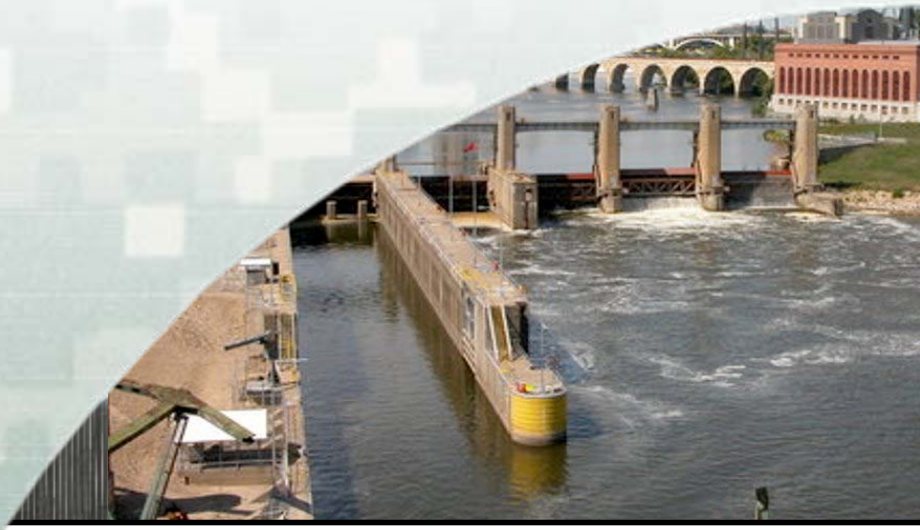
Lower St. Anthony Falls – Dam Sill Joint Repair

Jake Fall
Materials Engineer, St. Paul District
February 12, 2013



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Agenda…

- Location
- Overview
- Our Main Concern
- Foundation Conditions
- Dewatering Bulkhead
- On-Site Engineering
- Concrete Sill Inspection
- Repair Procedures
- Concrete Placement, Curing and Testing
- Construction Schedule and Cost
- Recommendations
- Conclusion
- Questions

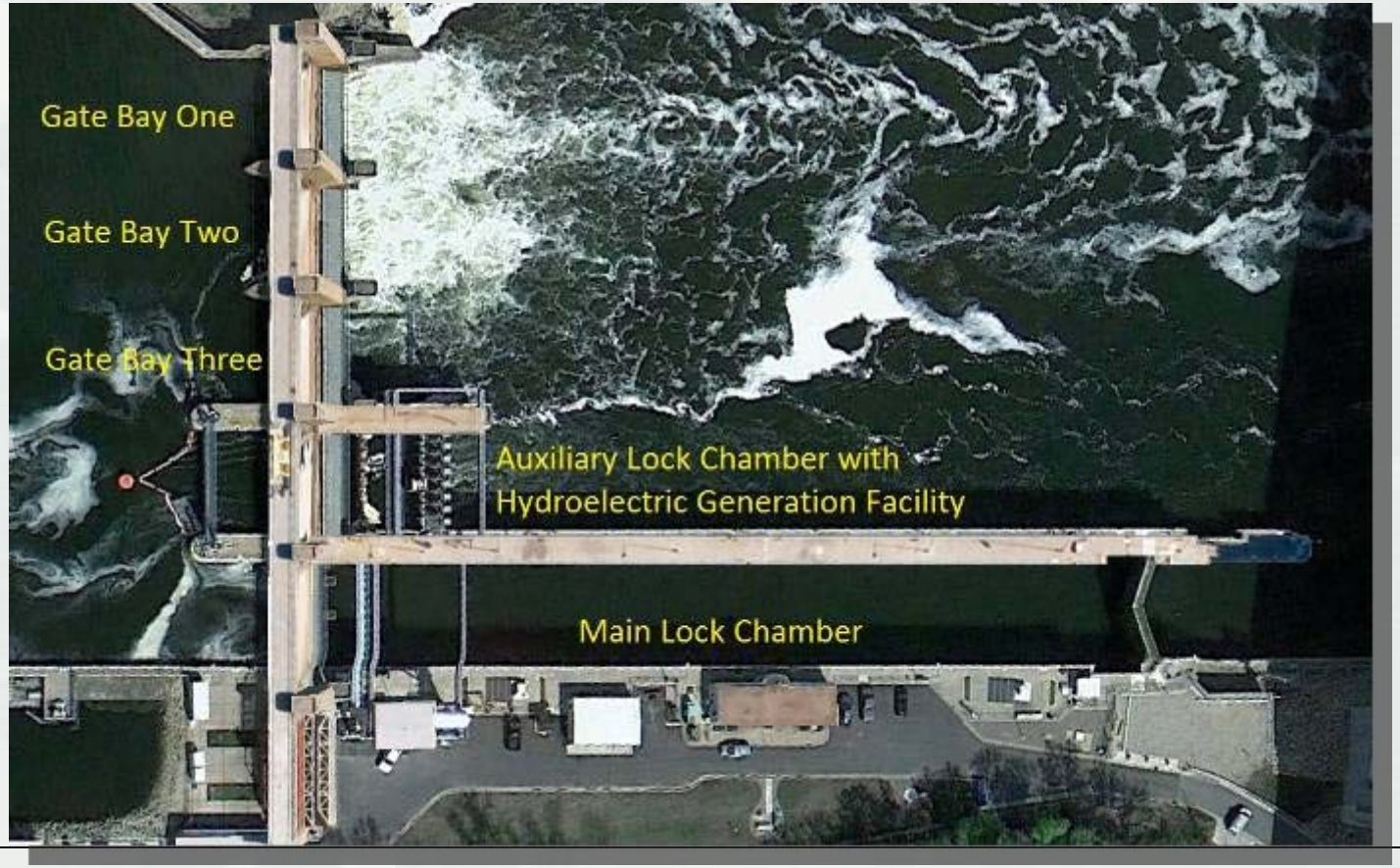
Concrete Placement - Gate Bay One, November 9th 2012

