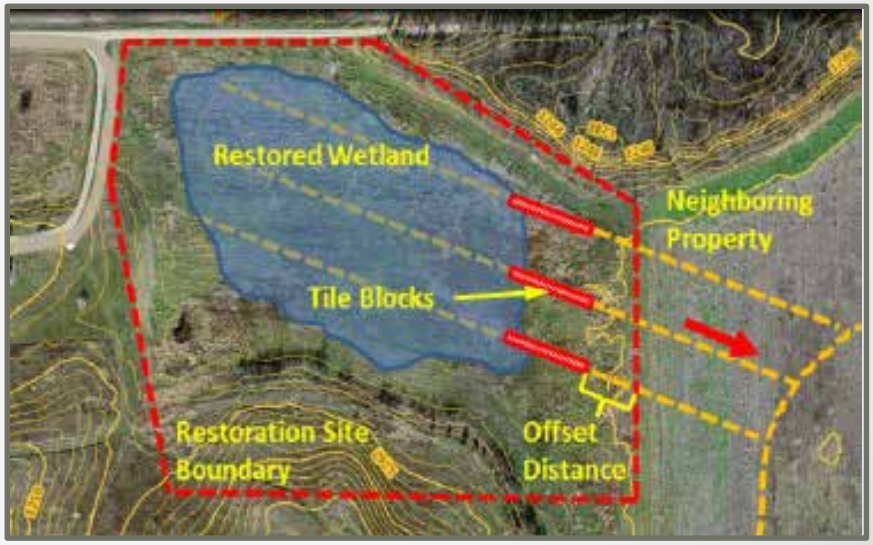


Tile Blocks

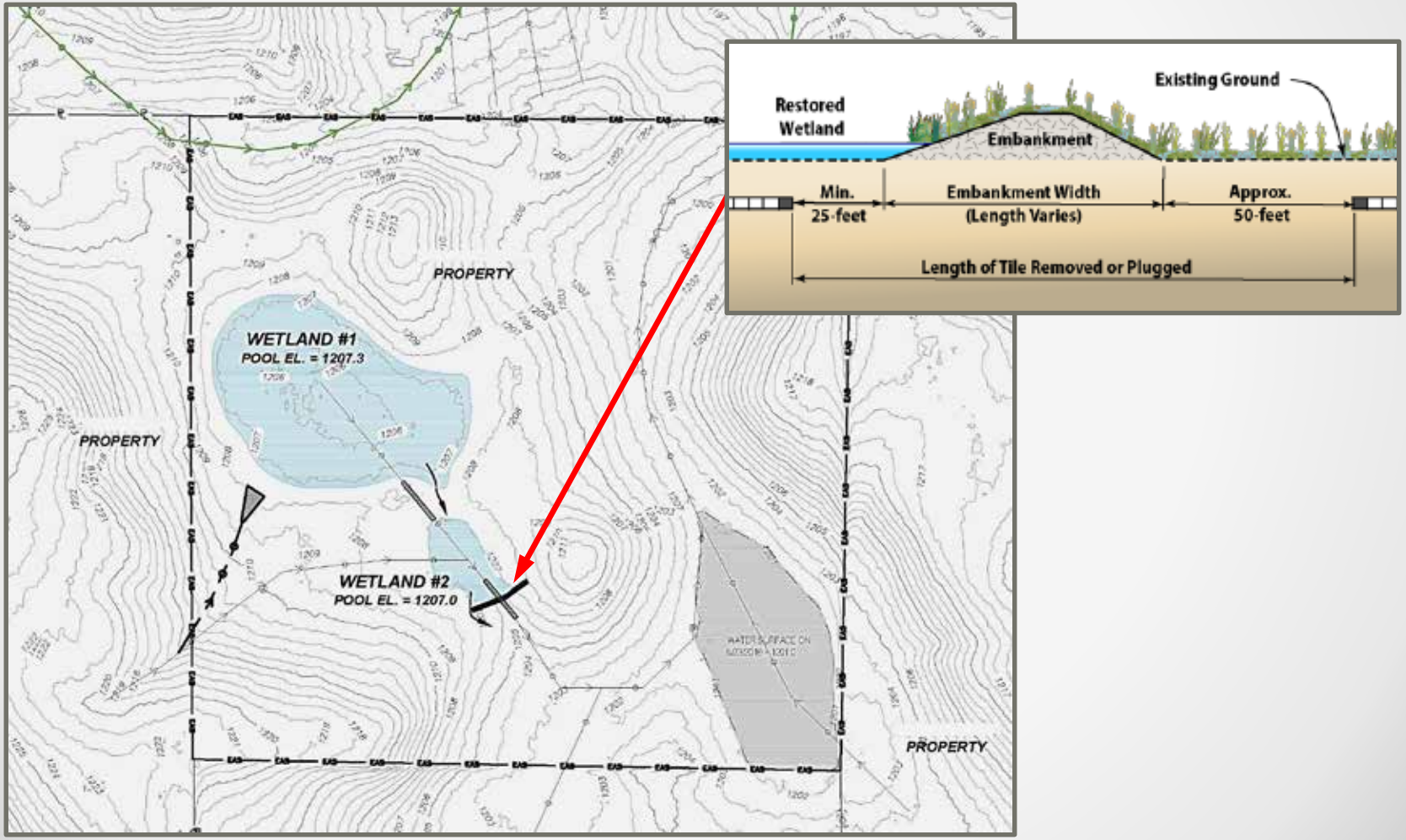

½L'
L'
L'
Existing Tile
100 ft (min)
L' =
Estimated Lateral
Effect Distance
Restoration Site
Boundary
Wetland Edge
Wetland Edge
Area of
Drainage Influence
Disabled
Non-Functioning Tile
Tile Removed
or Plugged
Functioning Tile

Tile Blocks

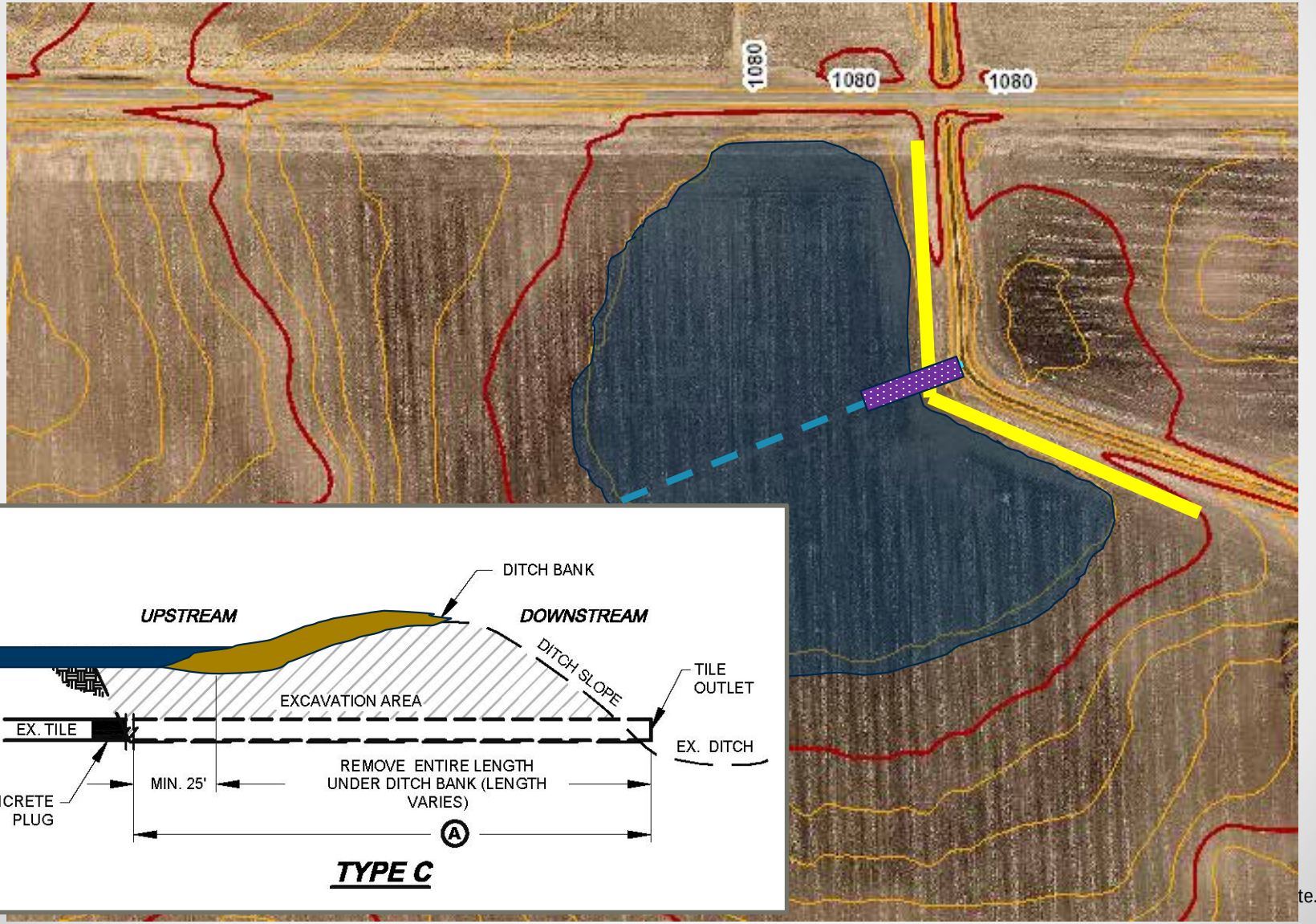

Supplemental Tile Blocks
Tile Main
Primary Tile Block


Restored Wetland
Neighboring
Property
Tile Blocks
Restoration Site
Boundary
Offset
Distance

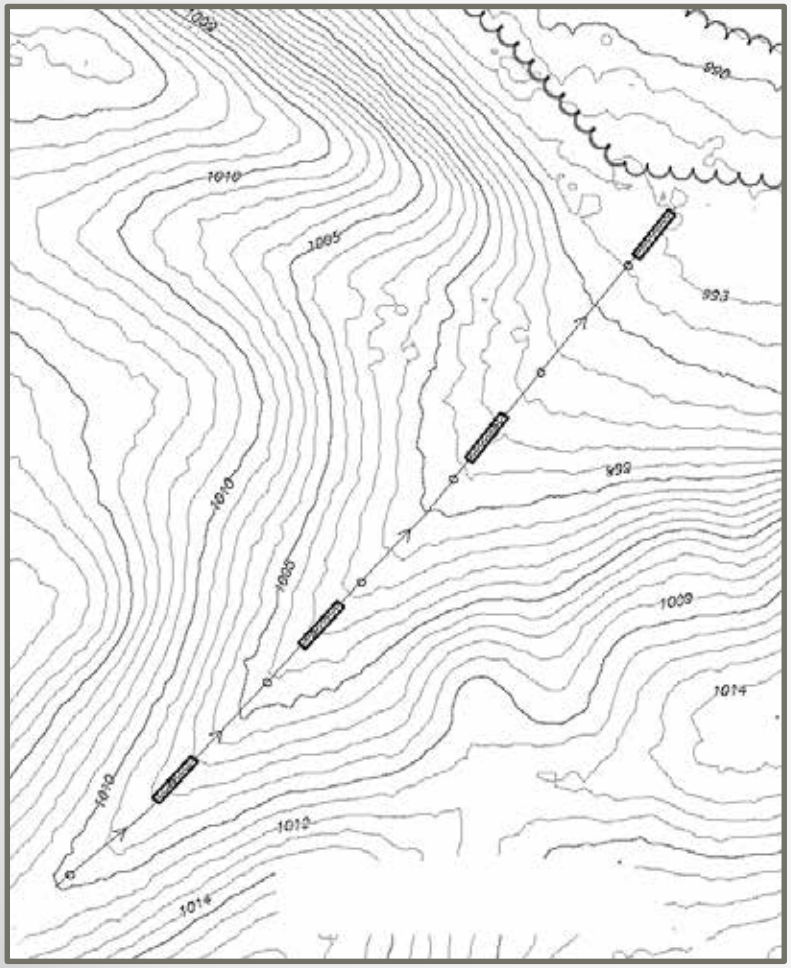
Tile Blocks

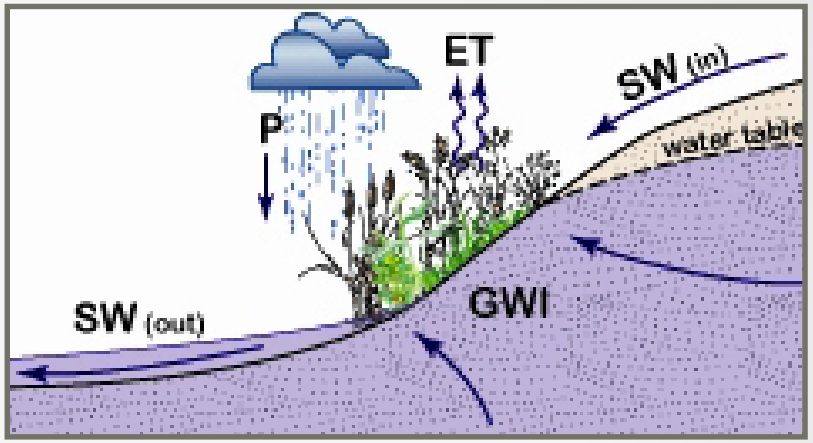

PROPERTY
WETLAND #1
POOL EL. = 1207.3
PROPERTY
WETLAND #2
POOL EL. = 1207.0
PROPERTY
Restored Wetland
Existing Ground
Embankment
Min. 25-feet
Embankment Width (Length Varies)
Approx. 50-feet
Length of Tile Removed or Plugged

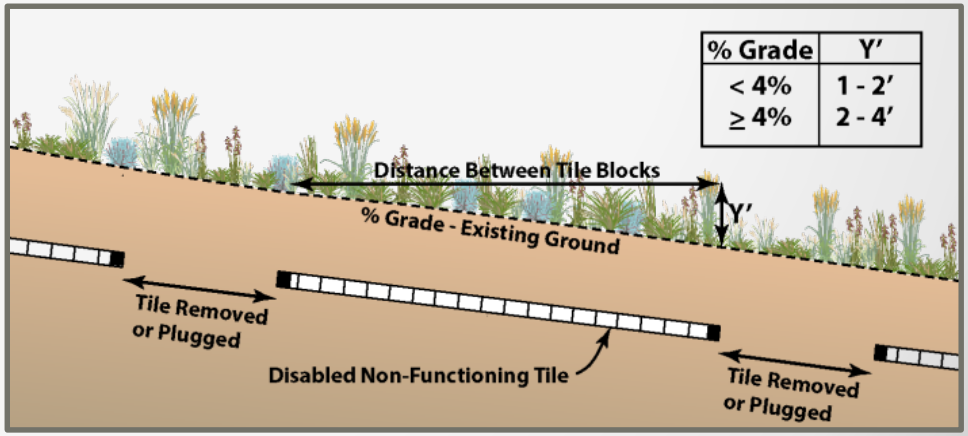
Tile Blocks


1080
1080
1080
DITCH BANK
UPSTREAM
DOWNSTREAM
DITCH SLOPE
TILE
OUTLET
EXCAVATION AREA
EX. TILE
EX. DITCH
CONCRETE
PLUG
MIN. 25'
REMOVE ENTIRE LENGTH
UNDER DITCH BANK (LENGTH
VARIES)
A
TYPE C

