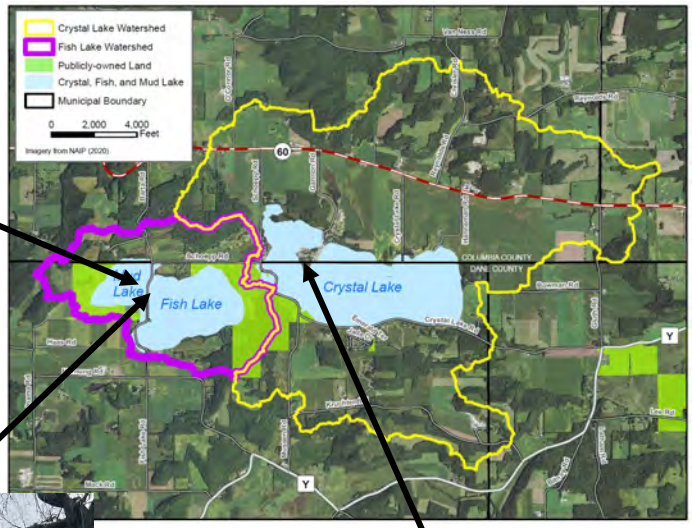
Fish & Crystal Lake Flooding

Technical Work Group Report

Fish Lake Road Inundated



Fish Lake Home Flood Damaged

Crystal Lake Campground Flooding

June 17, 2022

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1.0 Executive Summary

Fish, Mud, and Crystal Lakes are located in northwest Dane County and southeast Columbia County. These lakes are called seepage lakes because they do not have a stream inlet or outlet and may occasional overflow. Rising water levels have been occurring in Fish, Mud, and Crystal Lakes for the past decades. Water levels for Fish Lake were recorded starting in 1966 by periodic readings of an installed staff gage or by instrumentation. Water levels in Fish Lake rose more than 17 feet from the early 1970s to present day (50 years).

In order to understand and attempt to control fluctuating lake levels, there have been several efforts. In 2001, the U.S. Geological Survey (USGS), in collaboration with Dane County and Wisconsin Department of Natural Resources (WDNR), completed a 2-year study that described the hydrology of Fish, Mud, and Crystal Lakes, their watersheds, and their relation to the shallow groundwater system. The study concluded that withdrawing Fish Lake water by pumping would lower the stage of the lakes; however, without near-continuous withdrawal the lake stages should recover in a few years. Subsequently, the Crystal, Fish, Mud Lake District was formed in 2003 to provide a taxing entity to organize and partially fund pumping efforts. The Lake District installed and managed pumping stations for Fish Lake in 2009 and Crystal Lake in 2013. The pumping efforts have been costly, labor-intensive, and effective only for short periods of time. Several mitigation efforts have been implemented for flooded infrastructure. The Town of Roxbury invested in raising the elevation of Fish Lake and Mussen Roads, which was effective until 2018 at which point they were once again flooded. Dane County offered to purchase flood-damaged or at-risk structures along Fish Lake Road starting in the early 2000s through 2020. Over time, the majority of owners along Fish Lake Road sold by a voluntary buyout to Dane County.

Due to high water levels on Fish and Crystal lakes, the Town of Roxbury (Dane County) and the Town of West Point (Columbia County) contracted with MSA Professional Services to evaluate the viability of a gravity outfall from the Lakes to the Wisconsin River. Costs for the project were estimated to be $5.8 million, not including acquisition costs, legal fees, administrative/maintenance costs, or inflation of construction costs. The MSA report identified one potential solution of a gravity pipe; however, a comprehensive approach to assess other alternatives had not been conducted. Therefore, a technical work group was assembled to bring together experts related to various backgrounds and aspects to assess potential alternatives for mitigating flooding in Fish Lake.

A technical work group consisting of representatives from Dane County Land & Water Resources Department (LWRD), Dane County Department of Planning & Development, WDNR, Wisconsin Geologic & Natural History Survey (WGNHS), U.S. Department of Agricultural - Natural Resources Conservation Service (USDA-NRCS), MSA Professional Services, Dane County Board of Supervisors, and Town of Roxbury was formed and met to discuss flooding alternatives for Mud, Fish, and Crystal Lake. In total, eight alternatives were reviewed including challenges, benefits, and considerations. The technical workgroup did not make recommendations on an alternative to pursue. The purpose of the report is intended to provide information to the public, managers, and policy makers on water level impacts to Fish, Mud, and Crystal Lakes and possible mitigation alternatives.

2.0 Background

Fish, Mud, and Crystal Lakes are seepage lakes which do not have an inlet or an outlet and may occasional overflow. Seepage lakes are the most common lake type in Wisconsin and it is typical for water levels to fluctuate. Water levels in all of these lakes have been rising for decades, with a dramatic increase from 2018 - 2020. Seepage lakes throughout the state have been challenged with recent record years of high amounts of precipitation.

Fish Lake is 252 acres in size, located in northwest Dane County in the Town of Roxbury. Fish Lake has mainly an undeveloped shoreline with parklands on the east and west shorelines. The creation of Lussier County Park and boat launch have been great additions to this unique deep water seepage lake. The adjacent parkland have benefitted the water quality by reducing surface runoff pollution. Recreational lake uses include swimming, fishing, and non-gasoline motorized boating. The Fish Lake watershed is approximately 1,230 acres composed of a primary agriculture land use. Mud Lake was historically a northwest bay of Fish Lake that was mostly disconnected when Fish Lake Road was constructed. Currently, water levels have overtopped Fish Lake Road and have connected Fish and Mud Lake.

Crystal Lake is located less than a half mile to the east of Fish Lake located in the Town of Roxbury, Dane County and Town of West Point, Columbia County. The 525 acre shallow seepage lake provides recreational uses including gasoline motorized boating, fishing, water skiing, and swimming. In recent years, Crystal Lake has been a popular attraction for anglers to catch bluegill, crappie, and largemouth bass. The Crystal Lake watershed is approximately 5,189 acres. Additional recreational opportunities are located to the north at a campground park located on the Columbia County side of the lake.

Rising water levels have been occurring in Crystal, Mud, and Fish Lakes for the past decades (Krohelski et al. 2002). Water levels in Fish and Crystal Lakes are influenced from surface-water runoff (rain and snowmelt that runs off from lands that drain into the lakes) and from groundwater. Surface water runoff is generally determined from topographic maps based on land elevations. Groundwater movement occurs below ground in aquifer systems. The boundaries of surface water and groundwater watersheds do not always coincide as shown in Figure 1. Specifically, for Fish Lake, the surface water watershed to lake area ratio is relatively small at 5:1 compared to groundwater watershed to lake area ratio of 9:1, suggesting water levels are largely influenced by groundwater. The majority of water during rainfall either runs off the landscape or soaks into the ground and infiltrates. Inside the surface water watershed of Fish Lake, rainfall will influence lake levels by both runoff (surface water) and infiltration (groundwater). Just outside the surface water watershed of Fish Lake, but inside the groundwater watershed, rainfall will influence water levels by only infiltration to groundwater. For more information on determining the groundwater boundary as shown in Figure 1, see Appendix I. Surrounding Fish Lake and Crystal Lake, there is low use of groundwater for public water supplies (both municipal and private systems for residential, industrial and commercial uses) which does not reduce groundwater levels. Furthermore, other studies have predicted that increasing extreme rainfall events are likely to continue posing an increased risk for future flooding (WICCI, 2020). In summary, these seepage lakes are likely to continue to see fluctuating, and increasing, water levels due to their natural surface water and groundwater interaction influenced by precipitation.

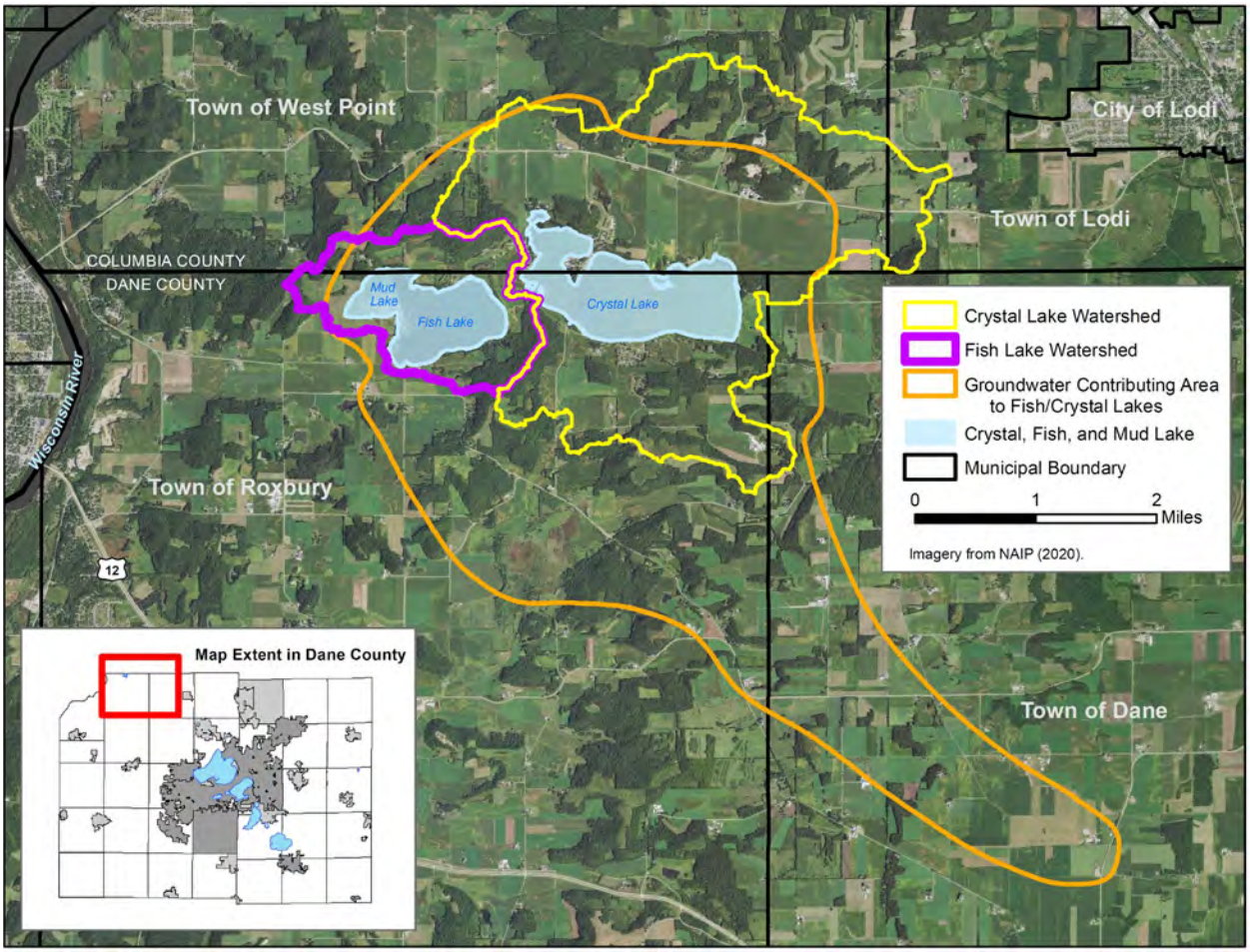


Figure 1: Map of Crystal Lake watershed (yellow), Fish Lake watershed (purple), and groundwater watershed (orange)

3.0 Water Level Changes

In 1937, water levels in Fish Lake were much lower than today; as shown in the aerial photo below with a connected wetland (Mud Lake) separated by a road (Figure 2). Mud Lake had open water only in its deepest spot with the remaining wetland area being farmed. Also, on Fish Lake, the western and southern shores had extensive exposed lake bed which today is inundated by water.

Figure 2: 1937 aerial photo of Fish and Mud Lakes

Water levels for Fish Lake were recorded starting in 1966 by periodic readings of an installed staff gage or by instrumentation. Water levels in Fish Lake were approximately at elevation 852 feet from 1966 to 1973 (7 years) as shown in Figure 4. Then, water levels in Fish Lake rose approximately 8 feet from 1973 to 2008 (35 years). During this period, two extreme rainfall years in 1993 and 2008 resulted in large increases in water levels. Specifically, in 1993, the aerial image shown in Figure 3 shows Fish and Mud Lakes were now fully interconnected water bodies. After 2008, flooding of homes and roads around Fish Lake's shoreline had become critical. These higher lake water levels were affected by periods of above normal precipitation (1993 and 2008) and steadily increasing groundwater levels (Krohelski et al. 2002).

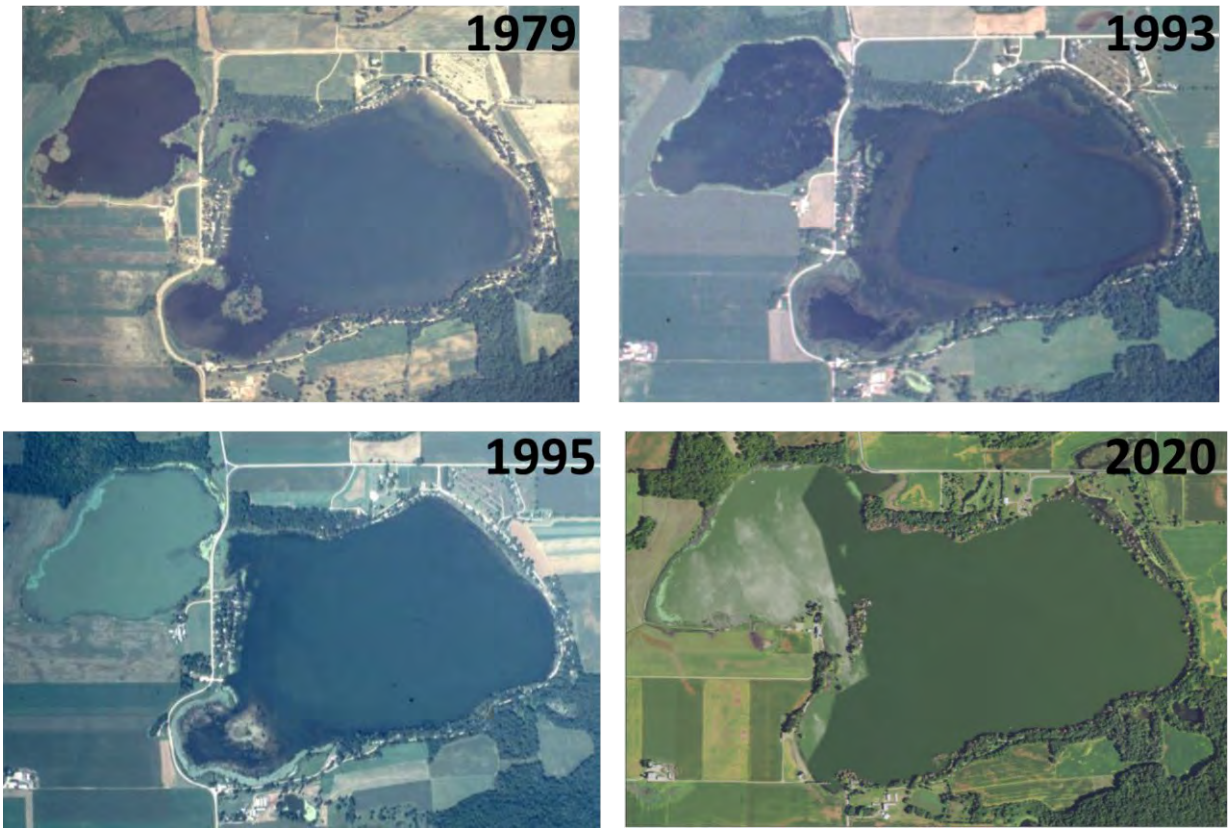


Figure 3: Aerial Images showing water level extents in Fish Lake from 1979 to 2020

The high lake water levels continued from 2009 to 2019 (10 years); despite the Lake District obtaining approvals and financing to install a pump and pipe system to lower water levels by discharging water from Fish and Mud Lakes in 2009 to the Wisconsin River and Crystal Lake in 2013 to Roxbury Creek. During this time period, the pump systems had problems including: never reaching design flow rates, intermittent use because outfall water quality permit limits were exceeded, frequent system breakdowns, electrical costs, etc. The pump system did remove some water from Fish and Mud Lakes during its years of operation, but the system could not lower water levels substantially.

Extreme precipitation in 2018 and 2019 caused water levels to rise in Crystal Lake causing it to overtop along its western shoreline and flow south into Fish Lake. This occurred despite the operation of Crystal Lake pump system. As a result, water levels in Fish Lake increased 8 feet from 2019 to 2021. All together Fish Lake rose more than 17 feet from the early 1970s to present day (50 years). The pump system at Fish Lake is now damaged due to flooding. Today, Fish Lake water levels remain approximately 2 feet below the overtop elevation, at which point water would flow overland to the west towards the Wisconsin River.

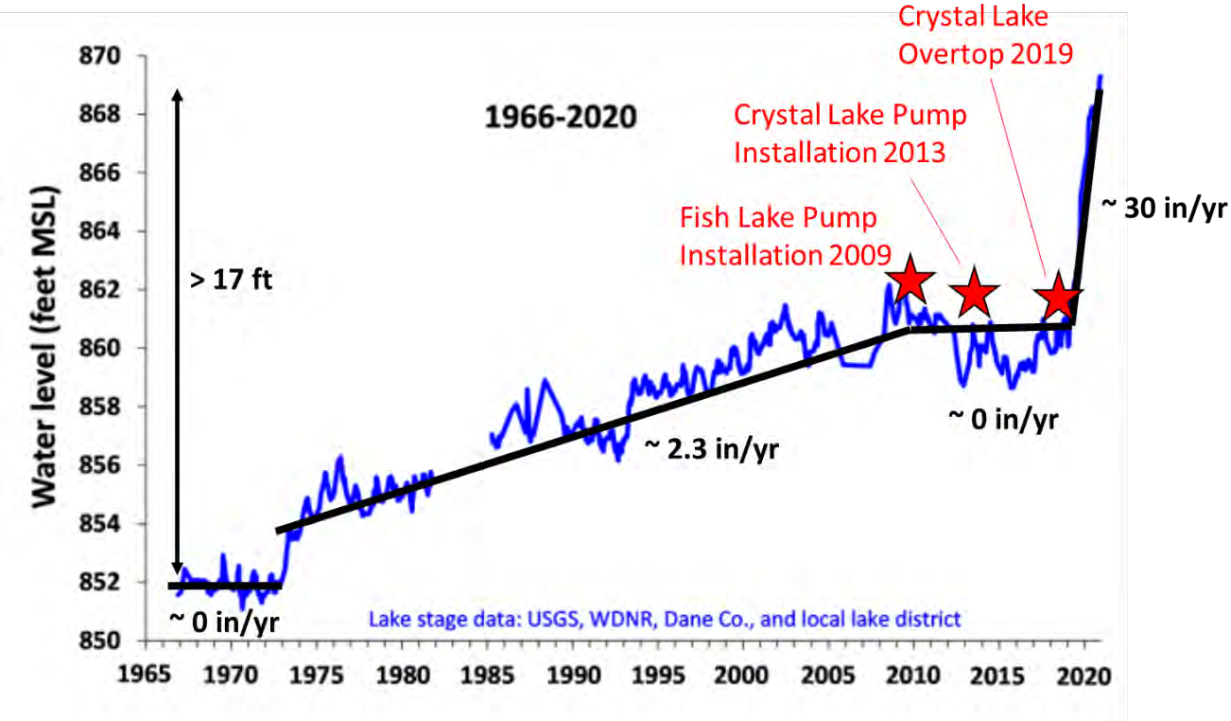


Figure 4: Fish Lake Water Level Chart

4.0 Water Quality and Ecological Impacts

Historically, Fish Lake had been classified as mesotrophic, containing moderate amounts of nutrients (DCRPC 1979). The deep bottom lake water, known as the hypolimnetic zone, has had declining dissolved oxygen levels since the late 1950s. Low oxygen levels resulted in periodic cisco fish kills over the past several decades. Today, no cisco have been found during recent Wisconsin Department of Natural Resources (WDNR) fish surveys of the lake. Within the last few decades, rising Trophic State Index (TSI) values indicate that Fish Lake has shifted from mesotrophic to eutrophic conditions, meaning it is rich in nutrients. The long term water quality decline is suggested to be affected by watershed nutrient runoff sources (Marshall et al. 1996). Lake and watershed monitoring studies were initiated in 1988 to understand the declining water quality where lake users were generally aware of the abundant aquatic plants in the lake. Invasive Eurasian watermilfoil (EWM) was first identified in 1967 and rapidly expanded throughout the lake in the 1980s. By 1991, dense growths of EWM covered the lake bottom area (Lillie 1996), resulting in the decline of numerous native species (Madsen et al. 1991).

Prior to the extreme rainfall in July 1993, Mud Lake to the west was a shallow lake/wetland system supporting aquatic plants. However, water quality deteriorated dramatically in Mud Lake by late spring 1995 when blue-green algal blooms became common, as shown by the green colored Mud Lake in Figure 3 of the 1995 aerial photo. The primary reason for Mud Lake's poor water conditions is due to rising water levels supporting carp populations, which are known for stirring up sediment and nutrients.

In response to the carp in Mud Lake, WDNR and Dane County partnered to reduce carp densities. Rotenone (a naturally occurring plant compound used to kill fish) was applied to Mud Lake in the winter of 2017. The carp eradication in Mud Lake was short-lived. A recruitment of young carp occurred in 2018 because adult carp were able to migrate back into Mud Lake through a culvert that had reopened. A second Rotenone treatment of carp in Mud Lake was planned for the winter of 2020; however, after the 2019 rainfall, rising water levels caused Mud and Fish Lakes to become one water body, as shown in Figure 3, which would compromise the efficacy of rotenone treatment.

Major changes had occurred in Fish and Mud Lakes over the last several decades including declining water quality and reduced native aquatic plant beds. However, despite the decline in water quality, recent WNDR fish surveys have shown positive outcomes to the fishery. In spring of 2021, the survey found that the northern pike fishery is improving and the size structure of the fishery is one of the best in the area providing anglers the opportunity to catch large fish over 40 inches. The panfish are abundant but the size structure and growth are poor which remains unchanged from when there were lower levels. The largemouth bass fishery on Fish Lake has greatly improved recently and is a destination for the area due to the amount and size of fish in the lake. It is likely that the fishery, especially the largemouth bass, has benefited from additional habitat created by rising water levels. The rising water levels have inundated trees, increased lake area to support more fish, and created a variable lake bottom consisting of shallow areas for spawning and deep drop off depths providing cooler water and safe hiding locations. Overall, the WDNR fish survey was conducted in high water levels suggesting rising levels contributed to an improved fishery; however, additional monitoring years are suggested to validate the findings.

5.0 Structural Impacts

Over the past decade, several homes on Fish Lake have been sold to Dane County, demolished, moved to higher ground, or became flooded and unlivable. Homes along Fish Lake Road were built in a low-lying area of the lake with hydric soils and within the FEMA 100-year flood plain. In early 2010's, Dane County and the Federal Emergency Management Agency (FEMA) offered to buy flood prone properties along Fish Lake Road. About half of the property owners (8 out of 16) who owned houses or cottages along Fish Lake Road accepted buyouts. Several properties did not experience flooding at this time but sold based on uncertainty whether lake pumping could actually keep lake levels low. Other property owners were resolute in not accepting buyouts until flooding in 2019 inundated homes. After 2019, another four property owners accepted voluntary buyouts from Dane County. Purchase of the properties was funded by Dane County as federal and state funding sources were not available due to unprecedented flooding in 2018 which allocated funds elsewhere. Funded by property owners, two homes were moved to higher ground and another home tore down and planned to be built on higher ground. Today, only three homes remain inundated from flood waters and did not accept a voluntary buyout.

In addition to homes impacted by flooding, roads were also inundated by flood waters. The Town of Roxbury invested in raising the elevation of Fish Lake and Mussen Roads due to flooding, which was effective until 2018 when they flooded again. High water levels also prompted road closures between Crystal Lake and Fish Lake by the town of Roxbury (Dane County) on Mussen Road and Schoepp Road by the Town of West Point (Columbia County). Today, Fish Lake Road and Mussen Road remain closed due to flooding and Schoepp Road is temporarily open in Columbia County. The road closures have increased the time and distance required for local travel and emergency response.

6.0 Recent Efforts

Several past efforts have been conducted to understand and attempt to control fluctuating lake levels. Dating back to the late 1990s and into the early 2000s, conversations started on how to reduce flooding of local roads and near-shore residences. In 2001, the USGS, in collaboration with Dane County and WDNR, completed a 2-year study that described the hydrology of Fish, Mud, and Crystal Lakes, the contributing watersheds, and the relation to the shallow groundwater system. As part of the study, a model was developed to simulate the effect of pumping water from Fish Lake on future lake stages. Simulation results indicated that withdrawing Fish Lake water would lower the stage of the lakes; however, without near-continuous withdrawal the lake stages would not be lower. Subsequently, the Crystal, Fish, Mud Lake District was formed in 2003 to provide a taxing entity to organize and partially fund pumping efforts. The Lake District installed and managed pumping stations for Fish Lake in 2009 and Crystal Lake in 2013. The DNR and Dane County also contributed to the installation and operating costs of the pumps. The pumping efforts have been costly, labor-intensive, and effective only for short periods of time. As of 2021, the Fish Lake pump has been inundated by flood waters and is not functional. The Crystal Lake pump is still operable in accordance with WDNR permit thresholds.

Several mitigation efforts have been implemented for flooded infrastructure. The Town of Roxbury invested in raising the elevation of Fish Lake and Mussen Roads, which was effective until 2018 at which point they were once again flooded. Dane County offered to purchase flood-damaged or at-risk structures along Fish Lake Road (which were a combination of year-round and seasonal homes) starting in the early 2000s through 2020. Over time, the majority of owners along Fish Lake Road sold through a voluntary buyout to Dane County. In total, 12 parcels were purchased out of 19 parcels identified. Out of the seven parcels not purchased, three buildings located along Fish Lake Road today are inundated by 6-8 feet of water.

Since Crystal Lake overtopped in 2019, there have been several attempts to help determine a solution for rising water levels. In 2019, at the request of the Lake District and State Legislators, WDNR provided an overview of seven discharge options (provided in Appendix II) to convey water away from the three lakes. The overview provided a synopsis of the permits required based on which option was pursued. A public meeting was hosted by the Town of Roxbury on October 7, 2019 where these options were presented. Following that meeting, the Town of Roxbury (Dane County) and the Town of West Point (Columbia County) contracted with MSA Professional Services to evaluate the viability of a gravity outfall

from the Lakes to the Wisconsin River. The intent of the analysis was to identify a route and preliminarily size the conveyance components in order to develop a cost estimate which was released in a report in April, 2020 (provided in Appendix III). Costs for the project were estimated to be $5.8 million, not including acquisition costs, legal fees, administrative/maintenance costs, or inflation of construction costs.

After the MSA report, the Dane County Board of Supervisors adopted a resolution on August 13, 2020. The resolution, titled "Supporting the Engineering Plan to Lower Flood-Level Waters in Crystal, Fish and Mud Lakes," states that Dane County acknowledges the WDNR study and MSA engineering report and supports a partnership with the other local governments to access state funds to safely lower the lake levels in this area using environmentally sound methods. Following adoption of the Dane County resolution, media reports erroneously reported that the County would fund the project. On March 25, 2021, a meeting was held where Dane County Land & Water Resources Department (LWRD) staff as well as Town of Roxbury officials, Lake District representatives, and property owners were present. At the meeting, LWRD staff identified questions regarding the feasibility and costs associated with the report findings and offered to convene a work group to further explore these questions. Furthermore, the report identified one potential solution of a gravity pipe; however, a comprehensive approach to assess other alternatives had yet to be conducted which is a requirement of several grants. Therefore, a technical work group was assembled to bring together experts related to various backgrounds and aspects to assess potential solutions for flooding in Fish Lake.

7.0 Workgroup Process

The technical workgroup met a total of 12 times with each meeting consisting of select topics. The discussions provided the necessary background information to consider various benefits and challenges when evaluating options for lowering lake levels. The premise of this report will detail the results of this exercise and offer various alternative solutions. It should be noted that these are options and do not reflect a recommendation from the technical workgroup.

The workgroup consists of experts in several fields related to the lakes and the impacts that residents near the lake are facing due to rising lake levels as well as the potential overflow of Mud Lake onto downstream lands. Members of the workgroup include:

- **Dane County Land & Water Resources Department**
    - Jeremy Balousek, WRE Division Manager
    - Seth Ebel, Agricultural Engineer
    - Laura Hicklin, Director
    - Peter Jopke, Water Resources Planner
    - Steve Ottelien, Conservation Specialist Advanced
    - Amy Piaget, County Conservationist
    - John Reimer, Assistant Director

- **Dane County Planning & Development Department**
    - Hans Hilbert, Assistant Zoning Administrator, Dane County Planning & Development

- **Wisconsin Department of Natural Resources**
    - Eugene Bekta, Water Resources Engineer

- **Wisconsin Geologic & Natural History Survey**
    - David Hart, Hydrogeologist
    - Michael Parsen, Hydrogeologist

- **USDA – Natural Resources Conservation Service, Wisconsin**
    - Michael Isaacson, Hydraulic Engineer

- **MSA Professional Services**
    - Chuck Bongard, Senior Project Engineer

- **Dane County Board of Supervisors**
    - Dave Ripp, District 29 Supervisor

- **Town of Roxbury**
    - Mike Bradley, Town Supervisor
    - Ervin Breunig, Town Chairperson
    - Lisa Meinholz, Town Clerk
    - Jim Wipperfurth, Town Supervisor

Due to the COVID-19 pandemic, the technical workgroup met virtually throughout the process. The first meeting was held to introduce members, provide a general history of the water levels on Fish and Crystal Lake, discuss the purpose for forming the team, and determine what issues the team wanted to learn more about. The individuals with topical expertise presented the group with the best information available. The next several meetings focused on several topics including: groundwater and geology, transportation and land use impacts, and fisheries and biology (see Appendix IV).

When the informational topics were all addressed, the workgroup met to identify potential alternatives that could be taken to address the rising lake levels and potential overflow of Mud Lake onto downstream lands. Also considered where benefits or challenges for each potential flood mitigation alternative. Several potential alternatives were identified and listed in a document that was shared with the workgroup. Members of the workgroup were asked to provide comments on each potential alternative. Comments were originally categorized as either being positive or negative in relation to the alternative. Once everyone on the workgroup had submitted their comments, the next several meetings were dedicated to reviewing each alternative and discussing the submitted comments. Statements were

not included in the final report unless a consensus was reached by the group. Many comments were combined and refined. Some were removed and some were added. Additionally, some comments were neither positive nor negative and were moved to a consideration section. After all discussion and evaluation of the potential alternatives was completed, they were included in the draft report to the technical workgroup.

8.0 Alternative Assessment

The technical workgroup spent multiple sessions discussing benefits, challenges, and considerations for each alternative. In total, eight alternatives were reviewed as listed below in no particular order:

- Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Construct overtop flow channel before lake overtops. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.
- Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Wait until the lake overtops and then construct flow channel. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.
- Construct another road route for emergency access needs. May be considered for all options that don't return to past water levels.
- Install engineered pipeline solution to establish a normal water level for Fish Lake at the ordinary high water mark of elevation 858.7 (10 feet lower from today). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.
- Install engineered pipeline solution to establish a normal water level for Fish Lake at approximately elevation 872 (natural overtop elevation). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.
- Reinstall pump system to attempt to achieve the ordinary high water mark elevation of 858.7.
- Connect surface water to permeable sediments located downstream establishing a maximum water level for Fish Lake at natural overtop elevation 872.
- Do nothing and allow Fish and Crystal lakes to overtop naturally at approximately elevation 872 for Mud and Crystal Lake.

Alternative 1: Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Construct overtop flow channel before lake overtops. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.

Benefits

- Less cropland damage without flow channel due to conveying flow
- Would address downstream flooding concerns and keep most of current farmland in production
- Easier to construct in no flow/drier conditions
- Plan flow path and identify overflow location, away from farm operations (buildings, storage, etc.)
- Maximum water level is known
- Less expensive compared to other alternatives
- Might benefit gamefish size

Challenges

- Timing of implementation
- Difficulty to design channel due to unknown flows
- Create manure application/farming setbacks
- Possible pathway for undesirable fish/invasive species movement
- May never reach the elevation required to overtop
- Flash flooding potential will increase with less storage capacity for the lakes which may compromise downstream roads with surges due to heavy rain
- Requires land between lakes and Wisconsin River to construct channel/ditch
- Fish Lake and Mussen Road remains underwater so additional work may be considered to provide improved recreation access, fire, and EMS service
- Less storage capacity than other alternatives
- Maintenance of system
- Transportation needs for farming operations and travel due to flooded roads

Considerations

- Permitting process
- Cost-benefit to be determined
- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Channel may not be large enough to convey all storms (groundwater, stormwater, lake overflow)
- Potential subsurface flow on agriculture lands
- Modification of natural surface drainage to property downstream
- Unreachable fields on other side of ditch
- Design outlet structure to provide some storage capacity for rainfall events
- Possibility that portions may be piped
- Constructed channel will not have navigability concerns prior to lakes over topping

Alternative 2: Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Wait until the lake overtops and then construct flow channel. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.

Benefits

- Less cropland damage without flow channel due to conveying flow
- Would address downstream flooding concerns and keep most of current farmland in production
- Plan flow path and identify overflow location, away from farm operations (buildings, storage, etc.)
- Maximum water level is known
- Less expensive compared to other alternatives
- Might benefit gamefish size

Challenges

- May be more difficult to construct in possible flow conditions compared to previous alternative of constructing before lake overtops
- Potentially may not be able to plan flow path
- Timing of implementation
- Engineering challenges do to unknowns
- Farm fields will be flooded and taken out of production, current farmlands would not produce and may/will cause cash flow issues for landowners
- Create manure application/farming setbacks
- Requires land between lakes and Wisconsin River to construct channel/ditch
- Possible pathway for undesirable fish/invasive species movement
- Flash flooding potential will increase with less storage capacity for the lakes which may compromise downstream roads with surges due to heavy rain
- Possible transport of nutrients (phosphorus) downstream
- Fish Lake and Mussen Road remains underwater so additional work may be considered to provide improved recreation access, fire, and EMS service
- Less storage capacity than other alternatives
- Maintenance of system
- Transportation needs for farming operations and travel due to flooded roads.

Considerations

- Permitting process
- Cost-benefit to be determined
- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Potential subsurface flow on agriculture lands
- Unreachable fields on other side of ditch
- Possibility that portions may be piped
- Natural channel may become navigable, additional permits may be necessary

Alternative 3: Construct another road route for emergency access needs. May be considered for all options that don't return to past water levels.
Benefits • Access is attainable • Addition of an alternate road route would improve access to property and potentially improve response time for emergency services • Improve transportation needs for farming operations and travel due to flooded roads
Challenges • Expensive • Challenges with topography • Requires land for road routes
Considerations • Would require cooperation of two towns in two counties • Existing Fish Lake Road would not be used • Benefits to be documented

Alternative 4: Install engineered pipeline solution to establish a normal water level for Fish Lake at the ordinary high water mark of elevation 858.7 (10 feet lower from today). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.

Benefits

- Would preserve and recover agricultural lands for production
- When operating under normal conditions, it would allow Fish Lake and Mussen road to reopen allowing homeowners and farmers access to property and will regain previous emergency response access.
- Not relying on topography for pipe route
- Would return the recreational opportunities to the water level previously enjoyed by many
- Although fluctuating, only alternative identified that allows lake levels to return to a level 10 feet lower from today
- Would provide a mechanism to regulate and store lake levels
- Long-term and low-energy tool for regulating water levels compared to pumping
- Lower expected maintenance compared to other alternatives

Challenges

- Water level will fluctuate – limited capacity and not guaranteed to convey all rainfall events
- Expensive initial cost
- Maintenance of control structure and pipe
- Potential for water quality impacts to the Wisconsin River
- Duration of implementation will be longer
- Poses risk for design of pipe size/slope due to unknown flows
- Possible pathway for undesirable fish/invasive species movement
- Compared to other alternatives more extensive potential loss of agricultural production and manure management during construction if done during growing season

Considerations

- Plan acknowledged by Town of Roxbury, Town of West Point, Dane County, and Columbia County
- Some landowners affected by the pipeline are aware of the project and generally supportive of the concept
- Permitting process
- Cost-benefit to be determined
- Potential for competing interests such as transfer of water downstream
- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Constructability needs to be determined (groundwater, bedrock, etc.)
- Transferring water downstream

Alternative 5: Install engineered pipeline solution to establish a normal water level for Fish Lake at approximately elevation 872 (natural overtop elevation). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.

Benefits

- Would reduce impacts to agricultural lands for production compared to overflow ditch
- Not relying on topography for pipe route
- Less expensive than deeper pipe
- Maximum water level is known
- Lower expected maintenance compared to other alternatives

Challenges

- Limited capacity and not guaranteed to convey all rainfall events
- Expensive initial cost
- Potential for water quality impacts to the Wisconsin River
- Maintenance of control structure and pipe
- Duration of implementation will be longer
- Poses risk for design of pipe size/slope due to unknown flows
- Possible pathway for undesirable fish/invasive species movement
- Fish Lake and Mussen Road remains underwater so additional work may be considered to provide improved recreation access, fire, and EMS service

Considerations

- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Permitting process
- Cost-benefit to be determined
- Potential for competing interests
- Constructability needs to be determined (groundwater, bedrock, etc.)
- Possibility that portions may be open ditch

Alternative 6: Reinstall pump system to attempt to achieve the ordinary high water mark elevation of 858.7.

Benefits

- Less Cropland Damage
- Not relying on topography for pipe route
- Could manage lake levels in very dry periods

Challenges

- Water levels still may overtop
- Noise
- Expensive to install, operate, and maintain
- Long term maintenance
- Water level is unknown
- Constructability (groundwater, etc.)
- Limited capacity and not guaranteed to convey all rainfall events
- May not be able to pump year round
- Management of system
- Timing of implementation
- Has been tried and did not work
- Operating costs (WPDES discharge permit fees and electricity)

Considerations

- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Water quality issues to Wisconsin River
- How big of pump system? Building new or existing system?
- Cost-Benefit to be determined
- Potential for competing interests such as transfer of water downstream
- Permitting process

Alternative 7: Connect surface water to permeable sediments located downstream establishing a maximum water level for Fish Lake at natural overtop elevation 872.