St. Paul District …

Site Location…

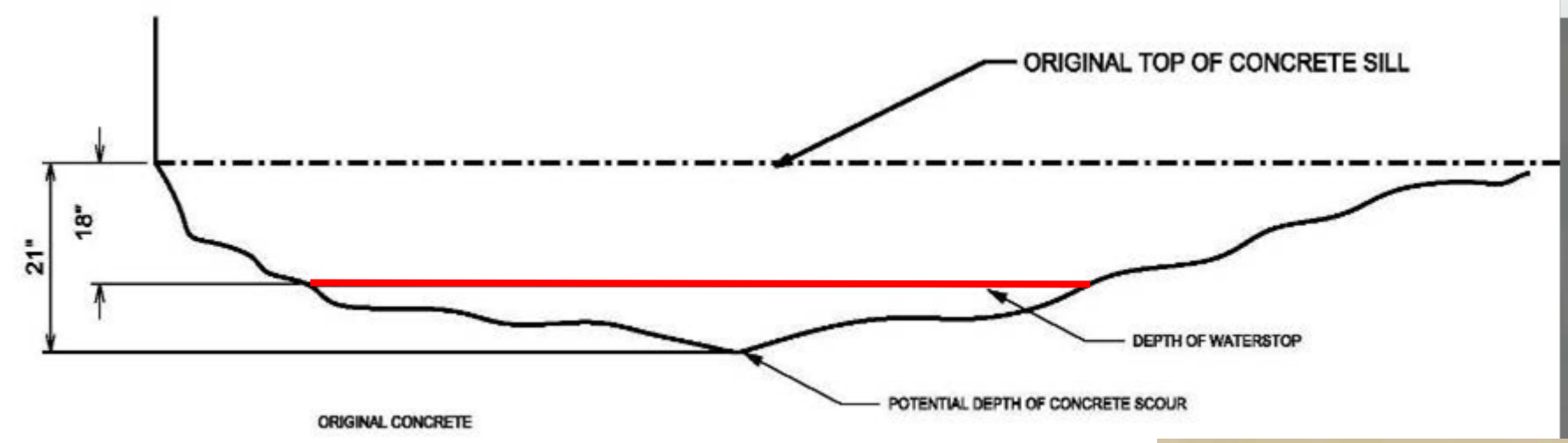
Site Overview…

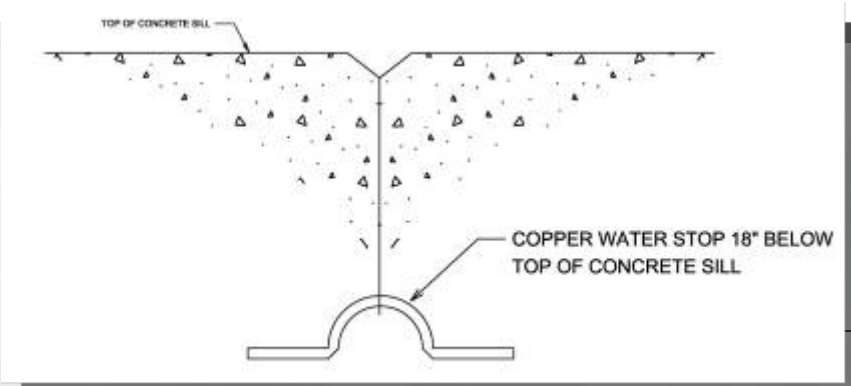
- **Main lock chamber is 56 ft wide by 400 ft long.**
- **Auxiliary lock chamber, housing a hydroelectric generation facility.**
- **Movable dam with three 56 ft wide tainter gates.**



Our Main Concern…

- **Compromised / Failed Water-stops.**
- **Gate bay 3 has experienced 18 – 21 inches of concrete scour in the monolith joint.**
- **The depth of the water stop is 18 inches below the concrete sill.**

