Landlocked Basin Flood Mitigation Comprehensive Planning Study: Stakeholder Kickoff

October 13, 2021

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Valley Branch Watershed District

US Army Corps of Engineers®

Agenda

- Stakeholder meetings/involvement and introductions
- Background on flooding
- Study scope
- Study schedule

Landlocked Basin Study Stakeholder & Public Involvement

- Project Stakeholder Team
  - Monthly virtual meetings (as needed) over the 2-year period (2021-2023)
  - More regular meetings beginning in 2022: Kickoff meeting, regular advisory meetings through the planning process, presentations of the draft plan, and public open house planning
- 3 anticipated public meetings
  - Project kickoff meeting/open house
  - Progress meeting
  - Presentation of final plan

Stakeholder Introductions

Project Partners:

- United States Army Corps of Engineers (through Planning Assistance to the States(PAS) program)
- Valley Branch Watershed District

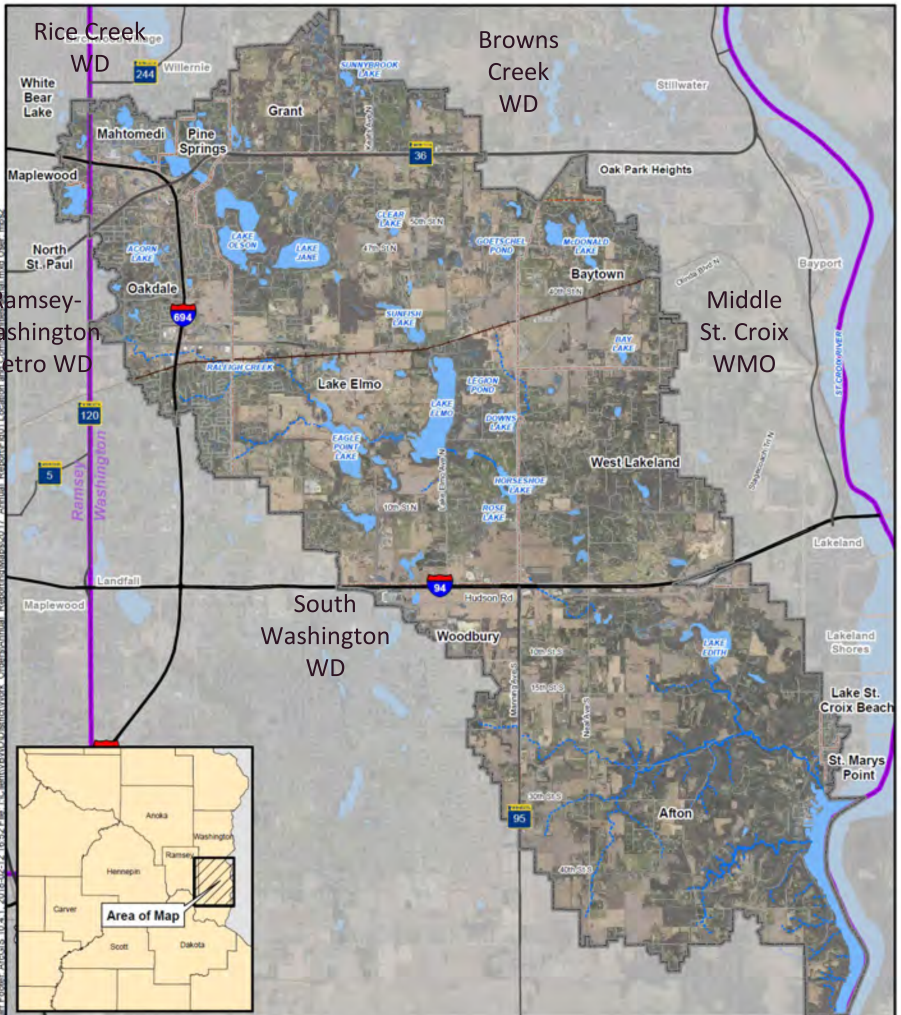
Project Stakeholders:

- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Minnesota Department of Transportation
- Washington County
- Lake Elmo
- Baytown Township
- West Lakeland Township
- Metropolitan Airports Commission
- US Department of the Interior

Public Input

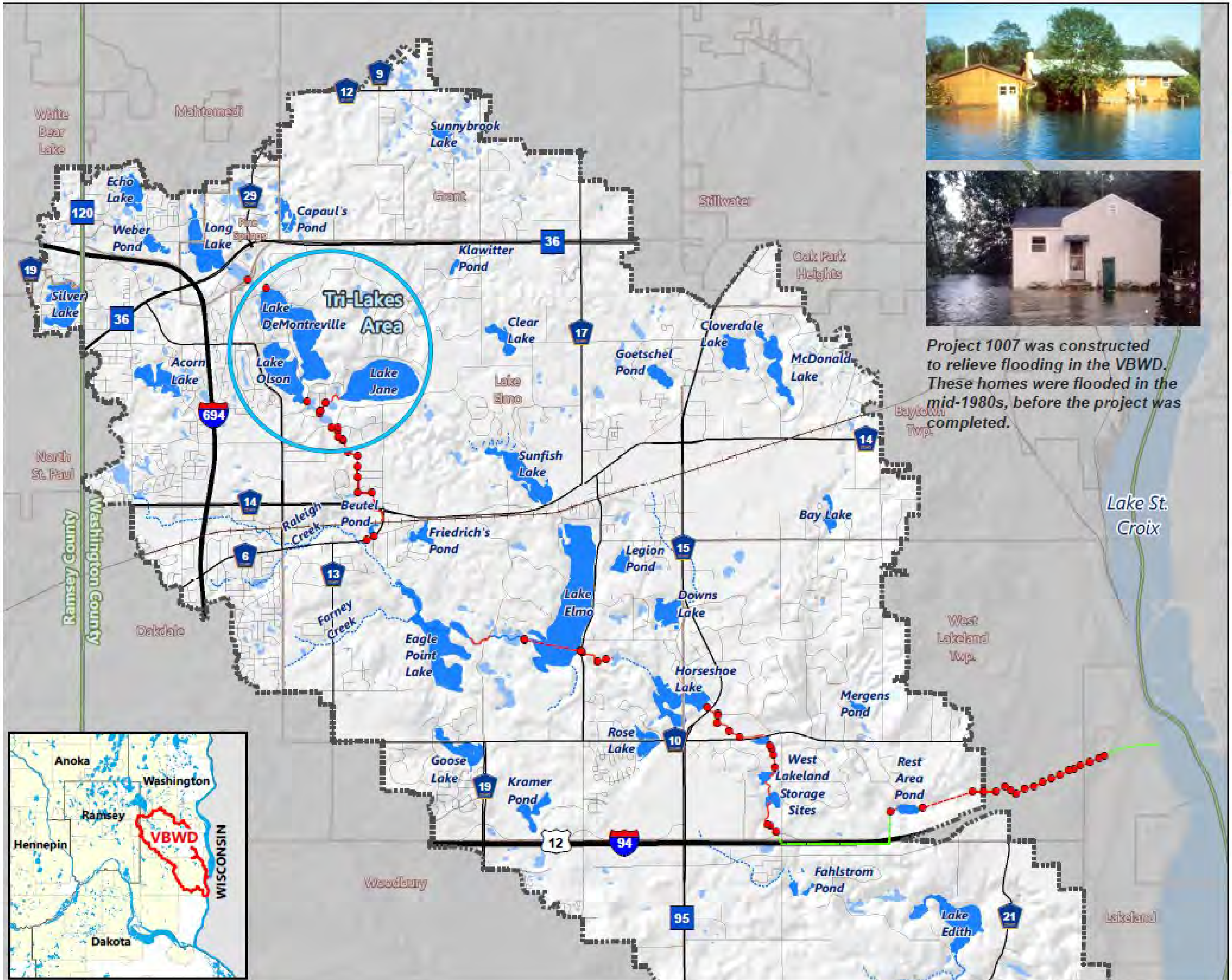
- Lake Associations/HOA around lakes
- Other Landowners

Introduction to the Valley Branch Watershed District (VBWD)



Source: Barr Engineering Co.

- Established in 1968 via petition from mostly Tri-Lakes' (DeMontreville-Olson-Jane) residents, making it the oldest watershed district in Washington County
- All or parts of 14 cities and townships
- Covers 70 square miles (including 1 square mile of Ramsey County)
- Primarily addressed flooding in early years
  - Project 1007 (1987)
- Ultimately drains to St. Croix River (if all landlocked areas overflow)



- Project 1007 Manhole or Catch Basin
- Project 1007 Channel
- Project 1007 Pipe
- Non-VBWD Pipe
- Tri-Lakes Area
- District Legal Boundary
- Municipal Boundary
- County Boundary

Project 1007 directs water flow from the northwest part of the VBWD south and east (along the red line shown) toward a storm sewer pipe along Interstate 94. The water ultimately discharges to the St. Croix River. The system has effectively controlled the flooding that plagued this landlocked area (see photos at left). No permitted homes have flooded since the project was completed in 1987.

Feet

5,000 0 5,000

Figure 1

PROJECT 1007 OVERVIEW

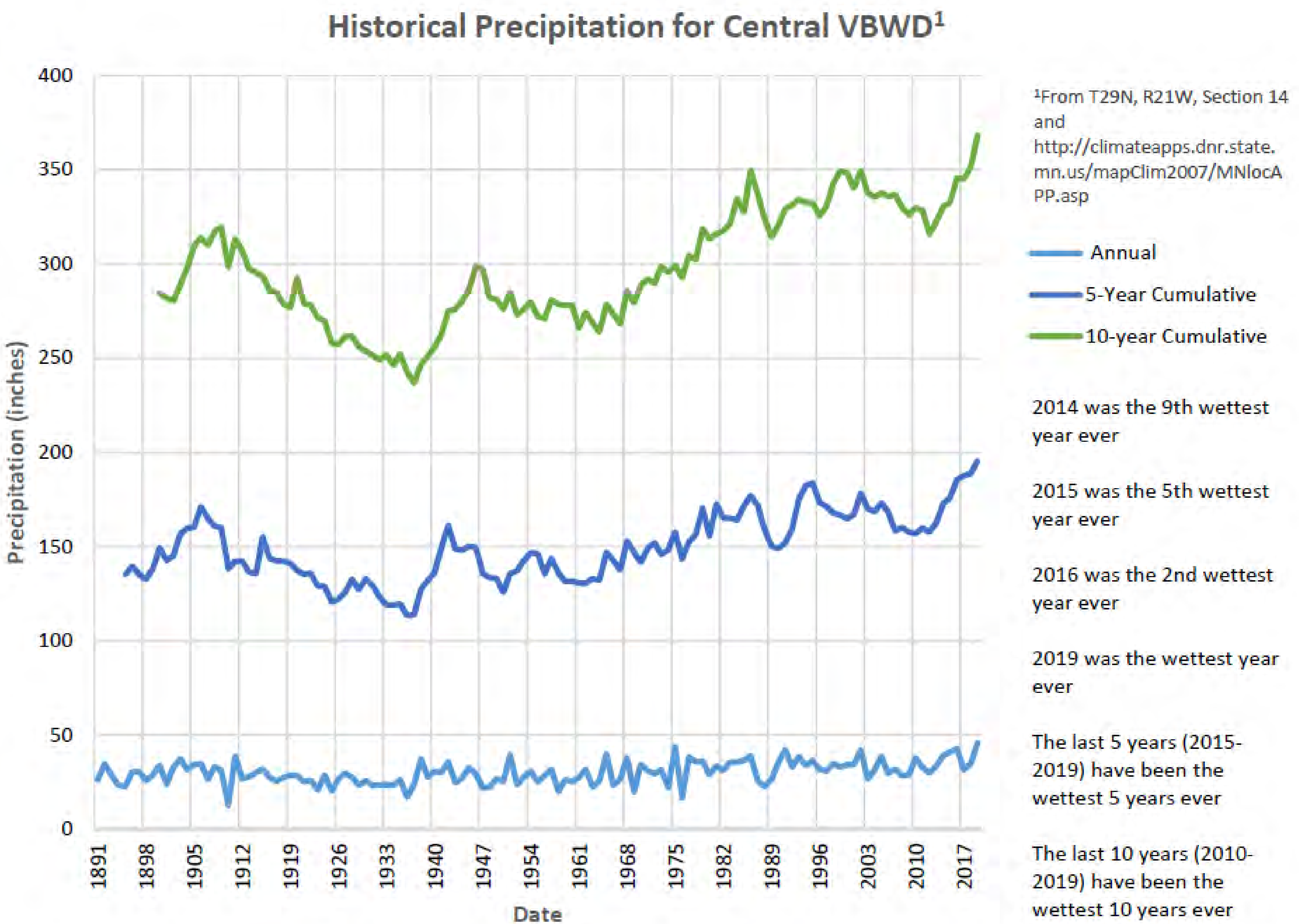
Valley Branch Watershed District

Flood Control in the VBWD

- Project 1007 built in 1986-87 and addressed flooding along main drainage through the watershed
- Numerous landlocked basins not addressed as part of Project 1007 as flooding was not a major issue at these basins at that time, community land-use plans did not project major changes, and regulations to control runoff and elevate new homes were in place
- High water levels around Sunnybrook Lake (groundwater/surface water) have been a chronic issue; VBWD recently acquired and removed 8 homes because a flood level reduction project was not feasible
- In recent years (2019/2020), VBWD and Washington County have had to mobilize emergency pumping to lower high-water levels on landlocked basins

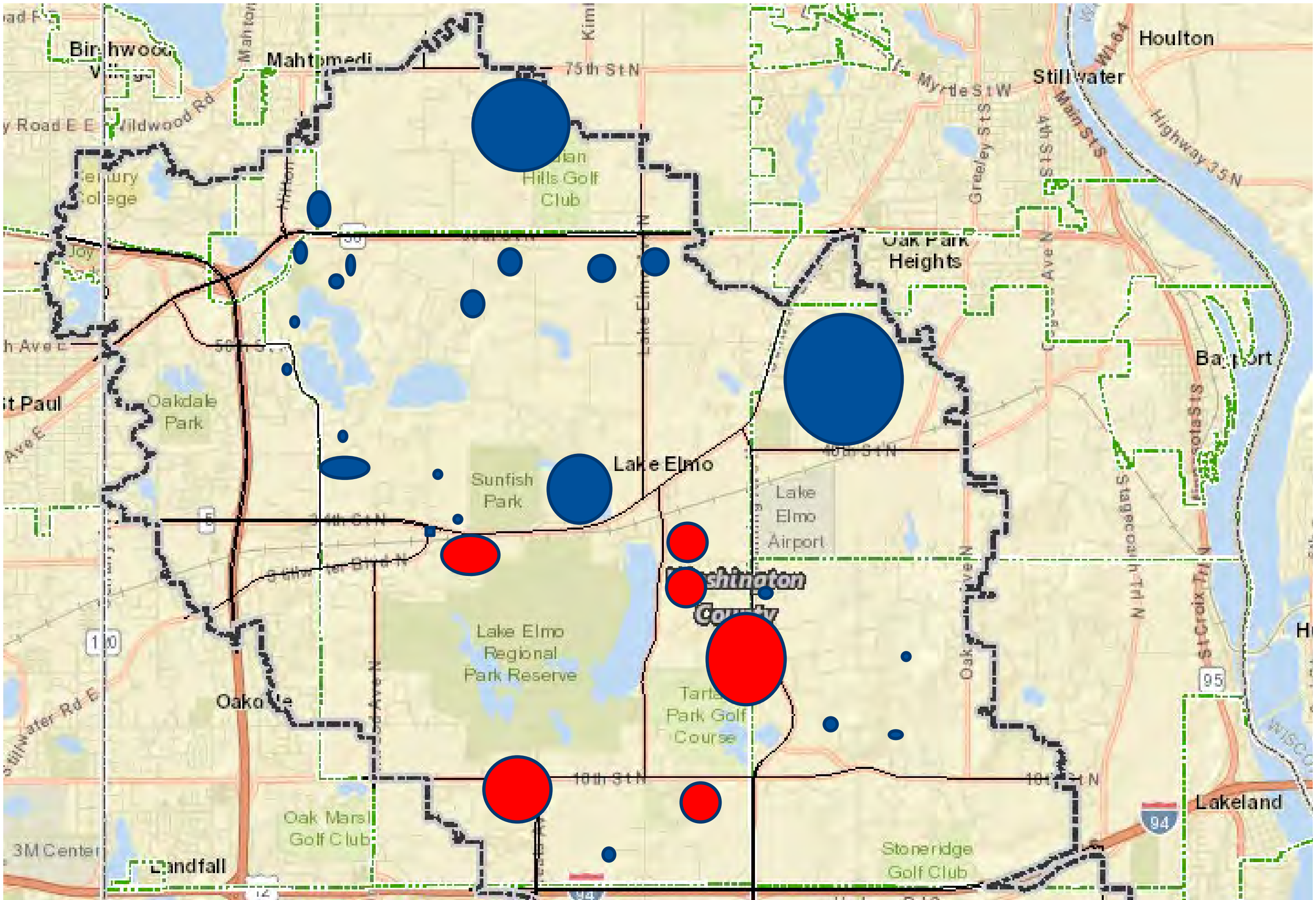
Recent Wet Conditions

- Recent decade:
  - 2019: Wettest year ever recorded for central Washington County since data was first recorded in 1891
  - 2015–2019: Wettest 5 years
  - 2010–2019: Wettest 10 years
- Landlocked basins: Water only leaves through evaporation and seepage. These processes can't keep up with the extreme amounts of precipitation the area has received, so water levels have risen.
- Result: In parts of VBWD, lakes flooded roads even after they had been raised several feet. Homes and septic systems flooded. VBWD had to encourage some homeowners to evacuate.
- Long-term: Groundwater and lake levels will remain high for months and years. Flooding at landlocked basins is not like river flooding that's usually over within a week.

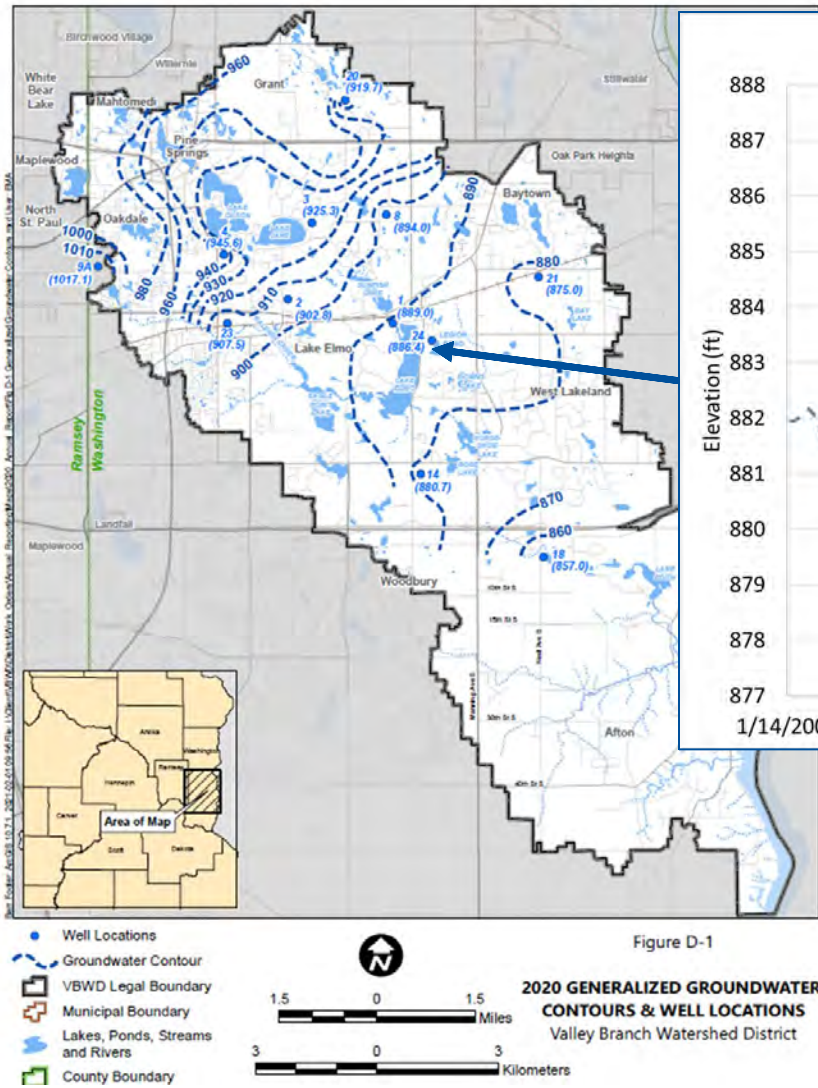


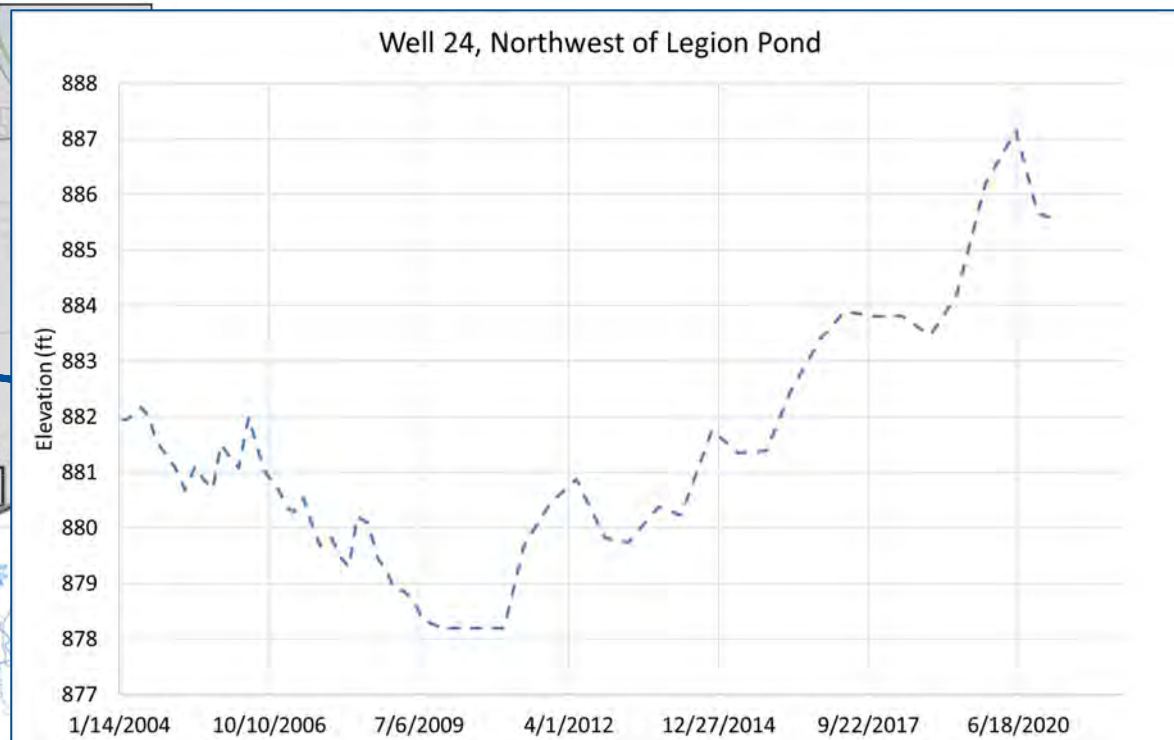
Historical Precipitation for Central VBWD[1]
400
350
300
250
200
150
100
50
0
Precipitation (inches)
1891
1898
1905
1912
1919
1926
1933
1940
1947
1954
1961
1968
1975
1982
1989
1996
2003
2010
2017
Date
[1]From T29N, R21W, Section 14 and http://climateapps.dnr.state.mn.us/mapClim2007/MNlocAPP.asp
Annual
5-Year Cumulative
10-year Cumulative
2014 was the 9th wettest year ever
2015 was the 5th wettest year ever
2016 was the 2nd wettest year ever
2019 was the wettest year ever
The last 5 years (2015-2019) have been the wettest 5 years ever
The last 10 years (2010-2019) have been the wettest 10 years ever

Recent Reports of Flooding in the VBWD (2019-2020)



High Groundwater Conditions: Legion Pond Area





High Groundwater Conditions: McDonald Lake Area

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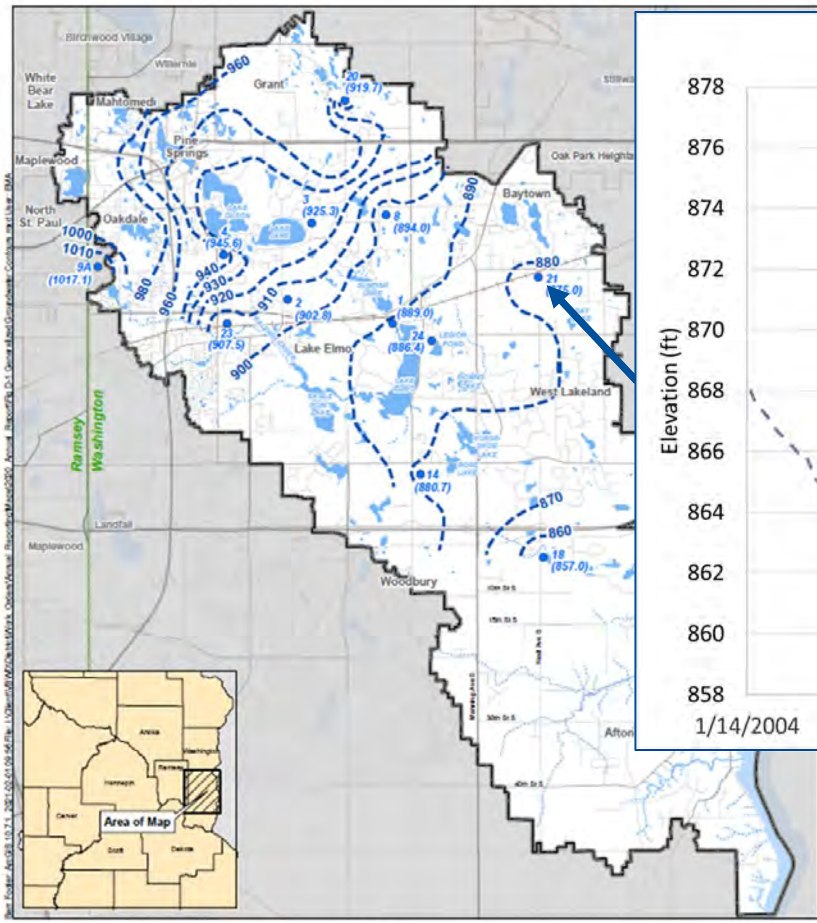

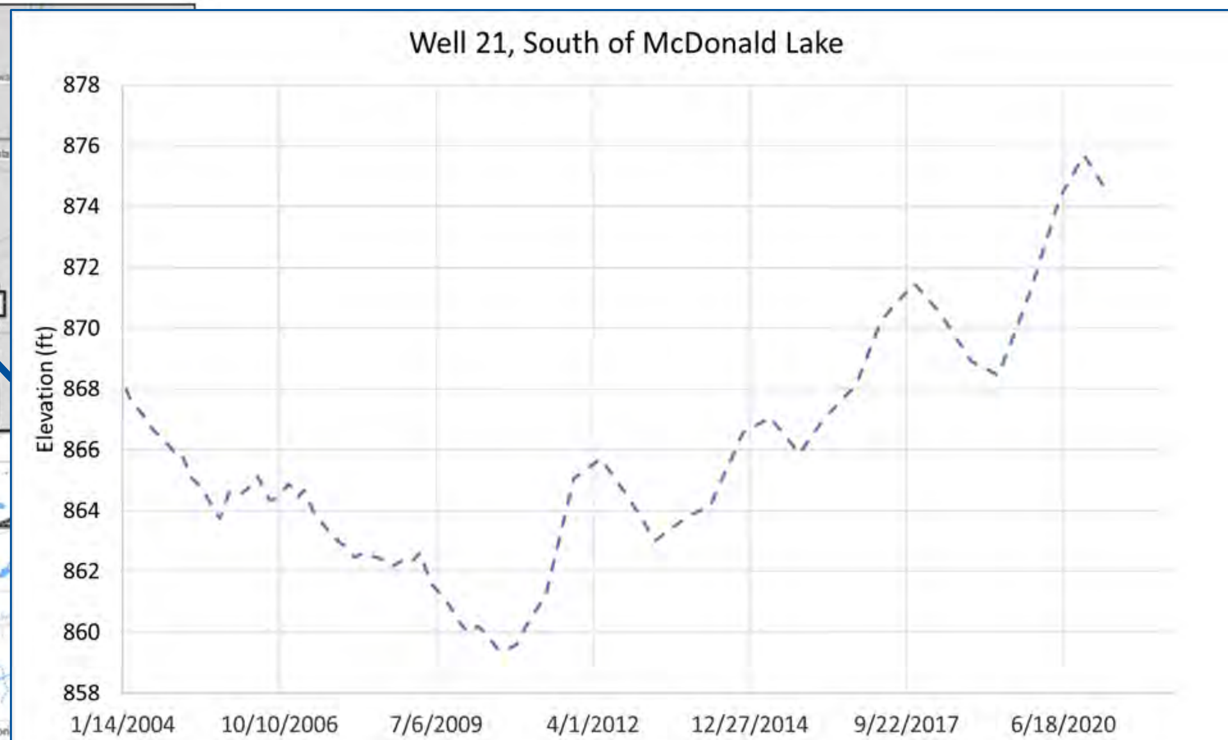

- Well Locations
- Groundwater Contour
- VBWD Legal Boundary
- Municipal Boundary
- Lakes, Ponds, Streams and Rivers
- County Boundary

1.5 0 1.5 Miles

3 0 3 Kilometers

Figure D-1

2020 GENERALIZED GROUNDWATER CONTOURS & WELL LOCATIONS

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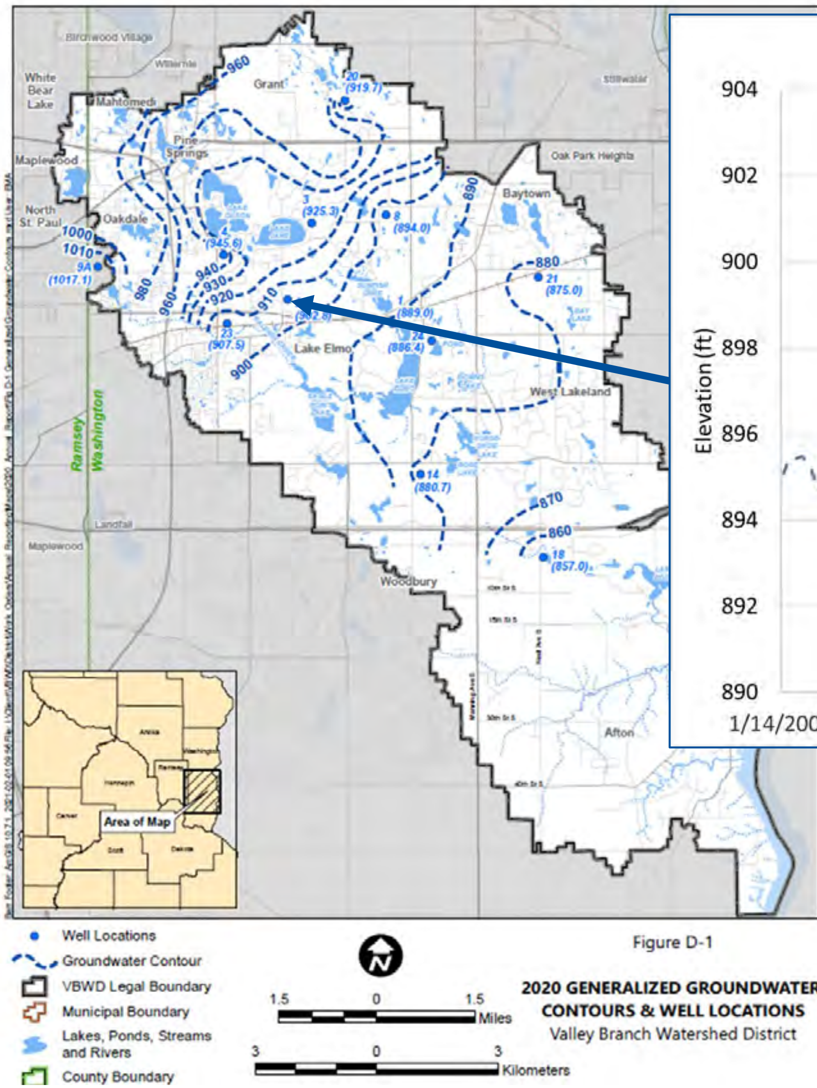
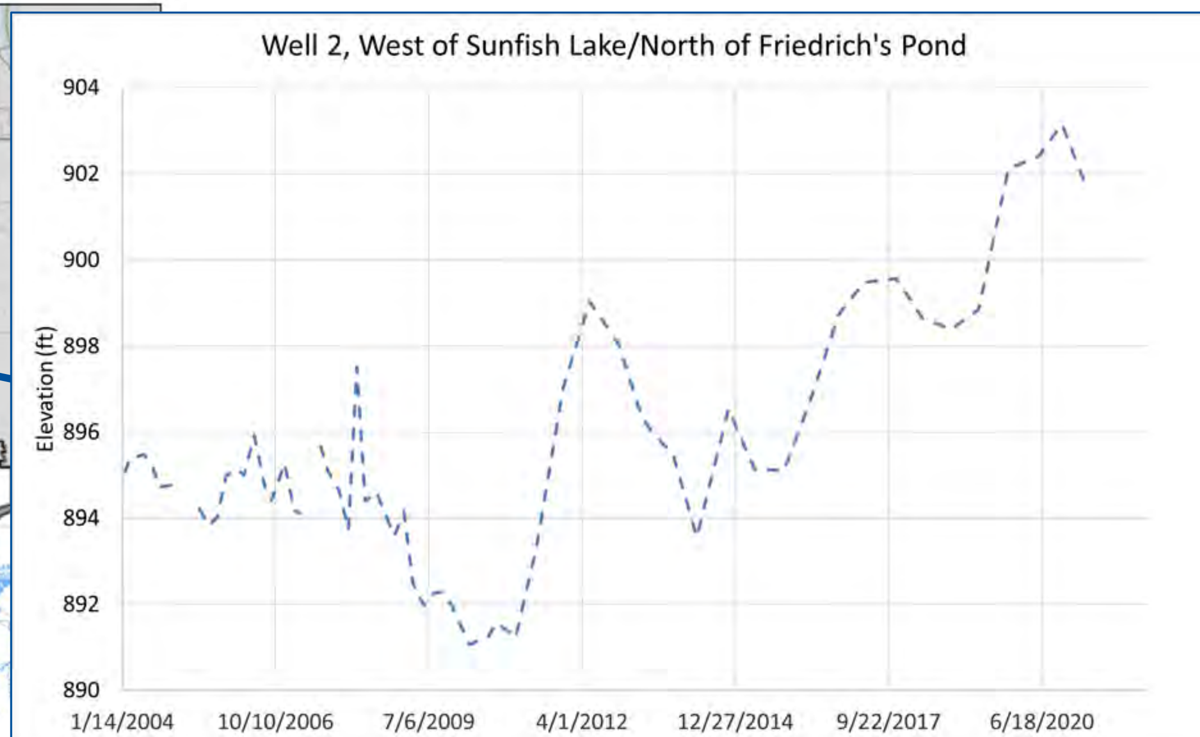
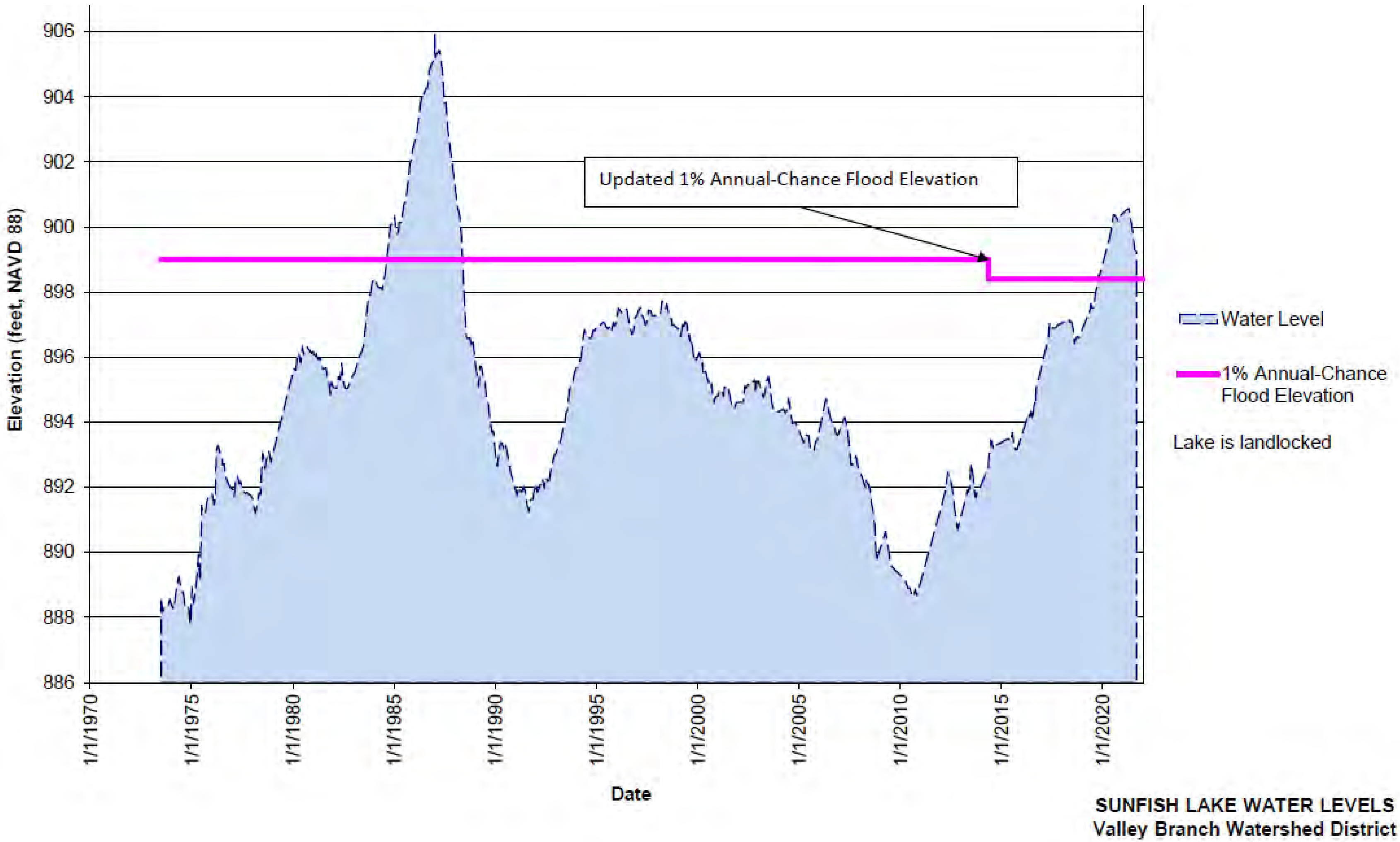
High Groundwater Conditions: Friedrich's Pond Area

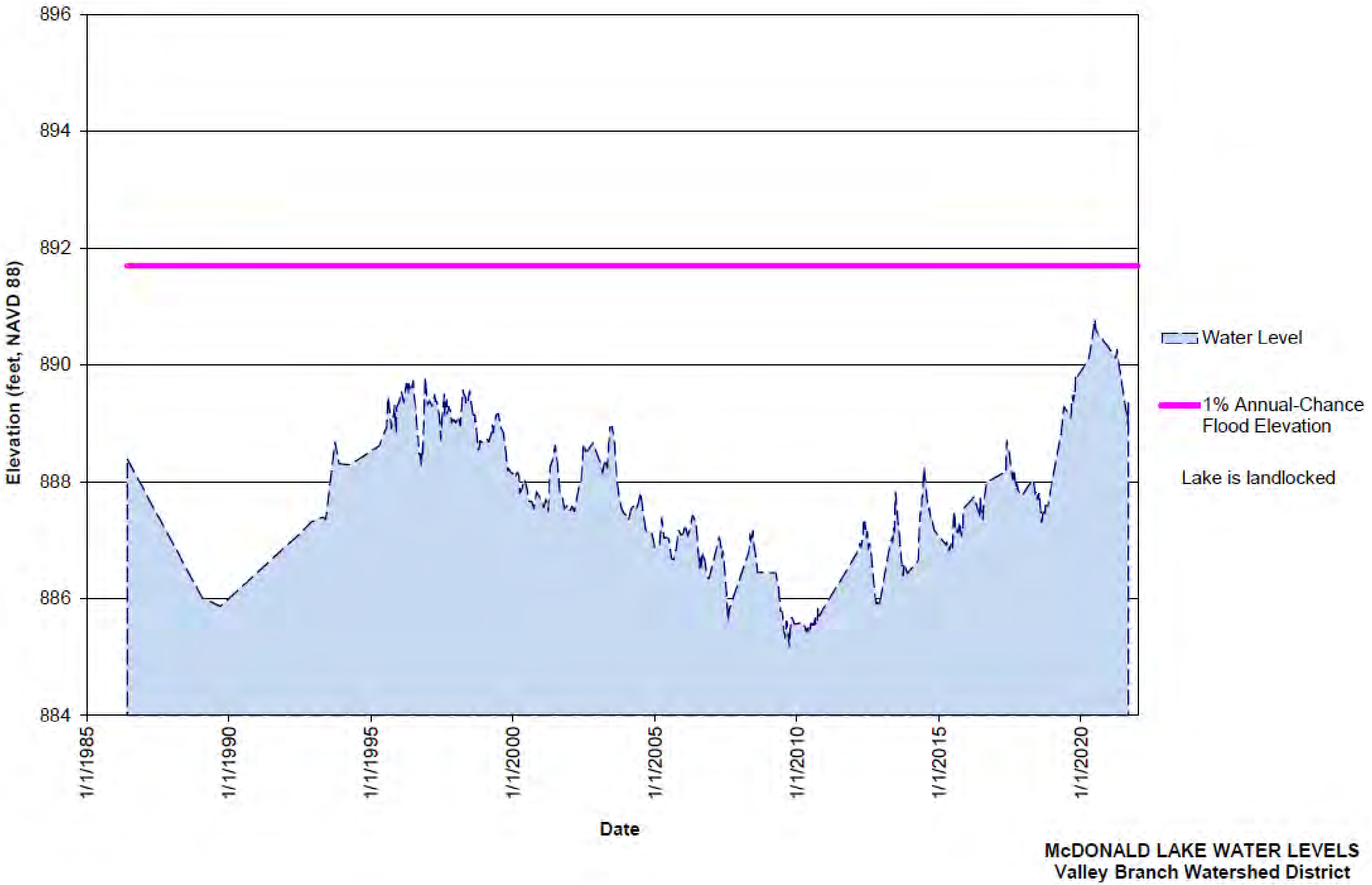




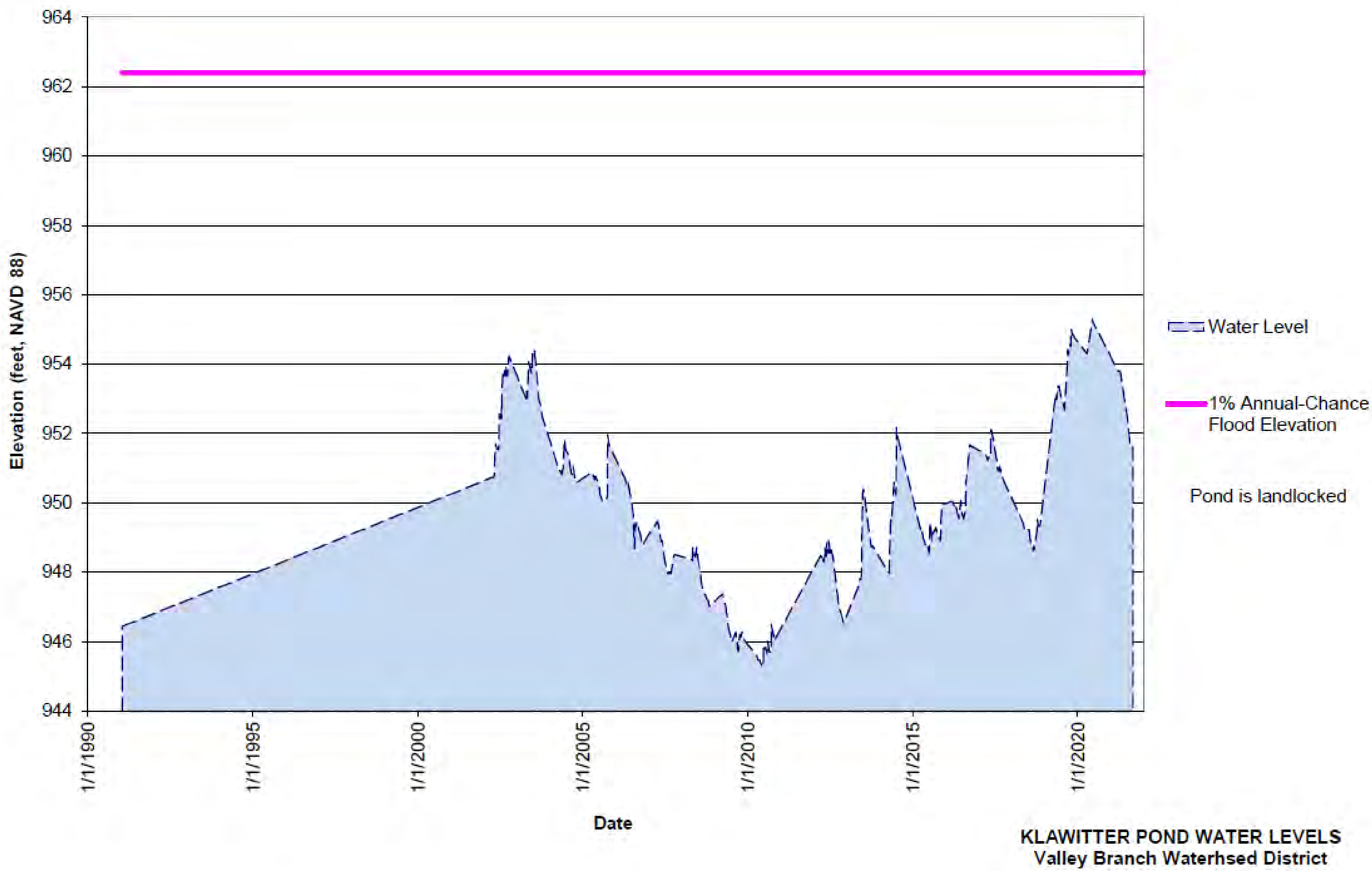
High Surface Water Conditions: Sunfish Lake



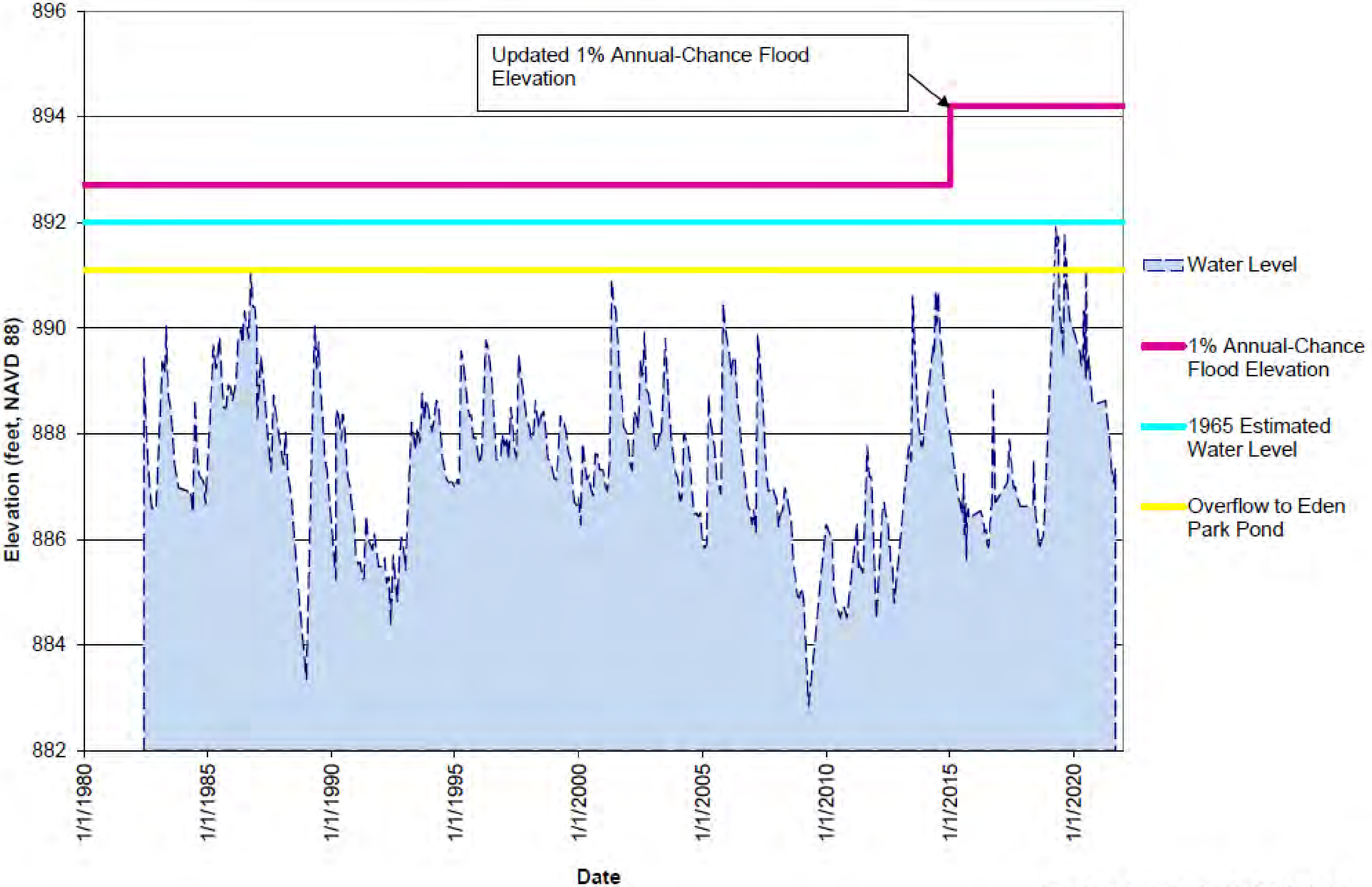
High Surface Water Conditions: McDonald Lake