Tile Blocks

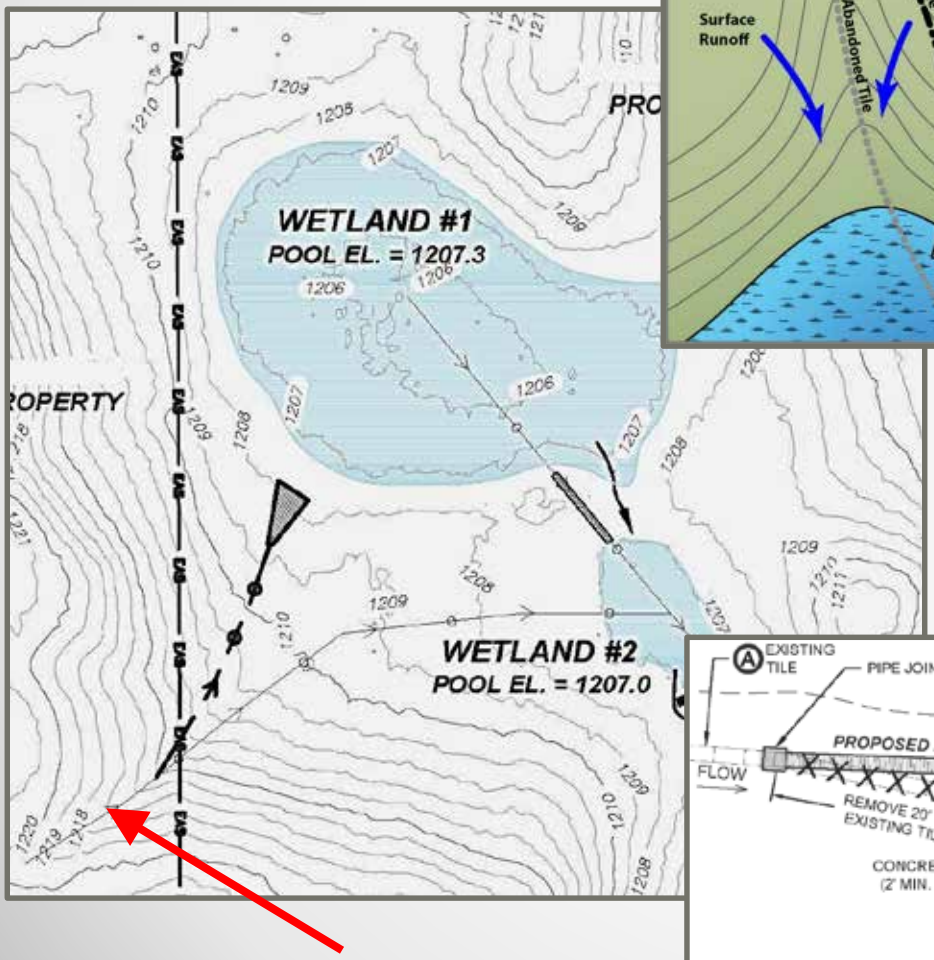


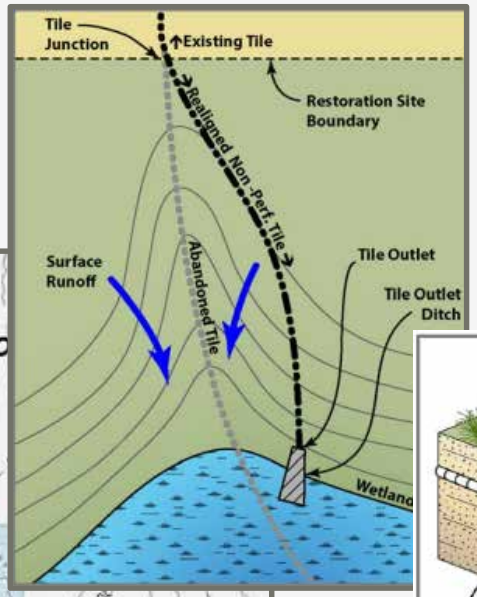

ET
P
SW (in)
water table
SW (out)
GWI

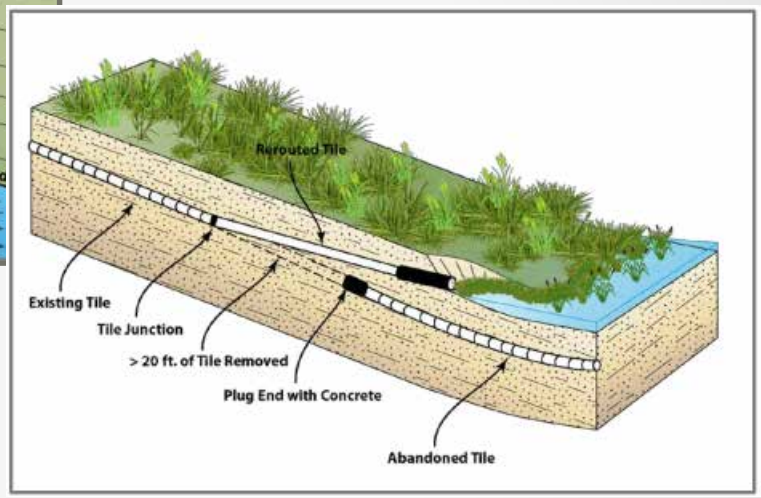

% Grade
Y'
< 4%
1 - 2'
≥ 4%
2 - 4'
Distance Between Tile Blocks
% Grade - Existing Ground
Y'
Tile Removed or Plugged
Disabled Non-Functioning Tile
Tile Removed or Plugged

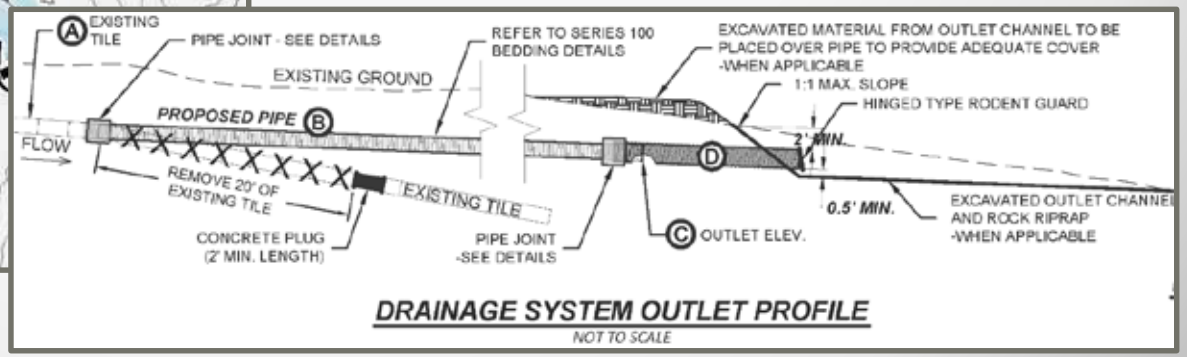
Overview of Restoration/ Construction Strategies

Outletting Drain Tile



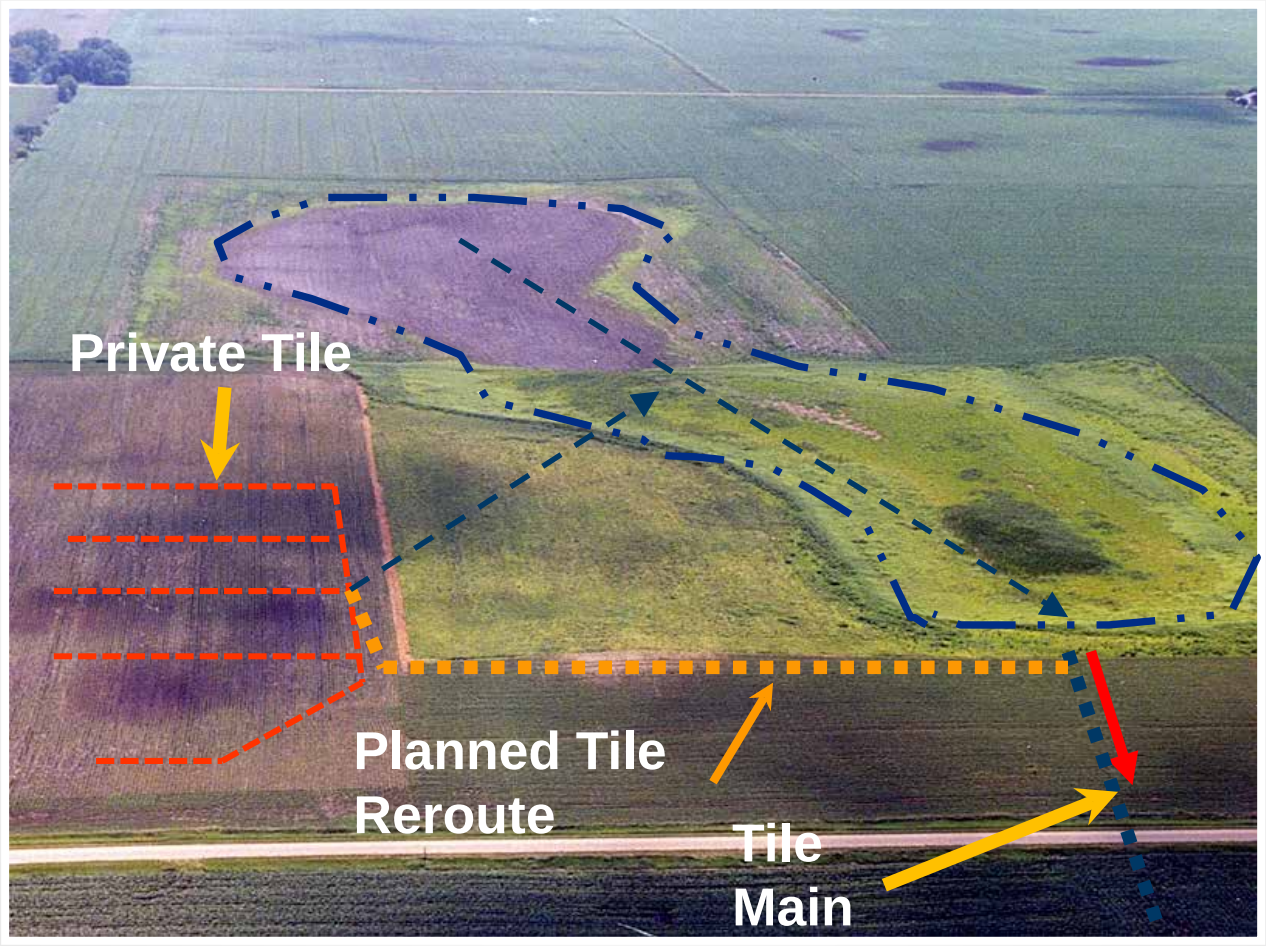






Outletting Drain Tile

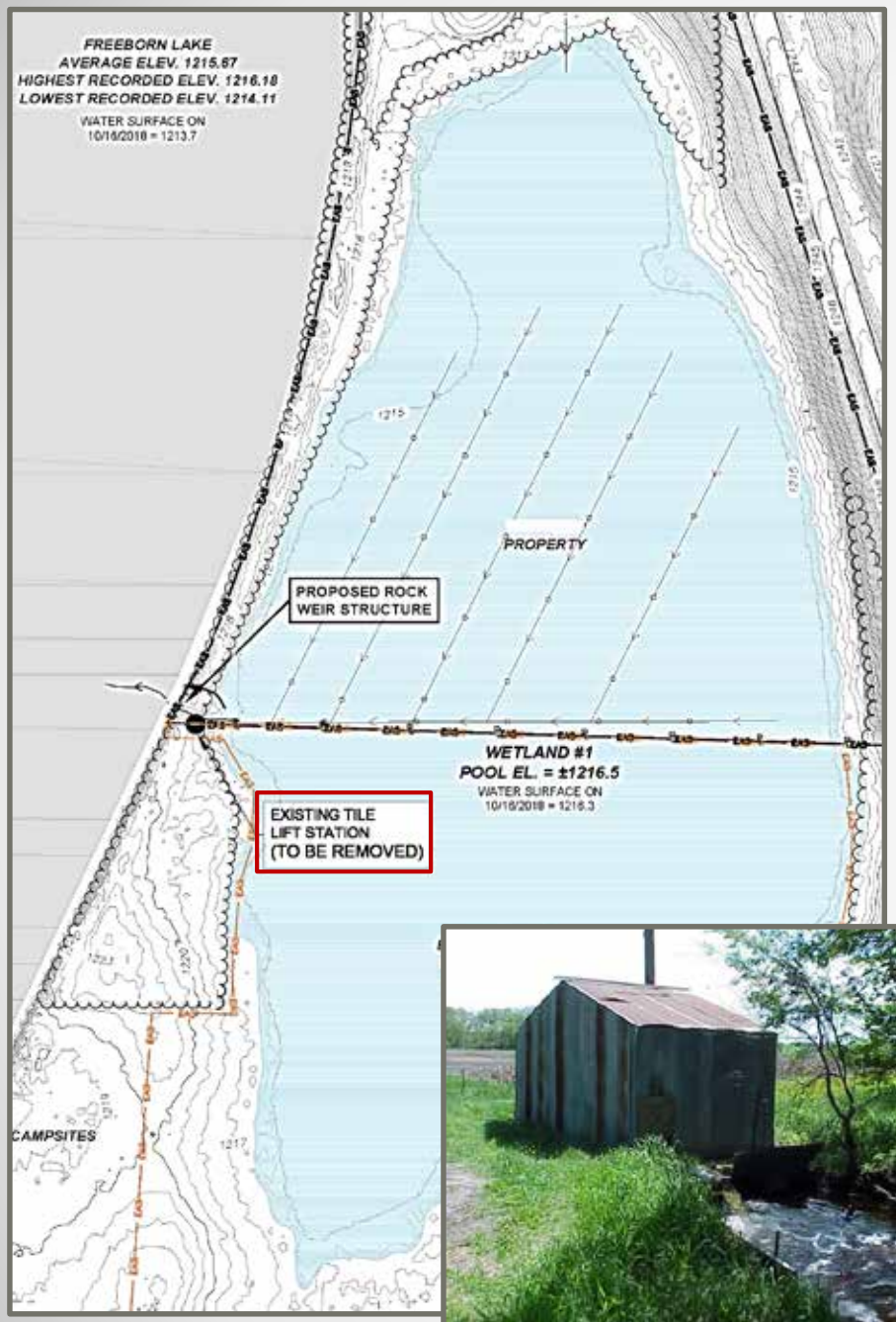
Rerouting Drain Tile and Ditch Systems



Rerouting Drain Tile and Ditch Systems

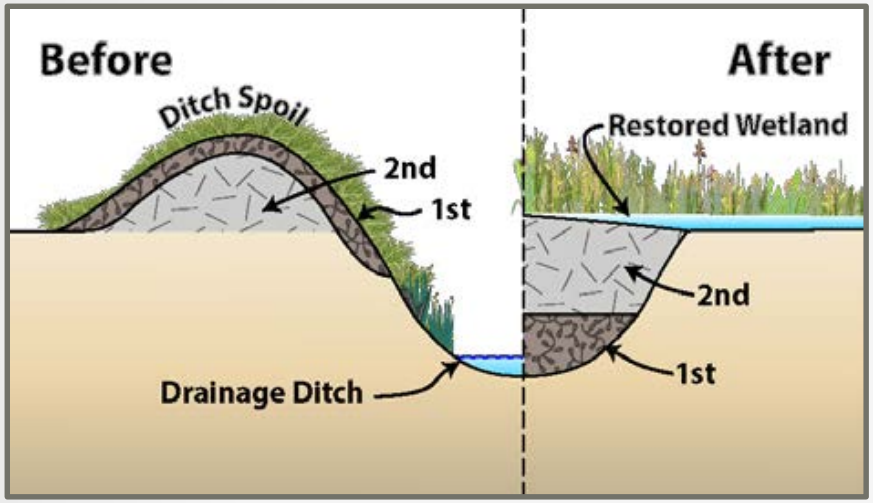
Overview of Restoration/ Construction Strategies