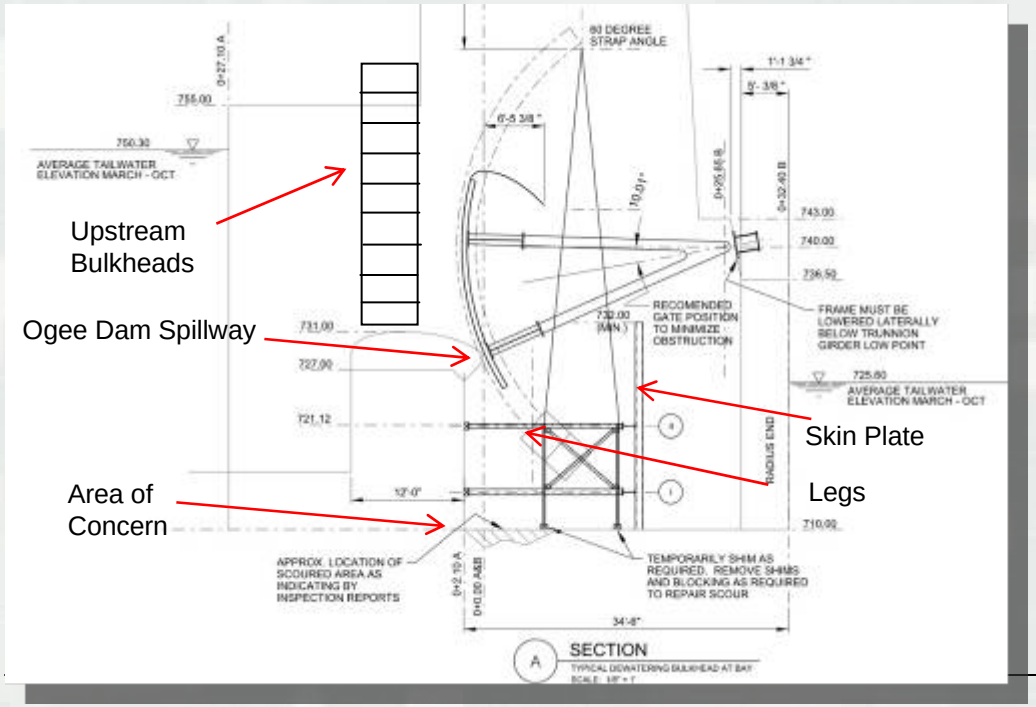


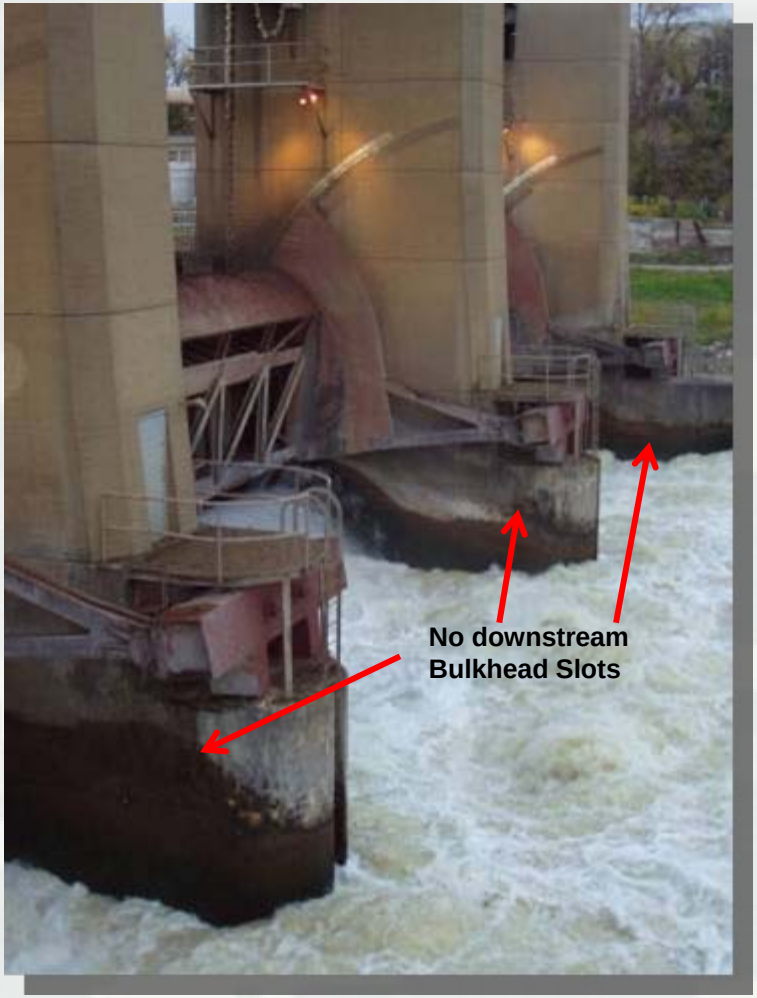


Foundation Conditions…

Dewatering Challenges…

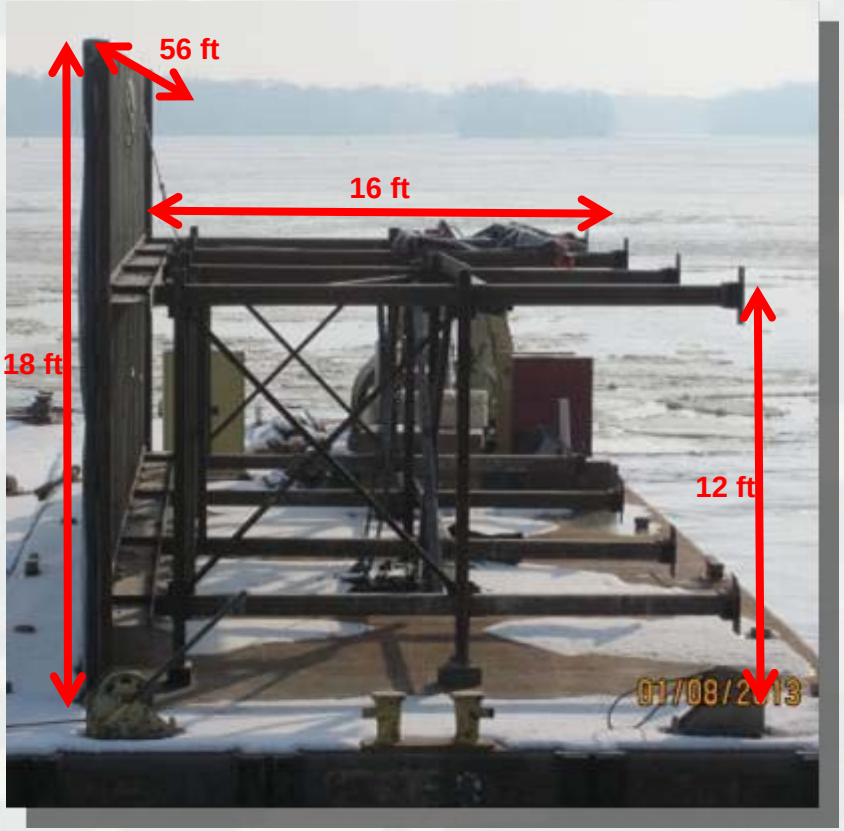
- Gate Bays requires dewatering
- Gate Closure Seal
- Downstream Pier Geometry
  - No downstream bulkhead or reaction slot
  - Ogee Dam Spillway
- Maintaining Flow Conditions





Dewatering Bulkhead Facts…

- **Height of Skin Plate: 18 ft.**
- **Height of Frame: 12 ft.**
- **Width: 56 ft.**
- **Depth: 16 ft.**
- **Weight: 26,000 lbs.**
- **Wall Clearance: 2 in. on each side.**
- **Skin Plate constructed from dewatering needles.**