High Surface Water Conditions: Klawitter Pond

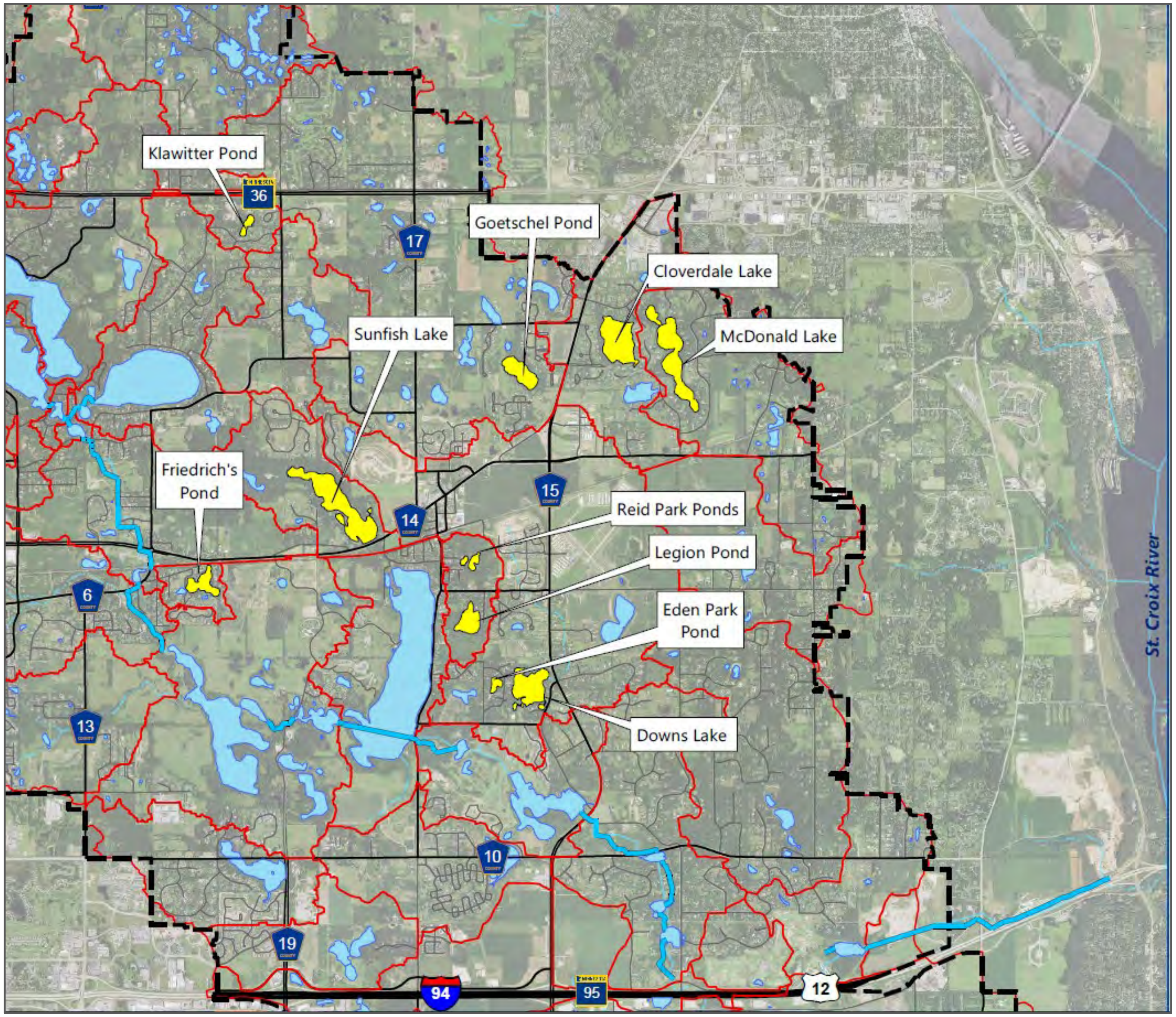


High Surface Water Conditions: Downs Lake



DOWNS LAKE WATER LEVELS
Valley Branch Watershed District

Landlocked Basins in Study



Klawitter Pond

- One 100-year-old house flooded in 2020—large barn rebuilt in floodplain
  - VBWD is in process of purchasing home – new home being build on higher ground
- One other home close to and parts of city road below current 100-year level
- Temporary pumping would be very expensive due to length needed
- Permanent outlet unlikely; closest waterbody with gravity outlet is Lake Jane
- VBWD plans to work with MnDOT to slow and treat runoff from Hwy 36, but that won't address flooding

Klawitter Pond Flooding (2020)

Legion Pond

- Approximately seven homes and one septic system affected by high water
- 2020: emergency pumping of 16 million gallons into Lake Elmo for one month ($80,000) lowered pond by 2 feet
- Heightened groundwater creates challenges

Legion Pond emergency pumping floating intake (2020)

Friedrich’s Pond

- One house and several outbuildings flooded
  - VBWD purchased and demolished flooded home in 2021
- Approximately five nearby homes might be affected by groundwater
- 2020: Emergency pumping through Lake Elmo Park Preserve, which conveyed water to Eagle Point Lake (part of Project 1007)

Friedrichs Pond levels flooding a home and driveway access (2020)

Reid Park Ponds

- One home flooding; two more and one septic system close
- 2020: Emergency pumping of 20 million gallons to east/Downs Lake ($40,000)
  - Downs Lake requires pumping to protect homes, roads, and septic system
- Ponds refilled some with groundwater
- Heightened groundwater likely a challenge to address

Reid Park Ponds flooding (2020)

Sunfish Lake

- Water level was/is above 100-year flood level
- Homes and septic systems are much higher than flood level but homeowners voiced concern
- Heightened groundwater likely a challenge to address
- Development planned in drainage area

Sunfish Lake Water Level increase from 2009 to 2019

Cloverdale Lake and McDonald Lake

Cloverdale Lake water levels about flow into McDonald Lake (2020)

- Both Cloverdale and McDonald Lakes are landlocked
- Cloverdale Lake was at 100-year flood level and spilled into or nearly spilled into McDonald Lake in 2020
- Sport courts and swimming pools currently at-risk
- Once Cloverdale Lake starts spilling into McDonald Lake, dozens of homes potentially at risk

Goetschel Pond

High water levels on Goetschel Pond (2020)

- Landlocked basin
- Trails flooded around the pond; homes/septics currently not threatened
- Large watershed of smaller landlocked basins, at least one has caused flood concerns (Country Sun Farm and Greenhouses)
- May be a receiving water for discharges for other pumped basins
- Heightened groundwater likely a challenge to address

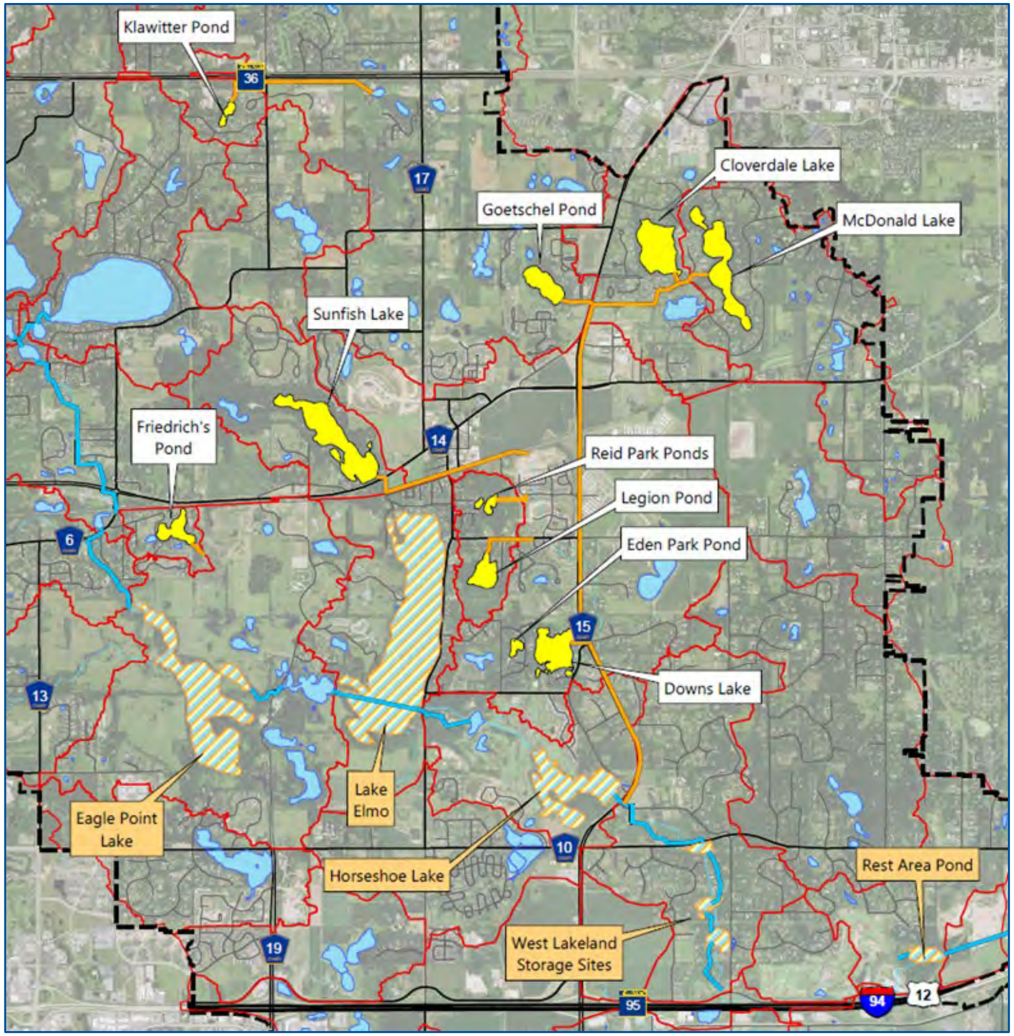
Downs Lake/Eden Park Pond

First drawdown of Downs Lake (2020)

- Intercommunity drainage and flood risk led VBWD to construct a barebones project 20 years ago
- Five homes and at least one septic system; parts of three city roads below 100-year flood level
- 2019: First year a drawdown ever implemented—had to be drawn down twice; FEMA reimbursed VBWD for one
- 2020: Emergency drawdown before late June's 4–7" rain; second drawdown mid-July
- Drawdown drains to Horseshoe Lake, which is part of VBWD's Project 1007 and has gravity outlet to West Lakeland Storage Sites, Rest Area Pond, and St. Croix River
- Much more development planned in drainage area

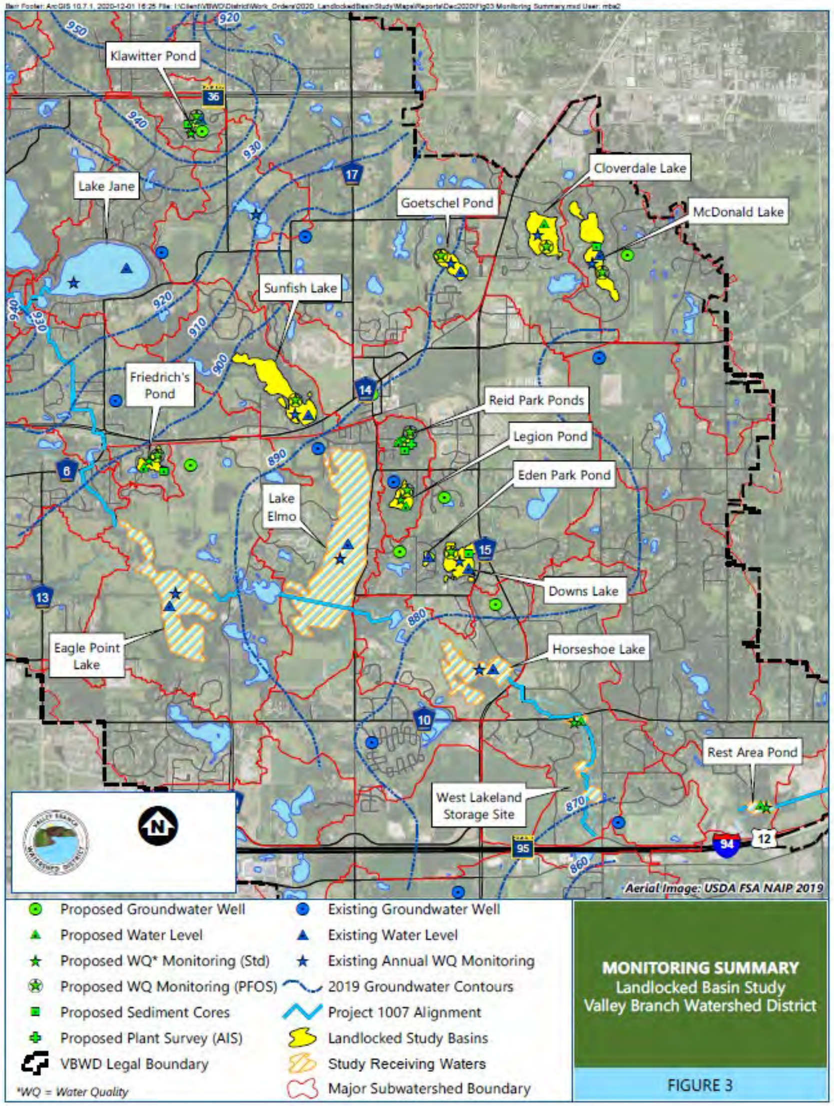
Landlocked Basin Study: Project Goals

- Studying high-water/ flooding conditions
- Developing and evaluating water level management alternatives
- Determining water quantity and water quality impacts of the proposed alternatives on downstream receiving waters
- Recommending water management approach for each of basin



Landlocked Basin Study Scope: Data Collection

- Compilation/review of historic studies
- Low flood/critical structure & drainage infrastructure survey
- Bathymetric survey
- Groundwater monitoring
- Water quality monitoring
  - Standard parameters (phosphorus, chlorophyll-a, Secchi depth)
  - PFOS/PFAS
  - Sediment cores/internal phosphorus release
- AIS survey – focus on aquatic plants where past surveys have not been completed
- Water level monitoring



Landlocked Basin Study Scope: Baseline (without project) Modeling

- Groundwater Modeling
  - Building off existing models and recent studies
  - Utilizing additional data collected as part of this study
- Hydrologic and Hydraulic Modeling
  - Since 2014, continuous XP-SWMM models have been developed for much of the VBWD
  - Models for several landlocked basins need to be developed/updated and calibrated
- Water Quality Modeling
  - Detailed modeling for Downs and McDonald (listed as impaired or could be listed as impaired during next MPCA assessment)
  - Simplified mass balance models will be used for other receiving waters
- Continuous simulations using historic and projected future climate data based on analysis of observed precipitation records and review of downscaled global climate models considering wet and dry climatic futures
- Existing and future watershed conditions (land use, other known projects) evaluated

Landlocked Basin Study Scope: Climate Change Assessment

- Qualitative climate assessment in accordance with USACE Engineering and Construction Bulletin (ECB) 2018-14

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ENGINEERING AND CONSTRUCTION BULLETIN

No. 2018-14 **Issuing Office:** CECW-EC **Issued:** 10 Sep 18 10 Sep 20, Rev 1 **Expires:** 10 Sep 20 10 Sep 22

SUBJECT: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects.

CATEGORY: Guidance.

1. **References.** See Attachment D.

2. **Purpose.** This Engineering and Construction Bulletin (ECB) reissues and updates the policy in ECB 2016-25 (reference a), Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. This ECB is effective immediately and applies to all hydrologic analyses supporting planning and engineering decisions having an extended decision time frame (i.e., not for short-term water management decisions). It provides guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate preparedness and resilience policy and ER 1105-2-101 (reference l) . This policy requires consideration of climate change in all current and future studies to reduce vulnerabilities and enhance the resilience of communities. Hence, consideration of climate change should occur early enough in the SMART planning process to inform plan formulation, evaluation, and selection of the tentatively selected plan.

Landlocked Basin Study Scope: Flood Risk Analysis and Establishment of Target Water Levels

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- Flood risk assessment (without project)
  - Existing and future land use
  - Wet and dry future climate projections
- Estimation of potential damages
- Estimation of target water levels and establishment of Ordinary High Water Level (OHWL) on basins – MnDNR typically allows outlets between 1.5 foot below the OHWL and the OHWL
  - Reid Park Ponds/Friedrich's Pond need OHWLs

Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

- Conceptual design of up to three concepts
  - Pumping from all basins
  - Acquisition of all at-risk properties (or relocation of at-risk infrastructure (e.g. moving septic systems, raising roads, etc.)
  - Combination of pumping and acquisition
- Evaluation of downstream impacts & potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality & Ecological Conditions (AIS)
- Planning level cost estimates
- Permitting requirements

Landlocked Basin Study Schedule

Task	Anticipated Completion
Stakeholder Engagement	May 2023
Data Collection	Most items complete by December 2022; Survey may extend into Spring 2022
Baseline modeling	May 2022
Flood Risk Analysis and Establishment of Target Water Levels	July 2022
With Project Alternatives Assessment	March 2023
Draft Comprehensive Planning Study Report	May 2023

Questions?

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Nicholas Vottero (USACE), nicholas.g.vottero@usace.army.mil

Jeremiah Jazdzewski (USACE), jeremiah.jazdzewski@usace.army.mil

Landlocked Basin Flood Mitigation Comprehensive Planning Study: Existing Conditions Review and Summary

January 12, 2023

Jennifer Koehler, Barr/VBWD
John Hanson, Barr/VBWD
Adam Janzen, Barr/VBWD
Jeremiah Jazdzewski, USACE

Agenda

- Project Goals
- Data Collection and Summary
- Climate Assessment Summary (Preliminary)
- Modeling Challenges and Results
  - Groundwater Modeling Results
  - Hydrologic & Hydraulic (Surface Water) Modeling Results
- Stakeholder Input
  - Future Conditions
  - Flood Risk Analysis, Target Water Levels, and Pumping Assessment
  - Preliminary Pumping/Outlet Alignment
- Next Steps

Project Stakeholders

Project Partners:

- United States Army Corps of Engineers (through Planning Assistance to the States(PAS) program)
- Valley Branch Watershed District

Project Stakeholders:

- Minnesota Department of Natural Resources
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High Surface Water Conditions

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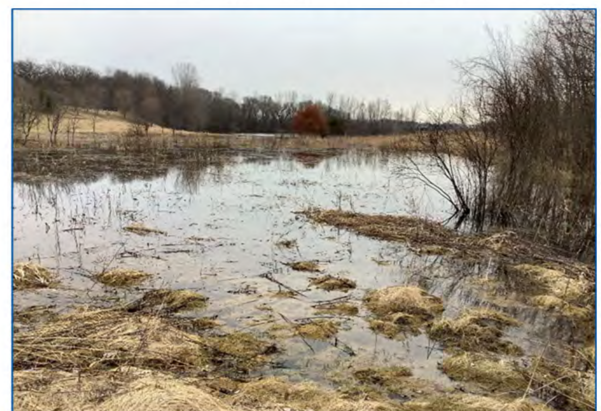
Klawitter Pond Flooding (2020)

Reid Park Ponds flooding (2020)

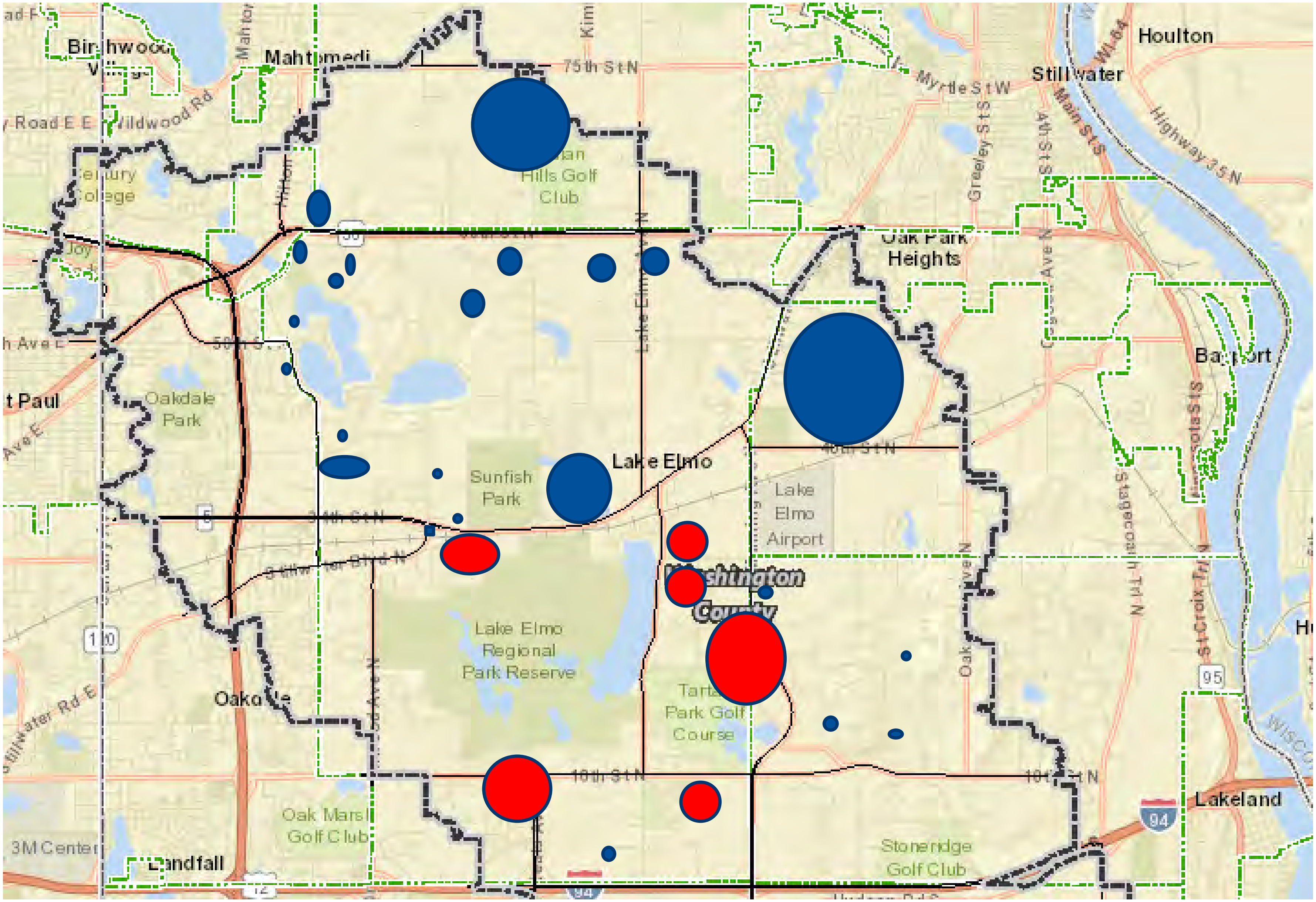
Friedrichs Pond levels flooding a home and driveway access (2020)

Legion Pond emergency pumping floating intake (2020)



High water levels on Goetschel Pond (2020)

Recent Reports of Flooding in the VBWD (2019-2020)



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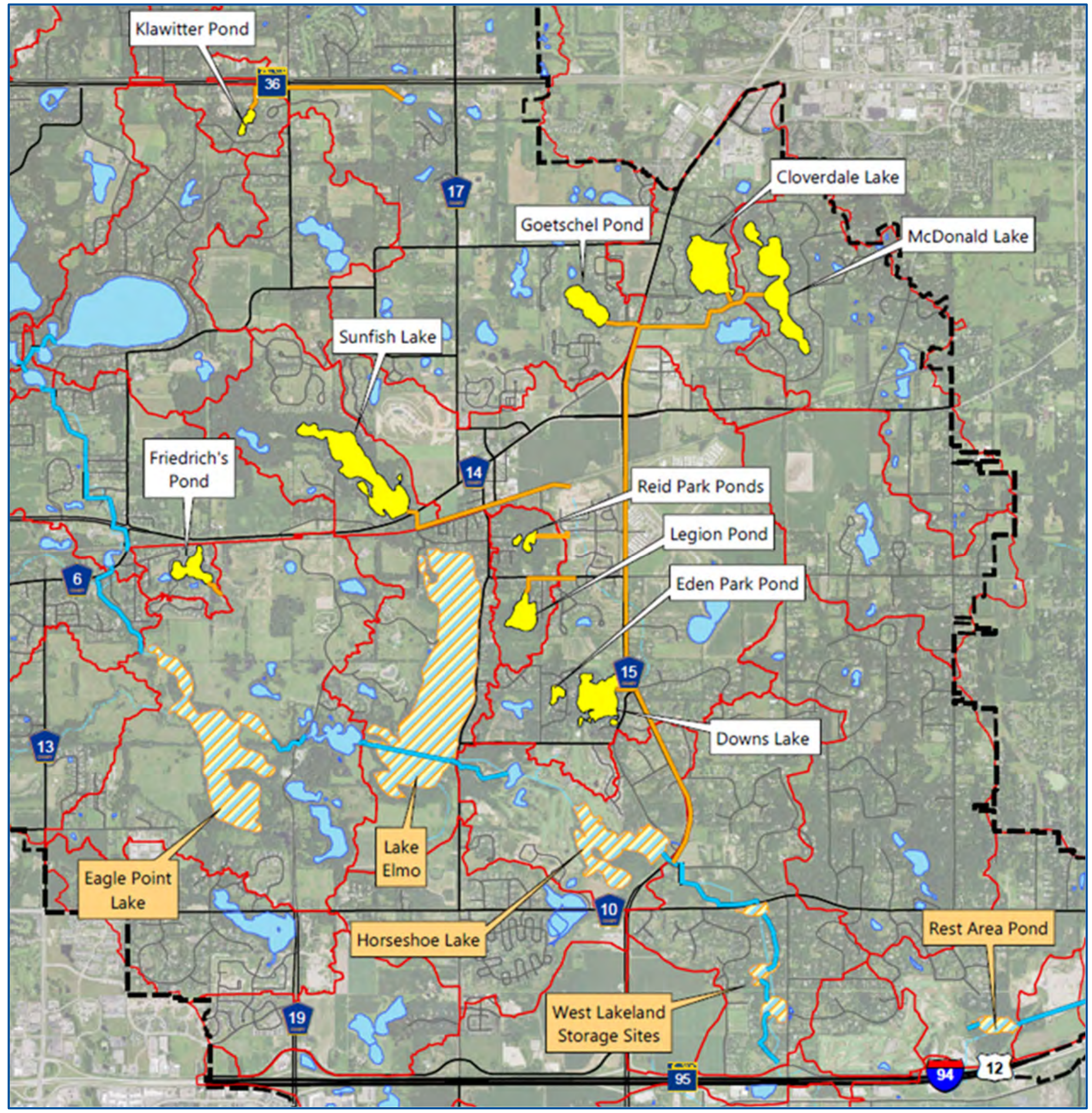

Data Collection and Summary

Landlocked Basin Study Scope: Data Collection

- Compilation/review of historic studies
- Low floor/critical structure & drainage infrastructure survey
- Bathymetric (below water) survey
- Groundwater monitoring
- Water quality monitoring
  - Standard parameters (phosphorus, chlorophyll-a, Secchi depth)
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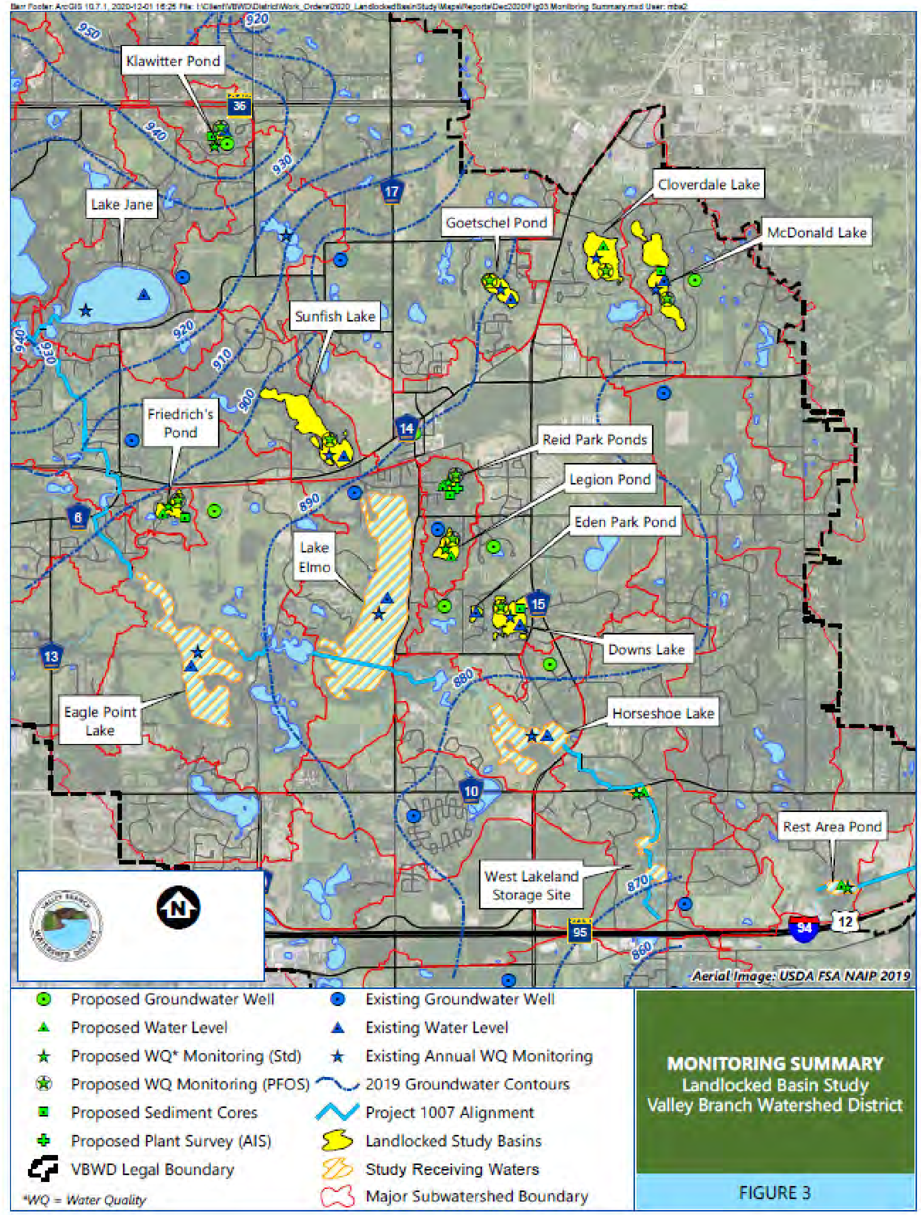


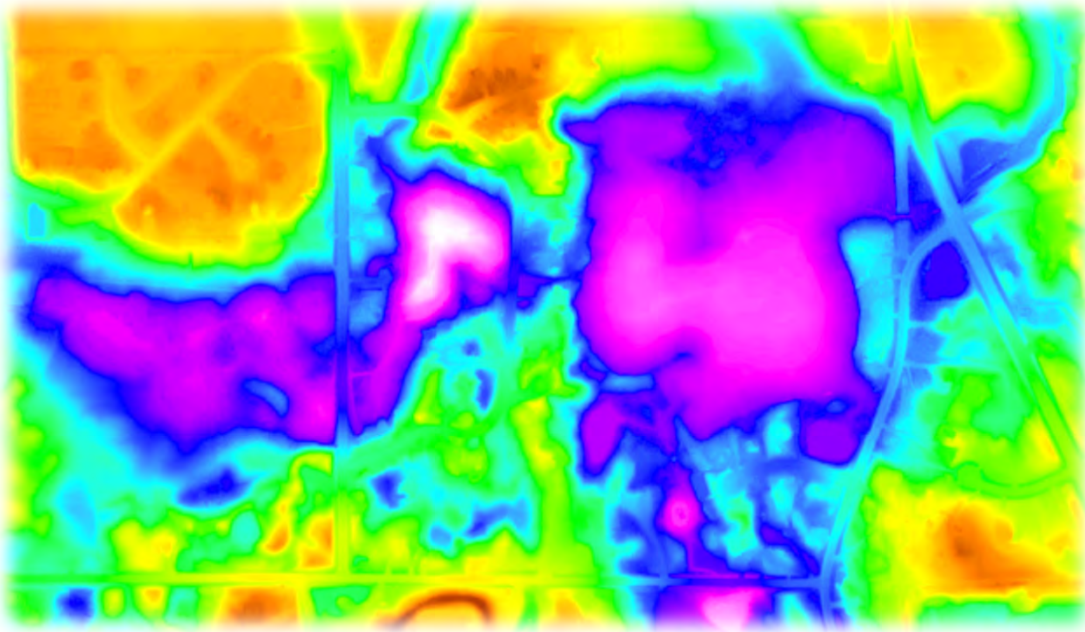
Landlocked Basin Study Scope: Critical Structure Survey

- Initial estimates of low opening/basement floor based on structure outlines and DNR LiDAR
- Three Tiers (Tier 1, 2, 3)
  - Three rounds of mailings in the first part of 2022
  - Surveys completed by USACE in spring/summer 2022
- For those not surveyed, using estimates based on structure footprint and 2011 DNR LiDAR
- This data can be used to evaluate potential damages (without project) and evaluate appropriate pumping rates/elevation for outlets from these basins to best protect homes

Basin	Estimated Low Homes	Surveyed Structures
Klawitter Pond	16	11
Friedrichs Pond	2	2
Reid Park Ponds	4	1
Legion Pond	24	13
Sunfish Lake	0	0
Goetschel Pond	6	3
Downs Lake/Eden Park Pond	24	13
Cloverdale Lake	17	9
McDonald Lake	1	1

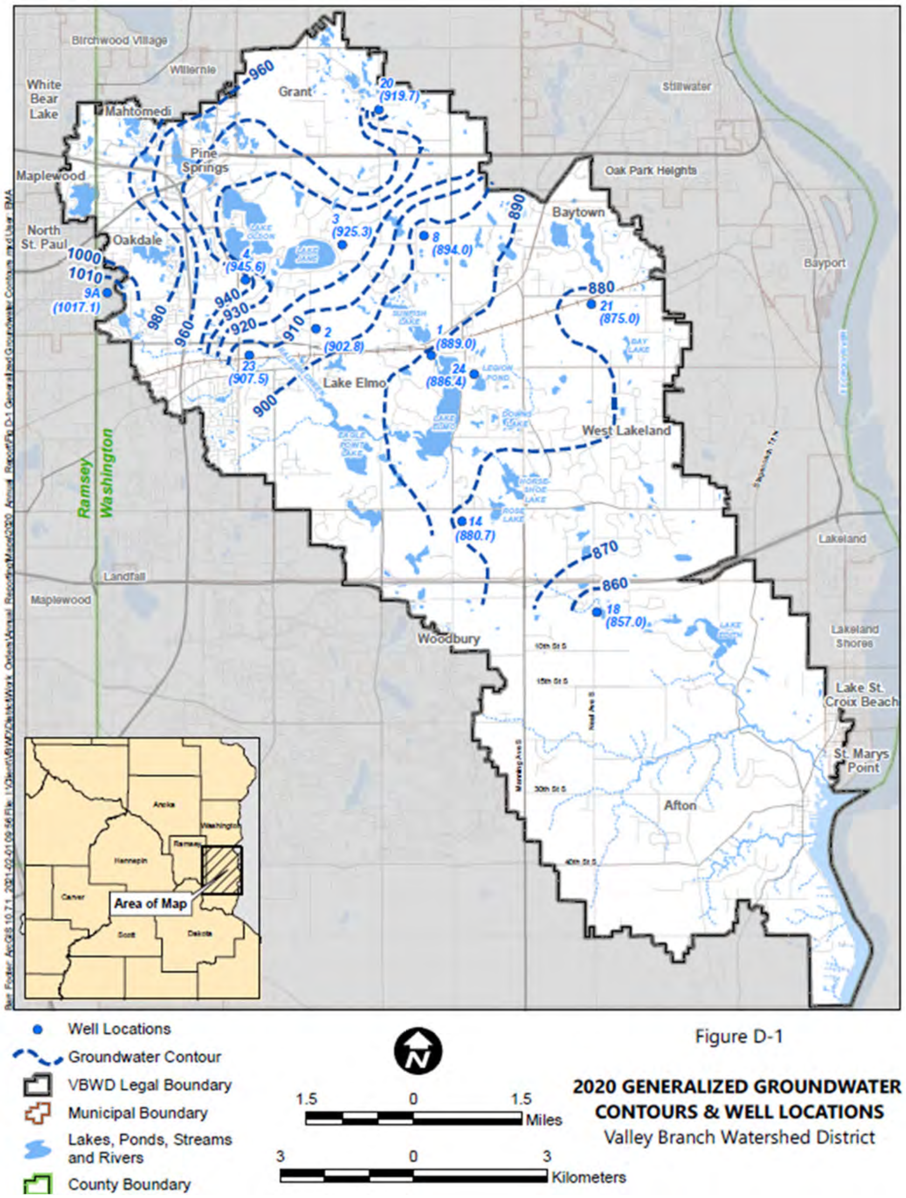
Landlocked Basin Study Scope: Bathymetric (Below Water) Survey

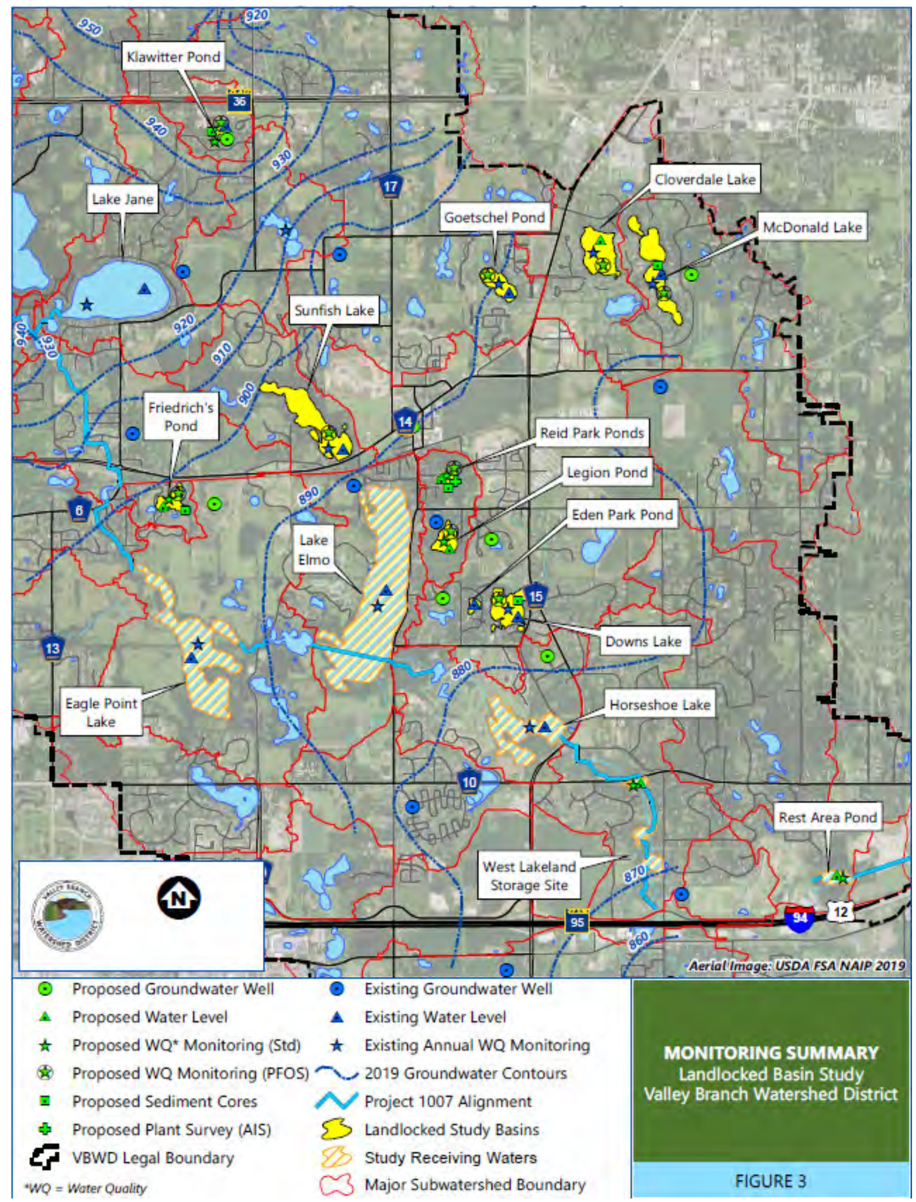
- Collected by USACE in 2021
  - Downs Lake
  - Reid Park Ponds
  - Legion Pond
  - Friedrich's Pond
  - Klawitter Pond
- Merged with DNR LiDAR and other bathymetric data for the VBWD
- Used in both surface water and groundwater modeling for storage curves used for each basin.



Downs Lake

VBWD Groundwater Monitoring





Landlocked Basin Study Scope: Lake Level Data/Ordinary High Water Level (OHWL) Summary

- All study and receiving waters were monitored in 2021 by Washington Conservation District (WCD)
- DNR established OHWL for Reid Park Ponds in 2022
- Some OWHLs are higher than long-term average water levels and one is significantly lower than the long-term average water level. ***Will the DNR ever revise the OWHLs?*** If so, could affect elevation at which pumping can start.