Removing, Relocating, and Installing Drainage Lift Stations

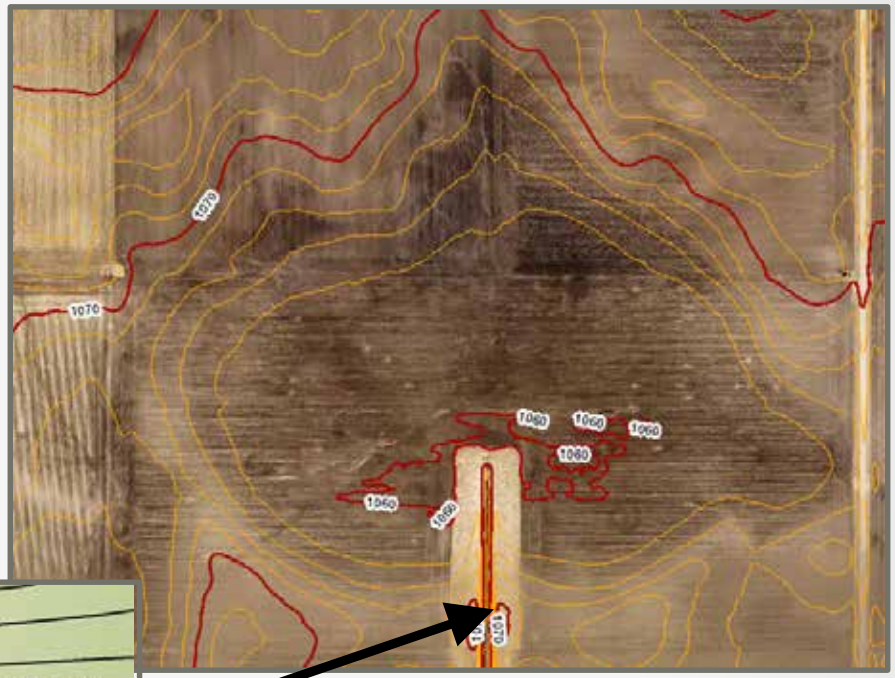


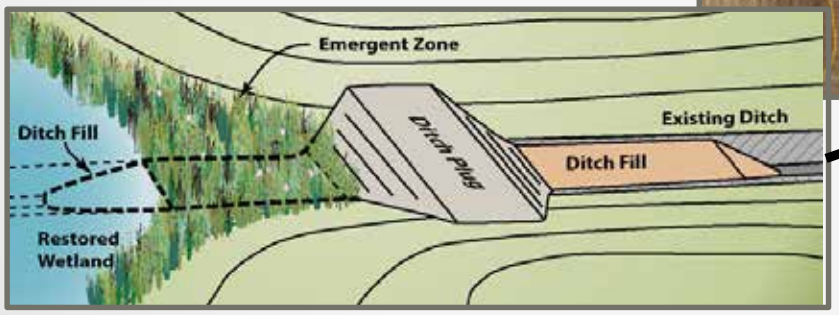
Sediment/Vegetation Removal

Filling Ditches

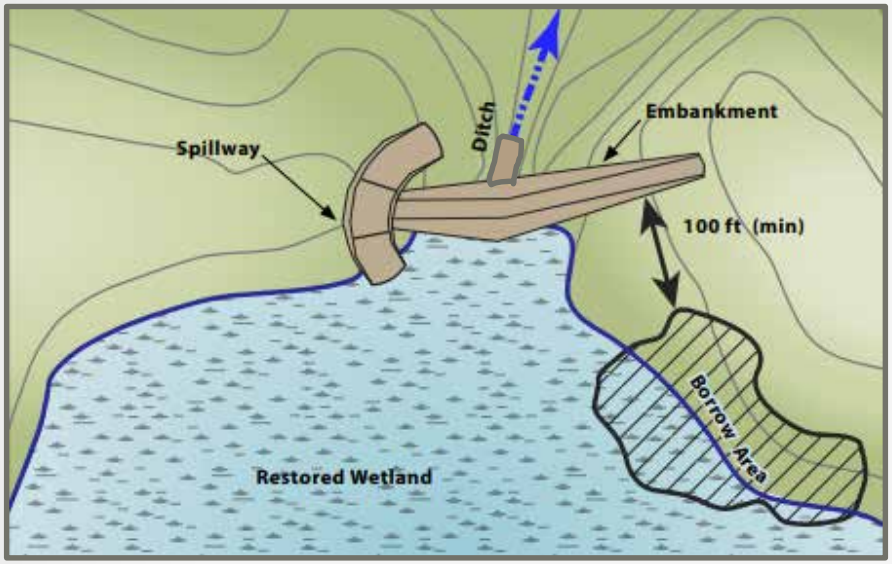


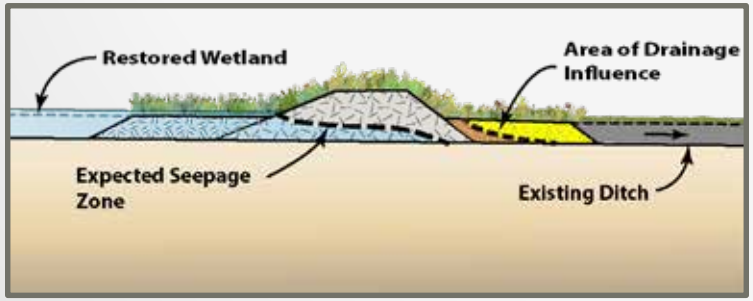
Ditch Plugs

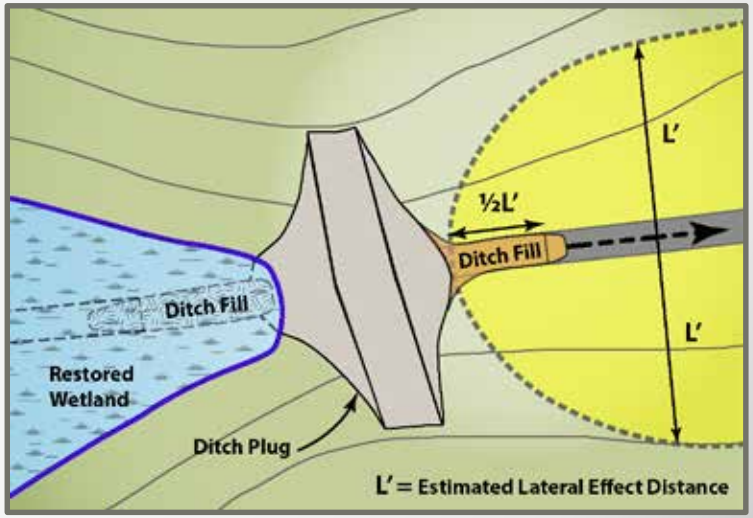

1070
1060
1050
1040
1030


Emergent Zone
Existing Ditch
Ditch Fill
Ditch Plug
Ditch Fill
Restored
Wetland

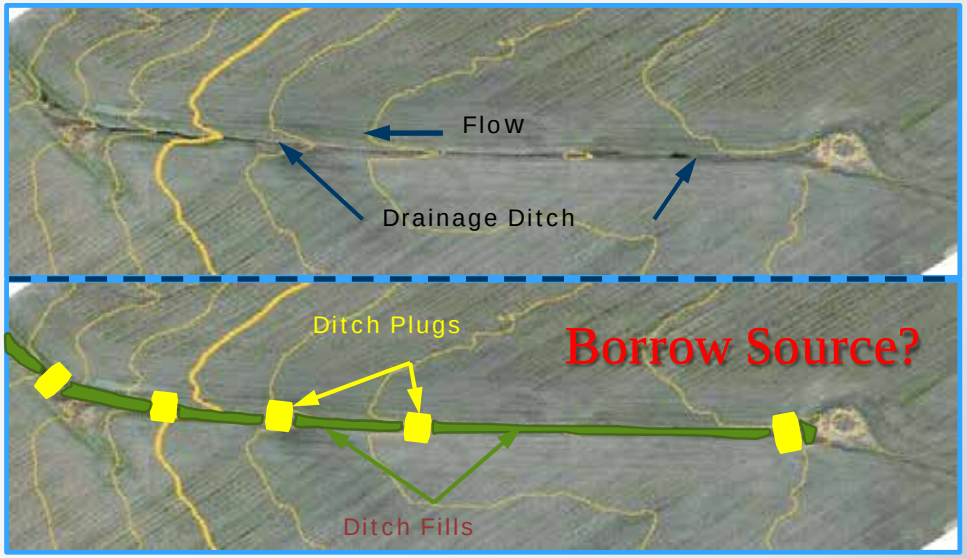
Ditch Plugs


Spillway
Ditch
Embankment
100 ft (min)
Borrow Area
Restored Wetland


Restored Wetland
Area of Drainage Influence
Expected Seepage Zone
Existing Ditch


½L'
L'
Ditch Fill
Ditch Fill
L'
Restored Wetland
Ditch Plug
L' = Estimated Lateral Effect Distance

Blocking (Plugging) and Filling Ditches (Combined)



Earthen Embankments

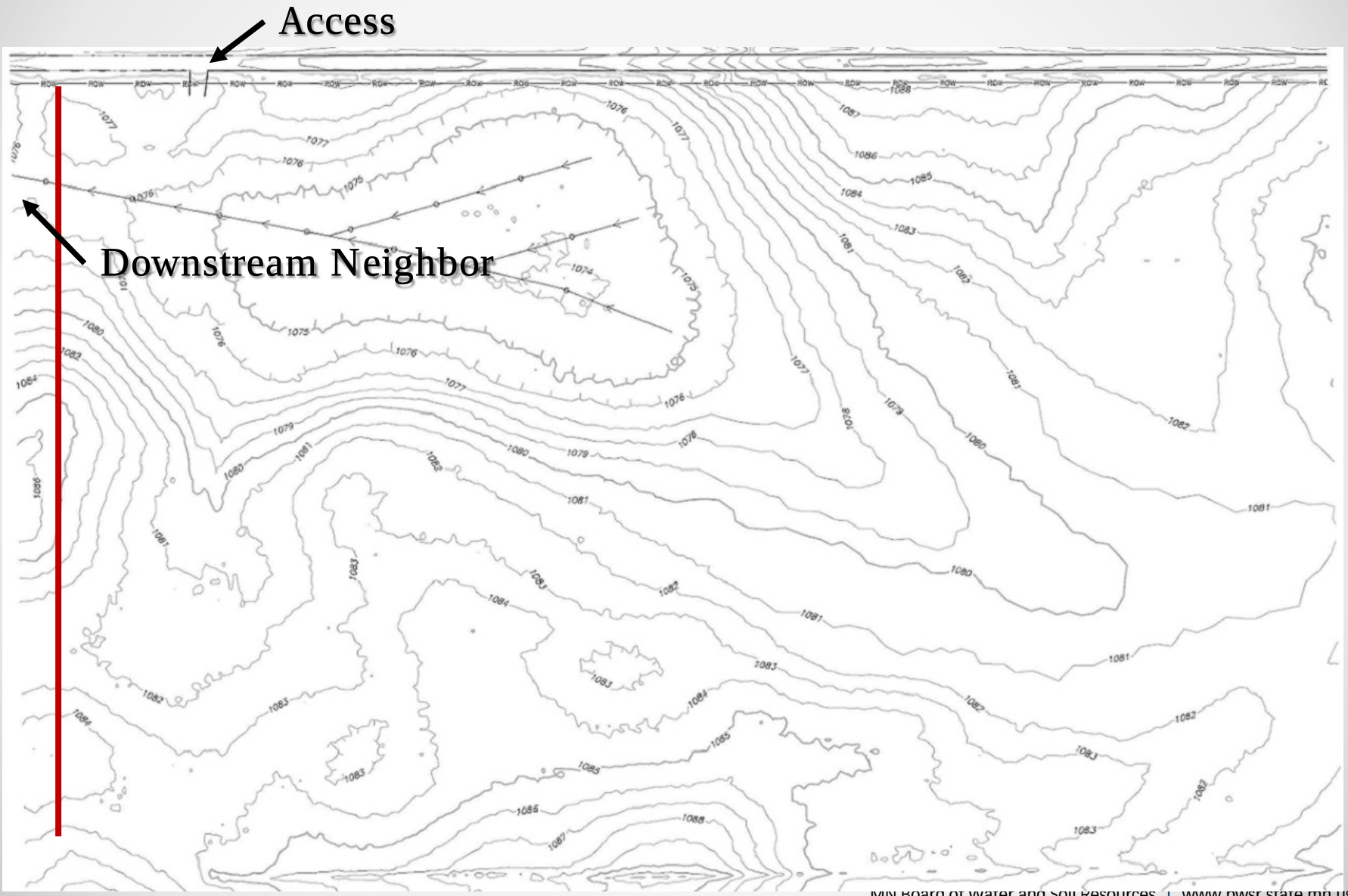
- Purpose - Are They Really Needed?