Benefits

- Increase infiltration resulting in smaller runoff volumes to the Wisconsin River
- Similar to other overflow scenarios that may require land for infiltration
- Provide flood storage and may reduce flows downstream with smaller channel capacities needed
- Increase surface area and provide shallow water depths to promote transpiration and evaporation
- Provides habitat for wildlife in the infiltration area
- Provides some water treatment prior to the Wisconsin River
- Maximum water level is known
- Might benefit gamefish size

Challenges

- Requires land for constructing the infiltration area
- Requires more maintenance than other alternatives
- Limited capacity and not guaranteed to convey all rainfall events
- Difficulty to design infiltration area and channel due to unknown flows
- Possible pathway for undesirable fish/invasive species movement
- Fish Lake and Mussen Road remains underwater so additional work may be considered to provide improved recreation access, fire, and EMS service

Considerations

- Permitting process
- Cost-benefit to be determined
- Timing of implementation
- Agreements with landowners (liability, easements, costs, maintenance, etc.)
- Infiltration capacity of glacial sediments needs to be confirmed

Alternative 8: Choose to take no action and allow Fish and Crystal lakes to overtop naturally at approximately elevation 872 for Mud and Crystal Lake.

Benefits

- Lowest cost of implementation
- Maximum water level is known
- Less competing interests due to not constructing conveyance

Challenges

- Fish Lake and Mussen Road remains underwater so additional work may be considered to provide improved recreation access, fire, and EMS service
- Flash flooding potential will increase with less storage capacity for the lakes which may compromise additional roads with surges due to heavy rain
- Possible pathway for undesirable fish/invasive species movement
- Erosion and flooding of farmland
- Maintenance of overflow path
- Transportation needs for farming operations and travel due to flooded roads and fields

Considerations

- No permitting
- May not reach the elevation required to overtop
- Potential subsurface flow on agriculture lands
- If water overtops it will affect people downstream
- May require future actions

9.0 Funding Opportunities

9.1 DNR Municipal Flood Control Grant Program

WDNR offers the Municipal Flood Control Grant Program. It is an assistance package to all cities, villages, towns, and metropolitan sewerage districts concerned with municipal flood control management. Assistance is provided in two ways:

1. Local assistance grants that support municipal flood control administrative activities; and
2. Acquisition and development grants to acquire and remove floodplain structures, elevate floodplain structures, restore riparian areas, acquire land and easements for flood storage, construct flood control structures and fund flood mapping projects.

The Town of Roxbury, with financial backing and administrative support from Dane County, successfully applied to this program in 2010 and was awarded $650,000 for reimbursement of 50% of the acquisition costs of properties that were acquired along Fish Lake Road. Dane County provided the 50% match for the acquisition costs and took on 100% of the demolition costs of the properties.

The Town of Roxbury, with financial backing and administrative support from Dane County, unsuccessfully applied for this program again 2020. The application was for $315,000 for reimbursement of 50% of the acquisition costs of additional properties that had been acquired along Fish Lake Road. Dane County funded 100% of the acquisition costs of the additional properties as well as 100% of the demolition costs.

The program is available every other year with a March 15th deadline. For 2022, $2.4 million in funding is available statewide. In 2020, $2.65 million was available statewide and applications totaled $10.5 million.

9.2 FEMA Flood Mitigation Assistance Grants

Floodplain mitigation grants are available to communities that have flood mitigation plans in place and are approved by the FEMA as well as Wisconsin Emergency Management (WEM). There are two types of grants available to communities:

1. Planning grants – grants to communities to develop or update flood mitigation plans.
2. Project grants – grants to communities to implement measures to reduce flood losses. This could take the form of such things as elevating, relocating, or dry flood-proofing of insured structures.

9.3 FEMA Hazard Mitigation Grants

The Hazard Mitigation Grant Program (HMGP) assists state and local governments in implementing long-term hazard mitigation measures following a major disaster declaration. Objectives of the HMGP are:

- To prevent future losses of lives and property due to disasters;
- To implement state or local mitigation plans;
- To enable mitigation measures to be implemented during immediate recovery from a disaster; and
- Provide funding for mitigation measures that benefit the disaster area.

Grants provide up to 87.5% of the eligible costs (75% funded by FEMA and 12.5% by WEM). The remaining 12.5% is a required local match. Federal funding under the HMGP is based on 15% of the federal funds spent on the Public and Individual Assistance programs for each disaster.

Eligible applicants are:

- State and local governments,
- Certain private, non-profit organizations or institutions,
- Indian tribes or authorized tribal organization.

Examples of eligible projects are:

- Retrofitting, such as flood-proofing,
- Acquisition and relocation of structures from hazard prone areas,
- Development of standards to protect structures,
- Structural hazard control such as debris basins or floodwalls.

Eligible projects are required to demonstrate:

- The project is cost/beneficial,
- The project is environmentally sound,
- Other alternatives have been considered,
- The project is the best alternative and will actually solve a problem and is a permanent solution.

Eligible applicants apply for the HMGP through WEM.

9.4 State Appropriation

A state appropriation may be another possible funding opportunity for flood mitigation projects of Mud, Fish, and Crystal Lakes. In recent decades, increasing rainfall and development have led to increased flood risk producing more demand for limited federal funding. FEMA mitigation projects are highly competitive and it is anticipated that flood mitigation projects for the three lakes would not rank high in a competitive process. FEMA requires the local government to share the cost of flood mitigation projects; which for smaller communities, funding may be challenging. This opportunity would require a state legislature to request funding and earmark funds specific to flood mitigation of Mud, Fish, and Crystal Lakes.

9.5 Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) is a method that determines the future risk reduction benefits of a flood mitigation project and compares those benefits to its costs. The result is a Benefit-Cost Ratio (BCR). A project is considered cost-effective when the BCR is 1.0 or greater. The list of federal and state grants provided above require a BCA to evaluate the project being cost-effective compared to other applications. Applicants must use FEMA-approved methodologies and tools to demonstrate the cost-effectiveness of their projects.

The BCA includes costs related to planning, design, and construction of mitigation projects. For the benefits of a project, the only items considered are those that mitigate damage to infrastructure such as buildings and transportation corridors. The BCA does not allow quantification of benefits to items such as reducing area of land that is inundated like agriculture land. For Fish Lake, no other buildings are anticipated to be flooded and as such a mitigation project would not prevent further damages to those buildings that are already damaged today. The only item allowed to quantify for benefits is that to transportation corridors.

A preliminary BCA was conducted for Fish Lake to quantify the BCR. The BCA tool requires the cost of the mitigation project and for illustration purposes a cost of $6,000,000 was used, which was reported by MSA for the expense of a gravity pipeline. For the benefits, the impacts to the transportation corridor was input into the tool. It requires input of items such as one-way traffic detour trips per day which was estimated from Wisconsin Department of Transportation (WDOT) counts of nearby roads (see Figure 5). Two nearby stations were considered. First, at Mack Road between Inama Road and Fish Lake Road experienced an annual daily traffic of 310 vehicles. Second, at County Highway J between State Highway 188 and Harmon Road experienced an annual daily traffic of 300 vehicles. In this analysis, a value of 300 daily vehicles were used. Also the tool required inputs of additional detour trip minutes (10 min.) and the number of additional transportation miles (7 mi.).

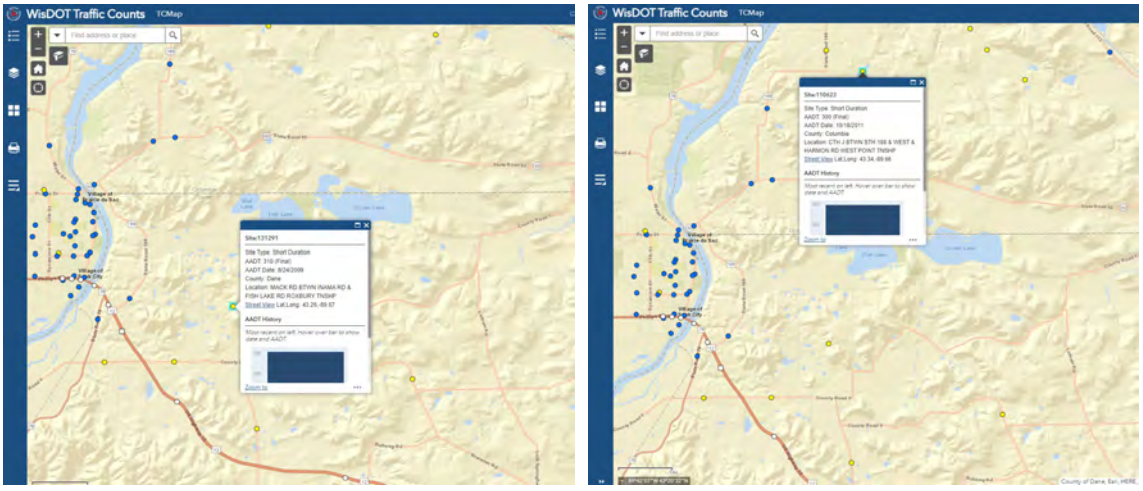


Figure 5: WDOT Traffic Count Map of the two closest locations near fish lake road

Fish Lake Road experiences a flood condition near the 50-year recurrence interval. Another important factor is how long the road has been closed for. Generally, the amount of time the road is closed is

dependent on the time of application. FEMA needs to see documentation the road has been closed for the length of time in the FEMA BCA toolkit. For example, if the road was closed on Febuary 1, 2020 and was still closed today, a theoretical application submitted on February 1, 2022 would document the road closure as two years. For this analysis, three simulations where investigated: the BCR after one year of road closures, BCR after 10 years, and how many years until the BCR is equal to one which is the minimum requirement for grant funding. Below, in Figure 6, is an example of the inputs to the toolkit for a one year transportation closure.

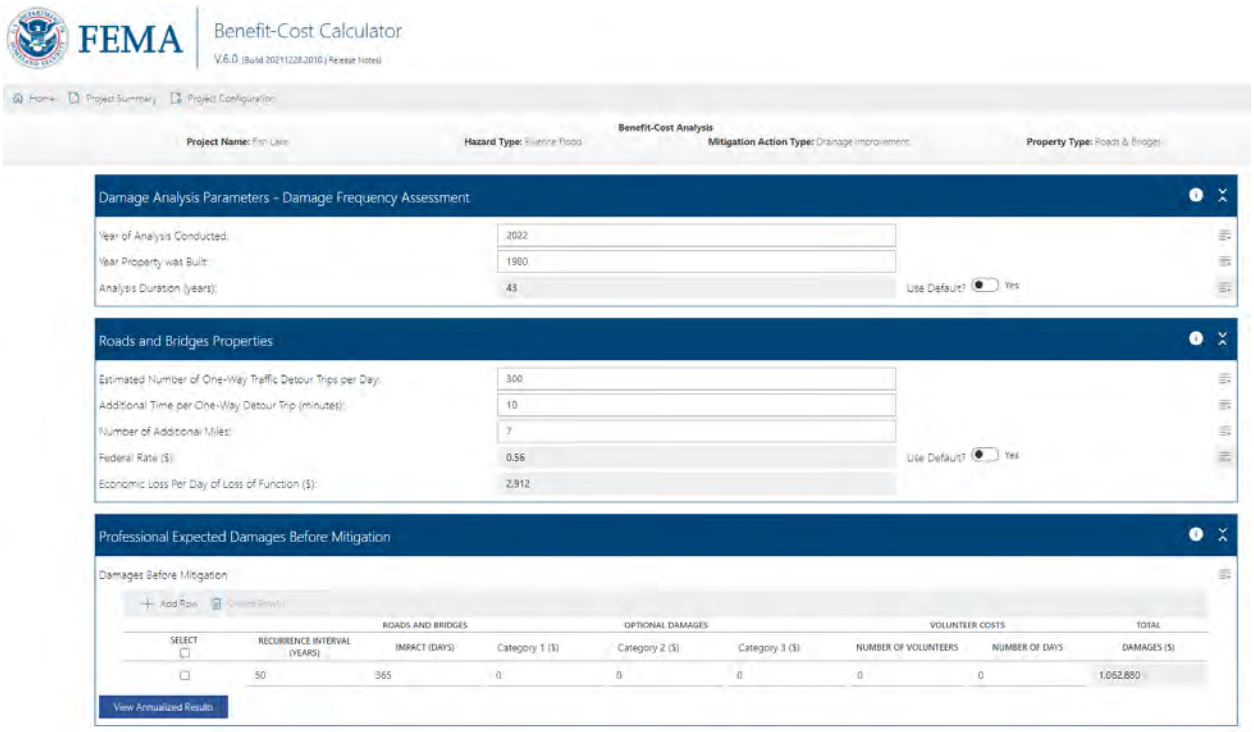


Figure 6: BCA inputs for a 1 year transportation closure

The results of the BCA are as follows:

- With a **1 year** transportation closure of Fish Lake and a $6M project cost, the **BCR is 0.04**.
- With a **10 year** transportation closure of Fish Lake and a $6M project cost, the **BCR is 0.36**.
- A **BCR is 1.0** when a transportation closure is experienced for **27.7 years**.

In summary, it is unlikely a project would be funded by FEMA due to a BCR today that is less than 1.0. Fish Lake Road would need to be flooded for 27.7 years before the project would meet a 1.0 BCR. This analysis assumes the project cost remains at $6 million, which is unlikely in the future due to rising construction costs.

10.0 Summary

A technical workgroup consisting of representatives from LWRD, Dane County Planning & Development, WDNR, WGNHS, USDA-NRCS, MSA Professional Services, Dane County Board of Supervisors, and Town of Roxbury met in total 12 times to discuss flooding alternatives for Mud, Fish, and Crystal Lake. In total, eight alternatives were reviewed with their challenges, benefits, and considerations. A list of the alternatives in no particular order are as follows:

- Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Construct overtop flow channel before lake overtops. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.
- Allow water levels to continue to rise and fall as a natural system dependent on weather patterns. Wait until the lake overtops and then construct flow channel. Overtop elevation is approximately elevation 872 for Mud and Crystal Lake.
- Construct another road route for emergency access needs. May be considered for all options that don't return to past water levels.
- Install engineered pipeline solution to establish a normal water level for Fish Lake at the ordinary high water mark of elevation 858.7 (10 feet lower from today). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.
- Install engineered pipeline solution to establish a normal water level for Fish Lake at approximately elevation 872 (natural overtop elevation). Pipeline will be constructed from Crystal to Mud/Fish Lake to Wisconsin River.
- Reinstall pump system to attempt to achieve the ordinary high water mark elevation of 858.7.
- Connect surface water to permeable sediments located downstream establishing a maximum water level for Fish Lake at natural overtop elevation 872.
- Do nothing and allow Fish and Crystal lakes to overtop naturally at approximately elevation 872 for Mud and Crystal Lake.

This report is intended to provide information to the public, managers, and policy makers on water level impacts to Mud, Fish, and Crystal Lakes and possible mitigation alternatives. Many of the alternatives are costly and would require millions of dollars of funding. To offset costs, state and federal grants may be desired. A preliminary benefit cost analysis was carried out for a pipeline option costing $6 million which showed, if the project were submitted today, it would not be selected due to its low benefit to cost ratio. In conclusion, the technical workgroup did not make recommendations on an alternative to pursue.

References

Krohelski, J.T., Y. Lin, W.J. Rose and R.J. Hunt. 2002. Simulation of Fish, Mud, and Crystal Lakes and the shallow ground-water system, Dane County, Wisconsin. U.S. G. S. Water Resources Investigations Report 02-4014.

Capital Area Regional Planning Commission. 2017. Appendix G: Groundwater Element of the Dane County Water Quality Plan.

Wisconsin initiative on Climate Change Impacts. 2021. Wisconsin's Changing Climate Impacts and Solutions for a Water Climate. Assessment Report.

Krohelski, J.T., Y. Lin, W.J. Rose and R.J. Hunt. 2002. Simulation of Fish, Mud, and Crystal Lakes and the shallow ground-water system, Dane County, Wisconsin. U.S. G. S. Water Resources Investigations Report 02-4014.Chen, C., Liu, H., and Beardsley, R.C. 2003. An unstructured grid, finite-volume, three-dimensional, primitive equations ocean model: Application to coastal ocean and estuaries. Journal of Atmospheric and Oceanic Technology. 20 (1), 159-186.

MSA Professional Services, Inc. 2020. Feasibility Analysis for a Gravity Outfall, Fish Lake, Crystal Lake, Mud Lake.

WICCI, Wisconsin Initiative on Climate Change Impacts, 2020. Report to the Governor's task force on climate change: Strategies to improve Wisconsin's climate resilience and readiness. University of Wisconsin-Madison and Wisconsin Department of Natural Resources.

Appendix I – Groundwater Delineation

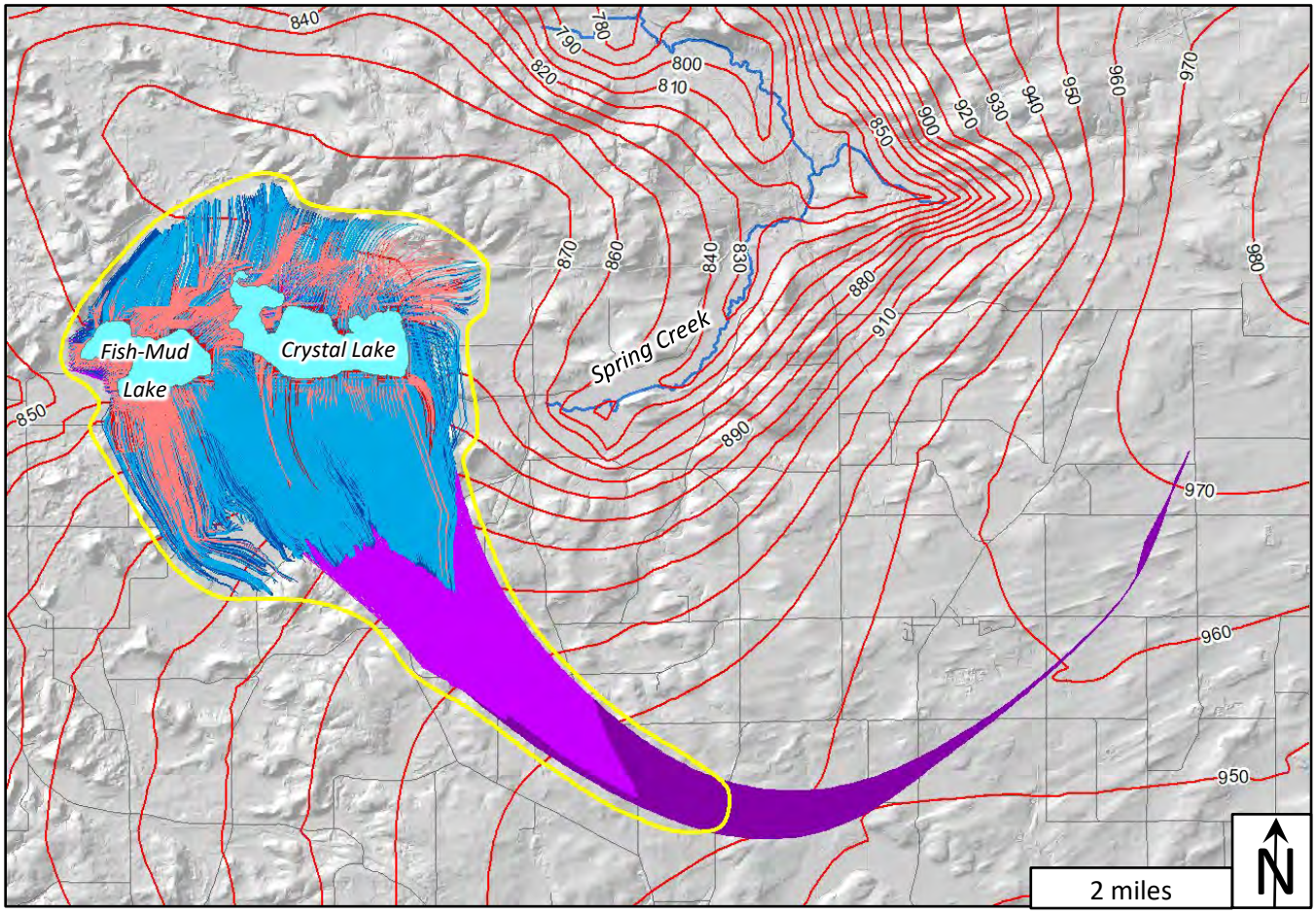
To delineate the groundwater contributing area for Fish, Crystal, and Mud Lakes in northwestern Dane County, Mike Parsen (Hydrogeologist, WGNHS) performed a particle-tracking analysis using the Dane County MODFLOW groundwater model (Parsen et al, 2016) and MODPATH. MODFLOW and MODPATH were run using Groundwater Vistas 8. Particles were distributed over the general area of the lakes, at multiple depths and run in reverse particle-tracking mode. Particles were allowed to propagate backwards over an extended time period (>100,000 years) until they either exited the groundwater system or reached groundwater divides.

Beneath the area for Fish, Crystal, and Mud lakes, batches of particles were released from multiple model layers, spanning the entire vertical profile of the groundwater system, extending from the water table to the base of the Mount Simon sandstone aquifer. Four particles were released from each 360-ft by 360-ft model cell, resulting in 2,296 particles in each vertical release layer and nearly 25,000 particles in total.

Although particles placed below the upper sand and gravel aquifer (model layer 1) may not discharge to the lakes but rather flow under the lakes in route to the Wisconsin River, they were included in this simulation to delineate the greatest potential spatial extent of the groundwater contributing area. This portion of the Dane County groundwater model was admittedly challenging to calibrate and a number of assumptions were made, such as the insertion of a high-hydraulic conductivity (high-K) channel to enhance groundwater flow from the Fish/Crystal Lake area, west to the Wisconsin River. While this high-K channel is generally consistent with our understanding of the geology, it serves as a good example of how modeled results may oversimplify the groundwater system. Furthermore, there was limited data to characterize vertical flow conditions and groundwater-surface water dynamics of the lakes. For these reasons, the simulation of deeper particles serves as a way to define the greatest spatial extent of the groundwater contributing area.

Figures 1 and 2 present the reverse-particle tracking results for several MODPATH runs and demonstrate the range of particle-tracking results by aquifer (i.e., model layer). Figures 1 and 2 show particle tracking results in relation to water table elevation contours and the potentiometric surface of the Mount Simon sandstone aquifer, respectively. Particles released from specific model layers are shown in different colors and the maximum potential groundwater contributing area is outlined in yellow. The long tail shown in dark purple corresponds to particles released from the bottom of the Mount Simon aquifer system, which tracked back to the regional groundwater divide. The entire tail was not included in the contributing area delineation because of the great depth at which these particles were released.

Figure 1



Particles released from the shallow sand and gravel aquifer *(model layer 1)*

Particles released from the deeper sand and gravel aquifer *(model layer 2)*

Particles released from upper bedrock aquifers *(model layers 3-8)*

Particles released from the Wonewoc sandstone aquifer *(model layer 9)*

Particles released from the upper and mid Mount Simon sandstone aquifer *(model layer 12)*

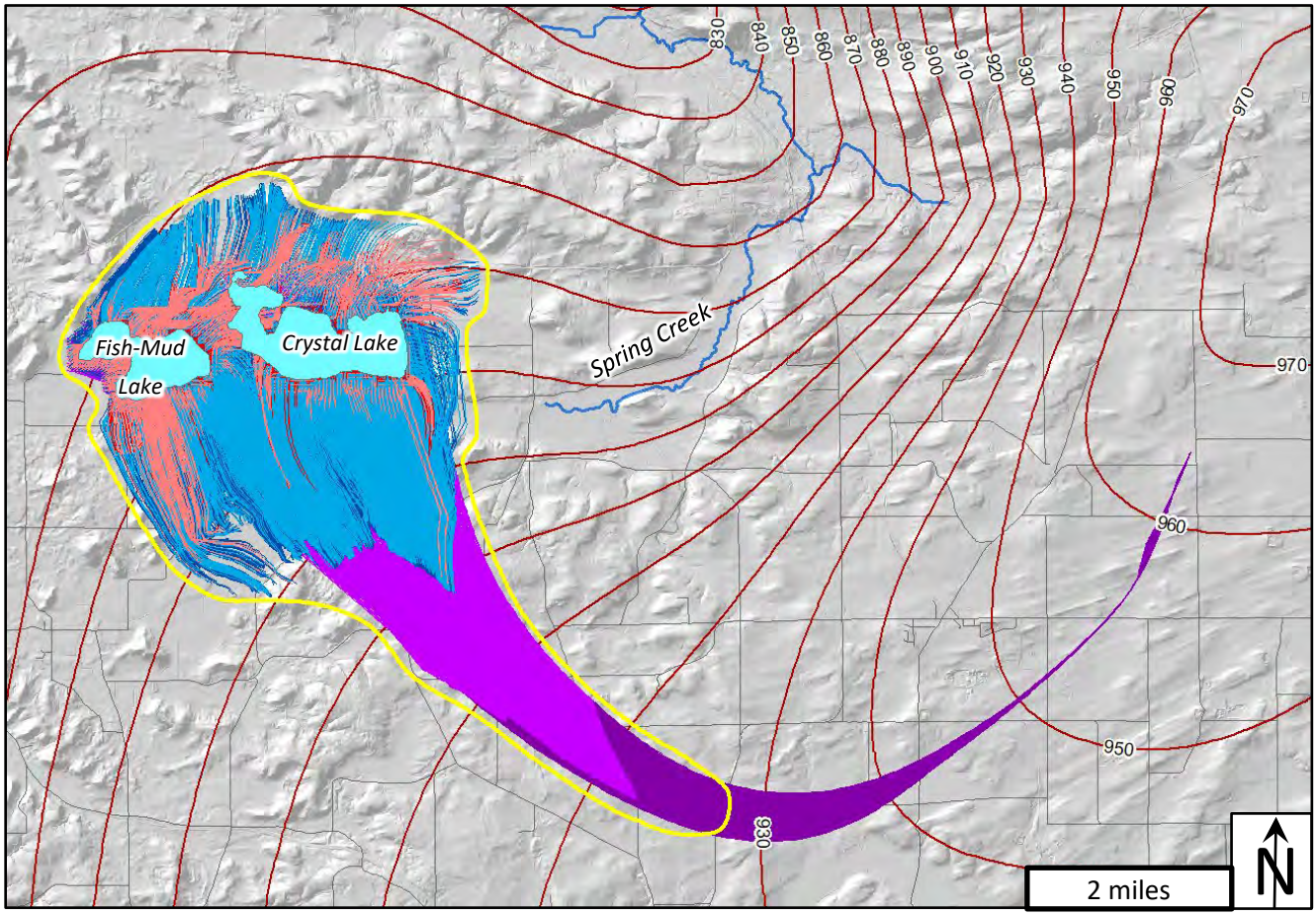
Particles released from the bottom Mount Simon sandstone aquifer *(model layer 12)*

Perennial streams

Water table elevation contours (feet above mean sea level)

WGNHS groundwater contributing area delineation to Fish, Crystal, and Mud lakes

Figure 2



Particles released from the shallow sand and gravel aquifer *(model layer 1)*

Particles released from the deeper sand and gravel aquifer *(model layer 2)*

Particles released from upper bedrock aquifers *(model layers 3-8)*

Particles released from the Wonewoc sandstone aquifer *(model layer 9)*

Particles released from the upper and mid Mount Simon sandstone aquifer *(model layer 12)*

Particles released from the bottom Mount Simon sandstone aquifer *(model layer 12)*

Perennial streams

Potentiometric contours for the Mount Simon sandstone aquifer

WGNHS groundwater contributing area delineation to Fish, Crystal, and Mud lakes

Appendix II – WDNR Permit Options

Crystal Lake/Fish Lake/Mud Lake Regulatory Requirements for Options Under Consideration

Water Body	Proposed Discharge Location	Receiving Water Designation	Required Permit for Pumping	Estimated Time for Permit	Concerns	Considerations
Crystal Lake	Roxbury Creek (Current Permitted Discharge)	Discharges to Exceptional Resource Water (ERW) and Limits must be protective	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	Permit in place. 2 to 3 months for a permit modification if needed	Current BOD limits are controling and difficult to attain during the warmer months. TSS must meet background concentrations in the LWR which may be challenging. Current maximum daily flow rate is 1.5 MGD. A permit modification will be required to change effluent limits along with an anit-degradation demonstration	Develop Flow-Based limits which requires stream flow monitoring. Additional TSS data may be collected to modify limits
Crystal Lake	Lower Wisconsin River	ERW	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits would be similar to the Roxbury Creek Discharge. BOD limits may be higher. Significant opposition to a direct discharge to the LWR in the past. Permit likely to be challenged delaying implementaton.	Likely not a viable solution both short and long term.
Crystal Lake	Lake Wisconsin	Impaired Water. Approved TMDL in place	Likely eligible for a general permit	2 weeks	The TMDL has set aside phosphorus allocation for general permits. The dicharge would need to be monitored under the general permit to determine the mass of phosphorus discharged and pumping would need to stop once the mass allocation is attained. A Wetlands and Waterway permit may be needed for an intake and discharge structure.	
Crystal Lake	Lodi/Spring Creek	ERW/Class II Trout Stream	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits for a discharge to an ERW must be set at background concentrations which will likely be difficult to attain. Likely high public opposition to a dishcarge due to public use of the State Wildlife Area and concerns with impacts to flooding in the Village of Lodi. A floodplain anaysis my be needed to determine potential impacts from the additional water. Any discharge would impact the Master Plan for the State Wildlife Area and require approval by the Natural Resources Board.	
Crystal Lake	Lodi Marsh	Discharges to ERW and Limits must be protective. Must not negatively impact wetlands	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits for a discharge to an ERW must be set at background concentrations which will be highly difficult to attain. High public opposition to a dishcarge due to public use of the State Wildlife Area and concerns with impacts to flooding in the Village of Lodi. A floodplain anaysis my be needed to determine potential impacts from the additional water. Any discharge would impact the Master Plan for the State Wildlife Area and require approval by the Natural Resources Board. The Lodi Marsh contains unique and fragile wetlands that may require more stringent limits.	
Fish Lake	Lower Wisconsin River (Current Permitted Discharge)	ERW	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	Permit in place. 2 to 3 months for a modification if needed	The maximum allowable flow rate in the current permit is 1.5 MGD. An increased discharge may required new limits and a permit modification.	

Appendix III – MSA Report on Feasibility for a Gravity Outfall

Feasibility Analysis for a Gravity Outfall
Fish Lake – Crystal Lake – Mud Lake

Town of Roxbury
Dane County, Wisconsin

Town of West Point
Columbia County, Wisconsin
April 2020

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Project No. 1017021

MSA

Feasibility Analysis of Gravity Outfall
Fish Lake - Crystal Lake – Mud Lake
Town of Roxbury

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CHAPTER 1 – BACKGROUND INFORMATION

1.1 BACKGROUND INFORMATION

Fish Lake, Crystal Lake and Mud Lake are located near the border of Dane County and Columbia County in the Township of Roxbury (Dane County) and in the Township of West Point (Columbia County). Fish Lake and Mud Lake (sometimes referred to as Mud Bay) are connected by culverts under Fish Lake Road but for the purposes of this report, they are referred to separately as they are distinctively different bodies of water. Water levels in these 3 lakes have been rising over the past four plus decades prompting property owners around the lakes to form a Lake District. The District has attempted to control the water levels in the Lakes by pumping but these efforts have been costly and largely ineffective, influenced by prolonged periods of above average precipitation.

Historically, the lakes have never had an overland gravity overflow. They are essentially “kettle” lakes that rely on seepage to the aquifer along with evaporation to control the water levels. That history changed in 2019 as Crystal Lake overflowed its banks to flow into Fish Lake. If current trends continue, Fish Lake and Mud Lake will continue to rise to the current level of Crystal Lake and then the three combined lakes will overflow a height of land south of Mud Lake and the runoff will then continue overland to the west eventually discharging to Wisconsin River through a quarry currently operated by Lycon, Incorporated.

Past lake level increases have resulted in the displacement of residents and in the loss of property. Recreational enjoyment of these resources has also be severely impacted as lake access is restricted. Recent, rapid water level increases have resulted in the inundation of Town Roads, dramatically impacting the ability of emergency responders to serve the Town residents and also resulting in large expenses to the taxpayers to maintain reasonable access to property.

In 2019, at the request of the Lake District and State Legislators, the Wisconsin Department of Natural Resources did an overview of 7 discharge options to convey water away from the three lakes (Table included as Appendix A). This overview was not an extensive engineering review of any of the options, but rather a synopsis of the permits required and the permit process if any of these options were to be pursued. A public meeting was hosted by the Town of Roxbury on October 7, 2019 where these options were presented and public opinion was expressed.

The general sentiment expressed at the public meeting by the legislators and the regulators was of a willingness to work together toward a long-term sustainable solution to the water level issue. It was also stated that the process needed to originate with the local units of government to determine what the proposed solution would be. As the solution is likely well beyond the financial wherewithal of the Towns, assistance would be sought from the State and/or Counties and through grants if available.

1.1.1 PURPOSE OF THIS REPORT

The Townships have met jointly and are working toward an intergovernmental agreement to cover costs that will be incurred during the front end of this process. They have engaged MSA Professional Services, to evaluate the viability of a gravity outfall from the Lakes to the Wisconsin

River. The intent of this analysis is to identify a route and preliminarily size the conveyance components in order to develop a cost estimate of the improvements. This effort will also provide a document that will aid in further discussions with regulating agencies, property owners and other key stakeholders. It will also enable the Townships to solicit financial support for the project.

CHAPTER 2 – THE OUTFALL

2.1 DESIRED OUTCOME

The goal of the water conveyance system described herein would be initially to draw the levels of the lakes down to what would be considered the historical ordinary high water mark for each lake and then ultimately to provide a level of control where water levels can be managed and maintained. It would also be the intent to implement this system with the minimum practical impact to the Wisconsin River which is classified as an Exceptional Resource Water (ERW).

Based on current regulatory requirements, the target elevation for Fish Lake and Mud Lake would be 858.7. (Currently at 865.5). The target elevation for Crystal Lake would be 868.2. (Currently at 873.4) It should be noted that these stated elevations are based on historical high water marks that have been realized only in the past 20 years. Ultimately, levels that are one to two feet lower than these most recent elevations would be beneficial in the ongoing management of the lake levels by allowing some level of storage and slow release.

By achieving this stated goal, the road system around the lakes that is currently inundated, could be reactivated allowing for better emergency response, safety and convenience to the travelling public and access to the lakes for recreational purposes.

2.1.1 THE CONVEYANCE SYSTEM

As stated previously, the current methodology for controlling the lake levels was by pumping of the lake water from two locations. The Fish Lake pumping station discharged to the Wisconsin River across from the Village of Prairie du Sac. That pump station is completely submerged and has been taken out of service. The Crystal Lake pumping station discharged to the Roxbury Creek in the Crane Lake Marsh near County Highway J in the Town of Roxbury. The use of that pump system has been somewhat sporadic due to water quality levels in Crystal Lake during different times of the year. When both pump systems were in service, the maximum discharge from the lakes was approximately 4 cubic feet per second (cfs). During dry periods of weather some progress could be noted on lake level control but any gains were quickly eliminated during heavy rains and/or prolonged periods of precipitation. This pumping came at a high cost for electricity to power the pumps.

The recommended conveyance system which is the subject of this analysis is a gravity pipe outfall from the combined lake system to the Wisconsin River. A gravity pipe will have a higher initial cost to install due to the deeper excavation required to achieve the necessary pipe gradient, however there will not be the operating costs associated with electrical power as there is no pumping required.

Previous studies have shown that there is a groundwater relationship between Fish Lake and Crystal Lake. Historically, Crystal Lake has been approximately 9-10 feet higher in elevation than Fish Lake. Studies have shown that lowering Fish Lake in elevation by one foot would result in a lowering of Crystal Lake by approximately one tenth of a foot. For this reason it is felt that any solution that does not include a drawdown structure on Crystal Lake would not provide the level

of relief that is desired for the entire area. The concept shown for this analysis includes a pipe from Crystal Lake to Mud Lake along the north side of Schoepp Road.

A number of different pipe sizes were analyzed for the gravity outfall. Two scenarios were considered in this analysis. The first is the lake drawdown scenario. The larger the outfall pipe, the less time that will be required to draw down the lakes from the current high levels to the proposed management levels.
The second discharge scenario would be the normal operating range of the lake management system. Flows during this scenario will be considerably less than the drawdown rates as level control outlet structures would be utilized to discharge at a lower rate over a longer period of time. The lakes can then be managed at levels that allow for some storage of larger rainfall events without significant increases in the discharge flows.

Since the lake drawdown period can be considered a temporary condition and since the normal operating flow of the system will be lower, it is important to consider the economics of the system in choosing the size of the pipe.

Flow capacity of a gravity pipe is a combination of the size of the pipe and the slope that the pipe is installed at. The steeper the pipe slope, the more capacity that it will have. In this system it is desirable to utilize a relatively flat pipe slope in order to avoid deep excavation for the installation. For the purposes of this report, a pipe slope of 0.10% was utilized which results in approximately 12 feet of fall from Fish Lake to State Highway 188. Table 1 below shows the flow capacities of various pipe sizes at a slope of 0.10% and the associated duration that it would take to draw down the lake for each pipe size.

Culvert Pipe Size	Capacity Flowing Full	Volume Per Day	Drawdown Duration
24-inch diameter	8 cubic feet per second	16 Acre Feet/Day	510 Days
30-inch diameter	14 cubic feet per second	28 Acre Feet/Day	290 Days
36-inch diameter	24 cubic feet per second	48 Acre Feet/Day	170 Days
42-inch diameter	34 cubic feet per second	68 Acre Feet/Day	120 Days
48-inch diameter	50 cubic feet per second	100 Acre Feet/Day	82 Days
60-inch diameter	90 cubic feet per second	180 Acre Feet/Day	45 Days

TABLE 1 – PIPE CAPACITIES

For the purposes of this report and the associated cost estimates, a pipe size of 42-inch diameter was chosen from Fish Lake to the Wisconsin River. A 30-inch diameter pipe was chosen for the Crystal Lake to Mud Lake segment. Further analysis may be warranted during final design of the system.

2.1.2 THE ROUTE

The old adage that “the shortest distance between two points is a straight line” would seem to indicate that the most direct route from the lakes to the river would be a straight line. Due to the nature of a gravity pipe system being installed at a specific grade, the topography of the land along the route dictates a more meandering course. Exhibits 1 & 2 in Appendix A show the approximate route that is the basis of this analysis. For the most part the route follows the path

that the water will flow overland in the event that the lakes exceed the current maximum capacity. This results in the shallowest possible excavation and hence the least cost for installation for the pipe between Fish Lake and State Highway 188. Preliminary discussions with the landowner west of STH 188 indicated no willingness to allow the flow from the lakes to pass through their property so from that point the route shifts to the north and through an area of deeper excavation. Ultimately the pipe is shown to discharge into the Clifton Road right-of-way adjacent to lands owned by the Wisconsin Department of Natural Resources. Depth of excavation was taken into account in the cost estimating for the project. Preliminary plan and profile drawings are included in Appendix B which show the depth of the installation along the selected route.