Water Body	OHWL	OHWL Minus 1.5 ft	Long-Term Average Water Level	Average High-Water Level (2014-2021)	Comments
Klawitter Pond	***955.0***	***953.5***	***949.8***	***951.0***	***Pumping elevation would require a variance from DNR; Would DNR ever revise OHWL?***
Reid Park Pond	885.5	884.0	886.9	886.9	Base pumping elevations on OHWL
Legion Pond	884.0	882.5	881.8	885.7	Base pumping elevations on OHWL
Cloverdale Lake	900.8	899.3	***904.1***	***906.4***	OHWL several feet below long-term average water level - ***Would DNR ever revise OHWL?***
McDonald Lake	887.6	886.1	887.5	887.9	Base pumping elevations on OHWL
Friedrich's Pond	909.4	907.9	907.4	908.8	Base pumping elevations on OHWL
Goetschel Pond	***900.8***	***899.3***	***889.3***	***894.8***	***Pumping elevation would require a variance from DNR; Would DNR ever revise OHWL?***
Sunfish Lake	896.3	894.8	895.2	896.4	Base pumping elevations on OHWL
Downs Lake	889.2	887.7	887.8	888.5	Base pumping elevations on OHWL

Landlocked Basin Study Scope: Water Quality – Standard Parameters

- All study and receiving waters were sampled in 2021 by WCD

Lake Name	Total Phosphorus (µg/L)		Secchi Disc Transparency (m)		Chlorophyll-*a* (µg/L)		Would MPCA Consider It Impaired?
	2021	2012–2021	2021	2012–2021	2021	2012–2021	
Deep Lake Standard:	***40***		***1.4***		***14***		
Lake DeMontreville	28	20	3.1	3	6	8	no
Lake Elmo	14	20	3.9	4.9	3	2	no
Lake Jane	21	14	4.7	4.4	2	3	no
Shallow Lake Standard:	***60***		***1.0***		***20***		
Cloverdale Lake	**24**	**33**	**2.7**	**2.6**	**9**	**11**	**no**
Downs Lake	**150**	**174**	**0.8**	**0.5**	**80**	**99**	**yes**
Goose Lake (South)	89	**93**	0.4	**0.5**	74	**69**	**yes**
Horseshoe Lake	62	47	1.8	1.3	55	**25**	no
McDonald Lake	**52**	**73**	**2**	**1.2**	**9**	**31**	**yes**
Lake Olson	25	20	3.4	3.3	3	6	no
Sunfish Lake	**22**	**40**	**3.5**	**1.5**	**3**	**20**	**Approved TMDL**
Wetland/Pond:	***None***		***None***		***None***		
Eagle Point Lake	45	100	0.6	0.8	12	30	--
Friedrich's Pond	**75**	**76**	**1**	**1**	**5**	**6**	**--**
Goestchel's Pond	**34**	**35**	**2.7**	**2.4**	**3**	**9**	**--**
Goose Lake (North)	199	195	0.3	0.4	141	98	--
Klawitter Pond	**120**	**96**	**0.5**	**0.7**	**48**	**39**	**--**
Legion Pond	**44**	**44**	**1.7**	**1.6**	**10**	**10**	**--**
Reid Park Pond	**40**	**40**	**1.1**	**1.1**	**9.2**	**9.2**	**--**
Rest Area Pond	85	94	1.1	1	24	35	--

Landlocked Basin Study Scope: Water Quality – Sediment Cores

- Sediment cores/internal phosphorus release –
  - Downs Lake
  - McDonald Lake
  - Friedrich's Pond
  - Reid Park Ponds
  - Klawitter Ponds
- Help with identifying potential mitigation measures for pumping (e.g. Alum Treatment to improve water quality)

Landlocked Basin Study Scope: Water Quality – PFOS/PFAS

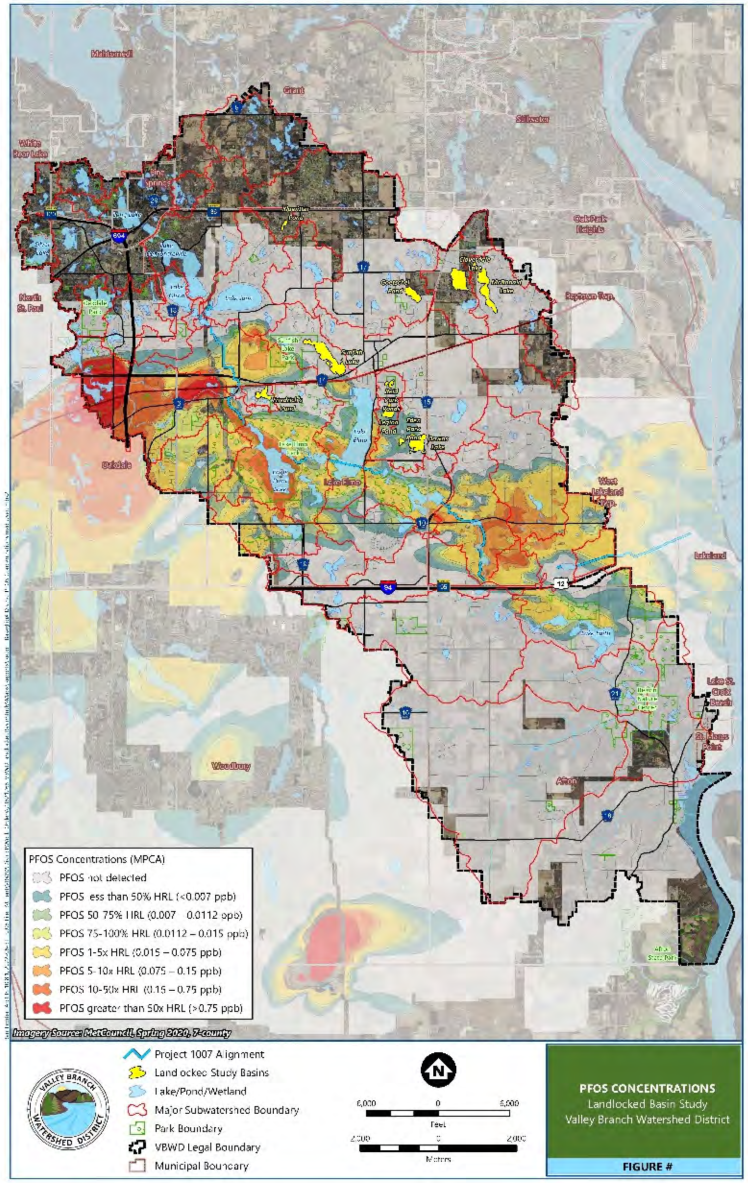
VALLEY BRANCH WATERSHED DISTRICT

US Army Corps of Engineers®

- Grab samples collected in late Fall 2021

Water Body	PFBA (ng/L)	PFOA (ng/L)	PFOS (ng/L)
Klawitter Pond	19	3.9	2.7
Reid Park Pond	**170**	**15**	**2.4**
Legion Pond	**125-130**	**10.8 – 13**	**3.9-5.32**
Cloverdale Lake	23	4.9	1.6
McDonald Lake	45	4.3	0.96
Friedrich's Pond	52.5-64	8.17-12	3.6-4.56
Goetschel Pond	**110**	**12**	**1.3**
Sunfish Lake	**2770-5020**	**71.1-120**	**1.06-18**
Downs Lake	32.0-37.1	3.43-3.7	1.8-1.94

Items in red exceed either EPA Drinking Water Health Advisories for PFAS, MDH Human Health-Based Water Guidance Table, MPCA Site-Specific Water Quality Criteria for PFOS



PFOS/PFAS may impact ability to pump from basins and limit mitigation options to reduce downstream impacts

Landlocked Basin Study Scope: AIS Summary

- AIS summary based on past VBWD surveys, DNR website, recent surveys (Reid Park Ponds)
- No public access to study basins
- ***No current data suggests AIS will be a significant concern with new outlets***


Basin	AIS Noted
Cloverdale Lake	Purple Loosestrife (PL)
McDonald Lake	Curlyleaf Pondweed (CLP)
Downs Lake	None noted
Reid Park Ponds	None noted
Legion Pond	None noted
Friedrich's Pond	CLP, PL
Sunfish Lake	CLP
Klawitter Pond	None noted
Goetschel Pond	PL

Climate Assessment

Climate Assessment (Preliminary) Goals

- Review historic data and trends
- Review global climate models and estimate what the future precipitation might look like in the VBWD
- Understand the likelihood that we will experience a wet climatic period similar to what was experienced in 2014-2020, based on historic data
- Consider how these conditions impact the evaluation and development of the with-project alternatives

Climate Assessment (Preliminary)

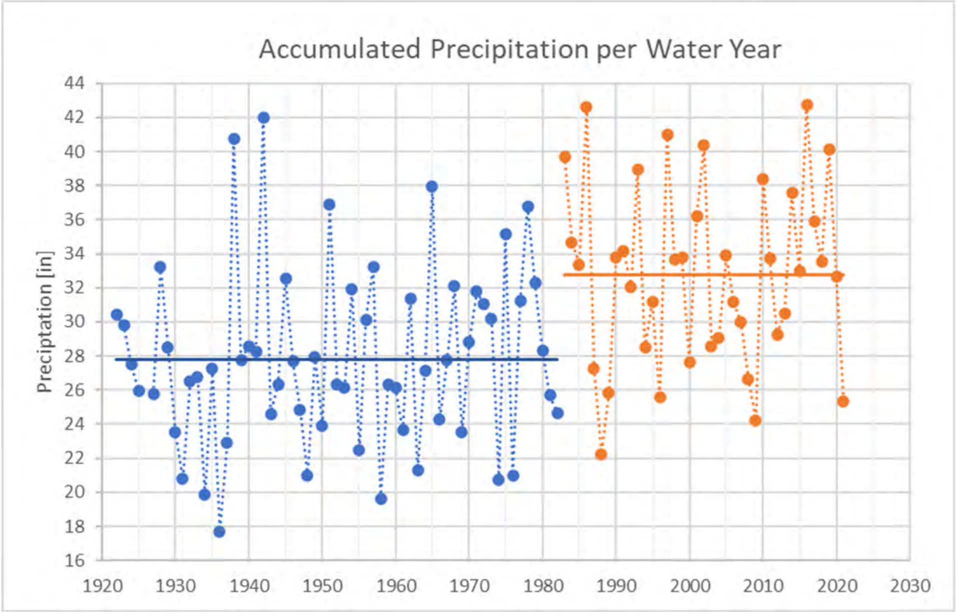
USACE Engineering and Construction Bulletin (ECB) 2018-14 Climate Assessment[1]

Report Components:

1. Summary of past work in UMR region
2. Observed trends and shifts precipitation, temperature, and streamflow in project area
3. Future climate conditions
4. Flood risk vulnerability assessment
5. Assessment of residual risk due to a changed climate

↑ Total precipitation concentrated in heavy precipitation events

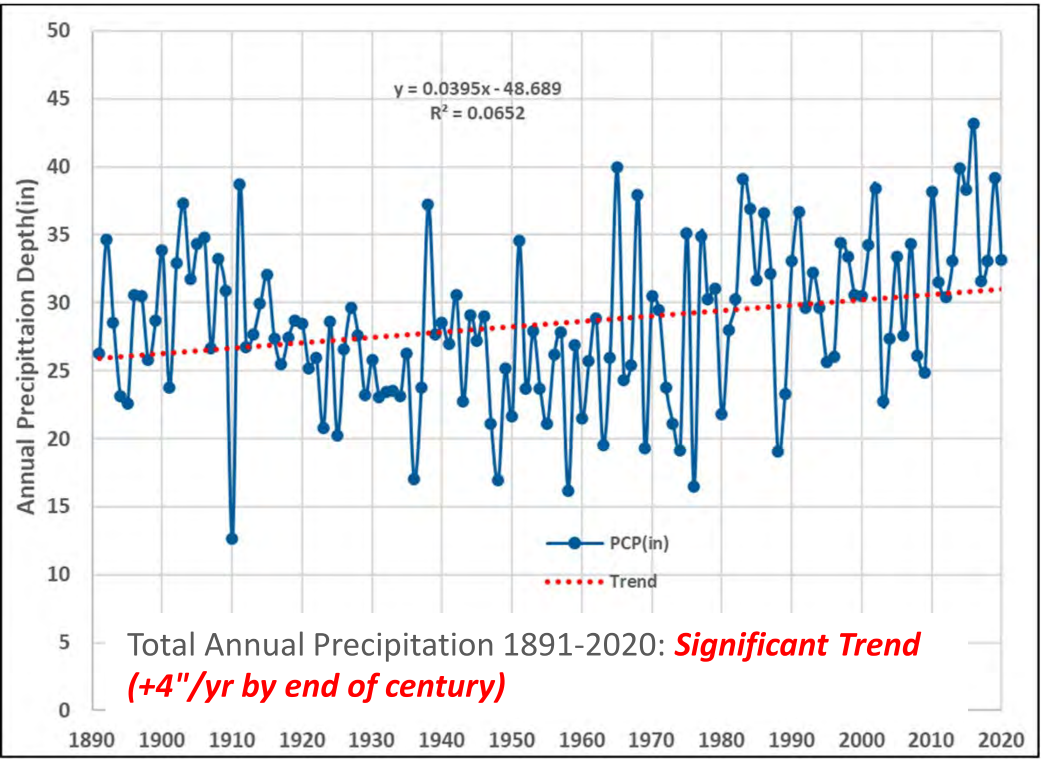
↑ Evapotranspiration with rising temperature expected to reduce infiltration to groundwater

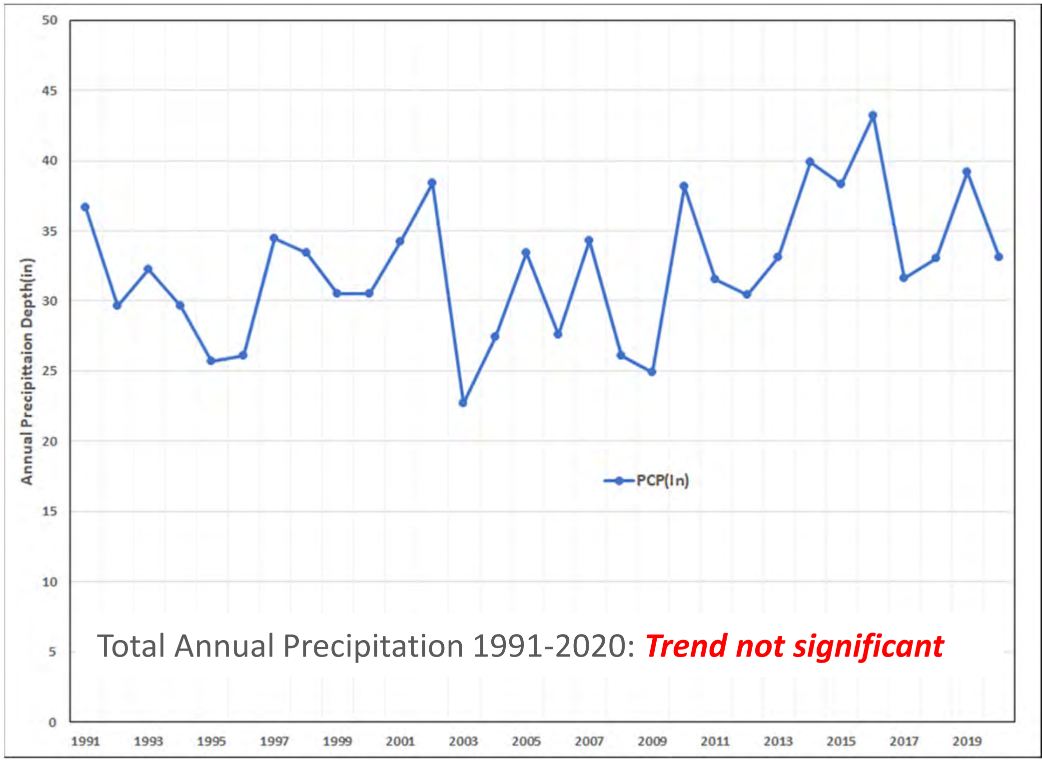


1- https://www.wbdg.org/FFC/ARMYCOE/COEECB/ecb_2018_14_rev_1.pdf

Climate Assessment (Preliminary)
Historic Data (MSP and Lake Elmo Airport)

Considering historic precipitation data local to VBWD (MSP and Lake Elmo Airport data)





Climate Assessment (Preliminary)
DNR Annual Precipitation (1991-2020)

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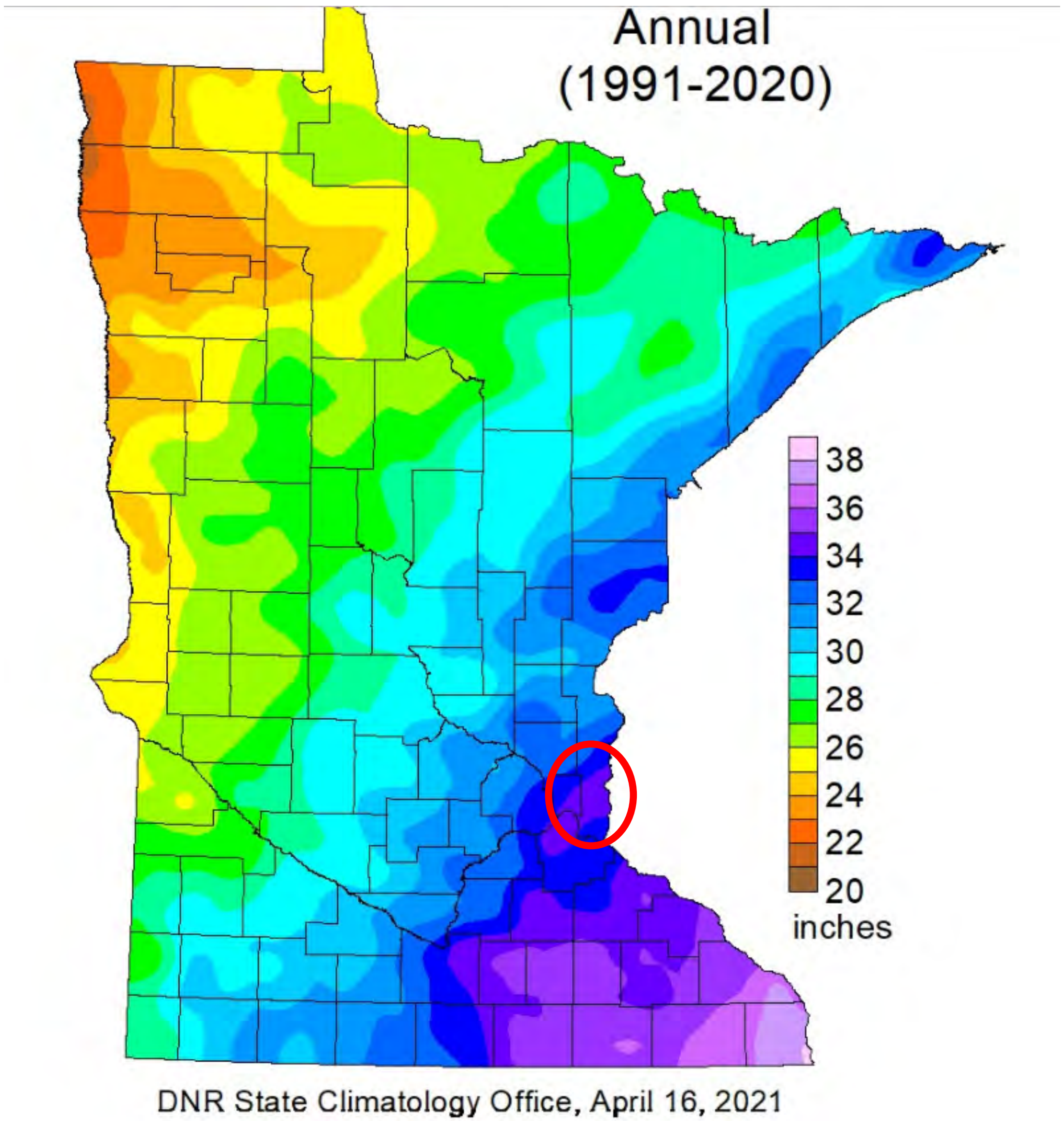
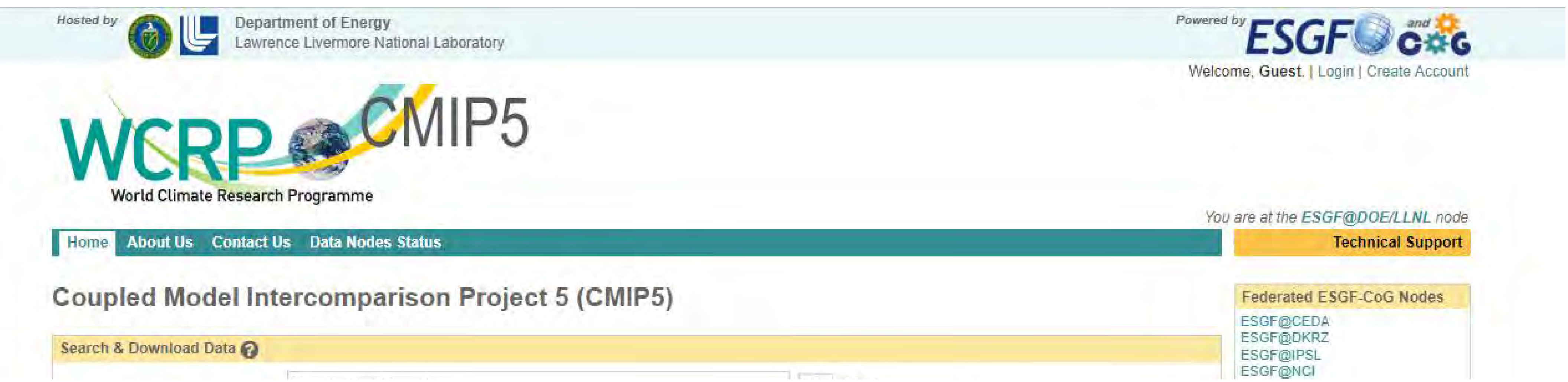


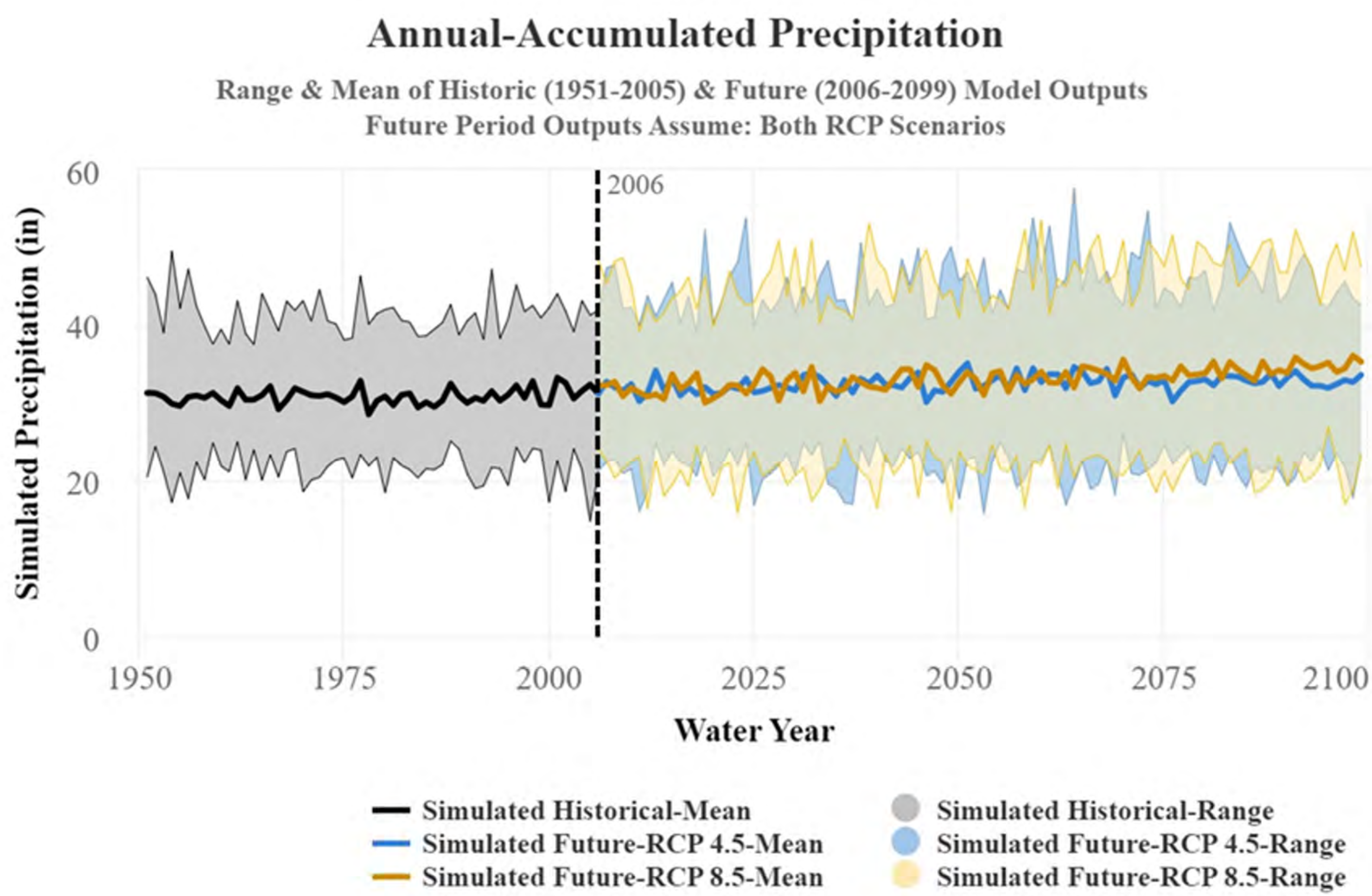
- Precipitation in VBWD (1991-2020)
  - 33-34 inches/year

Climate Assessment (Preliminary)
Global Climate Models

- Localized Constructed Analogs (LOCA) World Climate Research Program Coupled Model Intercomparison Project Phase 5 (CMIP5) daily climate data for a suite of climate models
  - 32 downscaled global climate models to reflect local estimates
    - 2 future greenhouse gas emission scenarios (Representative Concentration Pathway (RCP) 4.5 and RCP 8.5)
    - Data spans 2050-2099, with projections from 2006-2099
  - Evaluated the ensemble mean for trends in average annual precipitation (2006-2099)



Climate Assessment (Preliminary)
Global Climate Models

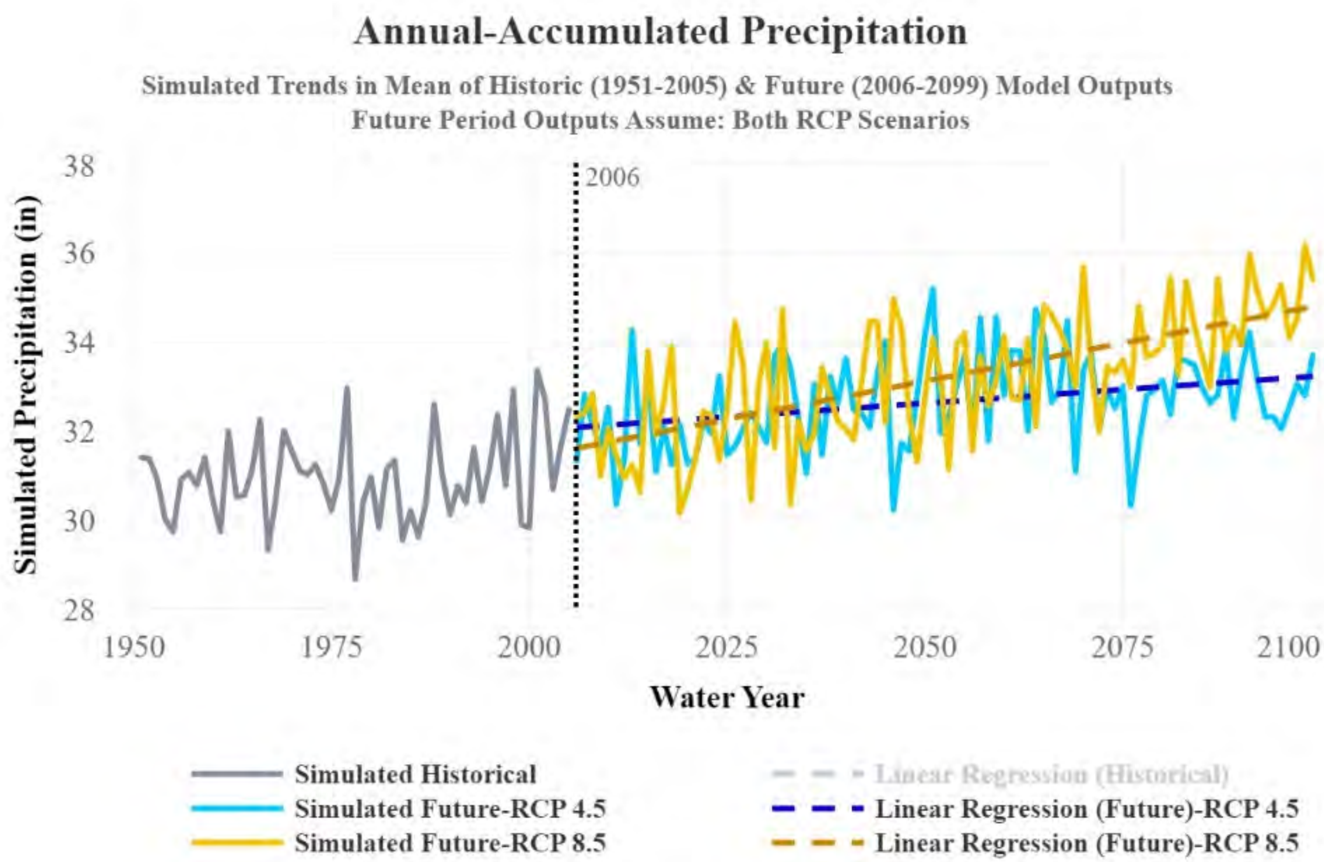


https://climate.sec.usace.army.mil/chat/

Climate Assessment (Preliminary)
Global Climate Models

Future Climate Conditions

- Average of 64 potential future climate conditions
  - Increasing precipitation
    - RCP4.5: +1.2 inches at end of century (~34 in/yr)
    - RCP8.5: +3.4 inches at end of century (~36 in/yr)
  - Increasing temperature
  - No trend flow in Lower St. Croix watershed



https://climate.sec.usace.army.mil/chat/

Climate Assessment (Preliminary) Likelihood of Exceedance – Historic Data

Preliminary Results:

10-30% chance *that the VBWD could experience a similar or wetter 7-year period as 2014-2020*

At the 95th and 99th percentiles, a wetter 7-year period could have between ***5-9% more total precipitation*** *than 2014-2020 period.*

- Statistical analysis of historic climate data **- assuming historic climate variability (does not reflect future climate change/projections)**
  - Understand how likely we will experience another 7-year wet period similar to 2014-2020 (258 inches (36.8 inches/year))
    - Recent 30-years (1991-2020, no trend)
  - Understand how much wetter another 7-year wet period could be when compared to 2014-2020
  - ***Still reviewing assessment with the USACE, so these conclusions are subject to change***

Climate Assessment (Preliminary) Key Takeaways

US Army Corps of Engineers

Review of historic annual precipitation

- Upward trend in annual precipitation (entire record)
- No trend in annual precipitation (1991-2020)

Global climate models

- Upward trend in annual precipitation toward end century (+1-3 inches/year by end of century (34-36 in/year))

Based on historic climate data, there is a 10-30% chance that the VBWD could experience a similar or wetter period to 2014-2020 and could have 5-9% more total precipitation than 2014-2020.

Baseline Groundwater and Surface Water Modeling

Modeling Challenges

All models are wrong
but some are useful

George E.P. Box

Modeling Challenges

- **Hydrologic and Hydraulic (surface water) modeling**
  - Complicated watersheds with numerous landlocked basins - contributing area varies
  - Changes in the watersheds/development over time
  - Continuous modeling (1998-2021) and model size
  - Long model run times (1+ weeks)
  - Challenges with snowpack/snowmelt modeling
  - Variability in precipitation over watershed – using MSP/Lake Elmo Airport data
  - Limited watershed monitoring data (e.g., runoff flow) – only lake level data & aerial photos
- **Groundwater modeling**
  - Long model run times (PEST calibration run ~1 week)
  - Approximate runoff estimates
  - Limited monitoring data (e.g., baseflow) – only lake level data & monitoring well levels
  - Emergency pumping data from 2019/2020 estimated (not metered)
- **Non-integrated groundwater and surface water models**
  - Separate models - Proprietary software/licensing issues with H&H models (XP-SWMM/PC-SWMM) not allowing for integration with MODFLOW
  - Costly to transition/QAQC propriety models to EPA-SWMM (public domain) and limited experience
  - More iterative than expected
- **Difference in resolution/time scales between groundwater and surface water models**
  - Monthly (groundwater) vs. sub-minute (surface water)

Groundwater Modeling

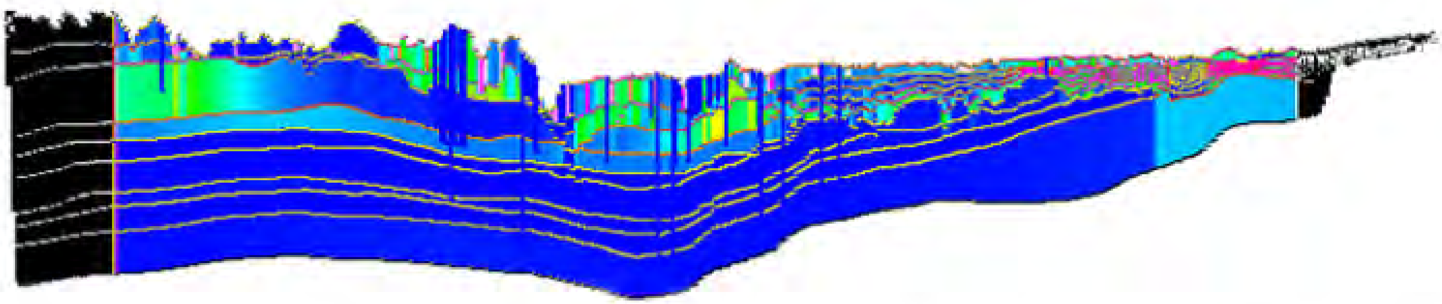
Groundwater Modeling Goals

- Understand groundwater conditions in the VBWD project area
- Provide estimates of the groundwater flows to and from (flux) the landlocked study basins to determine impact of groundwater on observed high water conditions
- Estimate impact of future “wetter conditions” on groundwater interaction at each basin
- Utilize this information to appropriately size high water level management alternatives

Baseline (without project) Modeling
Groundwater Model - Metro Model 3

METRO MODEL 3

Twin Cities Area Groundwater Flow Model



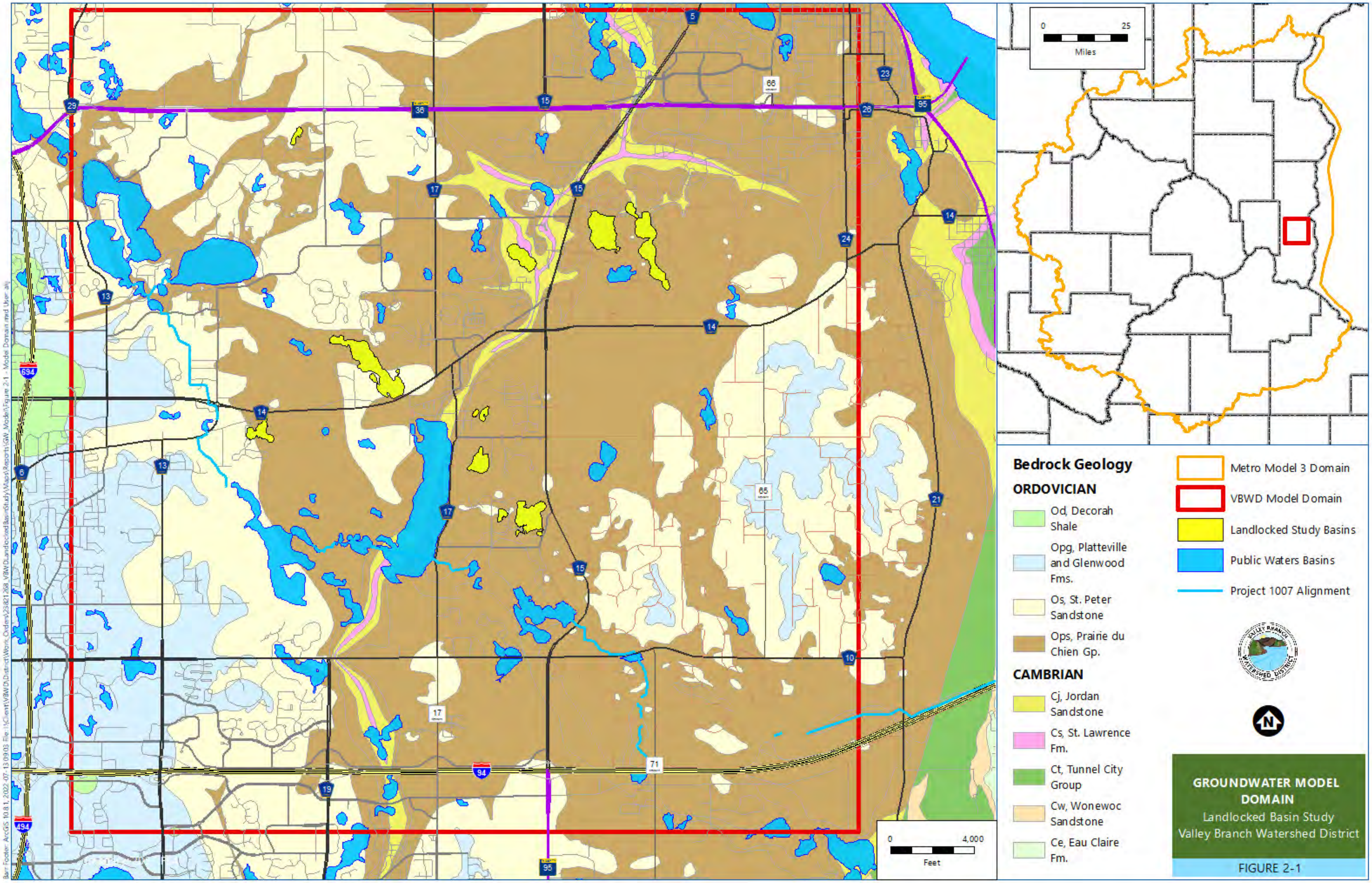
As part of the regional water supply planning effort, the Met Council updated Metro Model 2 with the assistance of Barr Engineering Company, a technical workgroup, and other stakeholders. Metro Model 3 includes updated technical data and updated modeling software.

Metro Model 3 is a regional model and is used to assess the impacts of possible management scenarios on projected groundwater levels based on land use changes, population growth, and water demand changes.

CLEAN WATER LAND & LEGACY AMENDMENT

- Metro Model 3 was used as a starting point for a new MODFLOW model of the VBWD study area

Development of the Local VBWD Groundwater Model



Groundwater Model Development: Representation of Lakes

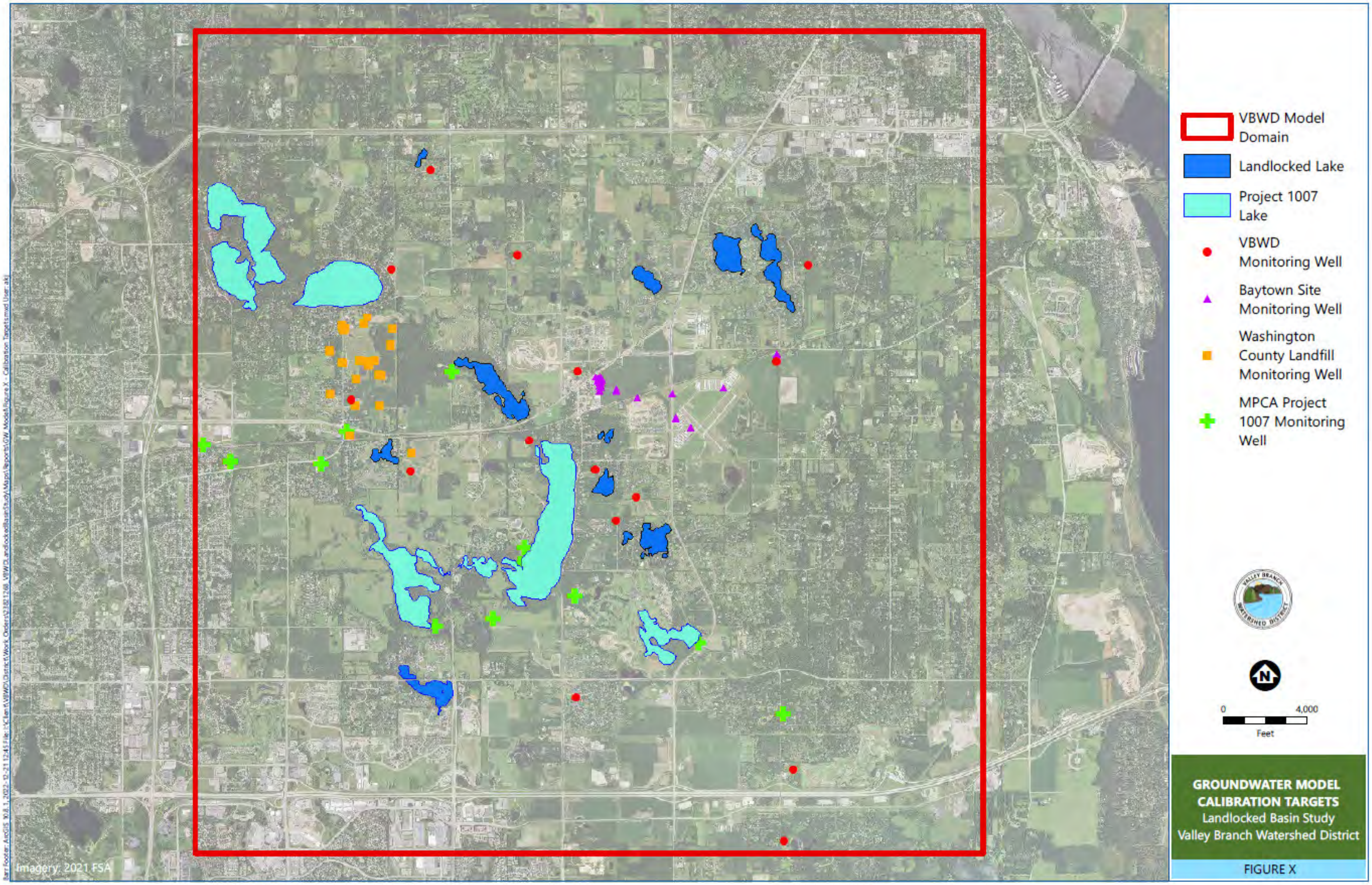
- Landlocked study basins and Project 1007 lakes were simulated using MODFLOW's lake boundary condition

Lake Boundary Condition Input	Source(s)
Runoff (including direct precip)	Estimated from H&H model results
Evaporation	Estimated with Hamon equation
Stage-storage-surface area curve	Bathymetric survey data
Outlet geometry	VBWD as-builts

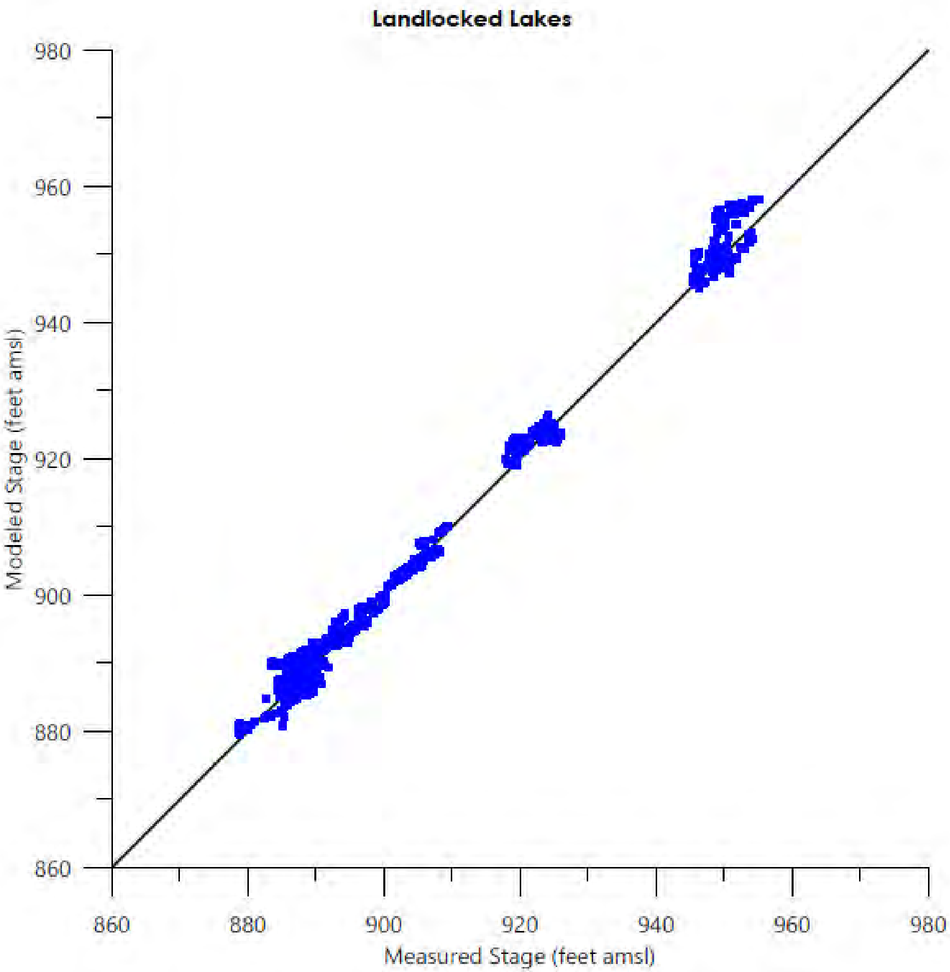
Calibration of the Local VBWD Groundwater Model

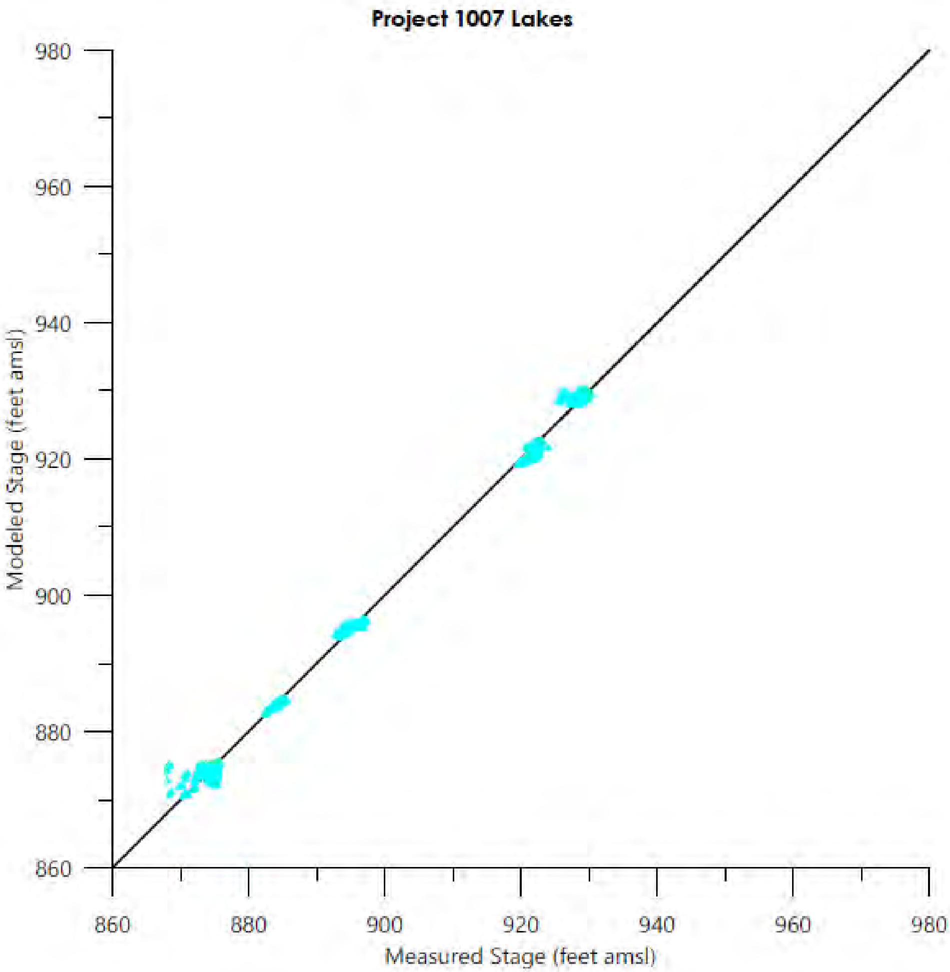
- Calibration is the process of adjusting model parameter values until the model results acceptably match actual measurements (i.e., calibration targets)
  - Parameter adjustment was automated using PESTPP-IES software
- Variable parameters
  - Aquifer hydraulic conductivity (horizontal and vertical)
  - Aquifer storage coefficients
  - Lakebed leakance
  - Recharge scaling factor
- Calibration targets (simulated 1998-2021 time period):
  - 2,294 lake level measurements
  - 3,962 groundwater level measurements
  - 555 groundwater level differences at nested well pairs

Local VBWD Groundwater Model Calibration Targets

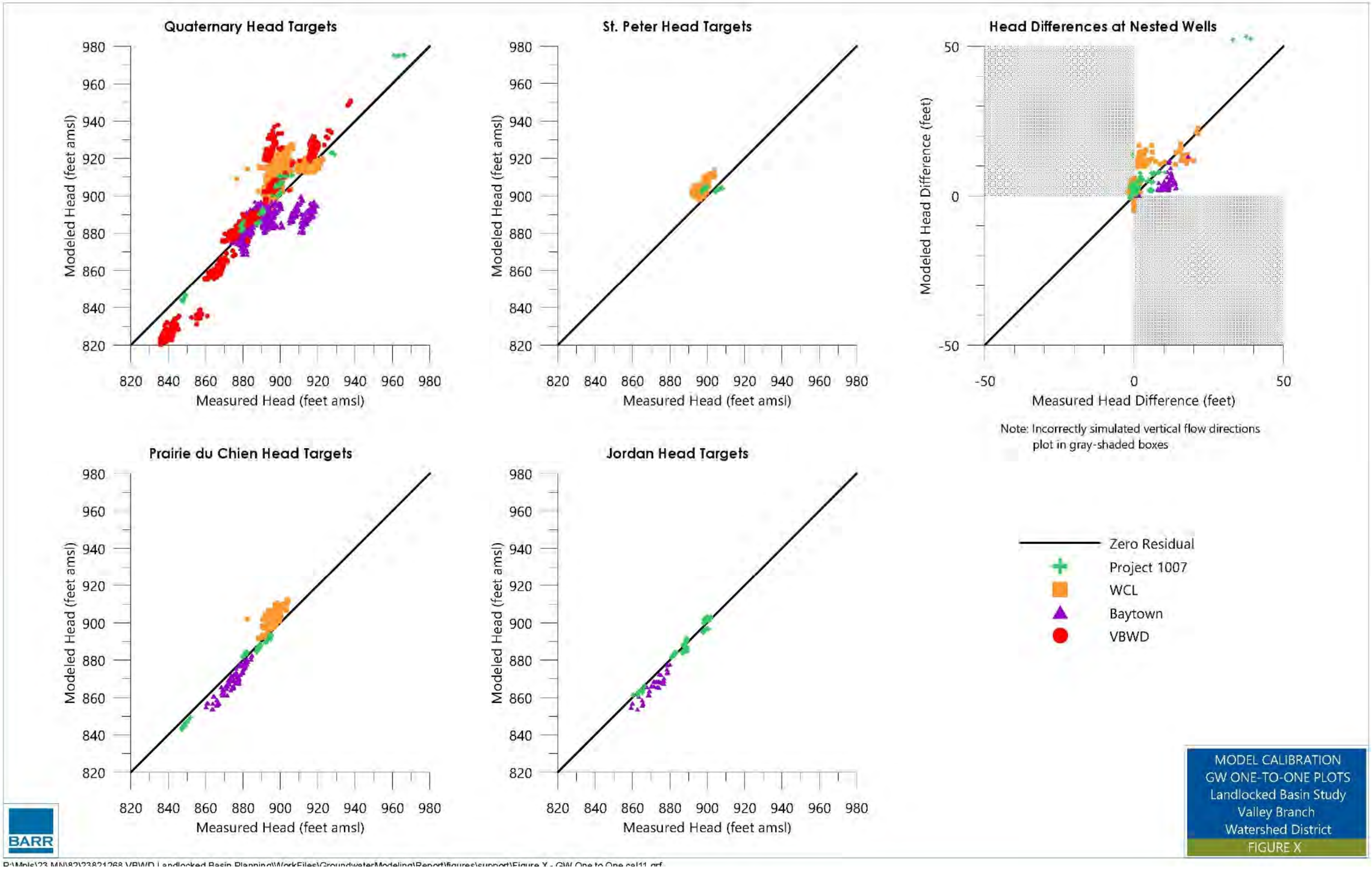


Groundwater Model Calibration: Fit to Lake Levels

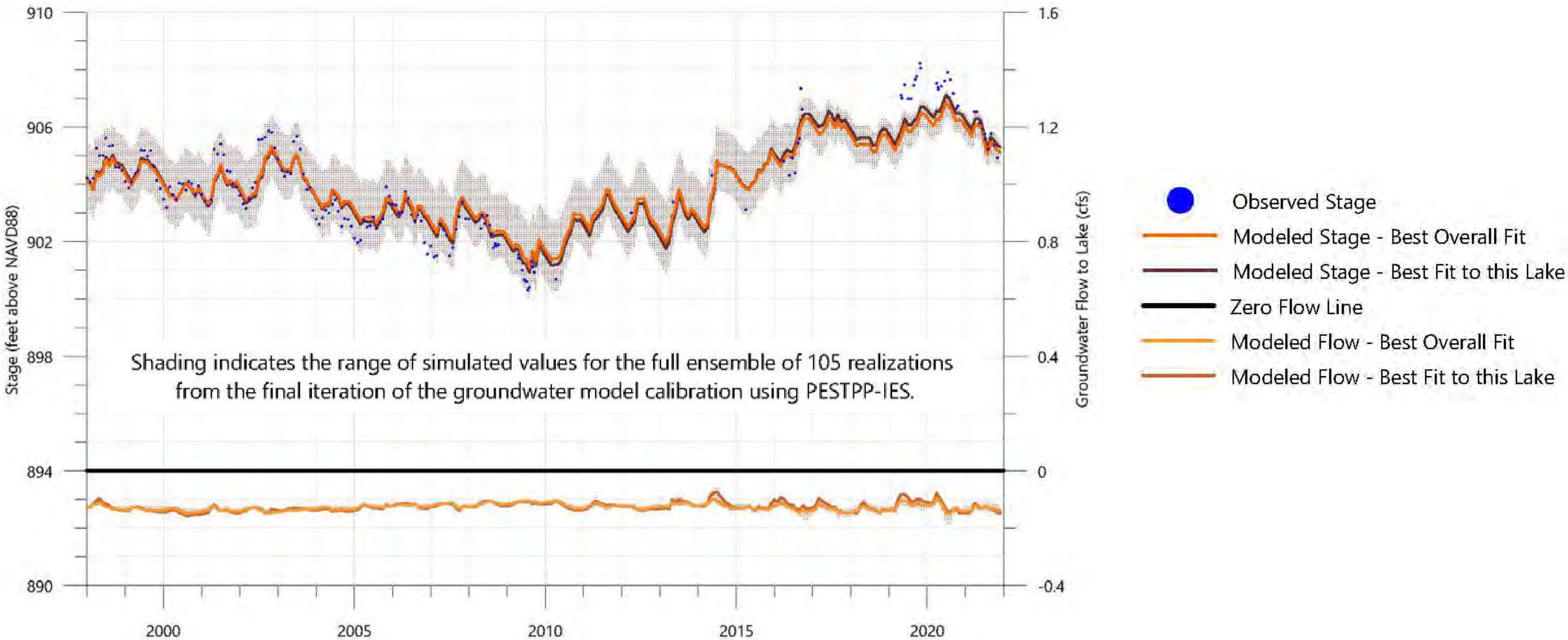




Groundwater Model Calibration: Fit to Groundwater Levels

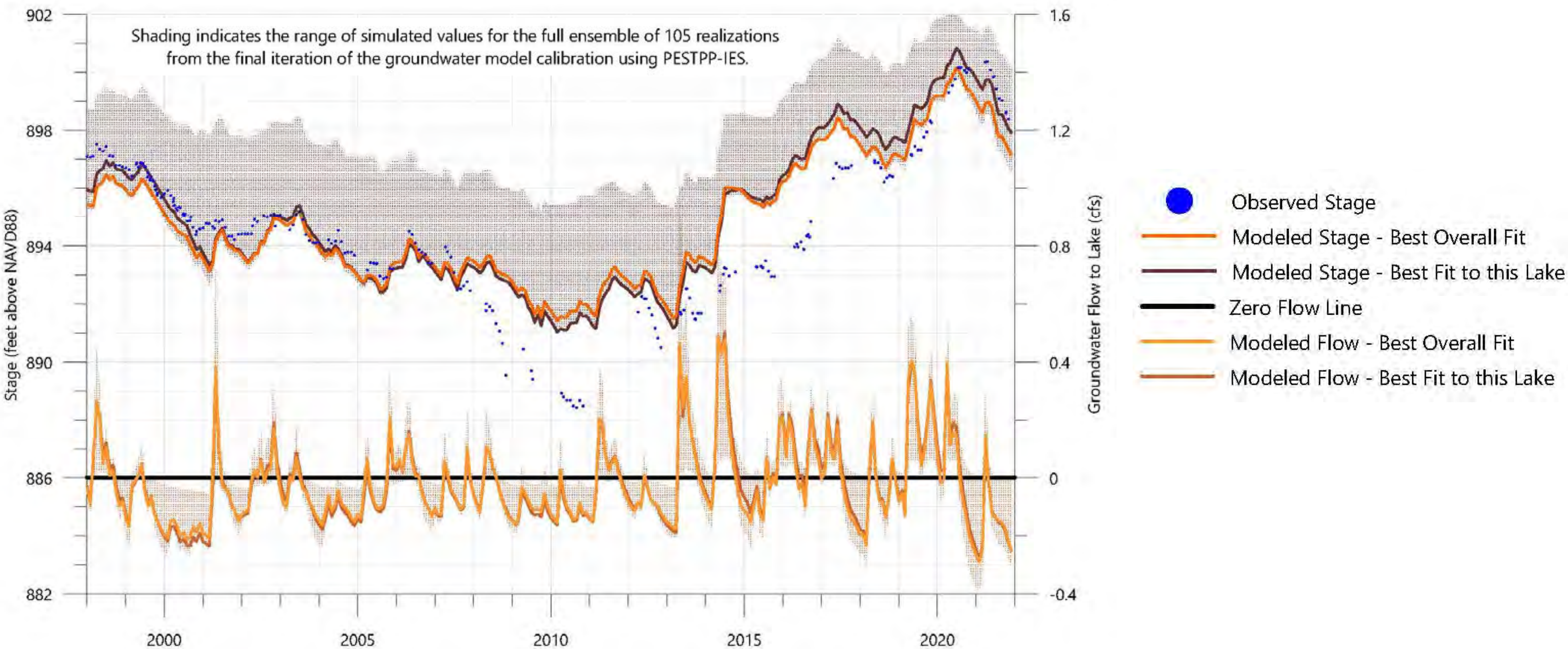


Groundwater Calibration Results Example: Cloverdale Lake



- Smaller uncertainty range for flows than stages due to input constraints:
  - Runoff to lake specified based on H&H modeling
  - Small variability in evaporative loss due to fluctuating simulated stage
  - Groundwater term closes lake water balance

