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

Mainstream Pumping Station and McCook Distribution Tunnel System *(complete)*

McCook Main Tunnel Connection System
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

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

Region with sub-atmospheric pressure
HYDRAULIC ANALYSIS
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](attachment:image.png)

*Velocity at water surface*
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
• 6 gates operated by hydraulic cylinders in guide slot by wheels
• 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
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.
A PARADIGM OF CRAFTSMANSHIP

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
SURFACE SUBASSEMBLY

- 10 m (33 ft) Diameter Pieces Assembled Onsite
RIGGING AND CONNECTIONS

- Bolted Connections
- Custom Rigging for each ring of liner
LINER SUPPORT

- Cross-Bracing Installation
ENVIRONMENTAL CONTROLS

- Surviving Chicago’s Winter
- Temporary Shelter
FINAL FIT-UP AND WELD-OUT

- FCAW Welding
- Seam Fitting
- Roundness Tolerance
QUALITY CONTROL

- Magnetic Particle (MT) inspection
- Ultrasonic Testing (UT) Inspection
“J” ANCHOR LAYOUT AND WELDING

- Over 16,000 Anchors-Field Installed
CHANGING GEOMETRY

- Bifurcation
- Bull Nose
HANDLING 33 FOOT DIAMETER SECTIONS

- Rotation of 164mt (180 tons)
HANDLING 33 FOOT DIAMETER SECTIONS

- Sections Lowered Down 91 m (300 ft) Shaft
• Sections transported into position

• Annular Bracing Installed
CIRCUMFERENTIAL SEAMS FITTING AND WELDING

- Over 937 m (3076 ft) of CJP tunnel welds performed
- Automatic and Semi-Automatic FCAW Welding
FINISHED STEEL TUNNEL LINER

KEY ELEMENTS OF SUCCESS

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