BUILDING A WORLD OF DIFFERENCE

MCCOOK MTS BIFURCATION – A PARADIGM OF CRAFTSMANSHIP

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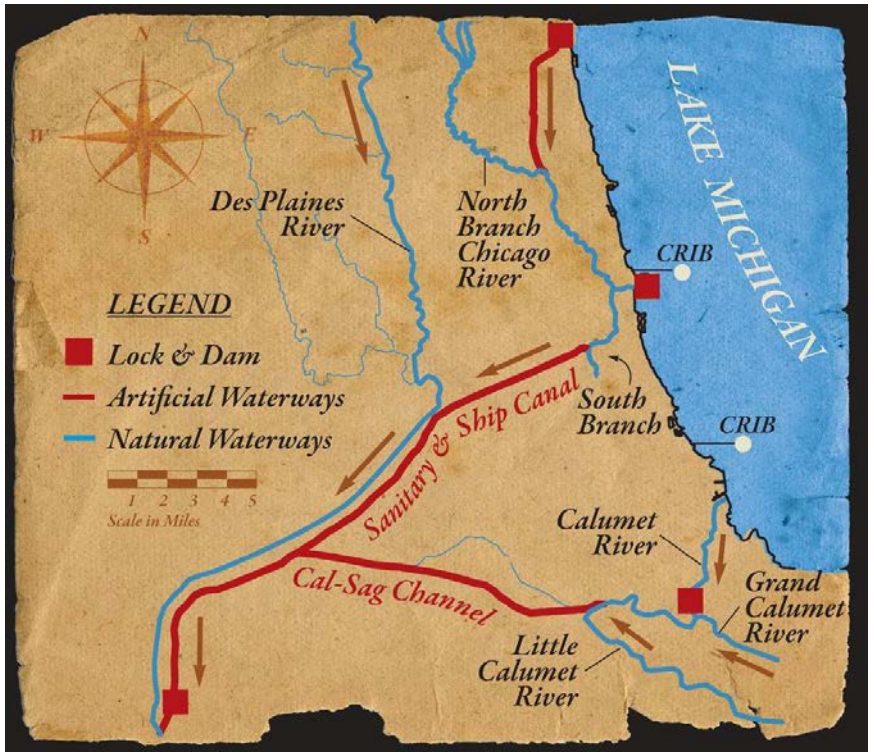
BLACK & VEATCH
Building a world of difference.®

HISTORY OF THE CHICAGOLAND UNDERFLOW PLAN

THE CHICAGOLAND UNDERFLOW PLAN
TARP - TUNNEL AND RESERVOIR PLAN

- Following the reversal of the Chicago River in the early 1900s, the Chicagoland area continued to develop & pollution of local waterways continued…