Groundwater Calibration Results
Example: Sunfish Lake



- Sunfish Lake surface area varies more with stage than Cloverdale Lake
  - As a result, more variability in simulated flows

Net Groundwater Flow at Study Basins

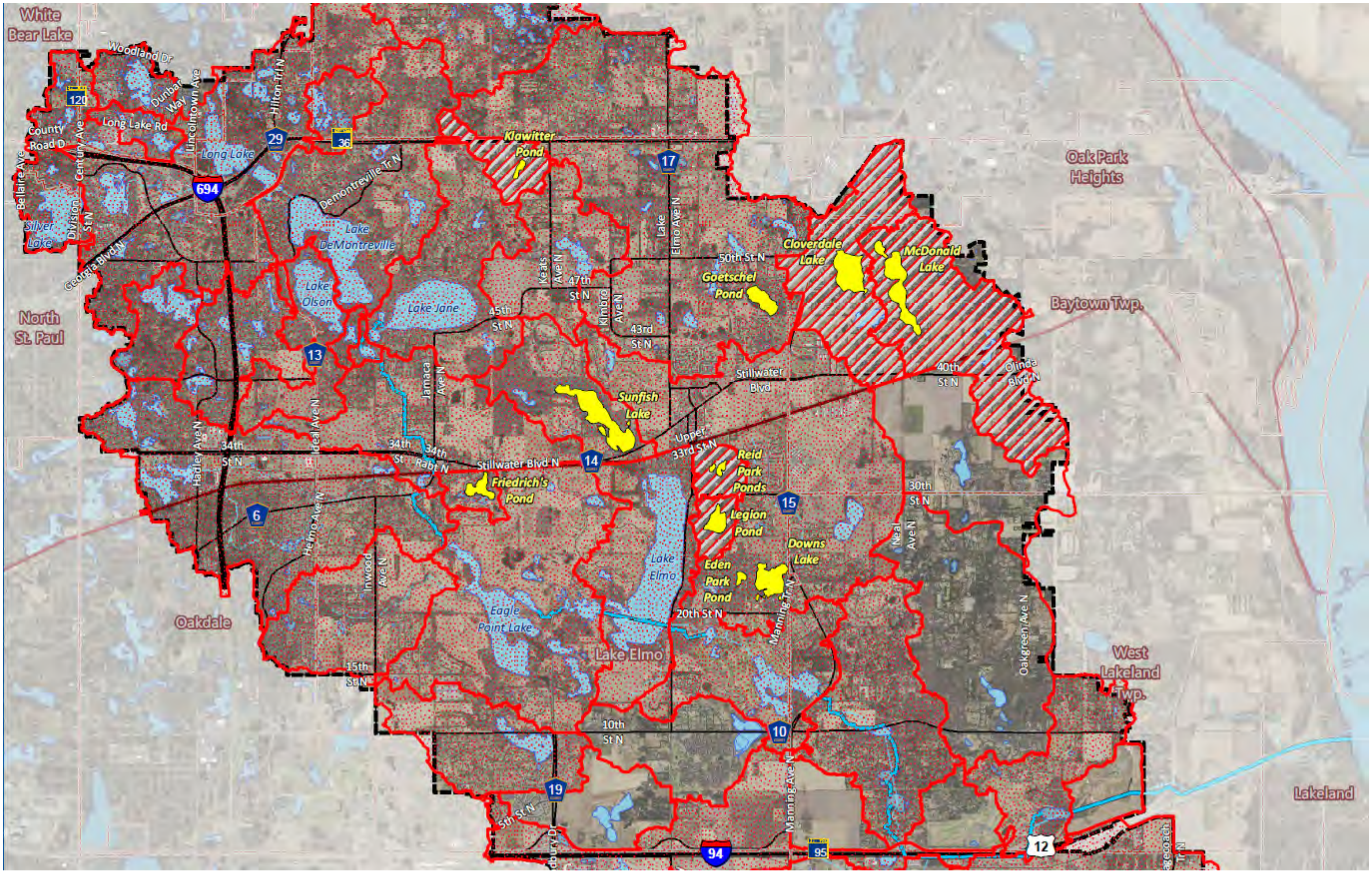
Water Body	Calibrated Net GW Flow Average (Min - Max) [cfs]	Uncertainty Range Net GW Flow (Min – Max) [cfs]	*Net Groundwater Flow Summary*
Klawitter Pond	-0.06 (-0.09 – 0.00)	(-0.11 – 0.20)	***Basin generally discharges to GW***
Reid Park Pond	-0.01 (-0.06 – 0.16)	(-0.08 – 0.23)	***Both discharges to and receives inflow from GW***
Legion Pond	-0.04 (-0.07 – 0.03)	(-0.08 – 0.08)	***Both discharges to and receives inflow from GW***
Cloverdale Lake	-0.13 (-0.15 – -0.10)	(-0.19 – -0.06)	***Basin generally discharges to GW***
McDonald Lake	-0.15 (-0.31 – 0.30)	(-0.35 – 0.59)	***Both discharges to and receives inflow from GW***
Friedrich's Pond	-0.01 (-0.03 – 0.05)	(-0.05 – 0.20)	***Both discharges to and receives inflow from GW***
Goetschel Pond	0.00 (-0.04 – 0.08)	(-0.09 – 0.23)	***Both discharges to and receives inflow from GW***
Sunfish Lake	-0.03 (-0.29 – 0.49)	(-0.39 – 1.09)	***Both discharges to and receives inflow from GW***
Downs Lake	-0.28 (-0.46 – -0.09)	(-0.52 – -0.03)	***Basin generally discharges to GW***
Eden Park Pond	-0.02 (-0.08 – 0.18)	(-0.17 – 0.21)	***Both discharges to and receives inflow from GW***

Hydrologic and Hydraulic (Surface Water) Modeling

Hydrologic and Hydraulic (Surface Water) Modeling Goals

- Quantify impact of runoff and groundwater flux on study basin water levels
- Evaluate design storm events to understand potential impacts/damages to structures and infrastructure
- Estimate impact of future land use/watershed conditions on water levels
- Size and evaluate the impact of long-term outlet/pumping on study basins and determine potential mitigation needs
- Use continuous simulations to determine potential frequency and volume of pumping annually
- Inform water quality modeling and assessment

Hydrologic and Hydraulic Models



Hydrologic and Hydraulic Models

US Army Corps of Engineers®

Existing VBWD XP-SWMM models (under development since 2014)

- Updates to impervious based on more recent data from U of MN
- Updates reflecting major changes/developments in key watersheds

↓

USACE developed new PC-SWMM models for

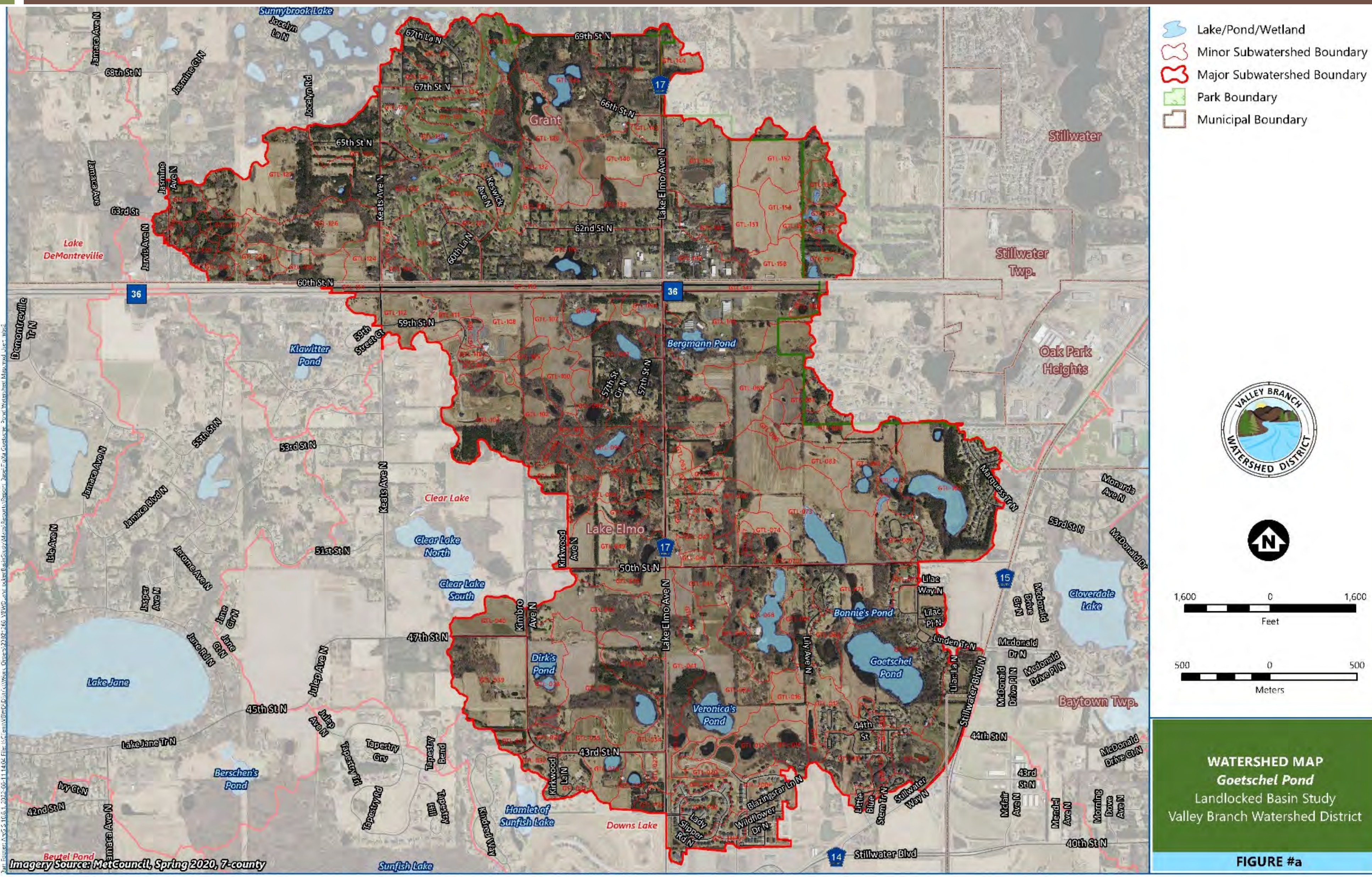
- Klawitter Pond
- Reid Park Ponds
- Legion Pond
- Cloverdale Lake
- McDonald Lake

↓

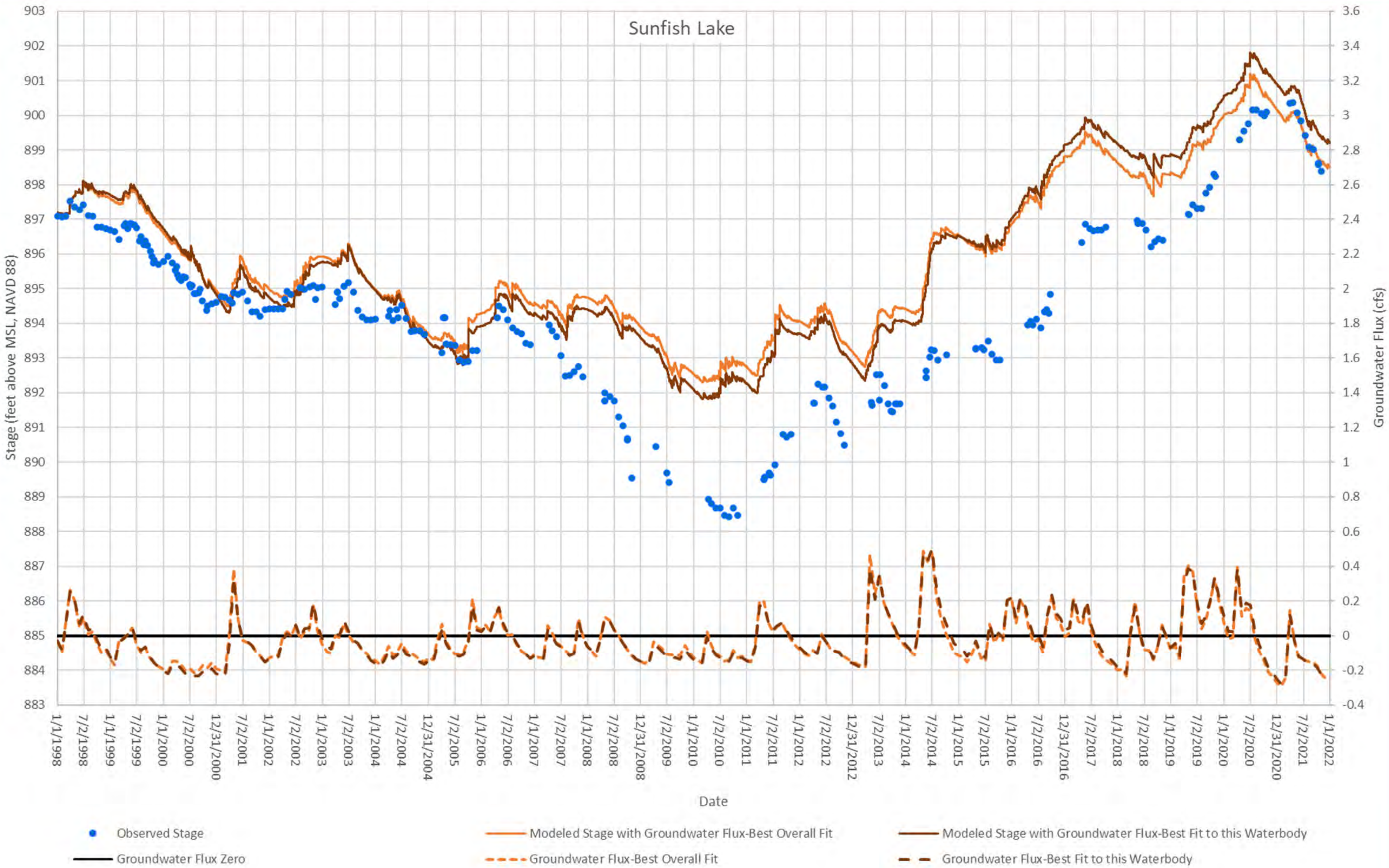
Incorporated net groundwater flux timeseries into the H&H models

- Continuous simulations using data from 1998-2021

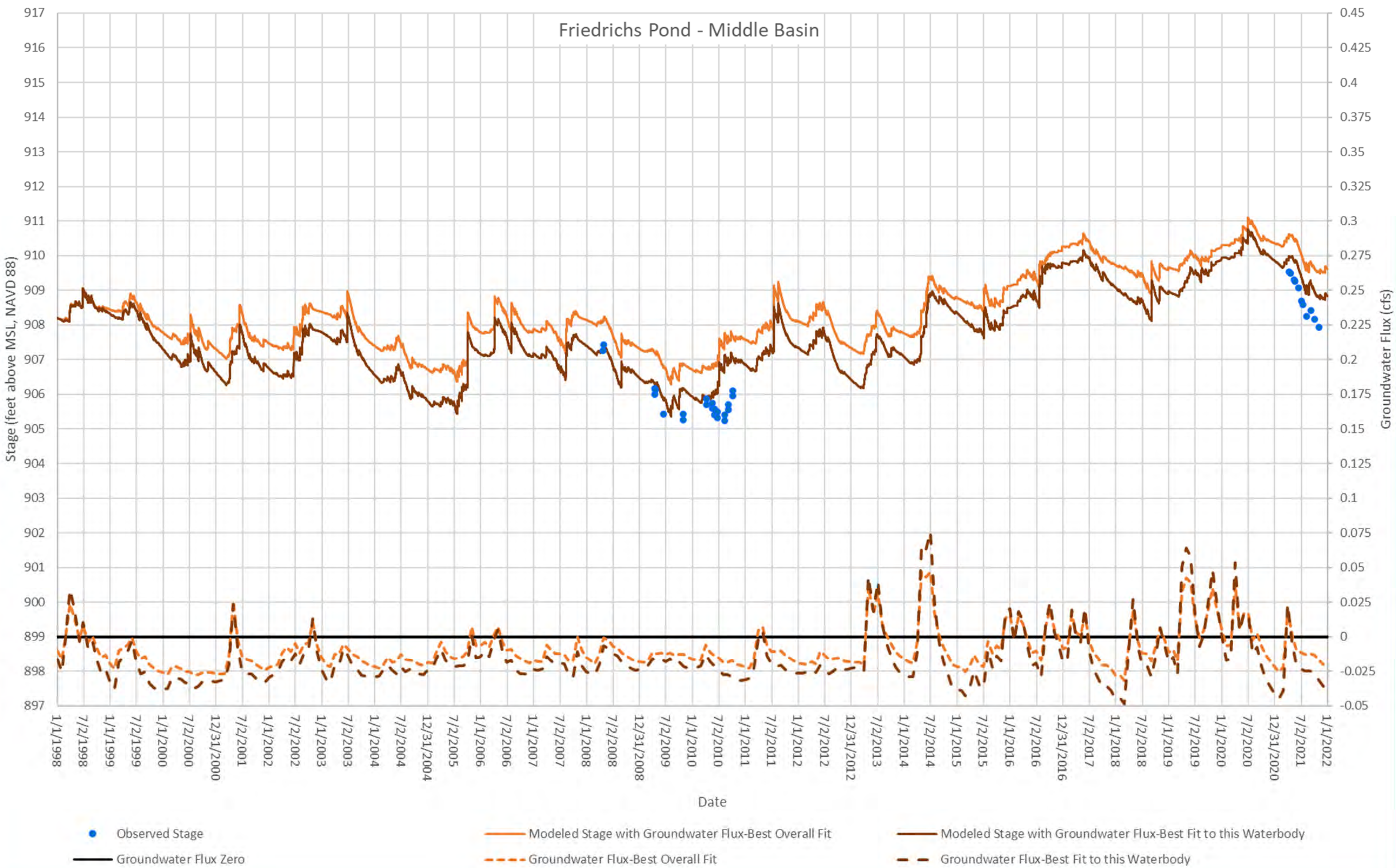
Hydrologic and Hydraulic Models
Example of Model Resolution



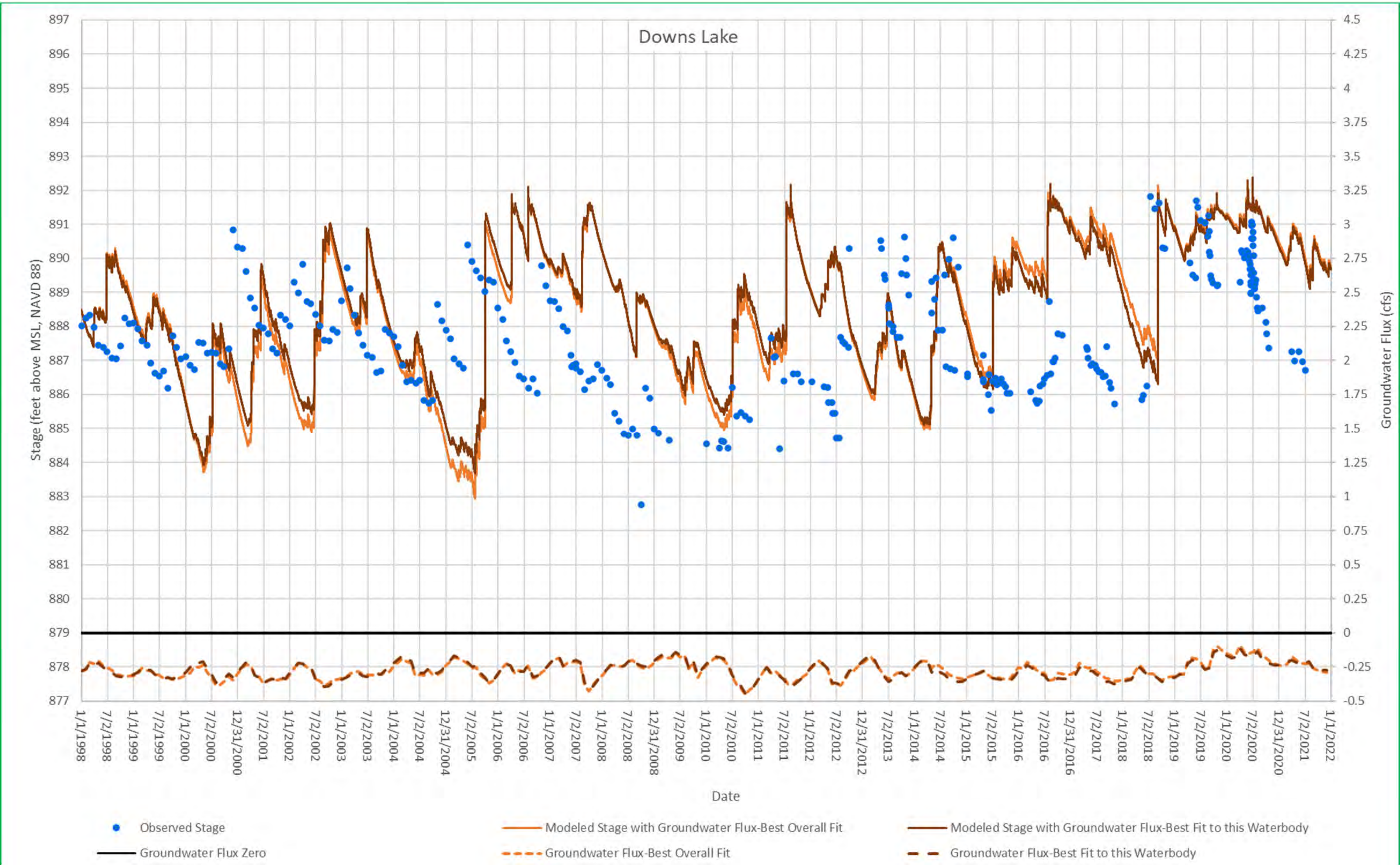
Hydrologic and Hydraulic Model Continuous Simulations: Sunfish Lake



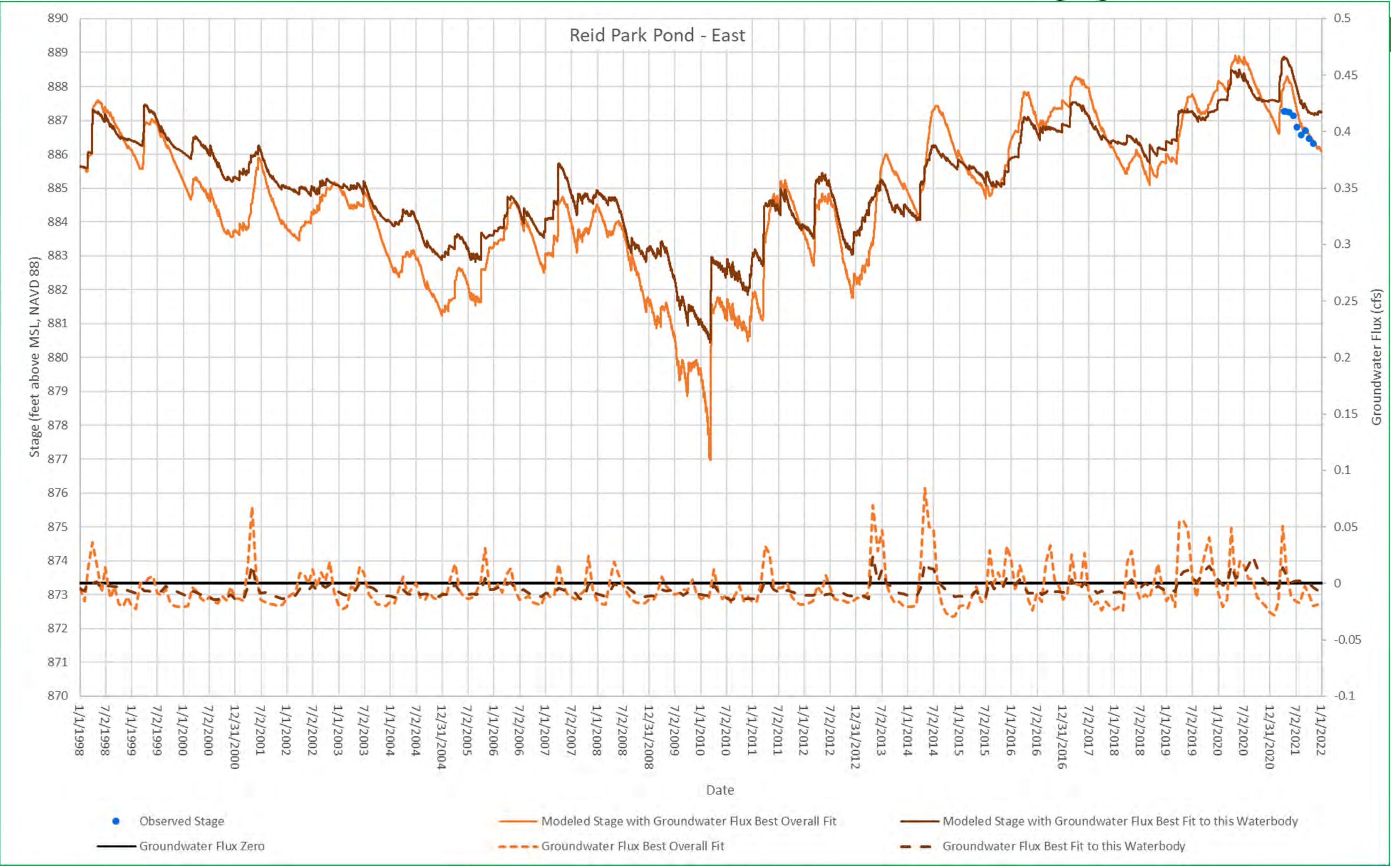
Hydrologic and Hydraulic Model Results
Example: Friedrich's Pond



Hydrologic and Hydraulic Model Results
Example: Downs Lake



Hydrologic and Hydraulic Model Results Example: Reid Park Ponds



Groundwater & Surface Water Modeling Key Takeaways

The groundwater and H&H models provide tools that capture the general magnitudes and trends in the observed lake level data.

The models allows us to quantify the impact of runoff and groundwater interaction at each of the study basins in both continuous (groundwater and H&H) and design storm event (H&H) simulations.

In combination, the groundwater model and H&H models can be used to develop concepts, size, and evaluate long-term water management alternatives.

Stakeholder Input and Future Work

Baseline (without project) Modeling
Hydrologic and Hydraulic Models

- Future watershed conditions – ***Need stakeholder confirmation/input***
  - Future land use (impervious) in all watersheds – Met Council 2040 land use
  - Implementation of other known major projects
    - ***City and Townships:***
      - ***Is Met Council 2040 land use appropriate for your land use?***
      - ***Besides general development, any other major watershed changes you are aware of/anticipate?***
    - ***Washington County:***
      - ***Do you anticipate you will pursue installation of a gravity outlet from Goose Lake?***
      - ***Any plans for reconstruction of Manning Avenue or significant changes to drainage?***
    - ***MPCA:***
      - ***If/how does the proposed PFOS/PFAS pump and treat system impact our future conditions?***
      - ***Will water be routed differently?***
      - ***Does PFOS/PFAS limit our ability to pump high water conditions on these basins?***
      - ***Are there any proposed changes regarding infiltration in karst?***
    - ***DNR:***
      - ***Does the DNR anticipate any modifications to OHWL based on discrepancies with observed water levels as noted in this study (Klawitter, Goetschel, Cloverdale)?***

Hydrologic and Hydraulic Models
Atlas 14 Design Events

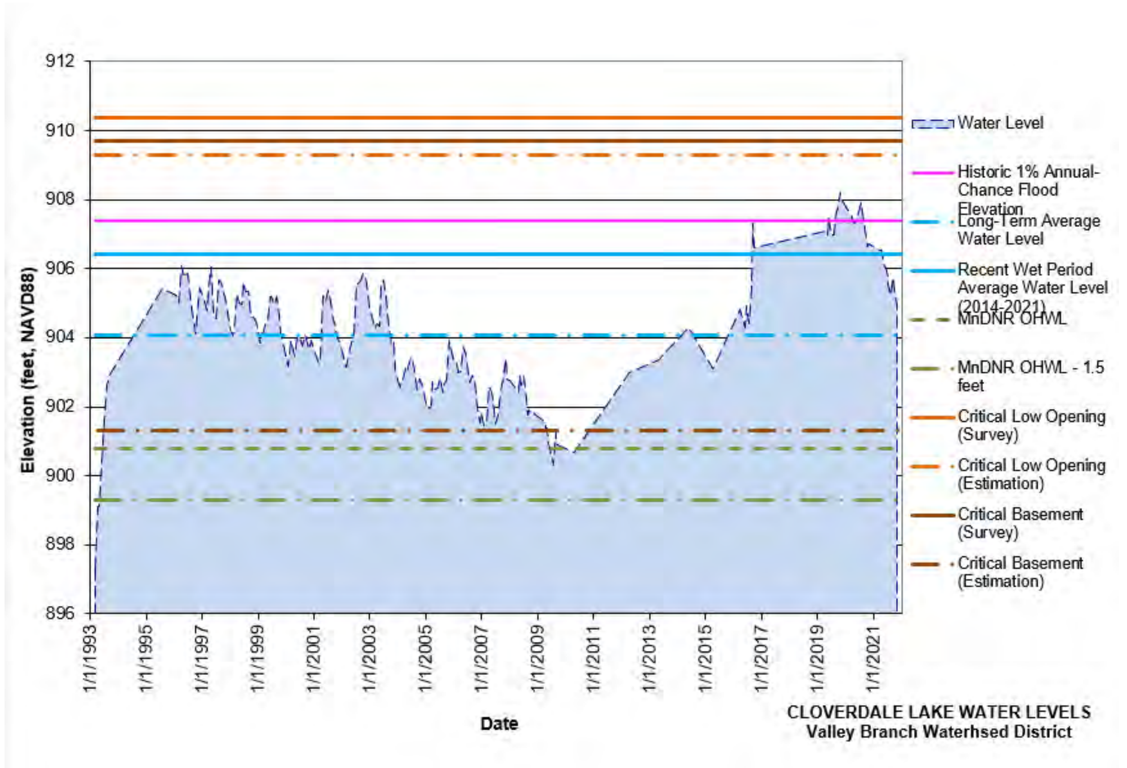
- NOAA Atlas 14 Design Storm Events
- Use to estimate peak elevations without project (existing and future land use)
- Use future land use models to evaluate and establish target pumping rates and elevations for each basin in combination with groundwater flux

Design Storm	Precipitation (in)
2-yr, 24-hr (50% probability)	2.8
10-yr, 24-hr (10% probability)	4.2
100-yr, 24-hr (1% probability)	7.3
500-yr, 24-hr (0.2% probability)	10.3

Flood Risk Analysis and Establishment of Target Water Levels

US Army Corps of Engineers

- Future conditions models to establish pumping rates and elevations for each basin
  - Atlas 14 design storm events
  - Different starting elevations:
    - Long-Term Average Water Level
    - Average High-Water Level (2014-2021)
    - Peak High-Water Level
    - OHWL
    - OHWL – 1.5 ft
- Estimation of potential damages (FEMA/USACE Depth Damage Curves) – without project conditions & critical structure survey/estimation
- Estimation of target pumping water levels and establishment of Ordinary High-Water Level (OHWL) on basins – DNR typically allows outlets between 1.5 foot below the OHWL and the OHWL



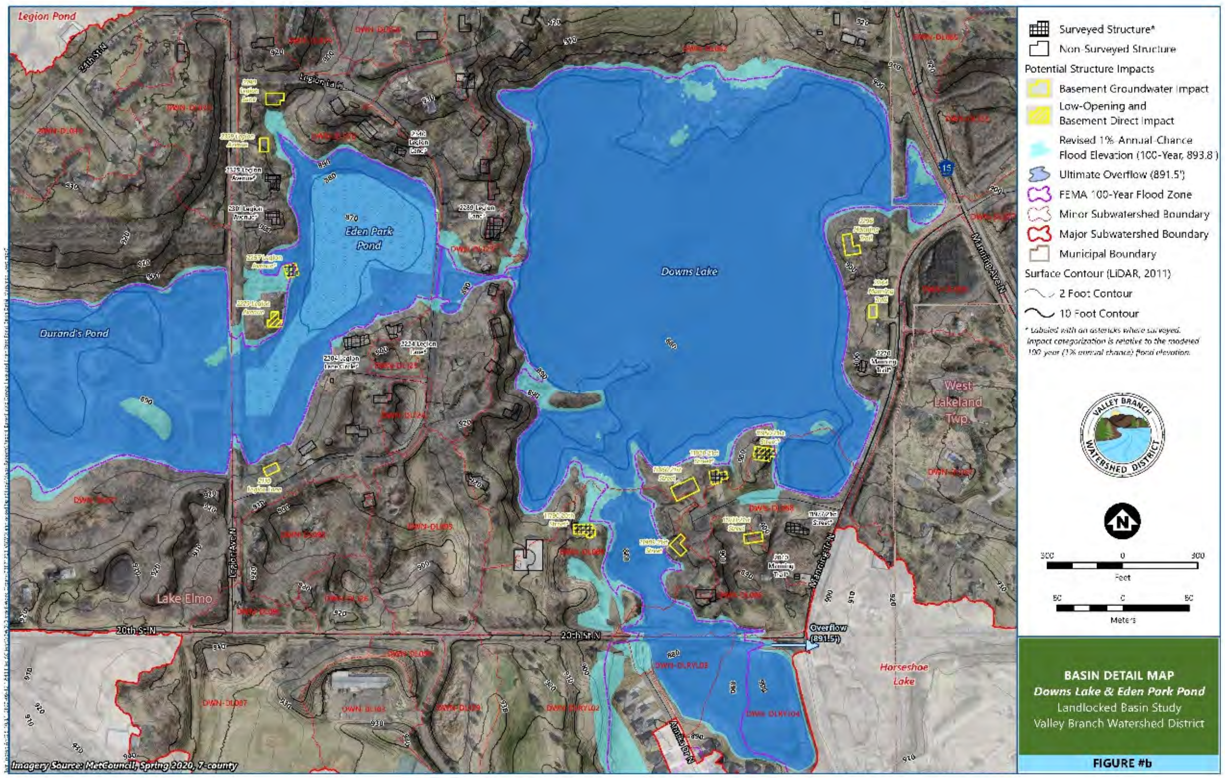
Flood Risk Analysis and Establishment of Target Water Levels

Lake	Historic 100-Year Water Level	Preliminary 100-YR, 24-HR Elevations[1]	Anticipated Pumping Elevations	Variance from OHWL	Impacted Structures (Low Opening)	Impacted Basements
Klawitter Pond	962.4	956.0 – 959.2	***949.8 – 955.0***	***Yes***	0	7-8
Friedrich's Pond	910.7	909.9 – 910.9	907.9 – 909.4	No	0	0
Sunfish Lake	898.4	896.4 – 906.9	894.8-896.3	No	0	0
Legion Pond	888.7	883.9 – 887.9	882.5 - 884	No	0-4	3-9
Reid Park Pond	N/A	885.7 – 888.5	884.0 – 885.5	No	0	1-2
Goetschel Pond	893.2	891.6 – 902.2	***889.2 – 895.6***	***Yes***	0	0-2
Cloverdale Lake	907.4	904.4 – 909.1	904.1 – 908.2	***OHWL below avg. water level***	0	7-8
McDonald Lake	891.7	888.5 – 895.2	886.1 – 887.6	No	0	0
Downs Lake/ Eden Park Pond	893.8 / 893.8	892.8 – 893.3 / 892.7 – 893.3	887.7 – 889.2	No	1-2 / 1-2	4-8 / 5

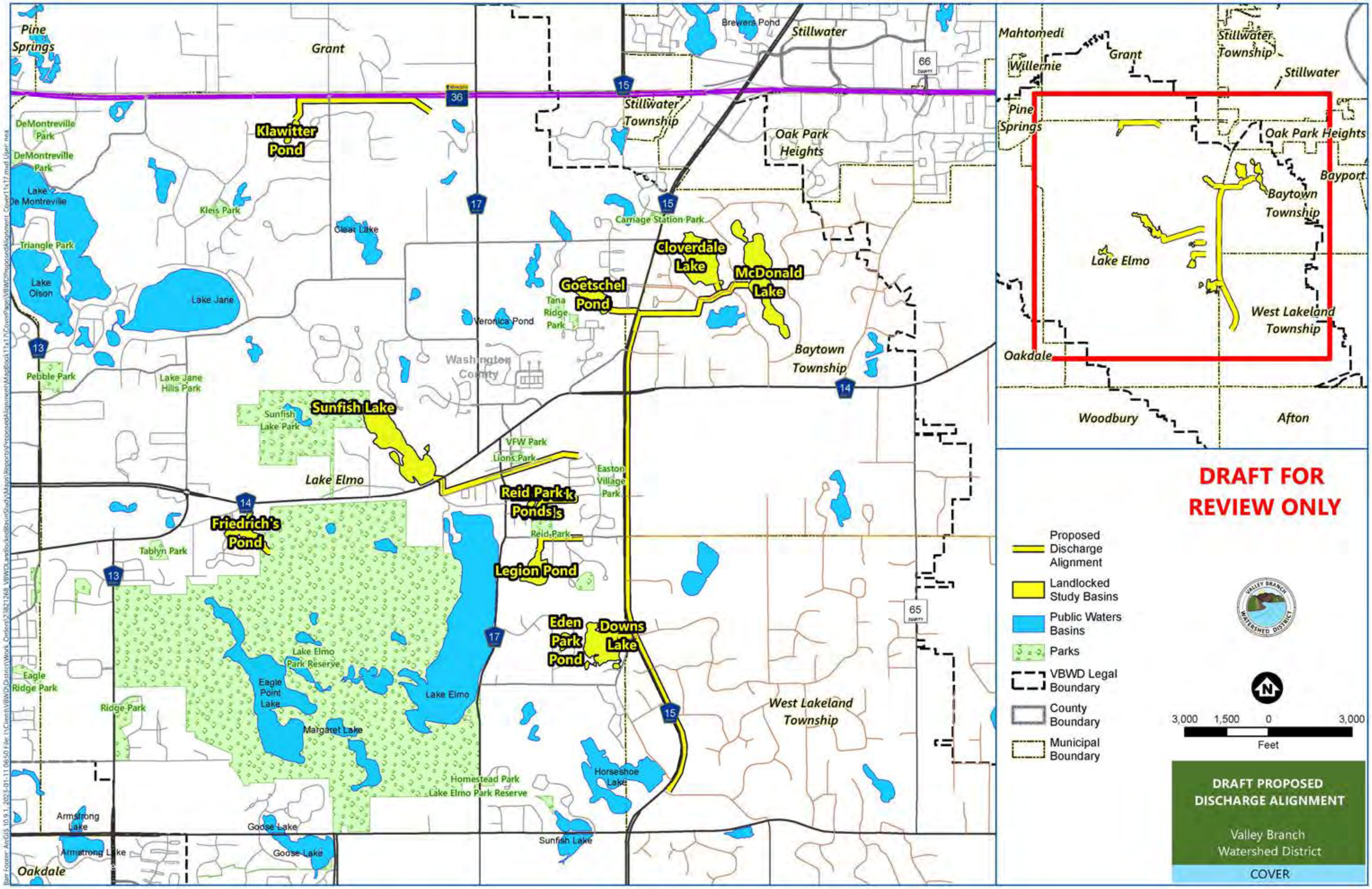
1 – Based on existing conditions modeling

Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

- Conceptual design of up to three concepts
  - Outlets/pumping from all basins
  - Acquisition of all at-risk properties (or relocation of at-risk infrastructure (e.g., moving septic systems, raising roads, etc.))
  - Combination of pumping and acquisition
- Evaluation of downstream impacts & potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality & Ecological Conditions (AIS)
- Planning level cost estimates
- Permitting requirements



Landlocked Basin Study Scope: Alternatives Analysis (With-Project)



Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

- ***Need Stakeholder Confirmation/Input***
  - Handouts of draft concept of pumped outlets/discharge alignments (attached to appointment and will send in a follow-up email)
  - ***Please review draft concept alignments in the context of your understanding of the drainage areas, upcoming projects, working relationships with landowners, etc. and provide feedback via email by January 27, 2023***

Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

- Evaluation of downstream impacts and potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality & Ecological Conditions (AIS)

<u>MPCA:</u> How does the current status of the PFAS/PFOS investigations in the area impact the ability to pump high water conditions landlocked basins within the watershed?

<u>MPCA:</u> How do karst and PFAS/PFOS impact our ability to infiltrate as a mitigation measure?

Estimated Focus of Next Stakeholder Meeting (Early March)

Flood Risk Analysis and Establishment of Target Pumping Water Levels

- Run future (without project) conditions H&H models
- Perform (without project) damage assessment
- Perform pumping assessment to establish target pumping rates/elevations
  - 3 elevations (OHWL, OHWL minus 1.5 feet, other)
  - Considering net groundwater flux at each basin
  - Atlas 14 2-, 10-, 100-, and 500-year, 24-hour design events
- Estimate acquisition/relocation costs for impacted structures

Alternatives Analysis (With-Project)

- Revise potential pumping alignment based on stakeholder feedback and outline proposed alternatives for further evaluation

Landlocked Basin Study Stakeholder and Public Involvement

- Project Stakeholder Team – Regular meetings moving forward
  - Early March 2023 - Flood risk analysis, establishment of target water levels, and outline with-project alternatives
  - May 2023 – Preliminary evaluation of with-project alternatives and identification of potential mitigation alternatives
  - June 2023 – Summary of with-project alternatives and mitigation alternatives
  - July/August 2023 - Presentation of draft report
  - September 2023 – Presentation of final report
- 3 Anticipated Public Meetings ***– What methods have been successful on any recent public outreach for projects? Advertisement?***
  - Project kickoff/existing conditions meeting/open house – March 2023
  - Progress meeting – May/June 2023
  - Presentation of final plan – September 2023

Landlocked Basin Study Schedule

Task	Anticipated Completion
Stakeholder Engagement	September 2023
Data Collection	Complete
Baseline modeling	Complete - January 2023
Flood Risk Analysis and Establishment of Target Water Levels	March 2023
With Project Alternatives Assessment	June 2023
Draft Comprehensive Planning Study Report	July 2023
Final Comprehensive Planning Study Report	September 2023

Questions?

