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Crystal Springs Watershed Initiative

Stutsman County Board of County Commissioners and Water Resource Board Joint Special Meeting
July 28, 2024

Crystal Springs Watershed Initiative

"What are we here to solve?" Harold Hamm

Removal of accumulated and excess floodwaters

Is it time to move water versus dirt?

- ✓ ***NDDOT Inundation (Crystals Springs and East)***
- ✓ ***BNSF Inundation (Main Line)***
- ✓ ***Township and County Roadways – overtopping***
- ✓ ***Crystal Springs Bible Camp – Facility at risk***
- ✓ ***Recreational Lake Cabins – Reule Lake Lots***
- ✓ ***Ag lands – expanded inundation areas***

Joint Meeting AGENDA - Study Update

- Crystal Springs Watershed Initiative Feasibility Study
- Presentation and Review of the Crystal Springs Lake
  - Preliminary Feasibility Study Findings
    - Update on local funding contributions
    - Department of Water Resources meeting 7-23-2025
    - Steering Committee meeting
    - Draft Report content and remaining items
- Discussion of next steps
  - Preferred Alternative Recommendation (Size and Capacity Options)
  - Preliminary Engineering Report (PER) funding
    - Projected costs and grant application opportunities
  - Final Report and Public Informational Meeting

Steering Committee – Meeting #3 (July 25, 2025)

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Crystal Lake Watershed Initiative
Steering Committee - Meeting #3

To: Steering Committee
From: Michael H. Gunsch, PE, CFM, Senior Project Manager
Josh Loosmore, Peritiacon
Subject: Project Status Update and Presentation Information
Date: ***July 25, 2025 Meeting Summary***
Project: HEI No. 12808-0001-007

The following is a summary of the July 25, 2025 Steering Committee Meeting. These minutes are a tabulation versus a transcript of the discussions.

Those in attendance included Anthoney Roorda (Stutsman County WRD), Levi Taylor (Stutsman County Commission) Les Ressler (Reule Lake), Don Mittleider (Kidder County), Tim Brenner (Crystal Springs Bible Camp), Charlie Dronen, Kidder County Commission, Dan Peltier (BNSF – on Teams). Michael May (Interstate Engineering on Teams), Michael Gunsch (HEI), Josh Loosemore (Peritiacon).

Scope and Budget Amendment – SWC Cost Share and Local Funding

Adequate local funding was secured ($22,000) to match the authorized SWC cost share funding to complete the additional groundwater evaluation. The County Commission authorized the feasibility study to proceed with the additional scope of services if local funding was secured. Total amendment was in the amount of $40,000.

Feasibility Study Schedule – Summary

1. Web Grant Approved – DWR Agreement Addendum #1
2. Local Funding secured – for scope revision (checks pending)
3. Evaluation of the watershed and outlet alternatives has been completed
4. Hydrologic and expanded Groundwater Evaluation is underway
5. Joint County Commission and WRD meeting – July 30, 2025
6. Feasibility Study Report (Pending groundwater evaluation and HMGP inquiry)

Project Updates:

The following documents were presented and discussed at the meeting are attached.

1. **Crystal Lake – Second Steering Committee Meeting Summary**
   a. This document was reviewed and accepted without comment or objection
2. **Project Status Report and Invoice Description**

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3. **Alternative Alignment Hydraulics (1)**
4. **Alignment – USFWS Regulatory (2)**
5. **CWSI Water Balance Equation (3)**
6. **Contributing Areas (4)**
7. **Lake Elevations and Controls (5)**
8. **Historic Lake Elevations (6)**
9. **Area Capacity Data – Removal Requirements (Water Balance) (7)**
10. **CWSI System Components and Opinion of Probable Costs (8)**
    a. Funding Options – HMGP, SWC
    b. Preliminary Engineering Report Cost
11. **Annual - O&M Expenses (9 and 9A) – initial years**
12. **Head loss and System Efficiency in pump system and benefits (10)**
13. **O&M Cost Projections for Alternatives – Supports the Preferred Alternative (11)**
14. **Downstream Impact Sheets (12)**
15. Economics
    a. **The total economic benefits were roughly determined for this feasibility study based on a 10-year planning horizon, and in general include the following, which are rough approximations and remain to be finalized.**
       i. BNSF – Grade Raise 3 more at $3.5 Million each = $10.5 million
       ii. Bible Camp Relocation = $11 Million
       iii. NDDOT – Single Grade Raise (3 feet) = $10 million (TBD)
       iv. 500-600 acres of Ag Land ($2,000/ac) = $1.2 million
           1. Land Value of inundated properties - no production recovery
       v. County Roadways ($1.5 million/mile) = $3 million
       vi. Interstate Commerce BNSF Lost Revenue = TBD

    Total Approximation $35.7 million + Lost Revenues
16. **Tributary Discharges – Impact Evaluation**
    a. See comments in Summary of Topics

Steering Committee – Meeting #3

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17. **Joint Stutsman County Commission and Water Resource District Meeting**
    a. July 30, 2025 – 9 am

18. **Public Informational Meeting – Feasibility Study**

SUMMARY OF TOPICS

The preliminary findings supported the conclusion that groundwater is clearly influencing and affecting lake elevations. That portion of the feasibility study remains on going and was delayed by local funding and the conclusion of the SWC Cost Share approval process. A meeting held with the NDDWR on July 23, 2025 to discuss their AEM Groundwater Study, they are not anticipating any further evaluation of the collected data, except for how it is applicable to future water permit allocations. They are supportive of the project and are interested in reviewing the final feasibility study report.

The preferred alternative is clearly the western route along the north side of Interstate #94, with a proposed 20 cfs capacity, based on the hydrologic evaluation – groundwater evaluation continues.

The discharge of waters into the downstream tributary has been evaluated based on both 10 cfs and 15 cfs long term releases. The existing crossings upstream from the Long Lake Refuge discharge all currently comply with the ND Stream Crossing Standards, including with the addition of the project discharges. The only crossing not in compliance is the BNSF Railroad crossing, which can be upgraded by installing an additional 42" culvert.

To accommodate and mitigate for project discharges all crossings would be upgraded with the installation of an additional 24" culvert or equivalent capacity. The needs at each crossing will be evaluated during the preliminary design phase. These improvements will be installed as a project cost at no expense to Kidder County, NDDOT or Townships. The need for easements along this corridor for any channel improvements is a regulatory determination that will be made during the permitting process.

This summary is being provided to the following via email and posted on the County Web Site:

- Crystal Springs Steering Committee
- Stutsman County Commission
- Stutsman County Water Resource District
- Crystal Springs Interested Parties Email Group – Includes doner list

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MEETING ACTION ITEMS...

Steering Committee – Third Meeting Summary

Request to the Stutsman County Commission and Water Resource District

- ✓ Funding options for the Preliminary Engineering Report
- ✓ Acceptance of the Feasibility Study Report on completion

NDDOT – provide comments on the draft report when provided.

BNSF – provide comments on the draft report when provided. Note interest in upgrading their stream crossing as part of the project expense or general compliance.

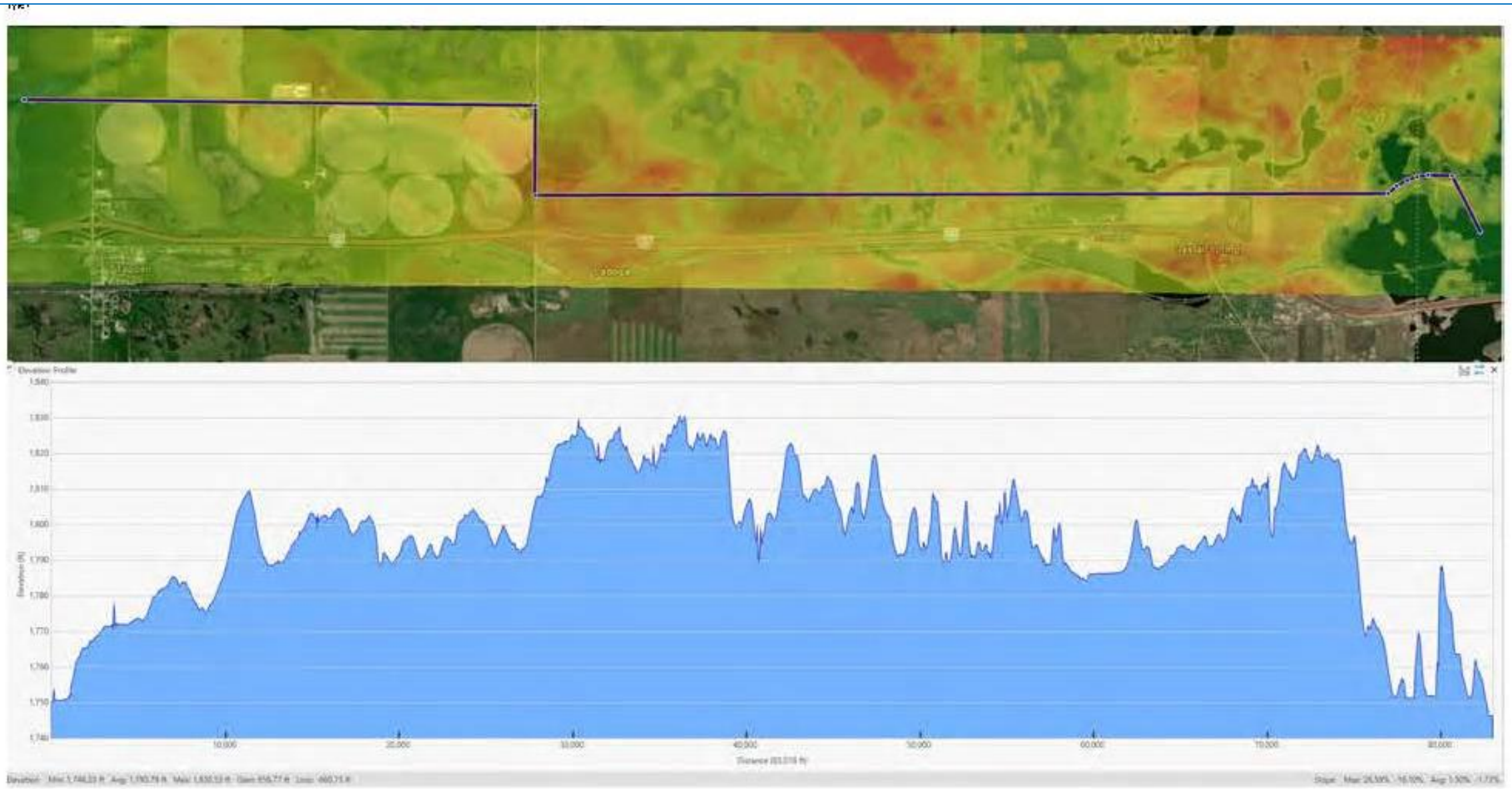
Stutsman County Highway Department – provide comments on the draft report when provided.