It should be noted that easements will be required along the route as it passes through private property. Since all of the pipe will be buried and the surface of the land restored to pre-existing condition, there should be minimal negative impact to the affected properties.

CHAPTER 3 – WATER QUALITY

3.1.1 BACKGROUND

A detailed analysis of water quality is beyond the scope of this analysis however some measures have been considered in the design to account for this issue.

As previously discussed, there have been two distinct pumping systems designed to control the lake levels. The Fish Lake pump station discharged to the Wisconsin River near to the area being considered for this proposed gravity outfall. The Crystal Lake pump station discharged along Mussen Road to County Trunk Highway Y near the Crane Lake marsh. Lake water quality issues and the impact to receiving waters has been a point of contention in the past and intake structures have been revamped and pumping curtailed at times when the water quality in the lakes did not meet the required standards. Historically the water quality in Fish Lake has been better than its counterpart Crystal Lake.

Currently the 3 lakes are essentially acting as one. Water from Crystal Lake has been flowing overland into Fish Lake for months and Fish Lake and Mud Lake are essentially one water body at this time. Some consideration will need to be given to this situation during the drawdown period as effective treatment will not be feasible at the flow rates that will be required to bring the lake levels down.

3.1.2 DESIGN CONSIDERATIONS

As mentioned earlier, the system presented in this report includes a drawdown structure from each of the lakes. The Crystal Lake outlet would be discharged first to the wetland area north of Schoepp Road where some treatment will occur. The overflow from this wetland area would flow to Mud Lake where additional settling of solids and treatment can occur.

Feedback from the Department of Natural Resources has indicated a desire to disconnect Mud Lake from Fish Lake for the purpose of better managing the fishery. So Mud Lake would have its own dedicated outlet to gravity outfall.

Finally, Fish Lake would have a dedicated outlet to the gravity pipe. Under this design configuration, after the drawdown period, each of lakes to could be managed to their own levels and according to the water quality conditions imposed as a part of the permitting process.

CHAPTER 4 – COST

4.1 PROJECT COST

The estimated cost of construction for the layout as show in Appendix B including engineering and contingencies is $5,800,000. A detailed breakdown of this cost is shown in Table 2 below.

TABLE 2 – PRELIMINARY CONSTRUCTION COST ESTIMATE

PRELIMINARY CONSTRUCTION COST ESTIMATE
FISH/CRYSTAL/MUD LAKES GRAVITY OUTFALL TO WISCONSIN RIVER
TOWNS OF ROXBURY AND WEST POINT
Feb-20

Estimate

ITEM NO.	ITEM DESCRIPTION	EST QTY	UNITS	UNIT PRICE	TOTAL PRICE
	Fish Lake & Mud Lake Outfalls				
1	Mobilization, Bonds and Insurance	1	LS	$ 25,000.00	$ 25,000.00
2.	Traffic Control	1	LS	$ 2,000.00	$ 2,000.00
3.	Erosion Control	1	LS	$ 20,000.00	$ 20,000.00
4.	42-inch Storm Sewer (10 ft minus depth)	9,550	LF	$ 140.00	$ 1,337,000.00
5.	42-Inch Storm Sewer (15 ft depth)	2,000	LF	$ 170.00	$ 340,000.00
6.	42-Inch Storm Sewer (20 ft depth)	1,450	LF	$ 200.00	$ 290,000.00
7.	42-Inch Storm Sewer (25 ft depth)	800	LF	$ 250.00	$ 200,000.00
8.	42-Inch Storm Sewer (30 ft depth)	650	LF	$ 300.00	$ 195,000.00
9.	42-Inch Storm Sewer (40 ft depth)	1,300	LF	$ 350.00	$ 455,000.00
10.	42-Inch Class IV Bore and Jack	150	LF	$ 500.00	$ 75,000.00
11.	30-Inch Storm Sewer	1,000	LF	$ 120.00	$ 120,000.00
12.	Storm Manholes	12	EA	$ 4,000.00	$ 48,000.00
13.	30-Inch Storm Sewer	1,300	LF	$ 150.00	$ 195,000.00
14.	42-Inch Endwall	1	EA	$ 800.00	$ 800.00
15.	Lake Outlet Structure	2	EA	$ 15,000.00	$ 30,000.00
16.	Medium Random RipRap	200	CY	$ 60.00	$ 12,000.00
17.	Surface Restoration	1	LS	$ 100,000.00	$ 100,000.00
18.	Dewatering	1	LS	$ 300,000.00	$ 300,000.00
19.	Cofferdam Construction for Inlet Structure	1	LS	$ 100,000.00	$ 100,000.00
	Subtotal				$ 3,844,800.00
	10% Contingency				$ 384,480.00
	Engineering				$ 576,720.00

	TOTAL			$	4,806,000.00

ITEM NO.	ITEM DESCRIPTION	EST QTY	UNITS	UNIT PRICE	TOTAL PRICE
	Crystal Lake Outfall				
20.	Traffic Control	1	LS	$ 2,000.00	$ 2,000.00
21.	Erosion Control	1	LS	$ 20,000.00	$ 20,000.00
22.	30-Inch Storm Sewer (10 ft minus depth)	2,800	LF	$ 120.00	$ 336,000.00
23.	30-Inch Storm Sewer (added depth)	1,000	LF	$ 250.00	$ 250,000.00
24.	Storm Manholes	4	EA	$ 3,500.00	$ 14,000.00
25.	30-Inch Endwall	2	EA	$ 650.00	$ 1,300.00
26.	Open Swale Excavation	100	LF	$ 100.00	$ 10,000.00
27.	Lake Outlet Structure	1	EA	$ 15,000.00	$ 15,000.00
28.	Medium Random RipRap	40	CY	$ 60.00	$ 2,400.00
29.	Surface Restoration	1	LS	$ 50,000.00	$ 50,000.00
30.	Dewatering	1	LS	$ 40,000.00	$ 40,000.00
31.	Cofferdam Construction for Inlet Structure	1	LS	$ 50,000.00	$ 50,000.00
	Subtotal				$ 790,700.00
	10% Contingency				$ 79,070.00
	Engineering				$ 118,605.00
	TOTAL				$ 988,375.00

Not Included
Legal and Administrative Costs
Easement or Property Acquistion Fees

CHAPTER 5 – SUMMARY

5.1 EXECUTIVE SUMMARY

Fish Lake, Crystal Lake and Mud Lake have continued to rise over the past decades. Absent a natural outlet for the lakes, the rising levels have displaced residents and inundated property resulting in a diminished enjoyment of the resource. It has also resulted in costs to the taxpayers to maintain access to properties. Emergency response time has also been impacted by the loss of connecting roads due to the high water.

Pumping the lakes as an effort to control the water levels has been largely ineffective and expensive. An alternate exists that is a gravity outfall pipe to the Wisconsin River. A gravity pipe will have a large initial cost to install but will not have the operating costs associated with the pump systems.

The gravity system as outlined in this report would draw down the lakes to historic levels where transportation around the lakes and enjoyment of the resource can be restored. Once the drawdown has been achieved, the lake levels will be able to be managed with greatly reduced discharge flows.

APPENDIX A

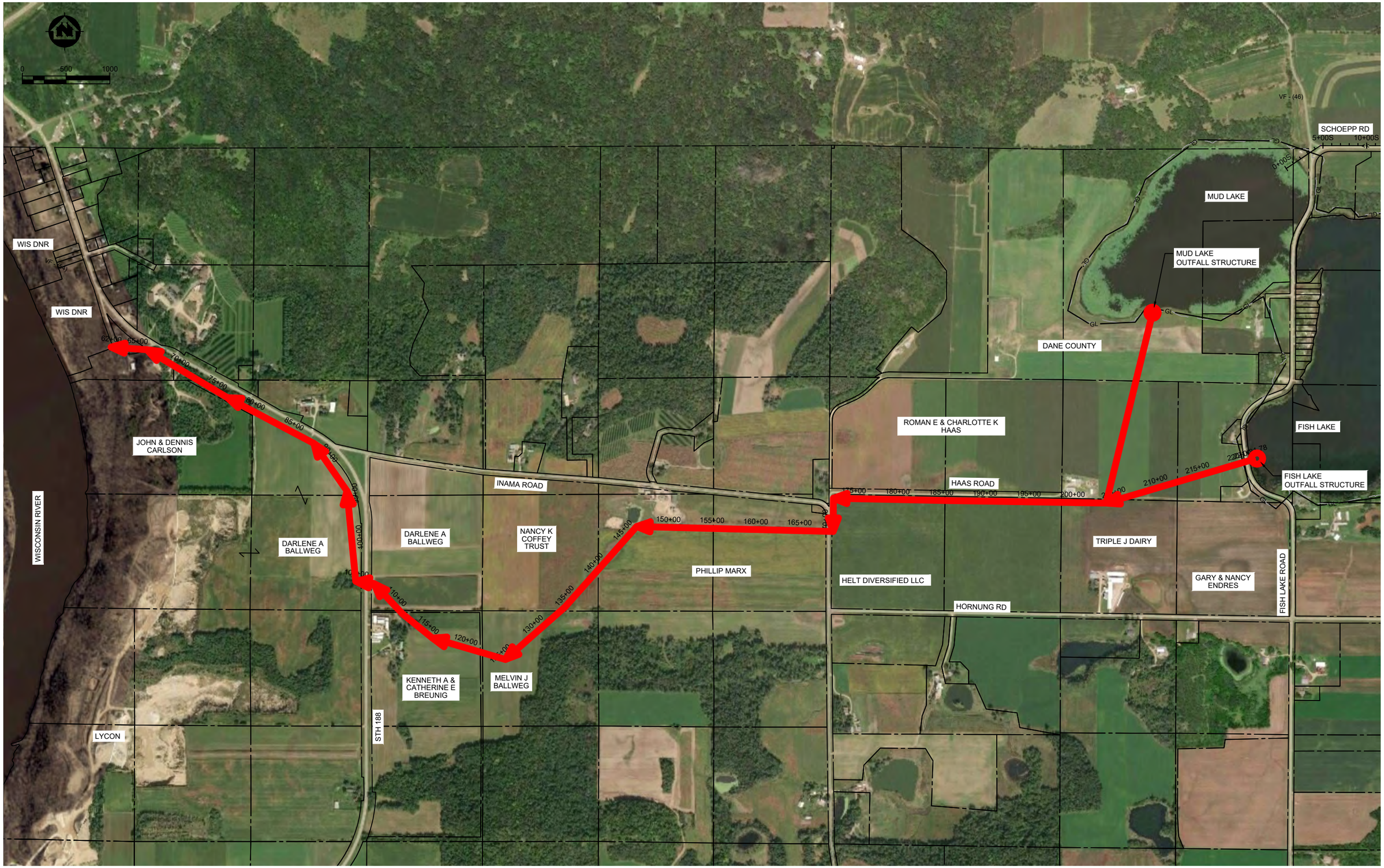
DEPARTMENT OF NATURAL RESOURCES EXHIBT

Crystal Lake/Fish Lake/Mud Lake Regulatory Requirements for Options Under Consideration

Water Body	Proposed Discharge Location	Receiving Water Designation	Required Permit for Pumping	Estimated Time for Permit	Concerns	Considerations
Crystal Lake	Roxbury Creek (Current Permitted Discharge)	Discharges to Exceptional Resource Water (ERW) and Limits must be protective	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	Permit in place. 2 to 3 months for a permit modification if needed	Current BOD limits are controling and difficult to attain during the warmer months. TSS must meet background concentrations in the LWR which may be challenging. Current maximum daily flow rate Is 1.5 MGD. A permit modification will be required to change effluent limits along with an anit-degradation demonstration	Develop Flow-Based limits which requires stream flow monitoring. Additional TSS data may be collected to modify limits
Crystal Lake	Lower Wisconsin River	ERW	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits would be similar to the Roxbury Creek Discharge. BOD limits may be higher. Significant opposition to a direct discharge to the LWR in the past. Permit likely to be challenged delaying implementaton.	Likely not a viable solution both short and long term.
Crystal Lake	Lake Wisconsin	Impaired Water. Approved TMDL in place	Likely eligible for a general permit	2 weeks	The TMDL has set aside phosphorus allocation for general permits. The dicharge would need to be monitored under the general permit to determine the mass of phosphorus discharged and pumping would need to stop once the mass allocation is attained. A Wetlands and Waterway permit may be needed for an intake and discharge structure.	
Crystal Lake	Lodi/Spring Creek	ERW/Class II Trout Stream	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits for a discharge to an ERW must be set at background concentrations which will likely be difficult to attain. Likely high public opposition to a dishcarge due to public use of the State Wildlife Area and concerns with impacts to flooding in the Village of Lodi. A floodplain anaysis my be needed to determine potential impacts from the additional water. Any discharge would impact the Master Plan for the State Wildlife Area and require approval by the Natural Resources Board.	
Crystal Lake	Lodi Marsh	Discharges to ERW and Limits must be protective. Must not negatively impact wetlands	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	2 to 3 months	Limits for a discharge to an ERW must be set at background concentrations which will be highly difficult to attain. High public opposition to a dishcarge due to public use of the State Wildlife Area and concerns with impacts to flooding in the Village of Lodi. A floodplain anaysis my be needed to determine potential impacts from the additional water. Any discharge would impact the Master Plan for the State Wildlife Area and require approval by the Natural Resources Board. The Lodi Marsh contains unique and fragile wetlands that may require more stringent limits.	
Fish Lake	Lower Wisconsin River (Current Permitted Discharge)	ERW	Ineligible for a general permit due to impacts to ERW. Individual WPDES Permit Required	Permit in place. 2 to 3 months for a modification if needed	The maximum allowable flow rate in the current permit is 1.5 MGD. An increased discharge may required new limits and a permit modification.	
Crystal Lake (constructed overflow)	Fish Lake	Impaired Water (total phosphorus and chlorophyll)	**Enlargement and Protection of Waterways:** Chapter 30.19 Individual permit for enlarging an artificial water body that connects with an existing navigable waterway. **Dams:** Chapter 31 permit to construct a dam. Department to set water level and public rights stage. **Water Quality:** Chapter 40.06 permit for trasport of invasives. **Wetlands:** Individual permit if disturbance is >10,000 sq. ft. **Stormwater:** General permit for earthwork.	6+ months	*Aquative invasive species transport (yellow bass, carp, milfoil, etc.) from Crystal Lake to Fish Lake *Aquatic Invasive Species Early Detection Monitoring *Flowage or flooding easements from each impacted property owner *Floodplain impacts regulated by Dane/Columbia Zoning Departments *Fish/Mud Lake water levels	*Consider impacts to landowners as well as to Mud Lake and beyond. *Structure for control of invasive species *Navigability of artificial waterway

APPENDIX B

PLAN VIEWS



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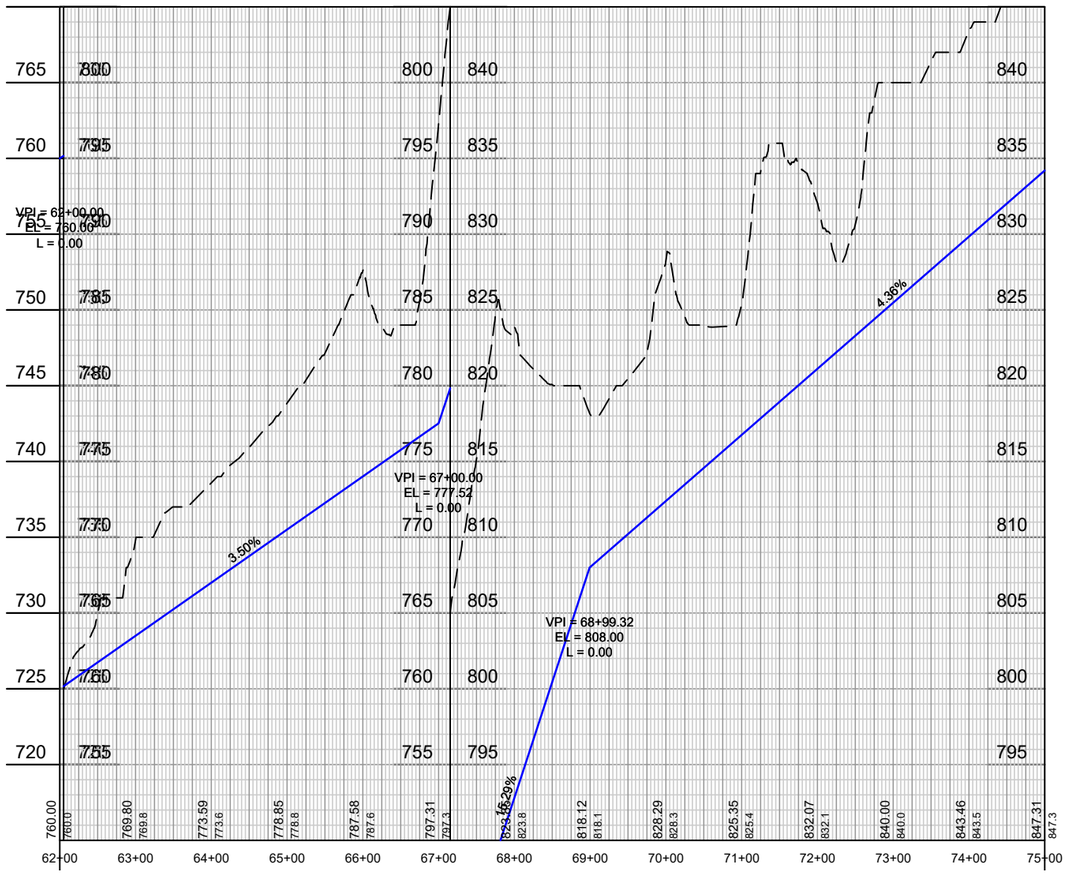
APPENDIX C

PLAN & PROFILE VIEWS



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TOWN OF ROXBURY
DANE COUNTY, WISCONSIN

PLAN & PROFILE - FISH LAKE OVERFLOW

PROJECT NO.
01017021

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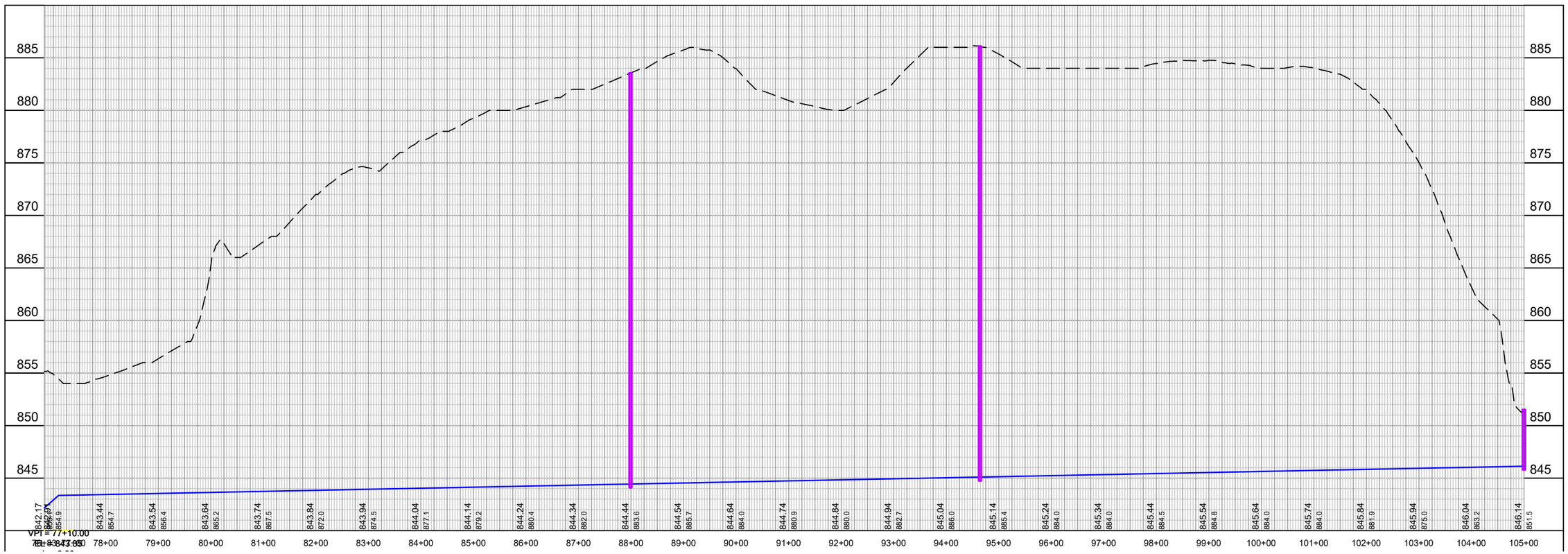

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DANE COUNTY, WISCONSIN

PLAN & PROFILE - FISH LAKE OVERFLOW

PROJECT NO. 01017021

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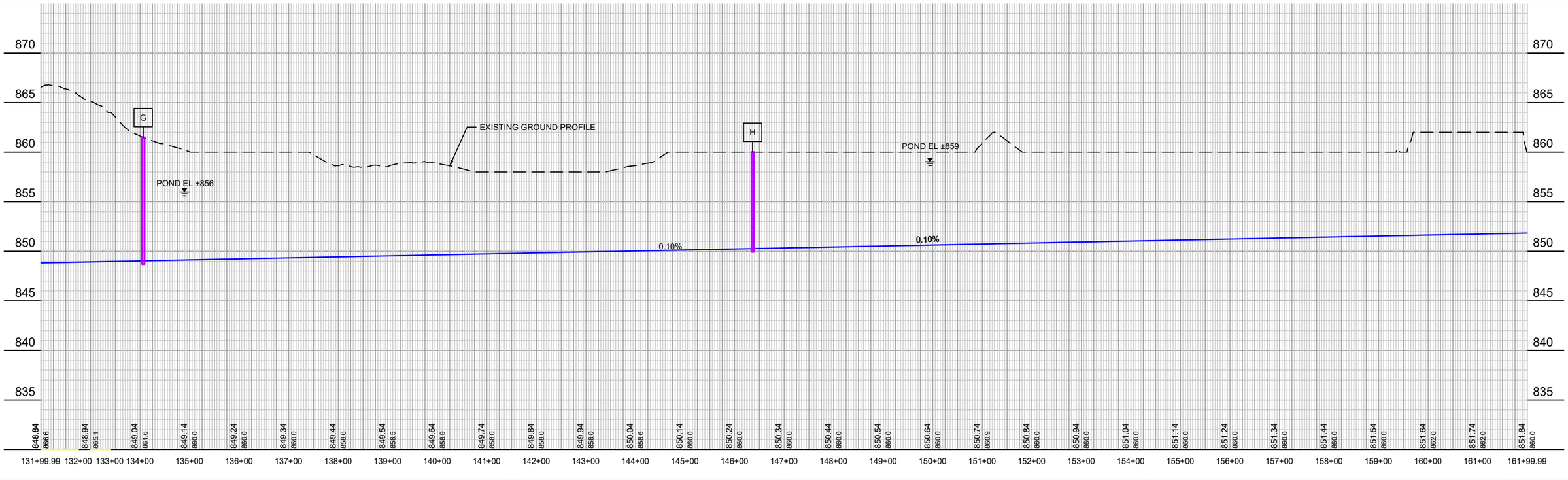

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PLAN & PROFILE - FISH LAKE OVERFLOW

PROJECT NO. 01017021

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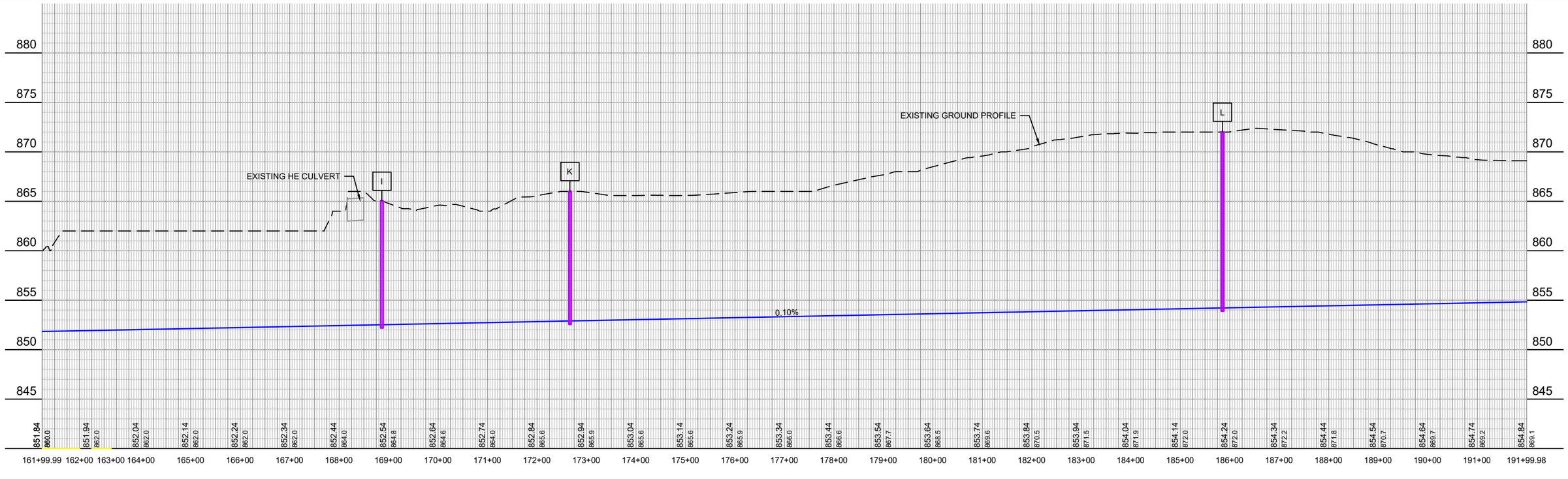

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PLAN & PROFILE - FISH LAKE OVERFLOW

PROJECT NO. 01017021

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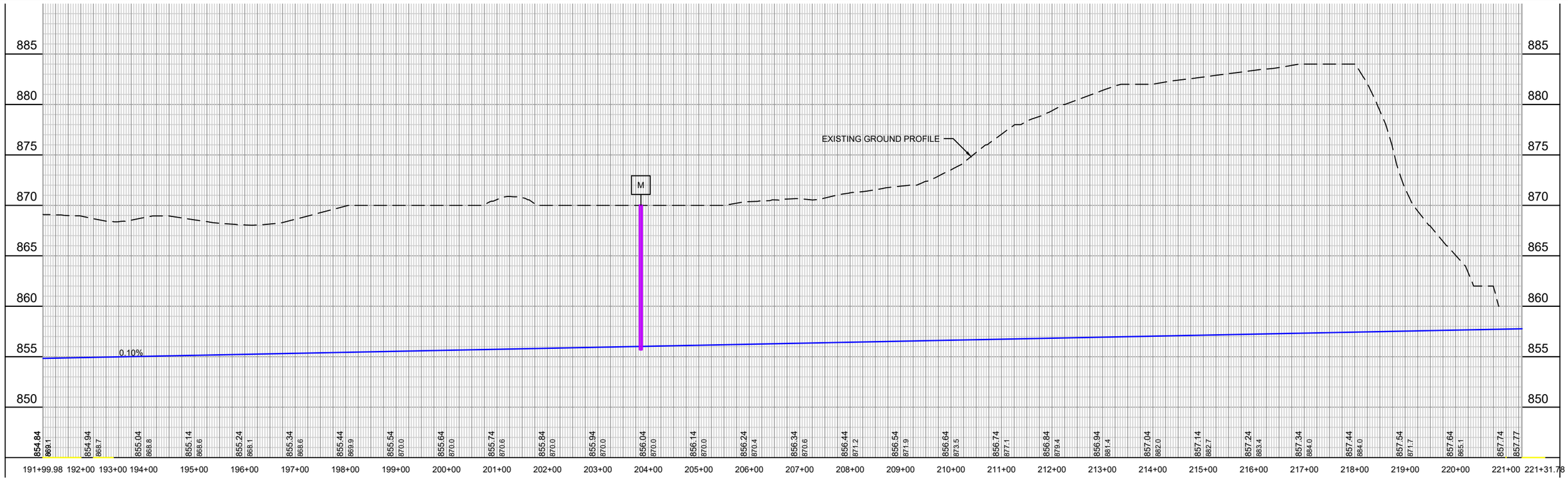

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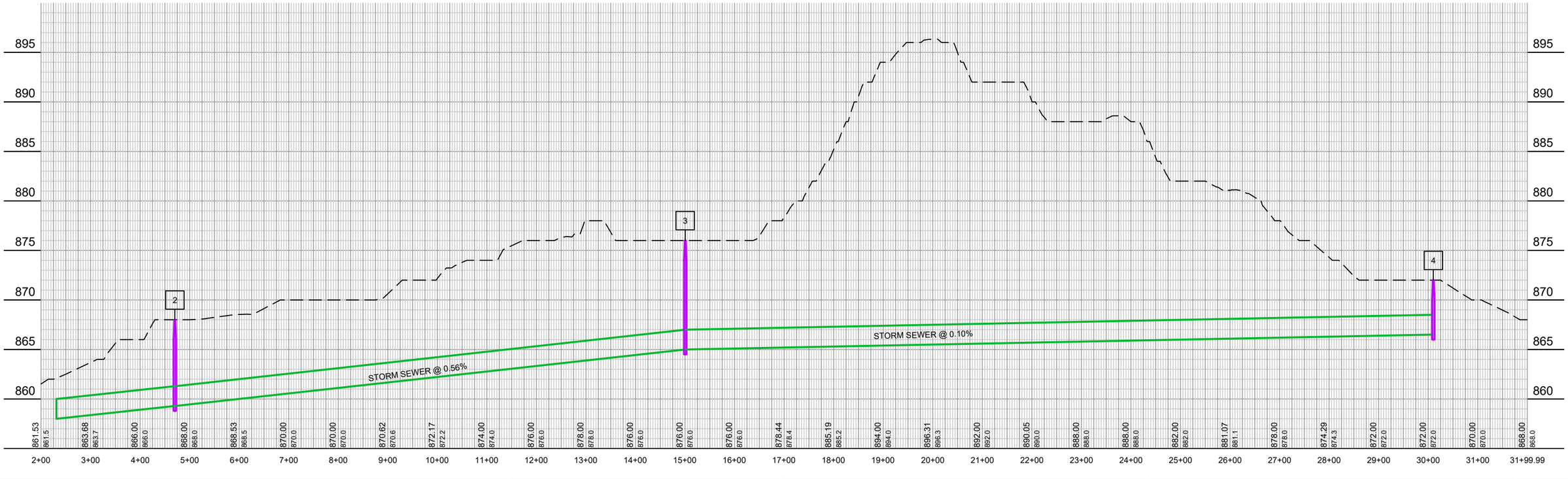

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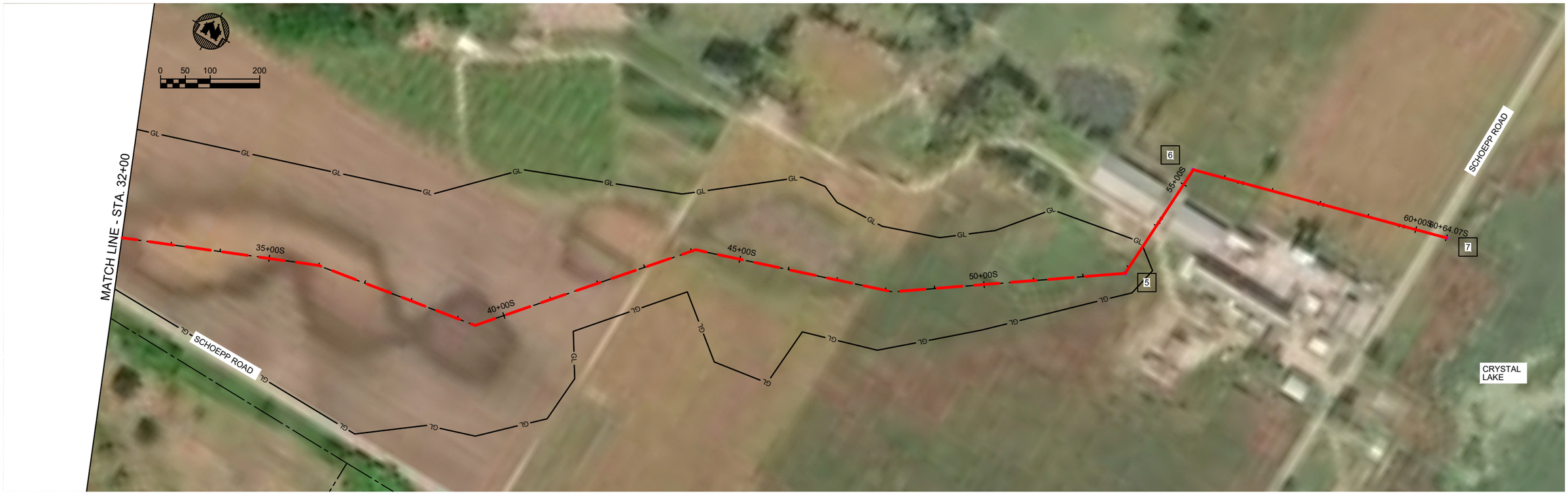
DANE COUNTY, WISCONSIN

PLAN & PROFILE - CRYSTAL LAKE OVERFLOW

PROJECT NO. 01017021

SHEET P7



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PLAN & PROFILE - CRYSTAL LAKE OVERFLOW

PROJECT NO. 01017021

SHEET P8

Appendix IV – Technical Workgroup Meeting Presentations

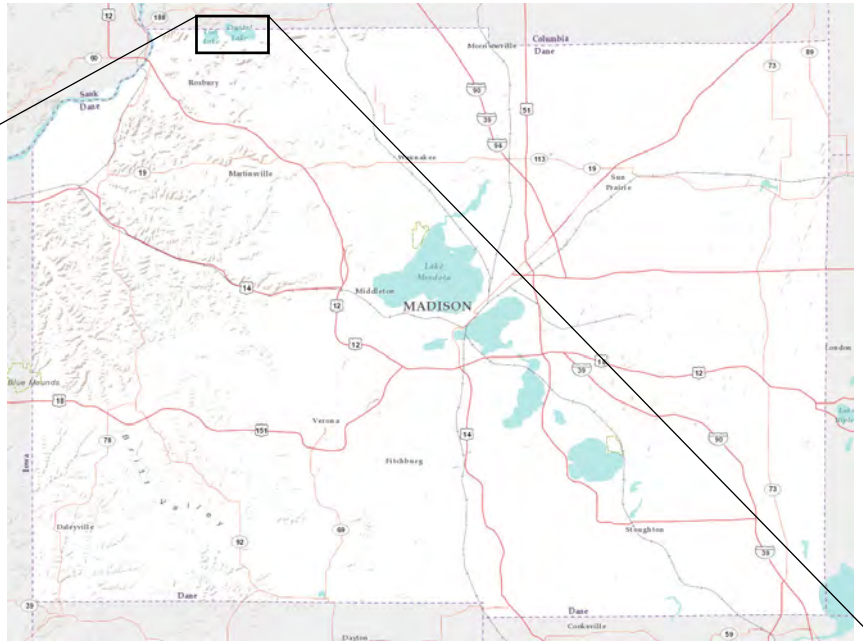
Fish and Crystal Lake Technical Meeting

May 26, 2021

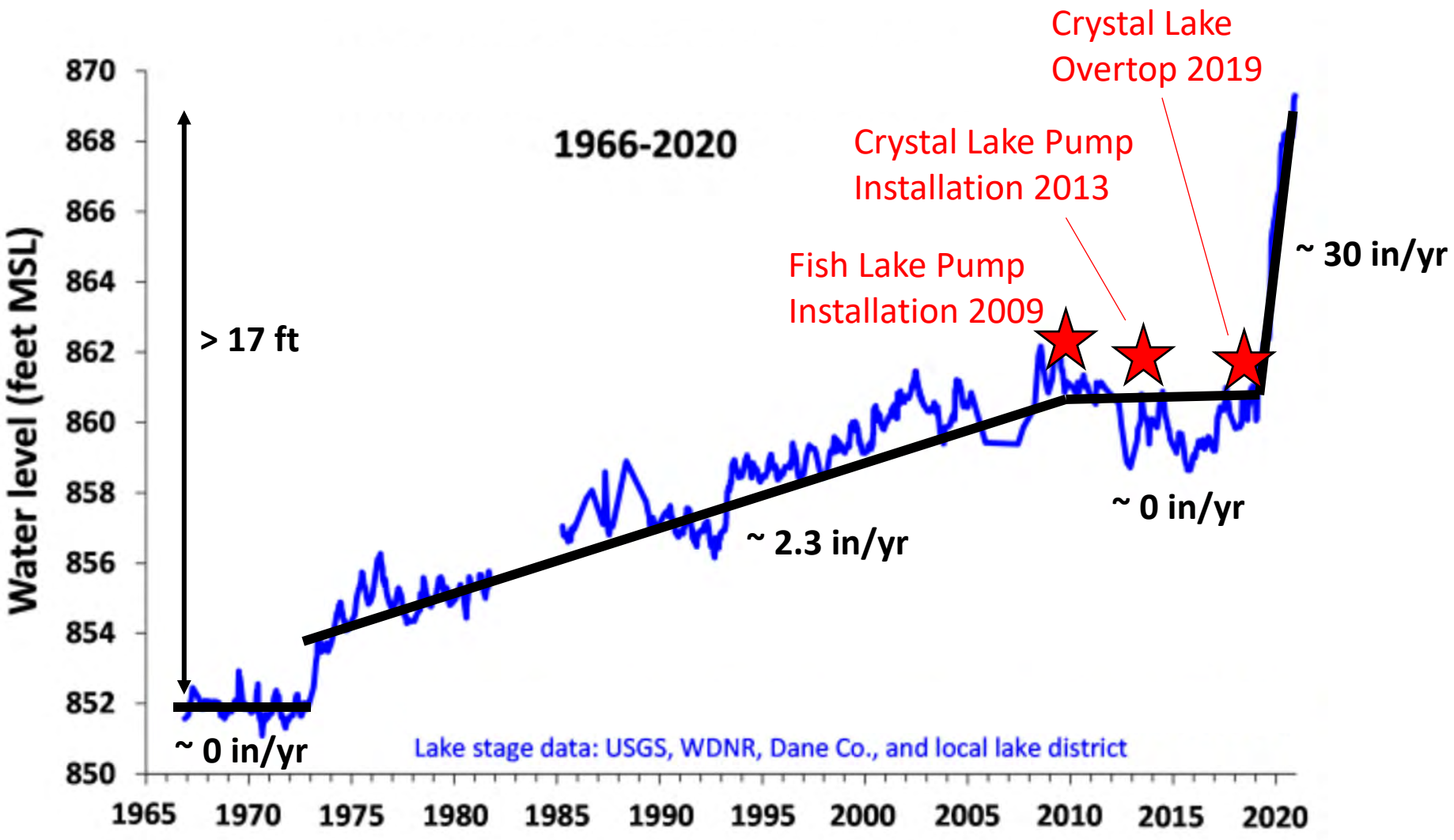
Meeting Agenda

- Background/History
- Group Charge
- Future Meeting Topics
- Meeting Dates/Times