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Landlocked Basin Flood Mitigation Comprehensive Planning Study: Without Project, Flood Risk, and Target Elevation/Pumping Rates

Valley Branch Watershed District

US Army Corps of Engineers®

March 30, 2023

Jennifer Koehler, Barr/VBWD
John Hanson, Barr/VBWD
Jeremiah Jazdzewski, USACE

Agenda

- Recap of last meeting and follow-up item summary
- "Without Project" flood risk analysis
- Damage/cost assessment
- Target pumping rates and elevations
- Outline basin water level management alternatives
  - Stakeholder input
- Next steps

Sandbagging at home on Klawitter Pond in 2020

Recap from Last Meeting/Stakeholder Input

Stakeholder Follow-up

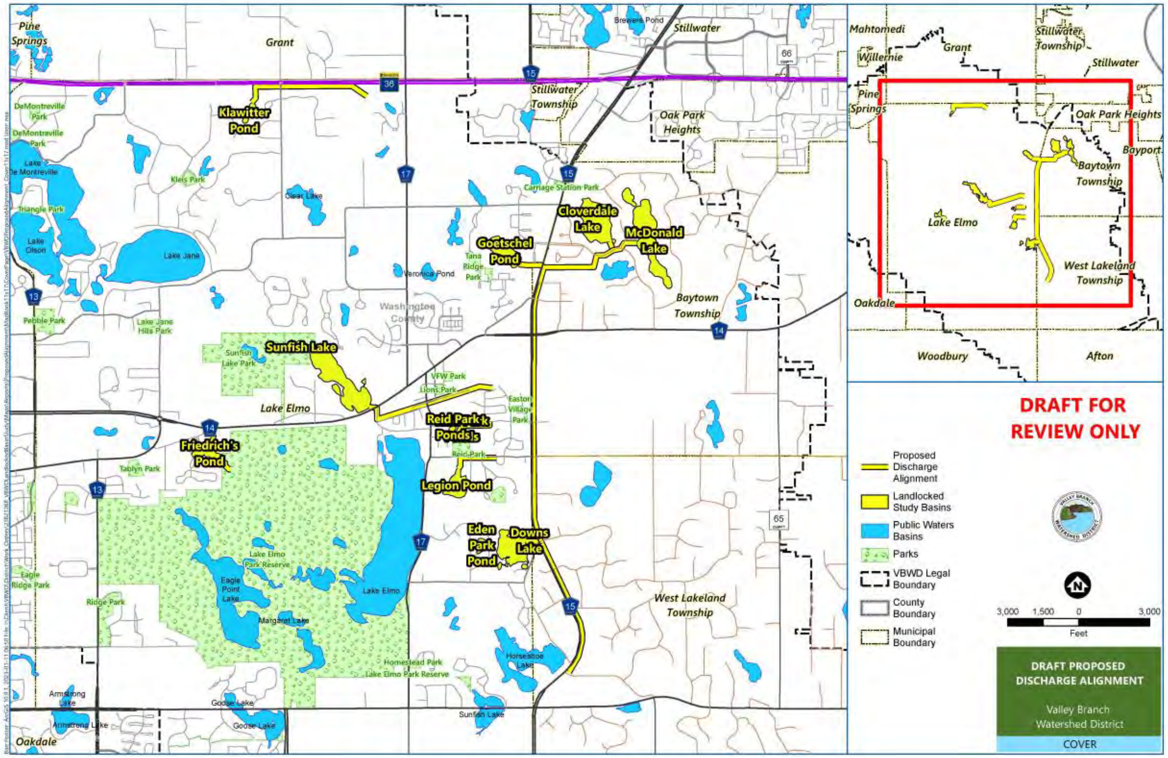
- Future watershed conditions
  - Future land use (impervious) in all watersheds – Met Council 2040 land use
  - Implementation of other known major projects
    - ***City and Townships:***
      - ***Is Met Council 2040 land use appropriate for your land use?***
      - ***Besides general development, any other major watershed changes you are aware of/anticipate?***
        - ***Response received from Lake Elmo***
    - ***Washington County:***
      - ***Do you anticipate you will pursue installation of a gravity outlet from Goose Lake?***
      - ***Any plans for reconstruction of Manning Avenue or significant changes to drainage?***
        - ***Response received***
    - ***MPCA:***
      - ***If/how does the proposed PFOS/PFAS pump and treat system impact our future conditions?***
      - ***Will water be routed differently?***
      - ***Does PFOS/PFAS limit our ability to pump high water conditions on these basins?***
      - ***Are there any proposed changes regarding infiltration in karst?***
        - ***MPCA has had internal discussions – no clear response received yet***
    - ***DNR:***
      - ***Does the DNR anticipate any modifications to OHWL based on discrepancies with observed water levels as noted in this study (Klawitter, Goetschel, Cloverdale)?***
        - ***Response received***

Stakeholder Follow-up

- Preliminary Alignment

  Comments received on the alignment from:

  - Lake Elmo
  - Washington County
  - MnDOT
  - West Lakeland Township



Without Project Flood Risk and Damage/Cost Assessment

Hydrologic and Hydraulic Models
Atlas 14 Design Events – Flood Risk

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- NOAA Atlas 14 Design Storm Events
- Use to estimate peak elevations without project (existing and future land use)
    - Long-Term Average Water Level
    - Average High-Water Level (2014-2021)
    - Peak High-Water Level
    - OHWL
    - OHWL minus 1.5 feet
- Use future land use models to evaluate flood elevations for each basin in combination with groundwater flux
    - Incorporated peak groundwater flux rate (if inflow into the basin, otherwise assumed zero)

Design Storm	Precipitation (in)
2-yr, 24-hr (50% probability)	2.8
10-yr, 24-hr (10% probability)	4.2
100-yr, 24-hr (1% probability)	***7.3***
500-yr, 24-hr (0.2% probability)	10.3

Flood Risk Analysis: 100-year, 24-hour Design Storm Event Elevations

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Lake	100-Year 24-Hour Design Storm Peak Water Level with Starting Water Level at:				
	Maximum Measured Water Level	Average Long Term Water Level	Average High-Water Period (2014-2021)	OHWL	OHWL minus 1.5 feet
Klawitter Pond	**959.21**	**955.99**	**956.77**	**959.02**	**958.23**
Friedrich's Pond	911.28	909.6	910.67	911.16	909.98
Sunfish Lake	**906.98**[3]	896.89	898.02	897.92	896.54
Legion Pond	**887.94**	884	**887.44**	885.88	884.57
Reid Park Pond	**888.52**	**888.17**	**888.17**	887.09	885.89
Goetschel Pond	898.08	892.76	897.36	896.75	895.31
Cloverdale Lake	909.06	908.07	908.76	905.92	904.79
McDonald Lake	895.76	890.54	892.43	890.01	888.72
Downs Lake	**894.64**	**893.47**	**893.74**	**893.98**	**893.42**
Eden Park Pond	**894.64**	**893.47**	**893.74**	**893.98**	**893.42**

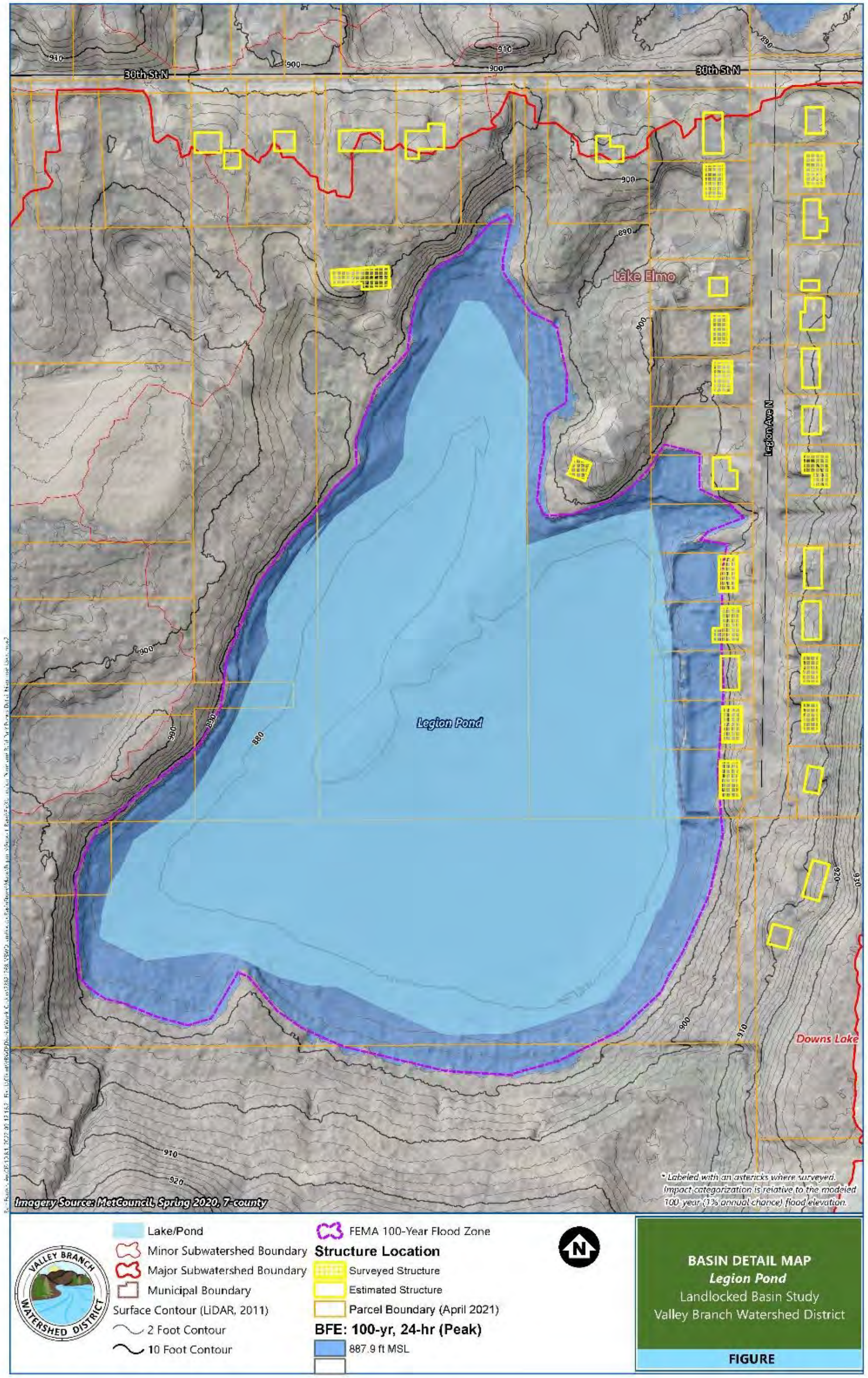
1 – Based on Atlas 14 100-year, 24-hour Design Storm Event with different starting elevations as noted

2 – Numbers in **red** indicate peak elevation higher than low opening, numbers in **orange** indicate peak elevation higher than low floor/basement

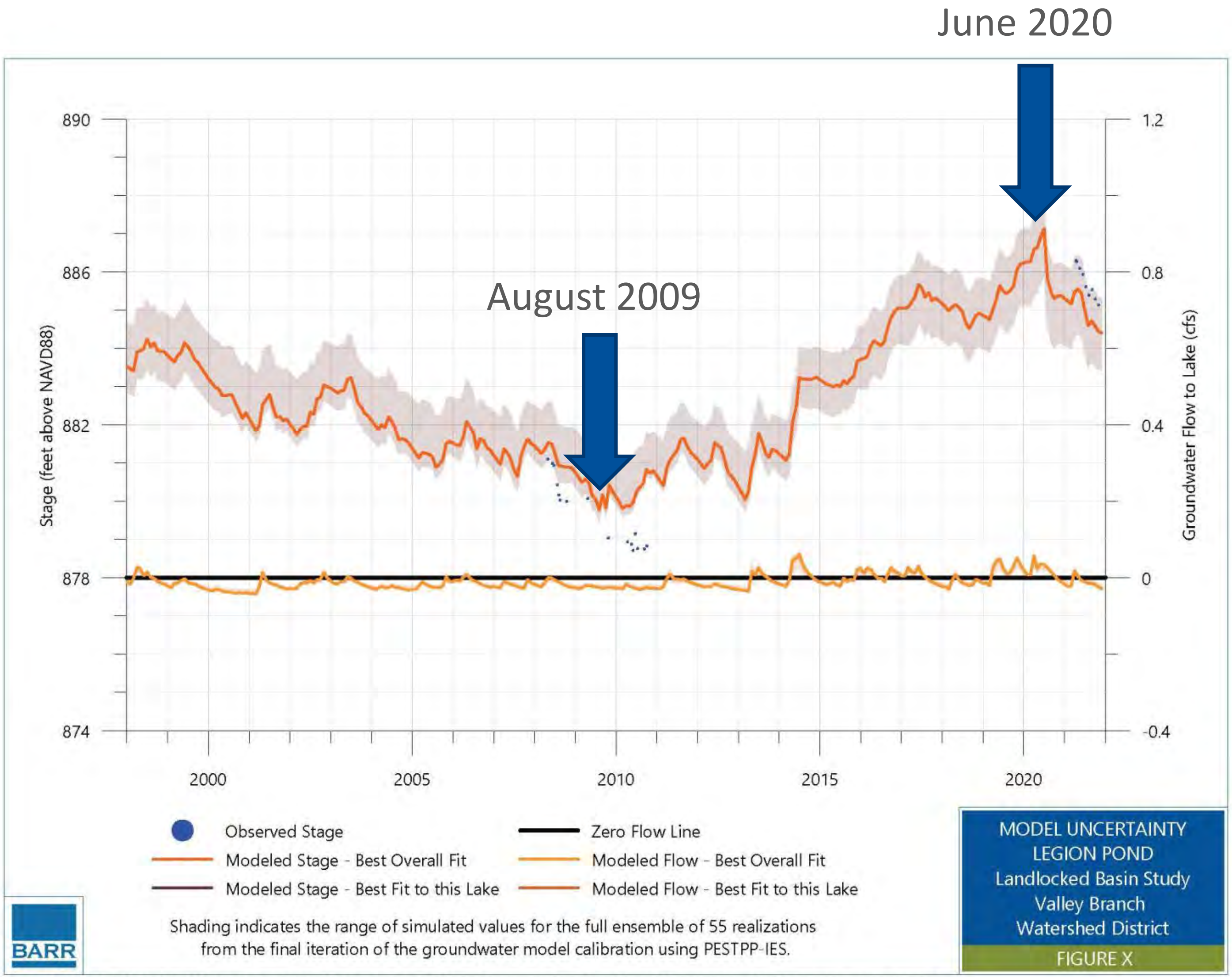
3 – Highest measured water level possibly caused by Lake Jane pumping increasing groundwater level and lake level, which is no longer done

Flood Risk Analysis

- Focus is on low dwellings around each basin (not evaluation of entire watershed)
- Based on either USACE survey or estimate (from LiDAR and other online information)
- Comparison of peak water level from 100-year, 24-hour events to low floor/basement and low opening
  - Consider groundwater proximity in relation to the basin water level in wet-dry-average conditions



Impacted Dwellings: Groundwater Proximity To Basin



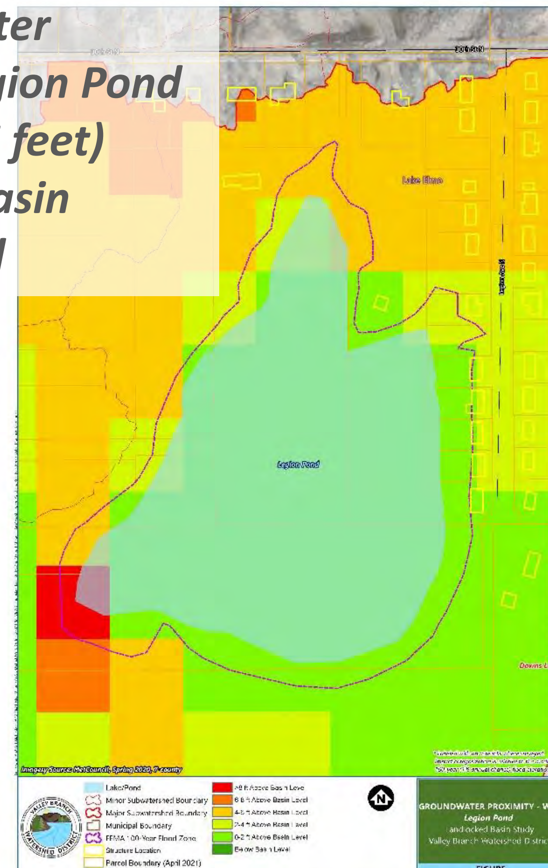
Impacted Dwellings: Groundwater Proximity to Basin

August 2009

Groundwater around Legion Pond <u>lower</u> (3-11 feet) than the basin water level

July 2020

Groundwater around Legion Pond <u>higher</u> (0-6 feet) than the basin water level



Impacted Dwellings: Groundwater Proximity To Basin

Estimated the range between dry and wet groundwater elevation relative to the basin water level – selected the mid-point as an average condition

An addition to the 100-year, 24-hour peak applied the **average and wet groundwater proximity adjustment factor** to peak basin elevation to determine impacted dwellings in the area around each basin

Applied the damage/cost assessments using constant 100-year, 24-hour peak as well as adjusted values to reflect groundwater

- Threshold Assessment Approach
- Acquisition Approach

Flood Risk Analysis and Impacted* Dwellings (*Impacts begin when low floor within 2 feet of peak elevation)

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Lake	Atlas 14 100-year, 24-hour Elevations[1]	Lowest Critical Dwelling Elevation Walkout/Basement	Impacted Dwellings: Low Opening/Walkout[2,3]	Impacted Dwellings: Basements[2]
Klawitter Pond	***956.0 – 959.2***	***954.72 / 954.72***	***1***	***1-2***
Friedrich's Pond	909.6 – 911.3	913.86 / 913.86	0	0
Sunfish Lake	***897.9 – 907.0***	***912.01 / 904.0***	0	***1***
Legion Pond	***884.0 – 887.9***	***886.4 / 886.4***	***6 (2)***	***2-10***
Reid Park Pond	***885.9 – 888.5***	***890.2 / 887.1***	***0***	***0-2***
Goetschel Pond	892.8 – 898.1	909.0 / 909.0	0	0
Cloverdale Lake	***904.8 – 909.1***	***909.3 / 909.3***	***7 (7)***	***1***
McDonald Lake	888.7 – 895.8	901.4 / 901.4	0	0
Downs Lake	***893.4 – 894.6***	***893.15 / 892.2***	***3***	***0-5***
Eden Park Pond	***893.4 – 894.6***	***890.31 / 890.31***	***4 (2)***	***0-1***

1 – Based on future land use/conditions modeling and varies depending on the starting water elevation assumed for the basin

2 – Estimated number of impacted dwellings varies, depending on approach applied (e.g., constant flood elevation versus adjusted flood elevation based on groundwater proximity adjustment)

3- Number of dwellings with walkouts that have less than 2 feet of freeboard from peak water elevation

Damage/Cost Assessment:
FEMA Depth-Damage Approach
(Riverine Flooding)

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Uses standard residential depth-damage curves from FEMA Benefit:Cost Assessment Toolkit 6.0

- Assumes Riverine Flooding
  - Floods waters rise and then recede in a relatively short amount of time

FEMA BCA Toolkit 6.0 Installation Instructions

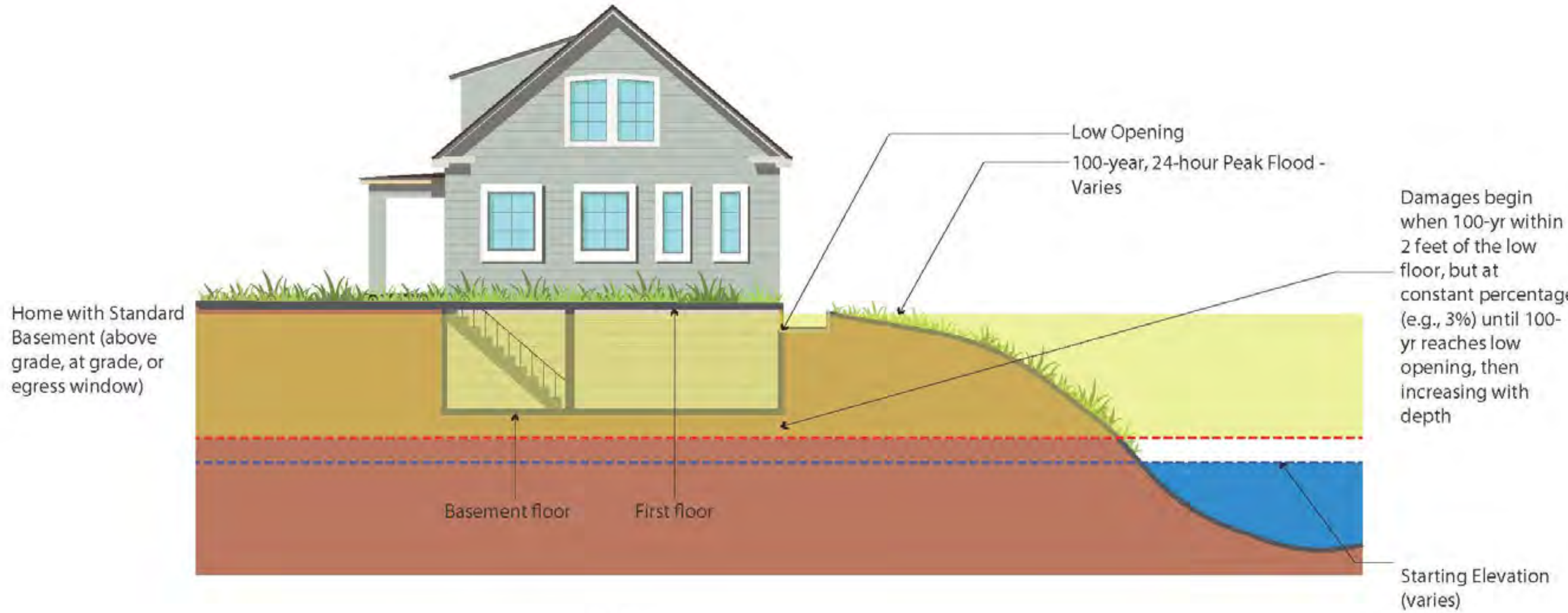
English

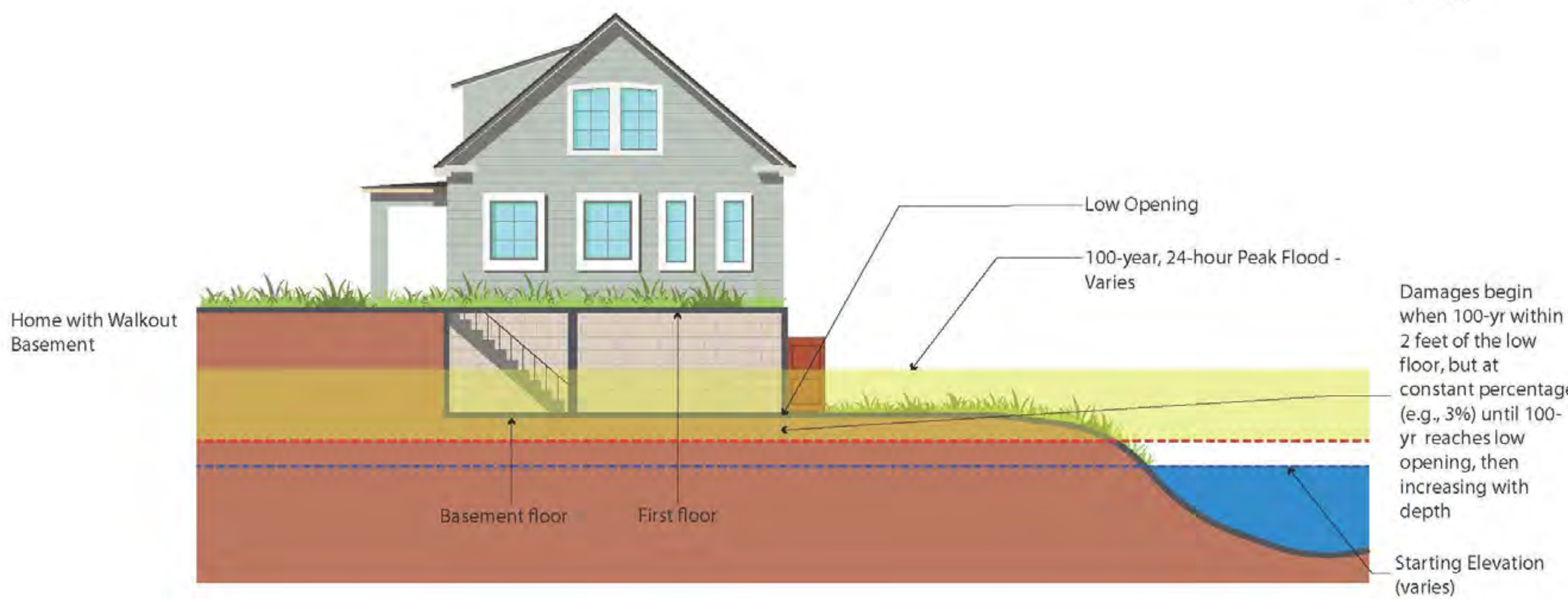
This page features installation and launch instructions for FEMA's Benefit-Cost Analysis (BCA) Toolkit Version 6.0. You can use BCA Toolkit 6.0 in Excel Desktop or in Excel Online.

Excel Desktop

The following directions are for using BCA Toolkit 6.0 in the desktop version of Excel. (Excel 2013 or newer is required.)

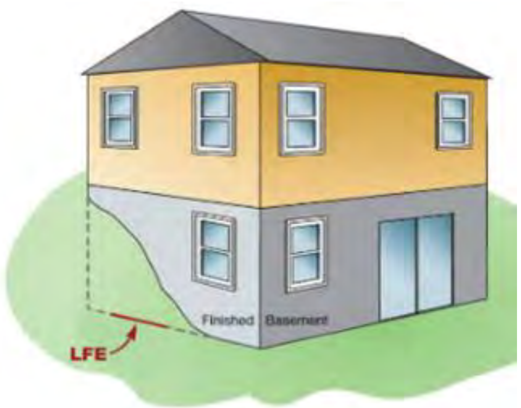
Damage/Cost Assessment: FEMA Depth-Damage Approach





Damage/Cost Assessment:
FEMA Depth-Damage Approach
(Riverine Flooding)

Two floor home with walkout



Flood Depth	Percent Damage
-2	0
-1	3
0	9.3
1	15.2
2	20.9
3	26.3
4	31.4
5	36.2
6	40.7
7	44.9

Two floor home with windows, 2 feet above ground level

Flood Depth	Percent Damage
-2	0
-1	3
0	3
1	3
2	20.9
3	26.3
4	31.4
5	36.2
6	40.7
7	44.9

Source: FEMA Benefit-Cost Guidance/Toolkit

Damage/Cost Assessment: Threshold Assessment Approach

- Approach considers sustained high-water conditions related to landlocked basins and groundwater
  - Unknown duration of how long water levels will remain high, but could be months to years
  - No clear guidance/damage information at federal/state levels in relation to high-water due to groundwater/non-riverine conditions in landlocked basins
- Recent experience in the VBWD around Sunnybrook Lake and Friedrich's Pond
  - Structural concerns
  - Mold and moisture and unlivable conditions
- Considered federal, state, and VBWD policies and guidance as it related to floodproofing, low floors, etc.
- Considers how groundwater changes in relation to the basin water levels based on dwellings/proximity to basin

Damage/Cost Assessment: Threshold Assessment Approach

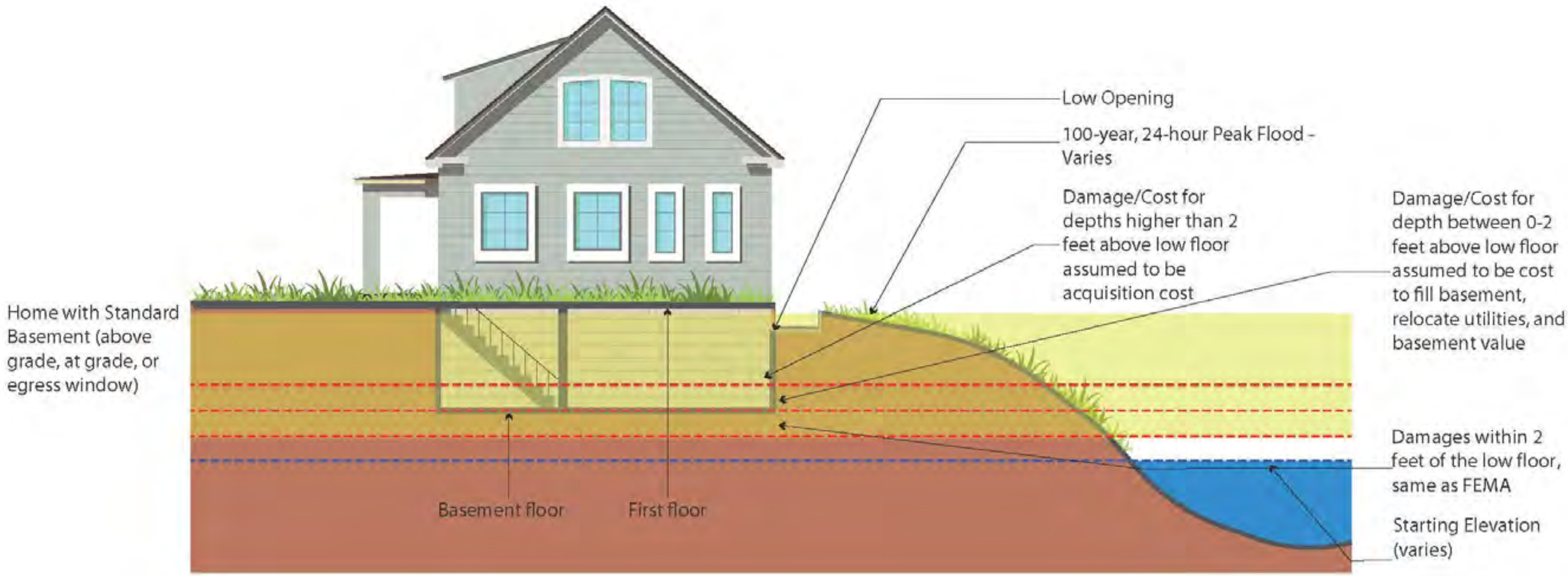
- Three thresholds for damaged/costs
  - FEMA depth/damages:
    - peak water level is -2 to 0 feet from lowest elevation of dwelling
  - Fill in basement/lost value of basement:
    - Peak water level is 0 to 2 feet from lowest elevation of dwelling
  - Acquisition:
    - Peak water level is higher than 2 feet above the lowest elevation of dwelling

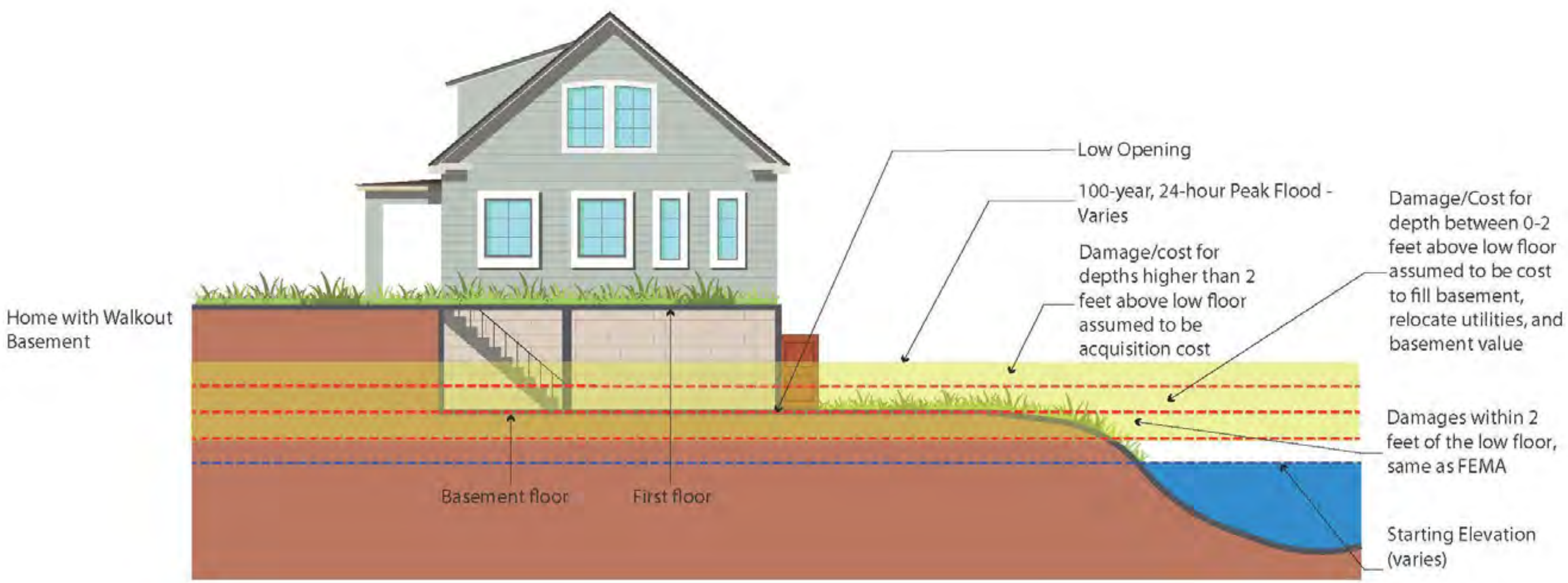
NONSTRUCTURAL FLOOD RISK MANAGEMENT MATRIX May 2019		PHYSICAL NONSTRUCTURAL MITIGATION MEASURES									
		Elevation									
		Extended Foundation	Piers	Posts	Columns	Piles	Fill (compacted)	Relocation	Acquisition	Dry Flood Proofing	Wet Flood Proofing
Flood Characteristics	**Flood Depth**										
	Shallow (<3 feet)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Deep (6 to 12 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Very Deep (>12 feet)	N	N	N	N	N	N	Y	Y	N	N
	Flood Velocity										
	Low (less than 3 feet per second)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet per second)	N	Y	Y	Y	Y	Y	Y	Y	N	N
	High (greater than 6 feet per second)	N	Y	N	N	Y	N	Y	Y	N	N
	Flash Flooding										
	Yes (less than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	N	N
	No (more than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Debris /Ice Flow										
	Yes	N	Y	N	N	Y	Y	Y	Y	N	N
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics	**Site Location**										
	Coastal Beach Front	N	N	N	N	Y	N	Y	Y	N	N
	Coastal Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Riverine Floodplain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Soil Type										
	Permeable	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Structure Characteristics	**Structure Foundation**										
	Slab on Grade (reinforced)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Crawlspace	N	N	N	N	N	Y	Y	Y	N	Y
	Basement	N	N	N	N	N	Y	Y	Y	N	Y
	Abandonment of Crawlspace/Basement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Structure Envelope/Exterior										
	Concrete, Stone, or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Overall Structure Condition										
	Excellent to Fair	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fair to Poor	N	N	N	N	N	N	N	Y	N	N

Figure 4. USACE Nonstructural Flood Risk Management Matrix

Source: USACE

Damage/Cost Assessment: Threshold Assessment Approach





Damage/Cost Assessment: Threshold Approach – Cost to Fill Basements/Lost Basement Value

- Applied to conditions with flood elevations 0-2 feet above low floor (basement floor)
- Cost to fill basement = Cost of filling and relocating utilities plus loss of basement value
- Assumed number of floors based on aerials, street view, and real-estate websites to estimate basement square footage
  - Basement Filling and Utility Relocation Cost
    - Assumed $50/sq ft (rounded up, per 2020 USACE document for Lower Meramec Basin in Missouri)
  - Basement Loss of Value
    - Online appraisal websites indicated basements typically valued at 50-70% of upper home levels in the Midwest
    - Basement value based on the scaled total cost per square foot per Washington County taxable market value and total square footage of basement, assuming 70%
    - Does not consider value of lost tax revenue for reduced value of properties

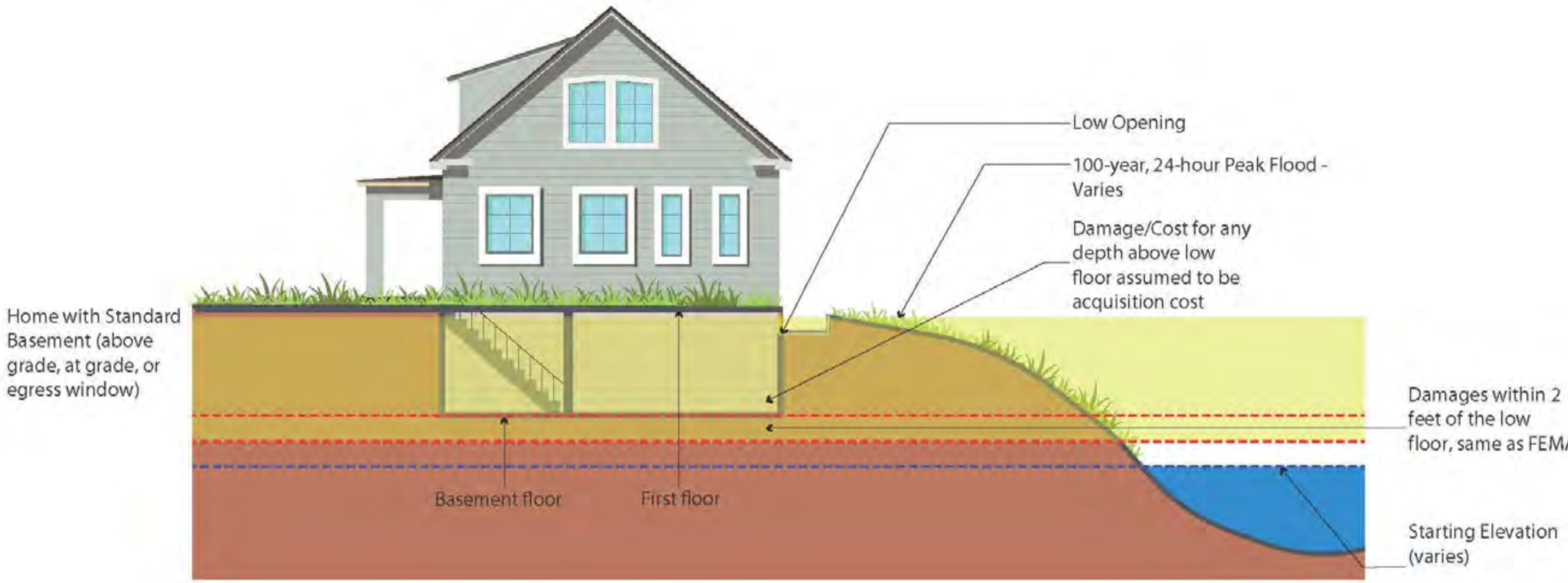
Damage/Cost Assessment: Threshold Approach - Acquisition

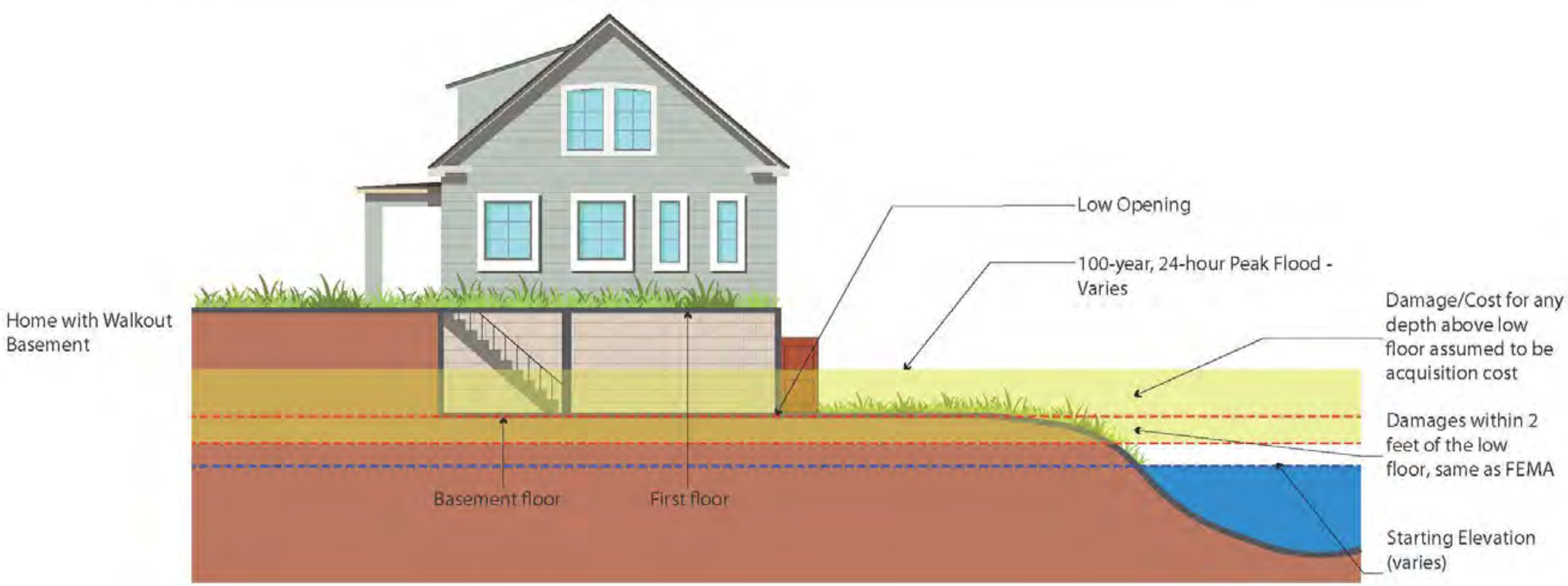
Home acquired and demolished at Sunnybrook Lake in recent years

Acquisition: Peak water level 2 feet or more higher than lowest elevation of dwelling

- Recent VBWD experiences at Sunnybrook Lake and Friedrich's Pond
  - $20,000 to $50,000 for demolition (includes sealing well and abandoning septic system)
  - Approximately $10,000 for other costs (closing and reselling)
  - Plus, additional for engineering/coordination
- Review of other recent flood studies (by Barr) including acquisition planning costs
  - Ranges from 120-150% for planning purposes (covers survey, engineering, legal, demo, relocation)
- Acquisition = Washington County taxable market value multiplied by 1.35 (135%)
- Does NOT consider value of lost tax revenue for acquired properties

Damage/Cost Assessment: Acquisition Approach





Damage/Cost Assessment: Summary

VALLEY BRANCH WATERSHED DISTRICT

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Lake	Total Impacted Dwellings[1]	FEMA Residential Depth-Damage Assessment	Threshold Assessment Approach[2,3]	Acquisition Approach [2,3]
Klawitter Pond	***1-3***	***$60,000***	***$630,000 - $1.3 million***	***$630,000 - $1.3 million***
Friedrich's Pond	0	$0	$0	$0
Sunfish Lake	***1***	***$51,000***	***$18,000-$585,000***	***$18,000 - $585,000***
Legion Pond	***8-16***	***$180,000***	***$425,000 - $3.6 million***	***$1.8 - $5.3 million***
Reid Park Pond	***0-2***	***$30,000***	***$0 - $160,000***	***$0 - $680,000***
Goetschel Pond	0	$0	$0	$0
Cloverdale Lake	***8***	***$185,000***	***$185,000 - $1.4 million***	***$185,000 - $1.4 million***
McDonald Lake	0	$0	$0	$0
Downs Lake	***3-8***	***$255,000***	***$ 410,000 - $ 1.5 million***	***$ 2.2 - $5.2 million***
Eden Park Pond	***4-5***	***$90,000***	***$ 650,000 - $ 660,000***	***$1.0 - $1.1 million***
Project Total	***25 - 43***	***$851,000***	***$2.3 - $9.2 million***	***$5.8 - $15.6 million***

1 – Estimated number of impacted dwellings varies, depending on approach applied and application of groundwater proximity factor for 100-year, 24-hour design storm event

2 – Range reflects three flood elevation scenarios (100-year, 24-hour peak along with adjusted elevation using mid and wet groundwater adjustment factors)

3 – Acquisition estimates assumed taxable market value multiplied by 1.35 to account for relocation and demolition costs

Target Pumping Rates and Elevations

Establishment of Pumping Rates and Target Water Levels

- Determine pumping rates considering:
  - Peak net groundwater flux into basins from calibrated groundwater model
  - Design storm event results
  - Basin storage/volume information
  - Assuming 100-year drawdown rates over 4-days, 7-day, and 14-days
- Estimate target pumping elevations based on evaluation using Atlas 14 design storm events
  - Ordinary High-Water Level (OHWL)
  - OHWL minus 1.5 feet
  - Other elevation to minimize impacts

Ultimate Goal: Optimize pumping rates/elevations while minimizing risk to potentially impacted dwellings

Flood Risk Analysis and Establishment of Target Water Levels

Legion Pond – Optimized Pumping

Starting Elevation/ Pumping Rate	500 gpm	1000 gpm	1700 gpm
OHWL (884.0)	885.76	885.72	885.69
OHWL minus 1.5 (882.5)	884.44	884.4	884.36
Protect Homes (880.6)	882.71	882.66	882.61

Reid Park Ponds – Optimized Pumping

Starting Elevation/ Pumping Rate	200 gpm	400 gpm	600 gpm
OHWL (885.53)	886.82	886.8	886.78
OHWL minus 1.5 (884.03)	885.58	885.55	885.53
Protect Homes (884.85)	886.25	886.22	886.21

Value in **green** indicate no impacts to dwellings during 100-year, 24-hour design event
Values in **orange** indicate potential basement impacts during 100-year, 24-hour design event
Value in **red** indicate potential low opening impacts to dwellings during 100-year, 24-hour design event

Flood Risk Analysis and Establishment of Target Water Levels

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Downs Lake – Optimized Pumping

Starting Elevation/ Pumping Rate	5400/ 8100 gpm	11,700/ 16,200 gpm	20,600/ 29,200 gpm
OHWL (889.15)	894.46	894.37	894.22
OHWL minus 1.5 (887.65)	894.18	894.05	893.85
Protect Low Opening (884.5)	893.28	892.99	892.41

Cloverdale Lake – Optimized Pumping

Starting Elevation/ Pumping Rate	2700 gpm	5600 gpm	9400 gpm
Average Long Term (904.07)	907.6	907.16	906.85
Average High Water (906.41)	908.68	908.59	908.44
Protect Basements (903.2)	906.99	906.51	906.17

Value in **green** indicate no impacts to dwellings during 100-year, 24-hour design event
Values in **orange** indicate potential basement impacts during 100-year, 24-hour design event
Value in **red** indicate potential low opening impacts to dwellings during 100-year, 24-hour design event

Summary of Optimized Target Water Levels and Pumping Rates

Lake	Atlas 14 100-year, 24-hour Elevations[1]	OHWL / OHWL minus 1.5	Target Pumping Rate	Target Pumping Elevation	Variance from DNR	Potential for Gravity Outlet
Klawitter Pond	***956.0 – 959.2***	***954.97 / 953.47***	***900 gpm***	***948.00***	***Yes***	***No***
Friedrich's Pond	909.6 – 911.3	909.40 / 907.90	500 gpm	909.40	No	Yes
Sunfish Lake	***897.9 – 907.0***	***896.33 / 894.83***	***1,800 gpm***	***896.33***	***No***	***No***
Legion Pond	***884.0 – 887.9***	***884.00 / 882.50***	***1,000 gpm***	***882.5***	***No***	***No***
Reid Park Pond	***885.9 – 888.5***	***885.53 / 884.03***	***600 gpm***	***884.03***	***No***	***No***
Goetschel Pond	892.8 – 898.1	894.00 / 892.50	1,800 gpm	894.00	No	No
Cloverdale Lake	***904.8 – 909.1***	***900.81 / 899.31***	***5,600 gpm***	***904.07***	***No***	***No***
McDonald Lake	888.7 – 895.8	887.62 / 886.12	1,800 gpm	887.62	No	No
Downs Lake	***893.4 – 894.6***	***889.15 / 887.65***	***16,200 gpm***	***884.50***	***Yes***	***Yes***
Eden Park Pond	***893.4 – 894.6***	***889.15 (assumed same as Downs)***	***2,700 gpm***	***887.65***	***TBD***	***No***

1 – Based on future landuse/conditions modeling

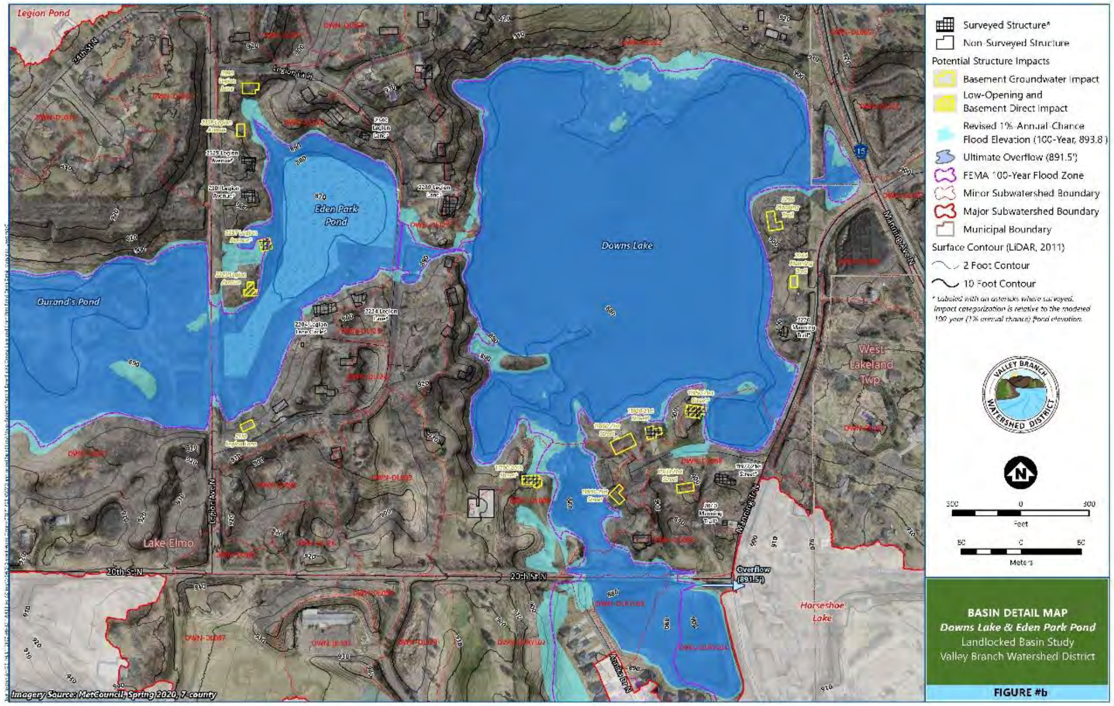
Feedback from Stakeholders

- Flood Risk Analysis, as presented, is using 100-year, 24-hour peak elevation assuming water levels on the basins are at the maximum observed water level. This is very conservative on some basins; however, we are concerned about wet/high-water conditions. Reactions/thoughts?
- For low homes not located directly on the basin, should we use the groundwater proximity adjustment factor as part of the analysis or just assume 100-year peak elevation as a constant? If we use the adjustment factor, should be apply the wet or average?
- For acquisition approach, is the assumption that acquisition of any property where peak water levels are above the low/basement floor? Should some other threshold be used?
- For Klawitter and Downs Lake, a variance would be required from the MnDNR to pump to the elevation needed to protect homes. Is this a concern to the MnDNR at this point?