- In 1972, MWRDGC adopted the Tunnel and Reservoir Plan (TARP) in the largest water infrastructure undertaking in Chicago ($3.5 billion)



TARP SYSTEM MAP

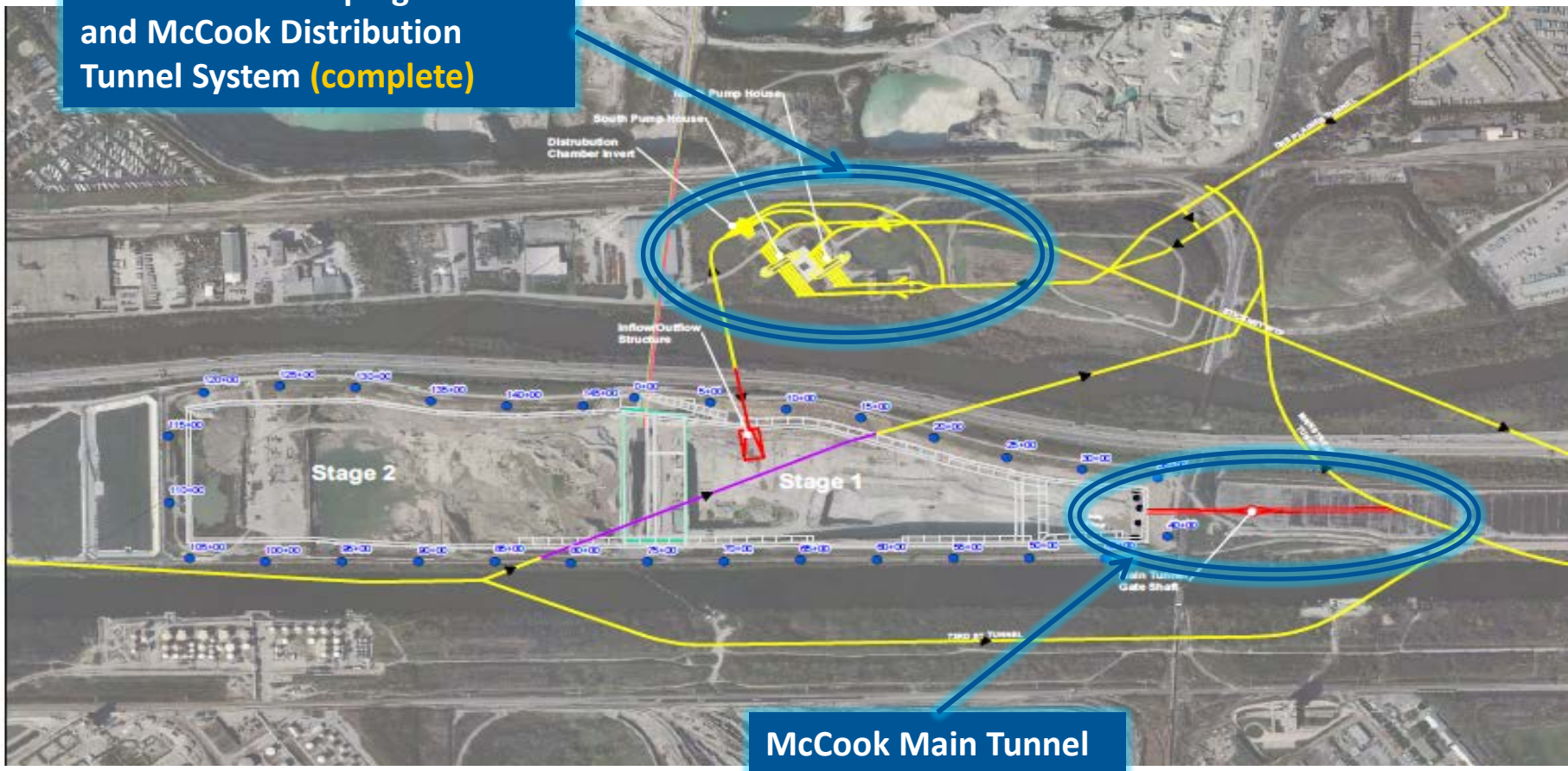
- **Phase I - 109.4 miles of tunnel**
  - Mainstream
  - Upper Des Plaines (O'Hare)
  - Des Plaines
  - Calumet
- **Phase II - Three large reservoirs:**
  - **McCook** (under construction)
  - **O'Hare** (complete)
  - **Thornton Composite** (under construction)