Others – Given the local funding provided there is a notable interest and support to proceed and implement a solution to this historic flooding situation.

These minutes were approved by consent by the Steering Committee at their _____ meeting. These minutes are included in the Third Meeting summary.

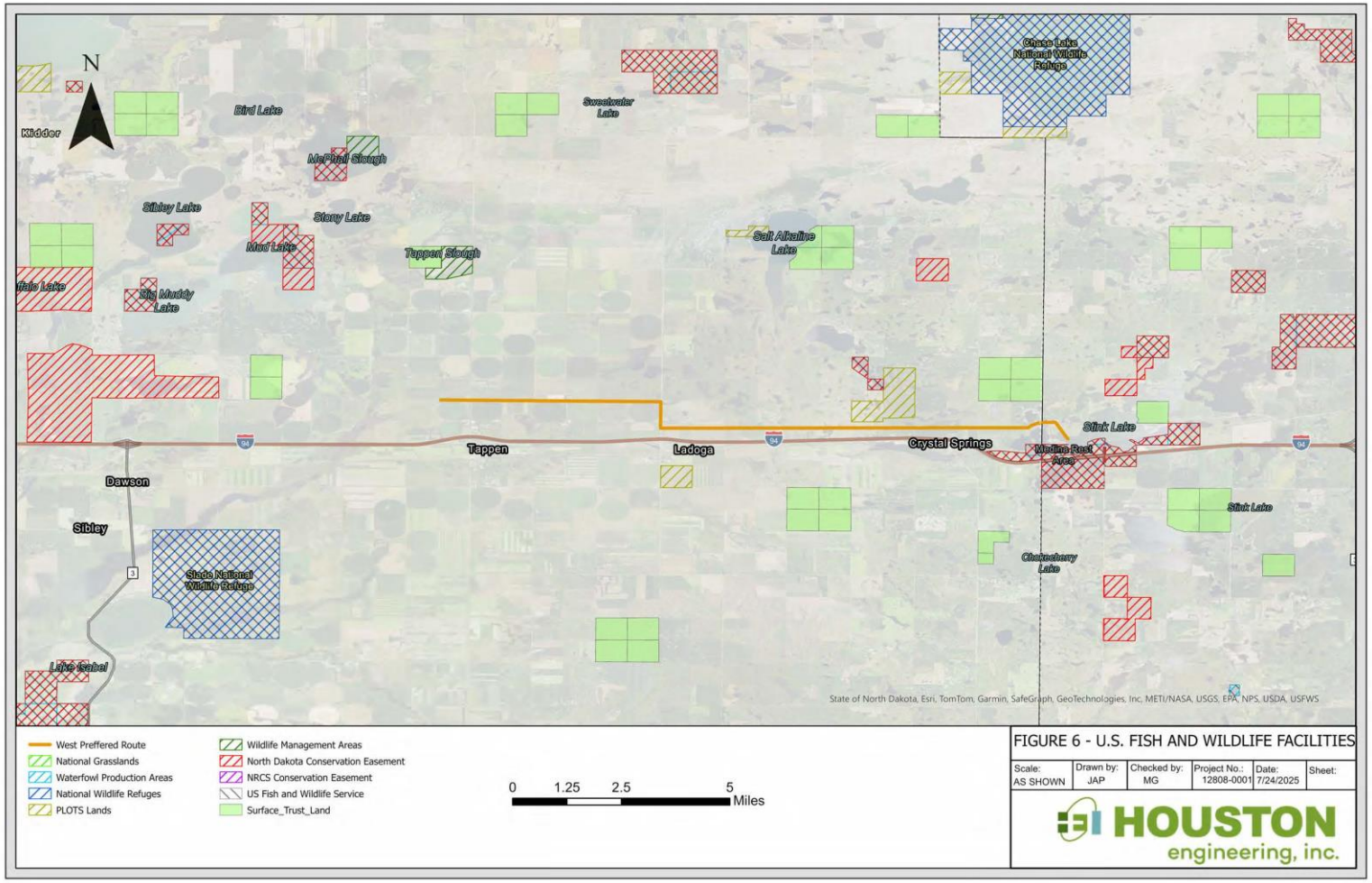
If there are questions, please contact Michael Gunsch at 701-527-2134 or mgunsch@houstoneng.com.

Preferred Alternative – Pipeline Profile (83,000 lineal feet)



Alignment – Regulatory

USFWS Interests and Easement Map



USFWS ownerships or easement impacts

Drainage Permit Interdistrict Significance

NDDWQ Water Quality Discharge Permit

USACE Permit (Pump Station) and potential Wetland Mitigation

Water Balance Equation – Removal Evaluation

Crystal Springs Watershed Initiative
System Water Balance Evaluation

The hydrological balance of water in the Crystal Springs lake system is a function of the following factors:

Surface Water (SW) inflows generated by runoff from the watershed including combined surface flows within the tributaries and lake/slough systems. Runoff is affected by soils conditions, land use and precipitation. The total runoff value was approximated using the *USGS Stream Gate at Harvey, North Dakota (09020202)* just north of the study area. Total ac-ft runoff is projected then using a prorated or weighted function of runoff per square mile. This value was approximated for each year utilizing the gage records.

Precipitation (P) from rainfall on the open water. **Direct Rainfall (DR)** contributes to the elevation of each lake system. Simply stated a 2" rainfall generally adds 2" to the water surface elevation. The total ac-ft contribution on the lake is the direct precipitation multiplied by the lake area at the time of rainfall. This value was approximated using the rainfall gage for *Tappen, North Dakota* (_____), and the available lake area-capacity information.

Evaporation (E) is generalized as a loss based on the open water area using *the North Dakota Hydrology Manual (NDHM), Chapter 8 Figure 8-3.* There is no available evaporation station data for this area, there the NDHM approximation was utilized. Subsequently, the annual losses were determined, while monthly percentage evaporation data could be applied for subsequent evaluations if necessary. Total evaporative losses in ac-ft are based on the lake area for a given lake elevation.

Groundwater (GW) is a significant factor and has a measurable impact on lake levels, and the inflows are being evaluated. This influence is difficult to directly determine but can be approximated using the other factors, like soils and the AEM data recently acquired by the ND Department of Water Resources (*circa February 2025*). The GW inflows in ac-ft are undetermined; however, it could be approximated using a water balance equation.

Annual Ac-Ft (AF) of change is determined utilizing the area-storage-capacity curves for each lake and combined lakes system and comparative values from year to year and lake level measurements.

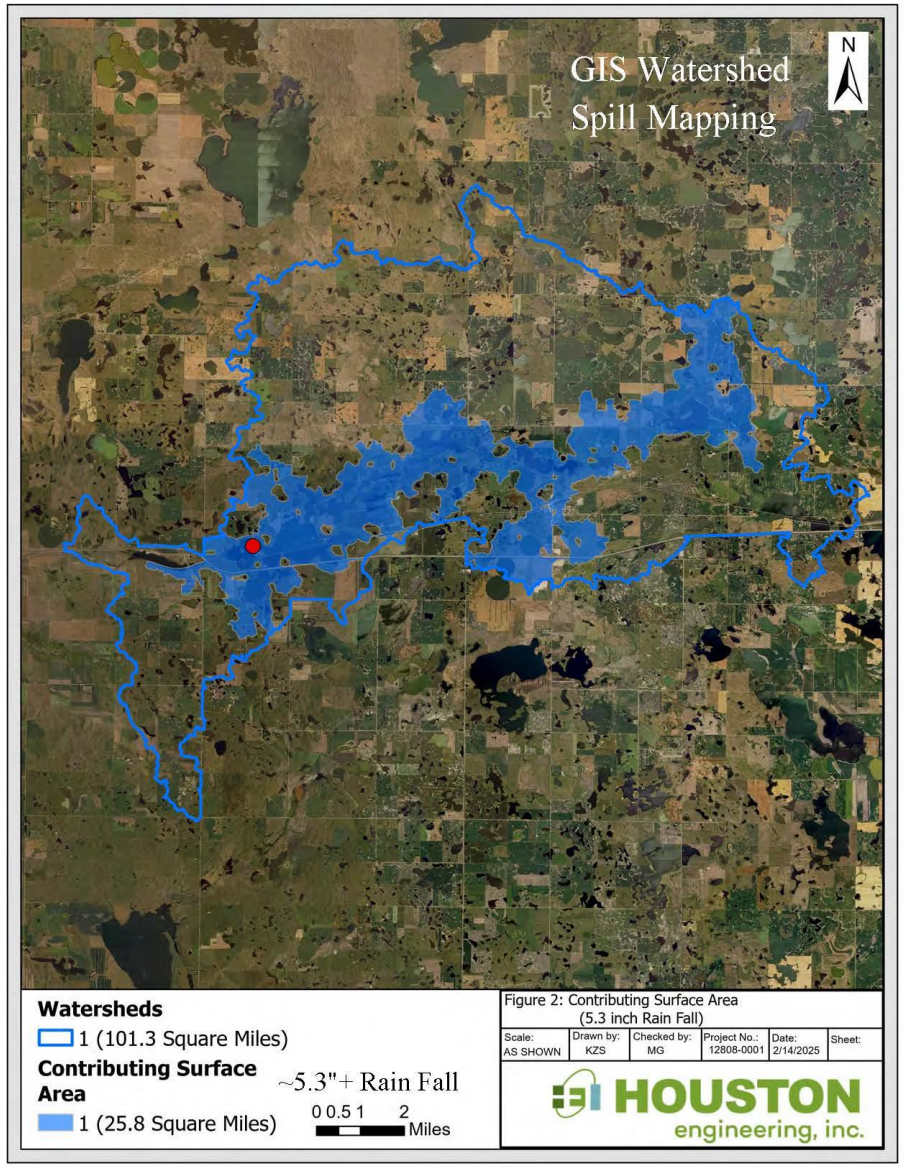
Annual Water Balance Equation in any given year is determined by the following equation.