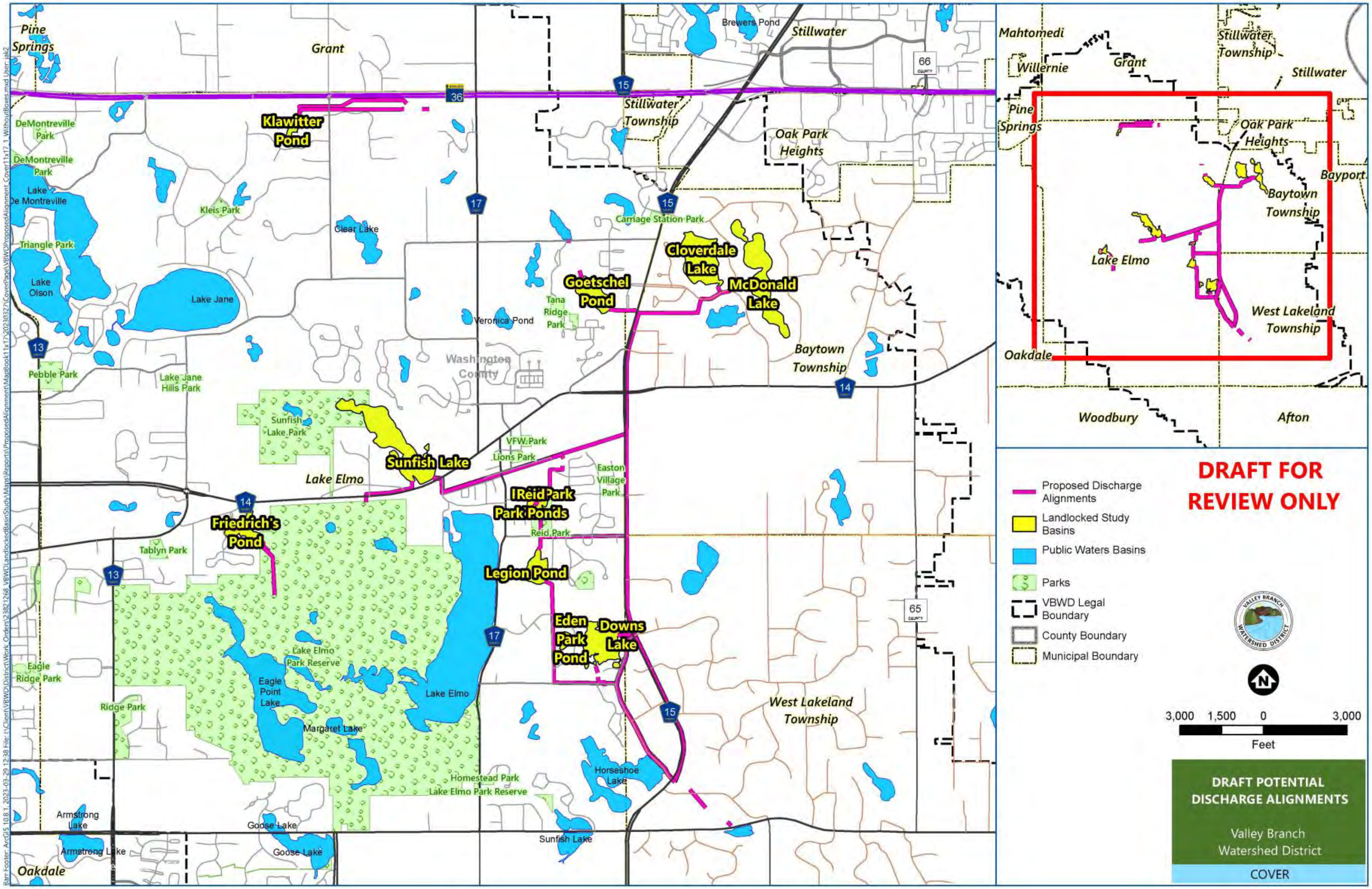
Alternatives Summary

Landlocked Basin Study Scope: Alternatives Analysis ("With Project")

- Conceptual design of up to three concepts
  - Outlets/pumping from all basins
  - Acquisition of all at-risk properties (or relocation of at-risk infrastructure (e.g., moving septic systems, raising roads, etc.))
  - Combination of outlets and acquisition
- Evaluation of downstream impacts and potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality and Ecological Conditions (AIS)
- Planning level cost estimates
- Permitting requirements



Landlocked Basin Study Scope: Alternatives Analysis (With-Project)



Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

- See Handouts

Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

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Please review alternatives and provide any feedback/thoughts by 4/10/2023 (handouts will be emailed out following the Stakeholder Meeting)

- For basins with low flood risk (e.g., no impacted dwelling during 100-year event during peak water conditions), do we perform any further evaluation of pumping? Or do we assume there is no action required?
- If a gravity outlet appears to be an option, should this take precedence over a pumped outlet?
- What considerations should we be making for PFAS?

Draft

Alternative 1: Pumping/Outlets

- Pumping/Outlet on:
  - Klawitter Pond
  - Reid Park Ponds
  - Legion Pond
  - Downs Lake/Eden Park Pond
  - Cloverdale Lake and/or McDonald
- Including mitigation for water quantity/quality impacts
- No acquisitions

Alternative 2: Acquisition

- Acquisition of all at-risk dwellings

Alternative 3: Combined Approach

- Pumping/Outlet on:
  - Reid Park Ponds
  - Legion Pond
  - Downs Lake/Eden Park Pond
- Including mitigation for water quantity/quality impacts
- Acquisition of remaining at-risk dwellings

Next Steps

Landlocked Basin Study Scope: Alternatives Analysis (With-Project)

Moving Forward:

- Concept Development and Evaluation
  - Use design event modeling to further develop concept, determine downstream impacts, and size/evaluate mitigation measures
  - Combined alternatives (once refined per above) will also be evaluated using continuous simulations to understand potential frequency and volumes of pumping over time (per year)
  - Water quality analysis will be performed to understand the impacts on loads (total phosphorus) to receiving waters, including the St. Croix River (approved TMDL)
- Planning level cost estimates (including easements/land acquisition)
- Permitting requirements

Landlocked Basin Study Schedule

Task	Anticipated Completion
Stakeholder Engagement	September 2023
Data Collection	Complete
Baseline modeling	Complete
Flood Risk Analysis and Establishment of Target Water Levels	Complete
With Project Alternatives Assessment	June 2023
Draft Comprehensive Planning Study Report	July 2023
Final Comprehensive Planning Study Report	September 2023

Landlocked Basin Study Stakeholder and Public Involvement

- Project Stakeholder Team – Regular meetings moving forward
  - June 2023: Summary of with-project alternatives and mitigation alternatives (including costs)
  - August 2023: Presentation of draft report
  - September 2023: Presentation of final report
- Anticipated Public Meetings
  - Public Engagement #1: Project summary, education, existing conditions open house/online input
    - April 5, 2023, 5-7 pm, Baytown Township Community Center
  - Public Engagement #2: Presentation of Plan
    - Late Summer 2023


Legion Pond emergency pumping floating intake (2020)

Questions?

Jennifer Koehler, Barr/VBWD, jkoehler@barr.com
(office: 952.832.2750 cell: 612.720.8810)

John Hanson, Barr/VBWD, jhanson@barr.com

Jeremiah Jazdzewski, USACE,
jeremiah.jazdzewski@usace.army.mil

Landlocked Basin Flood Mitigation Comprehensive Planning Study: Alternative Review

June 8, 2023

Jennifer Koehler, Barr/VBWD
John Hanson, Barr/VBWD
Jeremiah Jazdzewski, USACE

Valley Branch Watershed District

US Army Corps of Engineers®

Agenda

- Recap of last meeting and follow-up item summary
  - Public Engagement #1
- Review Alternatives
  - Alternative 1: Pumping/Outlets
  - Alternative 2: Acquisition
  - Alternative 3: Need stakeholder input to define
- Next Steps

Sandbagging at home on Klawitter Pond in 2020

Recap from Last Meeting

Study Basins

VALLEY BRANCH WATERSHED DISTRICT

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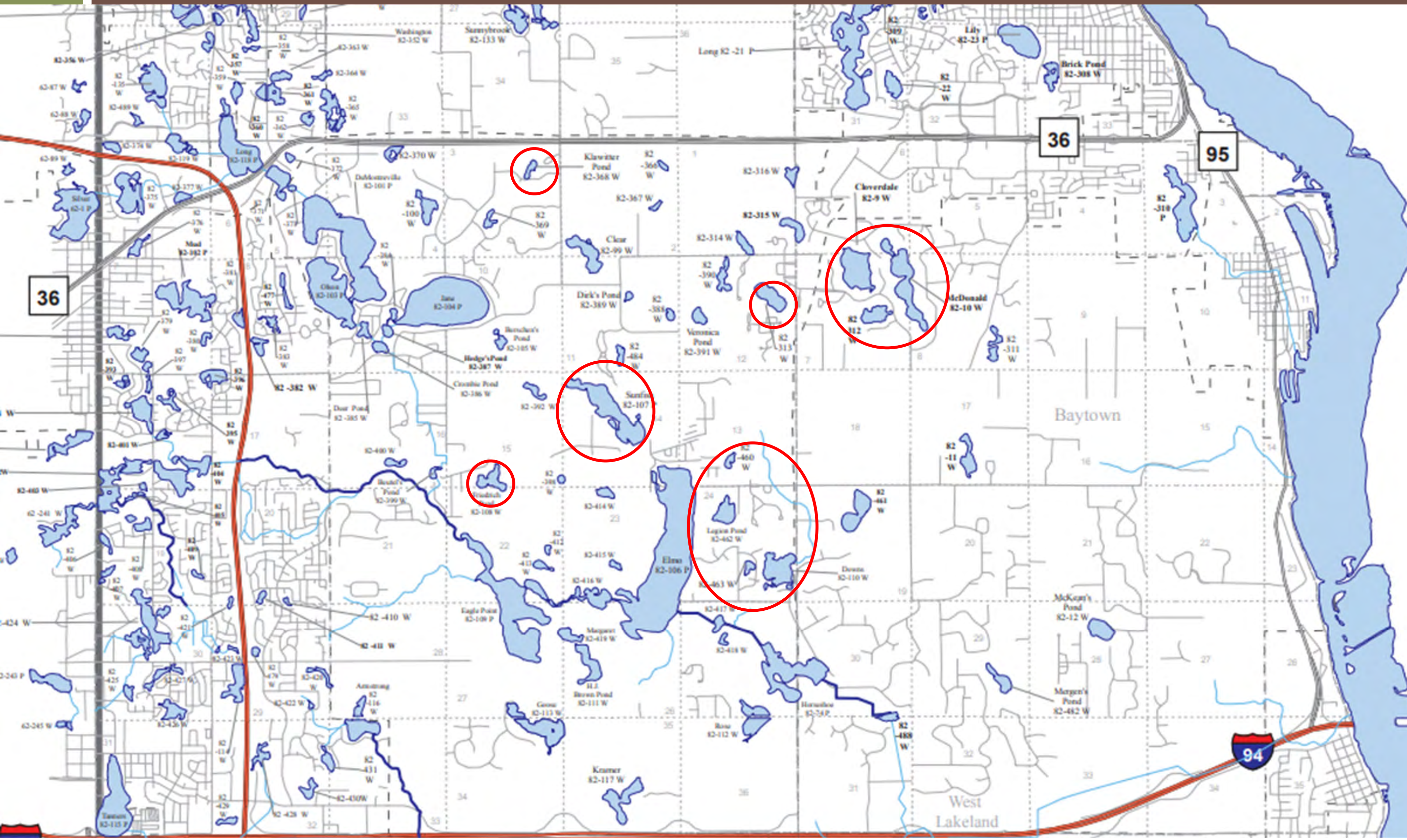

Recap from Last Meeting

March 2023 Stakeholder Meeting

- “Without Project” flood risk analysis
  - 100-year, 24-hour design events
  - Estimates of impacted dwellings
- Damage/cost assessment
  - 3 different approaches
- Target pumping rates and elevations
  - Intended to manage peak net groundwater flux and help manage flood risk
- Outline basin water level management alternatives

Damage Approach Summary

FEMA Depth-Damage Approach	Threshold Assessment Approach	Acquisition Approach
• Assumes riverine flooding • Constant flood elevation (100-year, 24-hour flood elevation) • Uses standard depth-damage curves	• 100-year, 24-hour flood elevation + GW adjustment factor • FEMA depth/ damages: Peak water level is -2 to 0 feet from lowest elevation of dwelling • Fill in basement/lost value of basement: Peak water level is 0 to 2 feet from lowest elevation of dwelling • Acquisition: Peak water level is higher than 2 feet above the lowest elevation of dwelling	• 100-year, 24-hour flood elevation + GW adjustment factor • FEMA depth/ damages: Peak water level is -2 to 0 feet from lowest elevation of dwelling • Acquisition: Peak water level is higher than 0 feet above the lowest elevation of dwelling

Existing Conditions: Damage/Cost Assessment Summary

Lake	Total Impacted Dwellings[1]	FEMA Residential Depth-Damage Assessment	Threshold Assessment Approach[2,3]	Acquisition Approach [2,3]
Klawitter Pond	***1-3***	***$60,000***	***$630,000 - $1.3 million***	***$630,000 - $1.3 million***
Friedrich's Pond	0	$0	$0	$0
Sunfish Lake	***1***	***$51,000***	***$18,000-$585,000***	***$18,000 - $585,000***
Legion Pond	***8-16***	***$180,000***	***$425,000 - $3.6 million***	***$1.8 - $5.3 million***
Reid Park Pond	***0-2***	***$30,000***	***$0 - $160,000***	***$0 - $680,000***
Goetschel Pond	0	$0	$0	$0
Cloverdale Lake	***8***	***$185,000***	***$185,000 - $1.4 million***	***$185,000 - $1.4 million***
McDonald Lake	0	$0	$0	$0
Downs Lake	***3-8***	***$255,000***	***$410,000 - $1.5 million***	***$ 2.2 - $5.2 million***
Eden Park Pond	***4-5***	***$90,000***	***$650,000 - $660,000***	***$1.0 - $1.1 million***
Project Total	***25 - 43***	***$851,000***	***$2.3 - $9.2 million***	***$5.8 - $15.6 million***

1 – Estimated number of impacted dwellings varies, depending on approach applied and application of groundwater proximity factor for 100-year, 24-hour design storm event

2 – Range reflects three flood elevation scenarios (100-year, 24-hour peak along with adjusted elevation using mid and wet groundwater adjustment factors)

3 – Acquisition estimates assumed taxable market value multiplied by 1.35 to account for relocation and demolition costs

Feedback from Stakeholders

- Flood Risk Analysis, as presented, is using peak elevation from the 100-year, 24-hour storm assuming starting water levels at the basins are at the maximum observed water level. This is very conservative on some basins; however, we are concerned about wet/high-water conditions. Reactions/thoughts?
  - **Proceed with the above approach as it reflects the sustained high-water condition in 2019/2020 and provides for more resiliency in the system**
- For low homes not located directly on the basin, should we use the groundwater proximity adjustment factor as part of the analysis or just assume 100-year peak elevation as a constant? If we use the adjustment factor, should be apply the wet or average?
  - **Additional summary provided following previous meeting and follow-up questions (next slides)**
- For acquisition approach, is the assumption that acquisition of any property where peak water levels are above the low/basement floor? Should some other threshold be used?
  - **Discussed variability of real estate approaches on USACE projects; VBWD current policy is voluntary acquisition of properties meeting certain criteria (adjacent to landlocked basin, cost of regional engineered solution more than property assessed value of dwellings with low floor elevations lower than 100-year flood level, cost of floodproofing more than assessed value, etc.)**
- For Klawitter Pond and Downs Lake, a variance would be required from the MnDNR to pump to the elevation needed to protect homes. Is this a concern to the MnDNR at this point?
  - **Getting a variance from the MnDNR would be challenging. Alternative assessment will only assume OHWL minus 1.5 feet, may require acquisition**

Impacted Dwellings:
Groundwater Proximity to Basin

Question/Comment: Understanding for the physical basis for the groundwater adjustment factor.

Question/Comment: Using more of a statistical approach to framing the combined risk and running the Design Storm Event models stochastically (e.g., using Monte Carlo simulations)

Impacted Dwellings: Groundwater Proximity to Basin

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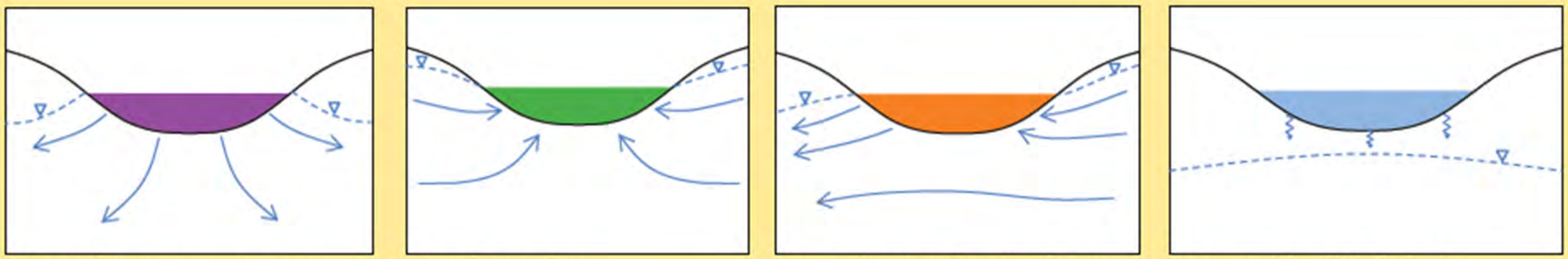
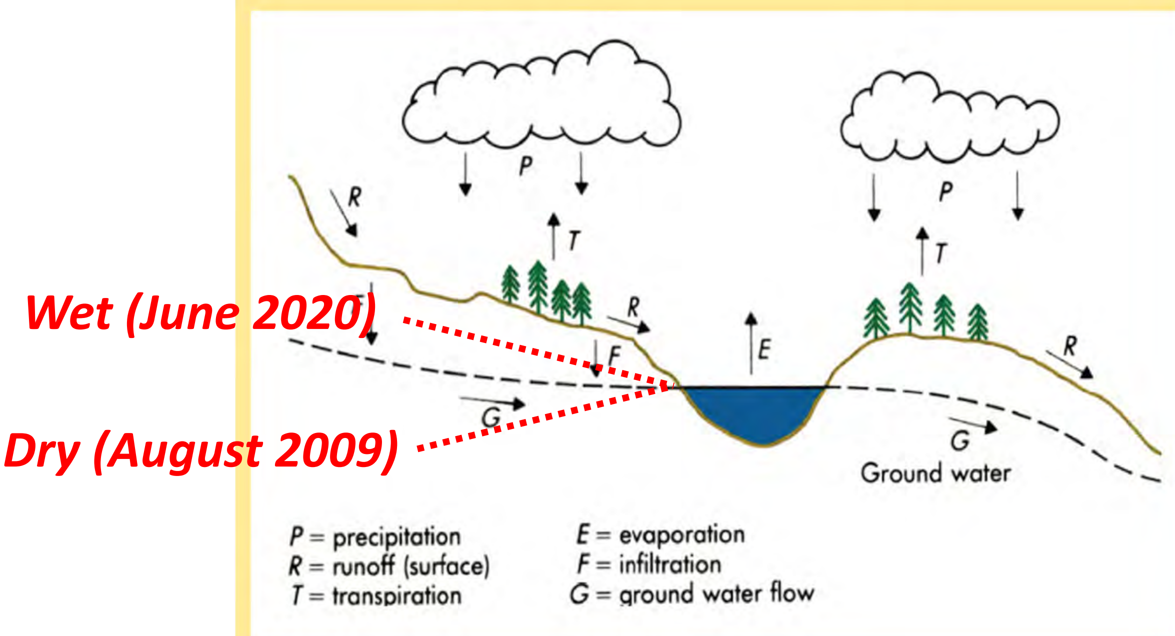


Mostly loses as seepage to groundwater

Mostly receives groundwater inflow

Groundwater flow both into and out of lake/wetland

Water table slightly below lake/wetland/stream bottom. Fluctuations in shallow water tables affect flow dynamics, but if the water table is deep enough, water table does not impact the basin.



Impacted Dwellings:
Groundwater Proximity to Basin

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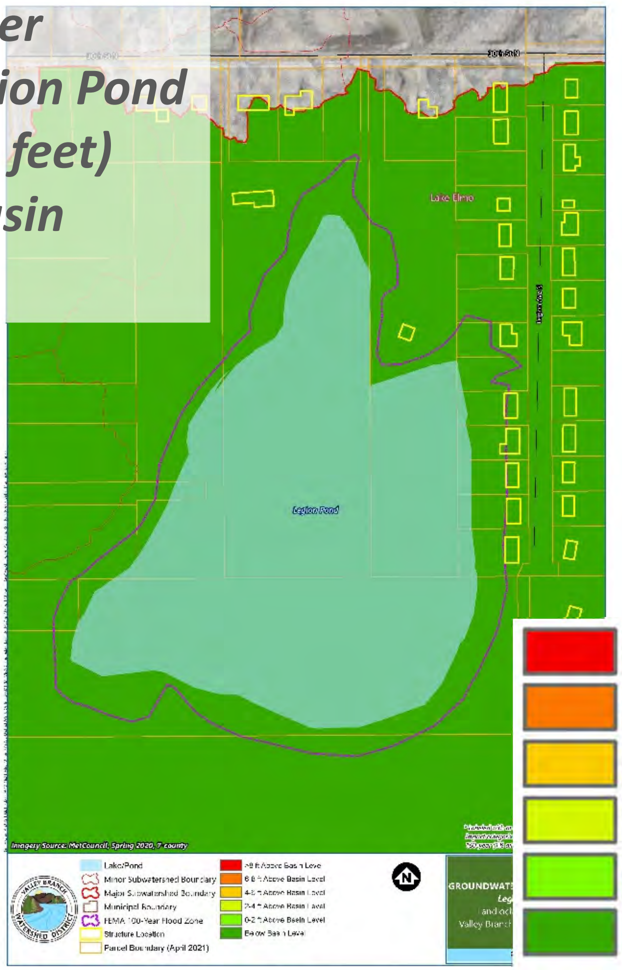
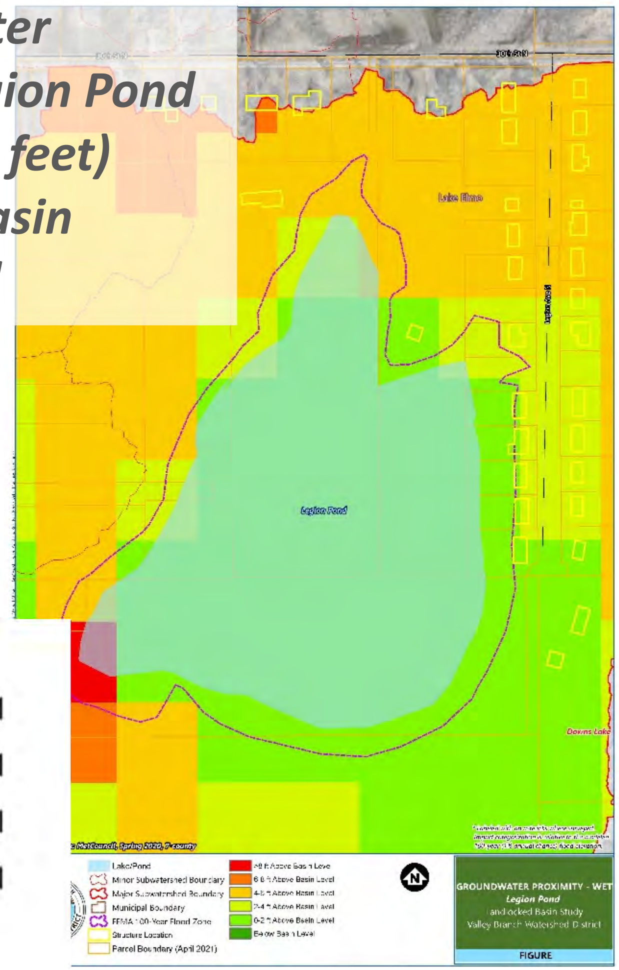
August 2009 (Dry)

Groundwater around Legion Pond <u>lower</u> (3-11 feet) than the basin water level



July 2020 (Wet)

Groundwater around Legion Pond <u>higher</u> (0-6 feet) than the basin water level



- >8 ft Above Basin Level
- 6-8 ft Above Basin Level
- 4-6 ft Above Basin Level
- 2-4 ft Above Basin Level
- 0-2 ft Above Basin Level
- Below Basin Level

Impacted Dwellings: Groundwater Proximity to Basin

See Handout (originally sent out following previous stakeholder meeting)

Lake	Impacted Dwellings (Constant Elevation)	Impacted Dwellings (Average Groundwater Level Adjacency Factor)	Impacted Dwellings (Wet Groundwater Level Adjacency Factor)
Klawitter Pond	***1 / 0***	***1 / 1***	***1 / 2***
Friedrich's Pond	0 / 0	0 / 0	0 / 0
Sunfish Lake	***0 / 1***	***0 / 1***	***0 / 1***
Legion Pond	***6 (2) / 4***	***6 (2) / 2***	***6 (2) / 10***
Reid Park Pond	***0 / 2***	***0 / 0***	***0 / 2***
Goetschel Pond	0 / 0	0 / 0	0 / 0
Cloverdale Lake	***7 (7) / 1***	***7 (7) / 1***	***7 (7) / 1***
McDonald Lake	0 / 0	0 / 0	0 / 0
Downs Lake	***3 / 5***	***3 / 0***	***3 / 3***
Eden Park Pond	***4 (2) / 0***	***4 (2) / 0***	***4 (2) / 1***
Project Total	***21 (11) / 13***	***21 (11) / 5***	***21 (11) / 20***

Impacted Dwellings: Groundwater Proximity Factor

Lake	Atlas 14 100-year, 24-hour Elevations[1]	Modeled Elevation of Basin in June 2020[2]
Klawitter Pond	***956.0 – 959.2***	***957.85***
Friedrich's Pond	909.6 – 911.3	
Sunfish Lake	***896.5– 907.0***	***898.57***
Legion Pond	***884.0 – 887.9***	***886.92***
Reid Park Pond	***885.9 – 888.5***	***889.8***
Goetschel Pond	892.8 – 898.1	
Cloverdale Lake	***904.8 – 909.1***	***906.54***
McDonald Lake	888.7 – 895.8	
Downs Lake	***892.7 – 894.6***	***889.09***
Eden Park Pond	***892.9 – 894.6***	***885.34***

1 – Based on future land use/conditions modeling and varies depending on the starting water elevation assumed for the basin
2 – June 2020 estimated basin elevation from calibrated groundwater model

Impacted Dwellings: Groundwater Proximity Factor

- There is some variability in the impacted dwelling results; however, the use of the groundwater factor:
  - Does not change estimates of impacted dwellings located on basins (just the estimates of potentially impacted basements for lower dwellings setback from the basins)
  - For most basins, the wet conditions water levels in 2020 fell within the range of the estimated 100-year, 24-hour design event peaks, depending on the starting elevation
- Proceeded with analysis/summary assuming groundwater adjustment factor (wet conditions) for impact and damage assessments

Landlocked Basin Study Scope: Alternatives Analysis (“With Project”)

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Alternative 1: Pumping/Outlets	Alternative 2: Acquisition	Alternative 3: Combined Approach
• Pumping/Outlet on: • Klawitter Pond • Reid Park Ponds • Legion Pond • Downs Lake/Eden Park Pond • Cloverdale Lake and/or McDonald • Mitigation for water quantity/quality impacts • No acquisitions • Emergency Response Plans on all other basins	• Acquisition of all at-risk dwellings	• TBD

Draft

Follow-up Items

Public Engagement #1

- Advertising:
  - Postcard mailings
  - Lake Elmo Newsletter – 2 weeks
  - Posted to VBWD website
  - Posted to Township websites

April 2023 Public Open House

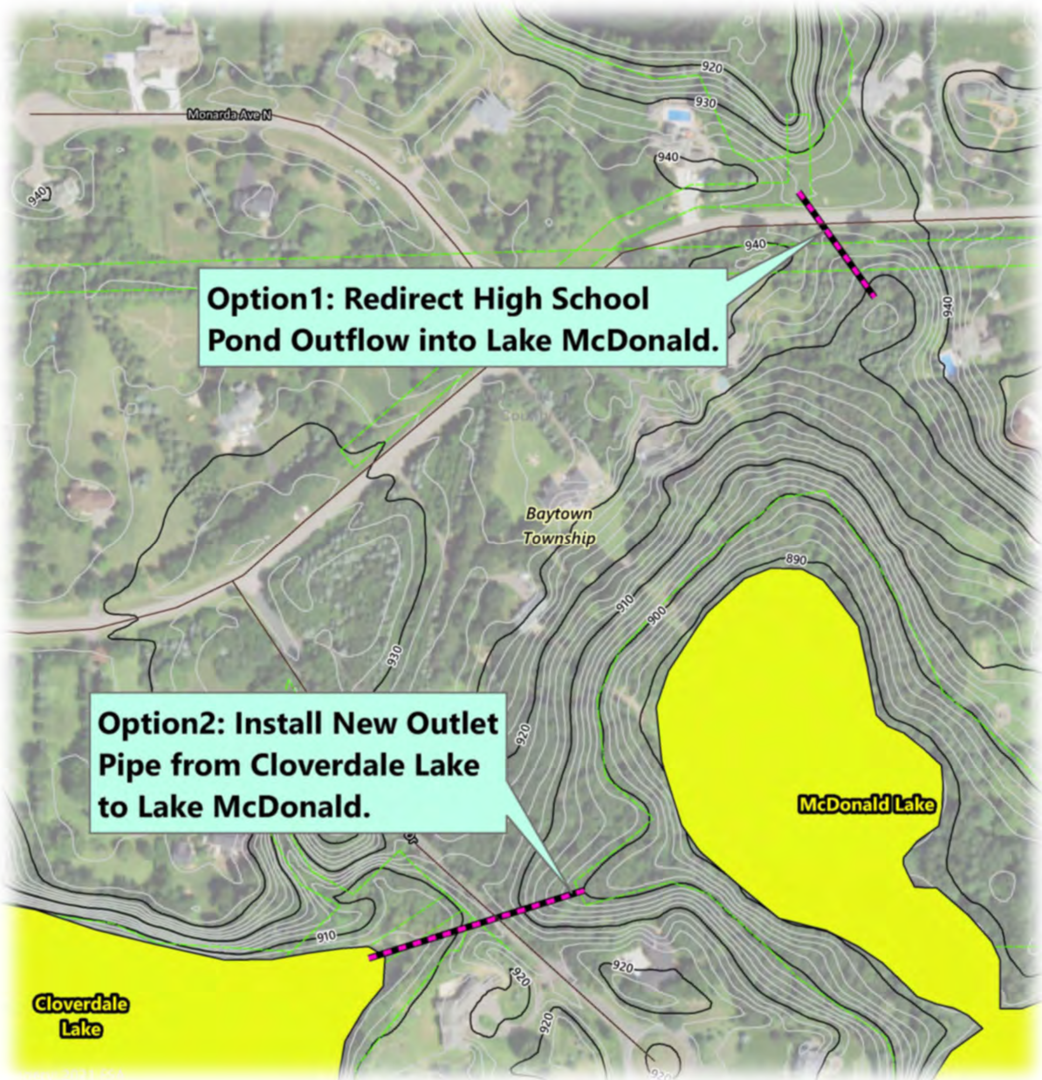
- Online StoryMap along with Survey Form and Interactive Map: March 24-April 14
  - 11 survey responses
    - 45% experienced high water
    - 81% concerned about future flooding
  - 5 points on map
- Open House: April 5 at Baytown Community Center
  - 30-40 attendees
  - 1 hardcopy survey submitted

Public Engagement #1: Summary of Comments

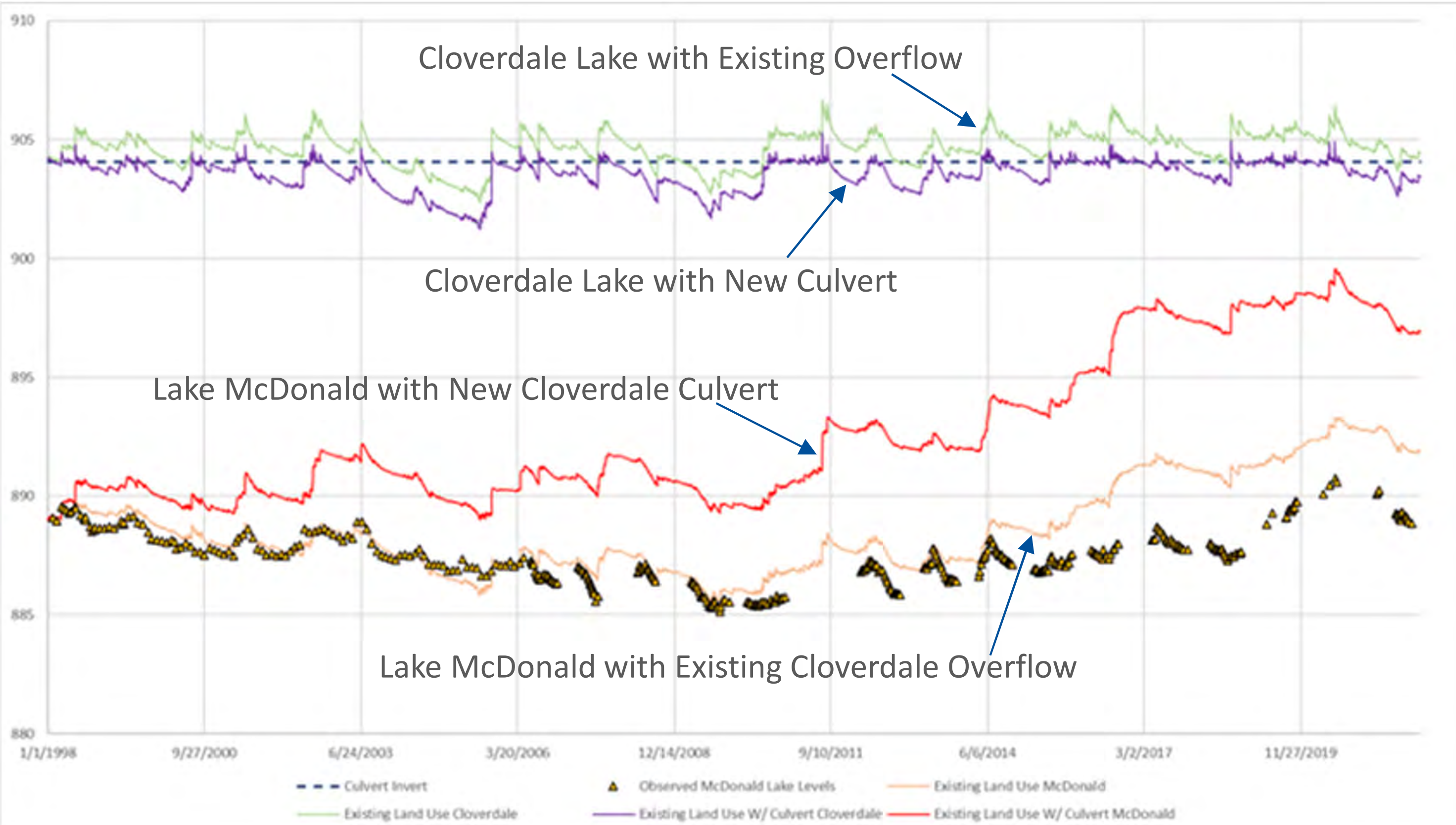
- **Legion Pond:**
  - Concern about future flooding and building resiliency
  - Consider impacts to invasive species and PFAS contamination
  - Walkout impacted by high water
  - Doing nothing is not acceptable, should look at outlet, acquisition, or potentially raising structures
- **Downs Lake:**
  - Concern about septic and well impacted by high water/contamination, need connections to regional sewer and water
  - Dislike temporary pumps aesthetics and sound
  - Preference for a gravity outlet from Downs Lake rather than pumping (noise, damage to trees/landscaping)
- **Klawitter Pond:**
  - Concern about future flooding and thankful high-water is being studied
- **Goetschel Pond:**
  - Concern about lack of use around Goetschel Pond due to trail flooding
  - Concern about a high-water level management system being too aggressive, drying out lakes and ponds and causing ecological impact
- **Reid Park Ponds:**
  - Would like water levels in Reid Park Ponds stabilized and a larger/lower connections between the two basins
- **McDonald Lake:**
  - Don’t drain the lake, need water in lake with steep slopes to lake
- **Unnamed wetland:**
  - Concern about floodplain and basement flooding
  - Interest in how water flows through his yard to Sunfish Lake
- **Others:**
  - No negative downstream impacts in West Lakeland Township
  - Concern about who takes on responsibility for implementation

Cloverdale/McDonald Lakes – Potential Alternatives

- Evaluated options:
  - Divert runoff away from Cloverdale Lake into McDonald Lake
  - Add pipe to connect Cloverdale Lake to McDonald Lake



Cloverdale/McDonald Lakes



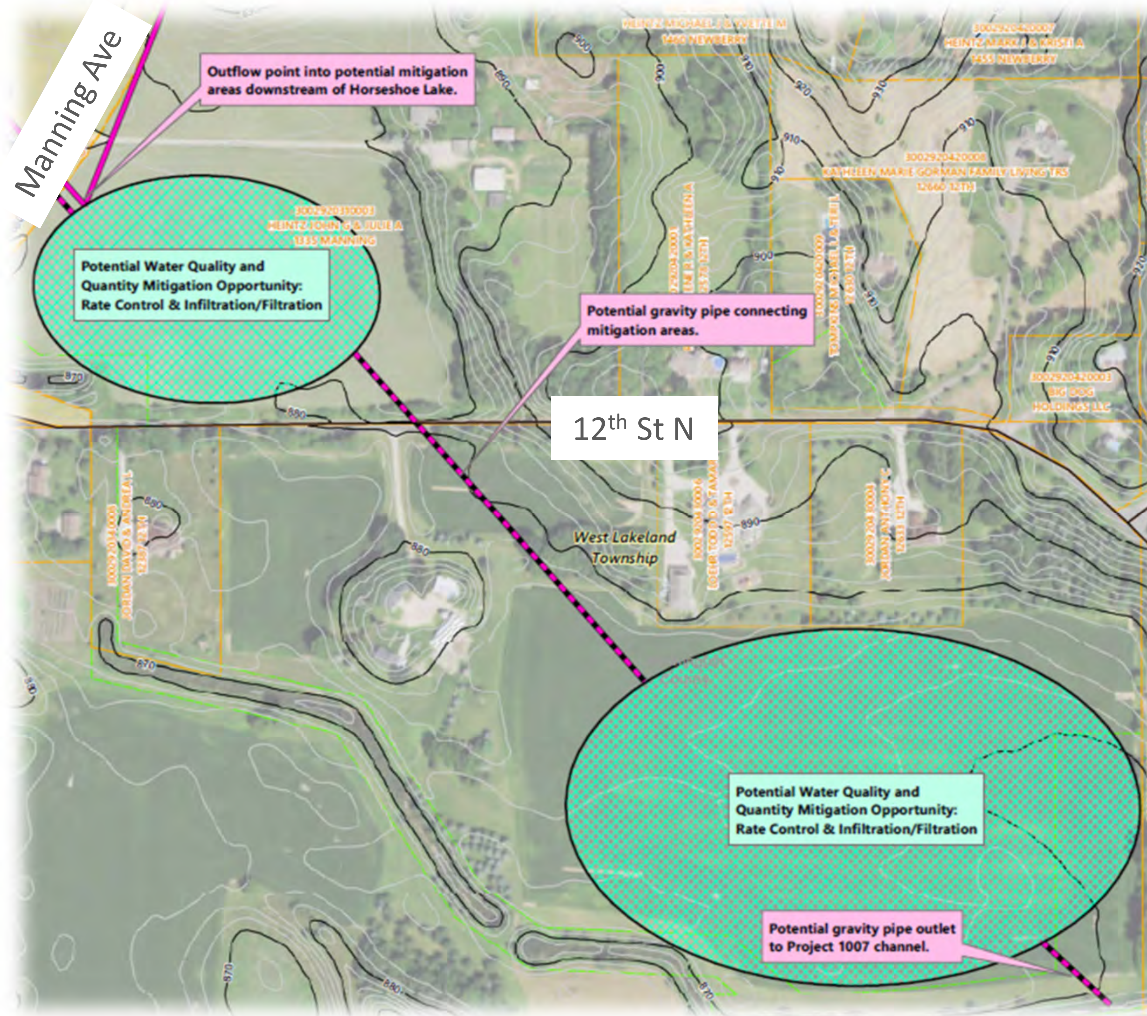
No proposed action at Cloverdale/McDonald Lakes:

- Impacted dwellings are only those with groundwater within 2 feet of basement floor
- No specific feedback from Cloverdale Lake residents about impacts to homes during recent high-water conditions and residents do not want pumping from Lake McDonald
- Levels in Lake McDonald continue to climb indefinitely (flood risk & vegetation impacts)

MPCA PFAS Conversation

- Meeting with Rebecca Higgins, MPCA following last stakeholder meeting

- ***Main Takeaways:***
  - MPCA cannot provide clear direction on exactly what will be required from PFAS standpoint as it relates to pumping/gravity outlets
  - MPCA is in the process of completing a feasibility study (i.e., detailed evaluation of alternative cleanup options) related to Project 1007 in the conveyance of PFAS (to be completed sometime in 2024)
  - Barr/VBWD highlighted there may be an opportunity to utilize the downstream mitigation storage as part of the larger PFAS treatment system (if storage for treatment is necessary)
  - Barr/VBWD will define alternatives for water management needs only, but will look at high-level PFAS costs based on recently published MPCA/LCCMR report



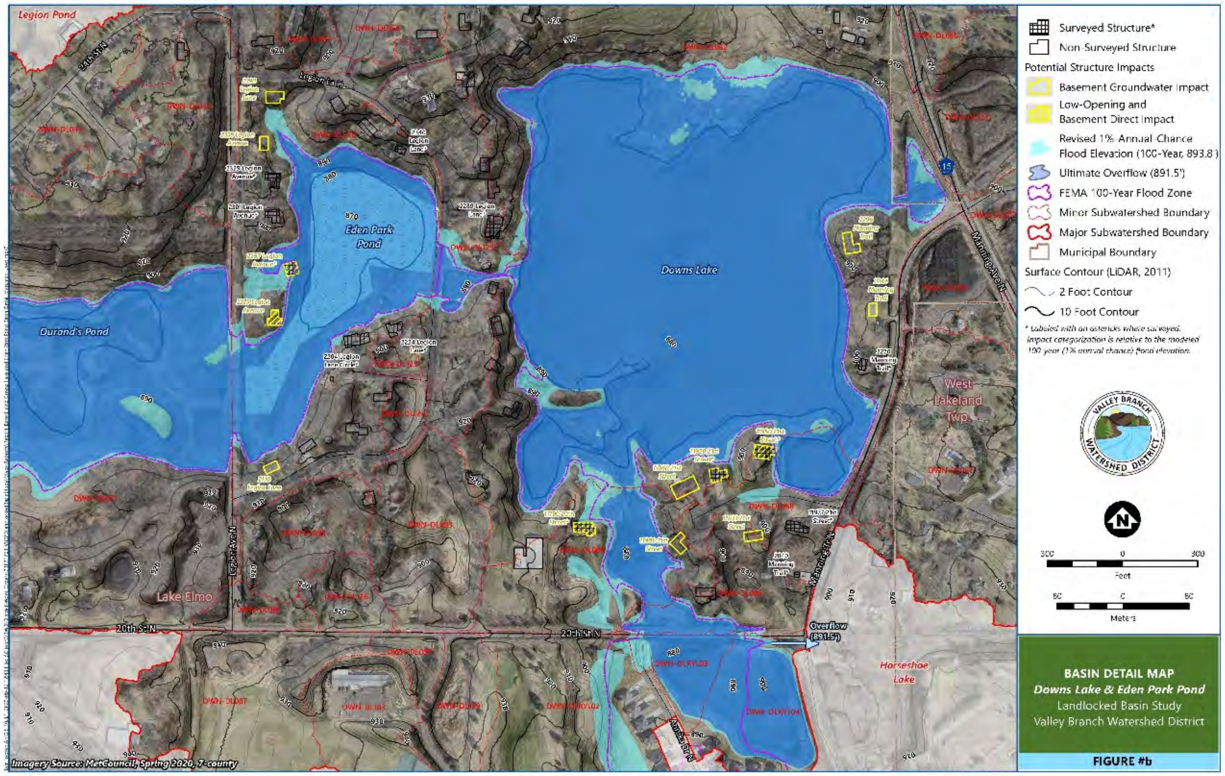
Potential Alternative: Pumping/Outlets

- Eliminated project at Cloverdale Lake/McDonald Lake
  - Also, no projects at Sunfish Lake, Friedrichs Pond, Goetschel Pond
- Under the pumped/outlet alternative, a few acquisitions will be needed to stay within OHWL minus 1.5 feet for outlet level limitation and to manage flood risk
- Focused on pumping/outlets from the following basins:
  - Klawitter Pond (pumped outlet, acquisition of 1 property)
  - Reid Park Ponds (pumped outlet)
  - Legion Pond (pumped outlet)
  - Eden Park Pond (pumped outlet, acquisition of 1 property)
  - Downs Lake (gravity outlet)

Alternatives Review

Landlocked Basin Study Scope: Alternatives Analysis (“With Project”)

- Conceptual design of up to three concepts
  - Outlets/pumping from all basins
  - Acquisition of all at-risk properties (or relocation of at-risk infrastructure (e.g., moving septic systems, raising roads, etc.))
  - Combination of outlets and acquisition
- Evaluation of downstream impacts and potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality and Ecological Conditions (AIS)
- Planning level cost estimates
- Permitting requirements

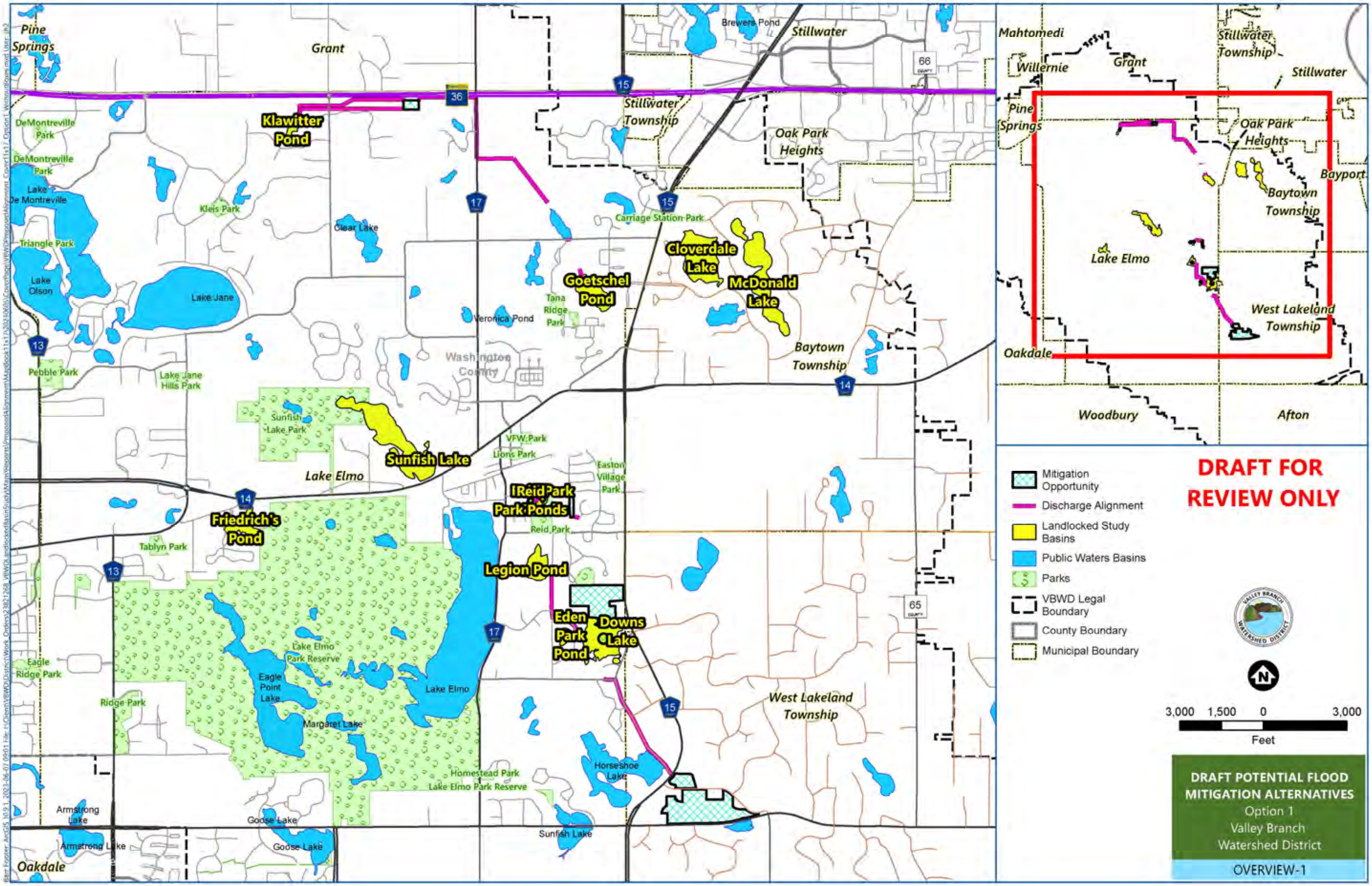


Landlocked Basin Study Scope: Alternatives Analysis ("With Project")