Maps of Fish Crystal Lakes



Fish Lake Water Levels



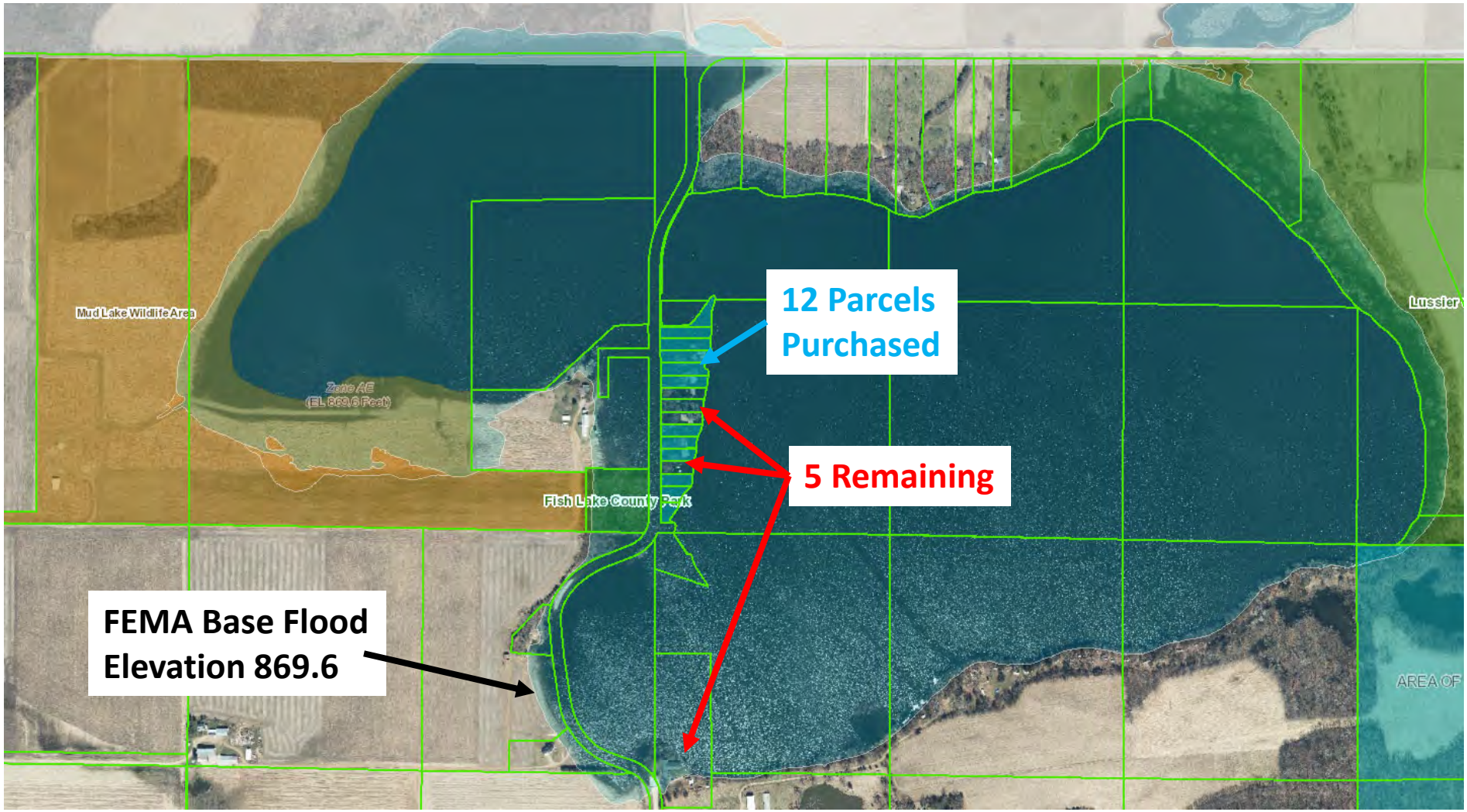
Historical Fish Lake Aerial Photos

Recent Fish Lake Aerial Photo

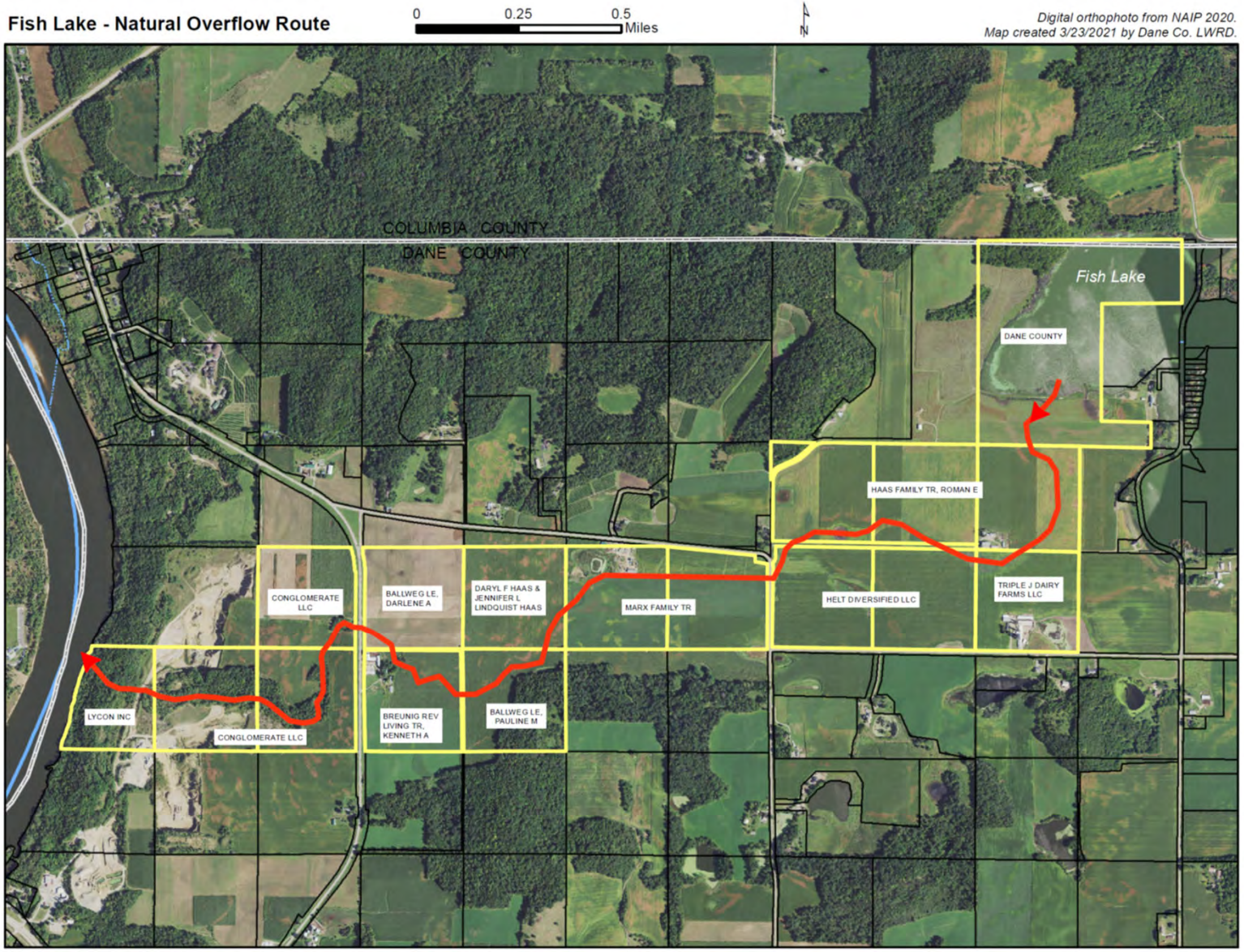
2020

Flooded Home Photos

Dane County Mitigation - Voluntary Home Buyout



Fish Lake Overflow Route



Additional Background or History others would like to share?

Technical Group Charge

- Example:

Provide recommendation for water level management and outlet flow path of Fish Lake.

Future Meeting Topic Ideas?

- Groundwater
- Hydrology/Hydraulics
- Land Use Impacts (Agriculture)
- Permits
- Transportation infrastructure (emergency services)
- Risk Analysis
- Biology/Fisheries
- Funding
- Options for flow conveyance (Pipeline, Overland Flow, etc.)

Meeting Dates/Times?

- Next Meeting – June 23 at 11 am

Fish/Mud & Crystal Lakes

Geology and hydrogeology overview

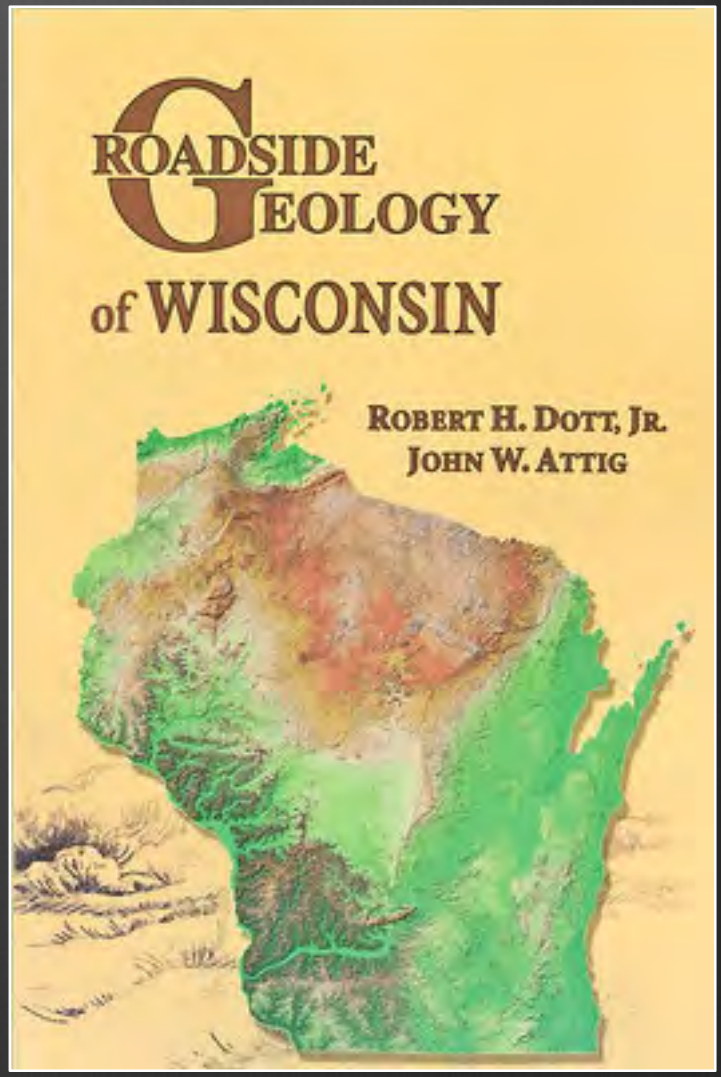
Dane County Technical Advisory Board Meeting – 6/23/2021

Mike Parsen (Hydrogeologist)
mike.parsen@wisc.edu

Dr. David Hart (Hydrogeologist)
david.hart@wisc.edu

Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON

Bedrock geology



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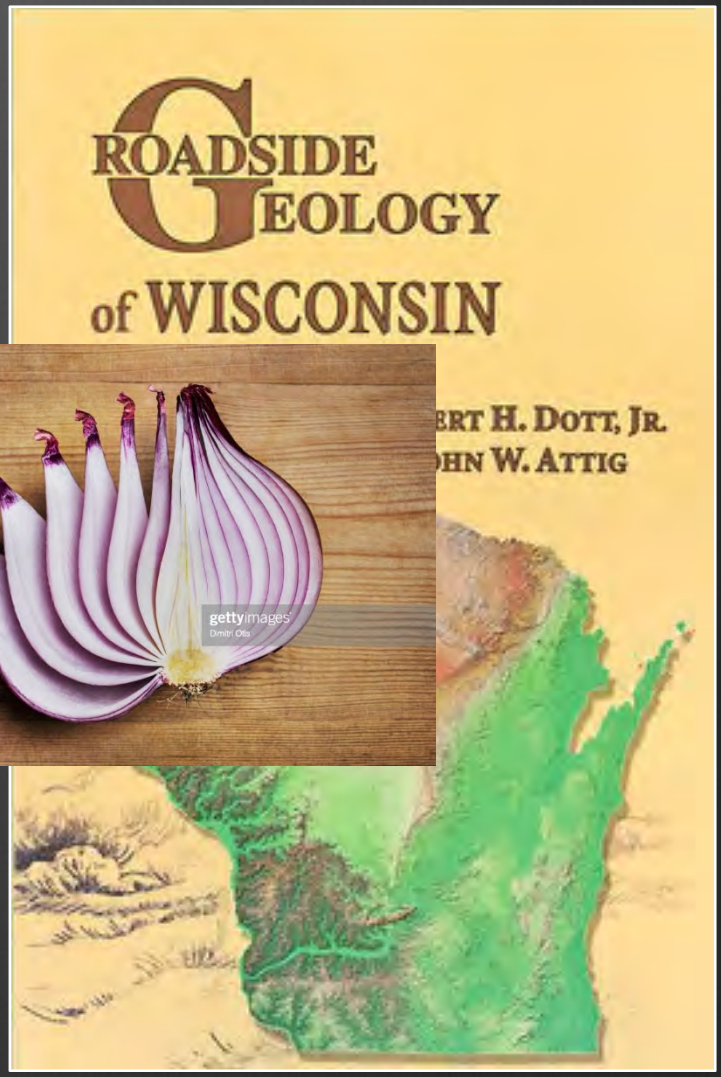
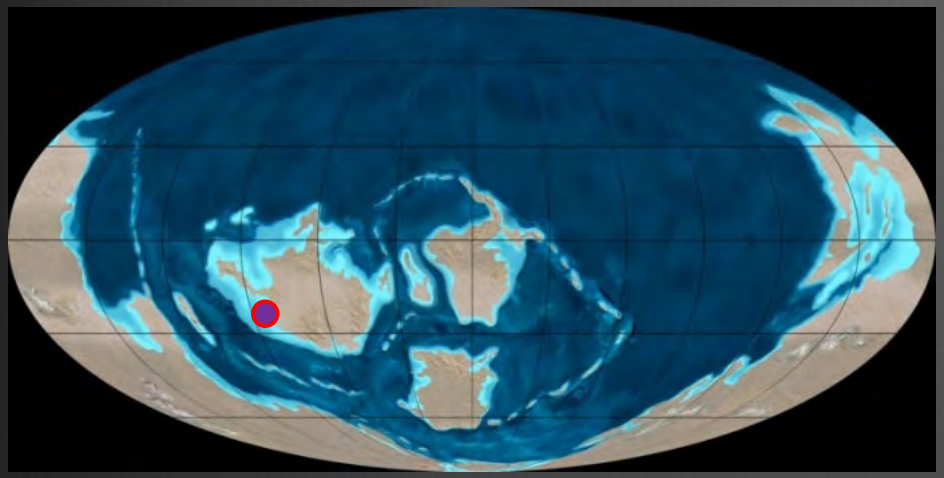
Bedrock geology

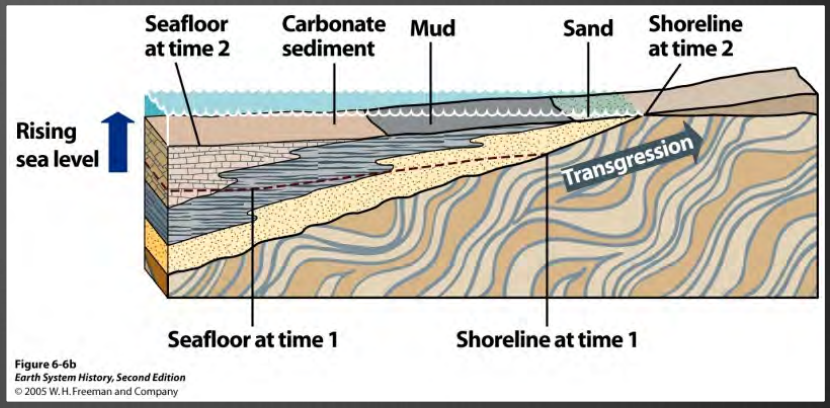


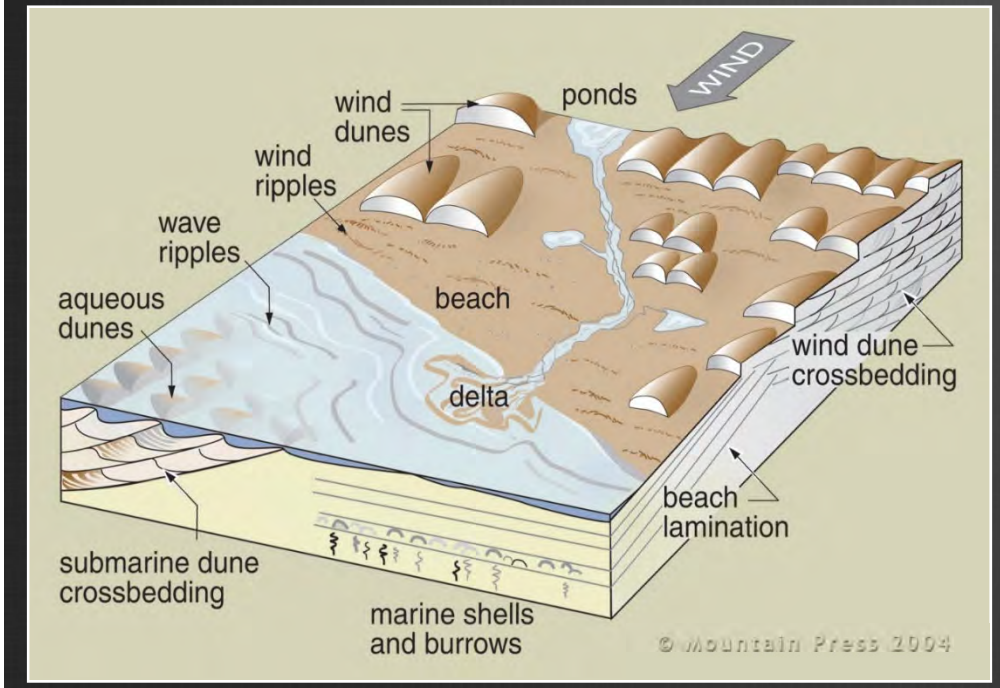
Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN–MADISON

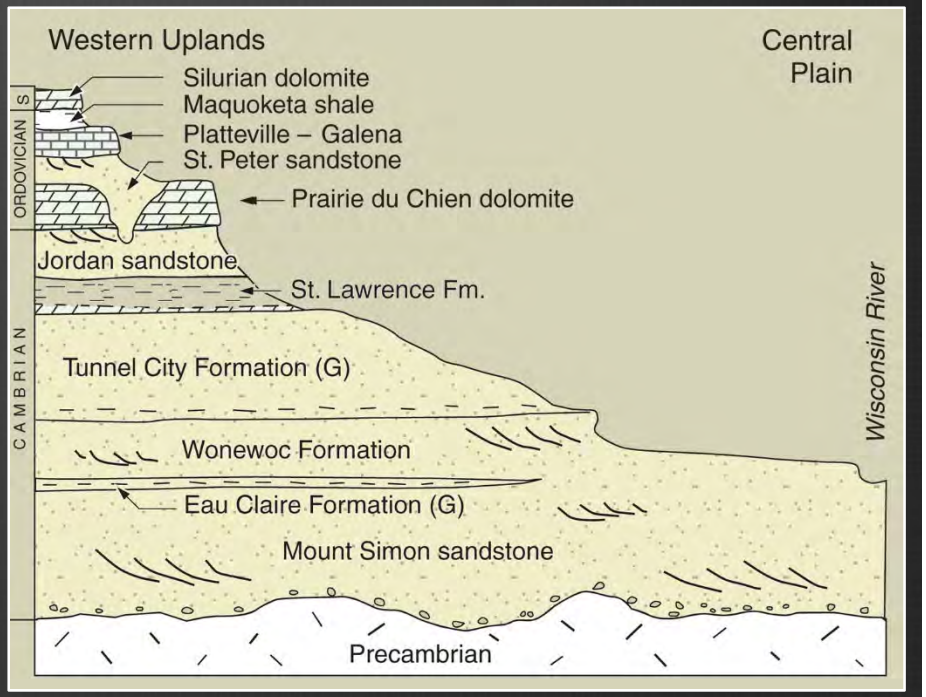
The long journey to where we are today…



Cambrian Period 520 to 490 million years ago



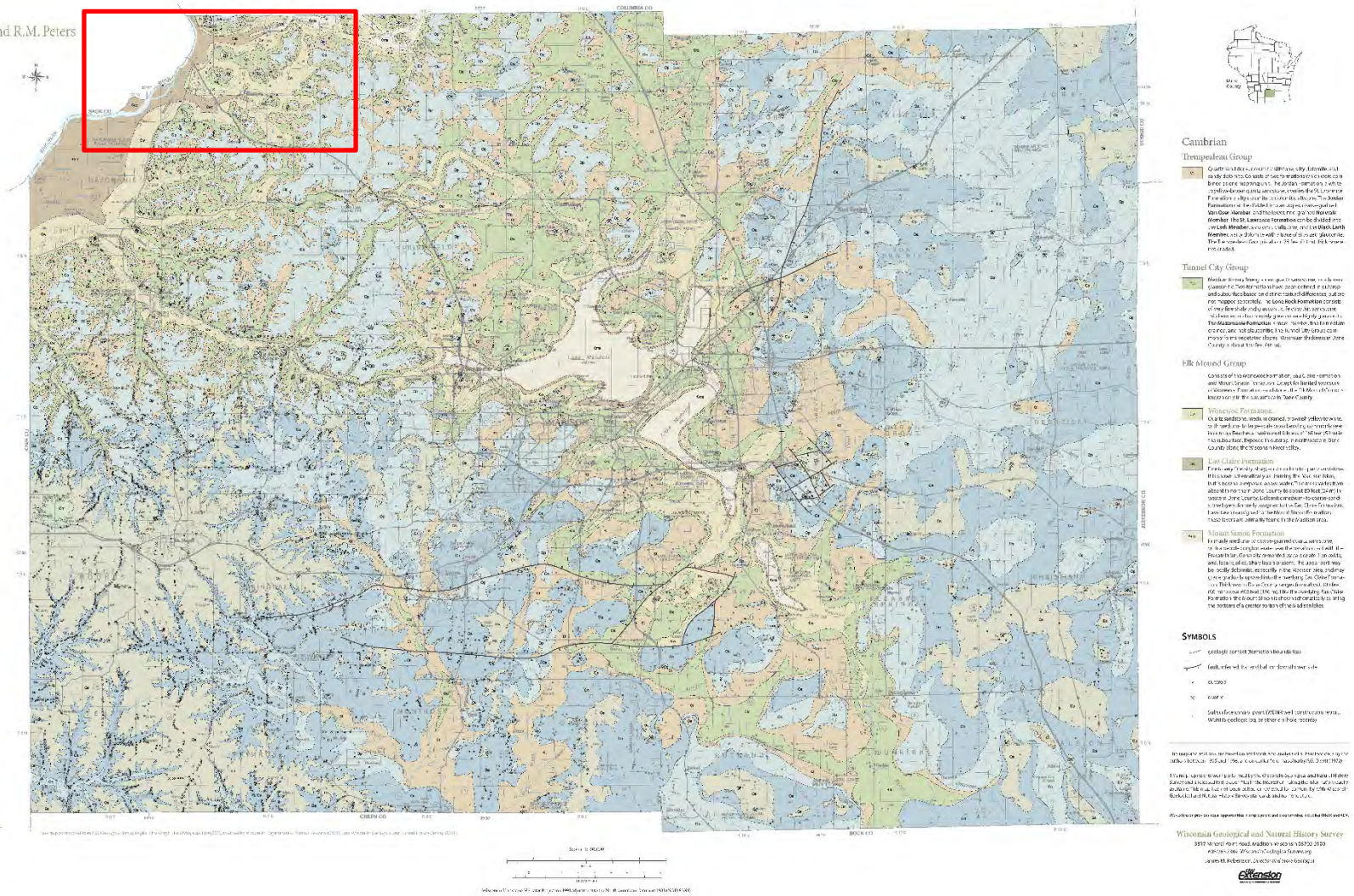




Roadside Geology of Wisconsin

Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON

Preliminary bedrock geology of Dane County, Wisconsin



Brown et al, 2013

Op – Prairie du Chien dolomite
Ct – Trempealeau sandstone/dolomite
Ctc – Tunnel City sandstone
Cw – Wonewoc sandstone
Cec - Eau Claire shale
Cms – Mount Simon sandstone

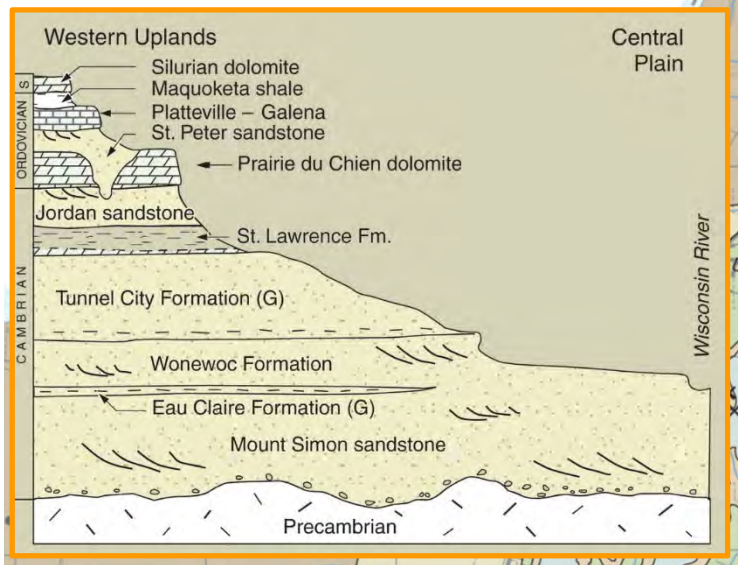
Bedrock Layers - mostly flat
Youngest on top (highest) to oldest (lowest) on bottom

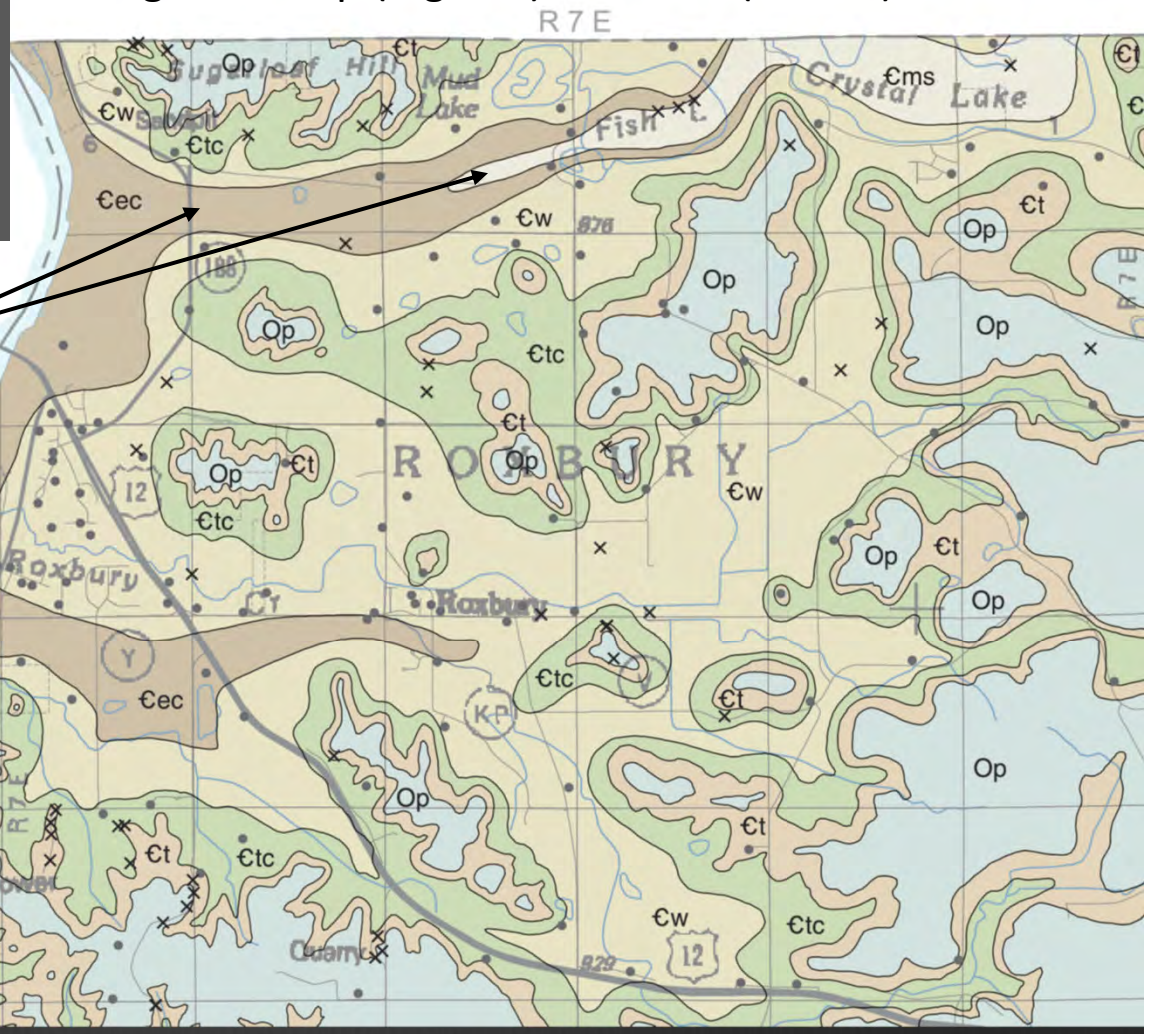
Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON

Op – Prairie du Chien dolomite
Ct – Trempealeau sandstone/dolomite
Ctc – Tunnel City sandstone
Cw – Wonewoc sandstone
Cec - Eau Claire shale
Cms – Mount Simon sandstone

Bedrock Layers - mostly flat
Youngest on top (highest) to oldest (lowest) on bottom

Bedrock erosional surface is interpreted to the EC and into the MS below Fish and Crystal Lakes





Geologic record (in Dane Co) is missing from 450 million up until Quaternary Period…

Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON

Glacial geology

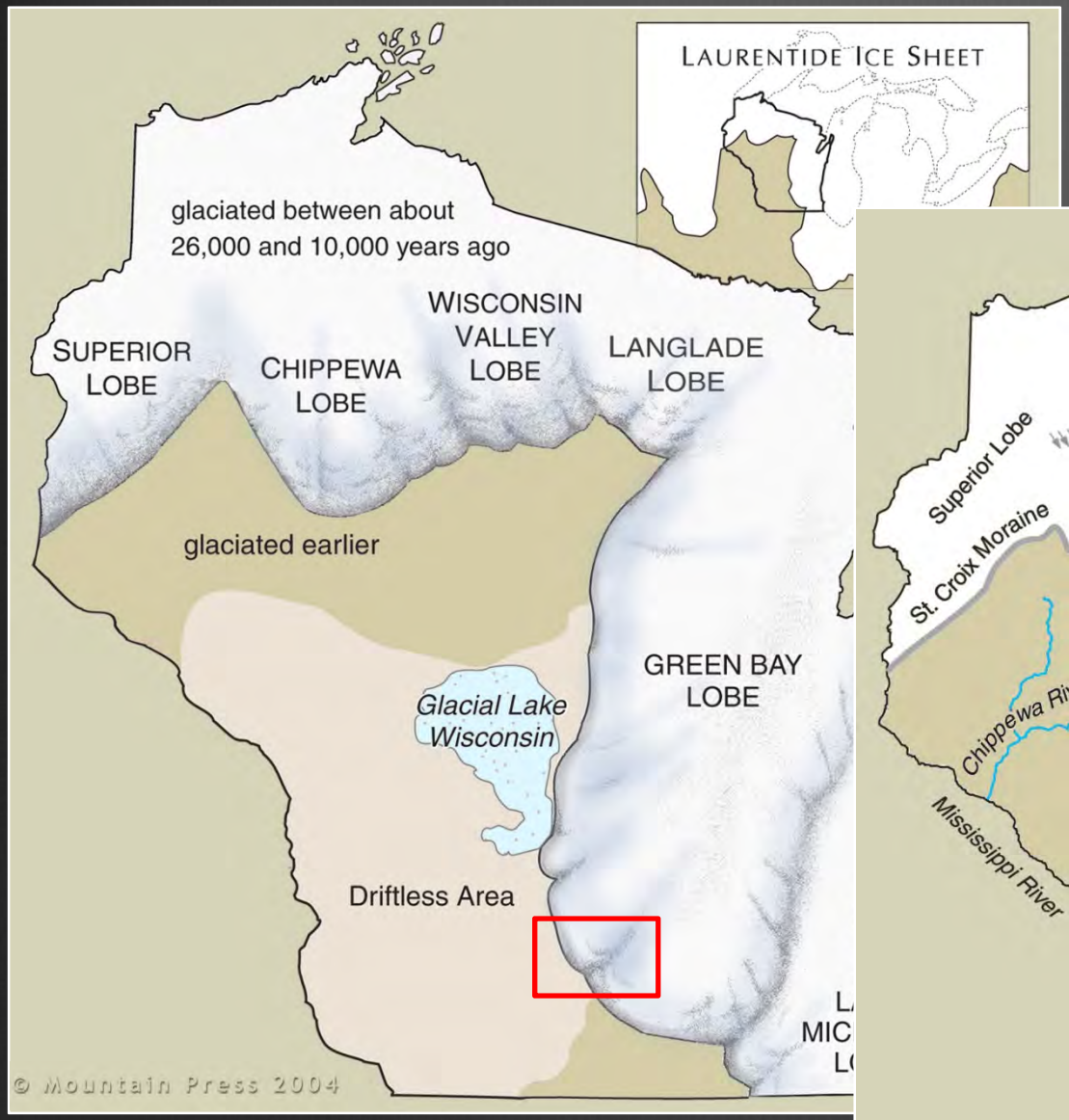
Roadside Geology of Wisconsin

Glaciers flow and pick up sediment

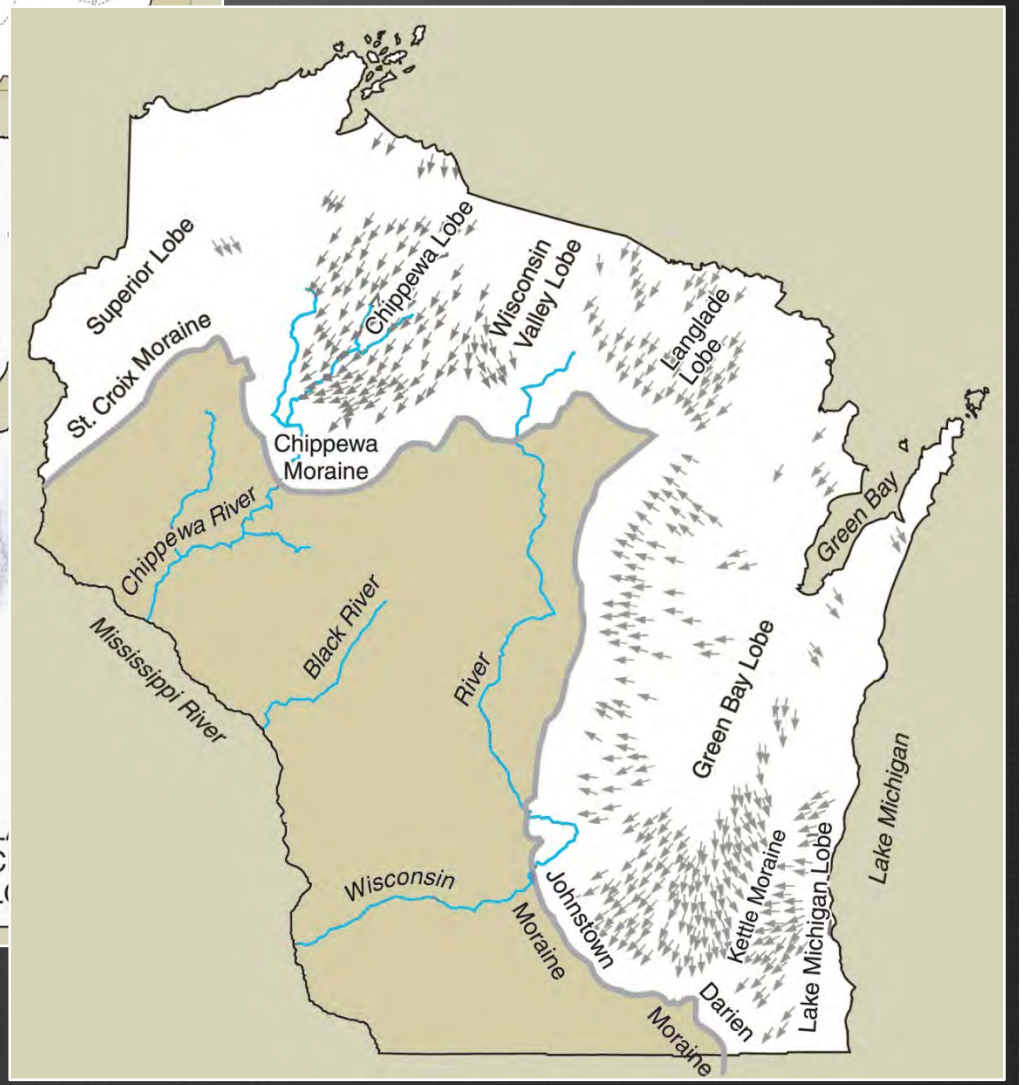
Both water and ice erode and deposit rock and sediment

Wisconsin Geological and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON

Glacial geology



Roadside Geology of Wisconsin



Glaciers flow and pick up sediment

Both water and ice erode and deposit rock and sediment

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Glaciers leave moraines (ridges) at their edge

NASA / Michael Studinger - http://www.nasa.gov/mission_pages/icebridge/index.html

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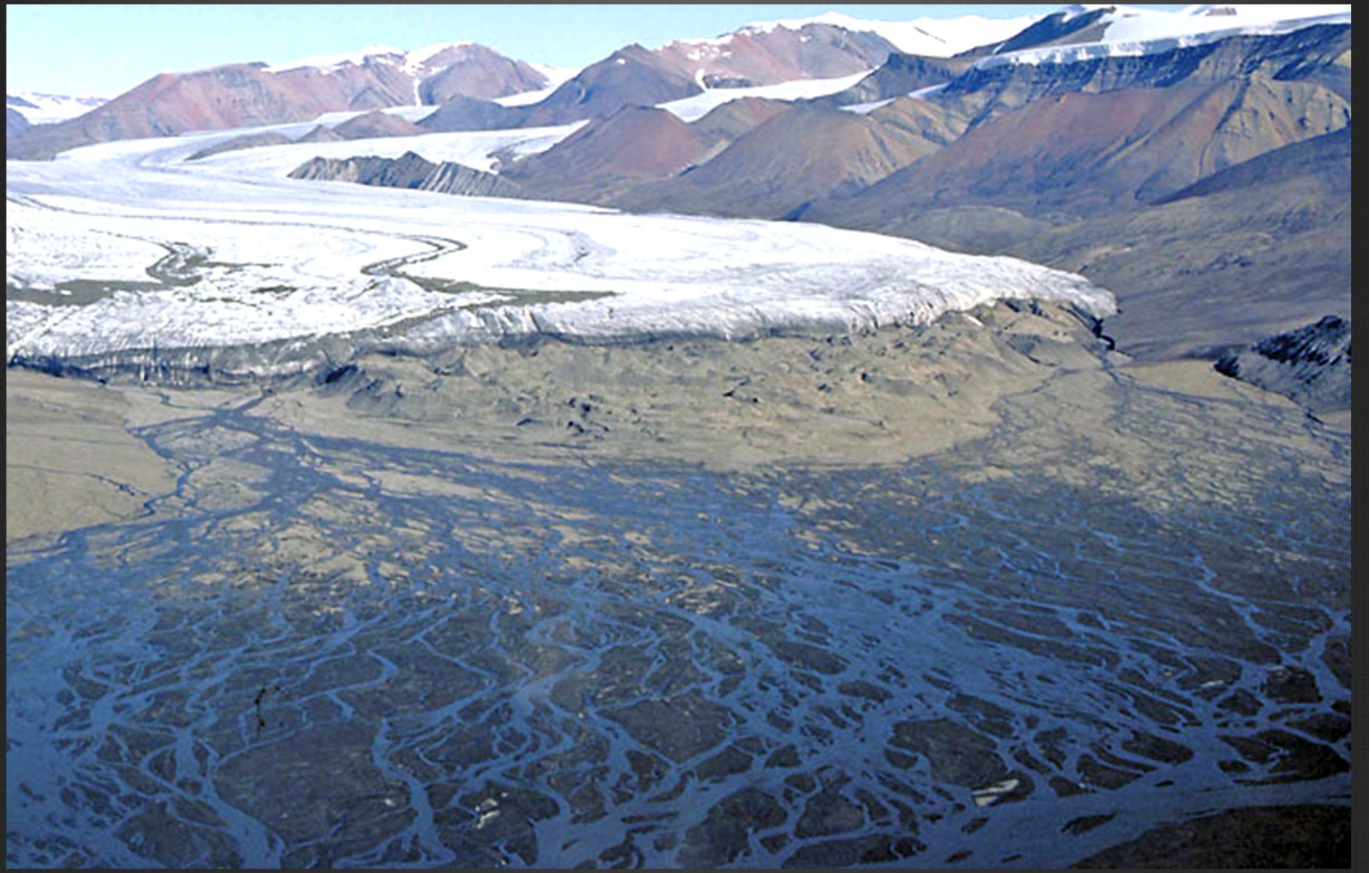
Glaciers often have plains of outwash



Glaciers leave tunnel channels through the moraines

Photograph from the book, by Peter G. Knight

The ice sometimes melts at the bottom of the glacier. That water needs a place to flow.