SW + DR - E + GW = Annual Acre-Feet (change in storage)

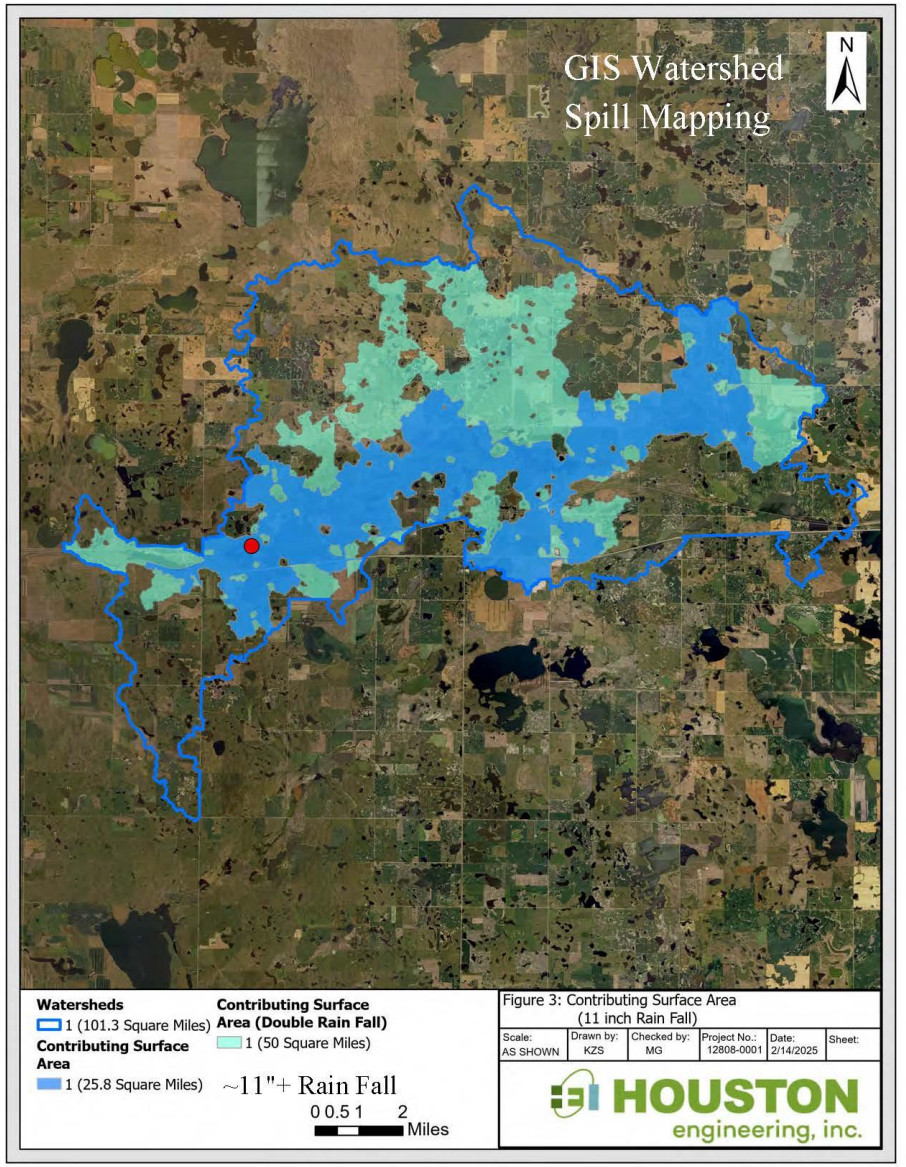
The only unknown in this equation is GW, which is projected over the 14+ year study period, based on the other variables. The others can be approximated as noted above.

The feasibility study is being completed to determine the amount of water to be removed to stabilize water levels in the system.

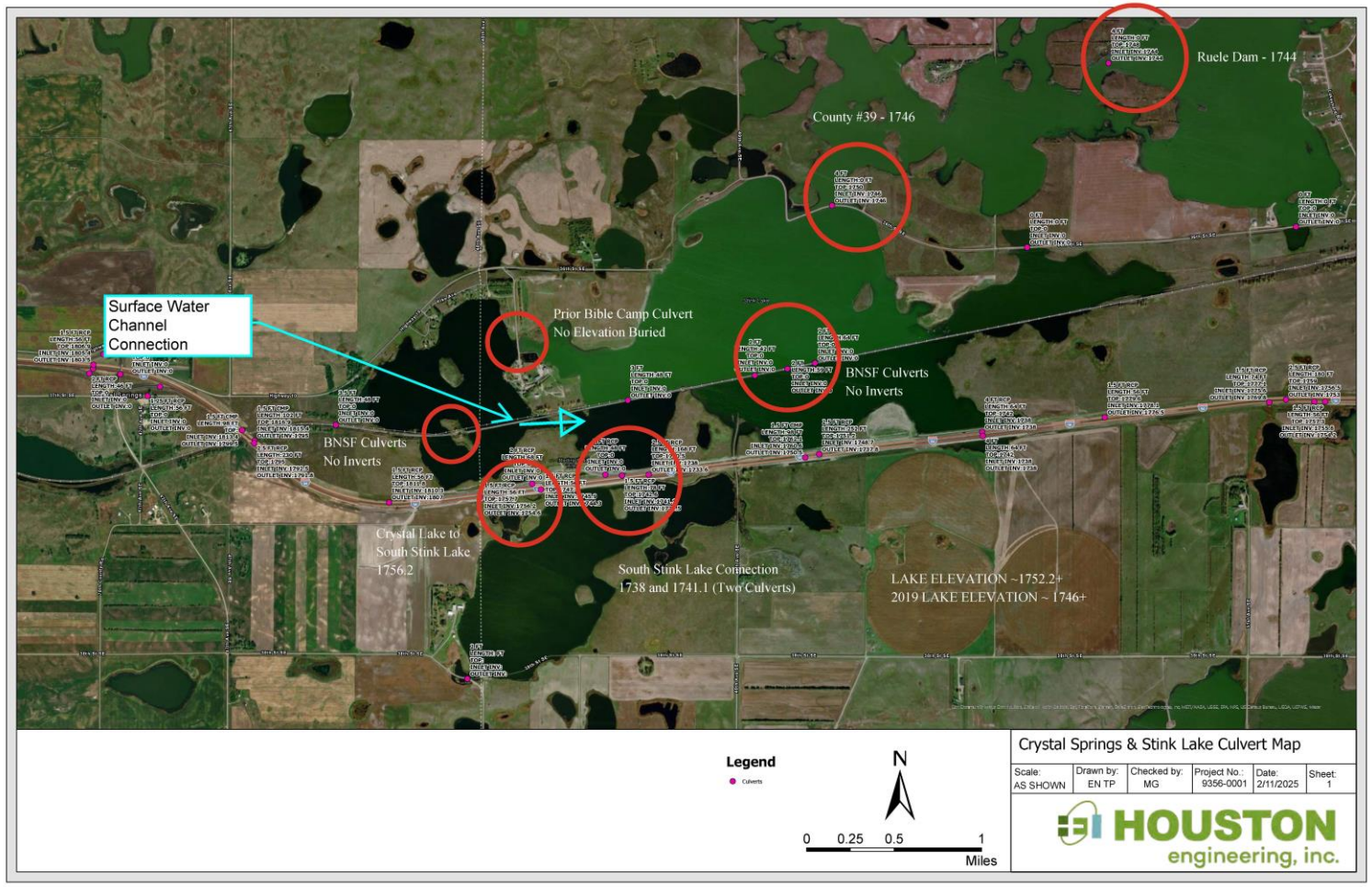
Contributing Watershed – Existing and Risk Projected



Existing
25.8 Sq. Mi.



Lake Control Elevations (Existing Culverts)



Elevation Considerations

Primary focus is to protect and provide benefits

Target Removal Elevation 1750

BNSF Rail	~1754
Interstate #94	~1762+
Bible Camp	~1754
County Rd #39	~1750
Ruele Lake Cabins	>1756

Natural Overflow 1744

1750 – 1752 provides around one year of average inflow storage

Historic Individual Lake Elevations

Crystal Springs Watershed Initiative

Aerial Photo/Lidar/Bathymetry Water Surface Elevations

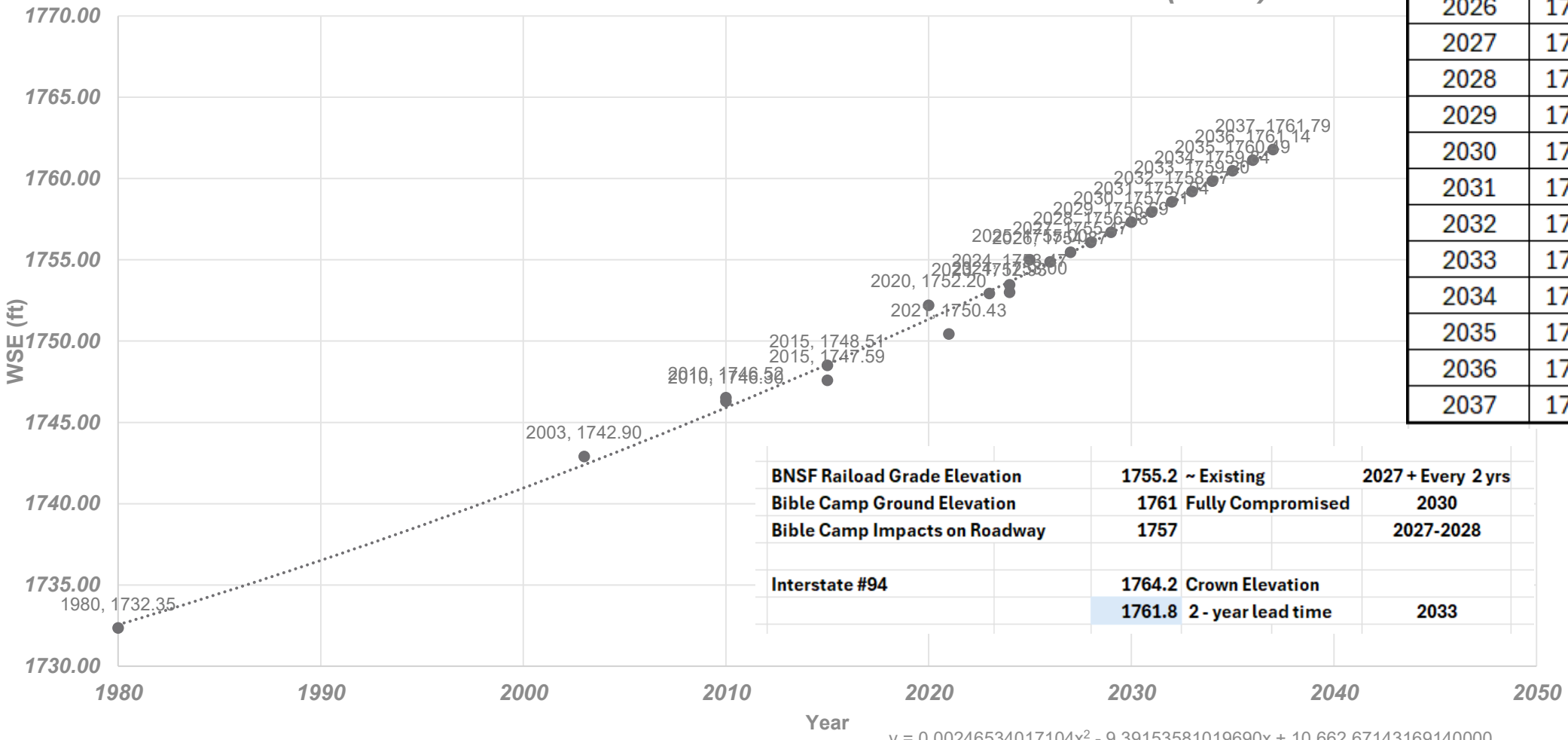
Lake	*Year*	*Elevation*	*Source*	*Difference*	
Crystal Lake	2024	1752.27	Aerial	0.28	
	2023	1751.99	Aerial	0.48	
	2021	1751.51	Aerial	1.46	
	2015	1750.05	Aerial	1.49	
	2010	1748.56	Aerial	-3.43	Fall in elevation?
	2003	1751.99	Aerial	5.28	
	1980	1746.71	Aerial	0.35	
	1957	1746.37	Aerial	5.90	Rise Since 1957
	Average	**1749.93**			
South Stink Lake	2024	1752.15	Aerial	-0.31	
	2023	1752.46	Aerial	1.82	
	2021	1750.64	Aerial	2.08	
	2015	1748.56	Aerial	2.77	
	2010	1745.79	Aerial	-1.41	Fall in elevation?
	2003	1747.20	Aerial	13.22	
	1980	1733.98	Aerial	-0.81	
	1957	1734.79	Aerial	17.36	Rise Since 1957
	Average	**1745.70**			