MCCOOK RESERVOIR OVERVIEW

MCCOOK RESERVOIR

- **Authorized in Water Resources Development act of 1999**
- **Will provide 10 BG of CSO and flood storage for TARP**
  - Mainstream and Des Plaines Deep Tunnel System
  - Stored volume will be pumped to Stickney WWTP for treatment before discharge into Des Plaines River

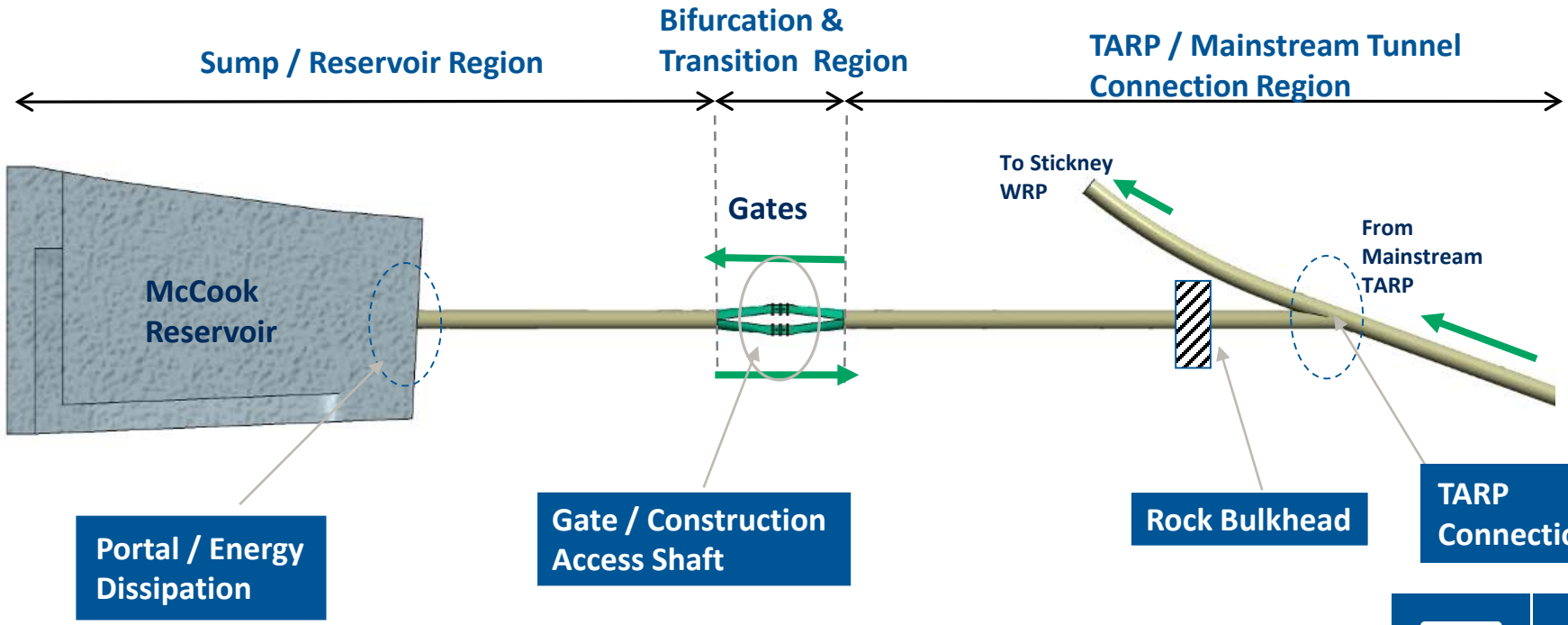
MCCOOK RESERVOIR – FACILITIES LAYOUT



MCCOOK MAIN TUNNEL SYSTEM

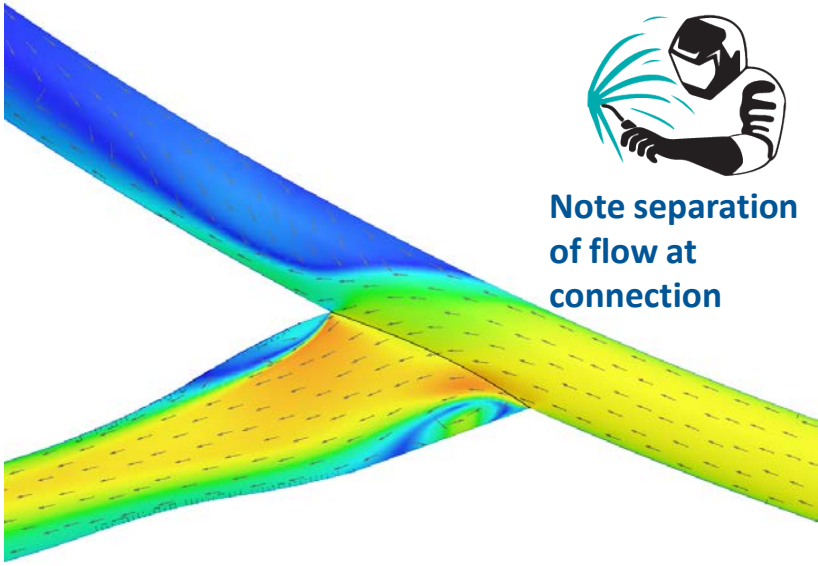
MCCOOK MAIN TUNNEL SYSTEM
KEY PROJECT ELEMENTS

- **Drill and Blast Tunnel connecting Mainstream Tunnel to McCook Reservoir**
  - 1,600 ft long
  - 33 ft diameter
  - Bifurcated for 290 ft through Main Gate/Access Shaft

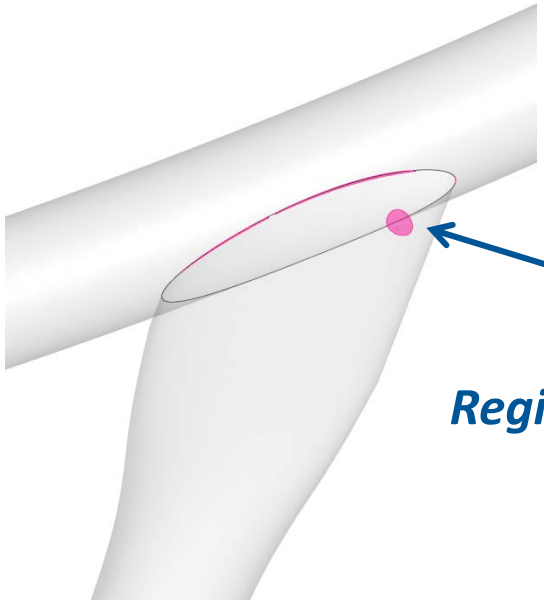


MCCOOK MAIN TUNNEL SYSTEM
KEY PROJECT ELEMENTS

- **Mainstream Tunnel Connection**
  - Live connection
  - Geometry analyzed with CFD to determine best geometry
  - 45 degree elliptical mitre