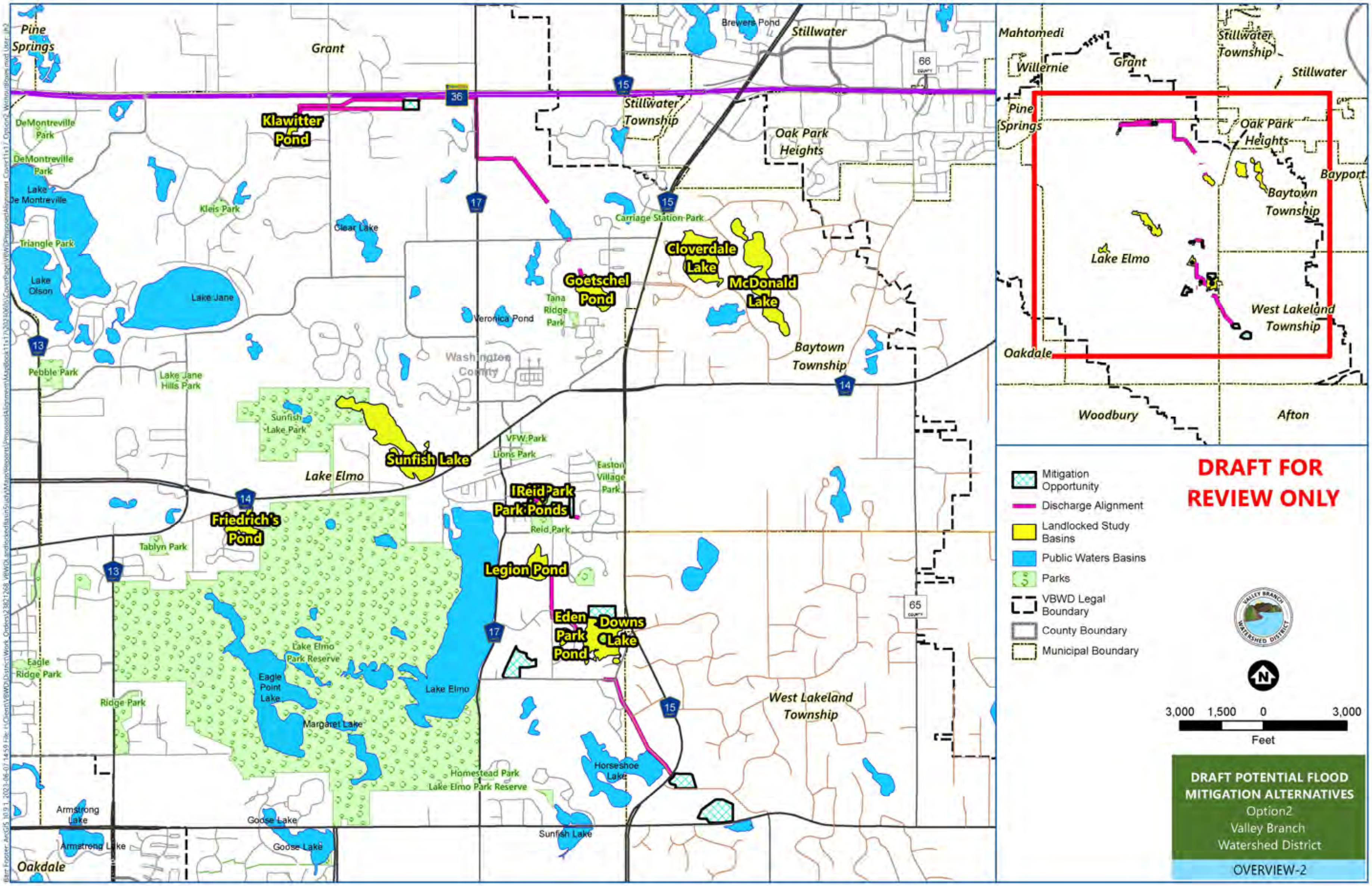
Alternative 1: Pumping/Outlets	Alternative 2: Acquisition	Alternative 3: Combined Approach

• Pumping/Outlet on:
  • Klawitter Pond
  • Reid Park Ponds
  • Legion Pond
  • Downs Lake/Eden Park Pond (2 options)
  • ~~Cloverdale Lake and/or McDonald~~
• Including mitigation for water quantity/quality impacts
• ~~No acquisitions~~ Few acquisitions
• Emergency Response Plans on all other basins
	• Acquisition of all at-risk dwellings	• **TBD - based on conversation today**

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

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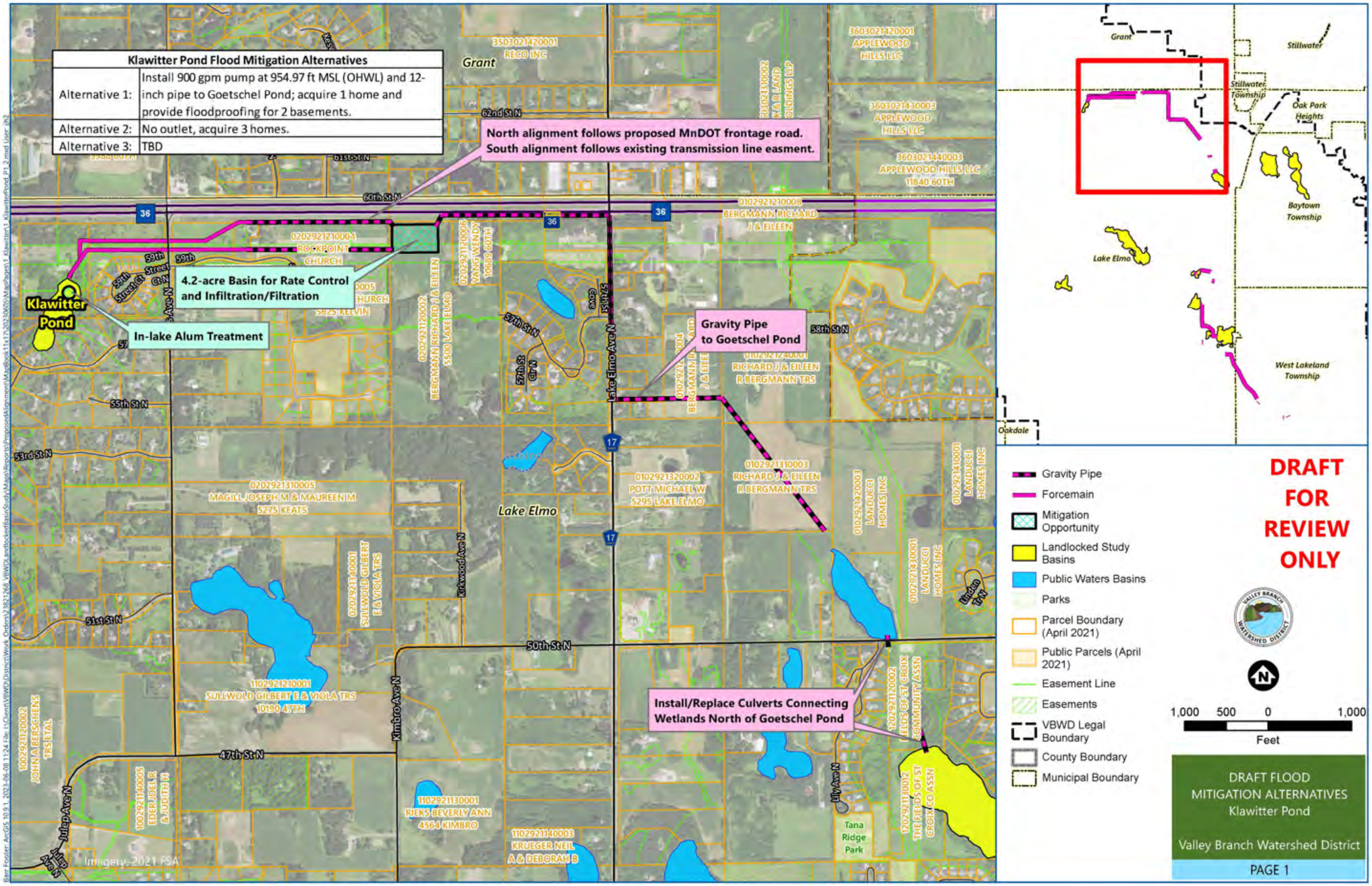
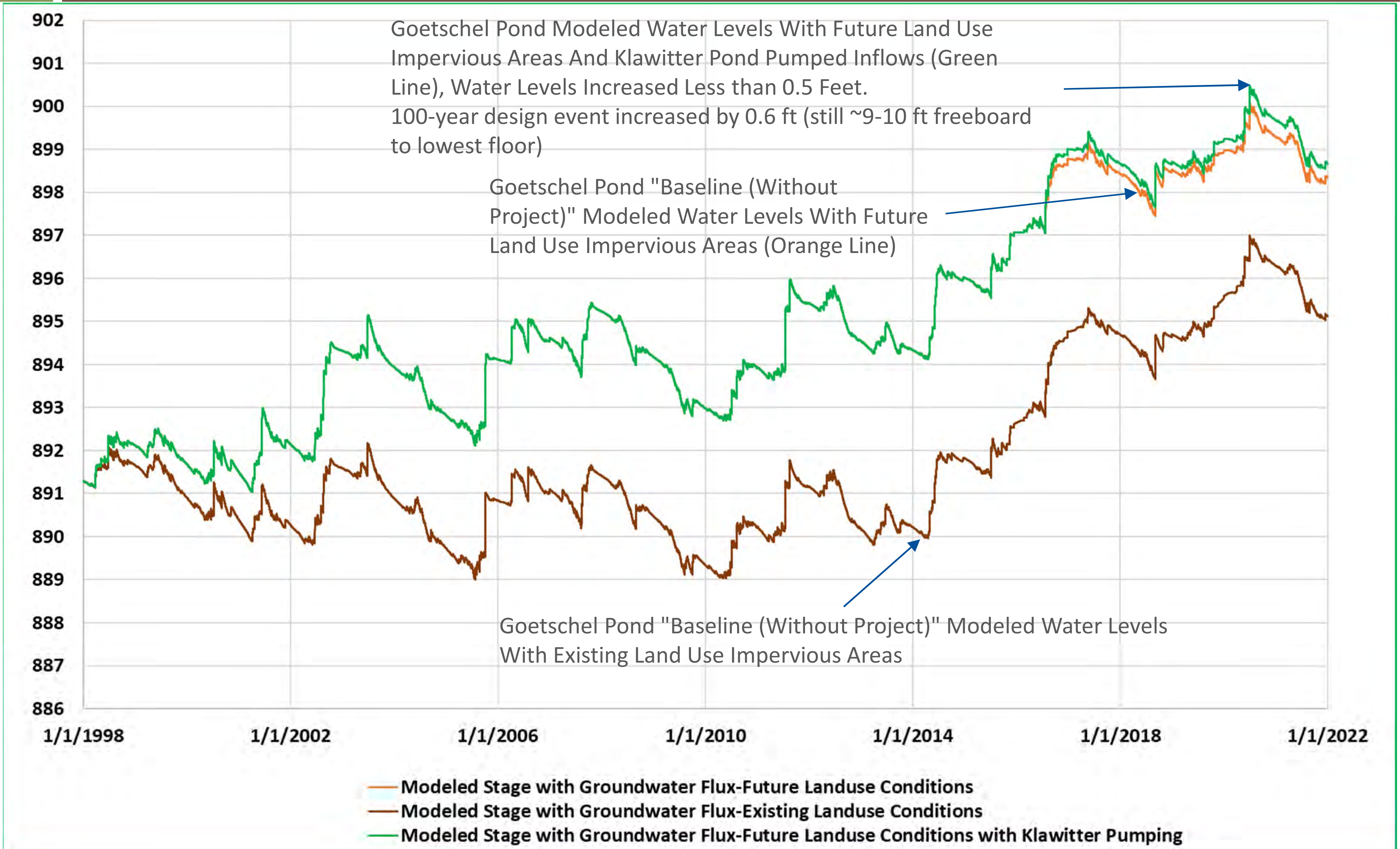


Klawitter Pond Pumping Impacts at Goetschel Pond



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

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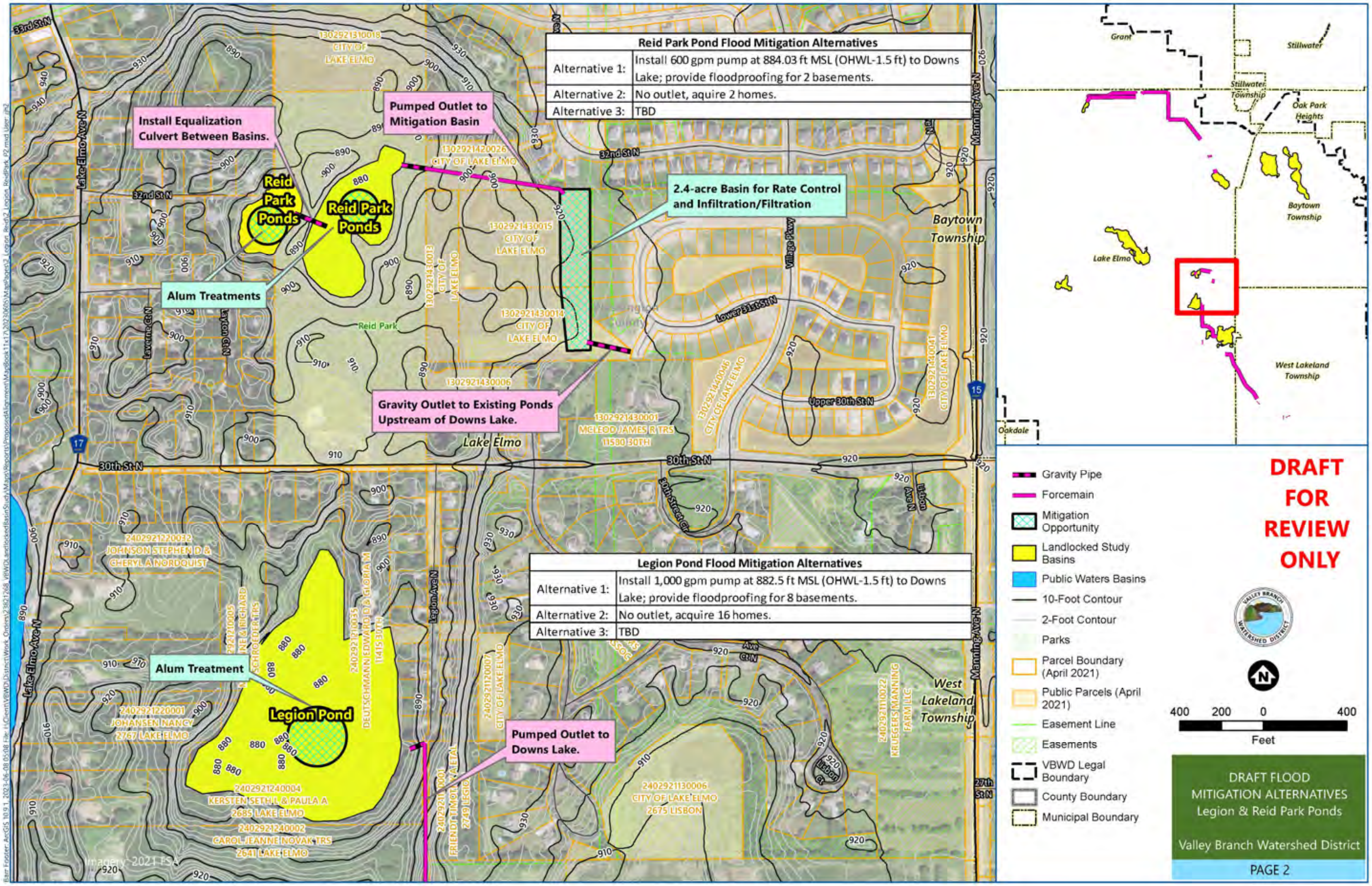

Reid Park Pond Flood Mitigation Alternatives

Alternative 1:	Install 600 gpm pump at 884.03 ft MSL (OHWL-1.5 ft) to Downs Lake; provide floodproofing for 2 basements.
Alternative 2:	No outlet, aquire 2 homes.
Alternative 3:	TBD

Legion Pond Flood Mitigation Alternatives

Alternative 1:	Install 1,000 gpm pump at 882.5 ft MSL (OHWL-1.5 ft) to Downs Lake; provide floodproofing for 8 basements.
Alternative 2:	No outlet, acquire 16 homes.
Alternative 3:	TBD

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

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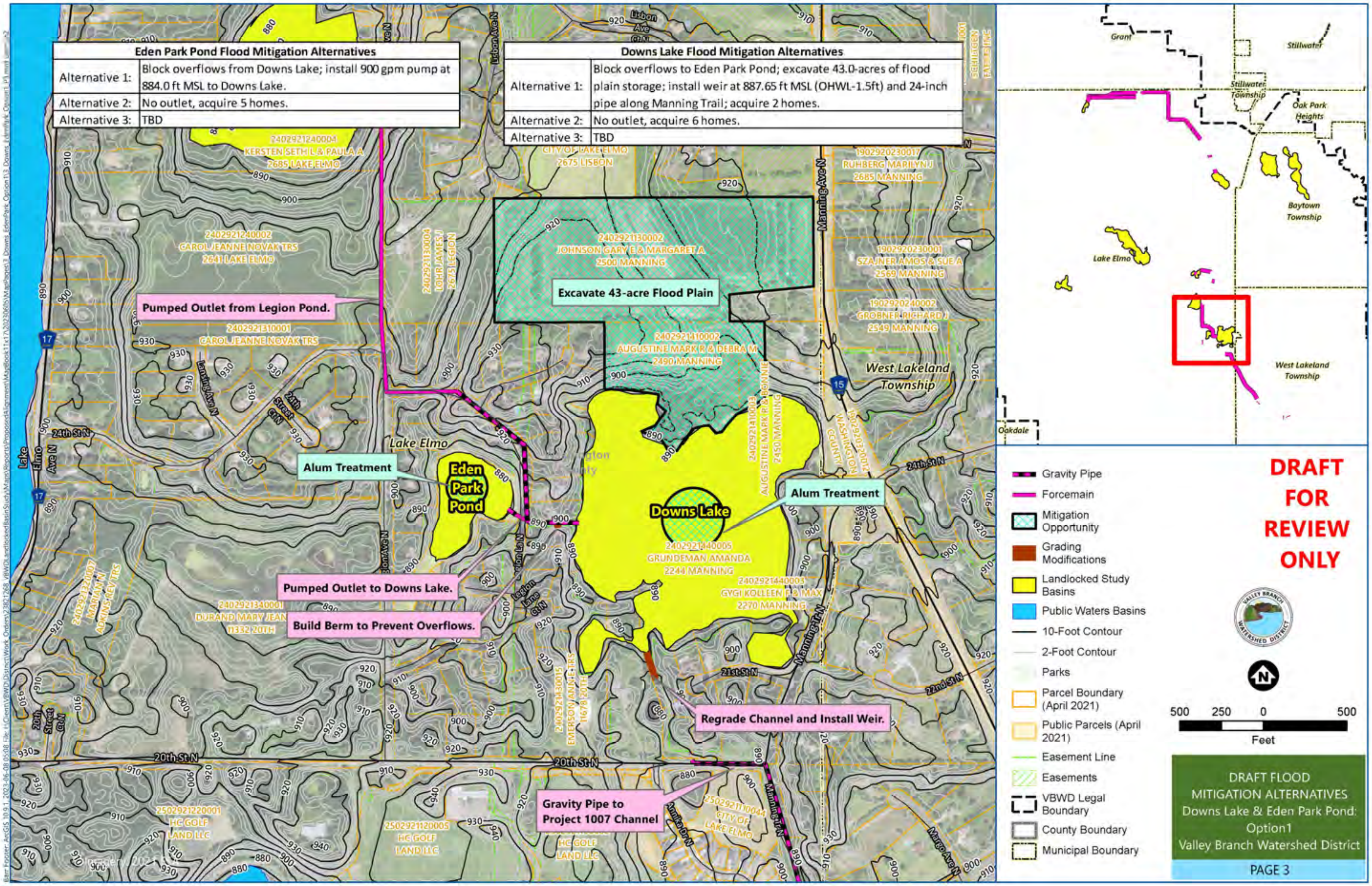
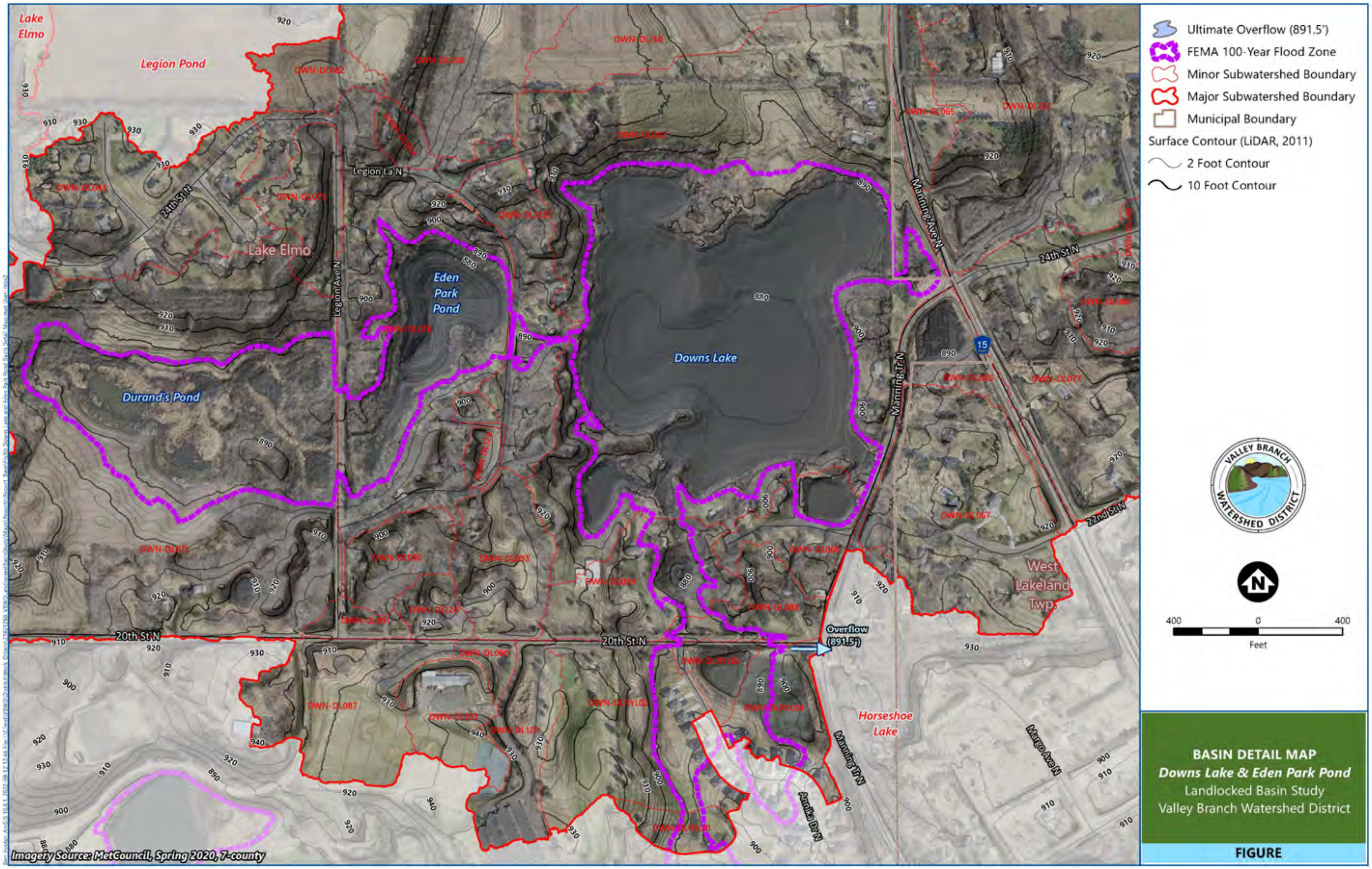
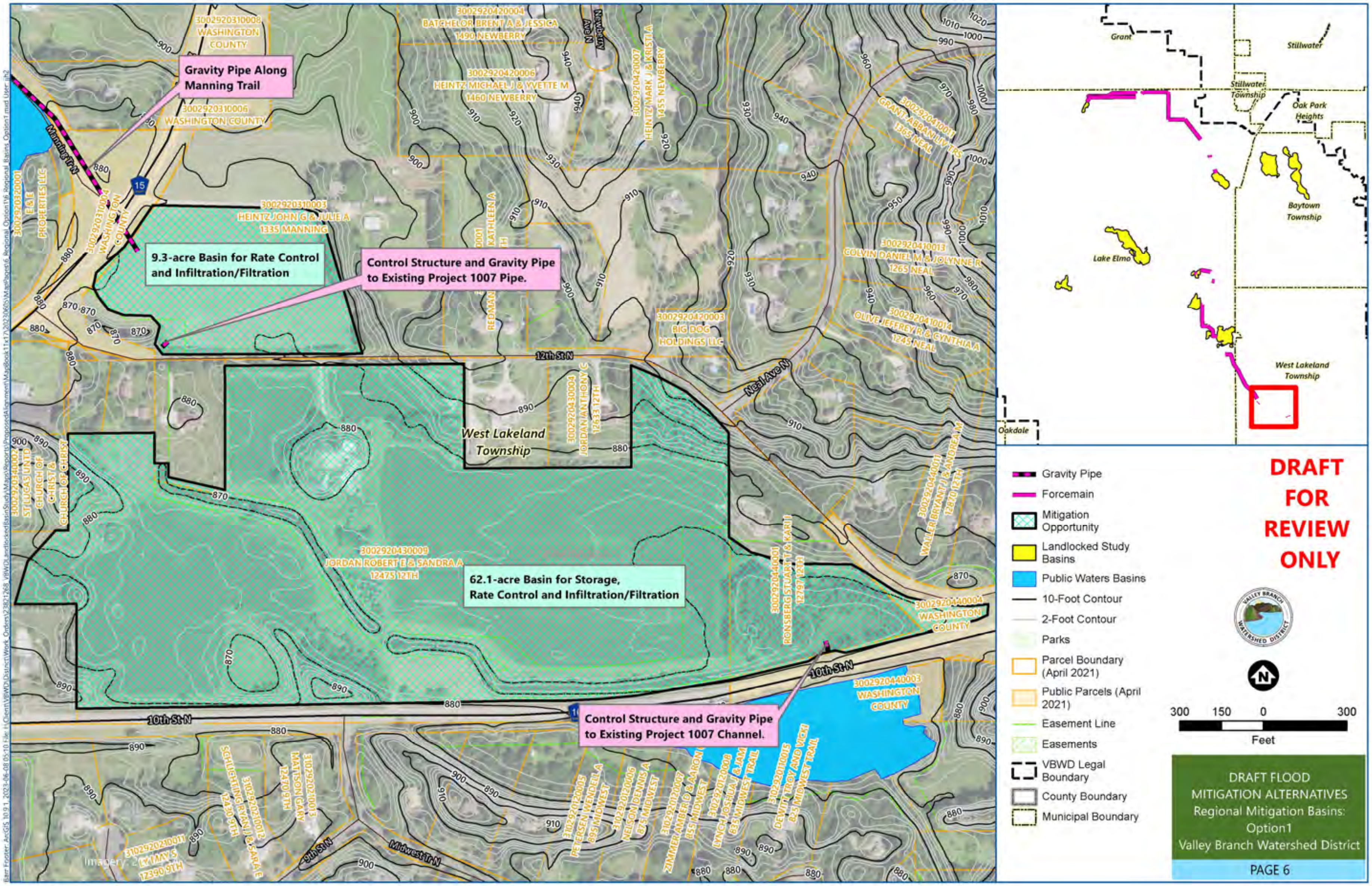


Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

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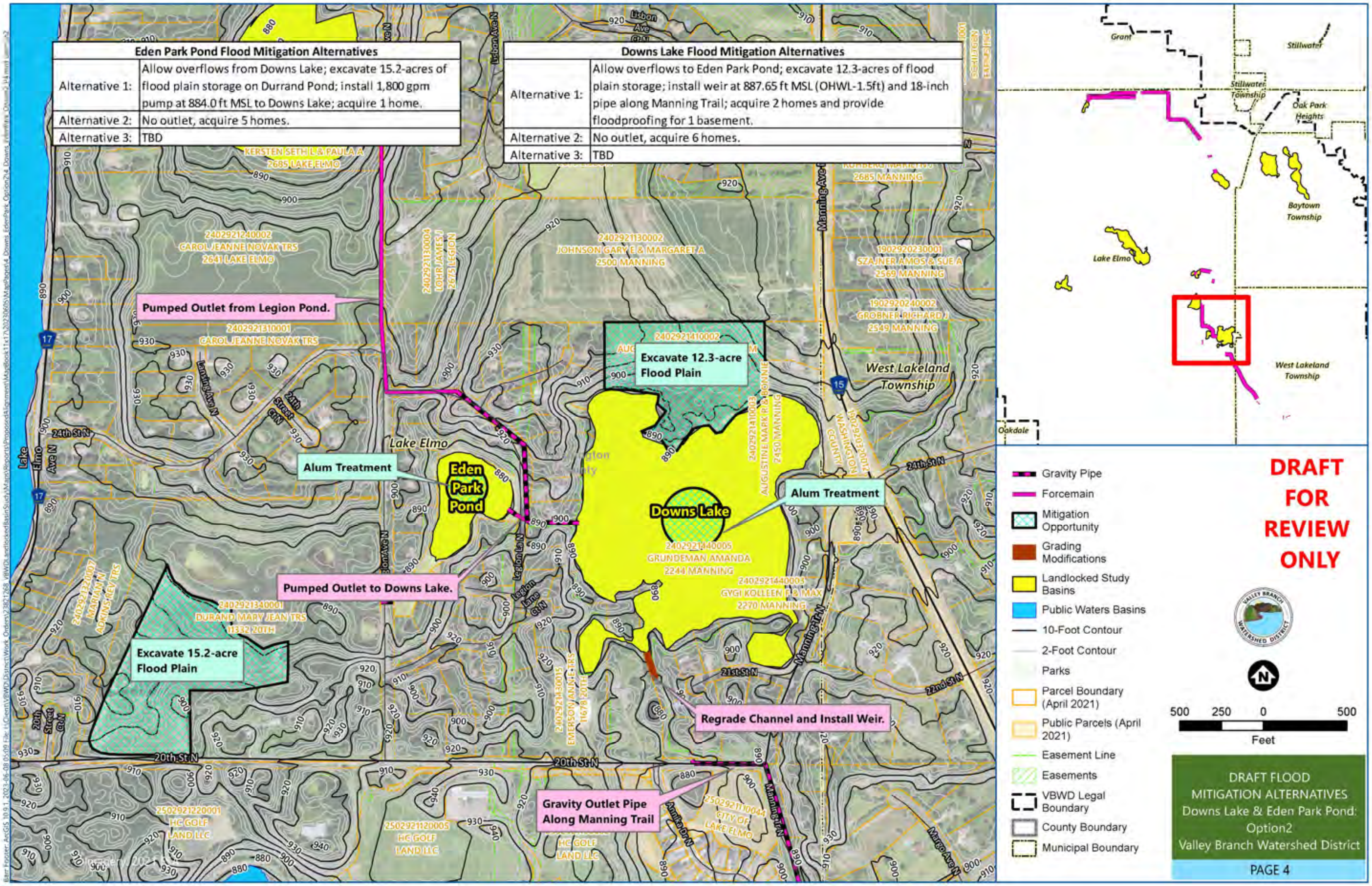
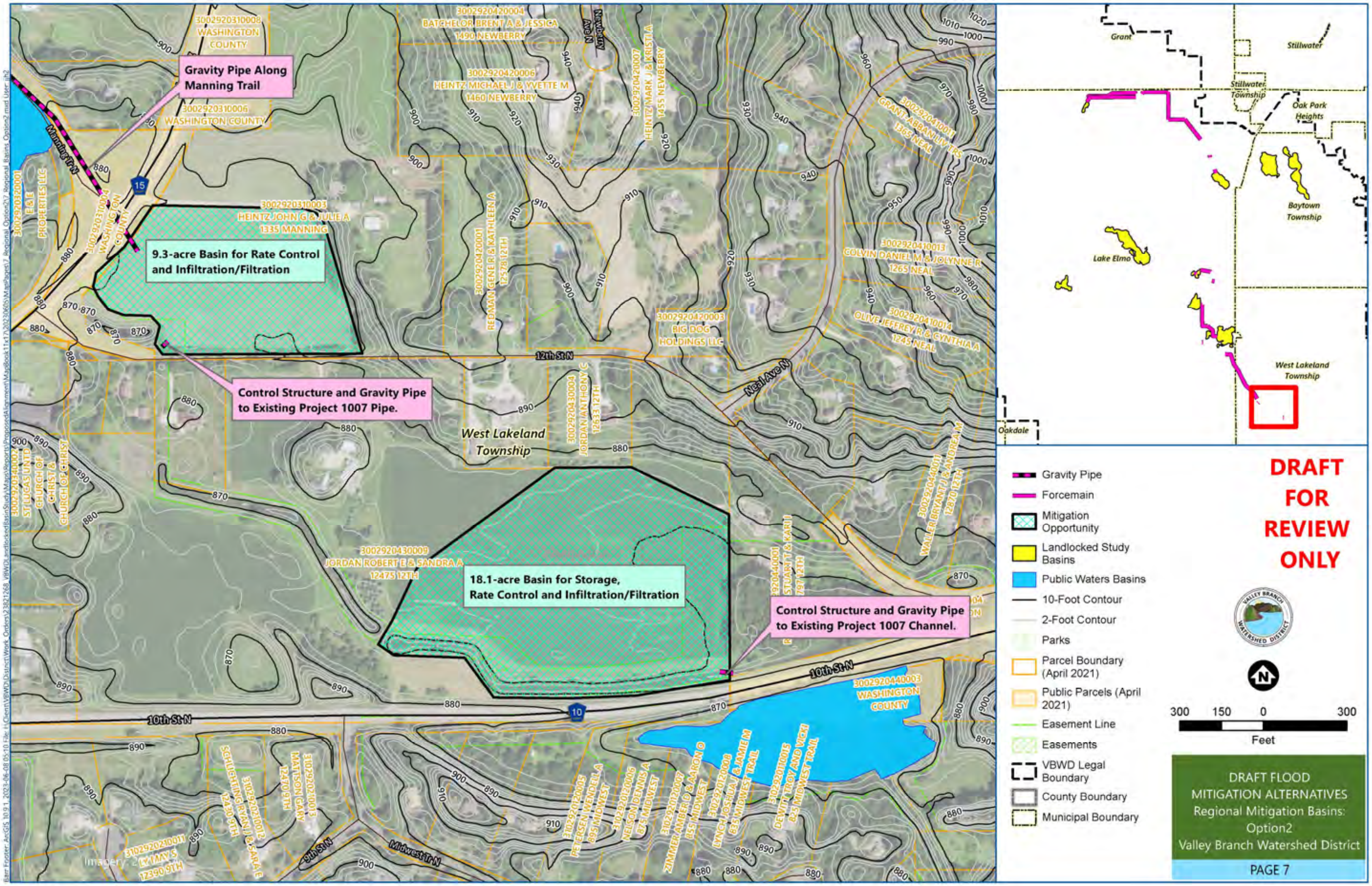


Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Summary of Impacted Dwellings

Lake	Baseline Impacted Dwellings[1]	Alternative 1, Option 1 Impacted Dwellings [1]	Estimated Damage for Option 1[2]	Alternative 1, Option 2 Impacted Dwellings[1]	Estimated Damage for Option 2[2]
Klawitter Pond	***1 / 2***	***1 / 2***	***$17,000[3]***	***1 / 2***	***$17,000[3]***
Friedrich's Pond	0 / 0	0 / 0	$0	0 / 0	$0
Sunfish Lake	***0 / 1***	***0 / 1***	***$51,000 - $585,000***	***0 / 1***	***$51,000 - $585,000***
Legion Pond	***6 (2) / 10***	***0 / 8***	***$0 - $330,000***	***0 / 8***	***$0 - $330,000***
Reid Park Pond	***0 / 2***	***0 / 2***	***$0 - $160,000***	***0 / 2***	***$0 - $160,000***
Goetschel Pond	0 / 0	0 / 0	$0	0 / 0	$0
Cloverdale Lake	***7 (7) / 1***	***7 (7) / 1***	***$185,000 - $1.4 million***	***7 (7) / 1***	***$185,000 - $1.4 million***
McDonald Lake	0 / 0	0 / 0	$0	0 / 0	$0
Downs Lake	***3 / 3***	***2 (1) / 0***	***$100,000 - $260,000***	***2 (1) / 1***	***$100,000 - $260,000***
Eden Park Pond	***4 (2) / 1***	***0 / 0***	***$0***	***1 / 0***	***$21,000 - $110,000***
Project Total	***21 (11) / 20***	***10 (8) / 14***	***$353,000 – $2.8 million***	***11 (8) / 14***	***$374,000 - $2.9 million***
Project Total (No Sunfish/Cloverdale)[4]	***14 (4) / 18***	***3 (1) / 12***	***$117,000 - $767,000***	***4 (1) / 13***	***$138,000 - $877,000***

1 – Using wet groundwater adjustment factor
2 – Range represents FEMA and Threshold damage approach estimates
3 – Homes that must be acquired are removed from this cost estimate
4 – Not including damages associated with Sunfish and Cloverdale Lakes

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 2: Acquisition

Home acquired and demolished in Sunnybrook Lake neighborhood in recent years

Acquisition: Peak water level 0 feet or higher than lowest elevation of dwelling

- Recent VBWD experiences at Sunnybrook Lake and Friedrich's Pond
  - $20,000 to $50,000 for demolition (includes sealing well and abandoning septic system)
  - Approximately $10,000 for other costs (closing and reselling)
  - Plus, additional for engineering/coordination
- Review of other recent flood studies (by Barr) including acquisition planning costs
  - Ranges from 120-150% for planning purposes (covers survey, engineering, legal, demo, relocation)
- Acquisition = Washington County taxable market value multiplied by 1.35 (135%)
- Does NOT consider value of lost tax revenue for acquired properties

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Summary of Costs

- Planning level construction costs (0-10% design)
- 25% construction contingency
- 25% planning, engineering, design, and permitting
- Includes land acquisition/easements based on alignment/if on private land (vs. public land/ROW)
  - Residential acquisition (Washington County Tax Assessed Value times 1.35 to include demolition/relocation costs if home on property)
  - Land acquisition (Washington County Tax Assessed Value times 1.1 to account for misc costs)
  - Easement ($30,000 per acre based on recent drainage easement acquisitions in VBWD)
- Assumes no special disposal requirements for excavated soils
- Includes mitigation components (alum treatment, mitigation storage)
- Does not include costs associated with PFAS

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Summary of Costs (Preliminary)

Lake	Alternative 1, Pumping/Outlets Option 1	Alternative 1, Pumping/Outlets Option 2	Alternative 2 Acquisition
Klawitter Pond	***$6,420,000***	***$6,420,000***	***$1.3 million***
Friedrich's Pond	N/A	N/A	N/A
Sunfish Lake	N/A	N/A	N/A
Legion Pond	***$1,470,000***	***$1,470,000***	***$5.5 million***
Reid Park Pond	***$1,840,000***	***$1,840,000***	***$0.7 million***
Goetschel Pond	N/A	N/A	N/A
Cloverdale Lake	N/A	N/A	N/A
McDonald Lake	N/A	N/A	N/A
Downs Lake	***$63,340,000***	***$20,650,000***	***$2.6 million***
Eden Park Pond	***$1,140,000***	***$1,200,000***	***$1.6 million***
Total Project Cost (-30% to +50%)	***$74.2 million ($51.9 million - $111.3 million)***	***$31.6 million ($22.1 million - $47.4 million)***	***$11.7 million***

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") PFAS Considerations

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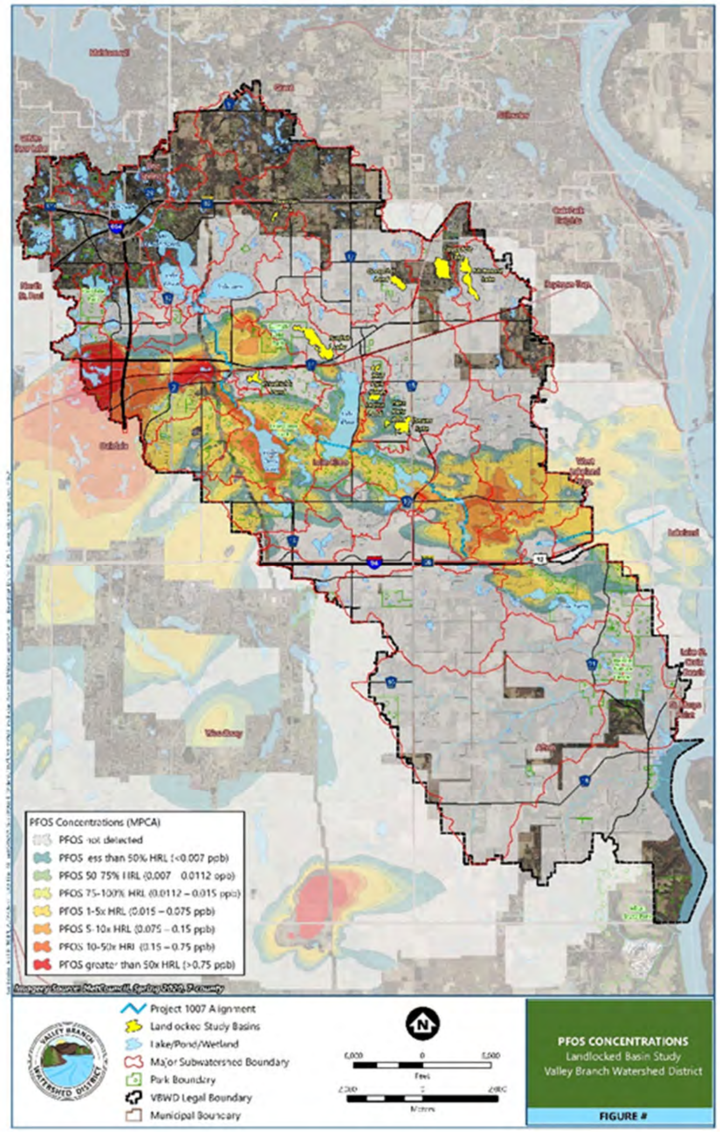
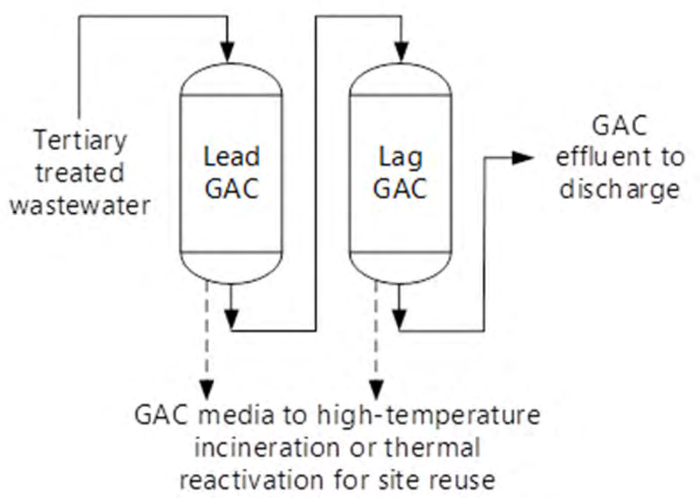
- Basins proposed to be pumped meet the current MDH Human Health Based Water Guidelines – if this standard used, may not require treatment; if other thresholds used, then may require treatment
- MPCA/LCCMR report (Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water) - Published 6/6/2023
  - Reviews separation and destruction technologies for various waste streams - all pump and treat/non-passive treatment technologies
    - Treatment technologies that were further investigated: nanofiltration/reverse osmosis membrane treatment, foam fractionation, ***granular activated carbon (GAC)***, anion exchange (AIX) resin, and modified clay
    - For municipal wastewater, conceptual designs and capital/annual O&M cost estimates were prepared relative to flowrate
    - Groundwater or surface water were not part of waste streams evaluated but technologies could still translate



Landlocked Basin Study Scope:
Alternatives Analysis ("With Project")
PFAS Treatment Costs

Flow Rate			Estimated Costs[1]	
GPM	MGD	CFS	Capital	Annual O&M
2740[2]	***3.9***	***6***	***$ 28,900,000***	***$ 2,900,000***
5470[3]	***7.9***	***12***	***$ 48,800,000***	***$ 5,200,000***
13900	20.0	30	$ 98,900,000	$ 12,300,000
25900	37.3	58	$ 158,500,000	$ 22,400,000

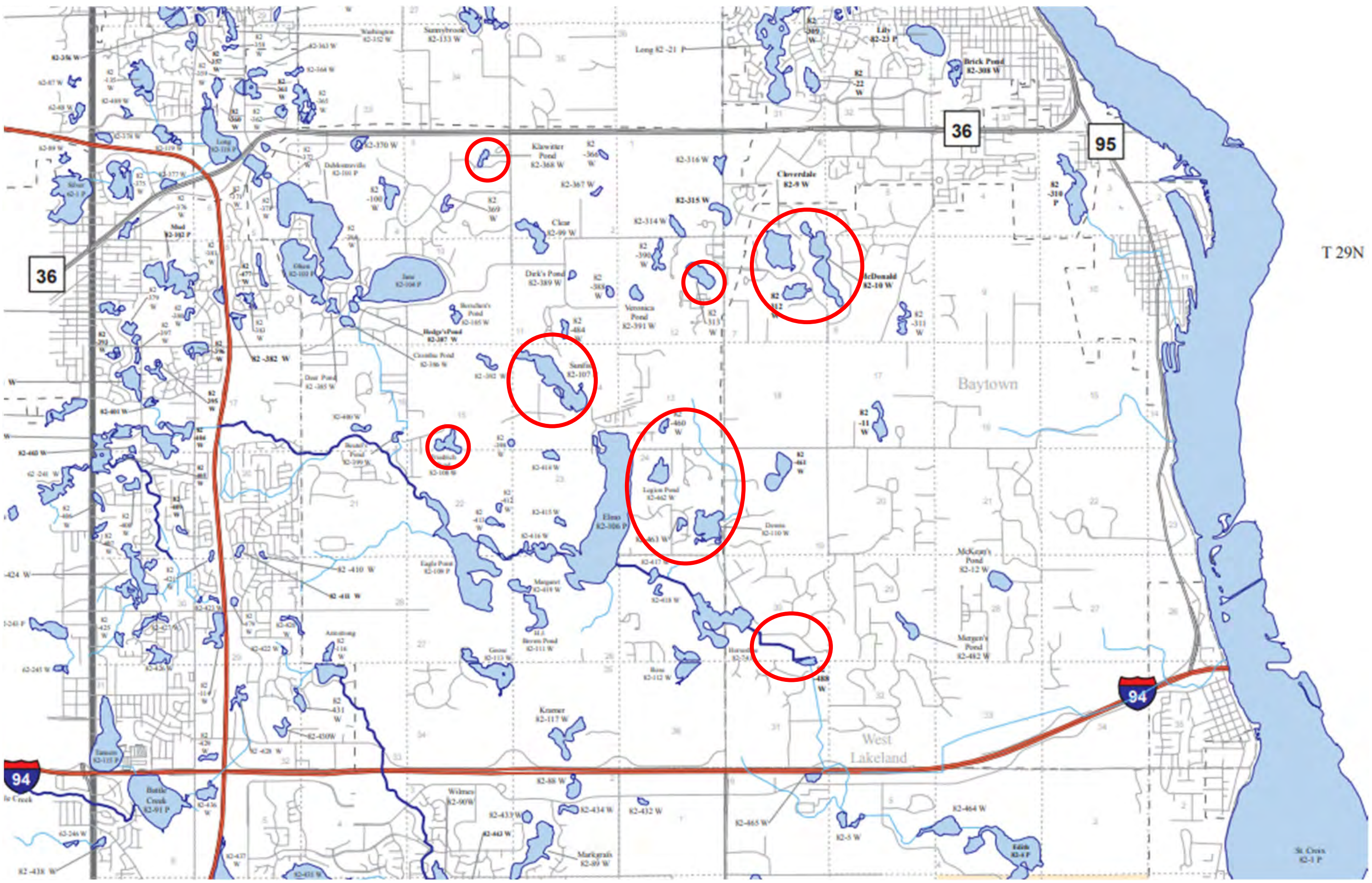
1 – Per LCCMR Report (June 2023)
2 – Discharge Downs Lake Option 2
3 – Discharge Downs Lake Option 1



VBWD Managers/Staff Tour Project 1007 PFAS Treatment System (April 2023)

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Permitting Considerations

MnDNR Public Waters and Water Courses – Washington County



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Permitting Considerations – Alternative 1

State of Minnesota EAW: If changing the course, current, or cross section of a public water of an acre or more (Downs Lake or discharge location)

MnDNR Public Water Work Permit: Outlets on landlocked basins, work below OHWL

MnDNR Appropriations Permit: Any pumped outlet (temporary and permanent) if >10,000 gallons per day or 1 million gallons per year), including VBWD notification

FEMA/MnDNR/VBWD Floodplain Permits: No rise, CLOMR/LOMR if modified

MPCA Construction Stormwater Permit: >1 acre disturbance, no anticipated increase in imperviousness

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Permitting Considerations – Alternative 1

VBWD Stormwater, Erosion Control, Wetland/Buffer, Floodplain Permits: >1 acre disturbance, reconstruct >6,000 square feet of impervious

WCA permit: Impacts above the OHWL if wetland or wetlands along pipe corridor

Local (Lake Elmo, West Lakeland Township, Washington County) Permits: ROW, utility, grading, erosion control, stormwater, home demolition (if acquisition required), others

USACE Section 404 permit: If Jurisdictional, but unknown until Jurisdictional Determination complete - likely triggered at discharge connection point to Project 1007
(Section 106 cultural resource review, Section 7 Federal T&E review, Section 401 WQ certification from the MPCA)

MnDOT Drainage Permit/Project 1007 Agreement: Expanded discharges to I-94

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Permitting Considerations – Alternative 1

Private easements/temporary construction access agreements and/or acquisition of land

May require alum treatment of basins

In Project 1007 PFAS groundwater contamination area

Landlocked Basin Study Scope: Alternatives Analysis ("With Project")

- Thoughts/Impressions for Alternatives 1 and 2?