Stink Lake is the primary infrastructure impact area. Used for projection analysis will all lakes connected.

Stink Lake	2024	1753.47	Aerial	0.54	
	2023	1752.92	Aerial	2.50	
	2021	1750.43	Aerial	2.84	
	2015	1747.59	Aerial	1.07	
	2010	1746.52	Aerial	3.62	
	2003	1742.90	Aerial	10.55	
	1980	1732.35	Aerial	0.47	
	1957	1731.88	Aerial	21.59	Rise Since 1957
	Average	**1744.76**			
Ruele Lake	2024	1753.27	Aerial	1.12	
	2023	1752.15	Aerial	1.68	
	2021	1750.46	Aerial	3.36	
	2015	1747.10	Aerial	4.12	
	2010	1742.98	Aerial	9.00	
	2003	1733.98	Aerial	0.00	
	1980	1733.98	Aerial	-0.81	
	1957	1734.79	Aerial	18.48	Rise Since 1957
	Average	**1743.59**			

Note: Basin overflow to the Missouri River Elevation 1801 (NDDOT) 47 ft

Elevation Projections – Future Planning and Impact Risks



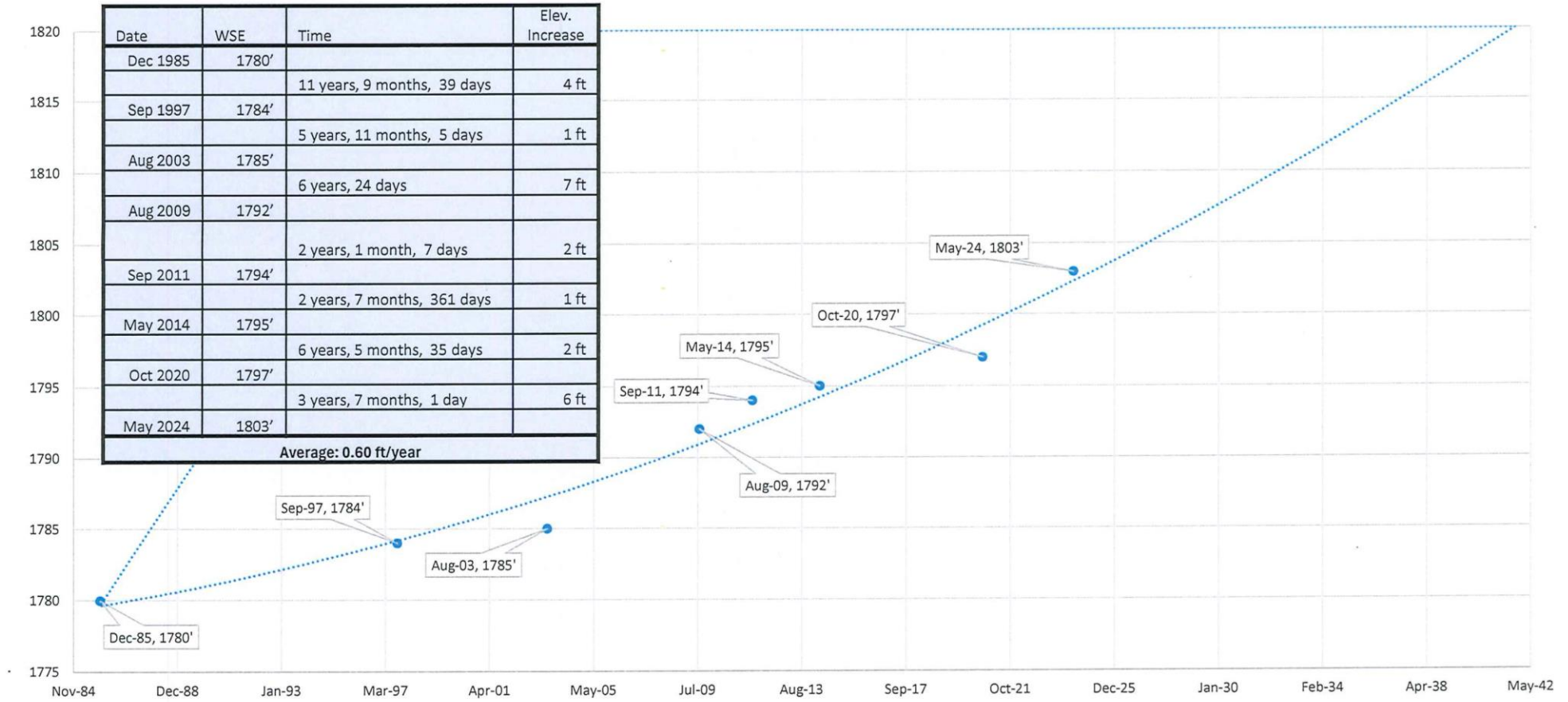
Year	Elevation
2025	1754.27
2026	1754.87
2027	1755.47
2028	1756.08
2029	1756.69
2030	1757.31
2031	1757.94
2032	1758.57
2033	1759.20
2034	1759.84
2035	1760.49
2036	1761.14
2037	1761.79

BNSF Raiload Grade Elevation	1755.2	~ Existing	2027 + Every 2 yrs
Bible Camp Ground Elevation	1761	Fully Compromised	2030
Bible Camp Impacts on Roadway	1757		2027-2028
Interstate #94	1764.2	Crown Elevation	
	1761.8	2 - year lead time	2033

Cleveland Water Level Increases and Trendline

Runner Slough Proposed Grade Raise Area
Historic Water Surface Elevations (WSE)

Date	WSE	Time	Elev. Increase
Dec 1985	1780′		
		11 years, 9 months, 39 days	4 ft
Sep 1997	1784′		
		5 years, 11 months, 5 days	1 ft
Aug 2003	1785′		
		6 years, 24 days	7 ft
Aug 2009	1792′		
		2 years, 1 month, 7 days	2 ft
Sep 2011	1794′		
		2 years, 7 months, 361 days	1 ft
May 2014	1795′		
		6 years, 5 months, 35 days	2 ft
Oct 2020	1797′		
		3 years, 7 months, 1 day	6 ft
May 2024	1803′		
Average: 0.60 ft/year			



Historic Lake Volume Inflow and Removal Capacity

14-Year Historic Record Evaluation - Crystal Springs Watershed Initiative

Year	*Elevation*	*Storage Volume - Area Capacity Curve*	
2024	1755	36,106	Acre-Feet
2010	1746	14,330	Acre-Feet
14	9	21,776	Acre-Feet
	Average	**1,555**	**Acre-Feet/Year**

Aerial Photo Storage Increase	*2010-2024*	
	42,335	Acre-Feet
Approximate ~ 0.5 ft	3,024	**Acre-Feet/Year**
100 Year Event Rainfall	***1,440***	***ac-ft***

	Per Year Removal (180)		
System Size (cfs)	*10*	3,564	**Acre-Feet**
	15	5,346	**Acre-Feet**
	20	7,128	**Acre-Feet**
	1.98	Ac/ft-Day- CFS	
	180	Operational Days	
Operational Removal	**3,024**	**Annual Ac-Ft (2021-2024)**	
2025 Inflow	**7,900**	**Ac-ft**	**(nearly 2 feet)**

Time to Remove Inflow - Area Capacity Value

Days	*Years*	*Target Elevation*	**1746**
1100	6.11		
733	4.07		
550	3.06		

15 cfs removal 1755-1746 = 4.07 Years

Focused Removal to Primary Structural Impact Areas - 1750

Preliminary Removal Projections

O&M Plan	**Total Lake Storage**	**1755 - 1750**	**15,271**	**Acre-Feet**
	Average Annual Inflow - times 2 years		6,048	**Acre-Feet**
	Retain Waters In Ruele			
	Elevation 1753 - 1750	Reduction in Removal	7,800	**Acre-Feet**
			13,519	**Acre-Feet**

With Ruele Storage (including average inflows)		**Without Ruele Storage (including average inflows)**	
5 feet removed	3.79 Yrs at 10 cfs	5 feet removed	5.98 Yrs at 10 cfs
5 feet removed	2.53 Yrs at 15 cfs	5 feet removed	3.99 Yrs at 15 cfs
5 feet removed	**1.90 Yrs at 20 cfs**	**5 feet removed**	**2.99 Yrs at 20 cfs**