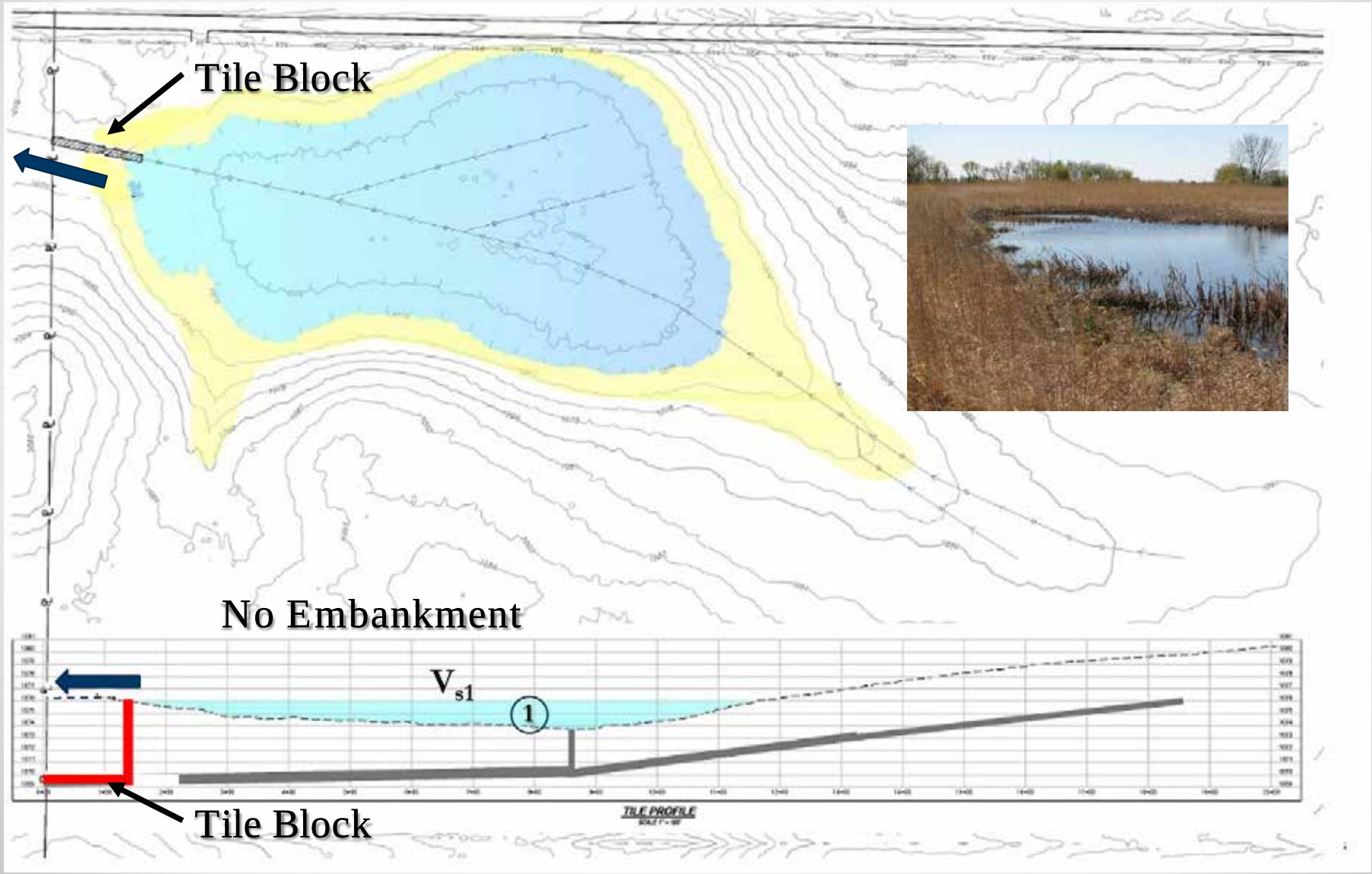
Earthen Embankments

- Purpose - Are They Really Needed?
- Can Help With:
  - Providing Suitable Access
  - Restoring Site Hydrology
  - Managing Wetland Outlet
  - Stabilizing Site Hydrology
  - Prevent Offsite Impacts
  - Providing Storage/Rate Control

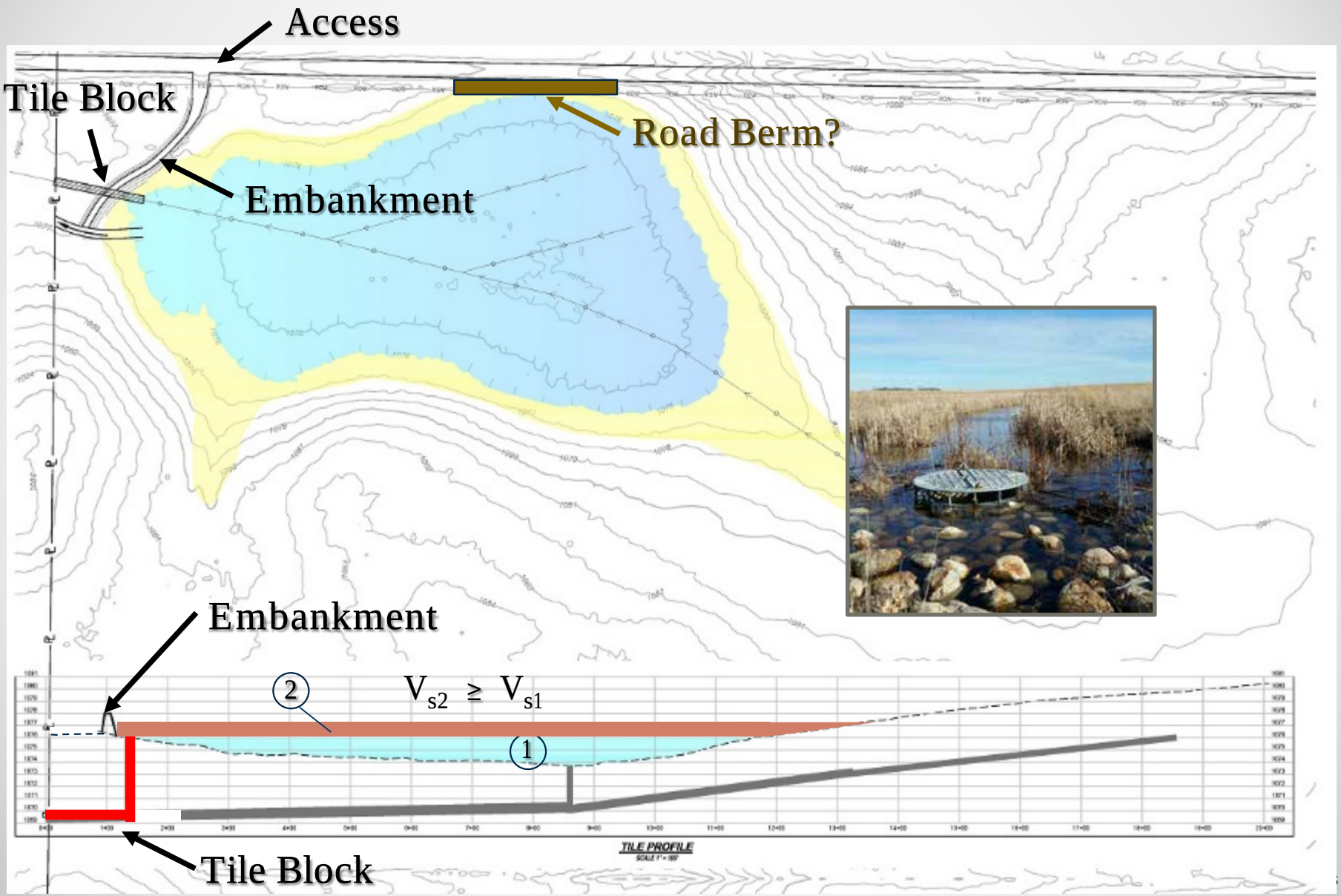
- Top Issues/Concerns
  - Used to Enhance Restoration Outcomes?
  - Difficult to Keep Maintained