- Thoughts about what Alternative 3 might entail?

Next Steps

Landlocked Basin Study Scope: Alternatives Analysis ("With Project")

- Finalizing evaluation of Alternatives
  - *Development of Alternative 3????*
  - Continuous simulation models running (1998-2021)
  - Water quality modeling and loading estimates
    - Impact of alum treatment on relative water quality
    - Inform nutrient loading estimates and compliance with VBWD MS4 permit
  - Sensitivity analysis through baseline and water management alternatives
    - "Wetter" conditions (2014-2020)
- USACE Climate Assessment being finalized
- Draft report under development

Landlocked Basin Study Stakeholder and Public Involvement

- Project Stakeholder Team – Regular meetings moving forward
  - ***July 2023: Review Alternative 3, discuss recommendations***
  - August 2023: Presentation of draft report
  - September 2023: Presentation of final report
- Anticipated Public Meetings
  - Public Engagement #2: Presentation of plan
    - Late Summer/Early Fall 2023

Landlocked Basin Study Schedule

Task	Anticipated Completion
Stakeholder Engagement	September 2023
Data Collection	Complete
Baseline modeling	Complete
Flood Risk Analysis and Establishment of Target Water Levels	Complete
With Project Alternatives Assessment	June 2023
Draft Comprehensive Planning Study Report	July 2023
Final Comprehensive Planning Study Report	September 2023

Legion Pond emergency pumping floating intake (2020)

Questions?

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John Hanson, Barr/VBWD, jhanson@barr.com

Jeremiah Jazdzewski, USACE,
jeremiah.jazdzewski@usace.army.mil

Landlocked Basin Flood Mitigation Comprehensive Planning Study: Draft Report Review

October 24, 2023

Jennifer Koehler, Barr/VBWD
John Hanson, Barr/VBWD
Jeremiah Jazdzewski, USACE

Valley Branch Watershed District

US Army Corps of Engineers®

Agenda

- Recap of last meeting and follow-up item summary
- Review Alternatives
  - Alternative 1: Pumping/Outlets
  - Alternative 2: Acquisition
  - Alternative 3: Pumping/Outlets from Individual Basins
- Conclusions and Next Steps

Sandbagging at home on Klawitter Pond in 2020

Recap and Follow-up from Last Meeting

Study Basins

VALLEY BRANCH WATERSHED DISTRICT

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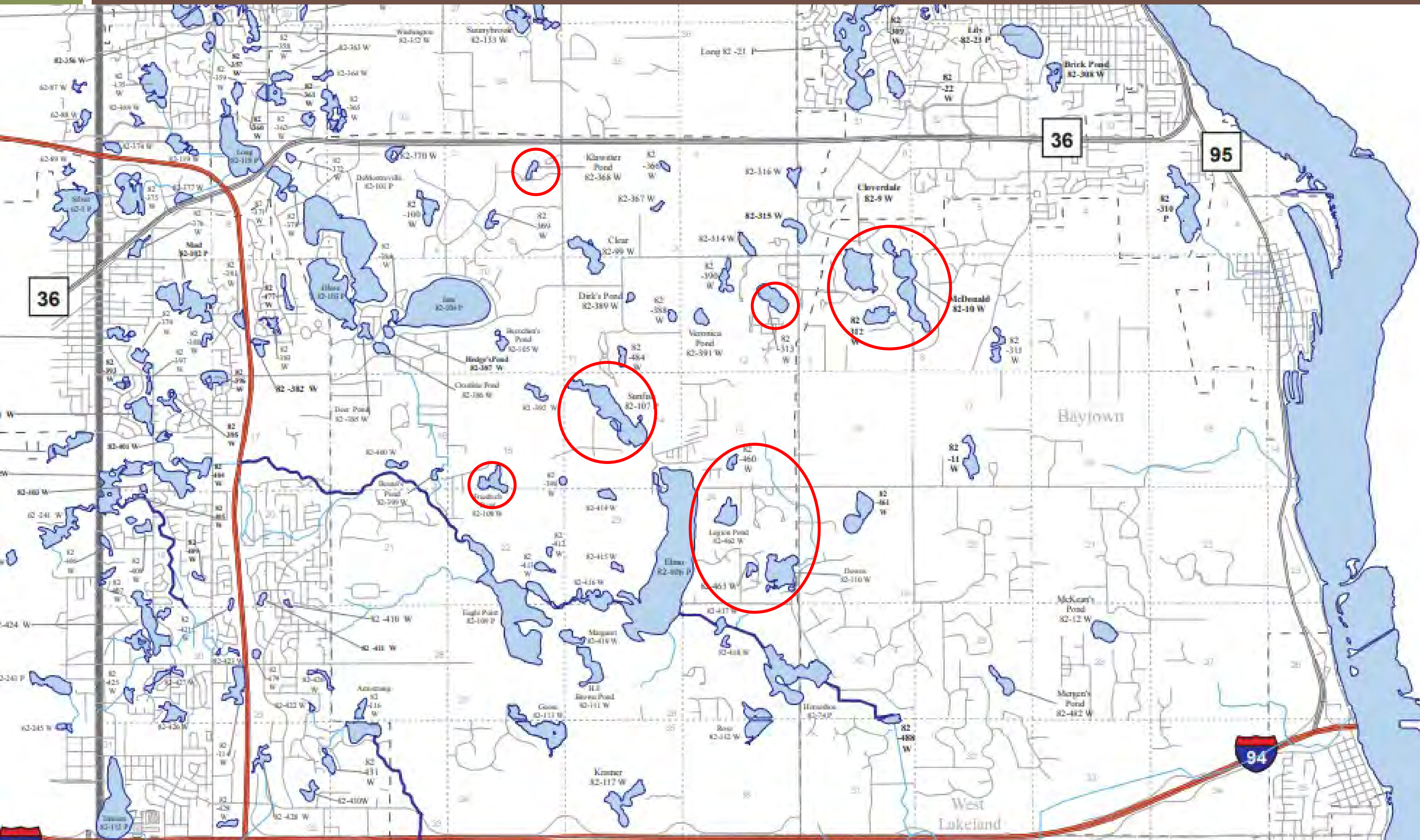

Recap from Last Meeting/Follow-up

June 2023 Stakeholder Meeting and Follow-up

- Reviewed Alternatives 1 and 2
  - Alternative 1: Pumping/Outlets
  - Alternative 2: Acquisition
- Met with Lake Elmo staff regarding alternatives
  - Questions about cost effectiveness if only parts of Alternative 1 were implemented
  - Used to inform Alternative 3
- Developed draft report
  - Through USACE review process
  - Provided to stakeholders for review

Alternatives Review

Landlocked Basin Study Scope: Alternatives Analysis (“With Project”)

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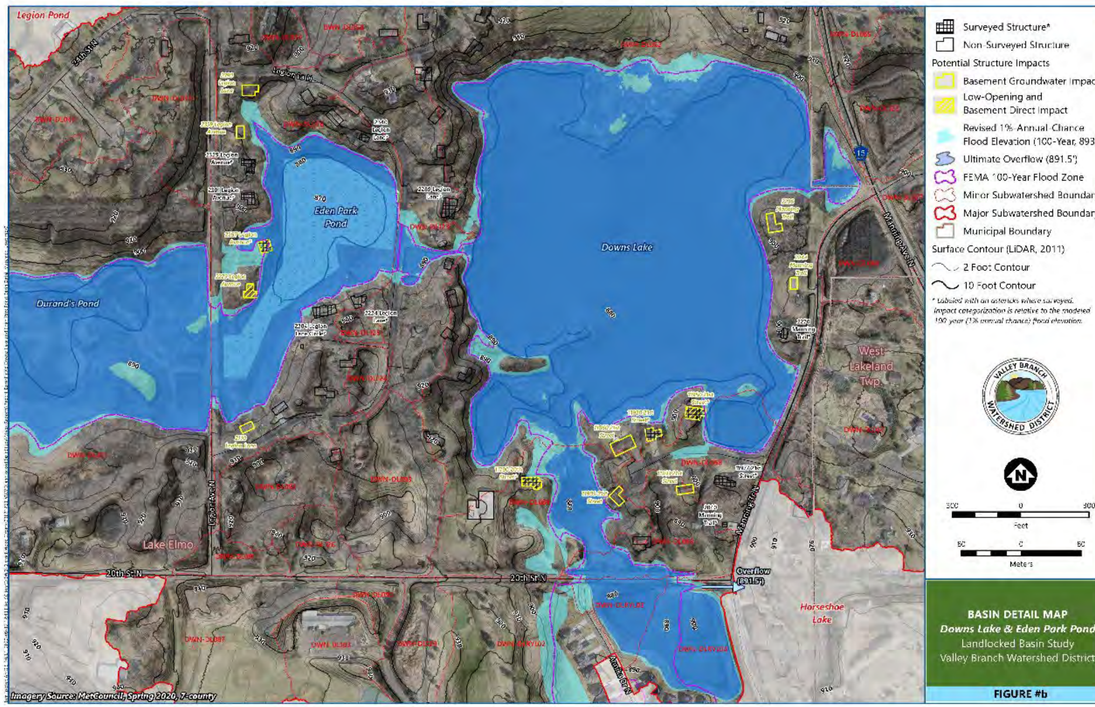
- Conceptual design of three alternatives for protecting dwellings
  - Outlets/pumping from basins
  - Acquisition of all at-risk properties
- Evaluation of downstream impacts and potential mitigation measures
  - H&H/Flooding Assessment
  - Water Quality and Ecological Conditions (AIS)
- Planning level cost estimates
- Permitting requirements



Landlocked Basin Study Scope: Alternatives Analysis ("With Project")

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Alternative 1: Pumping/Outlets

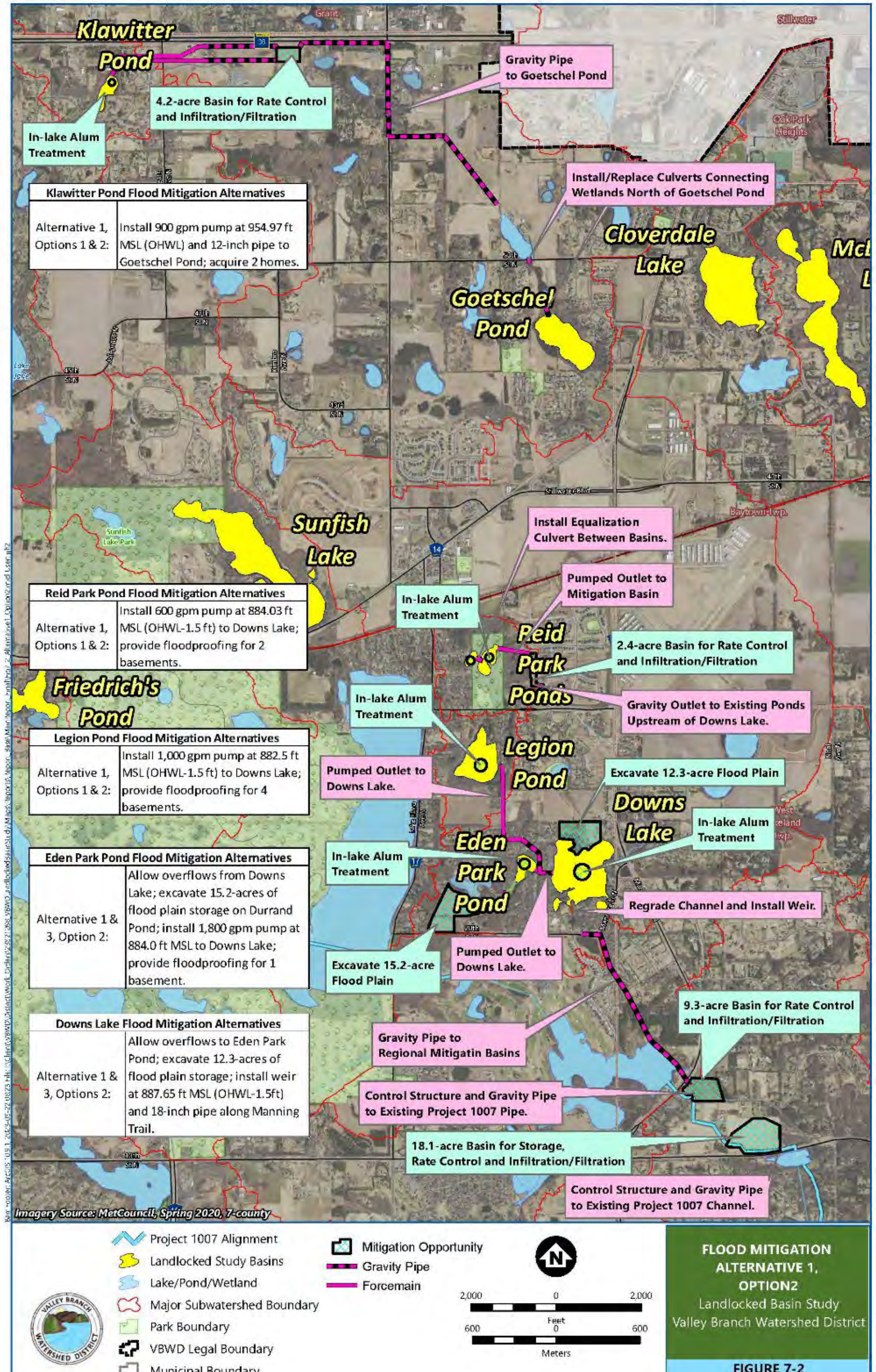
- Pumping/Outlet on:
  - Klawitter Pond
  - Reid Park Ponds
  - Legion Pond
  - Downs Lake/Eden Park Pond
- Mitigation for water quantity and quality impacts

Alternative 2: Voluntary Acquisition

- Acquisition of all at-risk dwellings

Alternative 3: Pumping/Outlets Individual Basin Evaluations

- Option 1: Reid Park Ponds and mitigation
- Option 2: Legion Pond and mitigation
- Option 3: Reid Park and Legion Ponds and mitigation
- Option 4: Downs Lake/Eden Park Pond and mitigation



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Alternative 1, Option 2: Pumping/Outlets

- Outlets on:
  - Klawitter Pond (pumped)
  - Reid Park Ponds (pumped)
  - Legion Pond (pumped)
  - Eden Park Pond (pumped)
  - Downs Lake (gravity)
- Significant mitigation (61.5 acres)

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1, Option 2: Pumping/Outlets

- Continuous Simulation: 1998–2021
  - Observed precipitation data/groundwater flux
  - Sensitivity precipitation data/groundwater flux
- Water quality (nutrients (total phosphorus))

Climate Sensitivity Assessment— Historic Data

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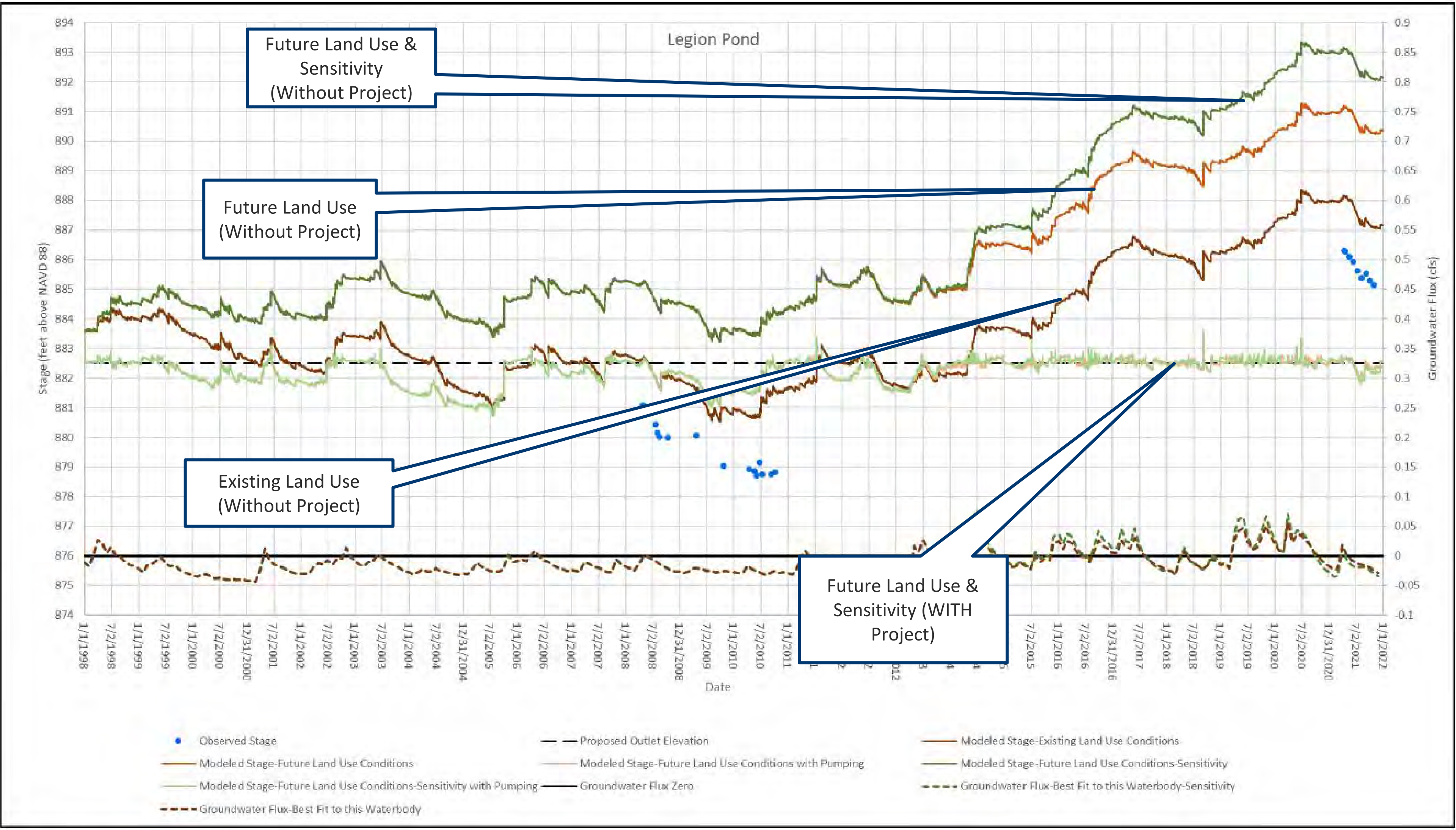
Results:

VBWD could experience a similar or wetter 7-year period as 2014–2020.

*A wetter 7-year period could have **5–9% more total precipitation** than 2014–2020 period.*

- Statistical analysis of historic climate data **- assuming historic climate variability (does not reflect future climate change/projections)**
  - Understand how likely we will experience another 7-year wet period similar to 2014–2020 (258 inches (36.8 inches/year))
    - Recent 30 years (1991–2020, no trend)
  - Understand how much wetter another 7-year wet period could be when compared to 2014–2020

Continuous Simulations



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

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Table 7-2 "With Project" Continuous Model Proposed Outlet Flow Frequency and Volume

Waterbody[1] (Listed Generally Upstream to Downstream)	"With Project" Future Land-Use Conditions			"With Project" Future Land-Use Conditions and Sensitivity Analysis		
	Flow Frequency[2] (%)	Total Flow Volume (ac-ft)	Annual Average Flow Volume (ac-ft/year)	Flow Frequency[2] (%)	Total Flow Volume (ac-ft)	Annual Average Flow Volume (ac-ft/year)
Klawitter Pond	0.10%	36.27	1.51	0.19%	69.42	2.89
Reid Park Ponds	0.56%	135.20	5.63	0.76%	184.02	7.67
Legion Pond	1.15%	459.52	19.15	1.38%	551.14	22.96
Downs Lake Alternative 1, Option 1	26.01%	4,285.48	178.56	25.97%	4,316.05	179.84
Downs Lake Alternative 1, Option 2	29.48%	4,265.84	177.74	29.40%	4,297.32	179.05
Eden Park Pond Alternative 1, Option 1	0.86%	300.50	12.52	0.77%	266.28	11.10
Eden Park Pond Alternative 1, Option 2	0.45%	316.36	13.18	0.39%	272.73	11.36

(1) Cloverdale Lake, Friedrichs Pond, McDonald Lake, and Sunfish Lake are not included in this table because we are not recommending outlets from these water bodies and did not run continuous simulations for "with project" scenarios.

(2) Flow frequency was calculated by summing the pumped or gravity flow periods and dividing this sum by the total modeled time (24 years).

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1, Option 2: Pumping/Outlets

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- Planning Level Water Quality Evaluation
  - Watershed pollutant load modeling
    - P8 (Downs Lake/Eden Park Pond)
    - Total phosphorus Event Mean Concentration based on land use in other watersheds
  - Annual lake response modeling using the Canfield Bachmann mass balance methodology for years with water quality monitoring data available
    - Watershed load
    - Groundwater load
    - Atmospheric load
    - Internal loading (informed by sediment core analysis)

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

- Impact of alum treatment on lake water quality, especially at Downs Lake
  - Impaired for nutrients
  - Last waterbody before all pumped discharges
- Overall impact on total phosphorus loads to the St. Croix River
  - VBWD Waste Load Allocation = 0.193 lbs/ac/yr
  - Assume no treatment of discharge to be conservative
  - Utilized effort for the 2021 VBWD MS4 permit

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 1: Pumping/Outlets

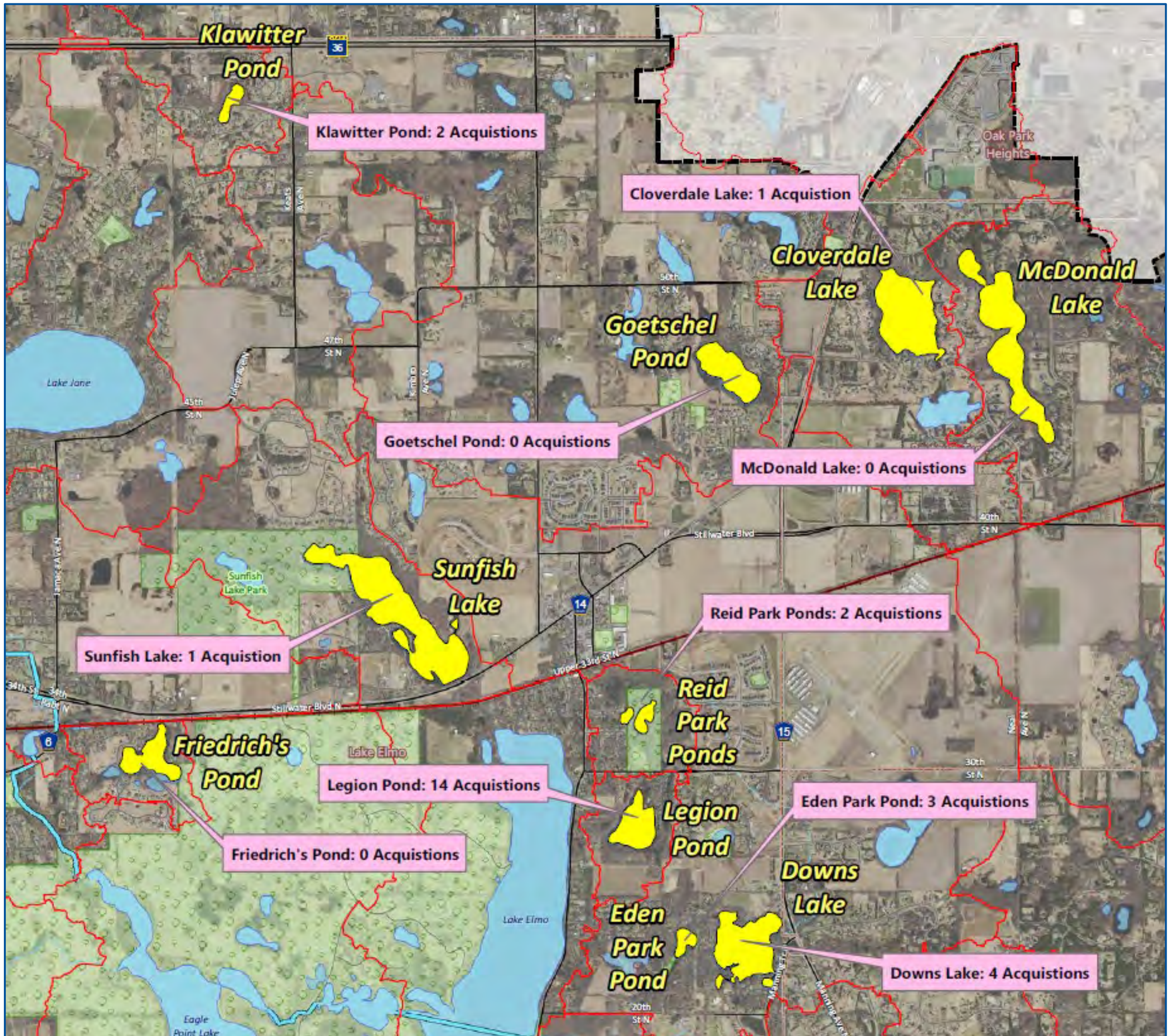
- Downs Lake will need both internal and watershed load reductions to meet state water quality standards

TMDL Scenario	Total Average Annual TP Load (lbs/yr)	Watershed Area (ac)[1]	Aerial TP Load (lbs/ac/yr)
Existing Conditions	2,859	43,755	0.065
Proposed Conditions with Downs Lake	2,927	43,755	0.067
Difference	68	0	0.002

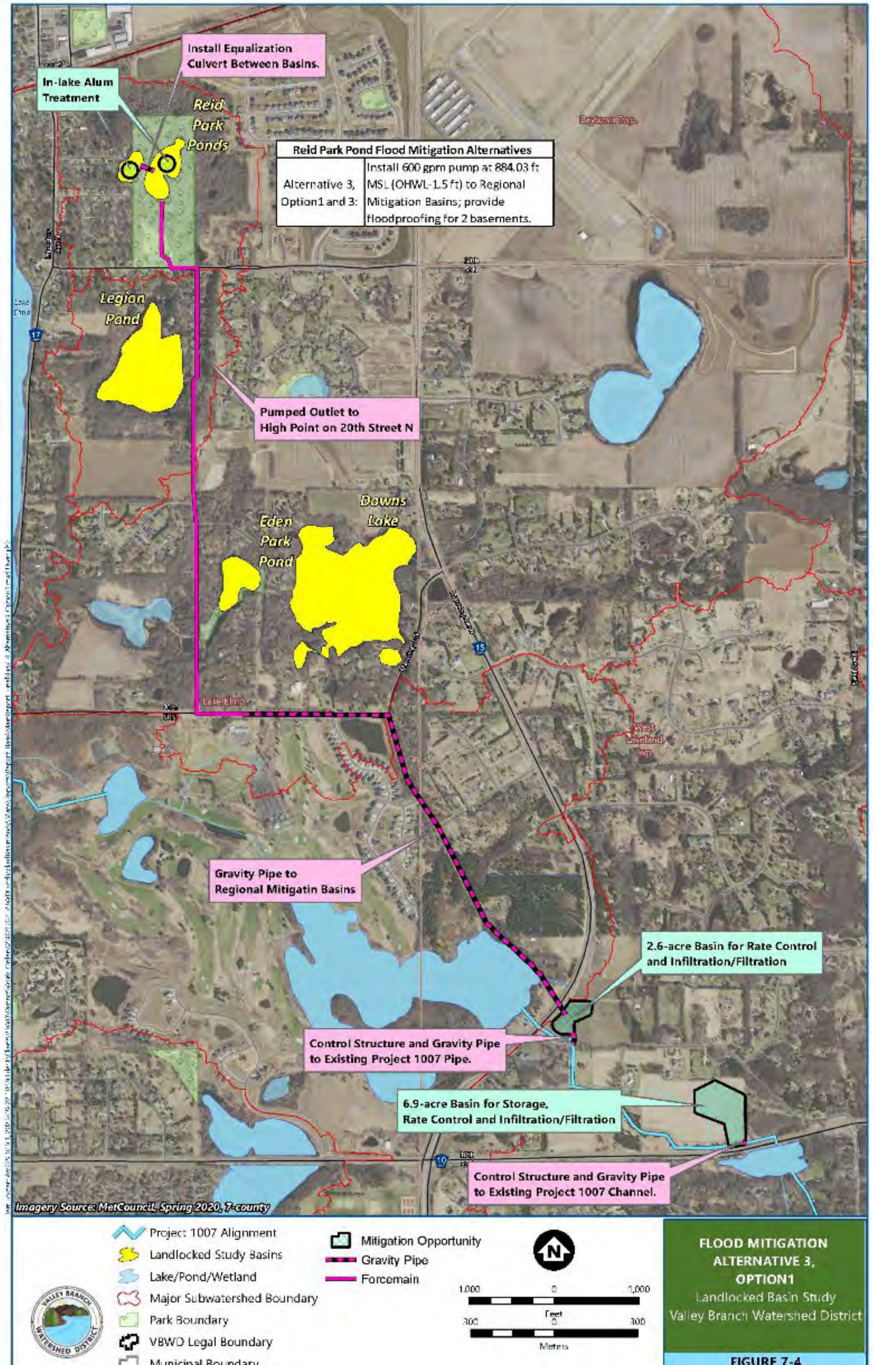
[1]Calculation uses watershed area from the TMDL (for the entire VBWD)

If the VBWD implemented a pumped solution, it should continue to meet the WLA for the Lake St. Croix TMDL and its conditions of its MS4 permit

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 2: Acquisition

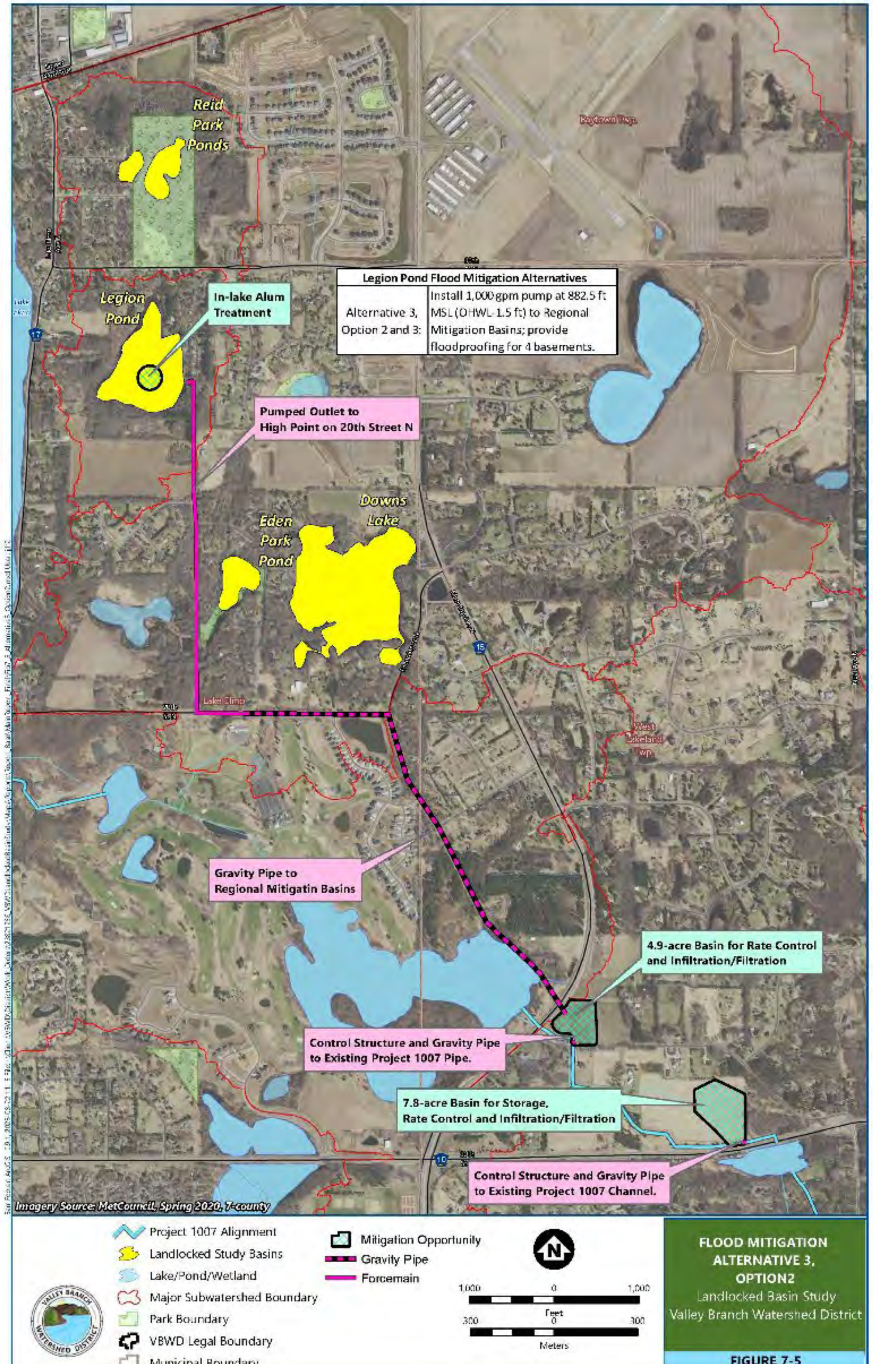


Total number of Acquired Dwellings: ~27



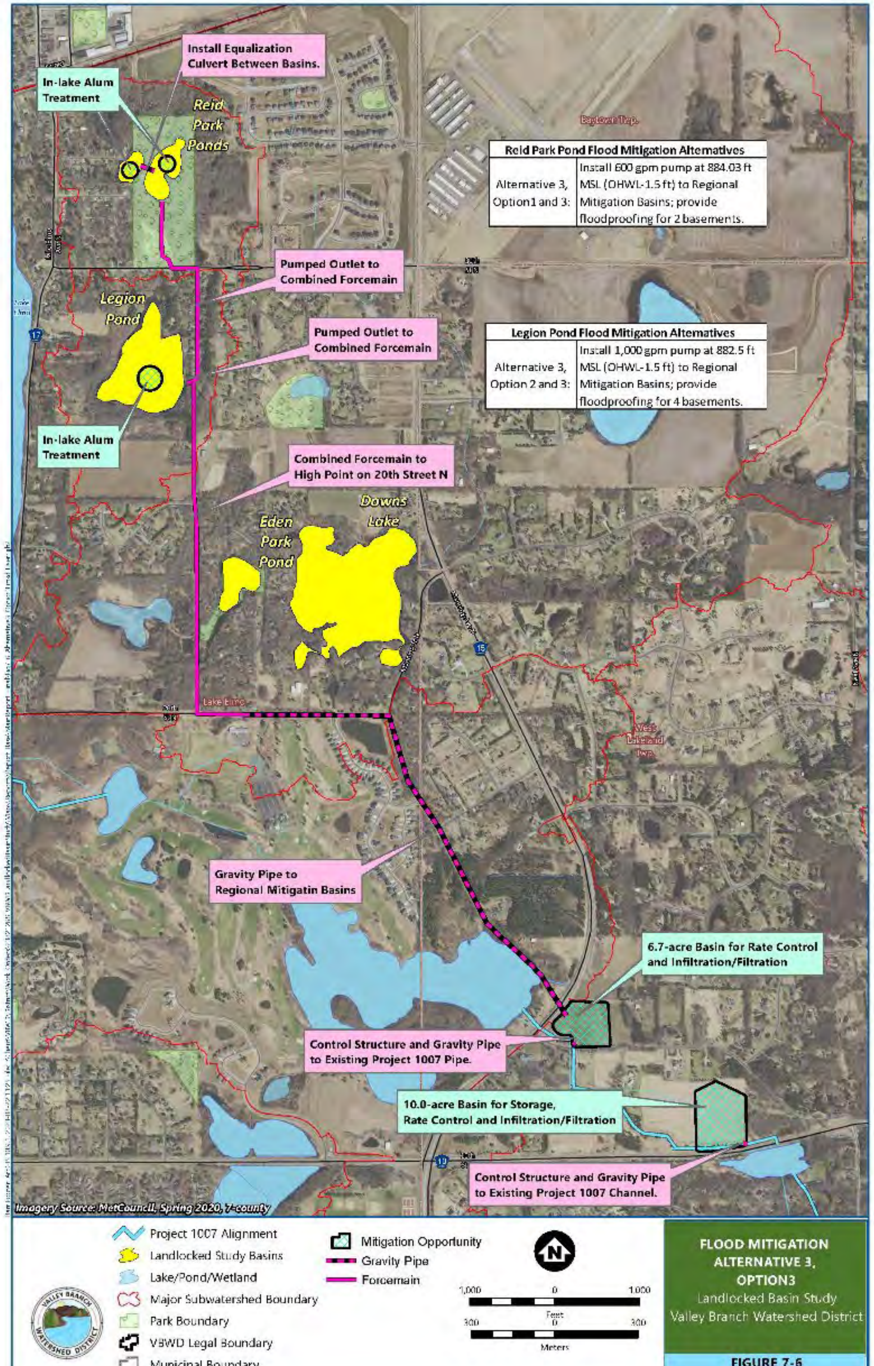
Alternative 3, Option 1

- Reid Park Ponds only and mitigation
  - 600 gpm pumps
  - Floodproofing 2 basements
  - 9.5 ac of regional mitigation



Alternative 3, Option 2

- Legion Pond and mitigation
  - 1,000 gpm pumps
  - Floodproofing 4 basements
  - 12.7 ac of regional mitigation



Alternative 3, Option 3

- Reid Park and Legion Ponds & Mitigation
  - 600 gpm pump (Reid)
  - 1,000 gpm pump (Legion)
  - Floodproofing 6 basements
  - 16.7 ac of regional mitigation

Landlocked Basin Study Scope: Alternatives Analysis (“With Project”) Alternative 3, Option 4

- Downs Lake/Eden Park Pond and mitigation
  - 1,800 gpm pump (Eden Park Pond)
  - Gravity outlet (Downs)
- Significant mitigation (54.9 acre of regional mitigation)
  - Not very different than Alternative 1

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Summary of Costs

- Planning level construction costs (0-10% design)
- 25% construction contingency
- 25% planning, engineering, design, and permitting
- Includes land acquisition/easements based on alignment/if on private land (vs. public land/ROW)
  - Residential acquisition (Washington County Tax Assessed Value times 1.35 to include demolition/relocation costs if home on property)
  - Land acquisition (Washington County Tax Assessed Value times 1.1 to account for misc. costs)
  - Easement ($30,000 per acre based on recent drainage easement acquisitions in VBWD)
- Assumes no special disposal requirements for excavated soils
- Includes mitigation components (alum treatment, mitigation storage)
- Does not include costs associated with PFAS

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") Alternative 2: Acquisition

Home acquired and demolished in Sunnybrook Lake neighborhood in recent years

Acquisition: Peak water level 0 feet or higher than lowest elevation of dwelling

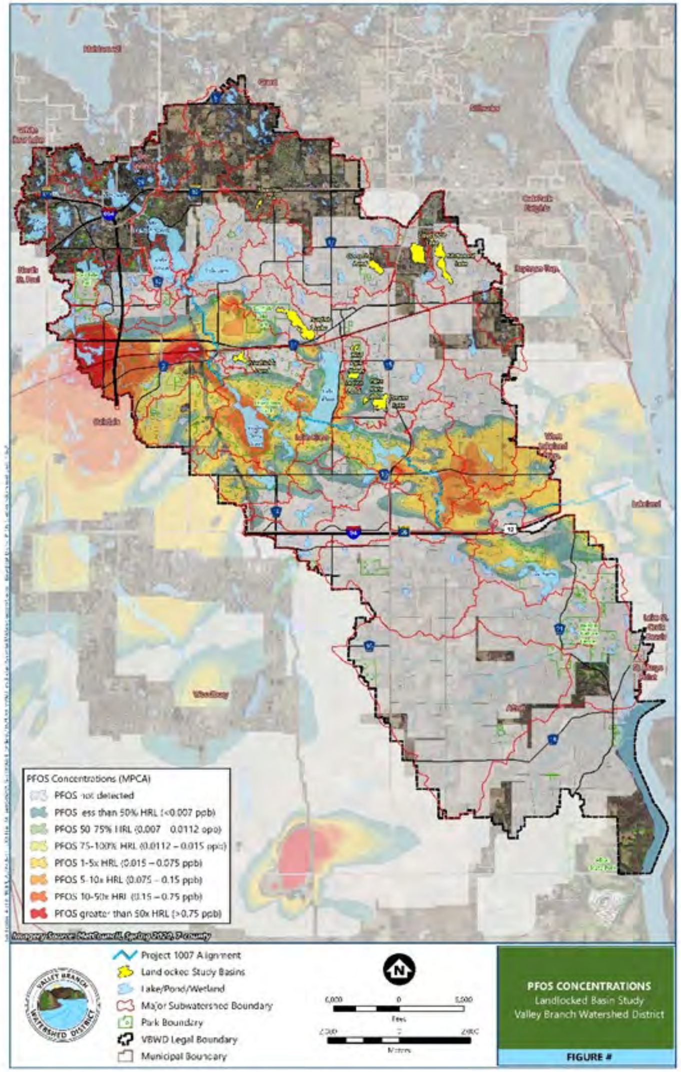
- Recent VBWD experiences at Sunnybrook Lake and Friedrich's Pond
  - $20,000 to $50,000 for demolition (includes sealing well and abandoning septic system)
  - Approximately $10,000 for other costs (closing and reselling)
  - Plus, additional for engineering/coordination
- Review of other recent flood studies (by Barr) including acquisition planning costs
  - Ranges from 120-150% for planning purposes (covers survey, engineering, legal, demo, relocation)
- Acquisition = Washington County taxable market value multiplied by 1.35 (135%)
- Does NOT consider value of lost tax revenue for acquired properties

Landlocked Basin Study Scope: Cost Summary

Basin	Existing Conditions – Potential Damages	Alterative 1, Option 2 Pumping/Outlets	Alterative 2 Acquisitions	Alterative 3, Options 1-4 Pumping/Outlets on Individual Basins
Cloverdale Lake	$185,000–$1.4 million	N/A	$1,240,000	N/A
Downs Lake	$255,000–$5.2 million	$14,010,000	$4,200,000	Option 4, Downs/Eden Park only: $15.0–$32.1 million
Eden Park Pond	$90,000–$1.6 million	Included with Downs	Included with Downs	Included with Downs
Friedrich's Pond	$0	N/A	N/A	N/A
Goetschel Pond	$0	N/A	N/A	N/A
Klawitter Pond	$60,000–$1.3 million	$7,050,000	$1,285,000	N/A
Legion Pond	$180,000–$5.3 million	$1,520,000	$5,465,000	Option 2, Legion only: $5.3–$11.4 million Option 3, Reid Park/Legion only: $7.0–$14.9 million
McDonald Lake	$0–$900,000	N/A	N/A	N/A
Reid Park Ponds	$0–$680,000	$2,270,000	$680,000	Option 1, Reid Park only: $4.5–$9.6 million Option 3, Reid Park/Legion only: $7.0–$14.9 million
Sunfish Lake	$51,000–$585,000	N/A	$585,000	N/A
Regional Mitigation	N/A	$7,410,000	N/A	N/A
Project Total	***$821,000–$17.0 million***	***$32.3 million ($22.6– $48.4 million)***	***$13.5 million ($9.5– $20.3 million)***	***Option 1 (Reid Only): $4.5–$9.6 million Option 2 (Legion Only): $5.3–$11.4 million Option 3 (Reid/Legion): $7.0–$14.9 million Option 4 (Eden Park Pond/Downs): $15.0–$32.1 million***

Landlocked Basin Study Scope: Alternatives Analysis ("With Project") PFAS Considerations

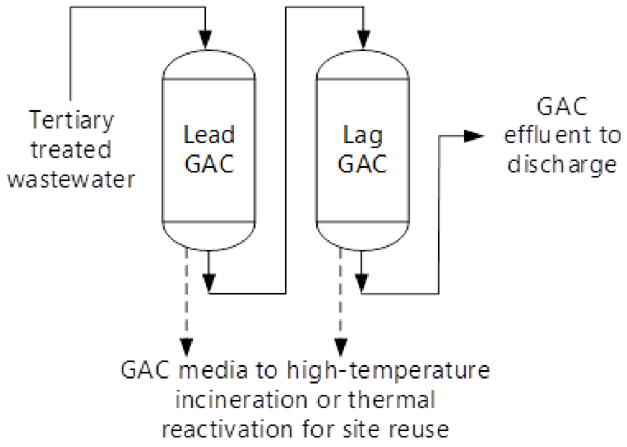
- Basins proposed to be pumped meet the current MDH Human Health Based Water Guidelines—If this standard used, may not require treatment; if other thresholds used, then may require treatment
- MPCA/LCCMR report (Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water) - Published 6/6/2023
  - Reviews separation and destruction technologies for various waste streams - all pump and treat/non-passive treatment technologies
    - Treatment technologies that were further investigated: nanofiltration/reverse osmosis membrane treatment, foam fractionation, ***granular activated carbon (GAC)***, anion exchange (AIX) resin, and modified clay
    - For municipal wastewater, conceptual designs and capital/annual O&M cost estimates were prepared relative to flowrate
    - Groundwater or surface water were not part of waste streams evaluated but technologies could still translate



Landlocked Basin Study Scope: Alternatives Analysis ("With Project") PFAS Treatment Costs

Flow Rate			Estimated Costs[1]	
GPM	MGD	CFS	Capital	Annual O&M
2740[2]	***3.9***	***6***	***$ 28,900,000***	***$ 2,900,000***
5470[3]	***7.9***	***12***	***$ 48,800,000***	***$ 5,200,000***
13900	20.0	30	$ 98,900,000	$ 12,300,000
25900	37.3	58	$ 158,500,000	$ 22,400,000

1 – Per LCCMR Report (June 2023)
2 – Discharge Downs Lake Option 2
3 – Discharge Downs Lake Option 1



VBWD Managers/Staff Tour Project 1007 PFAS Treatment System (April 2023)

Conclusions

Landlocked Basin Study Scope: Conclusions

- Higher precipitation → increased runoff and higher groundwater levels
- Similar or wetter continuous period is possible in the VBWD
- Highly variable water levels and flood risk/peak elevations depend on starting elevation
  - Low flood risk to dwellings on some basins
    - Sunfish Lake, Friedrich's Pond, Goetschel Pond (no impacts)
    - Cloverdale Lake, Reid Park Ponds, McDonald Lake (peak flood elevations are within 2 feet of the low floor elevation)
  - Higher flood risk to dwellings on other basins
    - Klawitter Pond, Legion Pond, Eden Park Ponds, and Downs Lake (peak flood elevations are above low opens)

Landlocked Basin Study Scope: Conclusions

- Future land use change (increased imperviousness) may impact long-term water levels
  - More significant change (e.g., McDonald Lake, Sunfish Lake, Goetschel Pond, and Legion Pond).
  - More significant to sensitivity analysis (i.e., 9% more precipitation) (e.g., Legion Pond, Goetschel Pond, and Sunfish Lake).
- "With project" alternative will reduce flood risk/consistent water levels
  - Klawitter Pond, Reid Park Ponds, Legion Pond, and Eden Park Pond—pumps used infrequently (less than 2%).
  - Downs gravity outlet—larger/more regular outflow (approximately 25% to 30%)
- In-lake alum treatments can help improve water quality before pumping/outlets; but Downs Lake would require alum and watershed management to improve water quality to state standards
- VBWD will still meet MS4 permit and Lake St. Croix/St. Croix River TMDL WLA with system in place

Landlocked Basin Study Scope: Conclusions

- Cost of a comprehensive high-water-level management system (e.g., Alternative 1, Option 2) is significant ($22.6 million–$48.4 million)
  - Due to the distributed nature of the flooding requiring individual lift stations or gravity outlets and significant conveyance systems and significant mitigation volume to limit downstream impacts
  - Exceed the estimated damages/costs due to high water/flooding conditions ($1.0 million to $17.0 million)
  - Uncertainty about how PFAS impacts if system could be implemented or if treatment were required
- Alternative 2: Voluntary acquisition of at-risk properties is a more cost-effective approach ($9.5 million – $20.3 million)
  - Often preferred by agencies to eliminate flood risk

Landlocked Basin Study Scope: Next Steps

- Review VBWD acquisition policy
- Prioritize acquisitions and investigate flood risk reduction at individual dwellings
  - Engage with MnDNR Flood Damage Reduction Grant program
- Review policies regarding development/land use change in landlocked basin watersheds
  - Volume retention limited due to PFAS/karst
  - Further technical analysis and modeling to support policy discussion
- Develop a policy and communications plan for future flooding events
  - Determine if VBWD will facilitate any emergency pumping in the future

Landlocked Basin Study Stakeholder and Public Involvement

- Project Stakeholder Team
  - October 2023: Presentation of draft report
  - ***Please provide any comments on draft report by 10/30/2023***
- Anticipated Public Meetings
  - Presentation to VBWD: November 9
  - Public Engagement #2: Presentation of plan
    - November 2023 –Working on scheduling this week at Baytown Township
- Report
  - Finalize report following Public Meeting #2

Legion Pond emergency pumping floating intake (2020)

Questions?

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