Note separation of flow at connection



Maximum velocity = 48ft/s
Minimum absolute pressure = 0.6atm

Region with sub-atmospheric pressure

HYDRAULIC ANALYSIS

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

Kiewit

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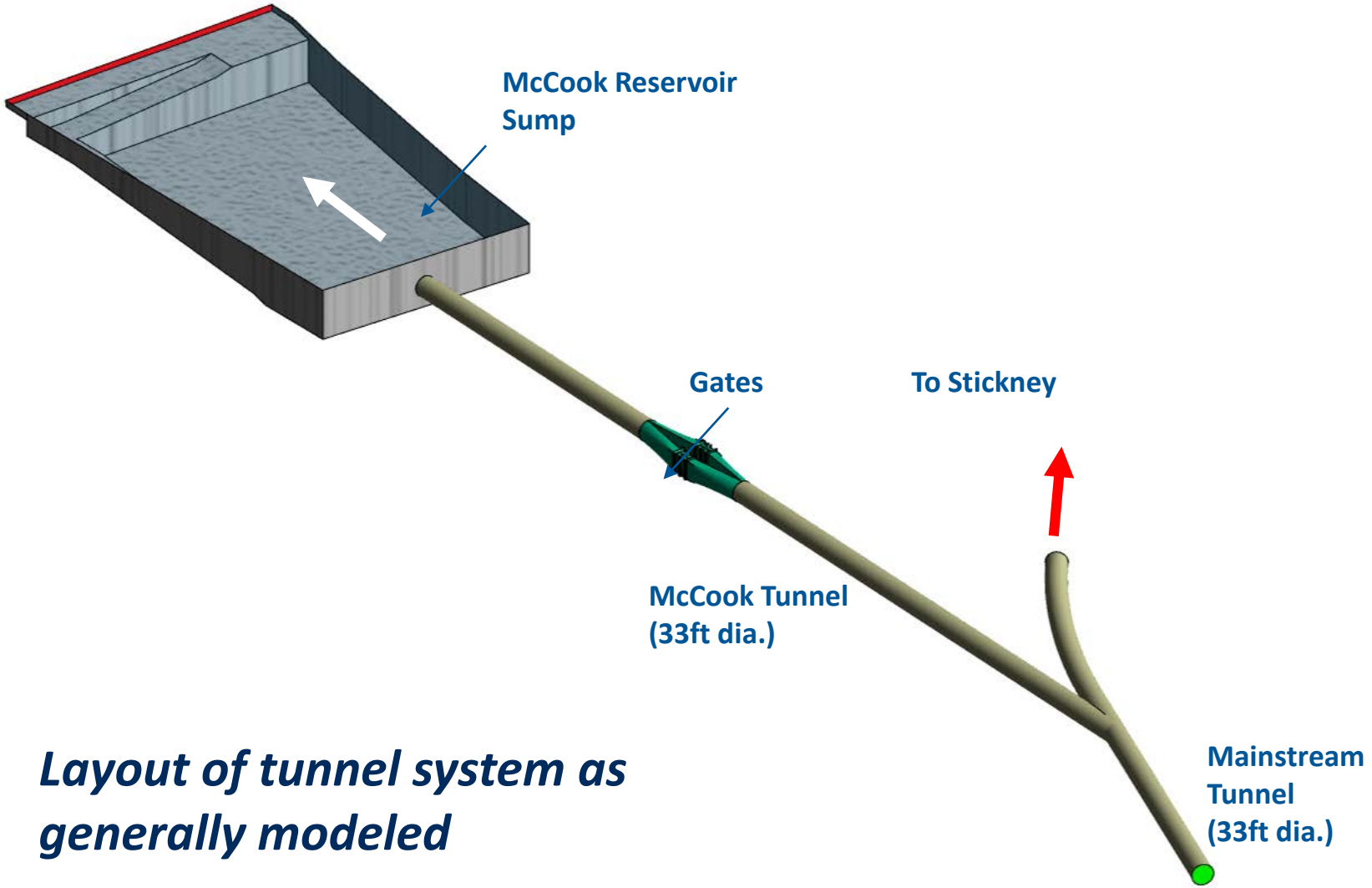
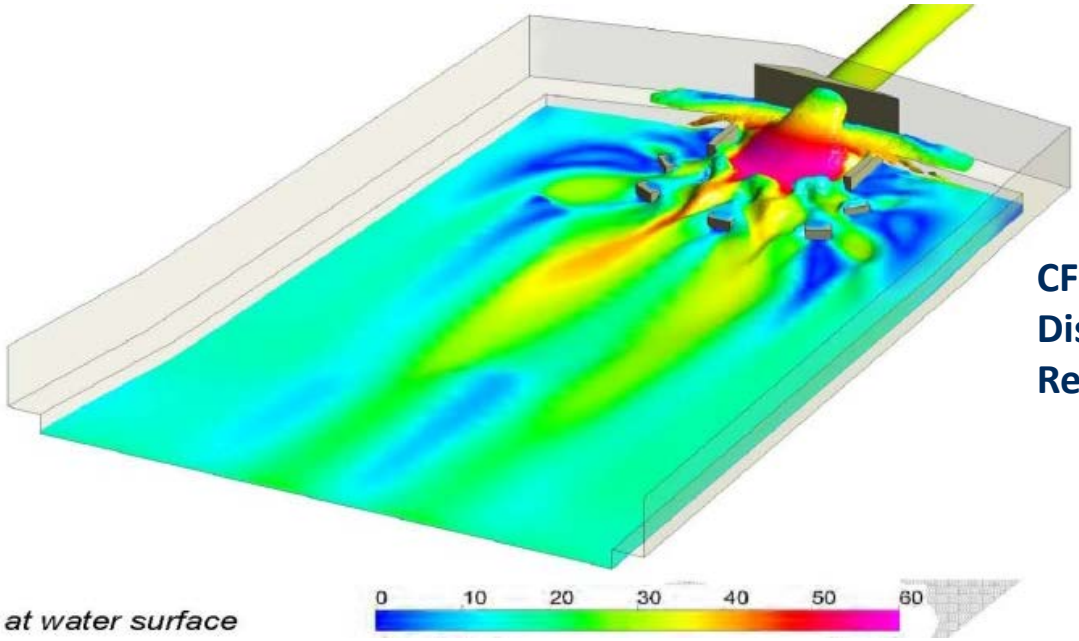
HYDRAULIC ANALYSIS – *PURPOSE*



Layout of tunnel system as generally modeled

HYDRAULIC ANALYSIS
MAIN CONCERNS

- **Cavitation**
  - The formation of vapor bubbles in low pressure areas
  - Vapor bubbles are carried downstream and in an area of higher pressure, will condense and collapse suddenly
- **Abrasion**
  - Damage to tunnel lining caused by significant quantities of sand, gravel, rock, and other debris found in storm water, in high velocity flows