Earthen Embankments



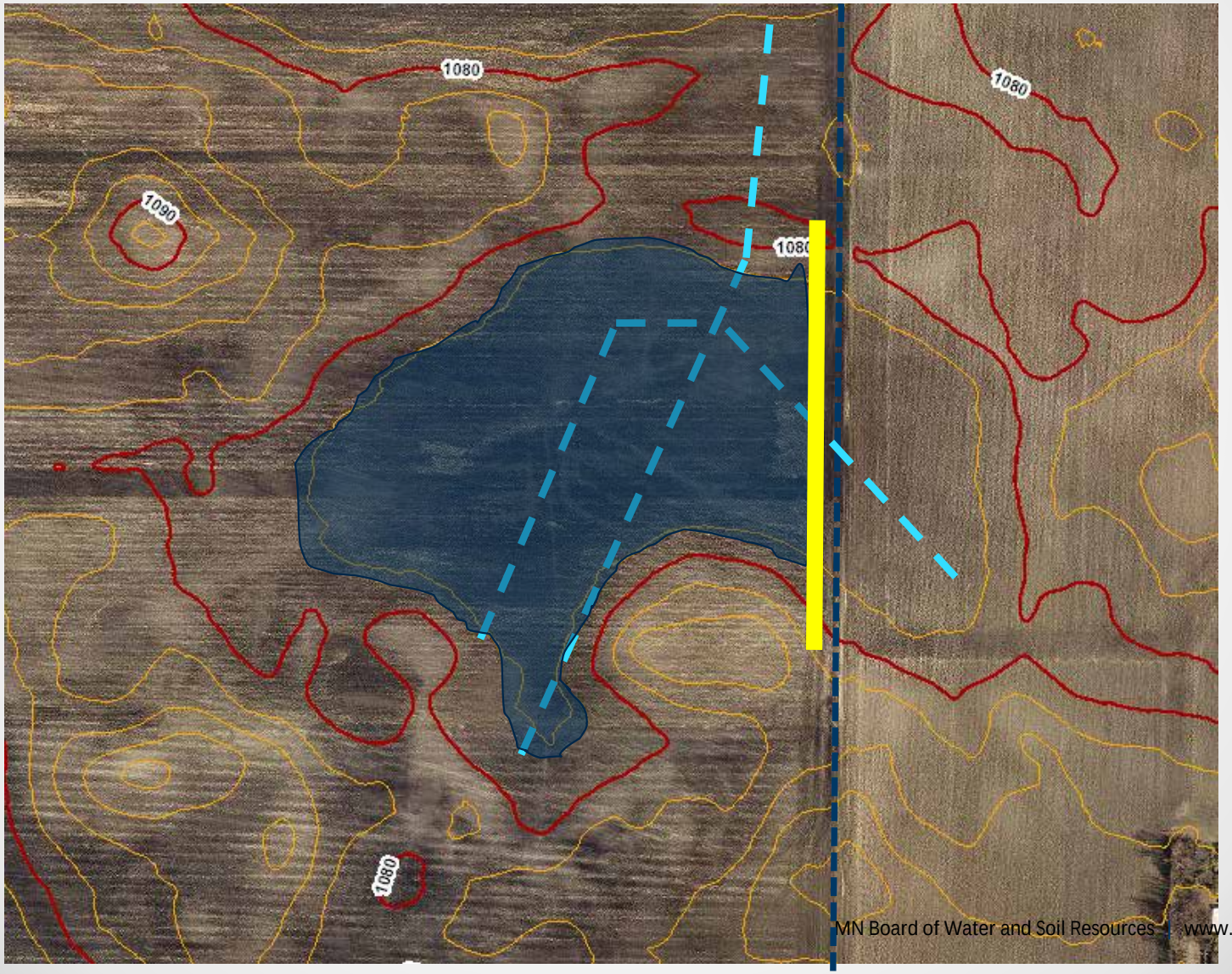

Tile Block
No Embankment
V_{s1}
1
TILE PROFILE
Tile Block

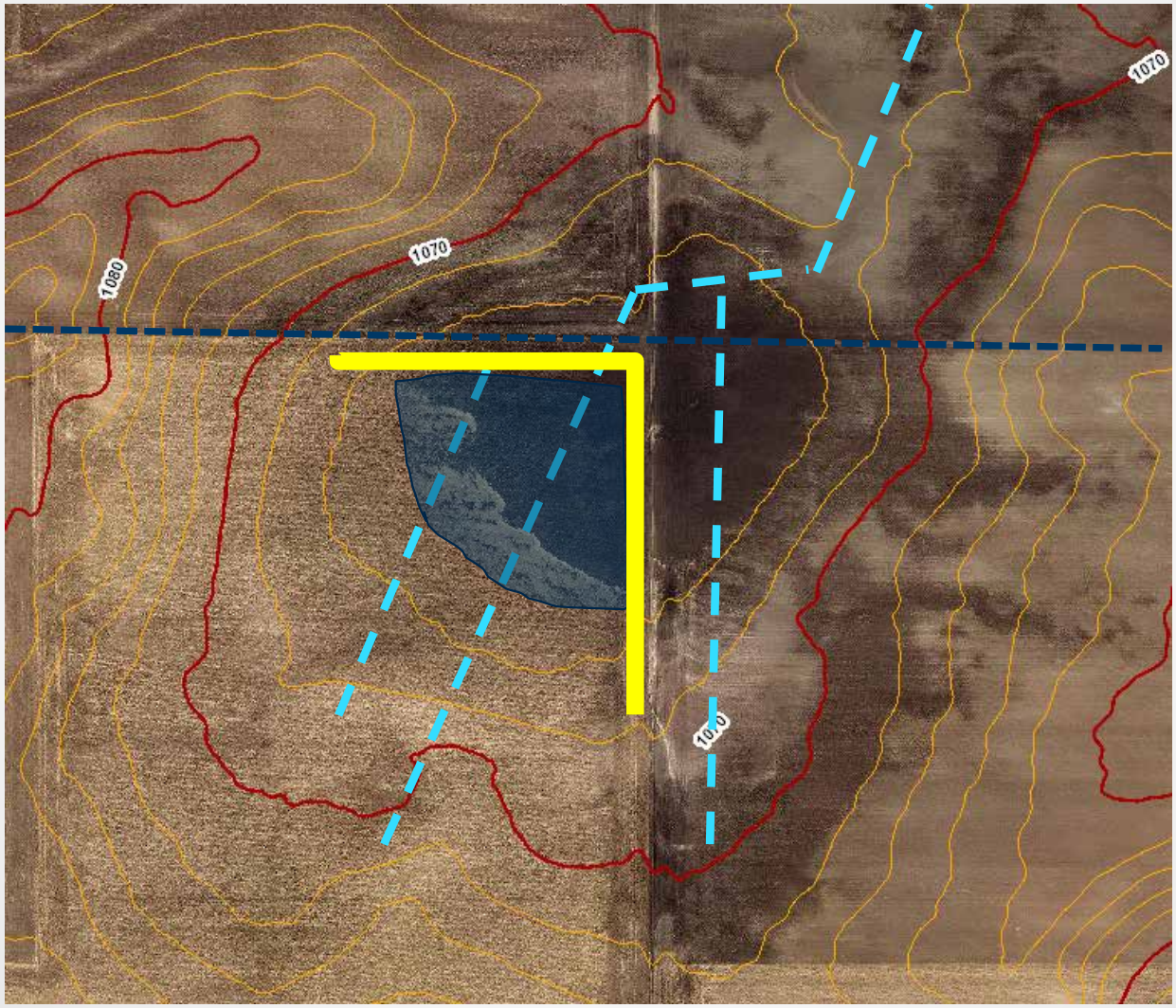
Earthen Embankments

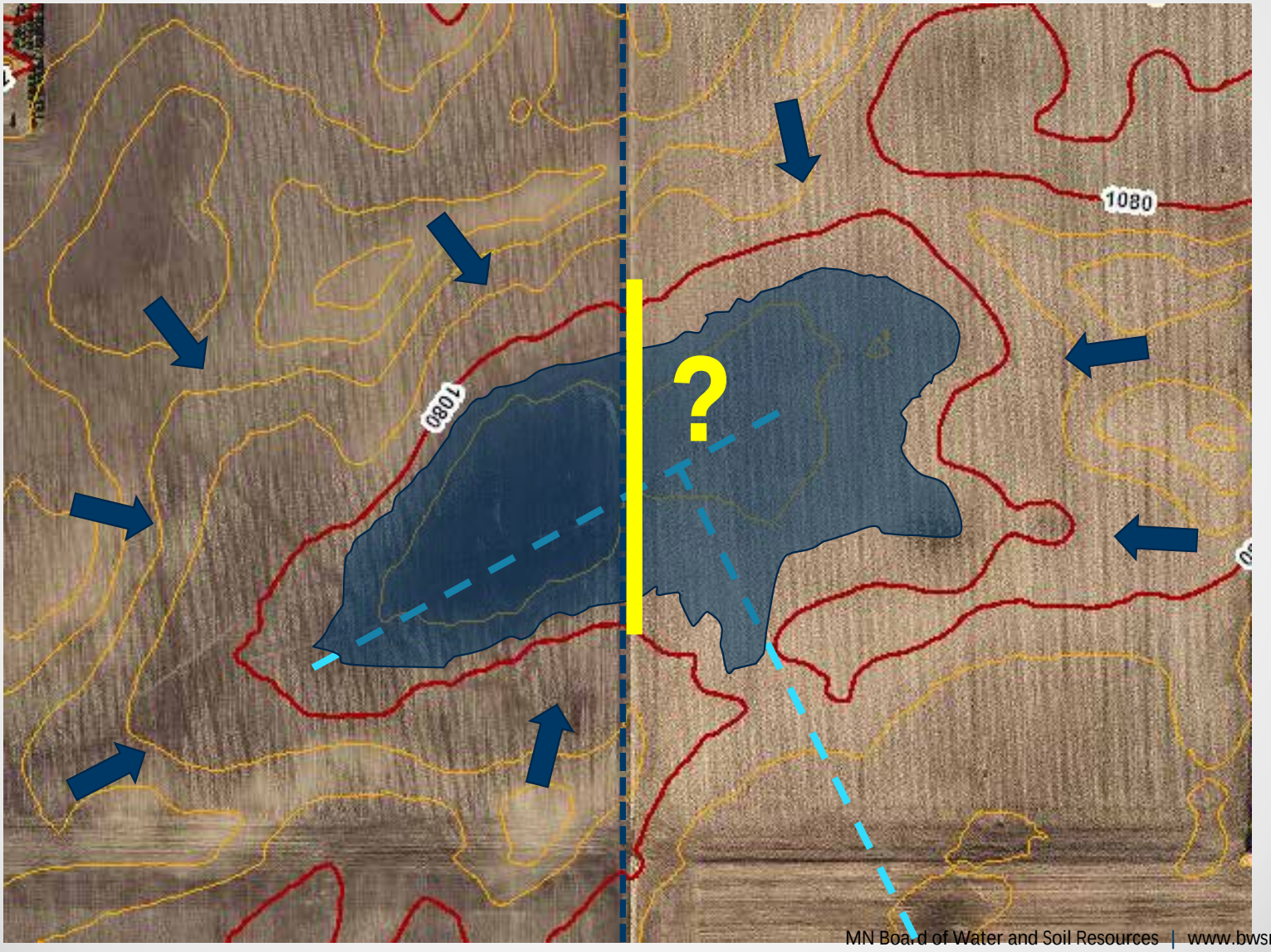



1090
1089
1090

Overview of Restoration/ Construction Strategies




1080
1070
1070
1070


1080
1080
?


1080
1080
1080
1080
1080
1080
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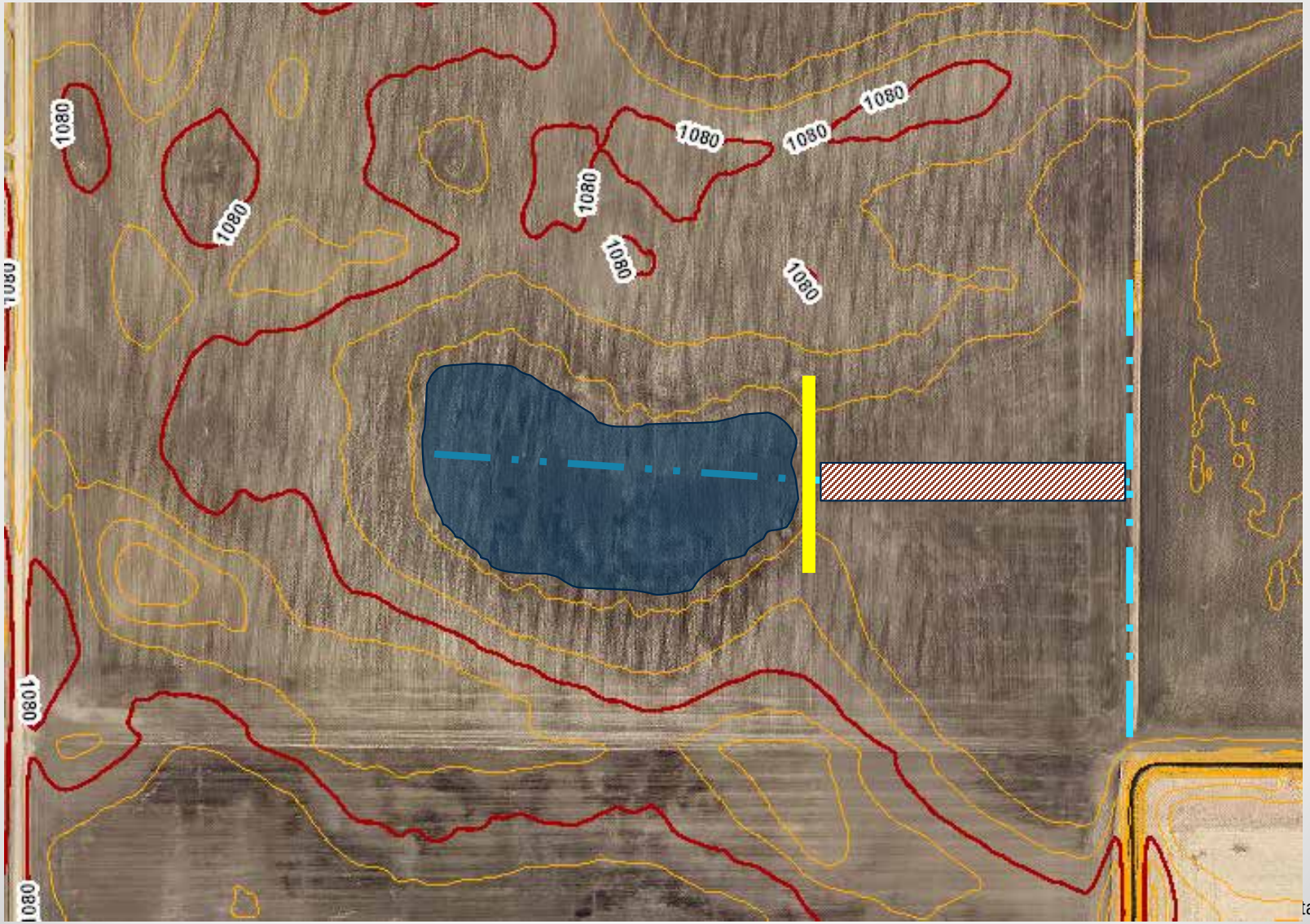
1080
1080
1080
X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1080
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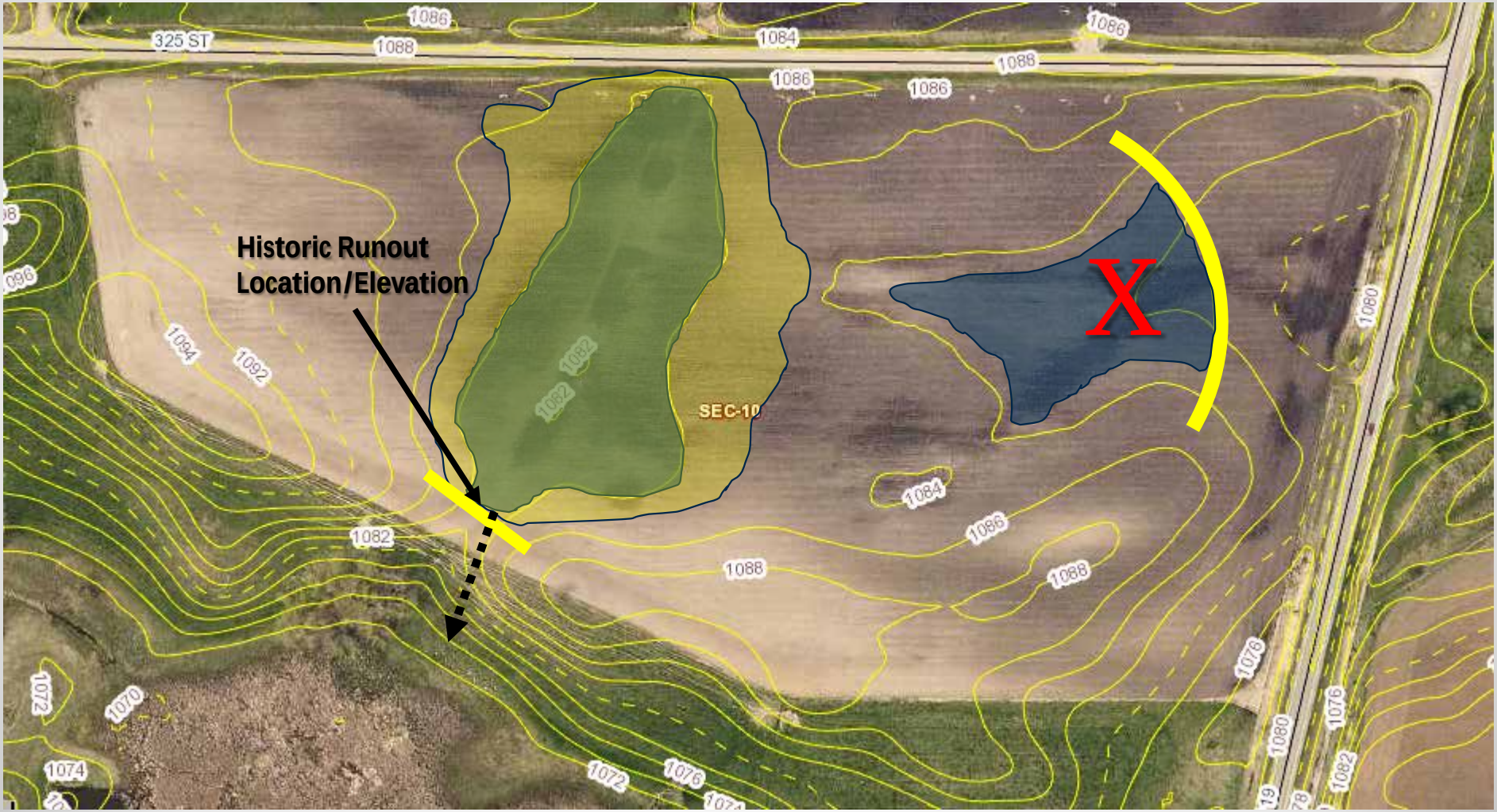
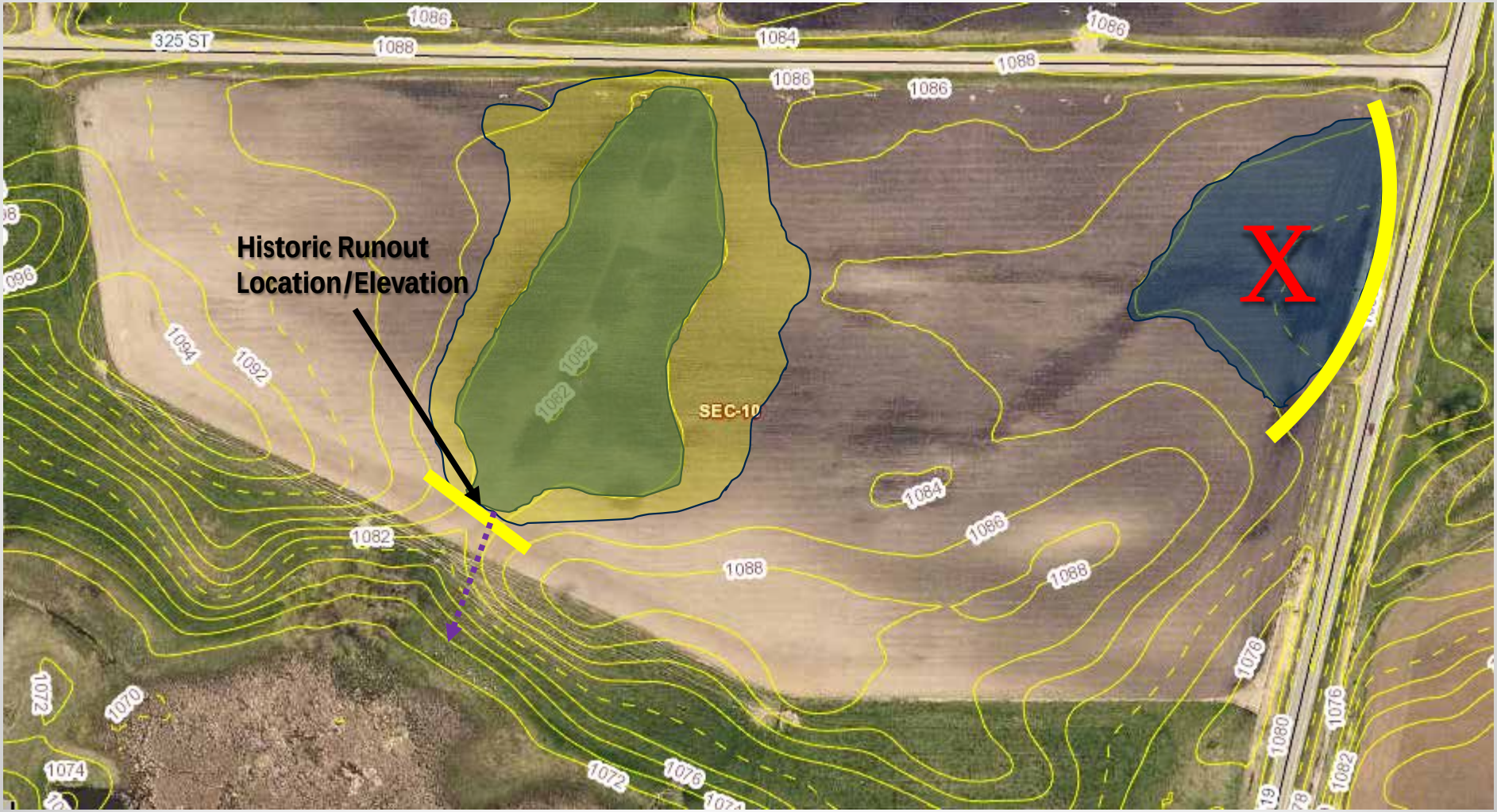
1080
1080
1080