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Glaciers leave tunnel channels through the moraines

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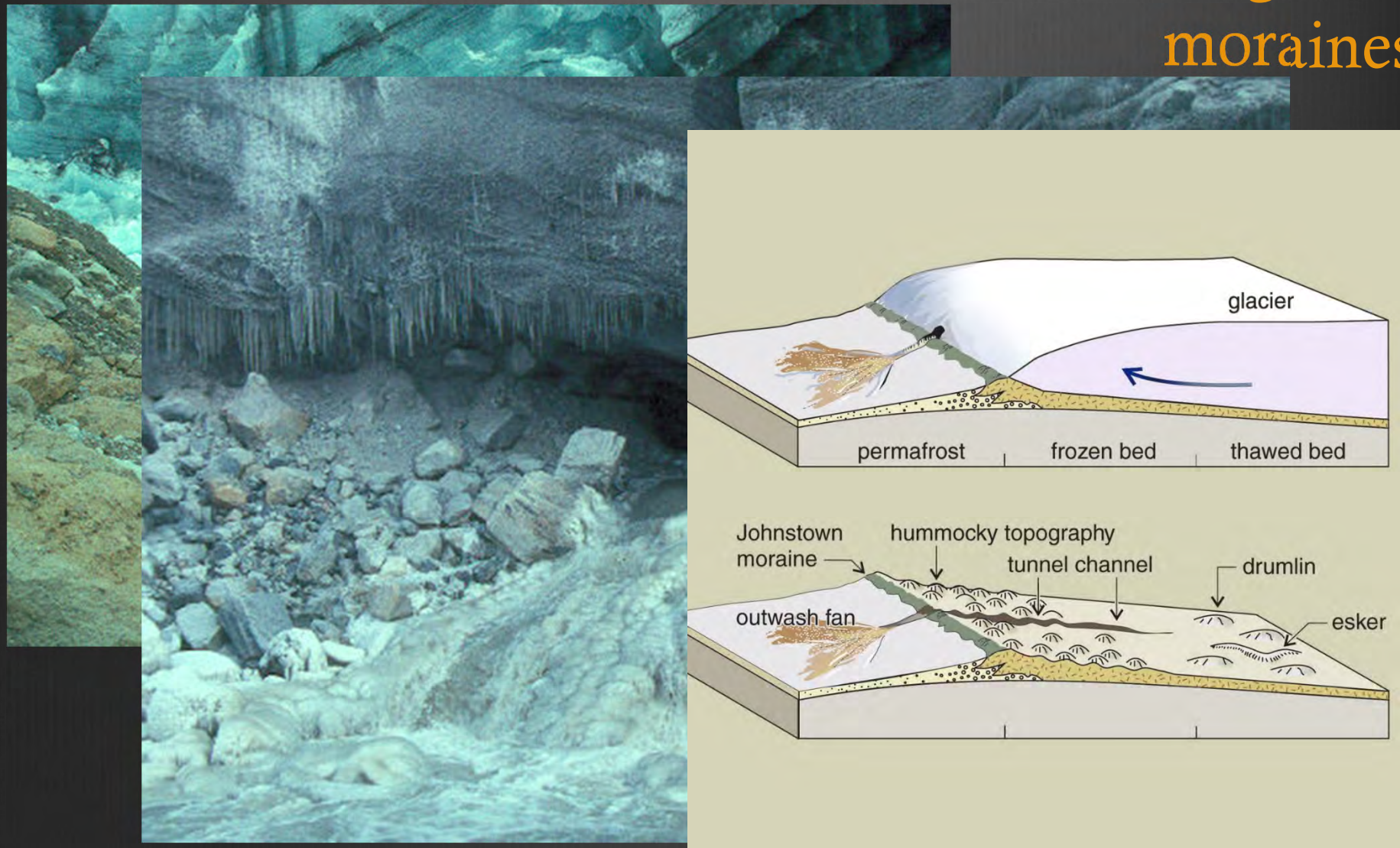


Roadside Geology of Wisconsin

© Mountain

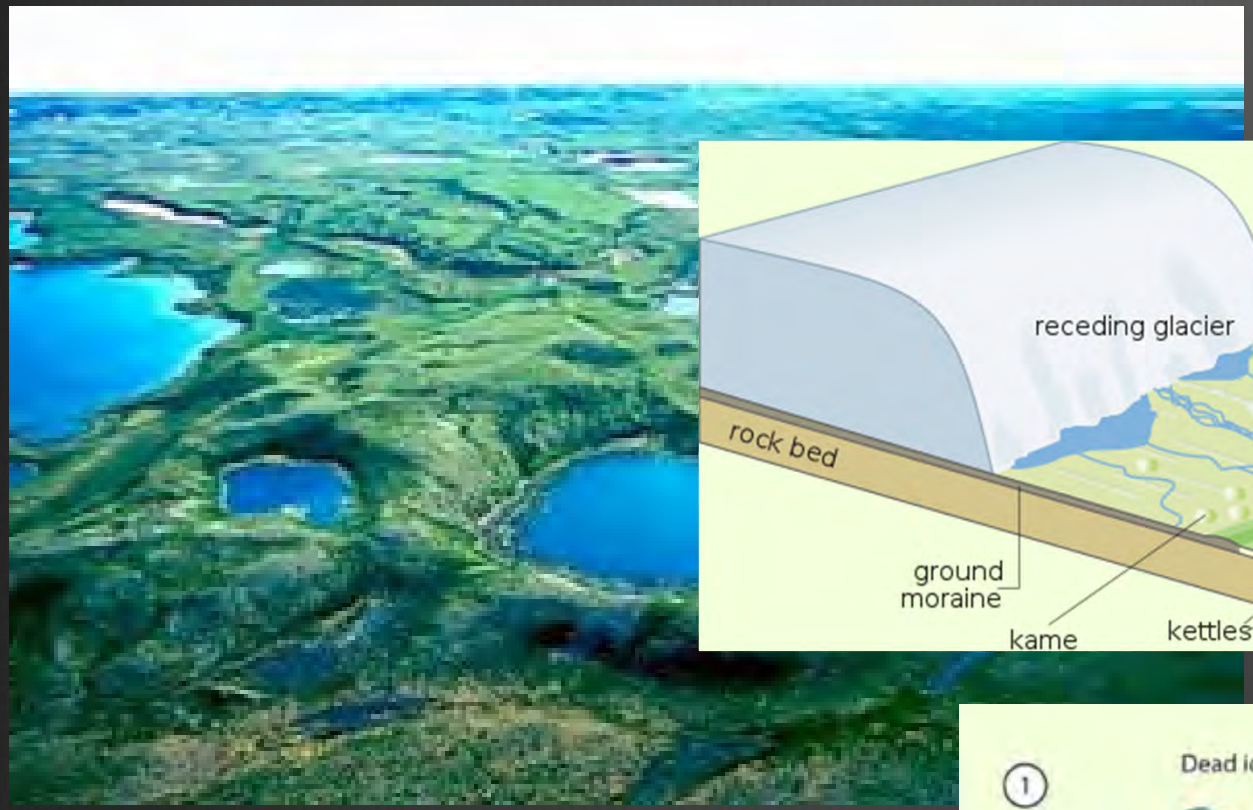
The ice sometimes melts at the bottom of the glacier. That water needs a place to flow.

Glaciers leave kettle lakes and meltwater-stream channels

http://www.geo.mtu.edu/KeweenawGeoheritage/Glaciers/Kettles.html

Kettles: lake created by melting of buried ice, creating depression on landscape that fills with water.

Glaciers leave kettle lakes and meltwater-stream channels



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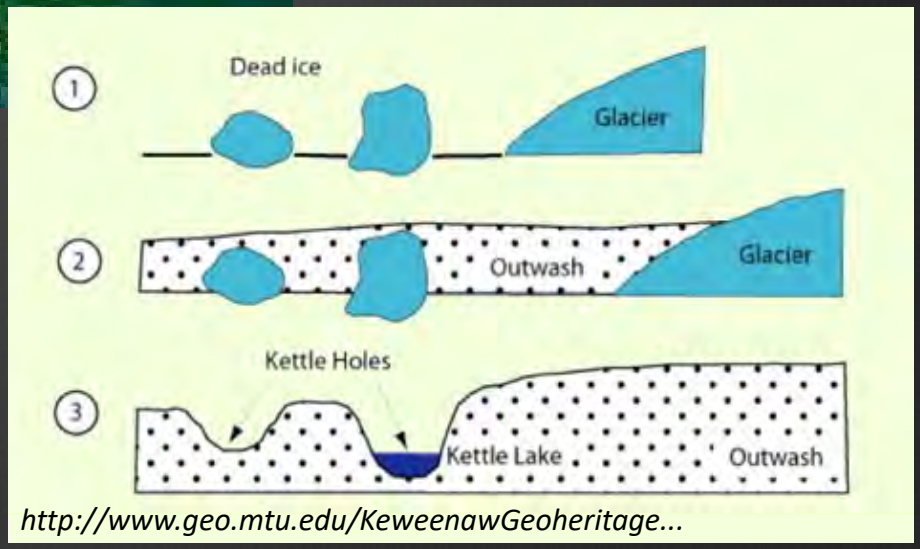

http://www.geo.mtu.edu/KeweenawGeoheritage...

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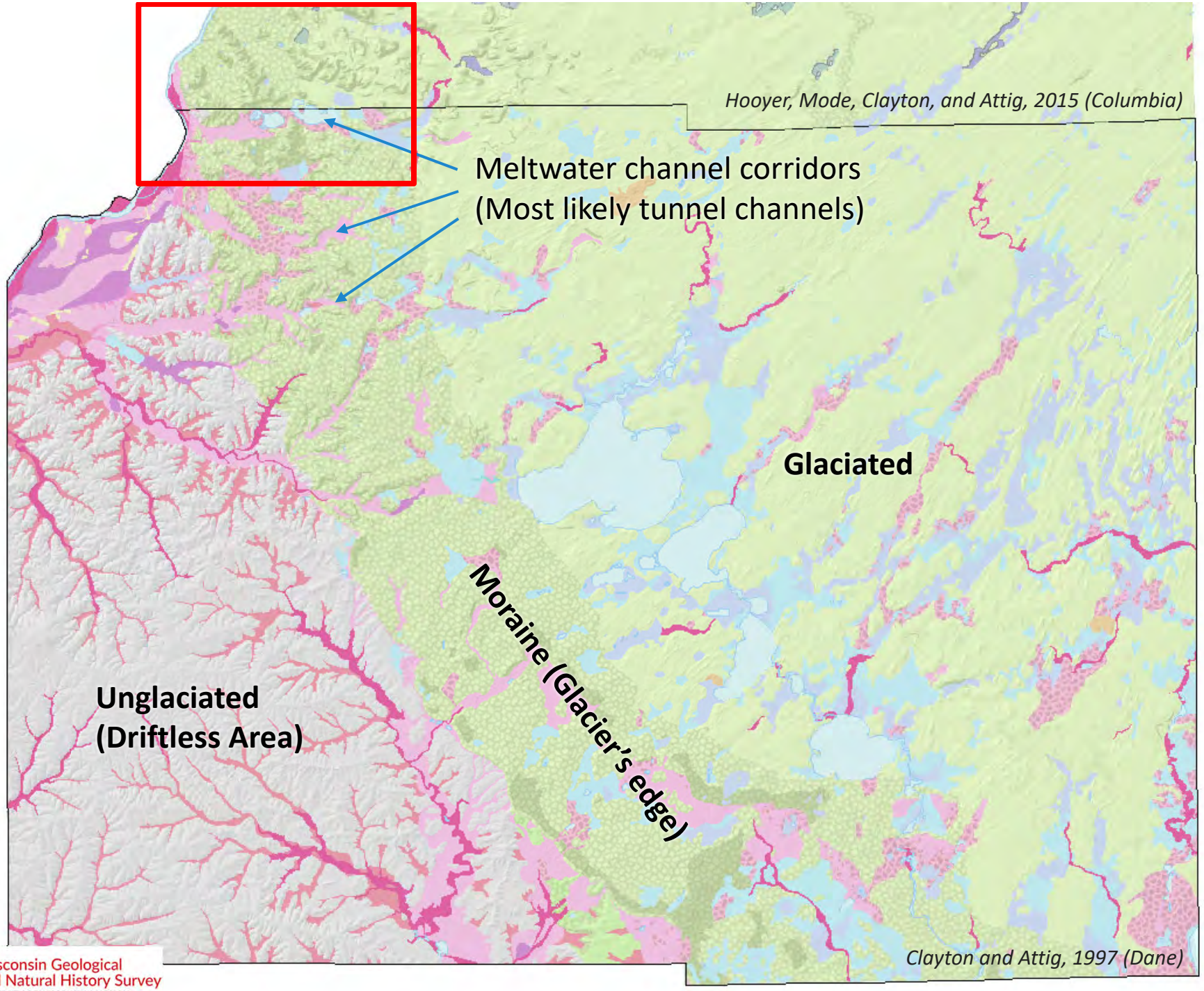

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Meltwater-stream sediment

"Sand and gravel; typically at least several meters thick; deposited by braided streams that carried glacial meltwater during the Wisconsin Glaciation"

sc → "Collapsed meltwater-stream sediment; deposited on stagnant glacial ice, resulting in hummocky topography when the ice melted"

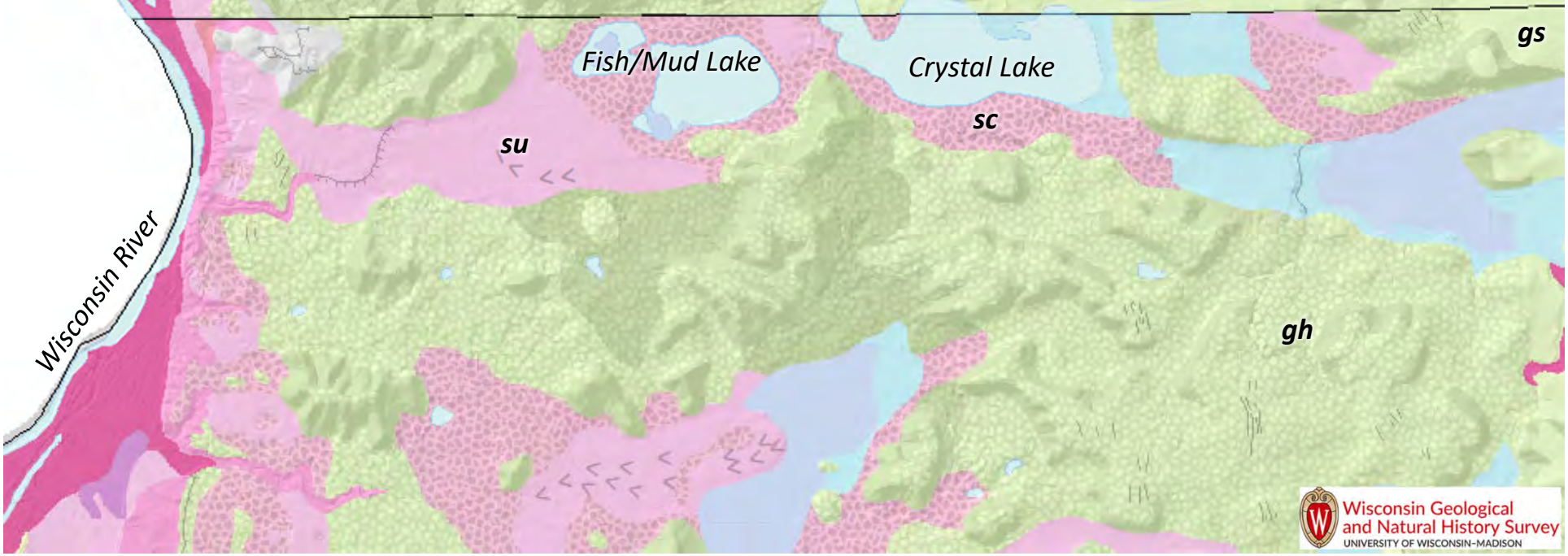
su → "Uncollapsed meltwater-stream sediment; flat outwash plains"

Till

"Gravelly, clayey, silty sand deposited by the Green Bay Lobe; generally at least a few meters thick;…; includes many small to large inclusions of meltwater stream sediment and glacial-lake sediment that could not be separately mapped"

gs → "Uniform subglacial till deposited during the last part of the Wisconsin Glaciation; smooth, streamlined topography with drumlins"

gh → "Non-uniform collapsed supraglacial till and sorted supraglacial debris deposited during the last part of the Wisconsin Glaciation; slightly hummocky topography"



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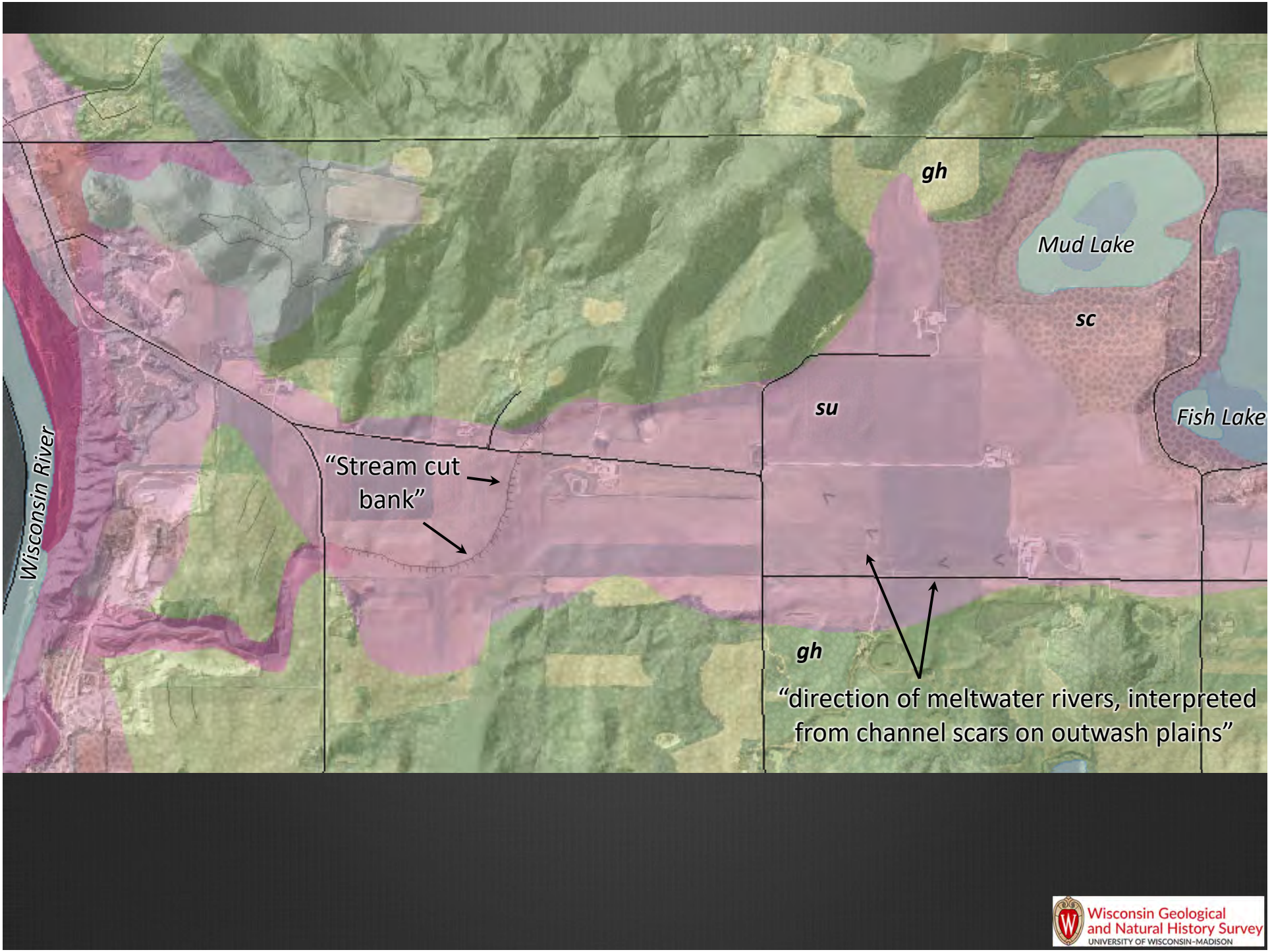

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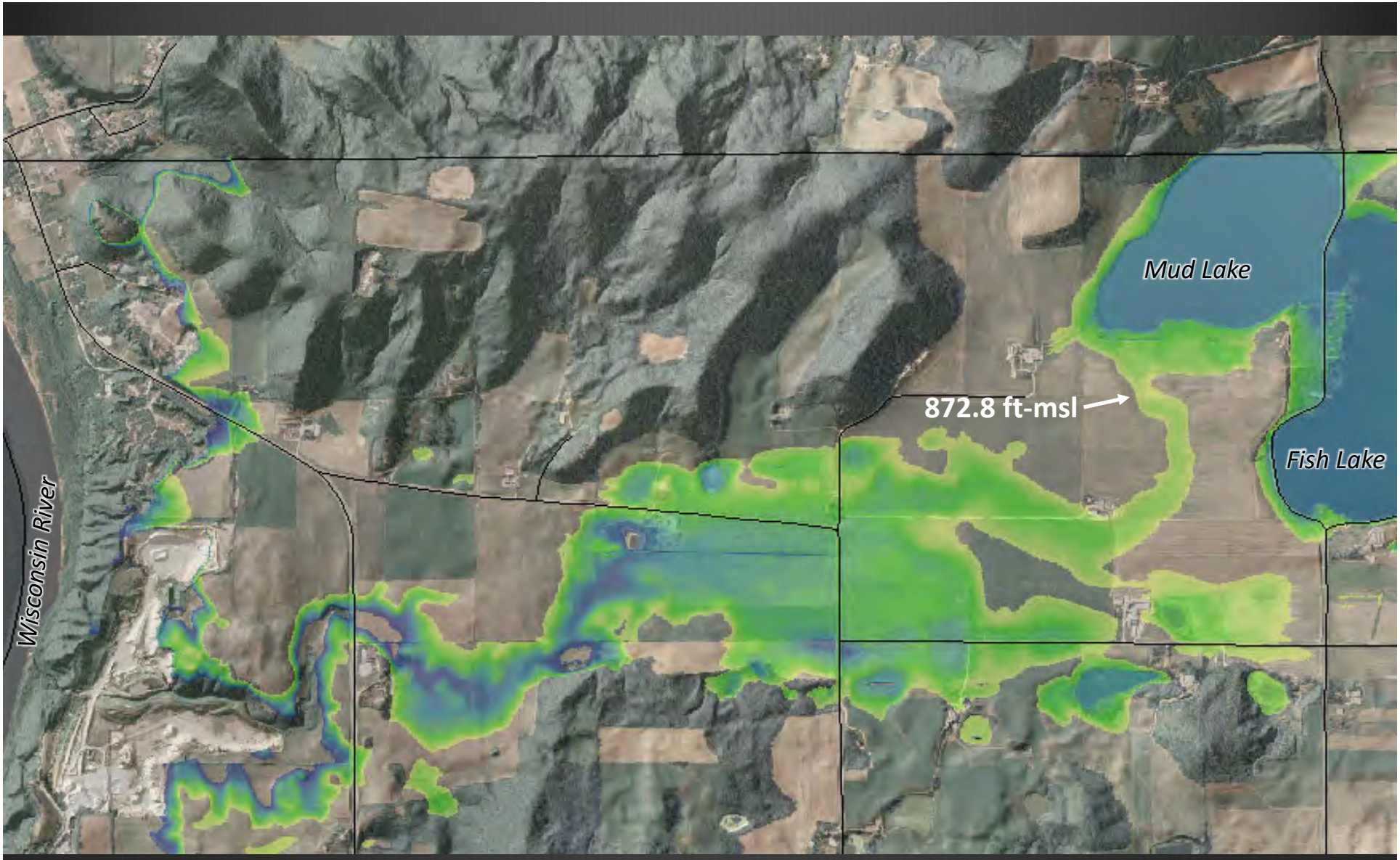

Lidar elevations from 873 - 855 ft-msl, showing general overland flow direction and closed depressions within this meltwater stream corridor

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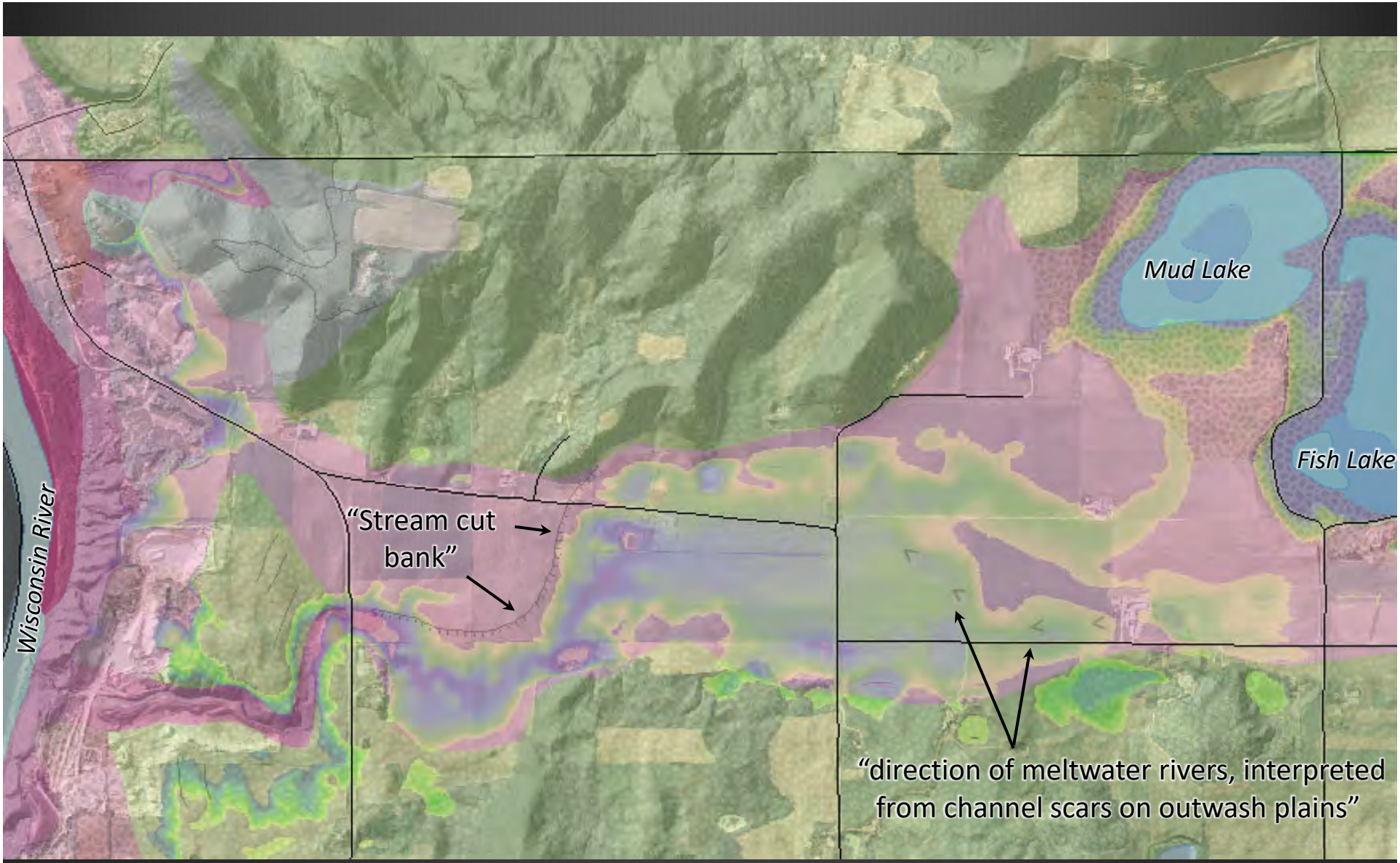

Now to the hydrogeology…

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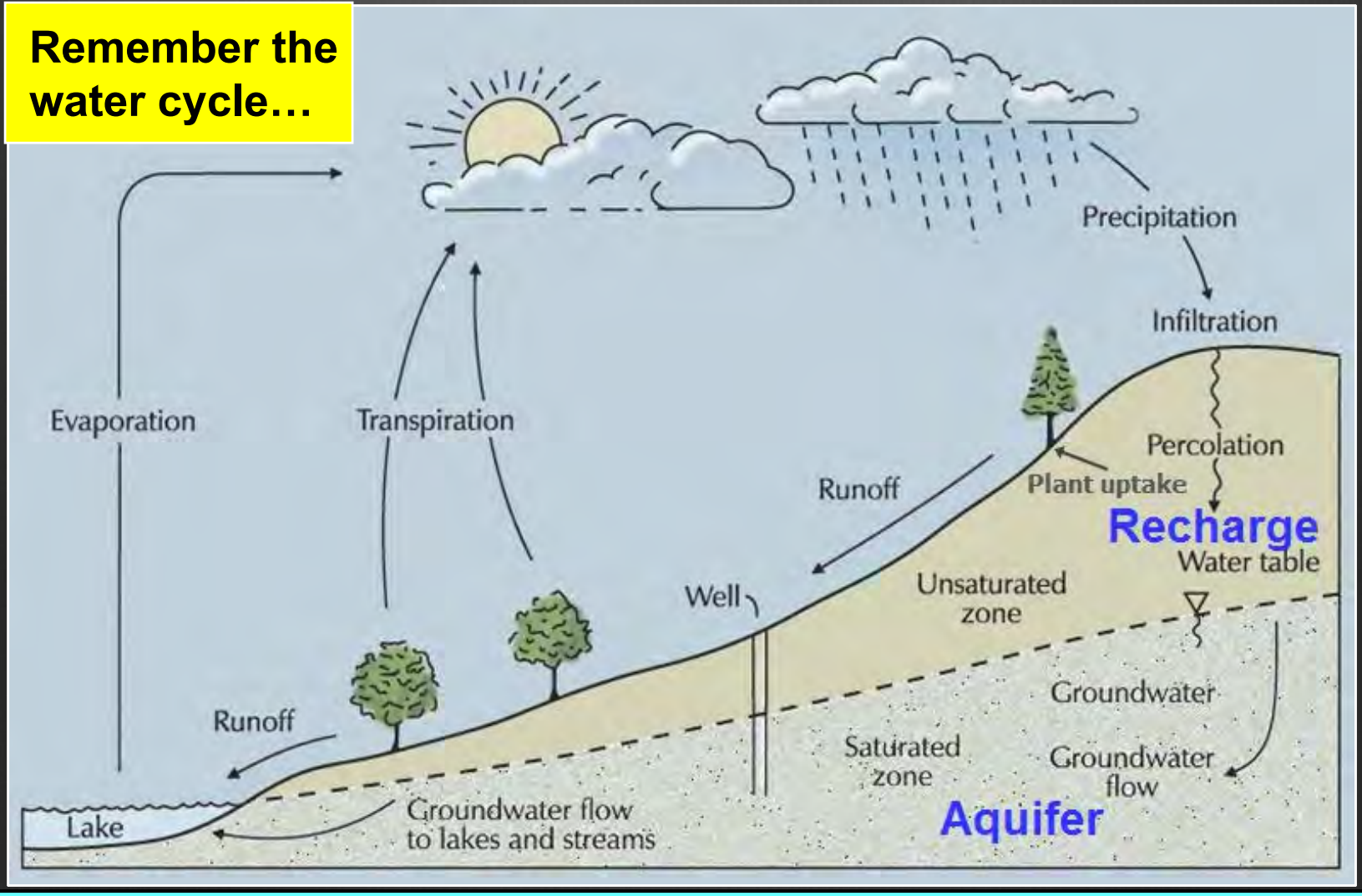
Hydrogeology

Remember the water cycle…



Recharge occurs everywhere on the landscape, not just the uplands…

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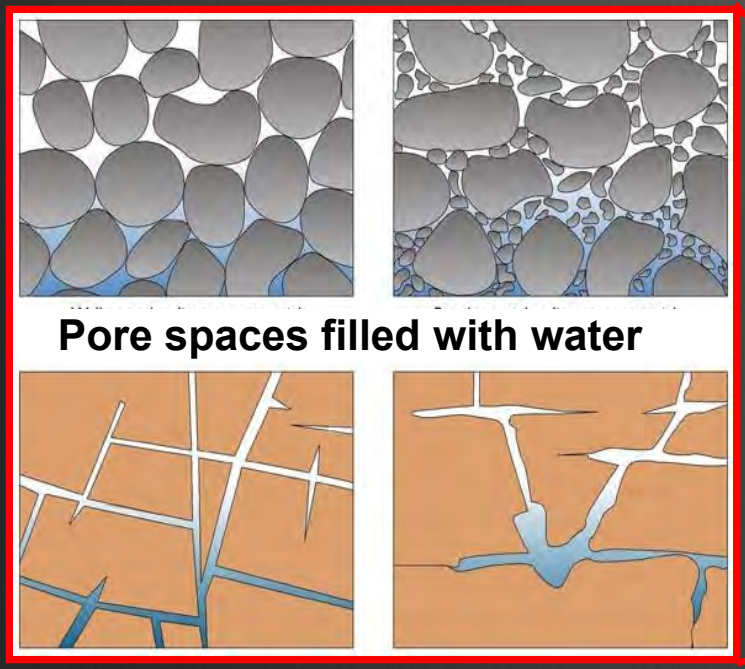
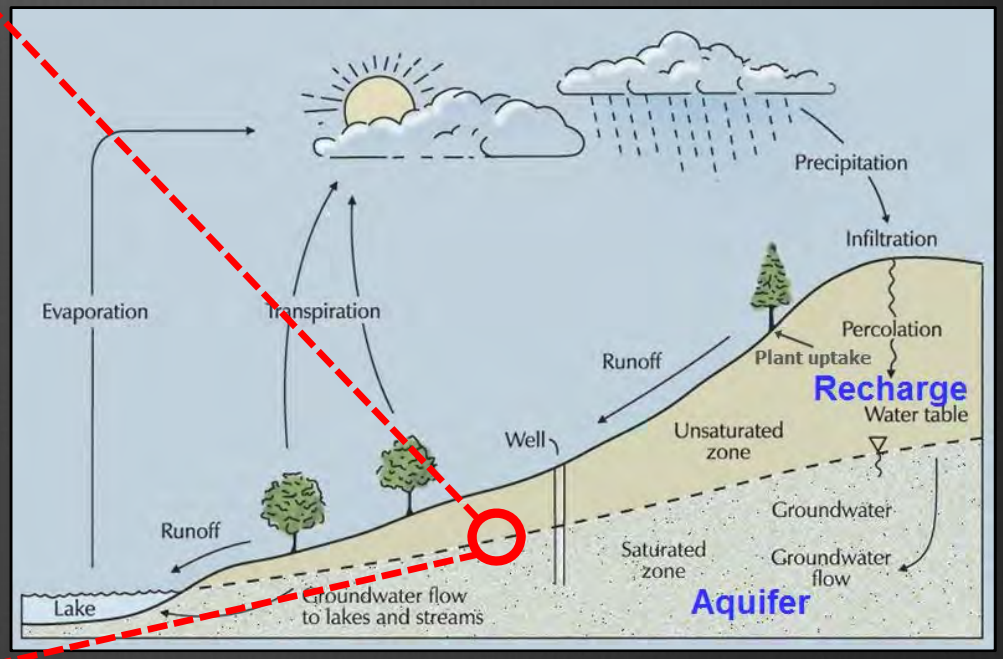
Hydrogeology

Groundwater fills pores, cracks, fractures and other voids in geologic materials





Once those spaces are filled, groundwater flows in response to gravity from high to low water levels.