Period of Record Volume Approximations		
Total Inflow USGS gage (SW)	41,455	ac-ft
Rainfall - Direct Precipitation (P-DR)	60,302	ac-ft
Evaporation (E)	(110,790)	ac-ft
Total SW+DR-E	**(9,034)**	**ac-ft**
Lake System Increase	**42,335**	**ac-ft**
Groundwater (GW) Compnent	**51,369**	**ac-ft**
	34%	of Total System Inflows

25.8	Square Miles
247.65	Total Inches (2010-2024)
32.5	Inches/Surface Area

Lake Surface Area (Acres)	
Elev 1744	2,324
Elev 1755	3,520
Average 2010-2014	***2,922***

20 cfs removal 1755-1750 = 1.9 to 1.99 Years

Crystal Springs Lake Pump Removal System – Preferred Alternative

Opinion of Probable Construction Cost ~$24.6 Million

Construction Cost	$16,262,000.00		
Contingency	$3,252,400.00	20%	Feasibility Level
Opinion of Probable Construction Cost	$19,514,400.00		
Preliminary Engineering Report (w/operations plan)	$975,720.00	5%	
Final Design/CMS Services	$1,951,440.00	10%	
Legal and Administration (assessment district, easements, etc.	$1,170,864.00	6%	
Regulatory/Environmental	$975,720.00	5%	
Draft Preliminary OPC	*$24,588,144.00*	*26%*	

Potential Funding Sources - Consideration and Requests

Funding Opportunities

HMGP – Federal

SWC (Rural Flood Control) State

	Full Project OPC				*Preliminary Engineering Report*
HMGP	$18,441,108.00	Federal	75%	Up To	$731,790.00
	$2,458,814.40	State	10%	of Federal	$97,572.00
	$3,688,221.60	Local	15%	Local	$146,358.00
	$24,588,144.00			***Total***	***$975,720.00***

	Full Project OPC			*Preliminary Engineering Report*
SWC Rural Flood Control	$11,064,664.80	State	45%	$439,074.00
	$13,523,479.20	Local	55%	$536,646.00
	$24,588,144.00		***Total***	***$975,720.00***

Design Considerations

1. Utilization of a 30" PVC allows for lower headlosses in the system and smaller pump requirements
2. The 30" PVC pipe will lower internal pressures and associated operations and maintenance and maintenace costs
3. The 30" PVC allow for the ability to add pump capacity at some point if conditions require.
4. Annual Operations and Maintenance Costs for the 24" PVC System $ ~250,000

Preliminary Engineering Report ~$976,000

Economic Benefits of Excess Floodwater Removal

- **The total economic benefits were roughly determined using a *10-year planning horizon*, and in general included the following, which are rough approximations, which remain to be formalized**
  - BNSF – Grade Raises (3) more at $3.5 Million each = ~$10.5 million
  - Bible Camp Relocation = ~$9 to 11 Million
  - NDDOT – Single Grade Raise (3 feet) = ~$16.5 million (2022) – (10-foot raise 2011 Hydrology Report)
  - 500-600 acres of Ag Land ($2,000/ac) = ~$1.2 million
    - Land Value of inundated properties - no production recovery
  - County Roadways ($4.3 million/mile) = ~$8.6 million (2 Miles two ~2 ft grade raise)
  - Interstate Commerce BNSF Lost Revenue = TBD (Loss of Use Days)

Total Benefit = $45.8 Millon
Total Cost = $24.6 Million

Benefit/Cost > 1.9:1

BNSF Raiload Grade Elevation	1755.2	~ Existing	2027 + every 2 yrs
Bible Camp Ground Elevation	1761	Fully Compromised	2030
Bible Camp Impacts on Roadway	1757		2027-2028
County #39 - Roadway is Unundated - Viable at Elevation 1750?			
Interstate #94	1764.2	Crown Elevation	
	1761.8	2 - year lead time	2033

Alternative Route Comparison – Mileage and O&M Expenses

Headloss at 20cfs for 2ft diameter HDPE pipe run

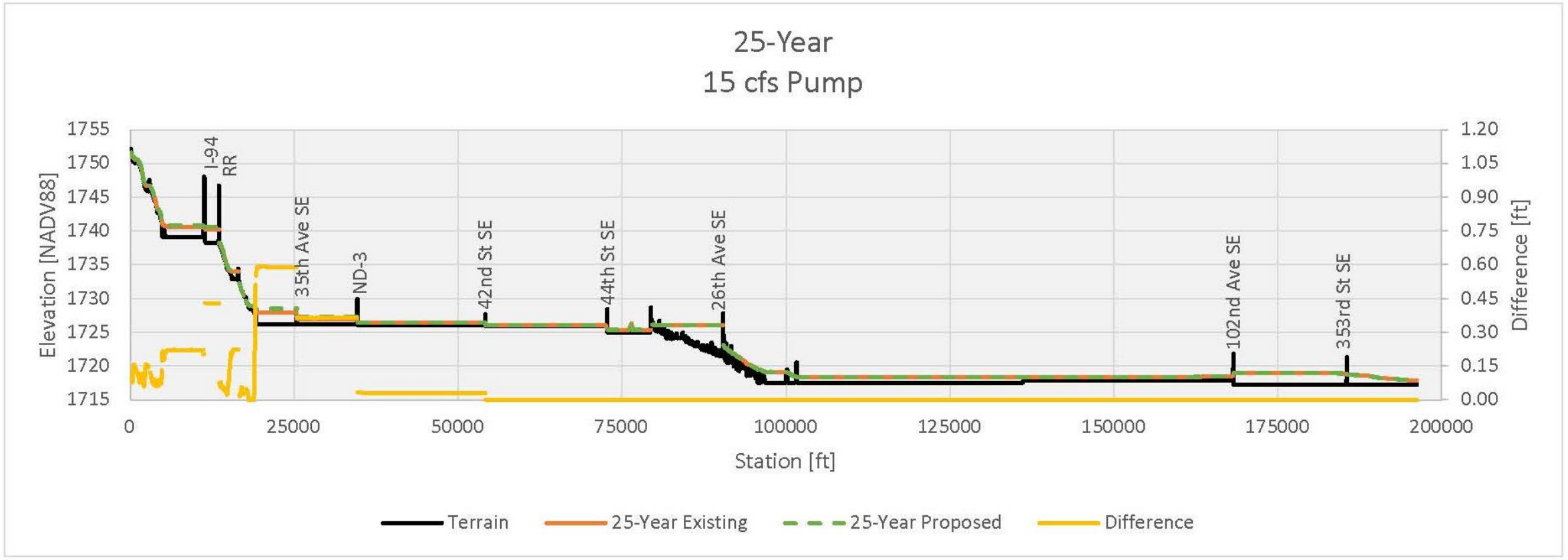
Route	Max Elevation (ft)	Piping Length (ft) Shown in miles	Frictional Headloss (H_l) (psi)	Static Headloss (psi)	Total Headloss (psi)	Cost Factor (CF) (O&M cost for preferred route times CF)
Upper Pipestem	1930	32.6	276.6	78.4	355	2.96
Lower Pipestem	1946	37.8	326.8	82	408.8	3.40
South	2110	17.5	151.3	157.2	308.5	2.57
West RR	1836	13.5	116.4	36.2	152.6	1.27
West North	1810	11.5	95.1	25	120.1	1

Note: This does not consider system losses or minor losses.

Preferred Alternative is the most economical and least cost to operate

Kidder County Tributary Evaluation and Improvements

Channel Profile in Tributary and Lake Etta to Long Lake Refuge



Water surface profiles are minimally changed and can be improved.

Long Lake Outfall Structure Downstream Elevation ~ 1713.5

Stream Crossing Compliance and Mitigation Evaluation

Crossing Name	Culvert Size [inch]	Culvert type	Invert of Culvert* [NADV88]	Design Event Return Frequency (ND Stream Crossing Standards)	Allowable Headwater Elevation [NADV88]	Water Surface Elevation for the Design Event [NADV88]		Change in Water Surface Elevation based on 15 cf added to roadway design event (inches)	Mitigation Measures	Pass/Fail
						Existing Conditions	Proposed 15 cfs Pump		Added Culvert and Channel Mainteance to accommodate 20 cfs with no rise in water surface profile	
Highway 10	3-36	RCP	1737.00	25 Year	1742.00	1740.67	1740.89	**2.6**	24" RCP	P - P - P
I-94	3-36	RCP	1737.00	50 Year	1742.00	1741.07	1741.27	**2.4**	24" RCP	P - P - P
Railroad	36	RCP	1735.00	50 - 100 Year	1738.00 - 1739.50	1740.93 - 1741.71	1741.14 - 1741.84	**1.6**	42" Steel Pipe	**F - F - F**
Dawson Hook	2-30, 2-24	CMP	1731.50	15 Year	1736.00	1733.65	1734.02	**4.4**	24" CMP	P - P - P
35th Ave	36	CMP	1723.23	10 Year	1728.23	1726.74	1727.86	**13.4**	24" CMP	P - P - P
Highway 3	2-18	Box Culvert Unconfirmed	1724.5	25 Year	1728.00	1727.12	1727.43	**3.7**	24" RCP	P - P - P
Whispering Stream	2-24	CMP	1723.60	10 Year	1727.60	1726.12	1726.12	**0.0**	24" CMP	P - P - P

*Values are based on survey data, while HEC-RAS modeling of culvert inverts are based on the lowest LiDAR value near the culvert

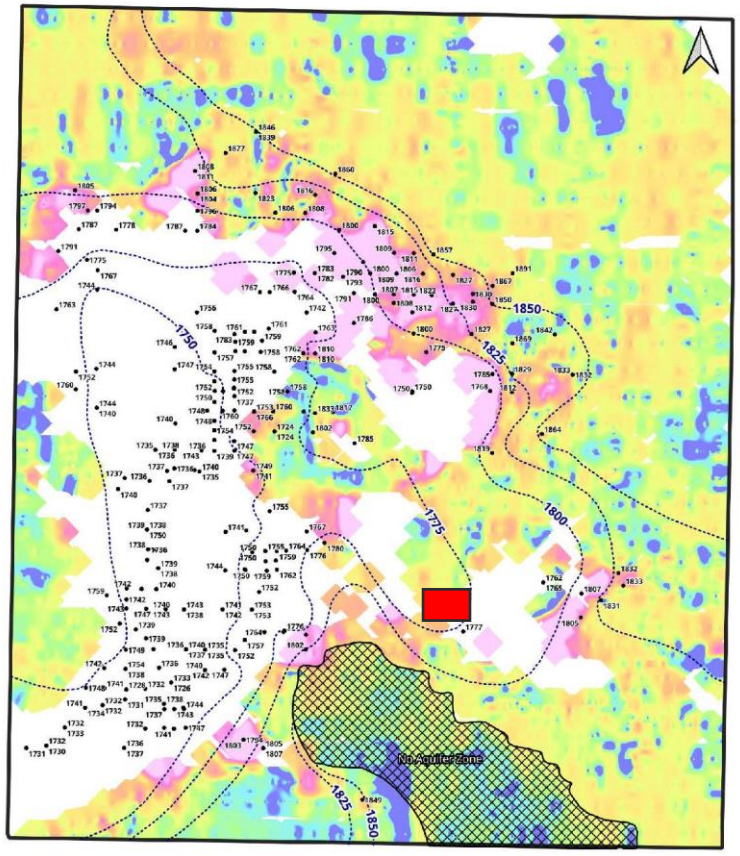
Recommendation for the Preliminary Engineering Report:

Evaluate the downstream mitigation features early in the process to address concerns.