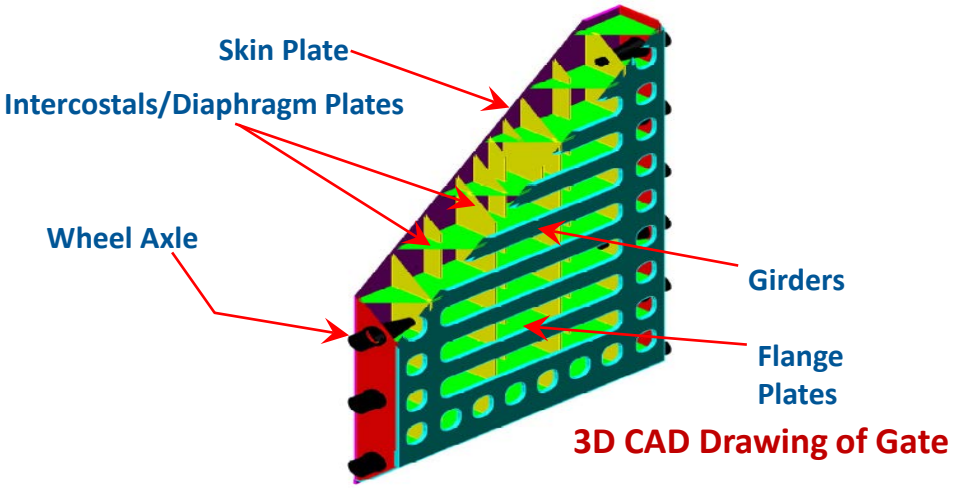


CFD Model of Energy Dissipation Structure in Reservoir

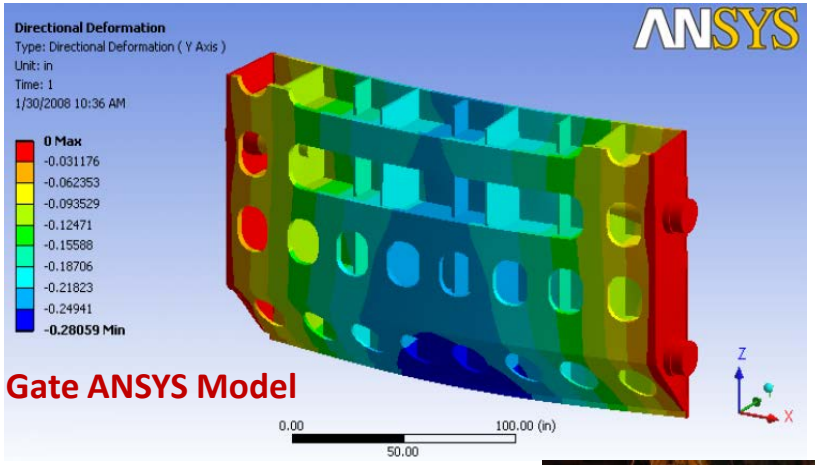
HYDRAULIC ANALYSIS
MODELING APPROACH

- **Computational Fluid Dynamics (CFD)**
  - ANSYS CFX Code
    - Set up a mesh which splits water into a large number of small elements
    - Predicts flow by solving iteratively a series of equations for conservation of mass momentum and energy
- **Peak flow**
  - During storm events, most of the flow in the Mainstream Tunnel will be routed through the Main Tunnel. Flows in the Mainstream Tunnel average 30 ft/s
- **Assumes gates are in open position**