Dewatering Procedure…

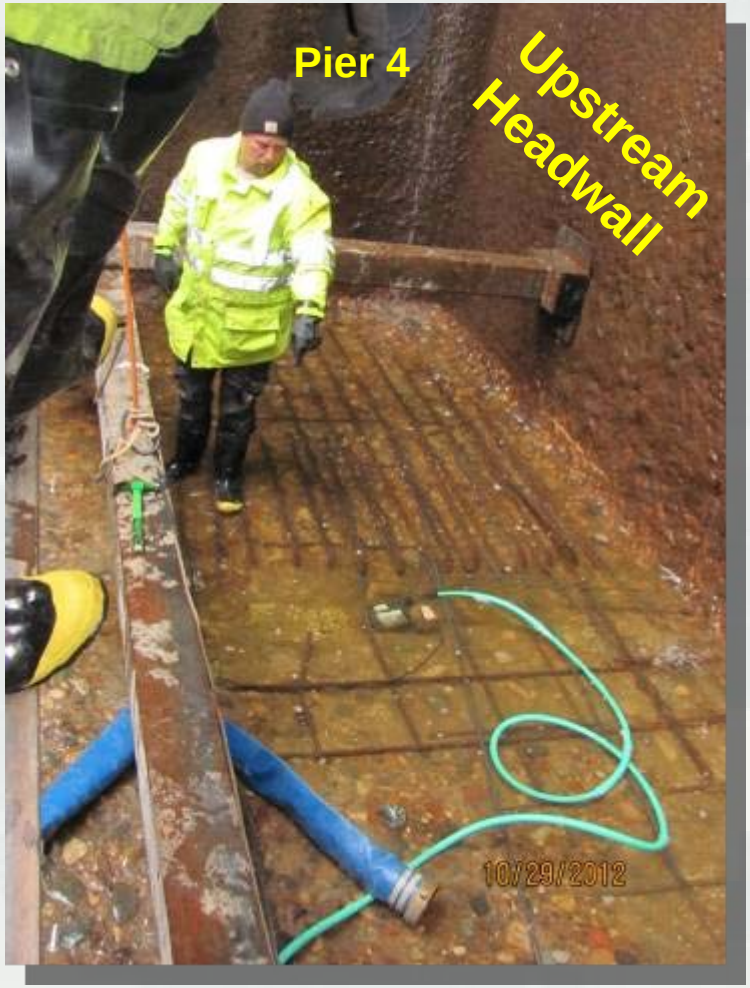
On Site Engineering…

Gate Bay 2

Gate Bay 3

Gate Bay Inspections…

Gate Bay 3



Gate Bay 2

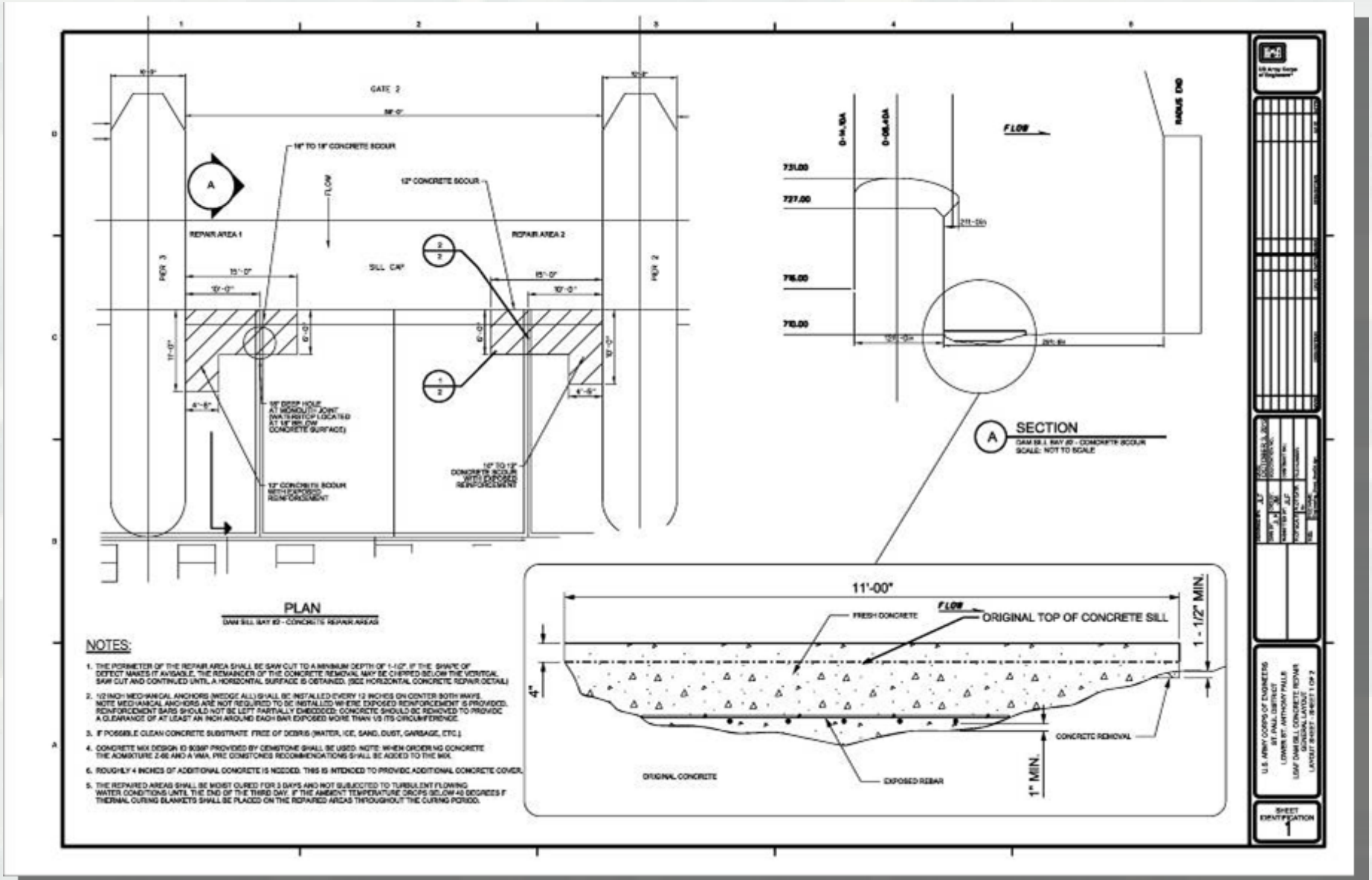
Gate Bay Inspections…

Gate Bay 3, Western Monolith Joint

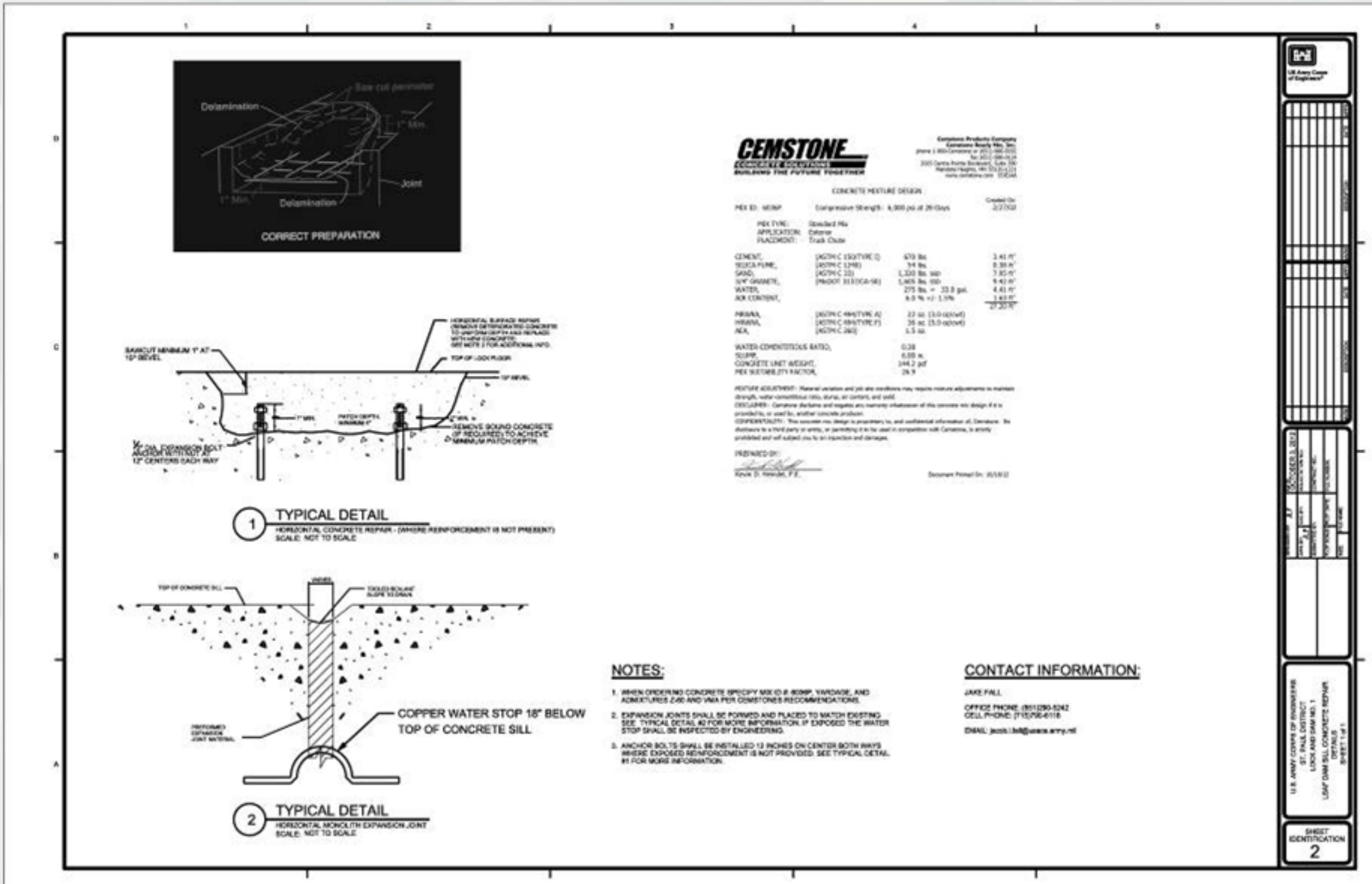
2” diameter hole

Monolith Joint

Repair Procedures…



Repair Procedures…



Gate Bay Repair Procedures…

- 4” wide by 2” deep trench was cut into the concrete.
- ½” anchor bolts were installed 12” on center both ways.
- All missing reinforcement was replaced.
- Each repair formed 4” above original concrete surface.
- The surface was cleaned.

Gate Bay 3

Concrete Placements…

Three concrete placements occurred.

- **Oct. 19th – Gate Bay Two – 13 cubic yards**
- **Oct. 29th – Gate Bay Three – 13 cubic yards**
- **Nov. 9th – Gate Bay One – 26 cubic yards**