Groundwater Evaluation - 2025 Spring Potentiometric Surface

DRAFT and PRELIMINARY

2025 Spring Potentiometric Surface – 1850 ft Resistivity Slice

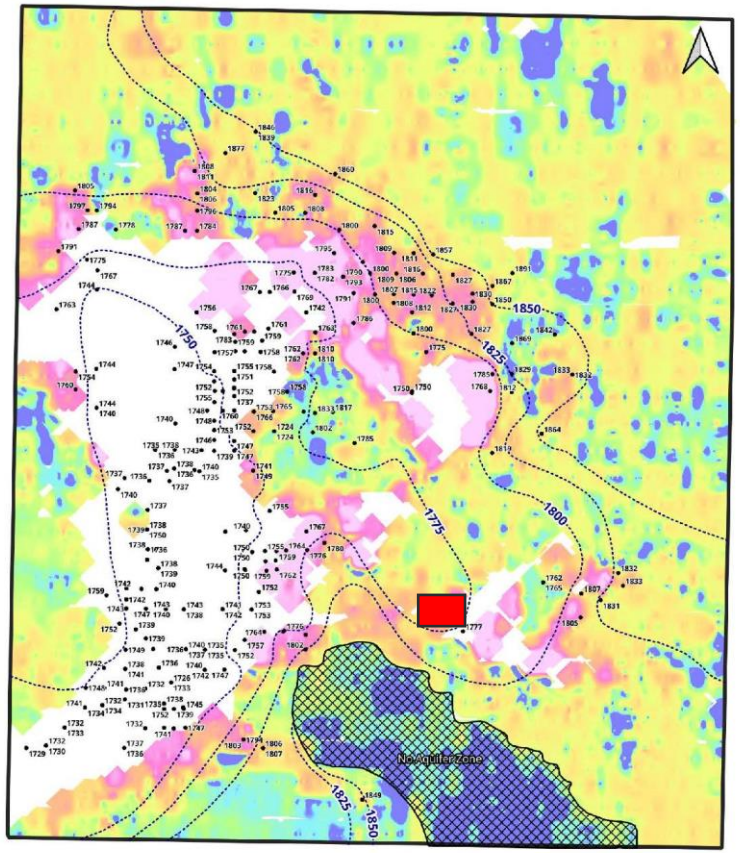


Crystal Springs Lake
Observation Wells - Spring Water Levels - 2025
Potentiometric Surface Contours - Spring 2025
No Aquifer Zone
AEM Area 1 Boundary
Resistivity Slice (ohm-m) - 1850 ft
Band 1: Height
100
7

120 E. 16th Street, Suite 207 Scottsbluff, NE 69361 (308) 633-2890
229 E. Kiowa Ave, Fort Morgan, CO 80701 (970) 370-2481
ari-water.com

DRAFT and PRELIMINARY

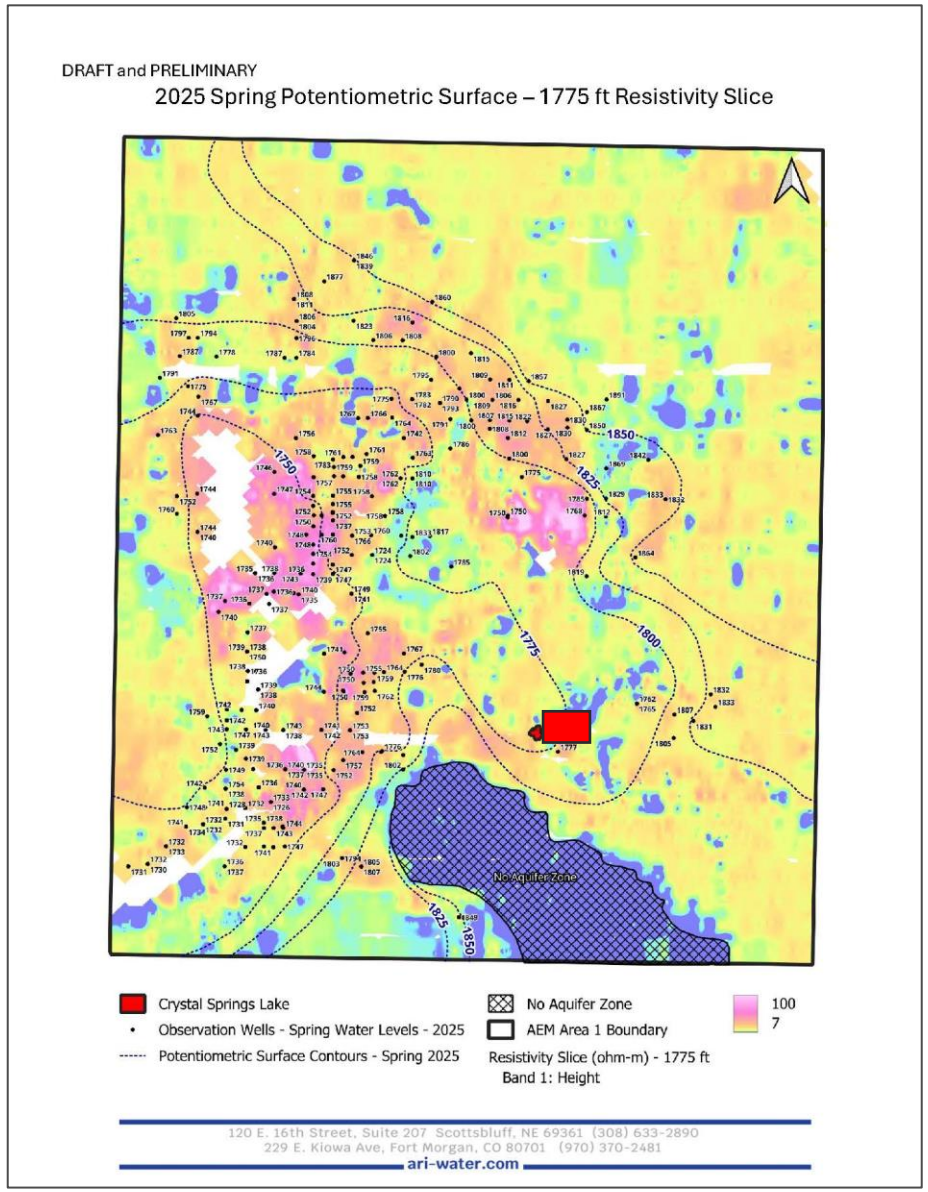
2025 Spring Potentiometric Surface – 1825 ft Resistivity Slice

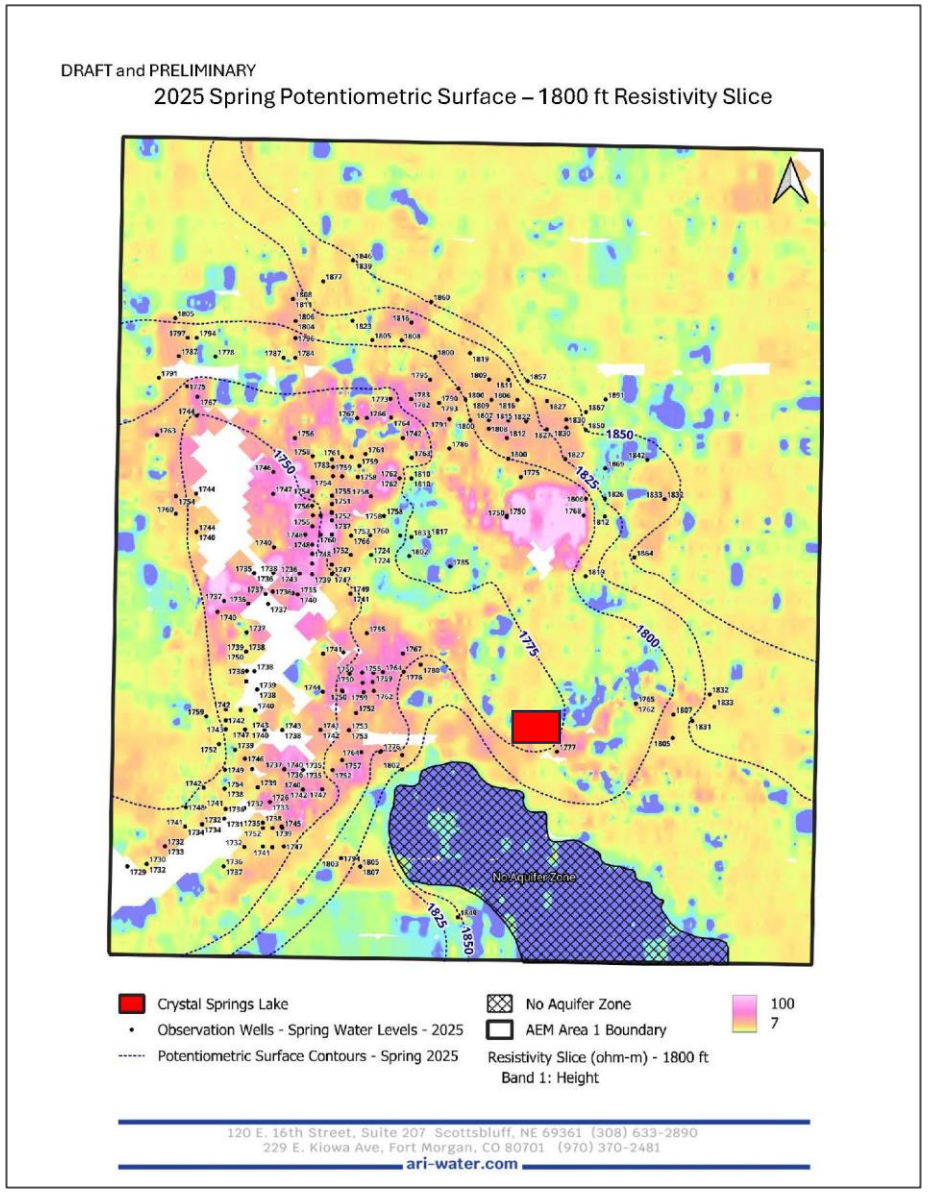


Crystal Springs Lake
Observation Wells - Spring Water Levels - 2025
Potentiometric Surface Contours - Spring 2025
No Aquifer Zone
AEM Area 1 Boundary
Resistivity Slice (ohm-m) - 1825 ft
Band 1: Height
100
7