MAIN GATE SHAFT



3D CAD Drawing of Gate



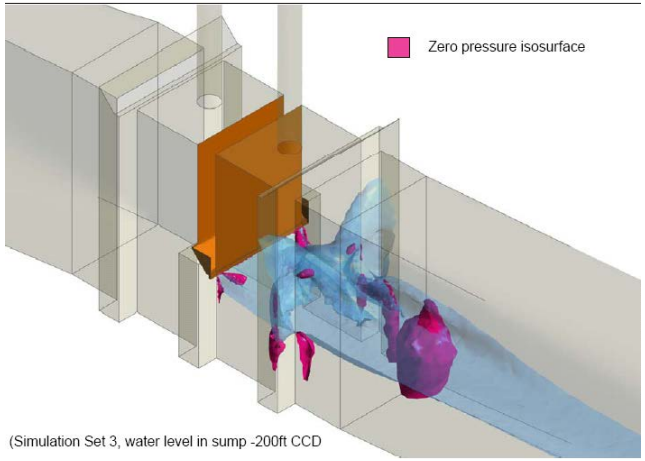
Gate ANSYS Model

- 6 gates operated by hydraulic cylinders in guide slot by wheels

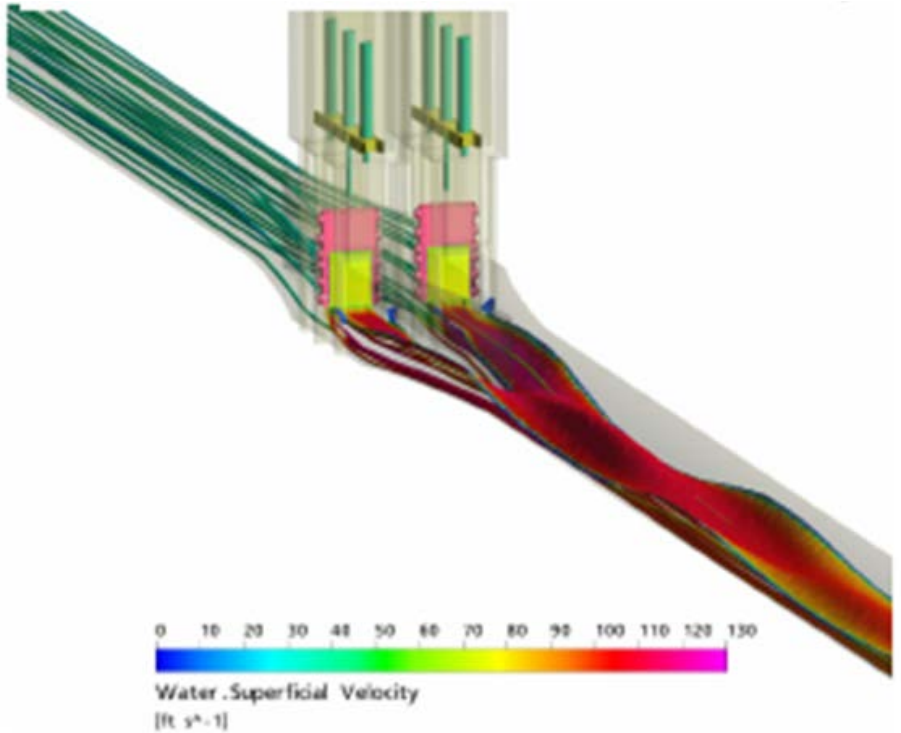
Gate Fabrication

MAIN GATE SHAFT
GATE HYDRAULICS

- **All gates designed to resist static load 250 – 300 ft of hydraulic head**
- **6 main gates**
  - Resist flow in both directions
  - 15 – 20 ft wide, approximately 30 ft tall
  - Over 200,000 lbs each



(Simulation Set 3, water level in sump -200ft CCD




STEEL LINER
CONSTRUCTION

THE RIGHT TEAM

- National Welding Corporation –Assemble, Fit, and Weld Steel Tunnel Liner
- Kiewit Infrastructure- General Contractor, Excavate, Concrete Lining, and oversight.
- Selway Corporation- Shop Drawings and Fabrication of Steel Liner Pieces.

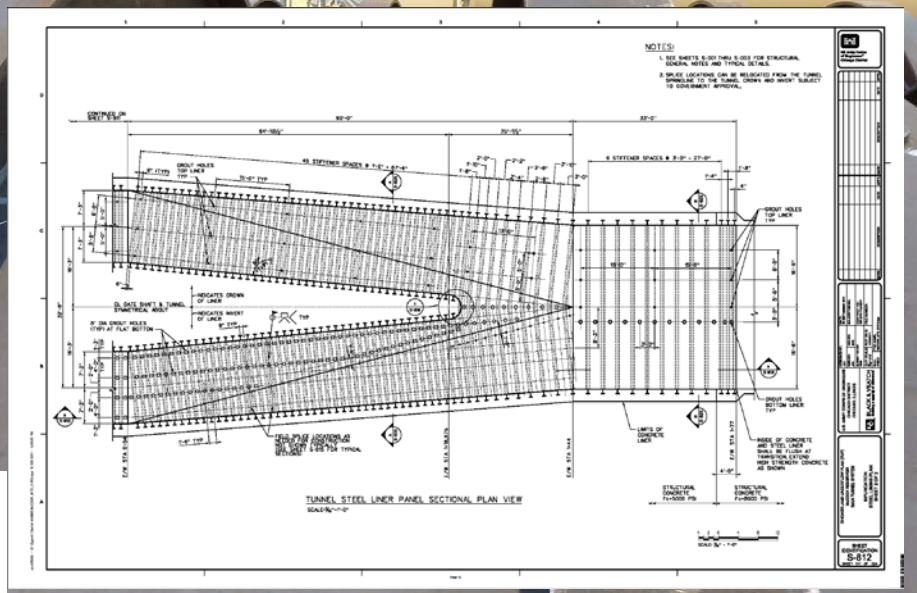
NATIONAL WELDING CORP.