Overview of Restoration/ Construction Strategies



Overview of Restoration/ Construction Strategies




325 ST
1086
1088
1084
1086
1088
1086
1086
1094
1092
1082
1082
SEC-10
1084
1086
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1076
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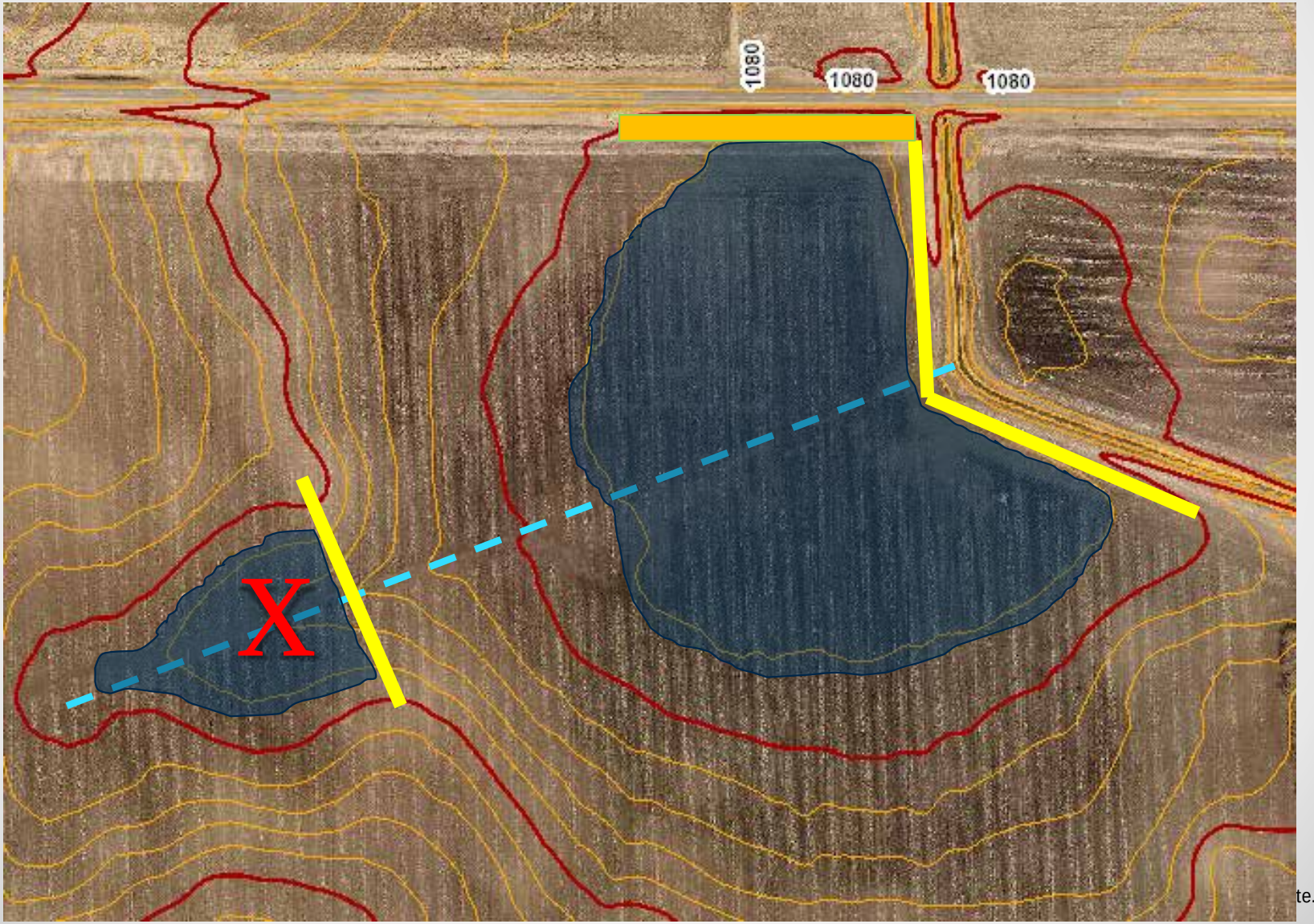
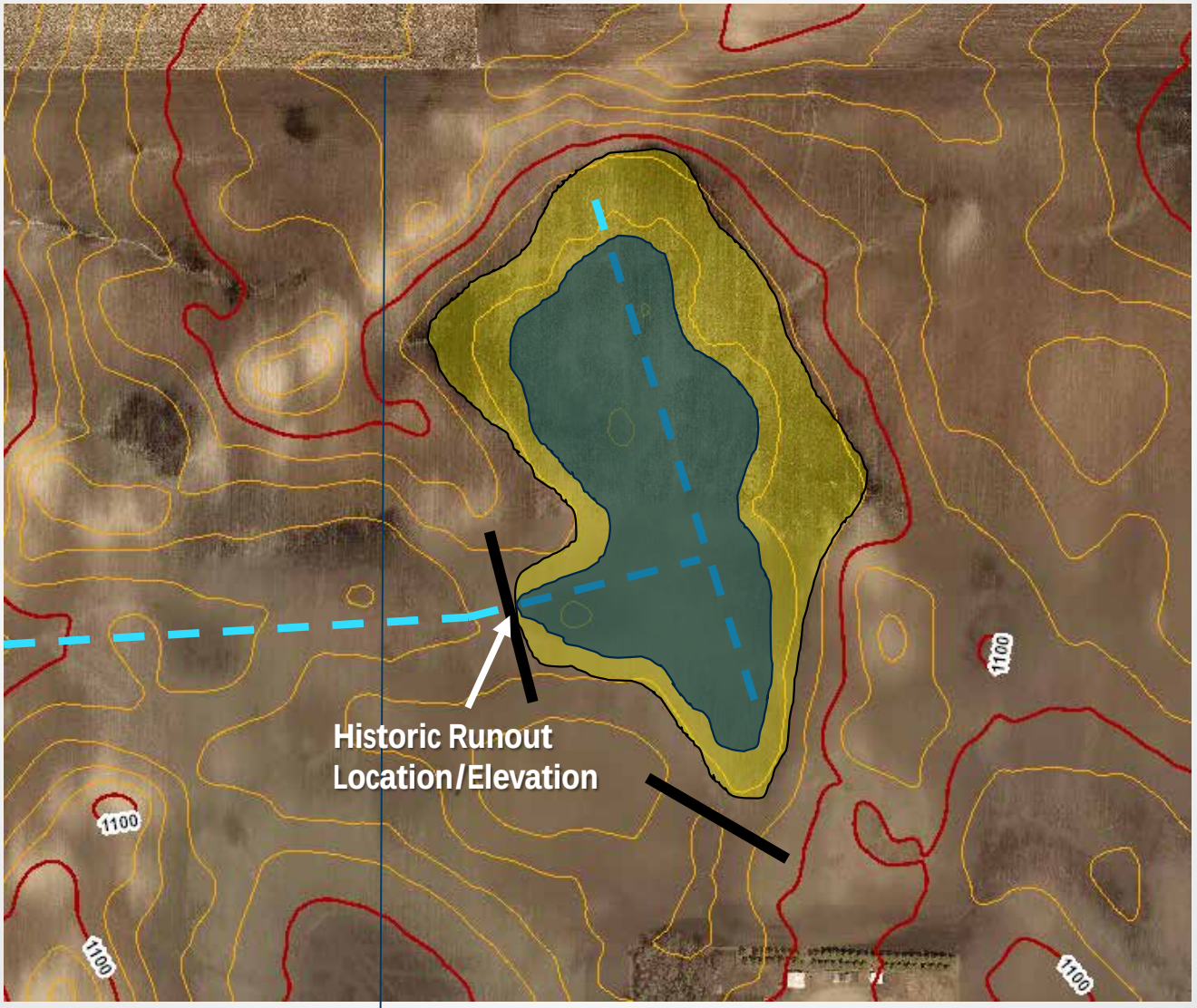
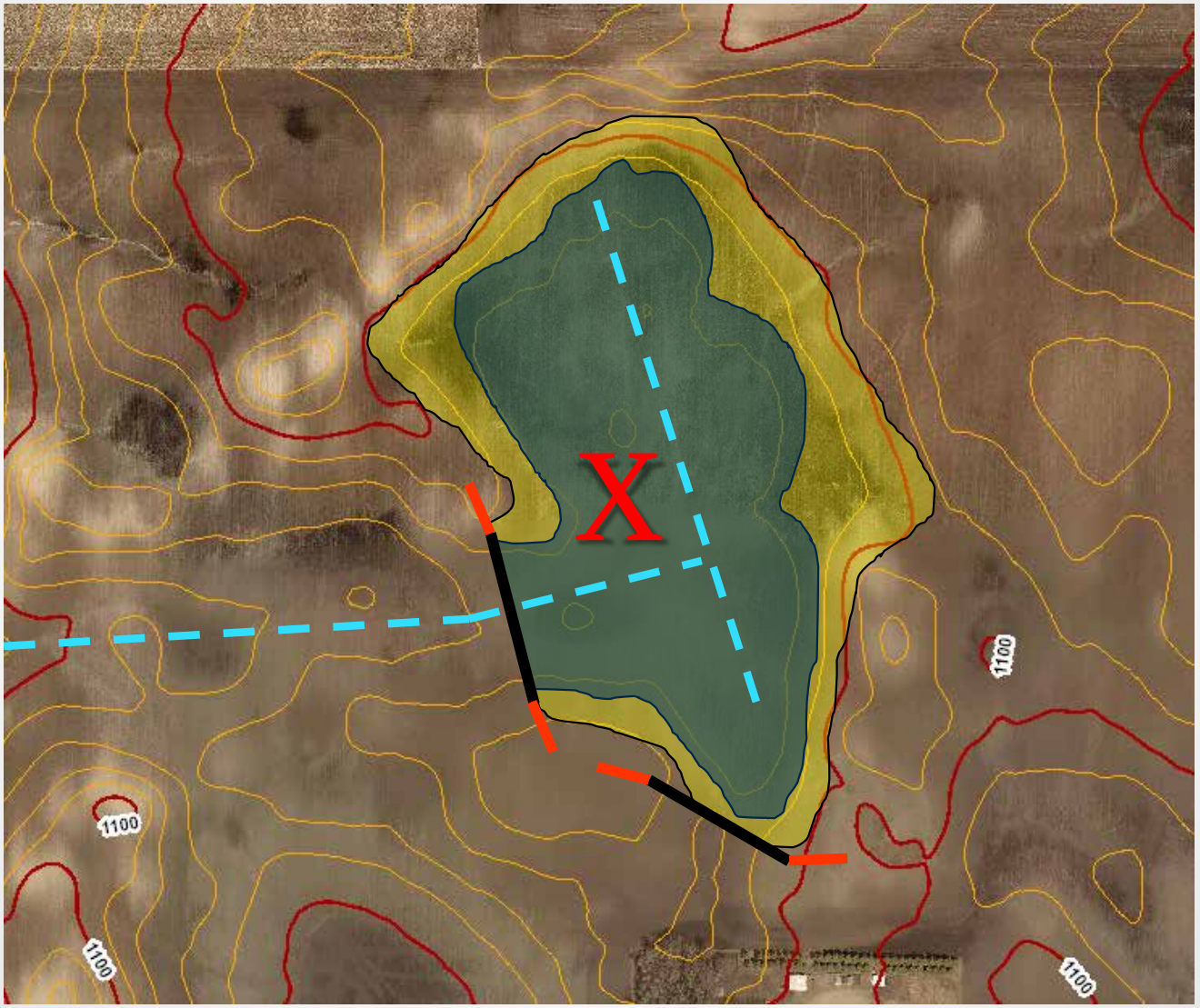
1082


1080
1080
1080
X

Overview of Restoration/ Construction Strategies


Historic Runout
Location/Elevation
1100
1100
1100
1100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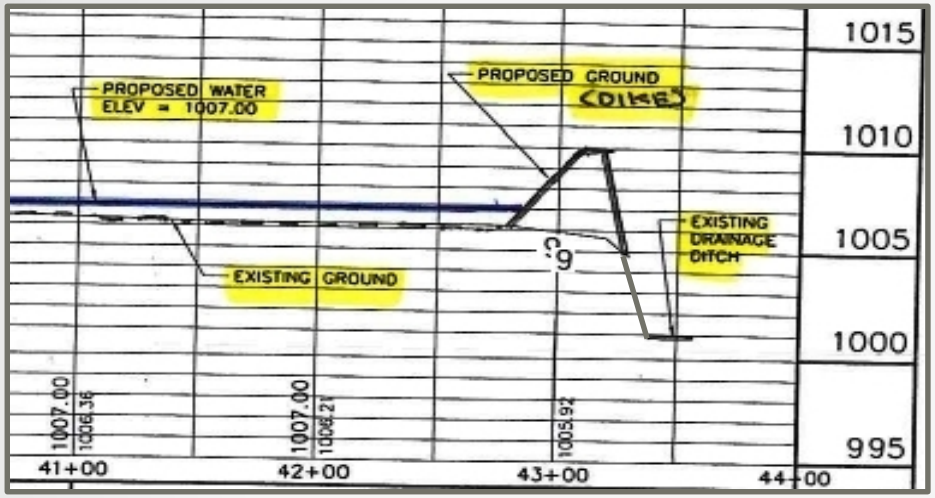
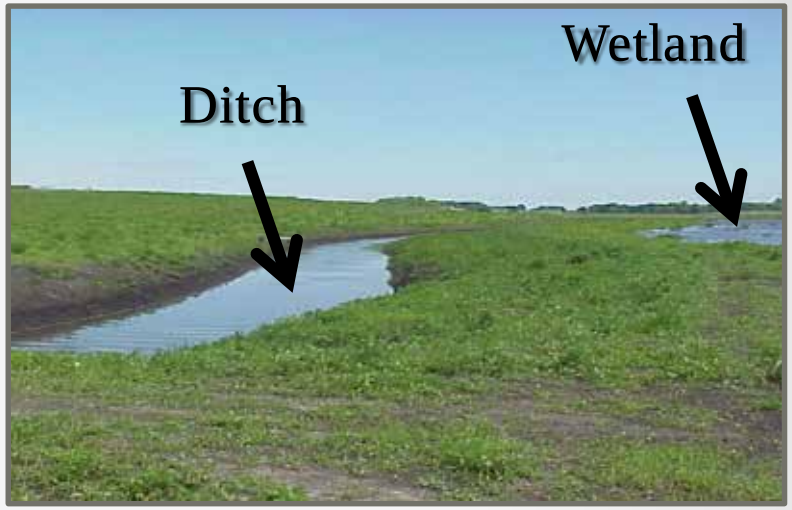
Design Considerations for all Earthen Plugs and Embankments

Design Considerations for all Earthen Plugs and Embankments

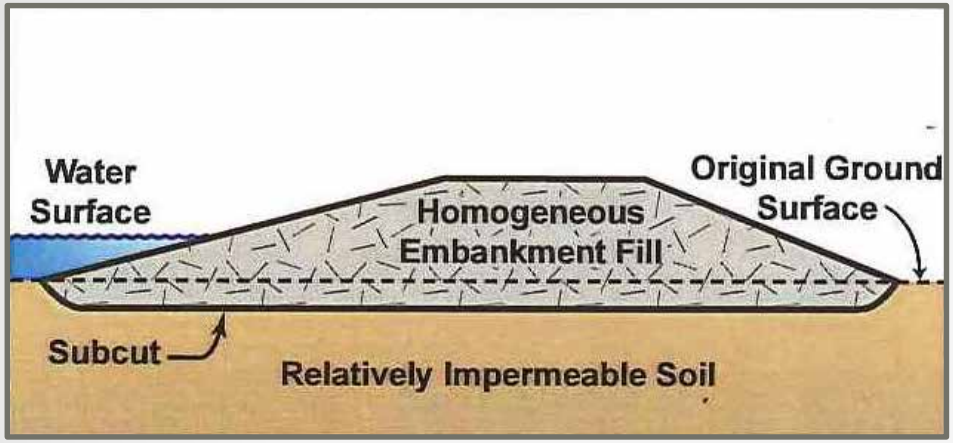
Design Considerations for all Earthen Plugs and Embankments