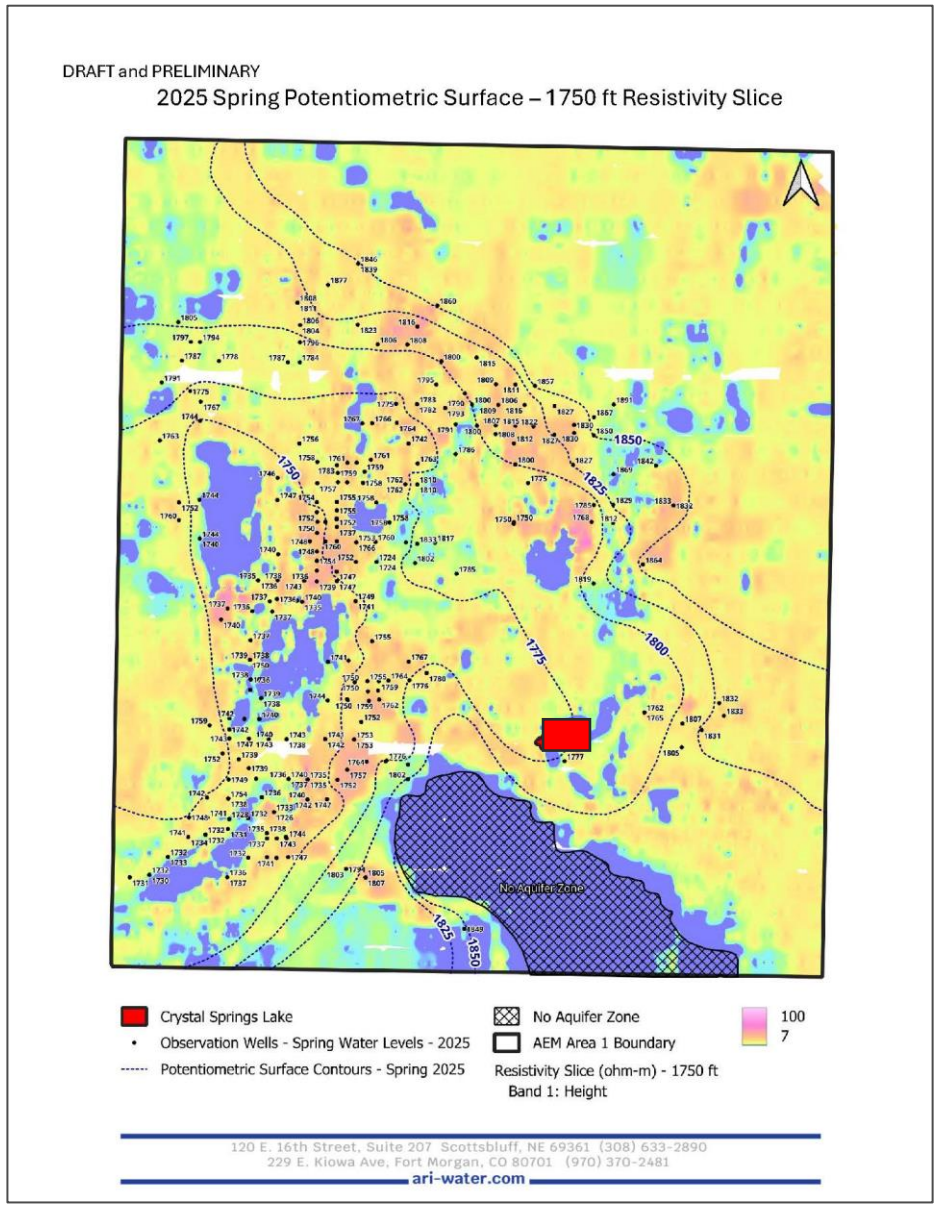
120 E. 16th Street, Suite 207 Scottsbluff, NE 69361 (308) 633-2890
229 E. Kiowa Ave, Fort Morgan, CO 80701 (970) 370-2481
ari-water.com

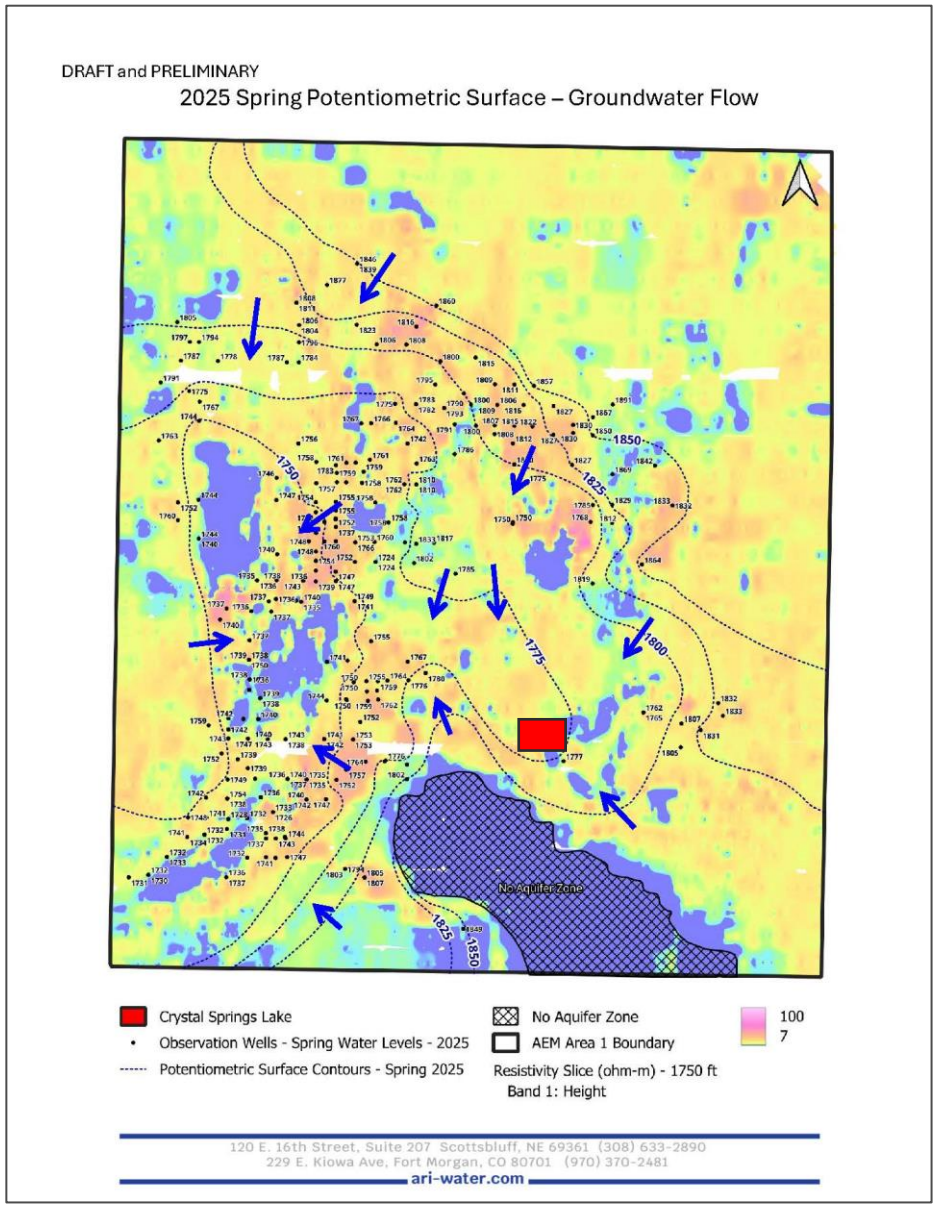
Groundwater Evaluation - 2025 Spring Potentiometric Surface