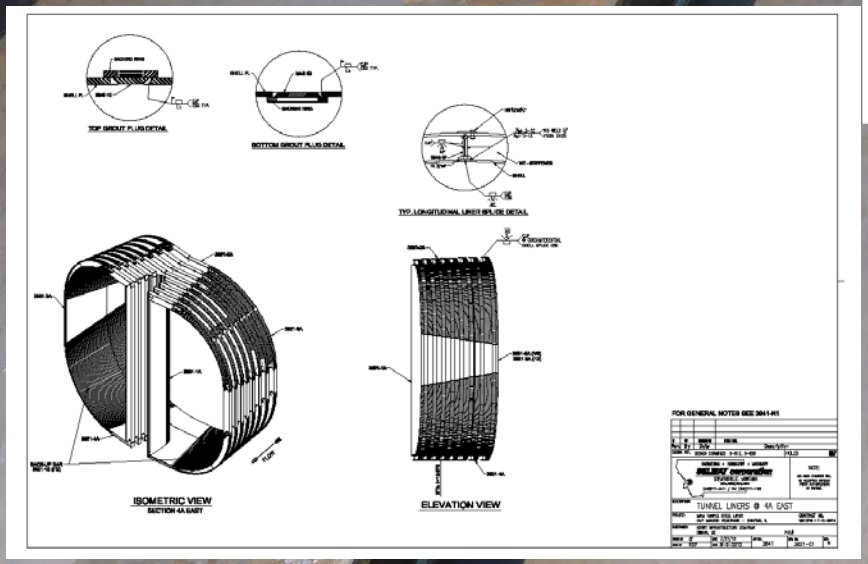
Kiewit

SELWAY

PREASSEMBLY PLANNING

- **Design**
  - 108 m (354 ft) of steel liner
  - Bifurcation from 10 m (33 ft) to 4x9.8 m (19x32 ft)





- **Changing Geometry**
- **“T” Steel rings**

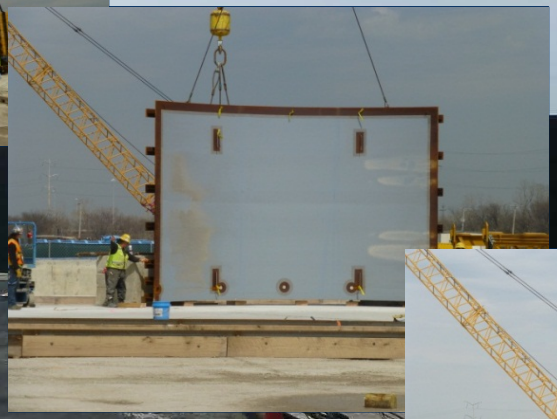
FABRICATION OF STEEL LINER SECTIONS

- Tolerances
- Connections
- Preassembly

- Shipping Considerations
- MT to IL using 48 special loads

A PARADIGM OF CRAFTSMANSHIP

SURFACE SUBASSEMBLY



- 10 m (33 ft) Diameter Pieces Assembled Onsite

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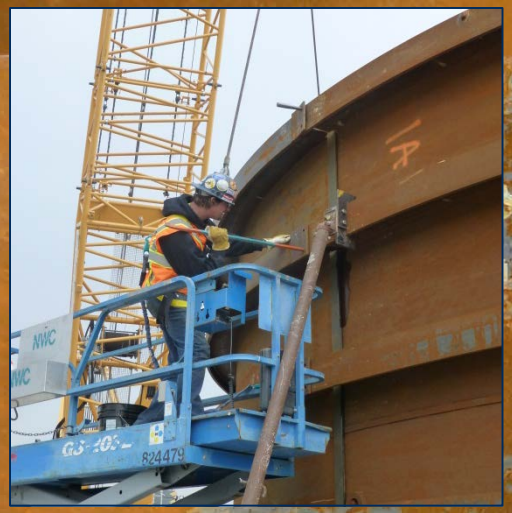
RIGGING AND CONNECTIONS



- Bolted Connections
- Custom Rigging for each ring of liner

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LINER SUPPORT

- Cross-Bracing Installation

A PARADIGM OF CRAFTSMANSHIP

ENVIRONMENTAL CONTROLS

- Surviving Chicago's Winter

- Temporary Shelter

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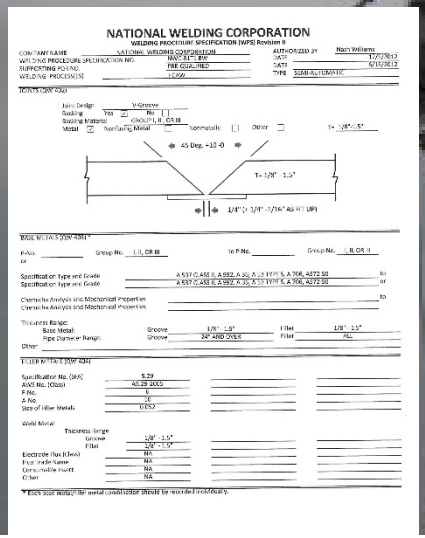
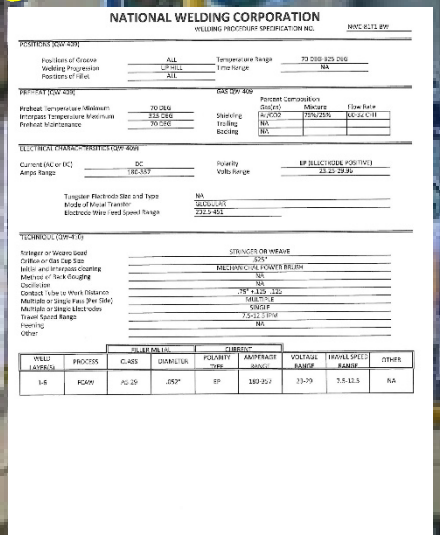
FINAL FIT-UP AND WELD-OUT

- Seam Fitting
- Roundness Tolerance

- FCAW Welding


NATIONAL WELDING CORPORATION
WELDING PROCEDURE SPECIFICATION (WPS) Revision 0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WELDING PROCEDURE SPECIFICATION NO. NWC-RLTL-BW