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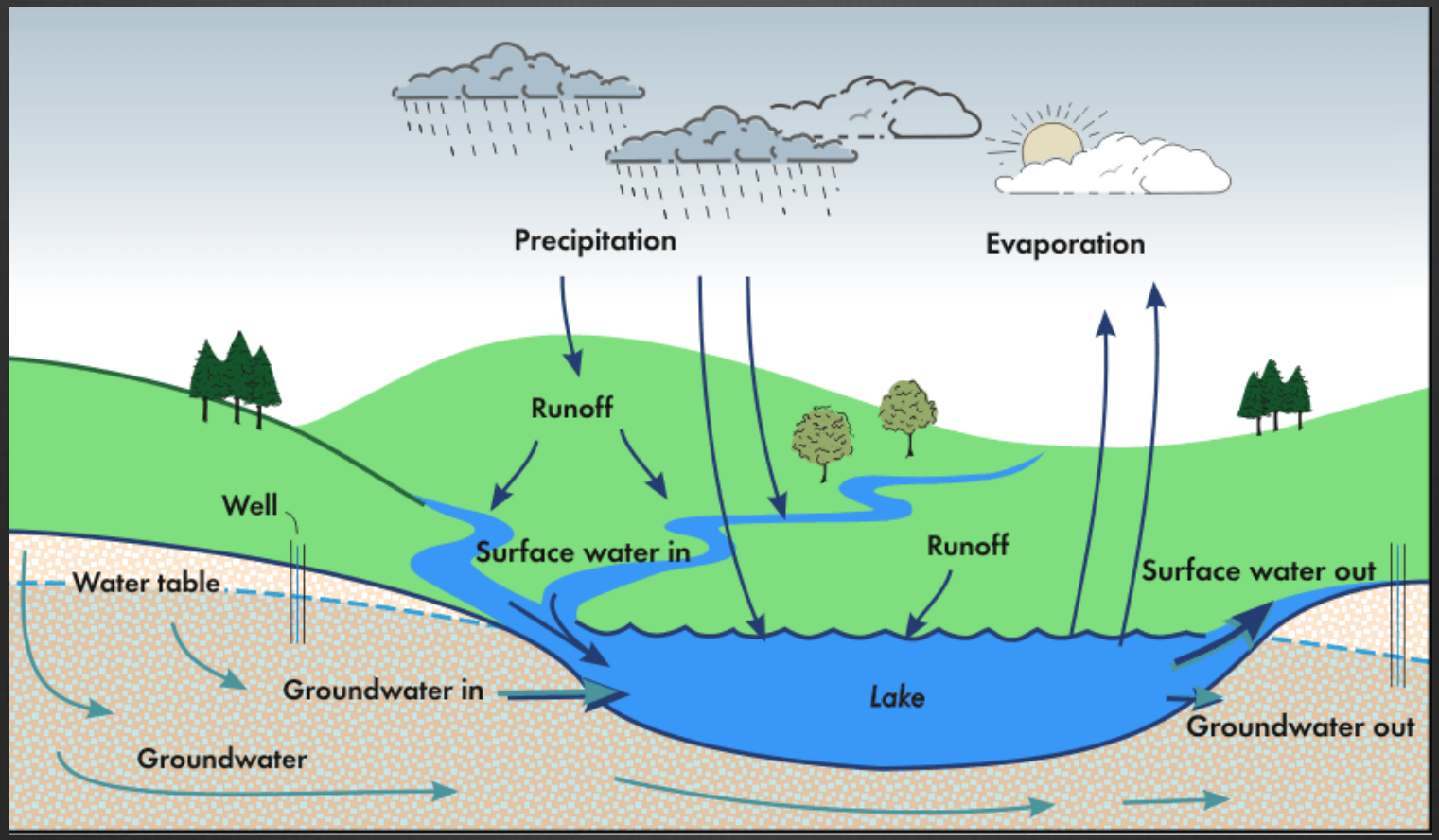
Water sources into and out of lakes are affected by: precipitation, temperature, runoff, streamflow, groundwater elevation, groundwater pumping



Adapted from USGS, 2002. Hydrology and Water Quality of Geneva Lake, Walworth County, Wisconsin

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Fish, Mud, and Crystal Lakes are seepage lakes, with no surface water inlets or outlets (runoff only)

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Issue isn't just budget for seepage lakes

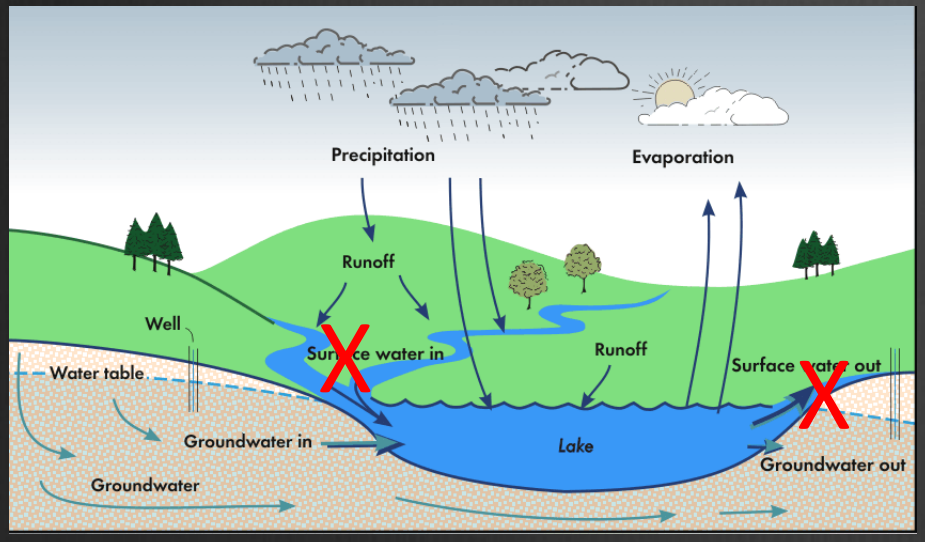
Inflows: Precipitation + Groundwater $_{in}$ + ~~Surface water $_{in}$~~ + Runoff

Outflows: Evaporation + Groundwater $_{out}$ + ~~Surface water $_{out}$~~

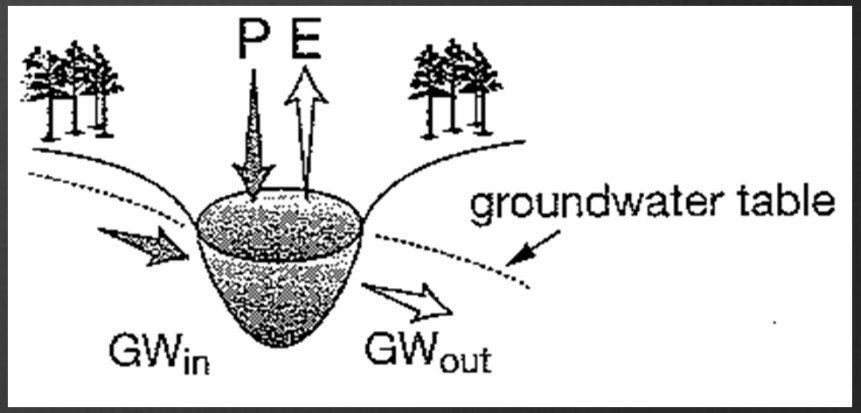
Water table elevation is also issue

High water table: lake is high and stays high

Low water table: lake is low and stays low



seepage lake



Webster et al, 2006

Fish and Crystal Lakes

Simulation of Fish, Mud, and Crystal Lakes and the Shallow Ground-Water System, Dane County, Wisconsin, 2002. USGS WRI Report 02-4014.

Krohelski, Lin, Rose, and Hunt

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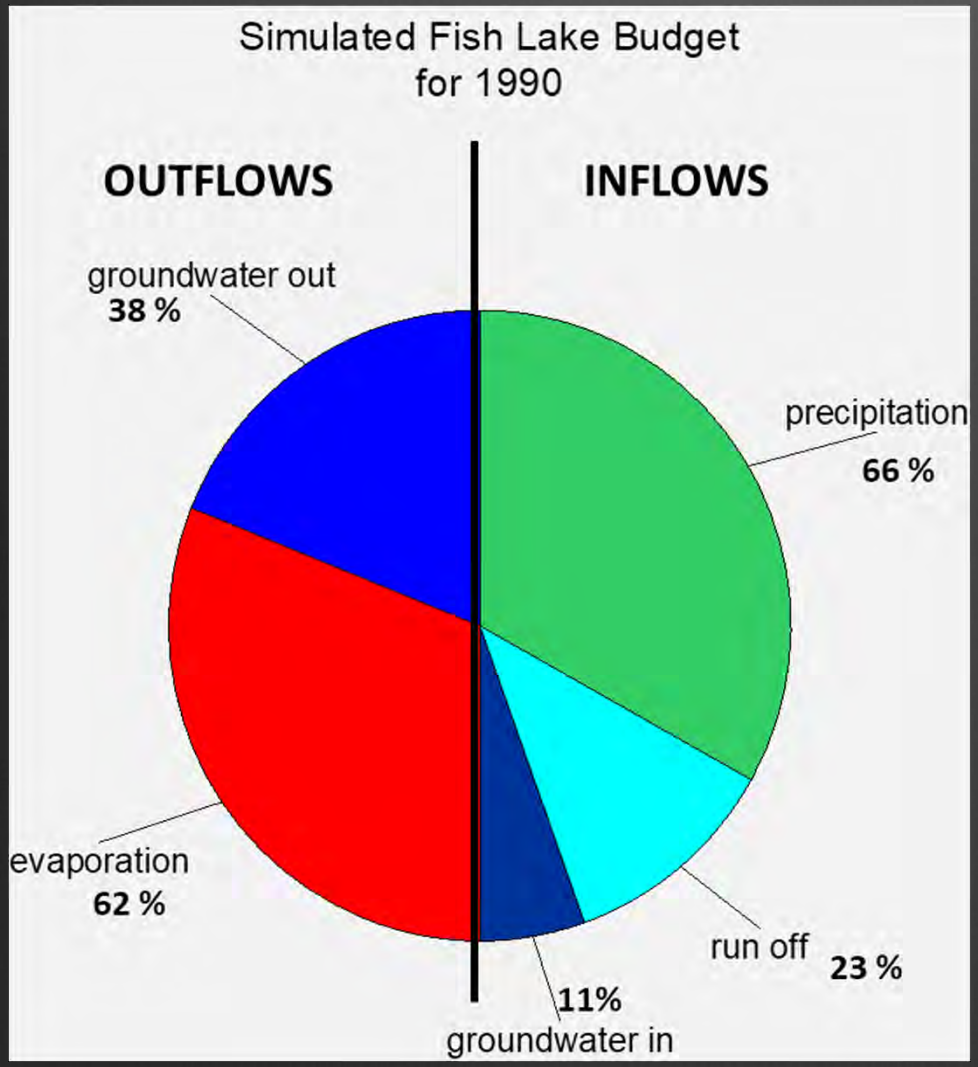
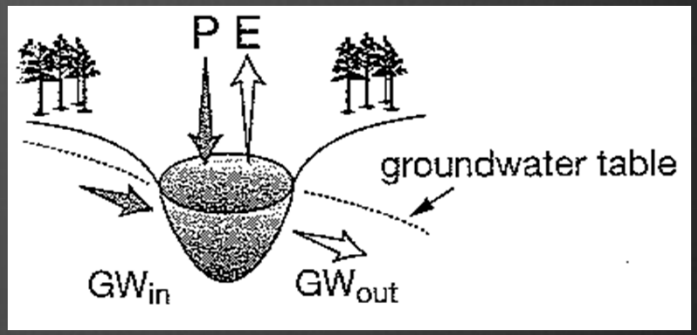
The USGS groundwater flow model simulates Fish Lake and the groundwater system.





Krohelski et al. 2002

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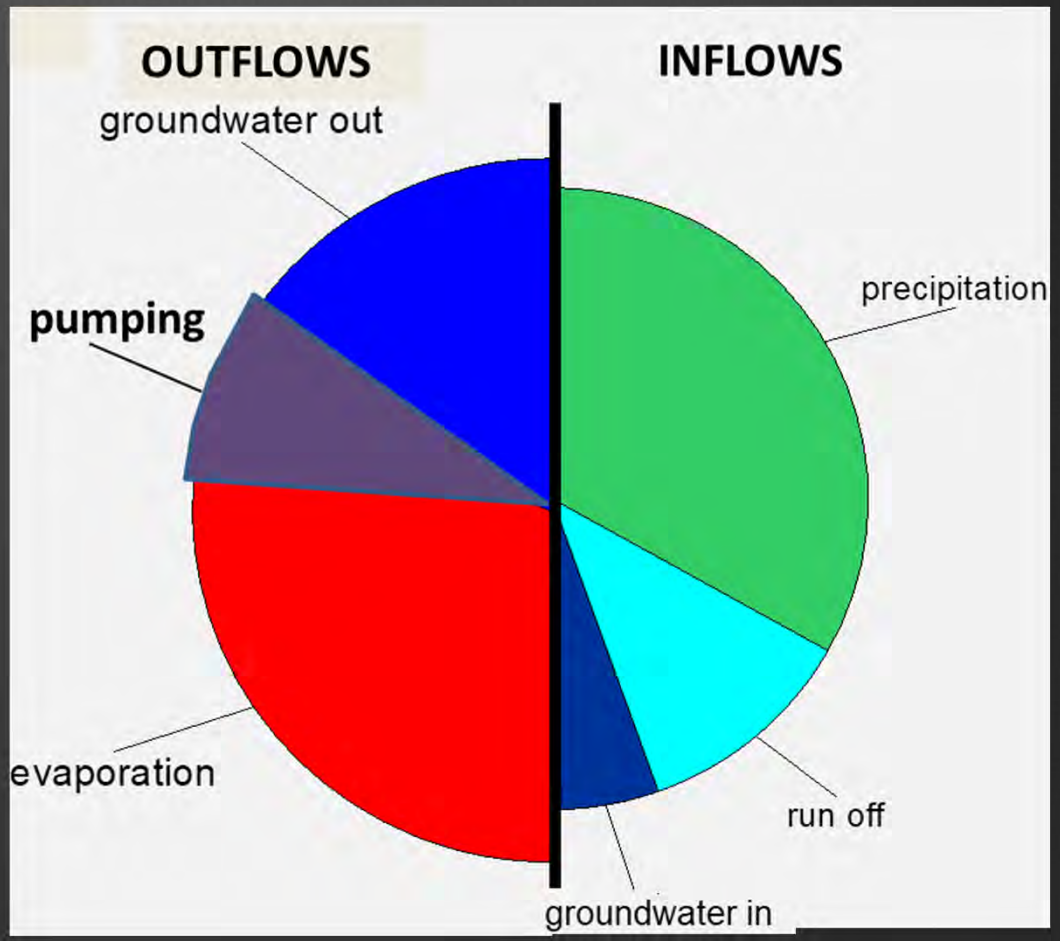
Model results indicate that near-continuous pumping (at 500 gpm) would lower Fish and Mud lakes by about 1-foot and lower Crystal Lake by less than 0.2 feet, *assuming 1990s climate.*

Change in lake budget due to pumping: Outflows exceed inflows, and lake stage declines.



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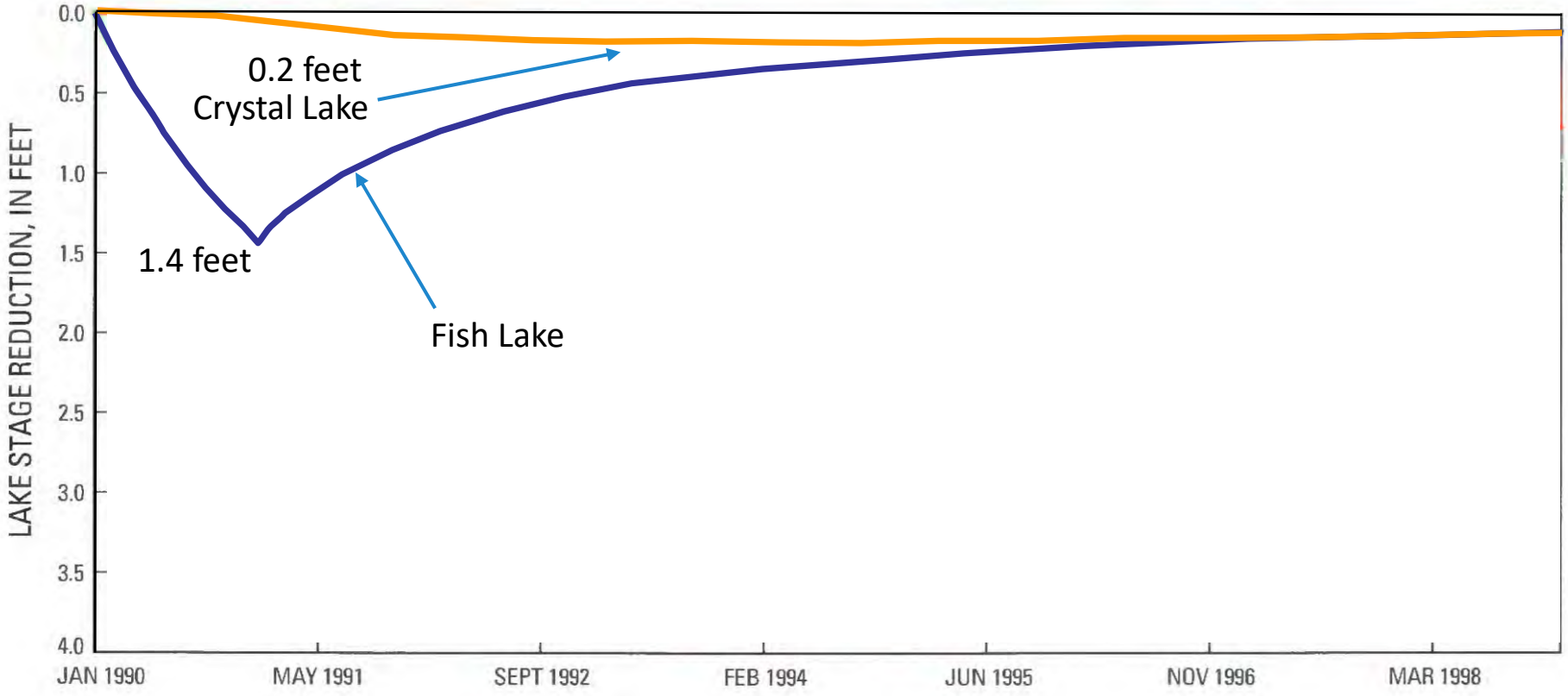

Scenario 1: Fish Lake pumped at 500 gpm for 1 year (Jan 1990 – Jan 1991).

- Drawdown isn't permanent. Fish Lake levels start recovering immediately as groundwater refills the lakes. Crystal Lake stage continues to decrease for 2 years before gradually recovering.

- Both Lakes recover to within 0.1 ft of initial stage after 8 years.

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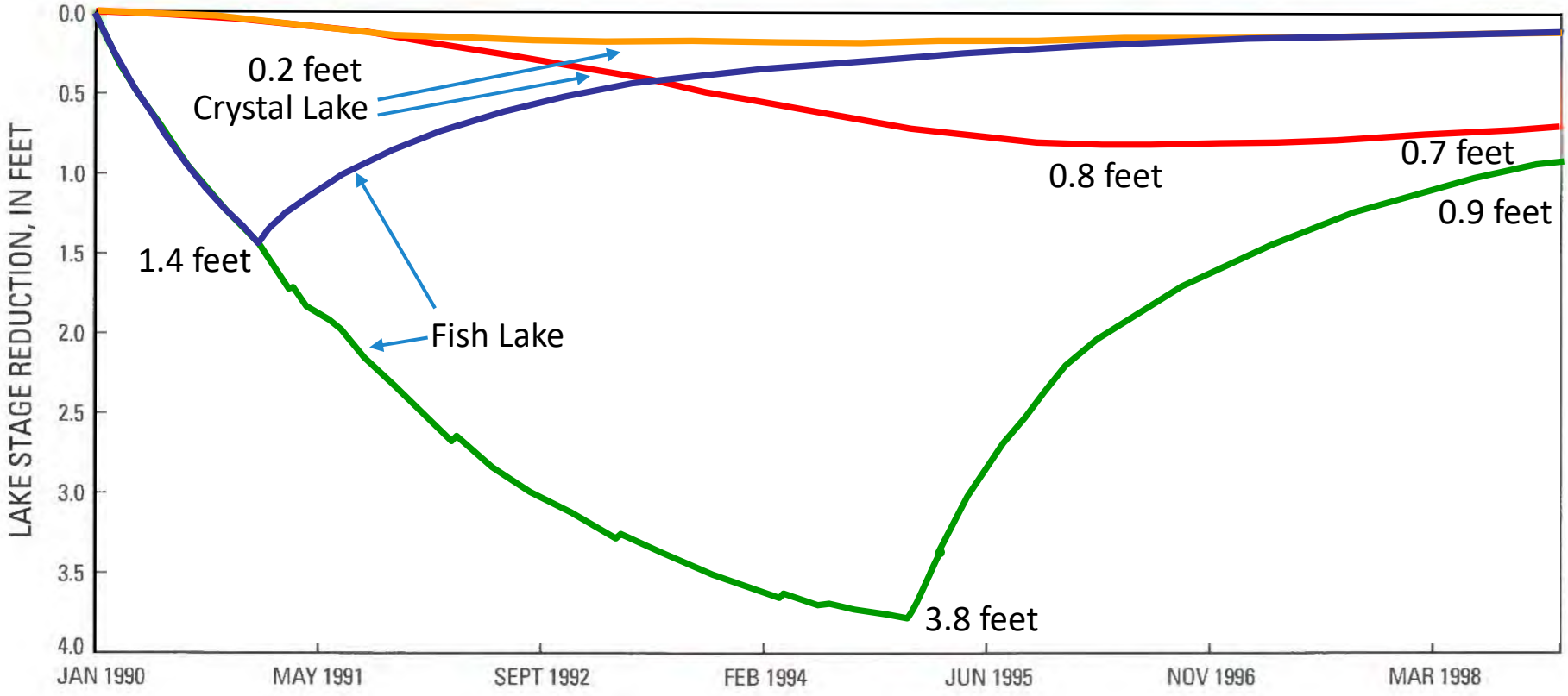

<u>Scenario 2</u>: Fish Lake pumped at 500 gpm for <u>5 years</u> (Jan 1990 – Jan 1995).

- Fish Lake levels drop to 3.8’ below initial level but start recovering immediately as groundwater refills the lakes. Crystal Lake stage continues to decrease for ~1 year (to 0.8’ below initial stage) before gradually recovering.

- After 8 years, Fish and Crystal Lakes recover to within 0.9’ and 0.7’ of initial lake stage, respectively.

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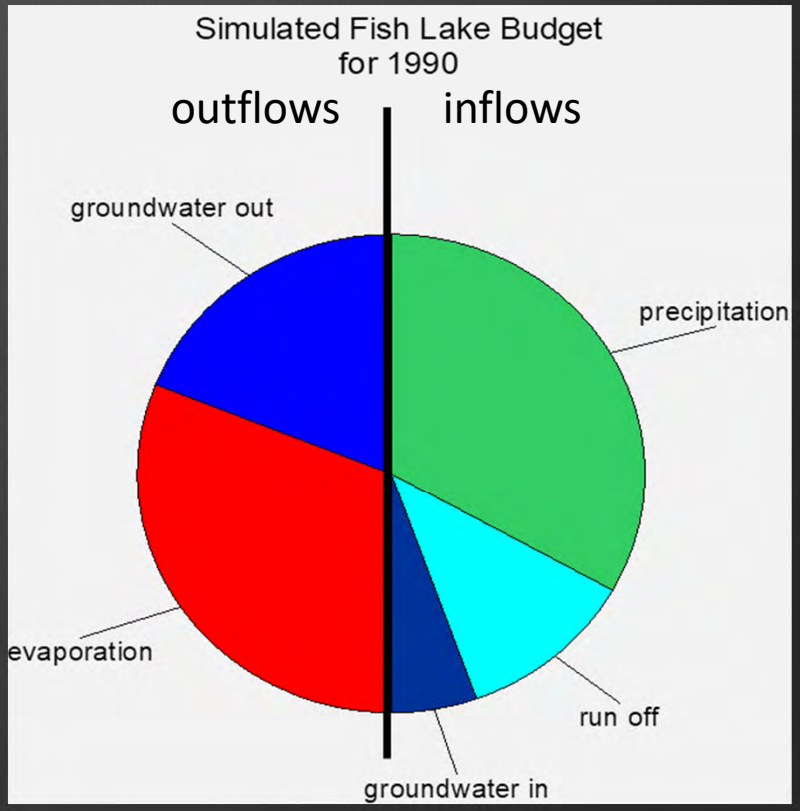
Hypothesized long-term changes in Fish Lake's budget and stage caused by?

- increase in precipitation
- increase in recharge and water table rise
- increase in runoff
- decrease in permeability of lake sediment

First three causes are all driven by precipitation.

So what are precipitation and groundwater levels doing?



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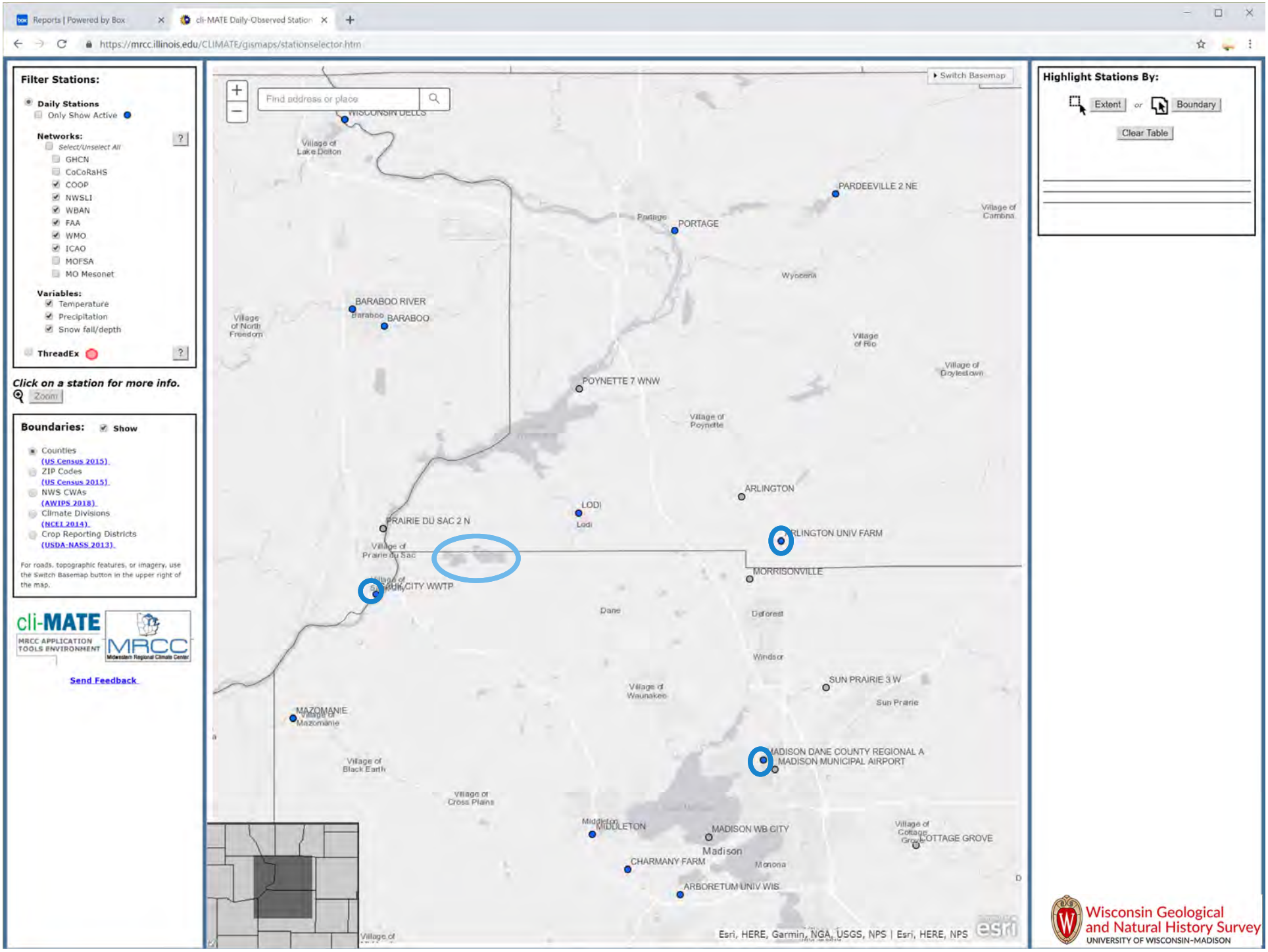
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Precipitation
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(US Census 2015)
ZIP Codes
(US Census 2015)
NWS CWAs
(AWIPS 2018)
Climate Divisions
(NCEI 2014)
Crop Reporting Districts
(USDA-NASS 2013)
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Baraboo
BARABOO
Village of North Freedom
Village of Rio
Village of Doylestown
POYNETTE 7 WNW
Village of Poynette
ARLINGTON
LODI
Lodi
PRAIRIE DU SAC 2 N
Village of Prairie du Sac
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MORRISONVILLE
PRAIRIE DU SAC CITY WWTP
Dane
DeForest
Windsor
SUN PRAIRIE 3 W
Village of Waunakee
Sun Prairie
MAZOMANIE
Village of Mazomanie
MADISON DANE COUNTY REGIONAL A
MADISON MUNICIPAL AIRPORT
Village of Black Earth
Village of Cross Plains
Middleton
MIDDLETON
MADISON WB CITY
Madison
Village of Cottage Grove
COTTAGE GROVE
CHARMANY FARM
Monona
ARBORETUM UNIV WIS
Village of
Esri, HERE, Garmin, NGA, USGS, NPS | Esri, HERE, NPS
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Highlight Stations By:
Extent
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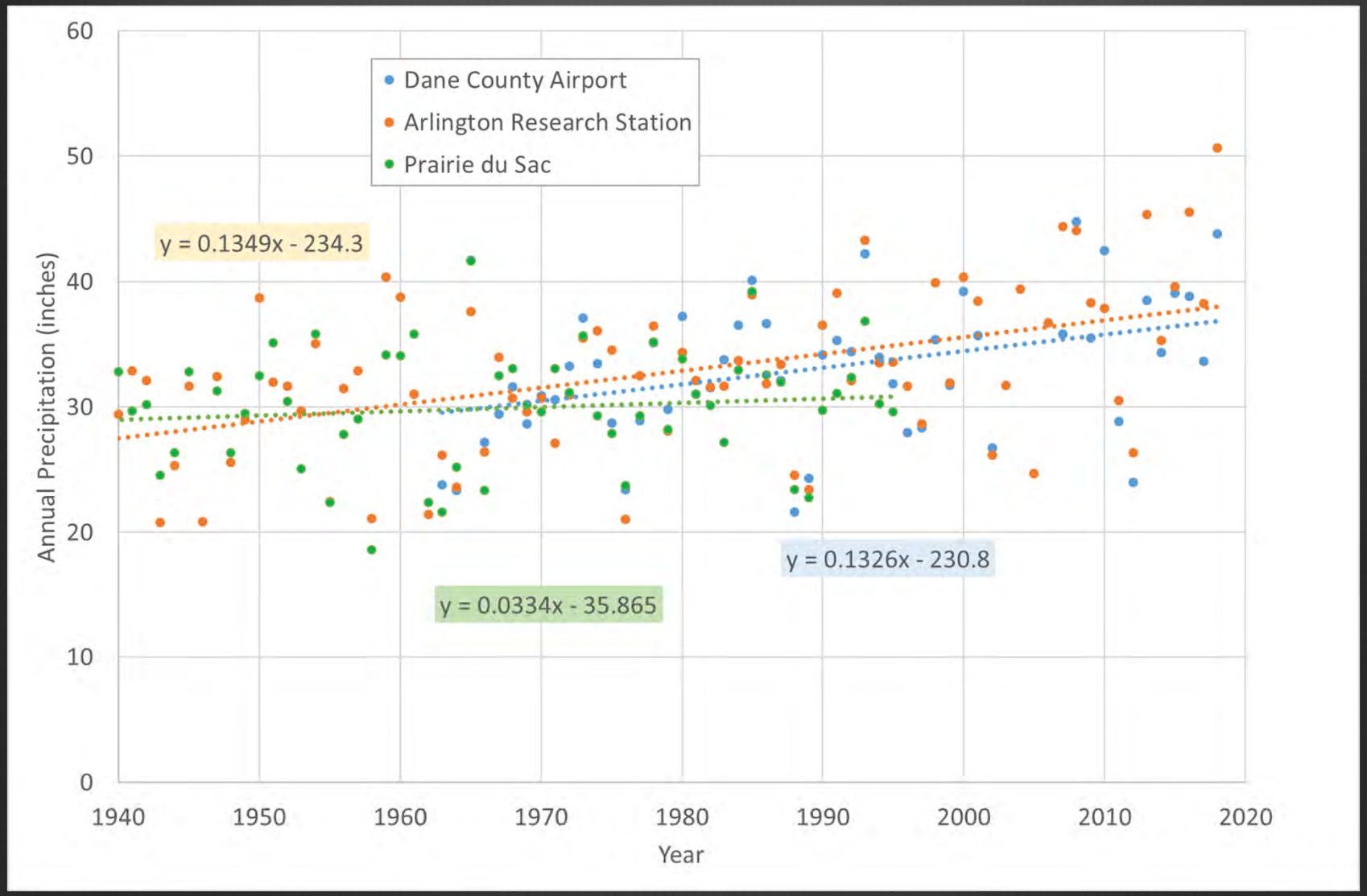
Precipitation and temperature trends at nearby and longer term weather stations



Midwestern Regional Climate Center

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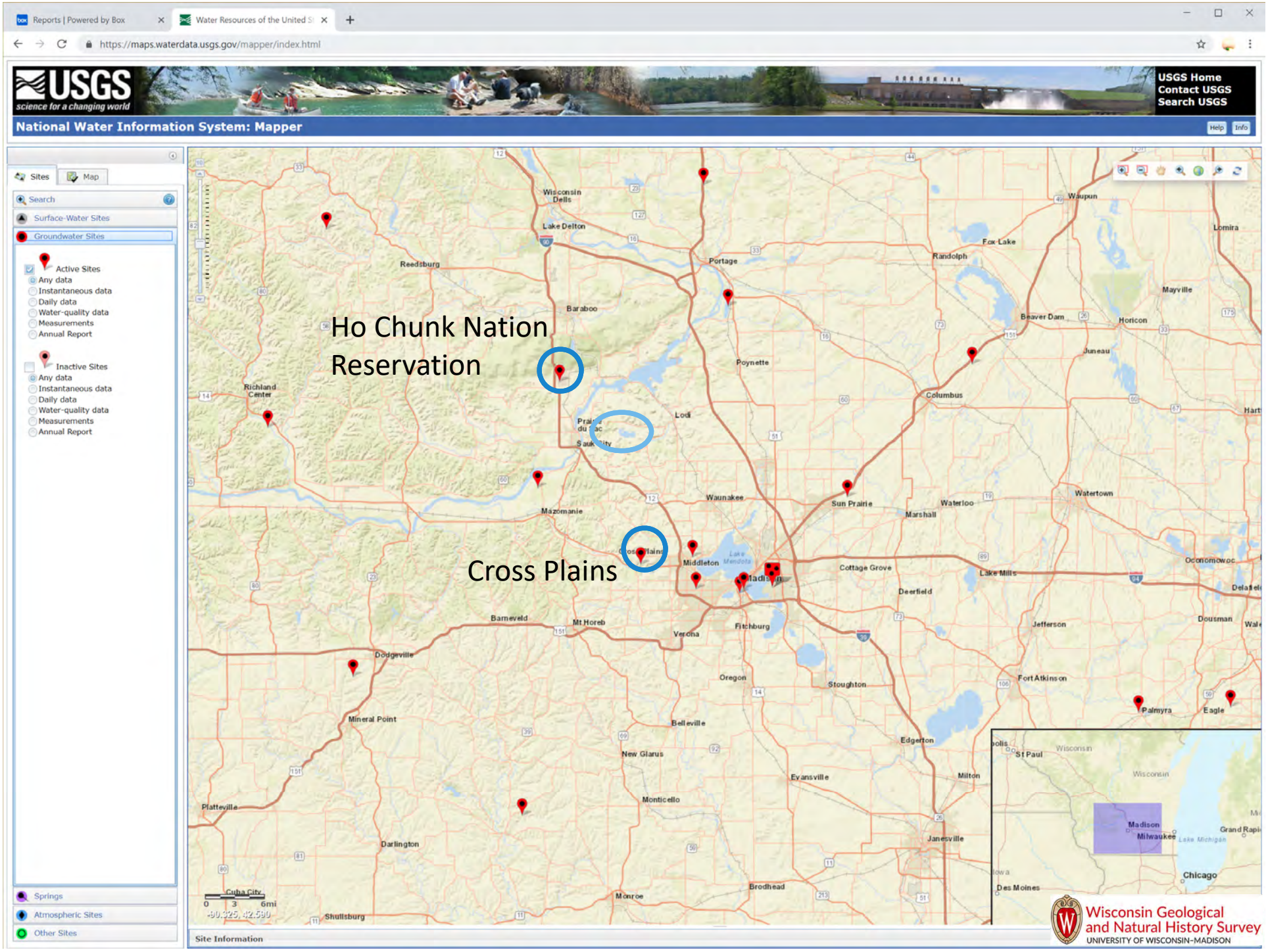
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Groundwater Sites
Active Sites
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Daily data
Water-quality data
Measurements
Annual Report
Inactive Sites
Any data
Instantaneous data
Daily data
Water-quality data
Measurements
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Atmospheric Sites
Other Sites
Ho Chunk Nation Reservation
Cross Plains
Wisconsin Dells
Lake Delton
Reedsburg
Baraboo
Portage
Waupun
Lomira
Fox Lake
Randolph
Mayville
Beaver Dam
Horicon
Juneau
Poynette
Columbus
Richland Center
Lodi
Waunakee
Sun Prairie
Marshall
Waterloo
Watertown
Mazomanie
Middleton
Cottage Grove
Lake Mills
Oconomowoc
Deerfield
Barneveld
Mt Horeb
Verona
Fitchburg
Jefferson
Dousman
Dodgeville
Oregon
Stoughton
Fort Atkinson
Palmyra
Eagle
Mineral Point
Belleville
Edgerton
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Milton
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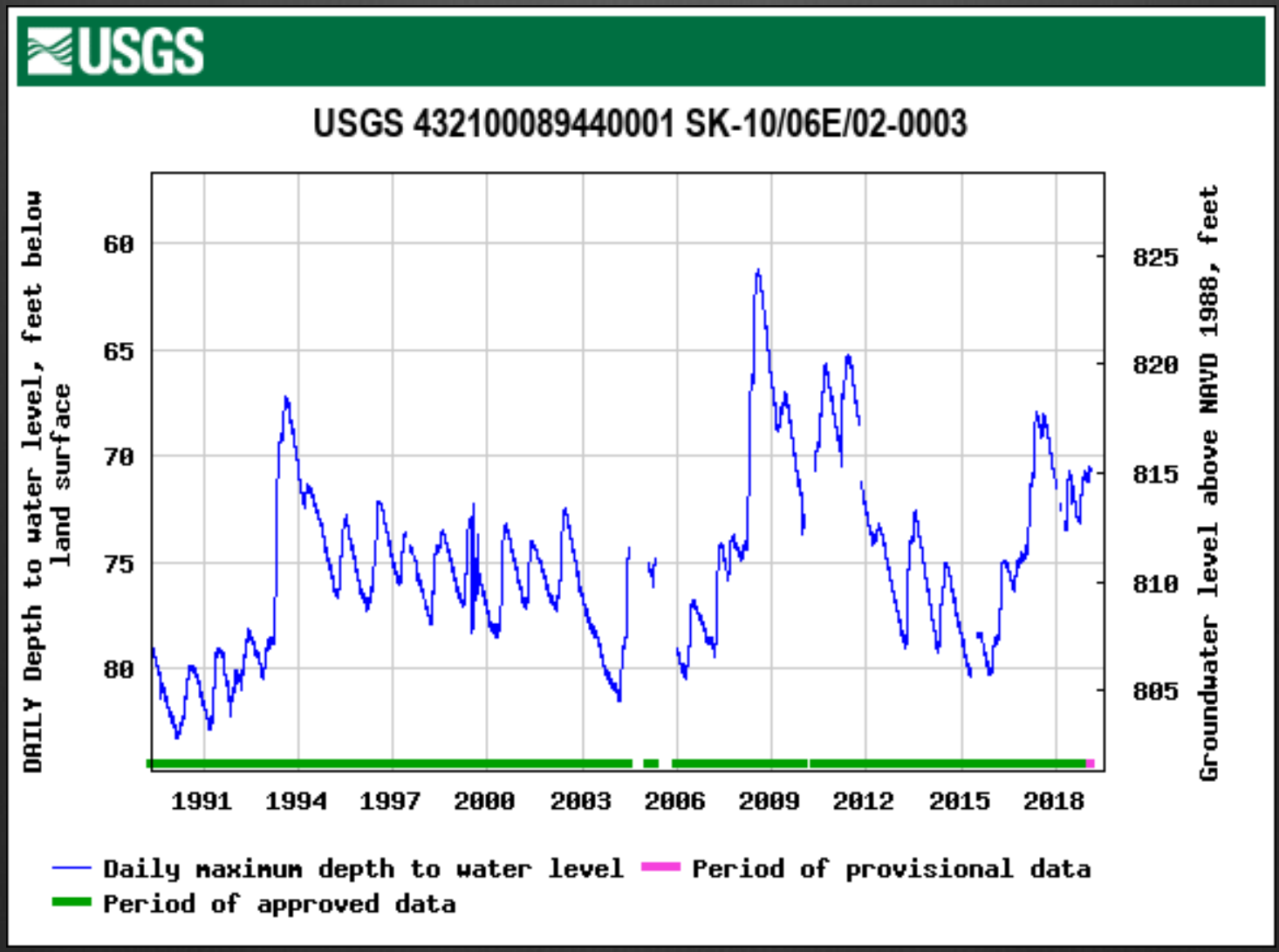
Groundwater level trends at nearby and longer term monitoring wells Ho Chunk Nation Reservation, WI