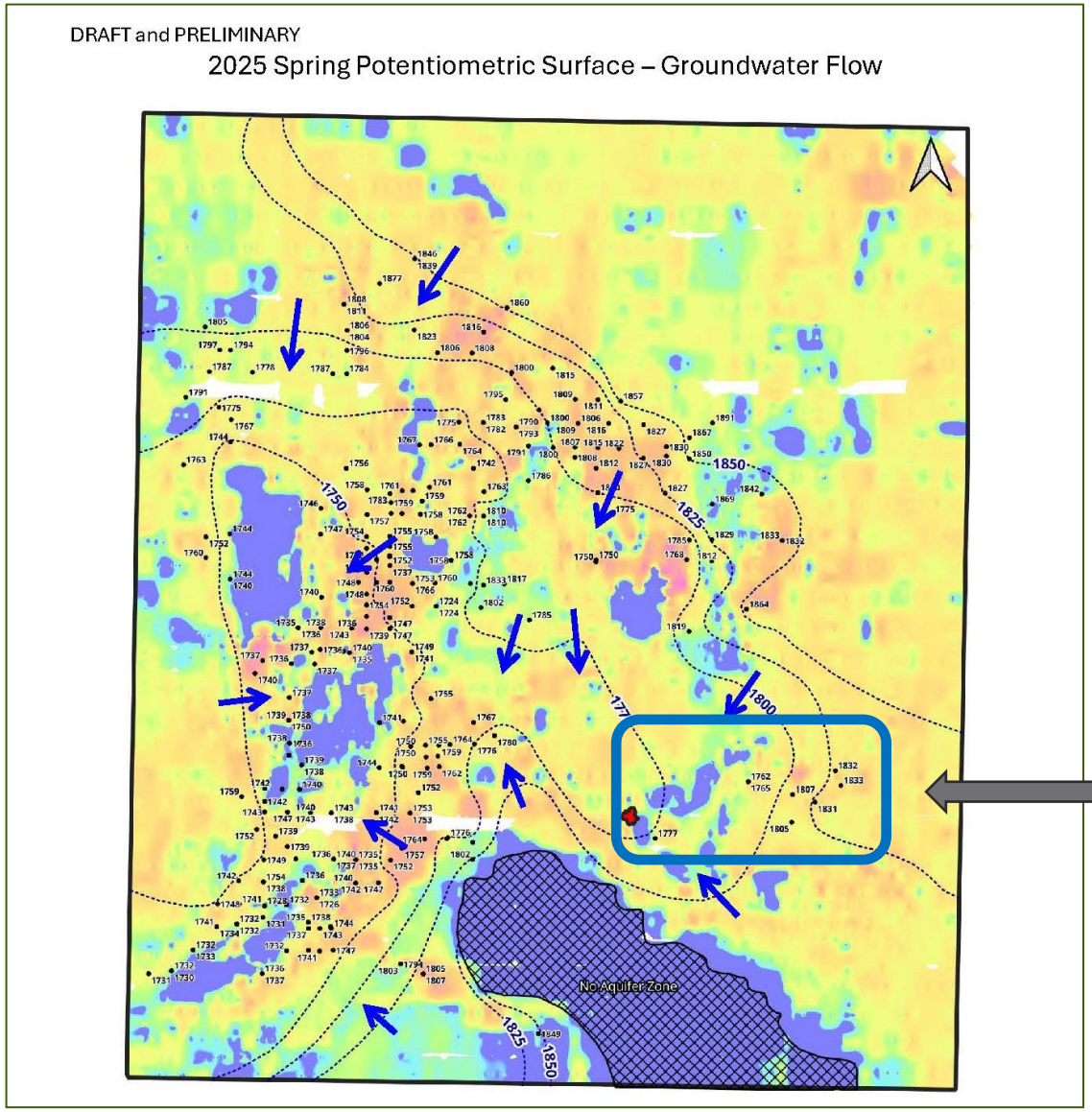


Groundwater Evaluation - 2025 Spring Potentiometric Surface





Groundwater Evaluation - 2025 Spring Potentiometric Surface

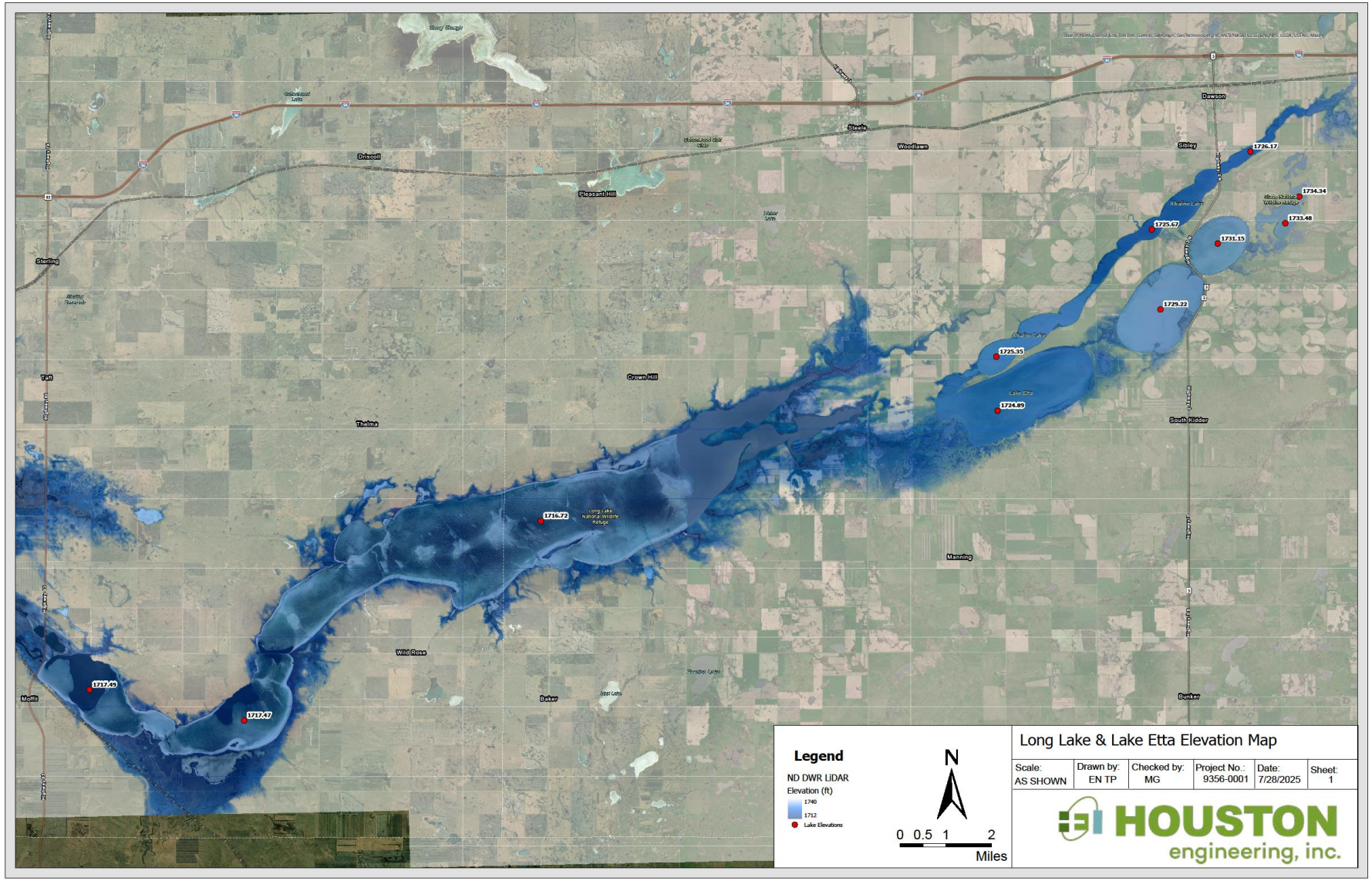


Groundwater Elevations well above the lake system
Contours are 1775 at the west and 1800 to the east

Lake Elevation (2025) is ~1754-55

Crystal Springs Lake System

Long Lake Refuge – Water Elevation Mapping (~1718)



Control Elevation
1713.5 (88 datum)
Raised ~18”?

Approximate Acreage
17,000 acres

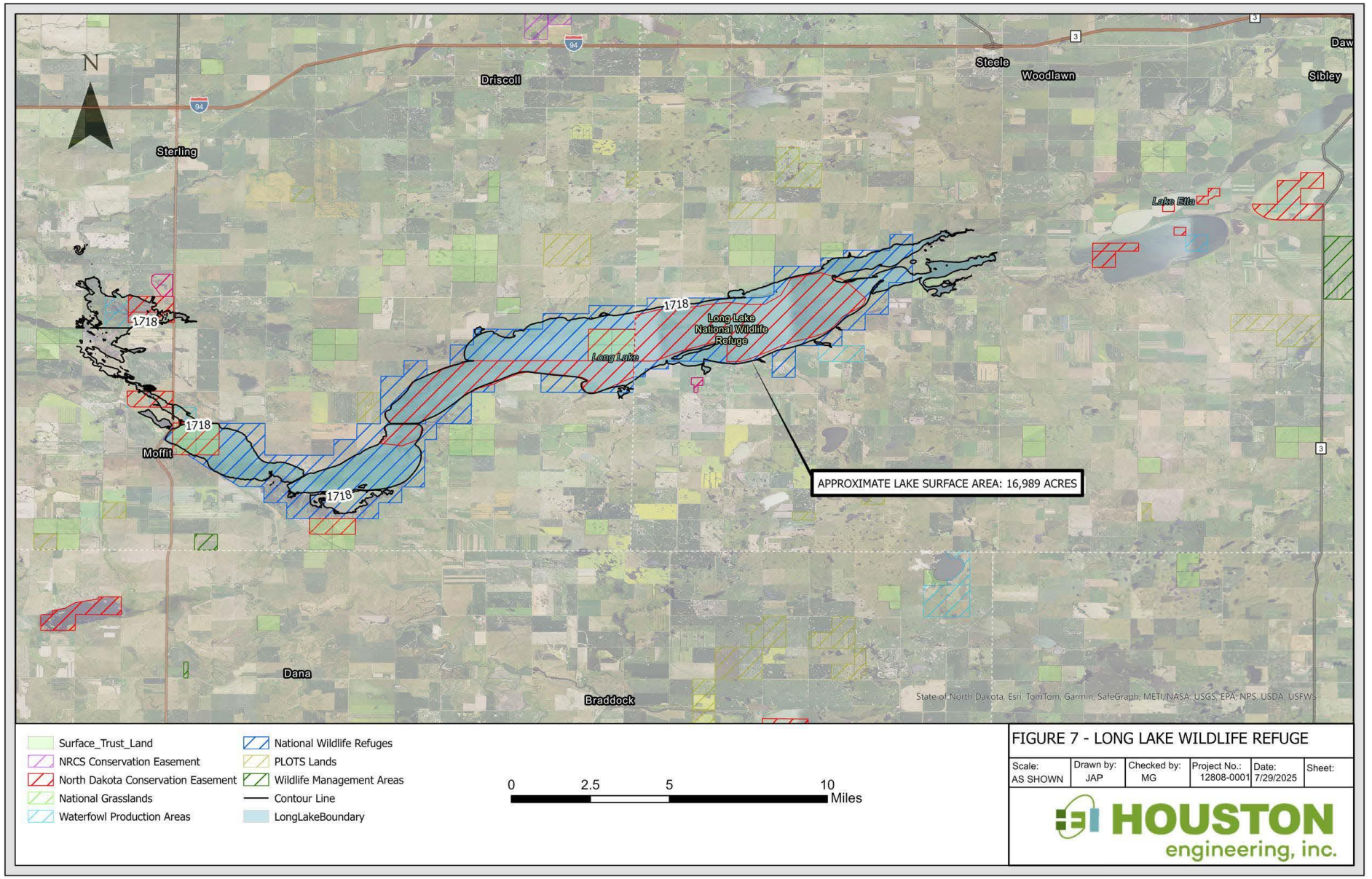
Total Annual
Crystal Lake Inflow
3,200 ac-ft

2” rise if all at once
Releases over 180 days

Drainage Area > 700 sq. mi.
Crystal Springs +3.7%

Lake Etta	**~1725**
Long Lake	**~1718**

Long Lake Refuge Boundaries



Concerns related to:

Control Elevation and Backwater (new gates 2015)

Operations and Management

Flood Impacts Outside Boundaries?

Water Permit Compliance