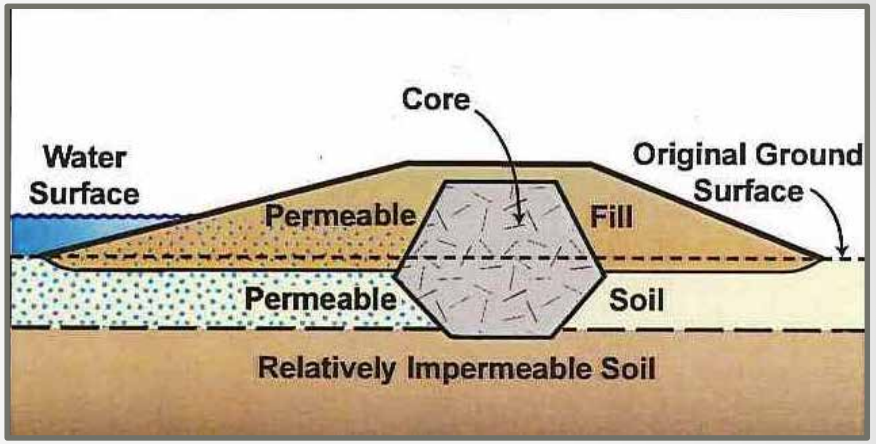
Overview of Restoration/ Construction Strategies

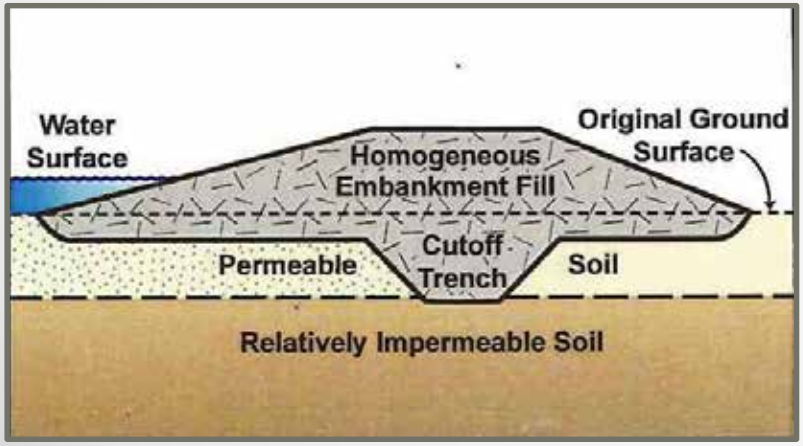


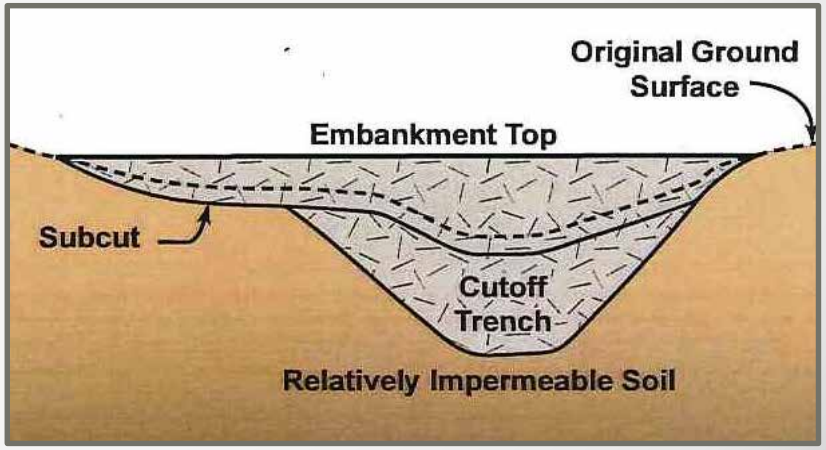


Design Considerations for all Earthen Plugs and Embankments



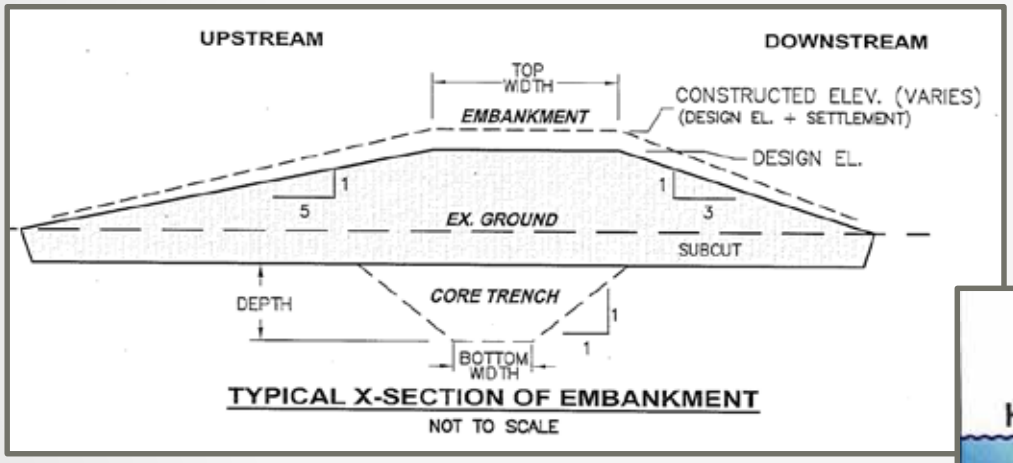


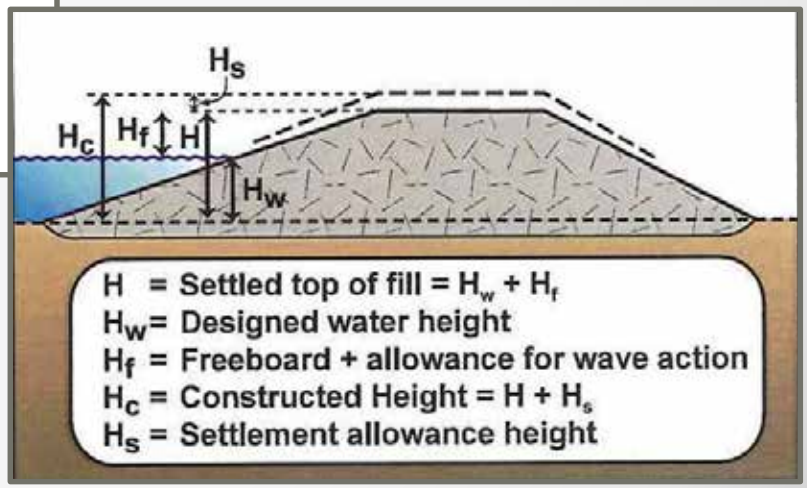




Geotechnical Investigations

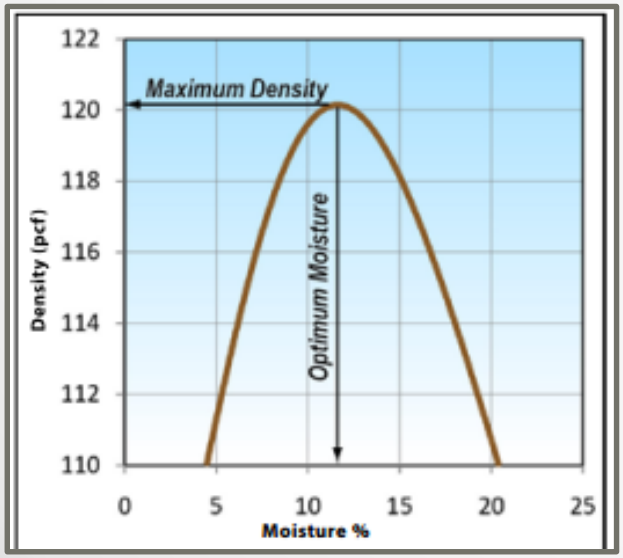
Design Considerations for all Earthen Plugs and Embankments



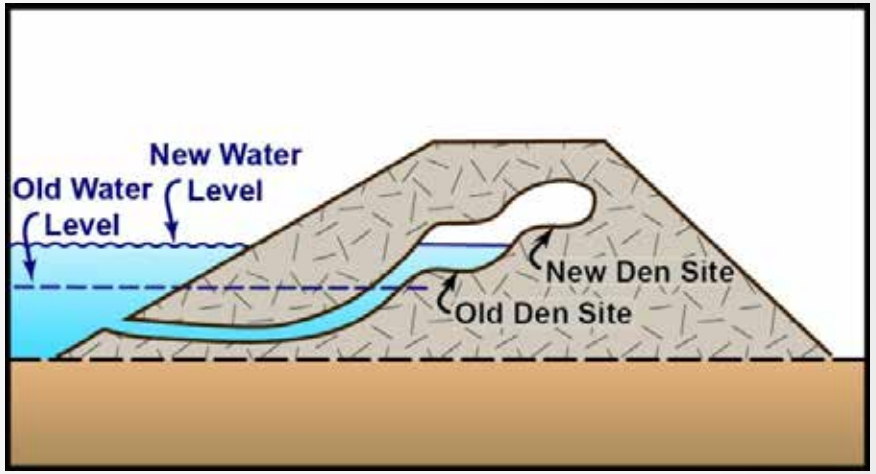


Design Considerations for all Earthen Plugs and Embankments

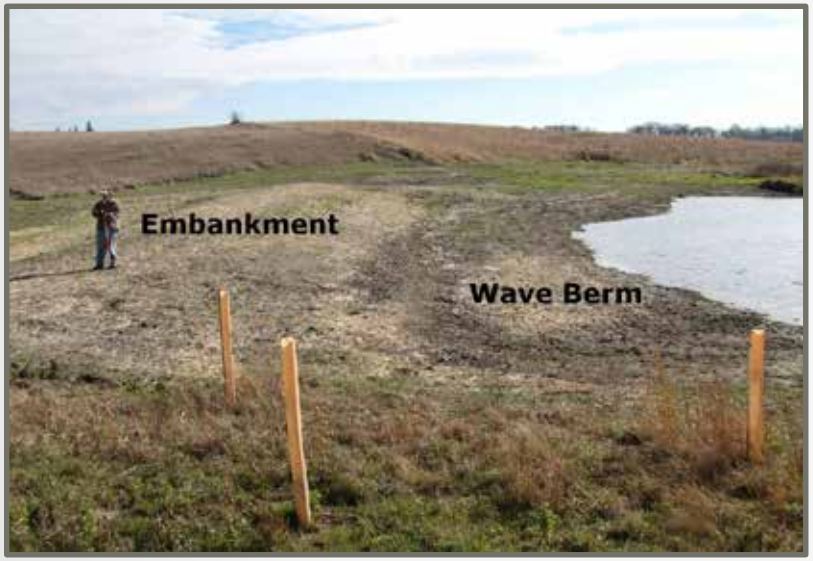
-Dozer	10-20 psi (lb/in$^{2)}$
-Loaded Scraper	100 psi (lb/in$^{2)}$
-Sheepsfoot	200 psi (lb/in$^{2)}$



Design Considerations for all Earthen Plugs and Embankments



Design Considerations for all Earthen Plugs and Embankments



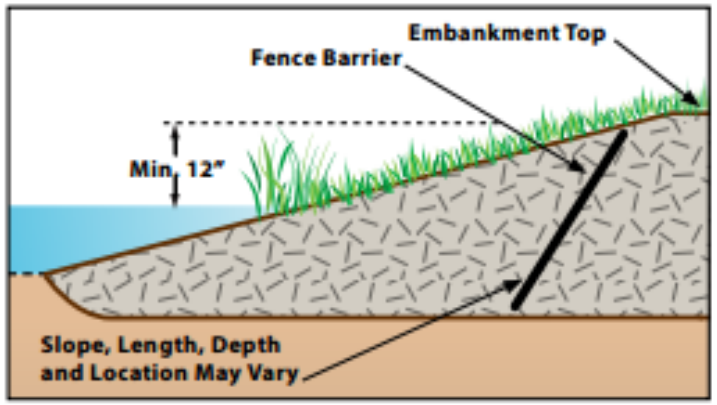


Figure 4.5.32 *Typical Rodent Fence Design Layout*

Design Considerations for all Earthen Plugs and Embankments

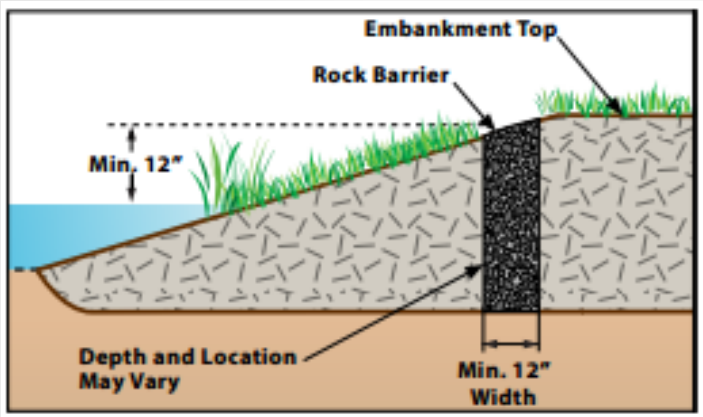


Figure 4.5.30 *Vertical Aggregate Barrier in Embankment*

Figure 4.5.31 *Construction of Aggregate Barrier*

- Top Issues/Concerns
  - Used to Enhance Restoration Outcomes?
  - Difficult to Keep Maintained

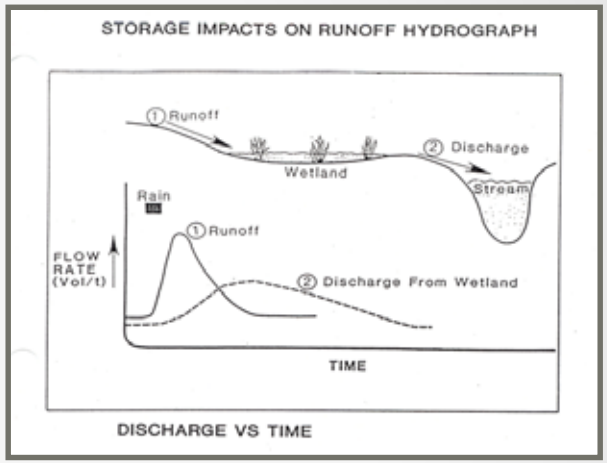
Design Considerations for all Earthen Plugs and Embankments

Wetland Outlets

- Purpose - Are They Really Needed?