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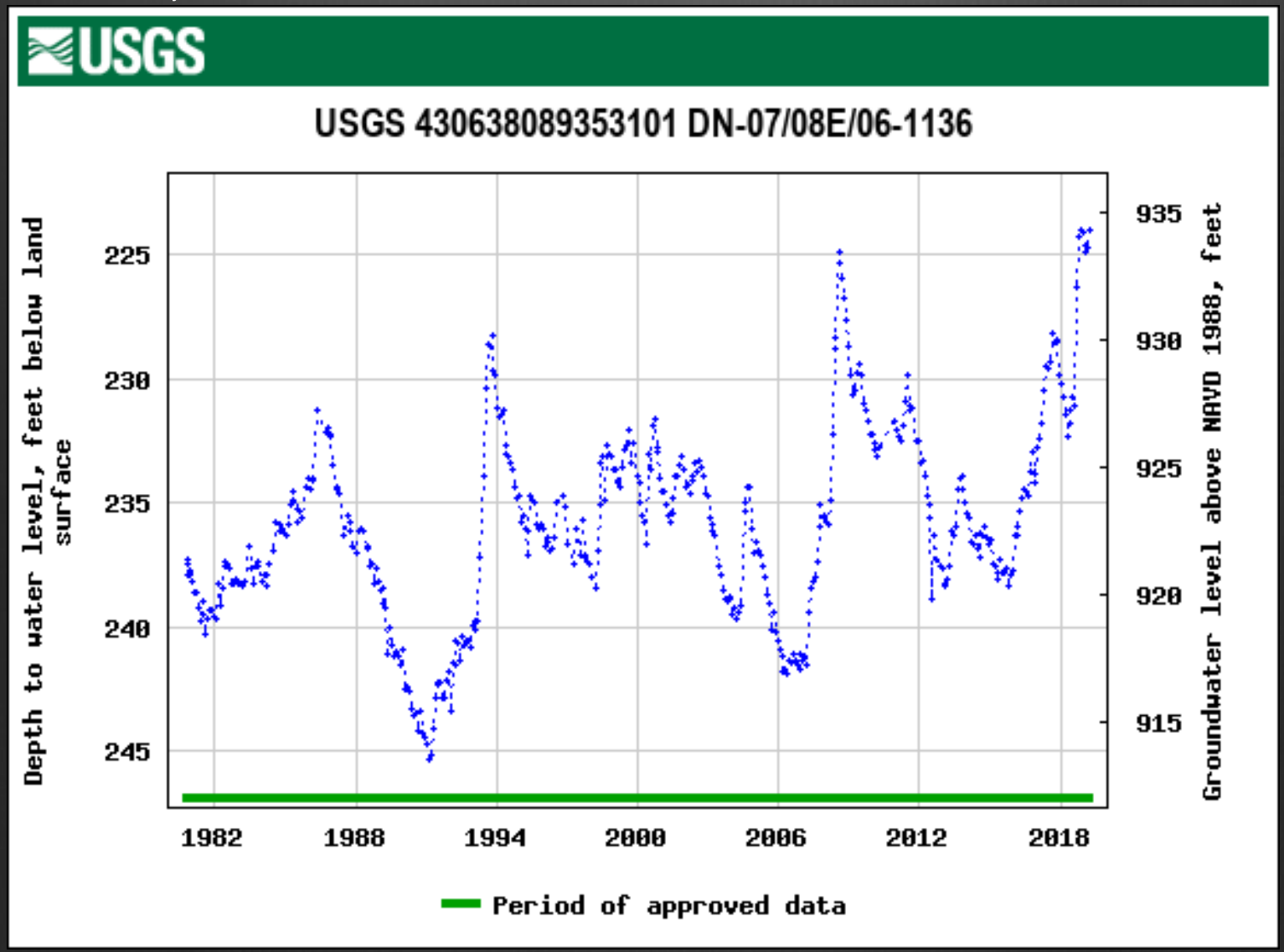
Groundwater level trends at nearby and longer term monitoring wells Cross Plains, WI



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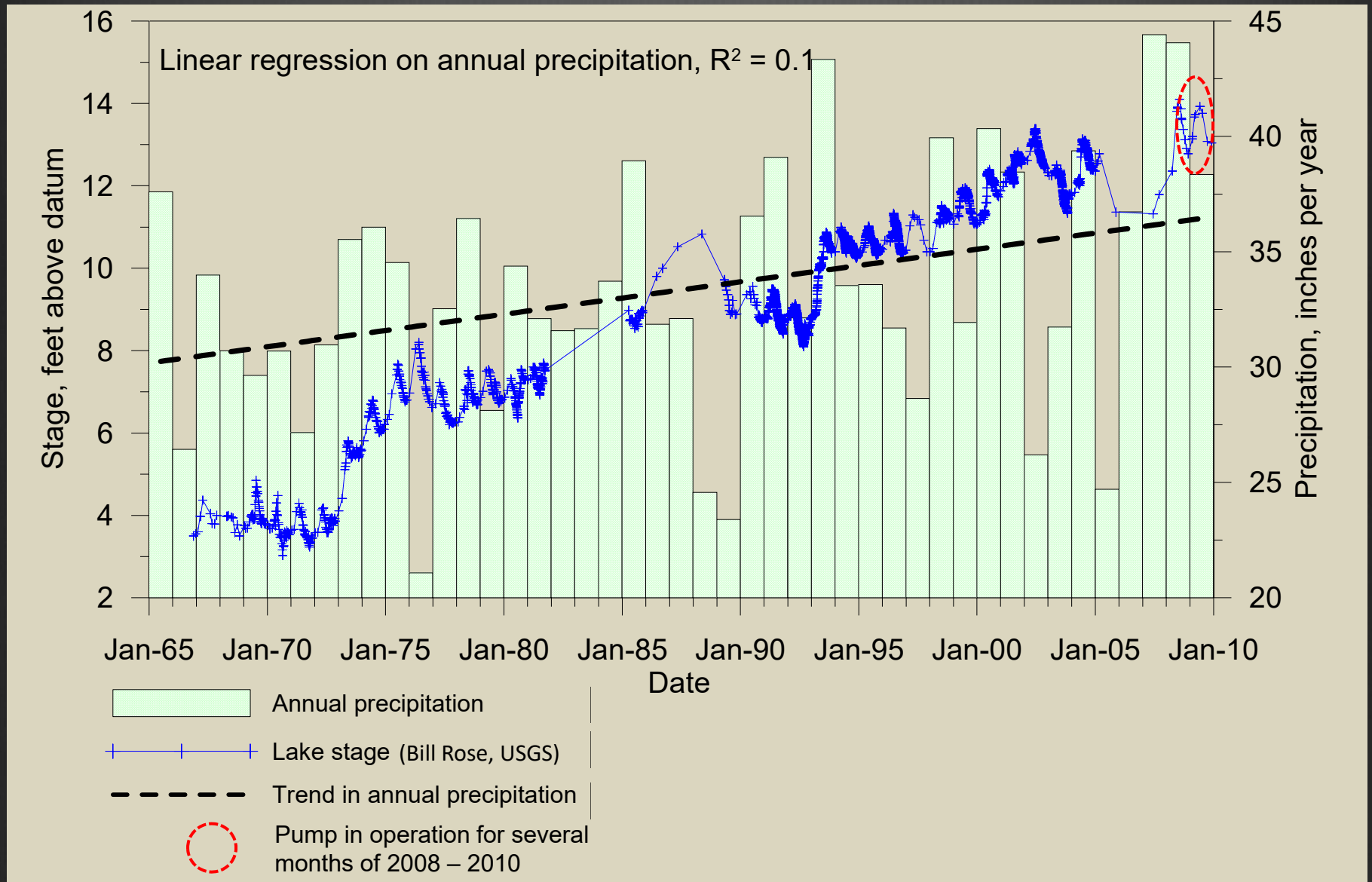
Fish Lake's stage has increased 8 to 9 feet over 40 years.



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Baseflow, another line of evidence for rising groundwater levels…

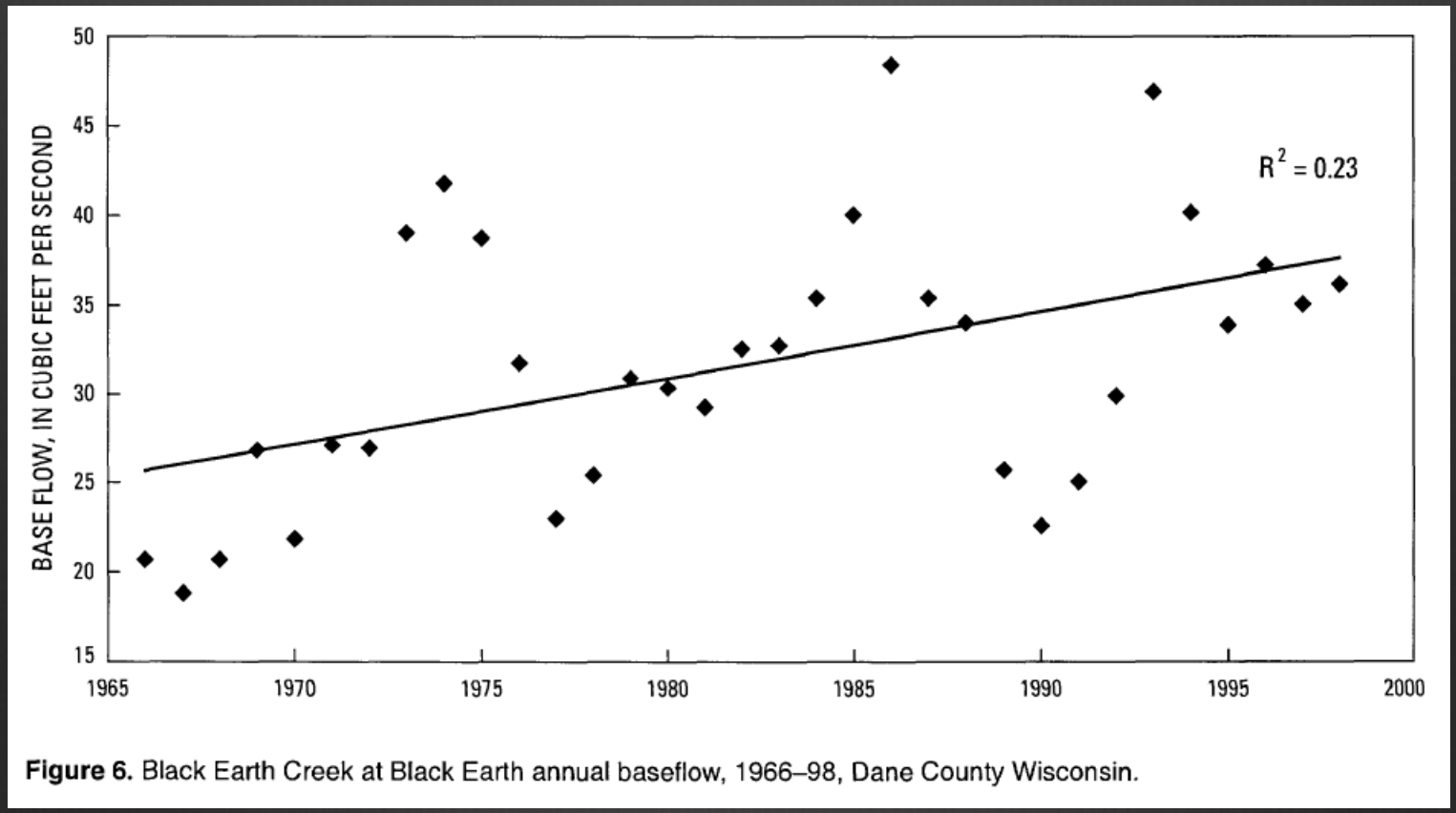

Figure 6. Black Earth Creek at Black Earth annual baseflow, 1966–98, Dane County Wisconsin.

Krohelski et al, 2002

↑ Precip. & ↑ recharge = ↑ lake/well stage & ↑ stream baseflow

A couple other recent studies…

Hydrogeology investigation – Johnson, Gotkowitz (2012)

UW Extension WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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James M. Robertson
Director and State Geologist

Evaluation of groundwater pumping to reduce the level of Crystal Lake Columbia County, Wisconsin

Report prepared for the Crystal, Fish, and Mud Lake District

Scott Johnson
Madeline Gotkowitz

2012

Open-File Report 2012-05

Hydrogeology investigation – Johnson, Gotkowitz (2012)

- In 2010, after years of pumping water from Fish Lake to control lake stage, the District began plans for a similar installation at Crystal Lake.
- Concerns about lake water quality and the effects of discharging lake water directly to Roxbury Creek led to a feasibility study of pumping groundwater from wells next to Crystal Lake.
- **The study was commissioned by the Crystal, Fish and Mud Lake District (District) and completed in July 2012.**
- This study evaluated the feasibility of lowering the water level of Crystal Lake by pumping groundwater from a near-by well or wells.

  → Concluded that it is not feasible to lower the level of Crystal Lake by pumping groundwater since the observed shallow sediment is too fined grained and exhibits low hydraulic permeability.

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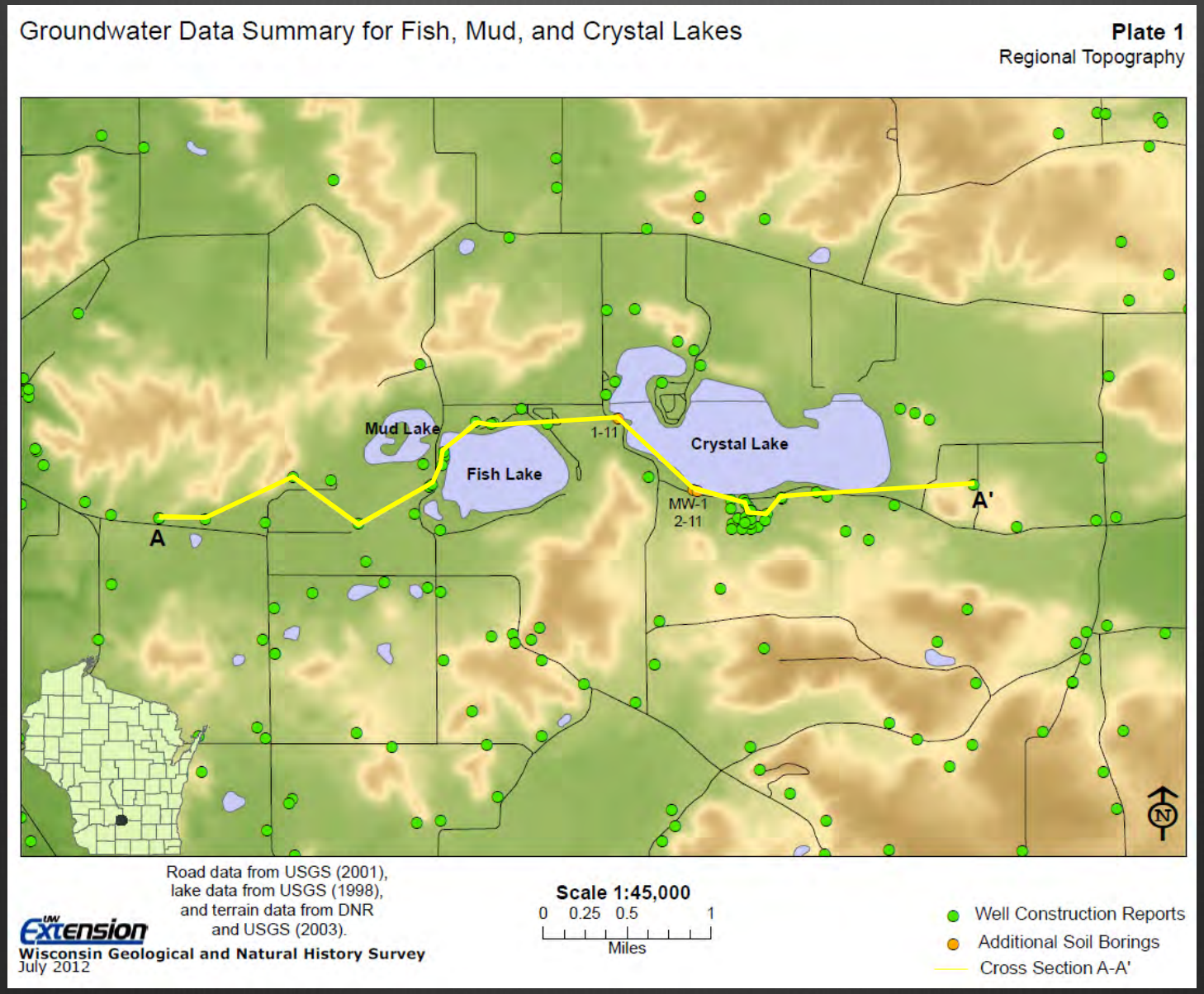
Hydrogeology investigation – Johnson, Gotkowitz (2012)



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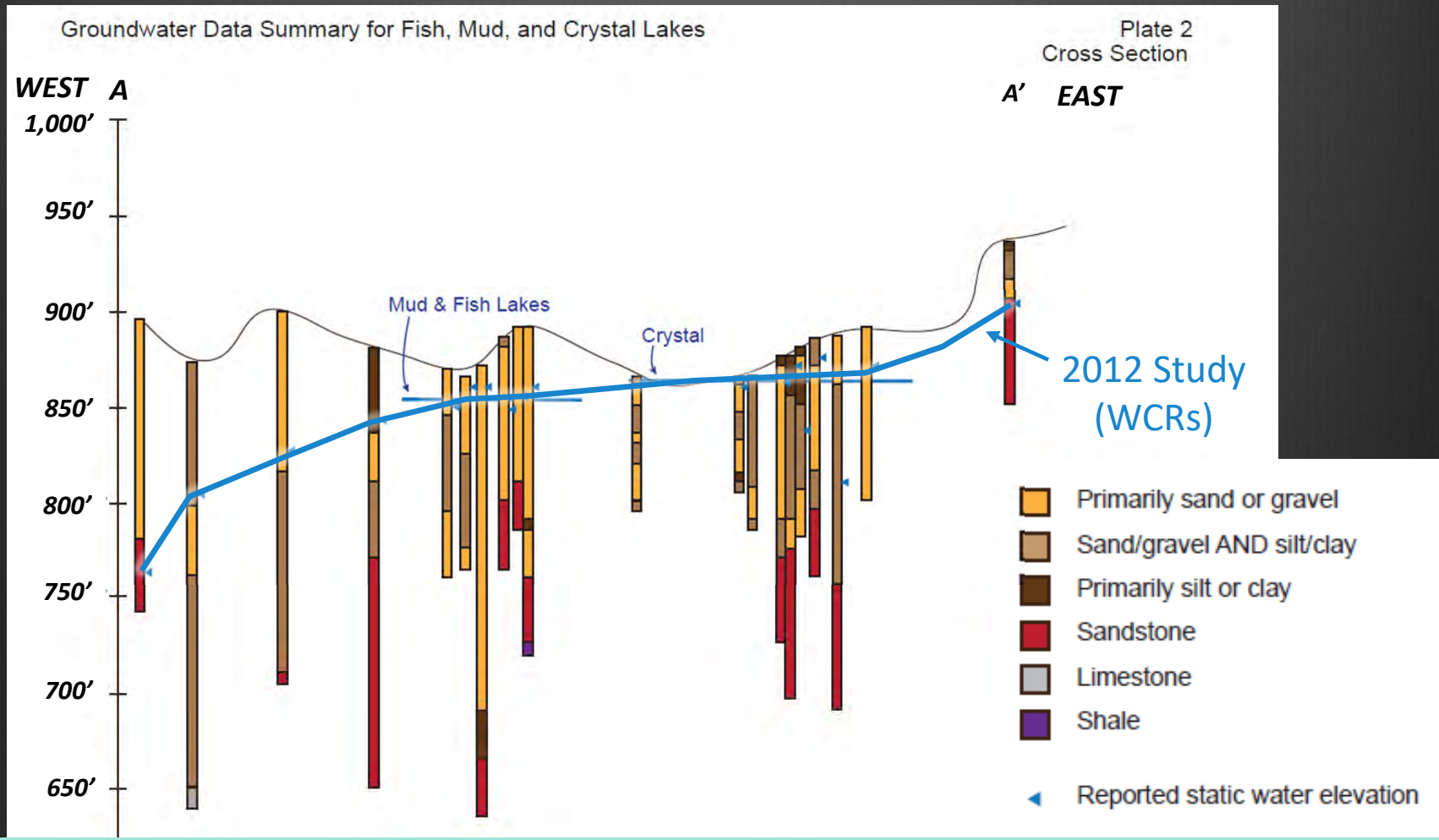
Hydrogeology investigation – Johnson, Gotkowitz (2012)



WI River 730'

"Correlation of continuous bodies of sediment along the cross section, such as lenses of sand, was difficult due to the heterogeneous nature of the sediment in the lake basin"

"…these drilling records as a whole indicate that sediment beneath Crystal Lake is finer-grained than sediment underlying Fish and Mud Lakes." (Coarsens to west)

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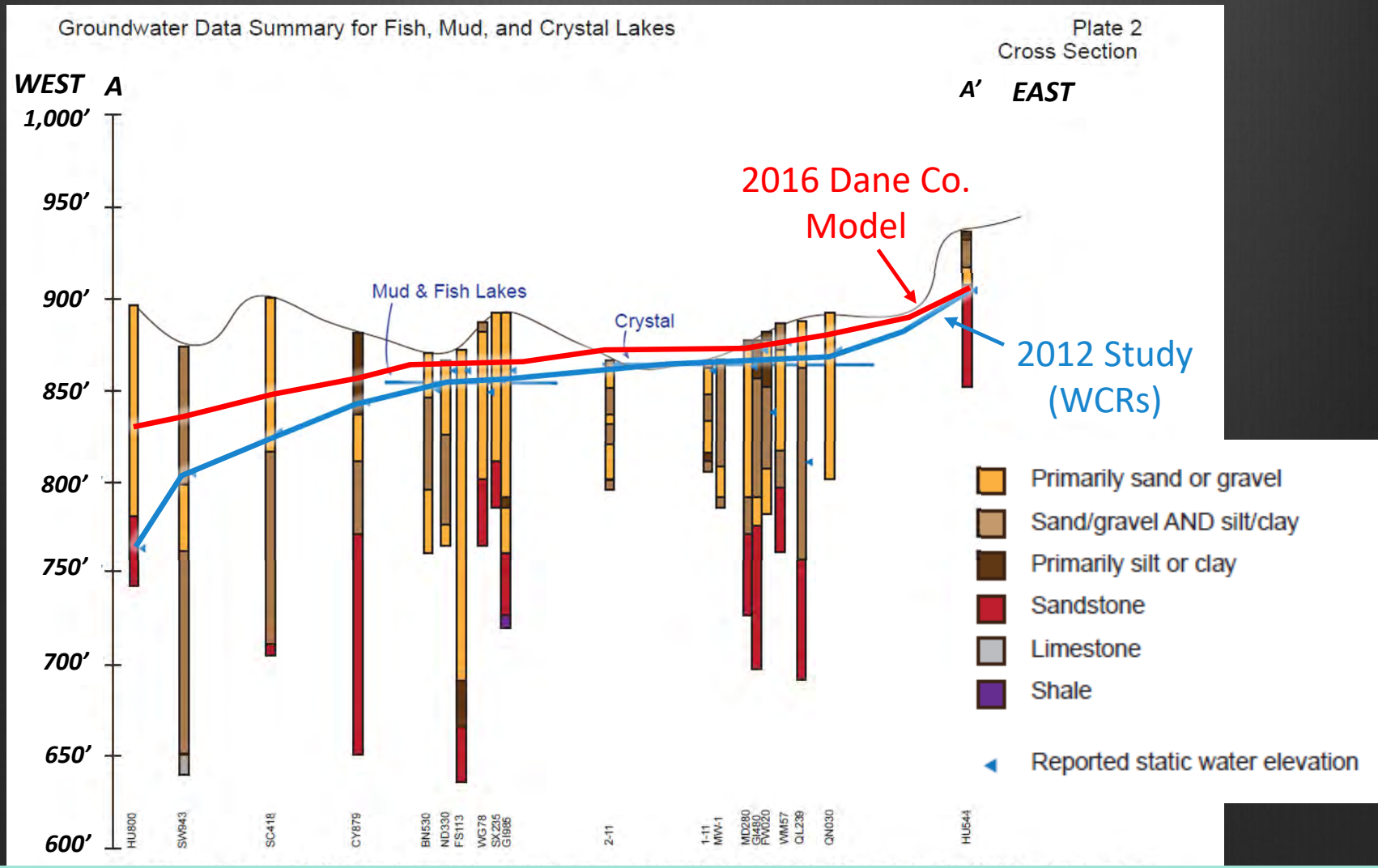
Hydrogeology investigation – Johnson, Gotkowitz (2012)



Well construction records (WCRs) shown in this 2012 report and the 2016 Dane Co. model suggest that water levels drop markedly west of Fish/Mud Lake

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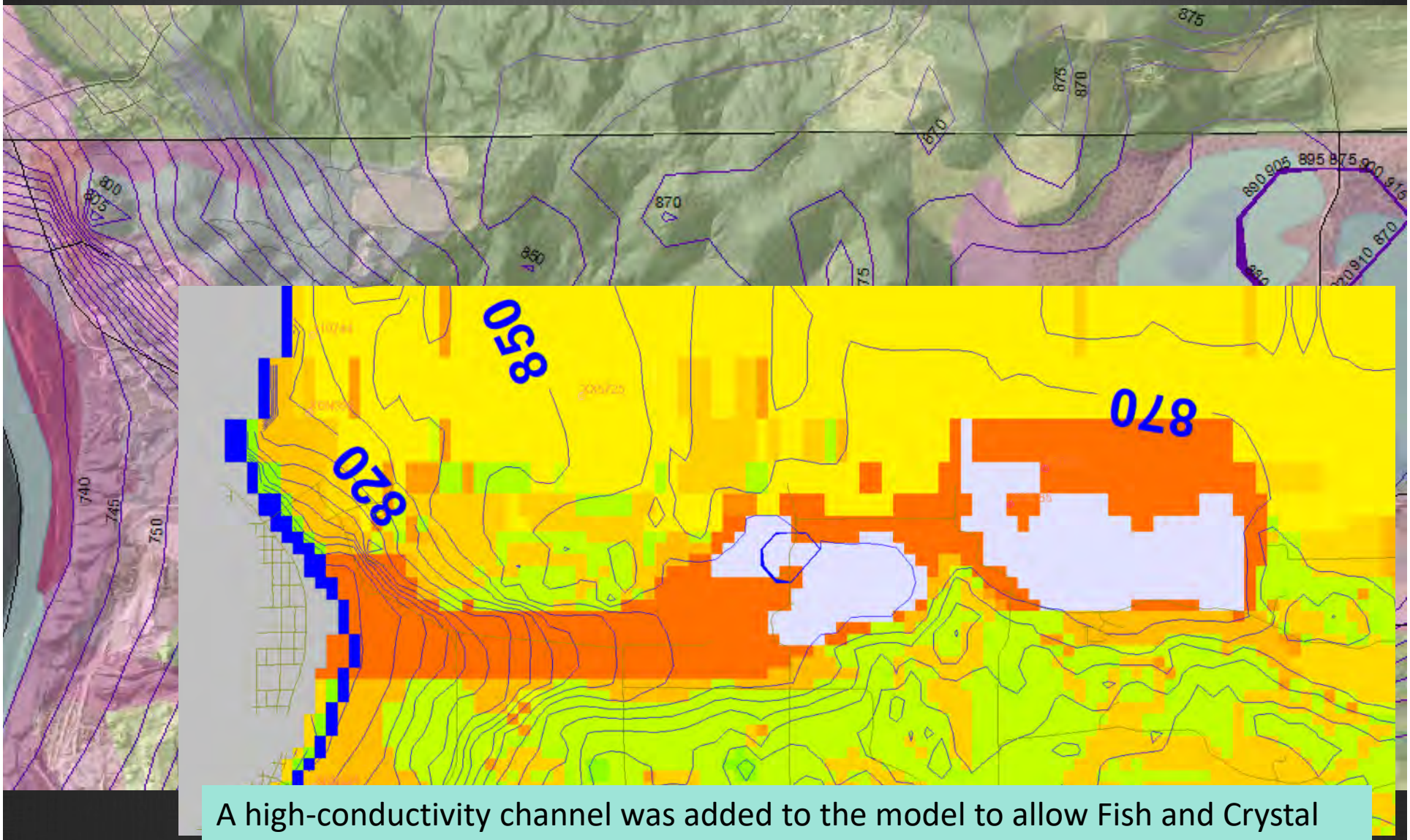
Dane Co. Groundwater Model – Parsen et al (2016)



A high-conductivity channel was added to the model to allow Fish and Crystal Lakes to hit lake-stage targets (~860 ft-msl). Kxy = 300 ft/d; Kv = 150 ft/d

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Some observations

- Mud, Fish, and Crystal Lakes are kettle lakes within a meltwater stream (tunnel channel) corridor and are well connected to groundwater
- Fine grained sediments observed in proximity to lakes
- Evidence of coarsening sediments to west, within this meltwater/tunnel channel corridor
- Precipitation rates are observed to slowly increase over time
- Groundwater and Lake Level trends seem to generally be increasing over time; long-term baseflow in nearby streams (e.g., Black Earth Cr.) has also risen
- Higher lake levels due to ↑ precipitation (↑ runoff & ↑ GW recharge)
- Steep hydraulic gradient from lakes to Wisconsin River
- Sediment variability poorly constrained west of Fish/Mud Lake
- Uncertainty regarding water-level elevations west of Fish/Mud Lake

Fish/Mud & Crystal Lakes

Geology and hydrogeology overview

Questions?

Dane County Technical Advisory Board Meeting – 6/23/2021

Mike Parsen (Hydrogeologist)
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Dr. David Hart (Hydrogeologist)
david.hart@wisc.edu

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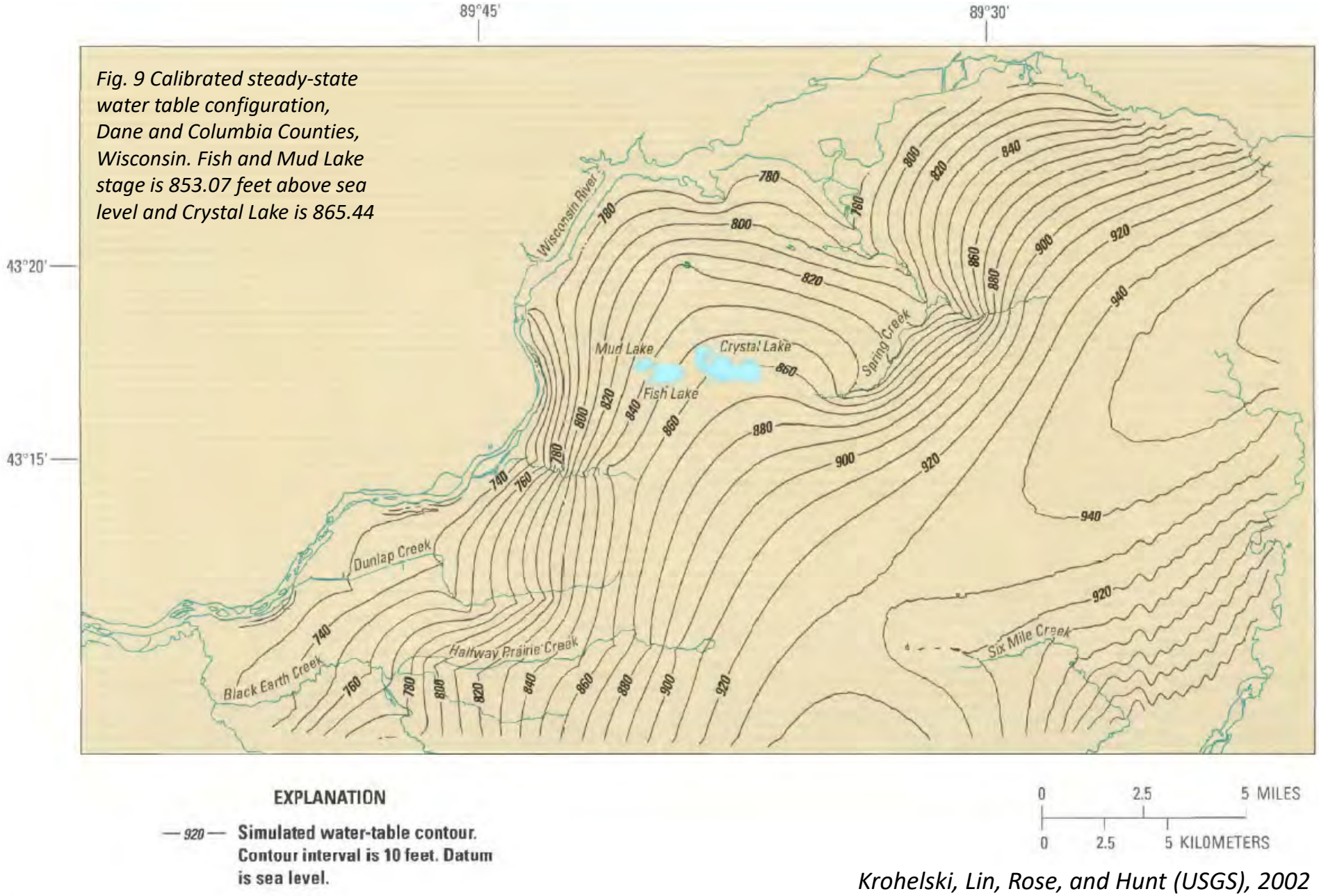

Fig. 9 Calibrated steady-state water table configuration, Dane and Columbia Counties, Wisconsin. Fish and Mud Lake stage is 853.07 feet above sea level and Crystal Lake is 865.44

Krohelski, Lin, Rose, and Hunt (USGS), 2002

Mike and Dave pointed out that there are very few surface water features which serve as an outlet for groundwater in this area and that the "groundwater shed" of Fish, Mud, Crystal Lakes may extend east of the surface watershed (basin).