Mix Design 6036P High Early Strength – Supplied by Cemstone Ready Mix, Inc.

Concrete Placements…

CEMSTONE™
CONCRETE SOLUTIONS
BUILDING THE FUTURE TOGETHER

Cemstone Products Company
Cemstone Ready Mix, Inc.
phone 1-800-Cemstone or (651) 688-9292
fax (651) 688-0124
2025 Centre Pointe Boulevard, Suite 300
Mendota Heights, MN 55120-1221
www.cemstone.com EOE/AA

CONCRETE MIXTURE DESIGN

MIX ID: 6036P Compressive Strength: 6,000 psi at 28-Days Created On: 2/27/02

MIX TYPE: Standard Mix
APPLICATION: Exterior
PLACEMENT: Truck Chute

CEMENT,	(ASTM C 150/TYPE I)	670 lbs.	3.41 ft^3
SILICA FUME,	(ASTM C 1240)	54 lbs.	0.38 ft^3
SAND,	(ASTM C 33)	1,320 lbs. SSD	7.95 ft^3
3/4" GRANITE,	(MnDOT 3137/CA-50)	1,605 lbs. SSD	9.42 ft^3
WATER,		275 lbs. = 33.0 gal.	4.41 ft^3
AIR CONTENT,		6.0 % +/- 1.5%	1.63 ft^3
			27.20 ft^3
MRWRA,	(ASTM C 494/TYPE A)	22 oz. (3.0 oz/cwt)	
HRWRA,	(ASTM C 494/TYPE F)	36 oz. (5.0 oz/cwt)	
AEA,	(ASTM C 260)	1.5 oz.	

WATER-CEMENTITIOUS RATIO,	0.38
SLUMP,	6.00 in.
CONCRETE UNIT WEIGHT,	144.2 pcf
MIX SUITABILITY FACTOR,	26.9

MIXTURE ADJUSTMENT: Material variation and job site conditions may require mixture adjustments to maintain strength, water-cementitious ratio, slump, air content, and yield.
DISCLAIMER: Cemstone disclaims and negates any warranty whatsoever of this concrete mix design if it is provided to, or used by, another concrete producer.
CONFIDENTIALITY: This concrete mix design is proprietary to, and confidential information of, Cemstone. Its disclosure to a third party or entity, or permitting it to be used in competition with Cemstone, is strictly prohibited and will subject you to an injunction and damages.