Wetland Outlets

- Purpose - Are They Really Needed?
- Can Help With:
  - Restoring Site Hydrology
  - Stabilizing Hydrology Levels / Preventing Offsite Impacts
  - Safely Passing Wetland Discharges into D/S Conveyance Systems
  - Providing Necessary Storage/Rate Controls
  - Managing Wetland Hydrology (Drawdown)



Wetland Outlets

Use appropriate, sound, and sustainable materials and strategies

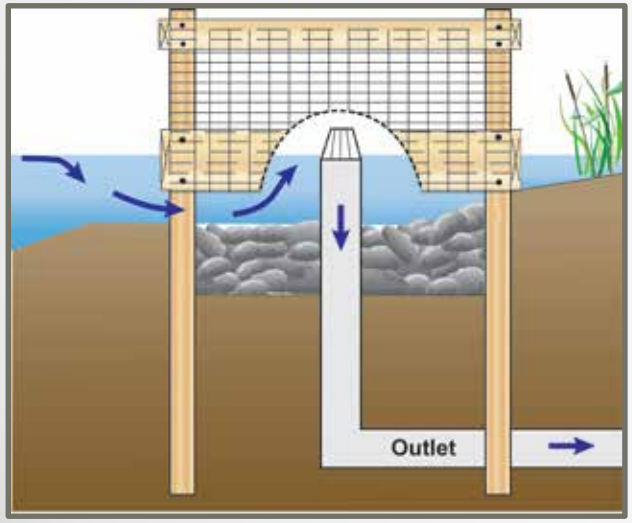






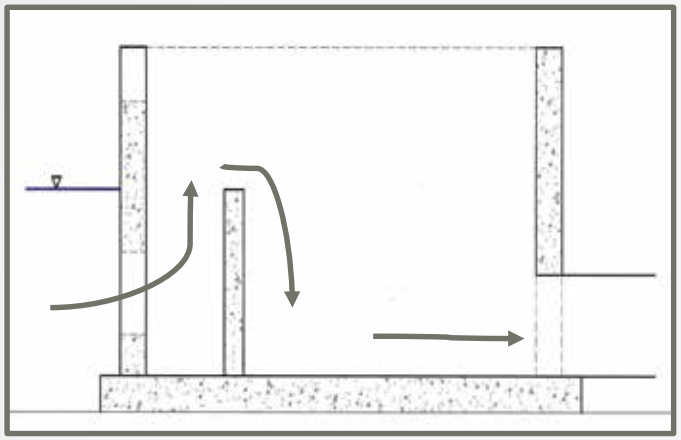


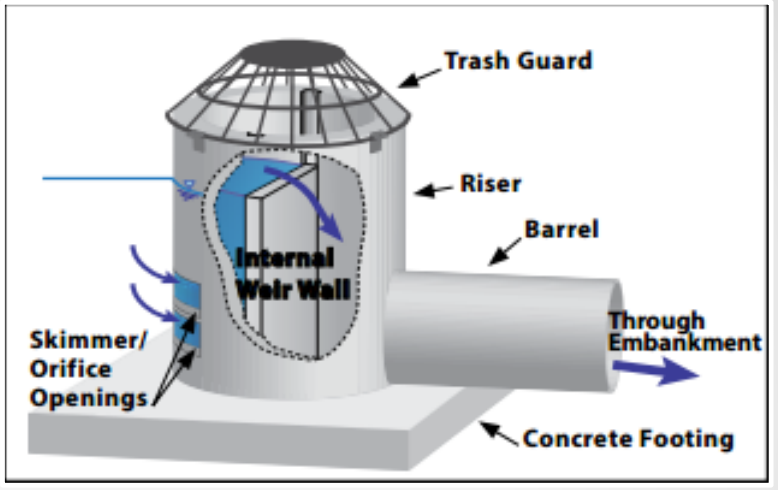
Wetland Outlets

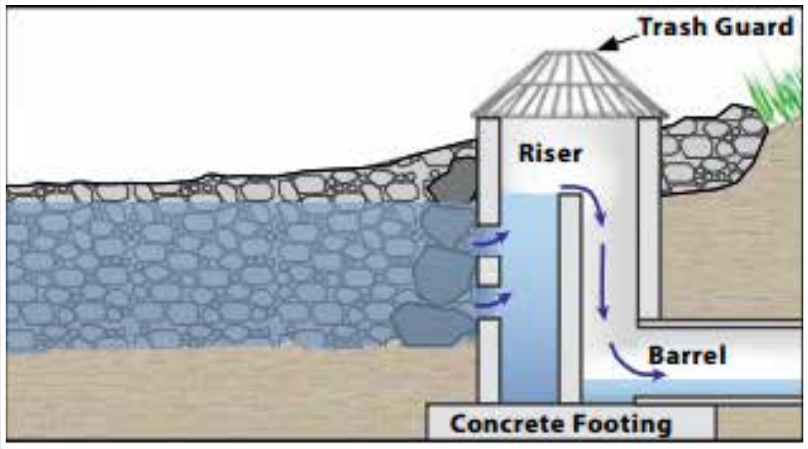


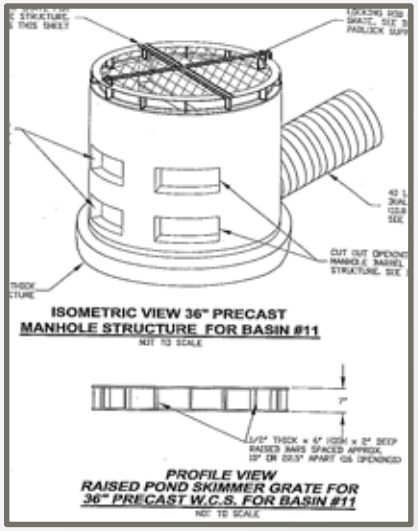
Wetland Outlets

Wetland Outlets

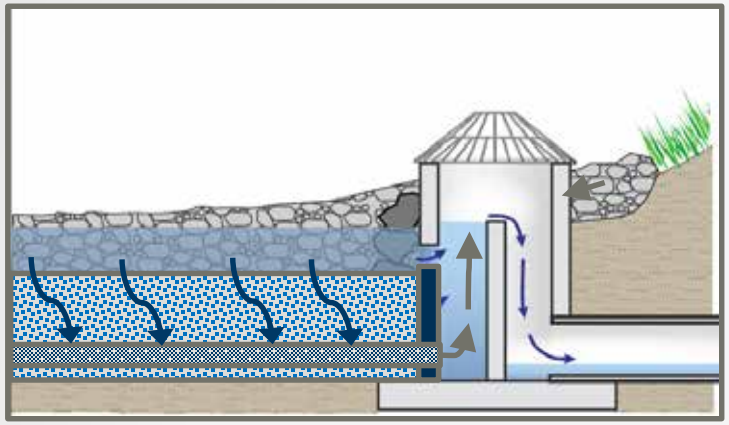






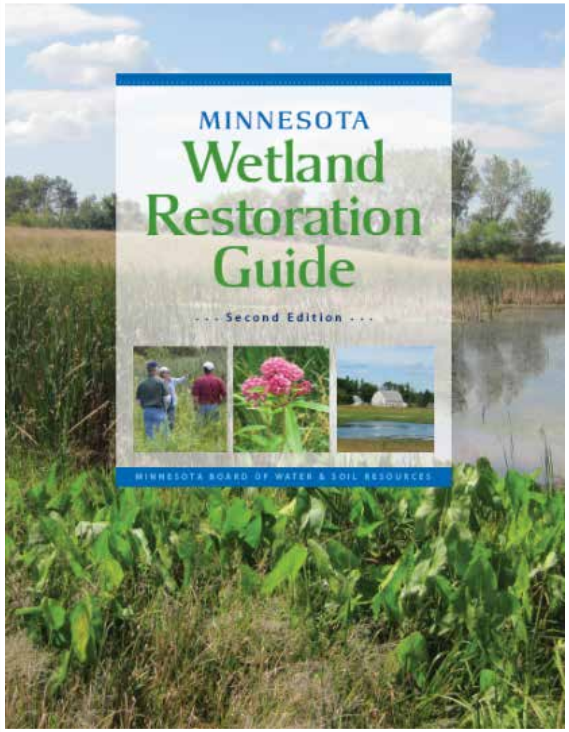


Wetland Outlets

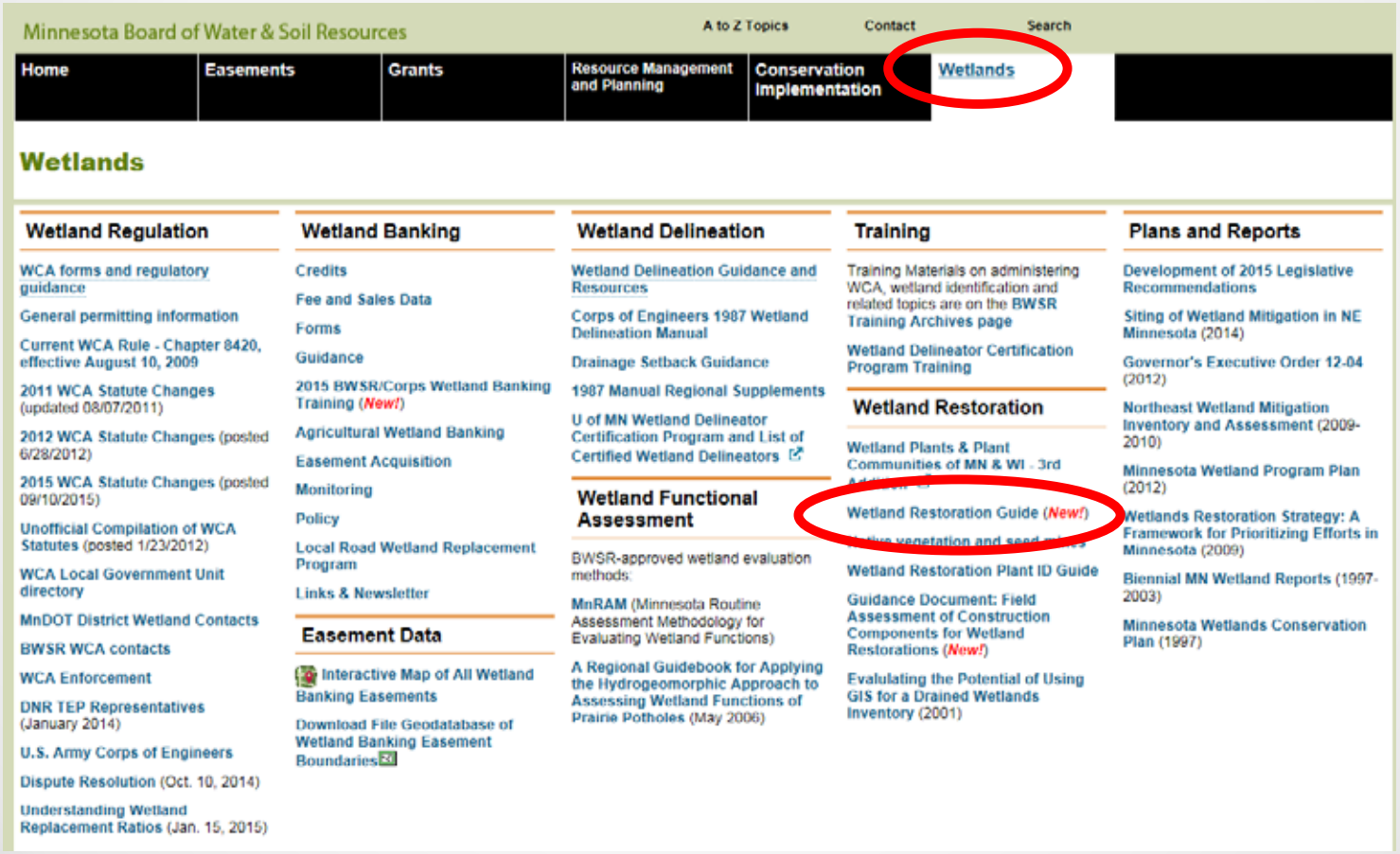


MN Board of Water and Soil Resources

Wetland Restoration Programs/Guide



Restoration Guide Website:
Located at: **bwsr.state.mn.us/restoration/index.html**



OUTLETTING DRAINAGE SYSTEMS

TECHNICAL GUIDANCE DOCUMENT

Document No.: WRG 4A-3
Publication Date: 10/14/2015

Table of Contents

- Introduction
- Application
- Design Considerations
- Construction Requirements
- Other Considerations
- Cost
- Maintenance
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INTRODUCTION

In Minnesota, wetlands planned for restoration are commonly drained by surface drainage ditches and subsurface drainage tile. These drainage systems often extend upstream from planned restoration sites and provide drainage to neighboring lands not part of a restoration project.

The restoration of wetlands in these types of drainage scenarios provides a number of design and construction challenges and may not always be possible. However, strategies to address incoming drainage systems as part of restoration do exist and should be considered, when feasible. These strategies include rerouting incoming drainage systems away from or around planned wetland restorations or when possible, outletting them directly into planned wetlands or other suitable areas within the restoration site.

Figure 1. Upstream Drainage Tile Outletting into Restored Wetland

APPLICATION

This Technical Guidance Document focuses on strategies to design effective and functional outlets within restoration sites for neighboring upstream drainage systems. The design of drainage system outlets will primarily be dependent on the type, location, elevation and grade of the drainage system as it approaches and enters the restoration site. If the approaching drainage system is steep enough in grade, then it may be possible to modify it and construct an effective and functional outlet directly onto the restoration site. The design will also be influenced by the general landscape of the planned outlet's location and, if part of a wetland restoration, the type of wetland being restored.

The strategies presented are most applicable to modifying subsurface tile drainage systems that

BLOCKING AND FILLING SURFACE DRAINAGE DITCHES

TECHNICAL GUIDANCE DOCUMENT

Document No.: WRG 4A-1
Publication Date: 10/14/2015

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INTRODUCTION

Surface ditches are common in Minnesota and have drained and altered countless wetlands. When attempting to restore wetlands drained by surface ditches, it is usually necessary to place earth fills at strategic locations within the drainage ditch to block the flow of water. This wetland restoration strategy is commonly referred to as constructing a "ditch plug". While these earthen fills are often thought of as being only small, simple structures, ditch plugs are essentially small dams and must be designed and constructed accordingly.

figure 1. Construction of an Earthen Plug Across Drainage Ditch

In addition to constructing appropriately located and designed ditch plugs, there is often a need or desire to also completely fill the entire reach of ditch within the planned restoration area. In certain landscape settings, this additional action will be necessary for the successful restoration of wetland hydrology.

APPLICATION

Drainage ditches remove excess water that collects on the land surface as well as in the soil profile. They provide a means to manage or lower water tables and can rapidly convey runoff from wetlands to areas downstream. Ditches can be just a few inches to many feet in depth, depending on topography and landscape setting.

Drainage ditches can be located in depressional wetlands, sloped wetlands, and wetland flats. As discussed in Section 3-A and in Appendix 3-A of the Guide, each of these wetland types interact with surface and ground water to varying degrees depending on hydrogeologic factors such as soil characteristics, geologic setting, and water table position. It is important that the dynamic nature of a drained wetland's hydrogeology be understood to accurately determine effective design strategies for restoration. More specifically, it will be important to determine if a ditch plug alone will be

Questions?