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Land Use Impacts

Fish Lake Technical Advisory Group

Friday, July 23, 2021

DANE COUNTY LAND&WATER RESOURCES DEPARTMENT

Land Conservation Division

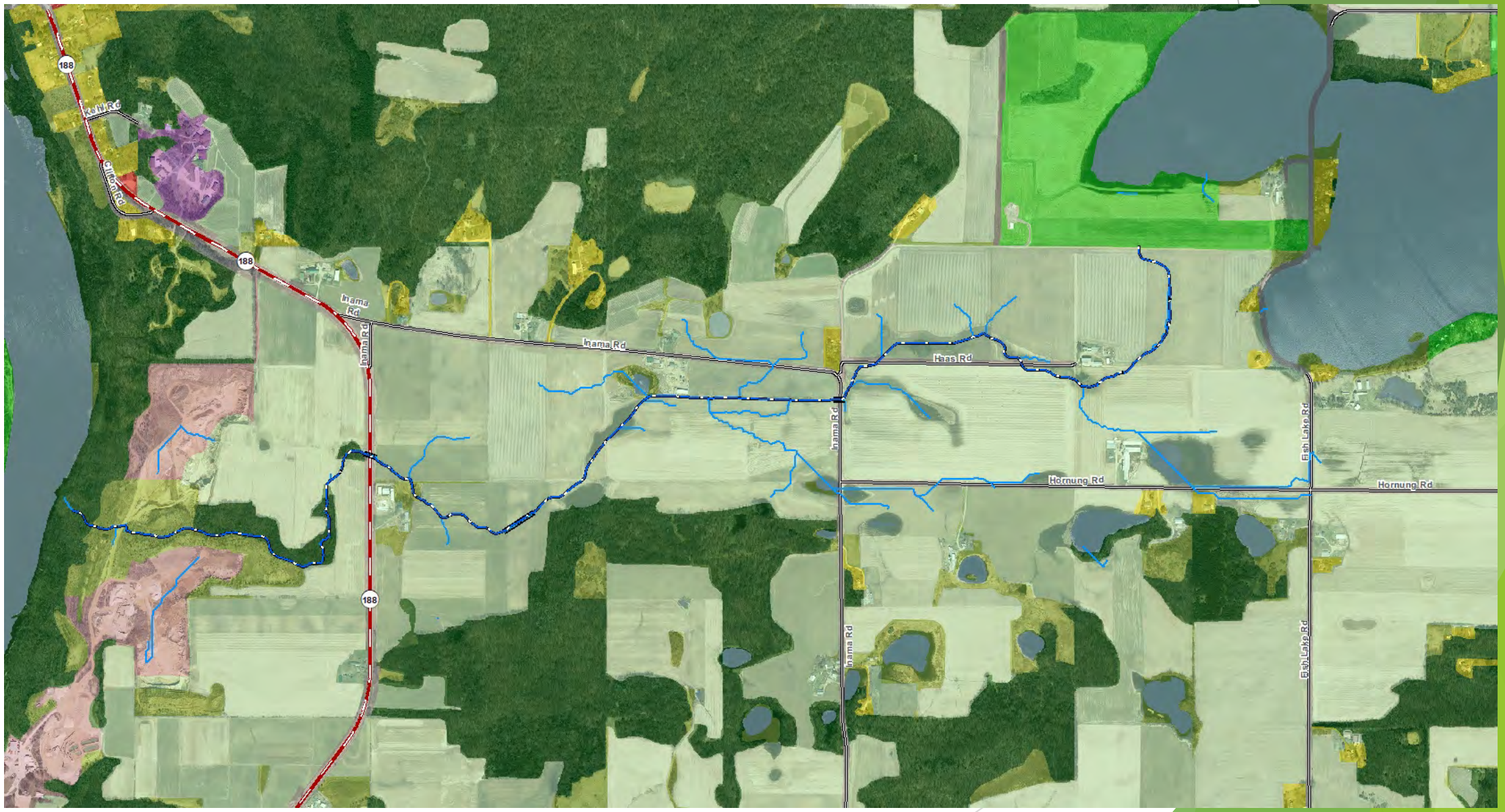
Amy Piaget, County Conservationist
Seth Ebel, Agricultural Engineer
Steve Ottelien, Conservation Specialist

Overview

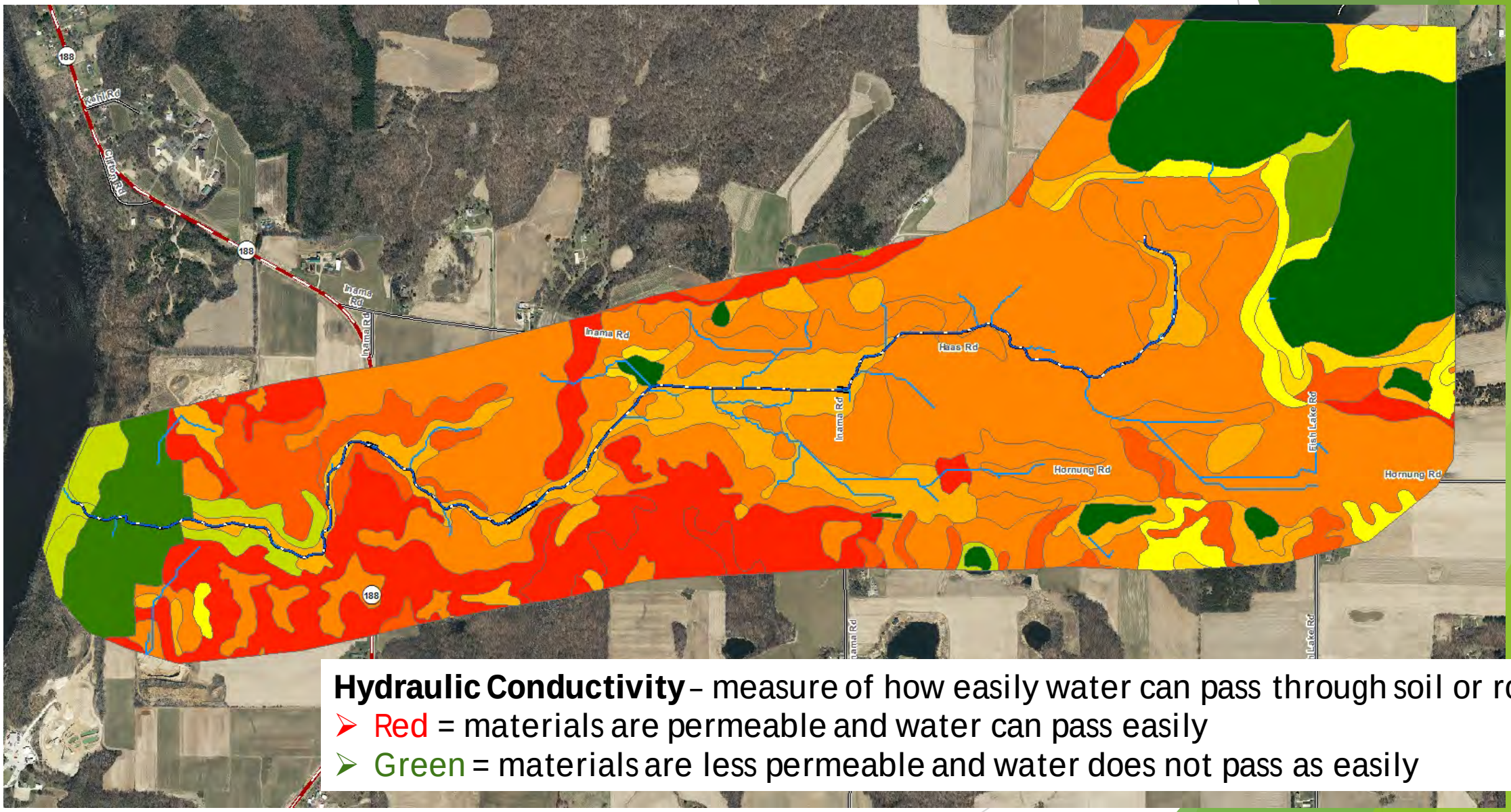
- Lay of the Land
  - Land Use
  - Soils
  - Slopes/Topography
  - Depressional Areas
- Considerations
  - Natural
  - Waterway/Channel
  - Pipe
- Potential Impacts
  - Ag Land Impacts
  - Permitting
  - Infrastructure

Potential Flow Path

Land Use



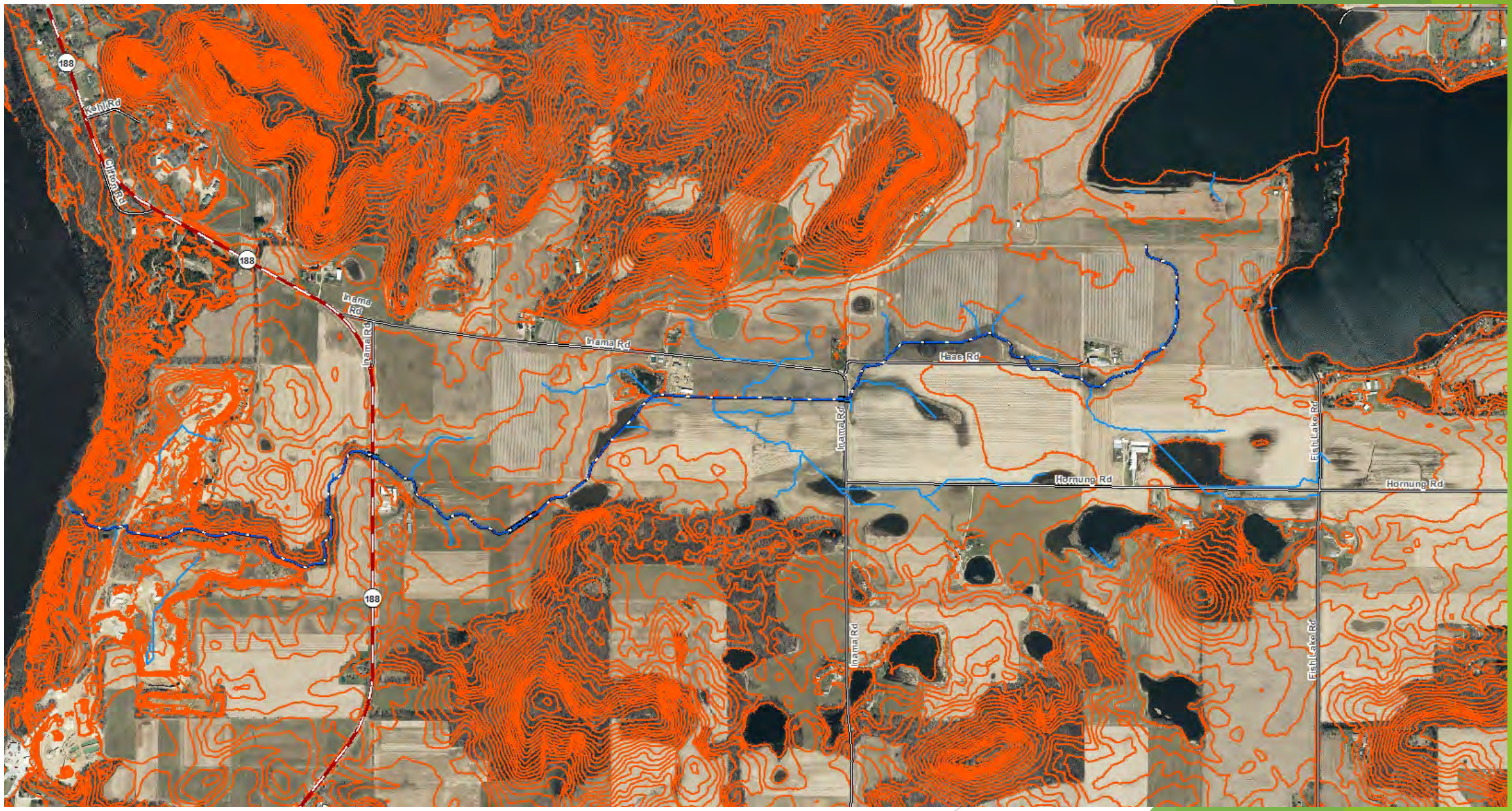
Hydraulic Conductivity of the Soils



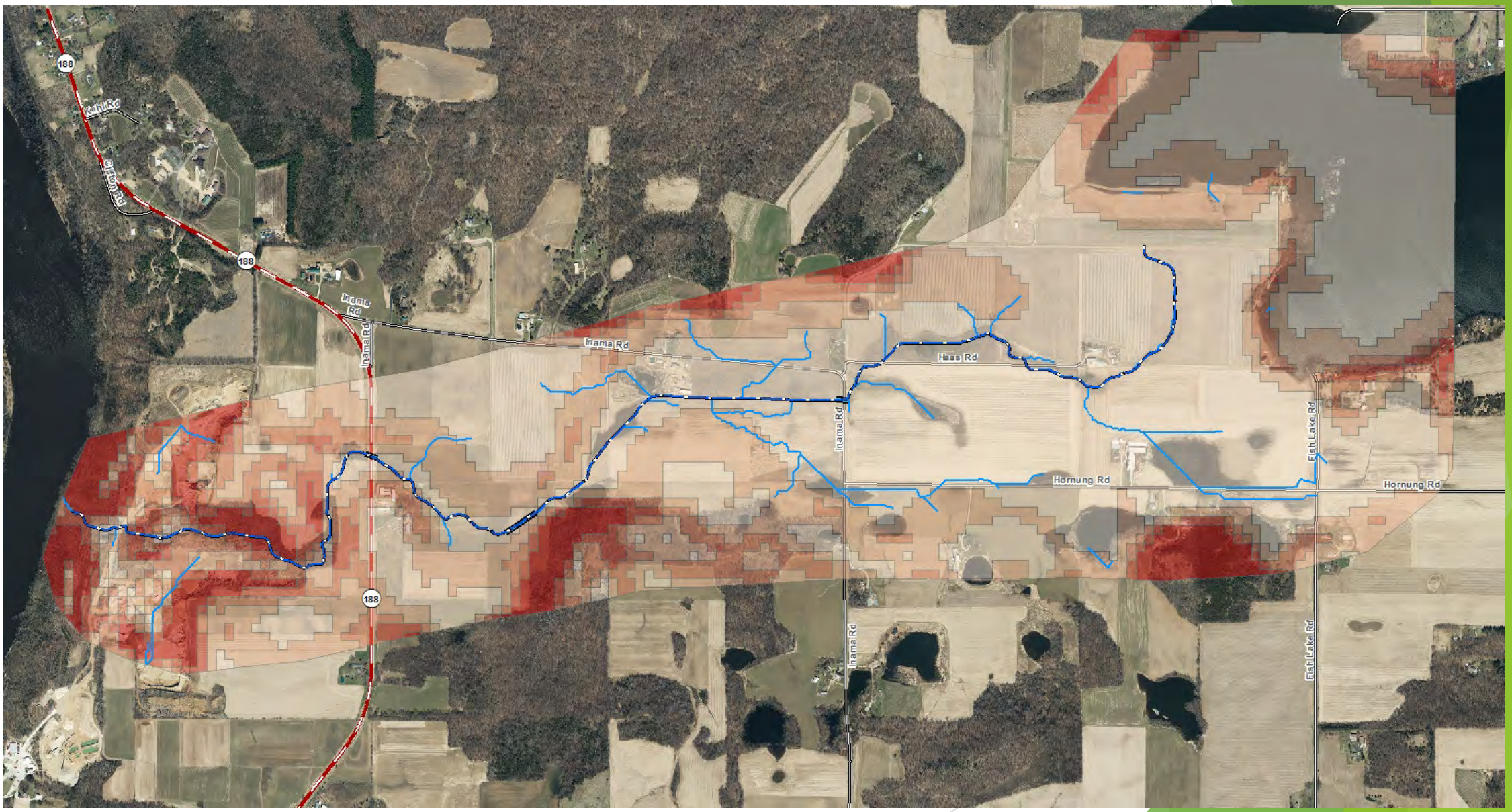
Hydraulic Conductivity – measure of how easily water can pass through soil or rock

- Red = materials are permeable and water can pass easily
- Green = materials are less permeable and water does not pass as easily

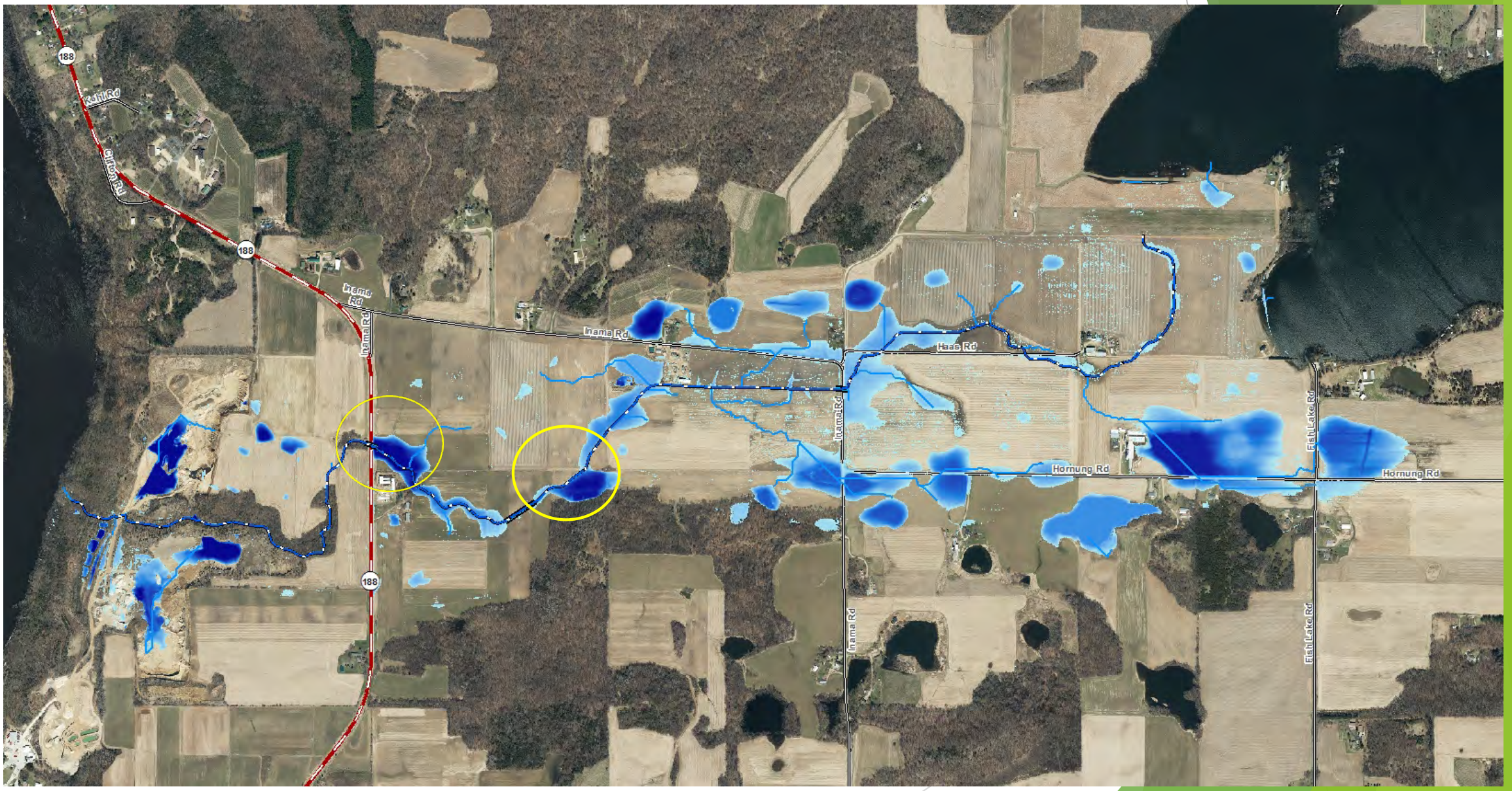
Contours



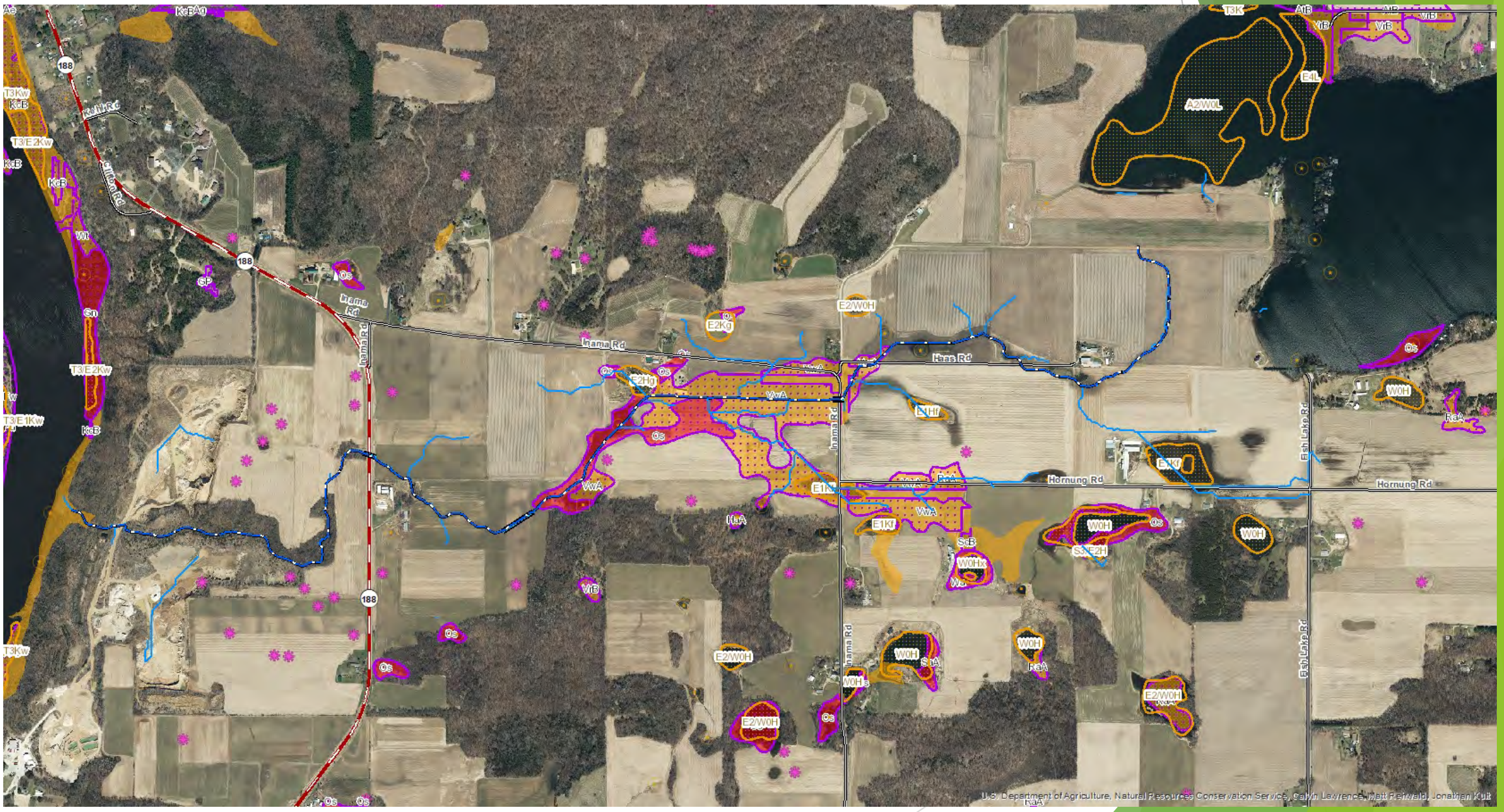
Slope


188
Kehl Rd
Clifton Rd
188
Inama Rd
Inama Rd
Inama Rd
Haas Rd
Inama Rd
Hornung Rd
Fish Lake Rd
Hornung Rd
188
Inama Rd
Fish Lake Rd

Depressional Areas



Wetlands & Hyrdic Soils

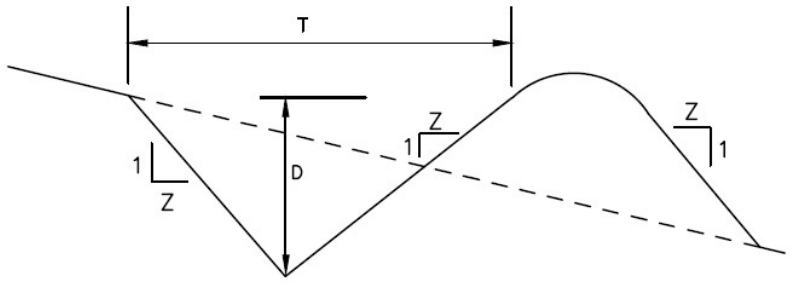


When nature takes its course…

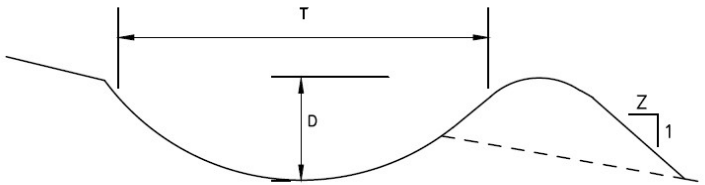
- Lake levels fluctuate over time
- Seepage across the landscape following anticipated flowpath
- Ponding in depressional areas

Defined waterway/channel is constructed…

V Shaped



Parabolic

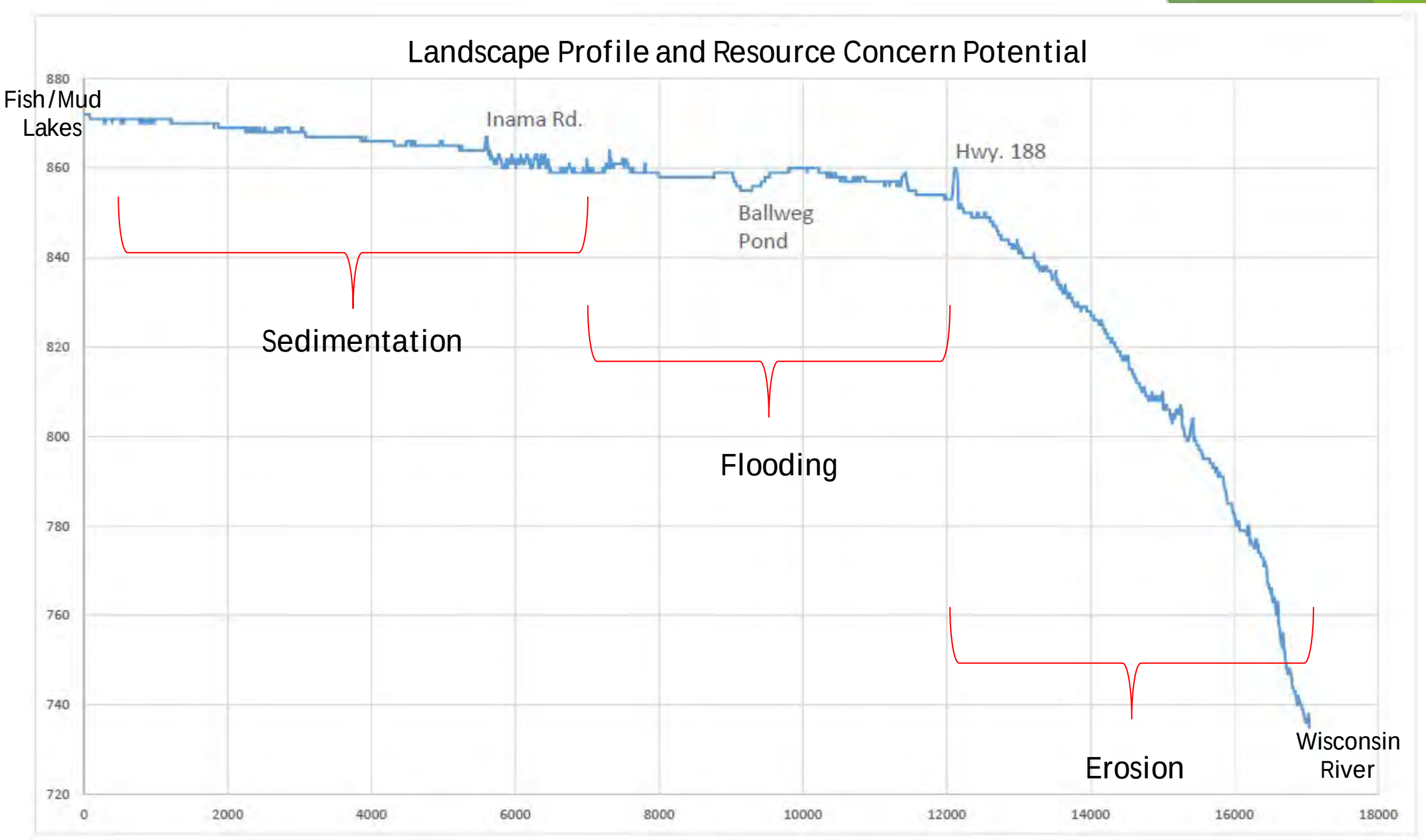


Continued waterway/channel…

- Culverts
  - 3 town roads potentially impacted, 1 state highway
- Drop Structures
  - Are they needed?
- Base Flow vs Storm Flow
  - Hydraulic conductivity of the surrounding soils
  - Rain events

Considerations for a pipeline…

- Sizing
- Path
- Easements
- Potential for Overland flow
- Maintenance


Landscape Profile and Resource Concern Potential
Fish/Mud Lakes
Inama Rd.
Hwy. 188
Ballweg Pond
Sedimentation
Flooding
Erosion
Wisconsin River
880
860
840
820
800
780
760
740
720
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

Impacts to agricultural lands…

- Land out of production
  - Flow path or waterway
  - Buffer setbacks from the path
- Fields being split
  - Smaller field sizes, more challenging depending on farm equipment
- Setbacks for manure applications from concentrated flow channels
  - Frozen and non-frozen conditions
- Cropland practices
  - Cover crops
  - Residue
  - Incorporation
  - Application limits on saturated soils
- Ponding of water in low areas (depressions)
  - Expansion of wetlands

Permits required…

In addition to permits for the lakes…

- Wetland permitting
  - Modify flow paths to avoid impacting wetlands?
  - Impact wetlands?
  - Wetland mitigation requirements?
- Waterway permitting
  - Creation of the flowpath that did not previously exist
  - Impacts to depressional areas/ponds
- Erosion control permitting
  - Construction requires permitting for erosion control
  - Shoreland zoning permitting?

Upgrades to infrastructure…

- Equipment crossings
  - Allow farming equipment to cross waterway
- Access Roads
  - May need additional access roads to get to cut-off fields
- Drainage
  - Drain tile challenges
  - Drainage district?
- Culverts
  - More culverts?
  - Upgrades to existing culverts?

Conclusions…

- Minimal slope / topography
- High hydraulic conductivity
- Primarily agricultural crop fields

Question?

Natural vs. Engineered solutions? Which is best?

Amy Piaget, County Conservationist

Seth Ebel, Agricultural Engineer

Steve Ottelien, Conservation Specialist

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(608) 224-3730

Fish-Mud Lake: Fisheries Management Preview

Nathan Nye

WDNR Fisheries Biologist-Poynette

September 1, 2021

Fish and Mud lakes: Then and Now

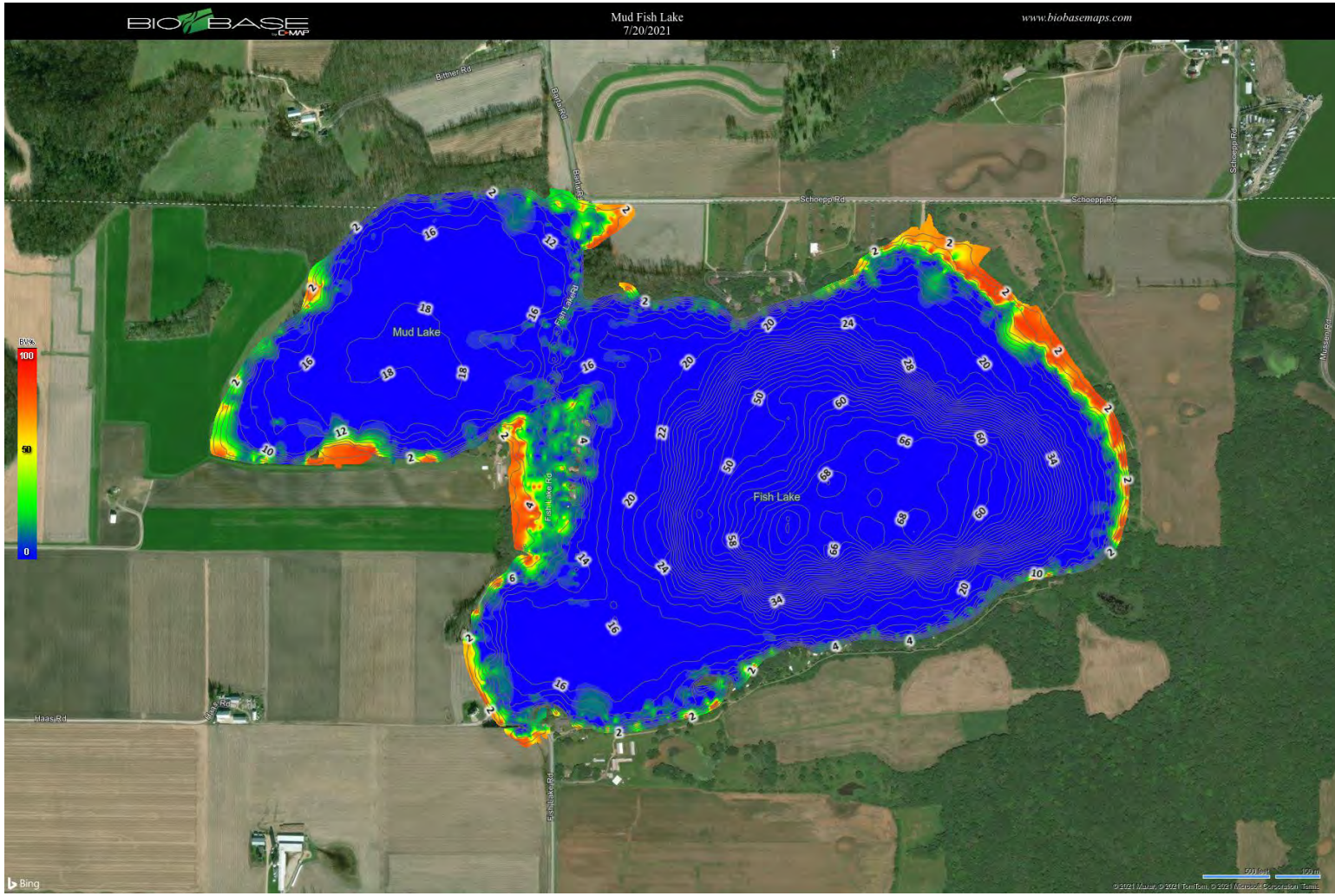
- Wisconsin DNR lake sampling schedule
  - What, when, how often?
  - Where do Crystal, Fish, and Mud fit in?
- 2015 Fishery Surveys of Fish and Mud lakes
  - Management strategy
  - Panfish, gamefish, detrimental species
  - Perspective

Fish and Mud lakes: Then and Now

- Carp Control Efforts 2016-2018
  - Chemical fishery eradication
  - Follow-up management
- Lake Separation 2018-19
  - Culverts, berm
  - Re-treatment planning

Fish and Mud lakes: Then and Now

- 2021 Comprehensive Fishery Survey
  - Changes? Perspective!
  - Sampling challenges?
  - NOP genetic study
  - Next survey
- Changes in the lake and its habitat
  - Depth
  - Clarity, aquatic plants
  - Timber/CWD
  - Fishery concerns



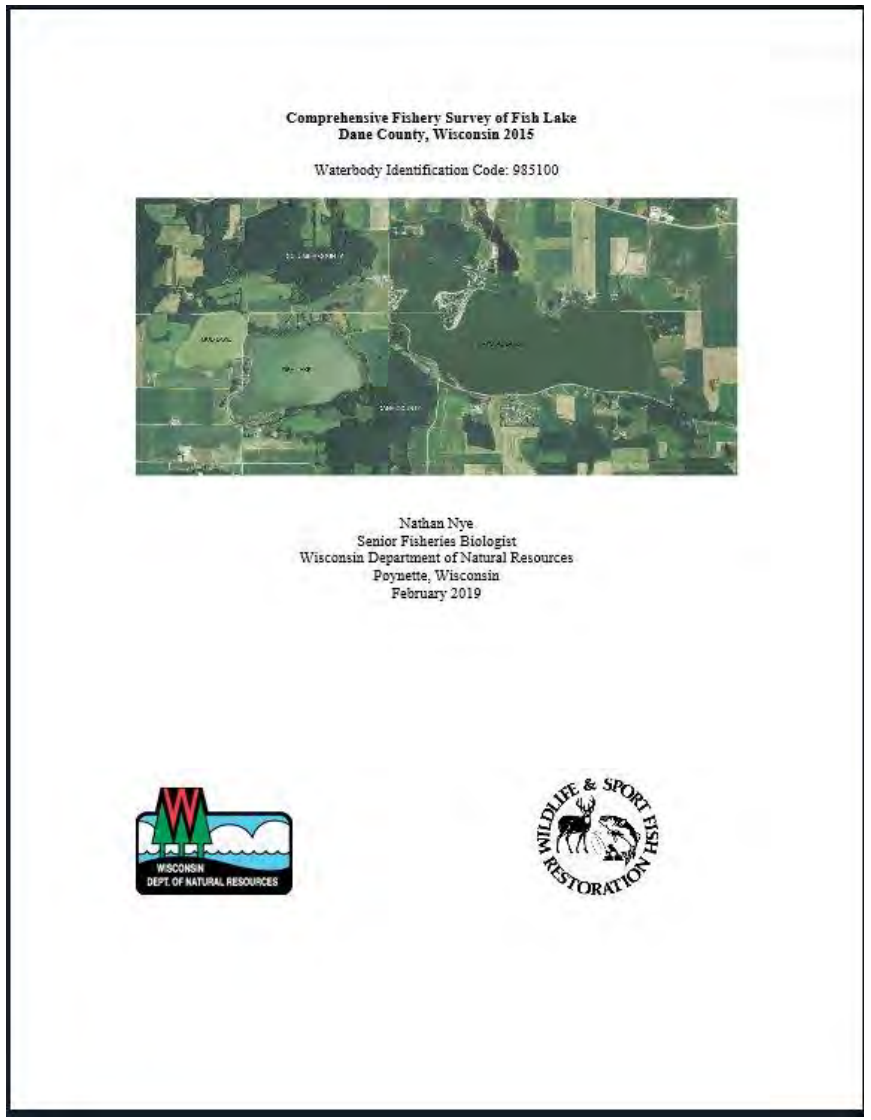
Homework: Available Resources

- Prior to the full presentation, please check out the following, available on the DNR website:
  - 2015 Fish and Mud Lake survey report

    https://p.widencdn.net/isnnm9/Reports_DaneFishMudLake2015Comprehensive

  - 2015 Crystal Lake survey report

    https://p.widencdn.net/nnnvlo/Reports_DaneCrystalLake2015Comprehensive



Comprehensive Fishery Survey of Fish Lake
Dane County, Wisconsin 2015

Waterbody Identification Code: 985100

Nathan Nye
Senior Fisheries Biologist
Wisconsin Department of Natural Resources
Poynette, Wisconsin
February 2019

CONNECT WITH US

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"WILD WISCONSIN:
OFF THE RECORD"