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QUALITY CONTROL

- Magnetic Particle (MT) inspection

- Ultrasonic Testing (UT) Inspection

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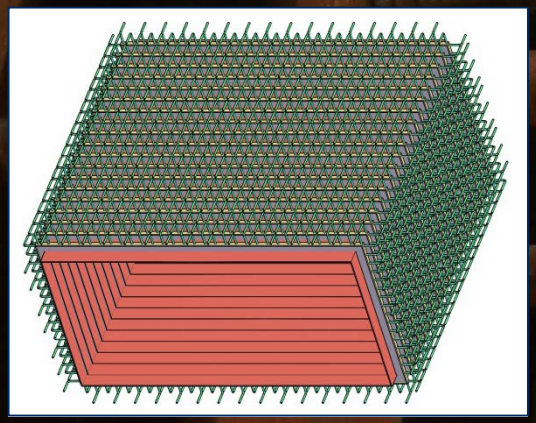
“J” ANCHOR LAYOUT AND WELDING



- Over 16,000 Anchors-Field Installed

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CHANGING GEOMETRY

- Bifurcation

- Bull Nose

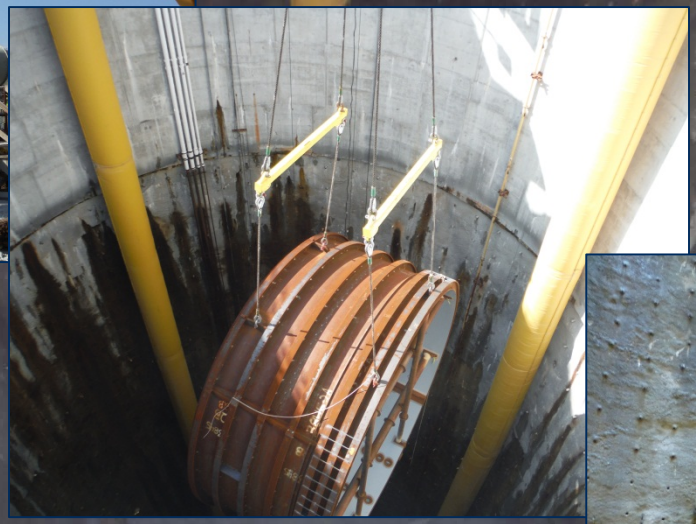
A PARADIGM OF CRAFTSMANSHIP

HANDLING 33 FOOT DIAMETER SECTIONS

- Rotation of 164mt (180 tons)

HANDLING 33 FOOT DIAMETER SECTIONS

- Sections Lowered Down 91 m (300 ft) Shaft



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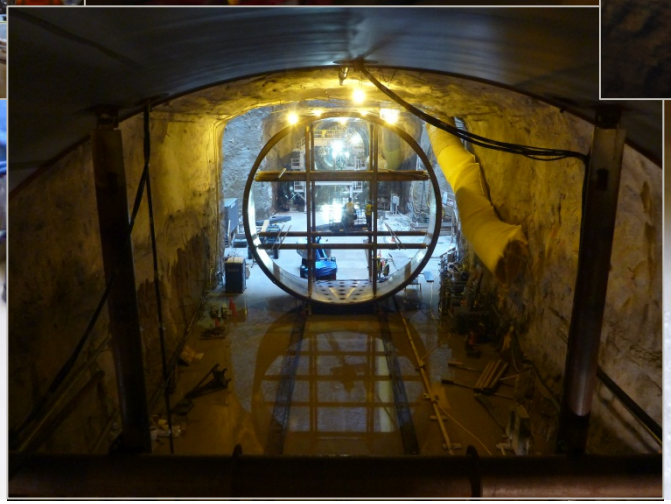
TUNNEL INSTALLATION

- Sections transported into position



- Annular Bracing Installed

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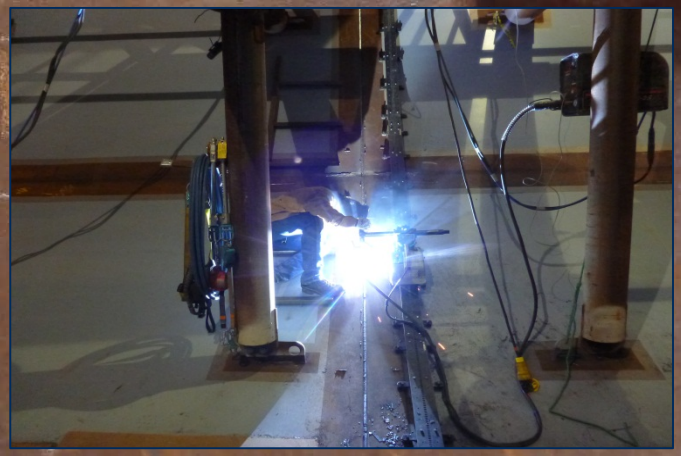
CIRCUMFERENTIAL SEAMS FITTING AND WELDING

- Over 937 m (3076 ft) of CJP tunnel welds performed

- Automatic and Semi-Automatic FCAW Welding



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FINISHED STEEL TUNNEL LINER

KEY ELEMENTS OF SUCCESS

1. Team Approach
2. Capable Team Members
3. Careful Planning and Development

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