PREPARED BY:

Kevin D. Heindel, P.E.

Document Printed On: 10/18/12

Concrete Placement…

Concrete Placement – Gate Bay Two

Concrete Placement – Gate Bay Two

Area 1

Area 2

Concrete Placement – Gate Bay Three

Concrete Placement – Gate Bay Three

Area 1

Area 2

Concrete Placement – Gate Bay One

Curing Procedures…

- **Moist Curing was applied to each repair according to ACI 308R-01 Guide to Curing Concrete.**

Gate Bay 1

Curing Schedule…

- **The curing schedule was established based on…**
  - **The Concrete Mix Design.**
  - **The minimum compressive strength of 6000 (pounds per square inch) psi at 28 days.**

- **3 days – 50% of minimum design strength**
- **7 days – 75% of minimum design strength**
- **14 days – 100% of minimum design strength**

Concrete Placement – Compressive Strength

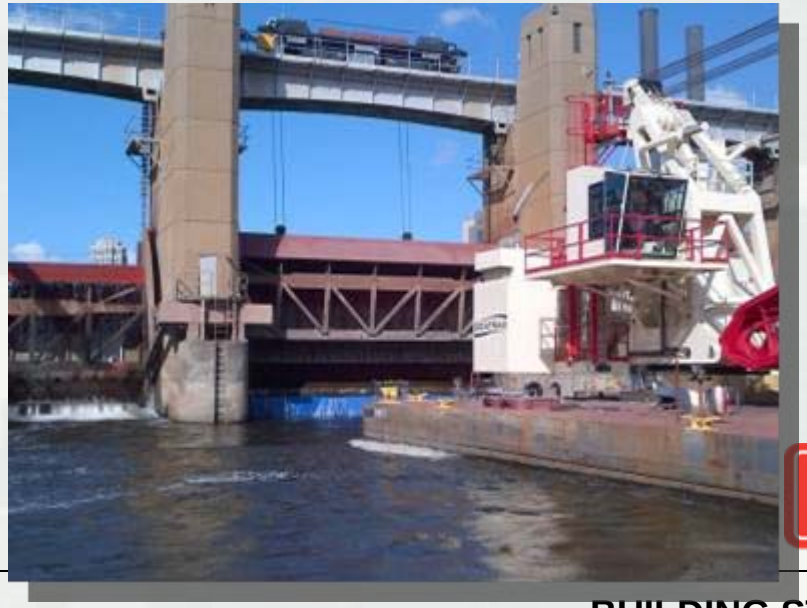
Tested Compressive Strength in psi

- 7 day – 5040 psi
- 14 day – 6365 psi
- 28 day – 7540 psi

Minimum Design Strength 6000 psi at 28 days

Construction Schedule…

- **Recommended for Repair 2005.**
- **Design started January 2009.**
  - **Final Bulkhead Drawings June 30, 2011.**
- **Dewatering bulkhead constructed within 1 week in 2012.**
- **On-site construction 32 days, October 16th – November 16th, 2012.**



Construction Cost…

Item(s)	Cost ($)
Crane Barge – Leonard	55,500
Construction – Dewatering Bulkhead	14,000
Cast in Place – Concrete	12,000
Travel, Labor, Supplies and Materials	250,000
Total Cost	**$331,500**

Recommendations…

- **Dive Inspection Schedule**
  - **Initial 6 month dive inspection**
  - **Periodic Dive Inspection every 5 years**
- **Up front coordination and communication between….**
  - **Engineering and Design**
  - **Locks and Dams**
  - **Maintenance and Repair**

Conclusion …

- **This was a unique, challenging, and successful project for the St. Paul District.**
- **The success of this project was the result of several key factors including:**
  - **historically low flow conditions.**
  - **a unique dewatering box that was designed and constructed specifically for this project.**
  - **an effective surface preparation, concrete placement, and curing procedure.**

Conclusion Continued…

- **Communication**
  - **Locks and Dams**
  - **Maintenance and Repair**
  - **Engineering and Design**

Contact Information…

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- If you have any questions, please feel free to contact me.

Questions …