Winfield Hydraulic Cylinder Replacement

Waylon Humphrey, PE

LRL-Maintenance Section

Project Engineer

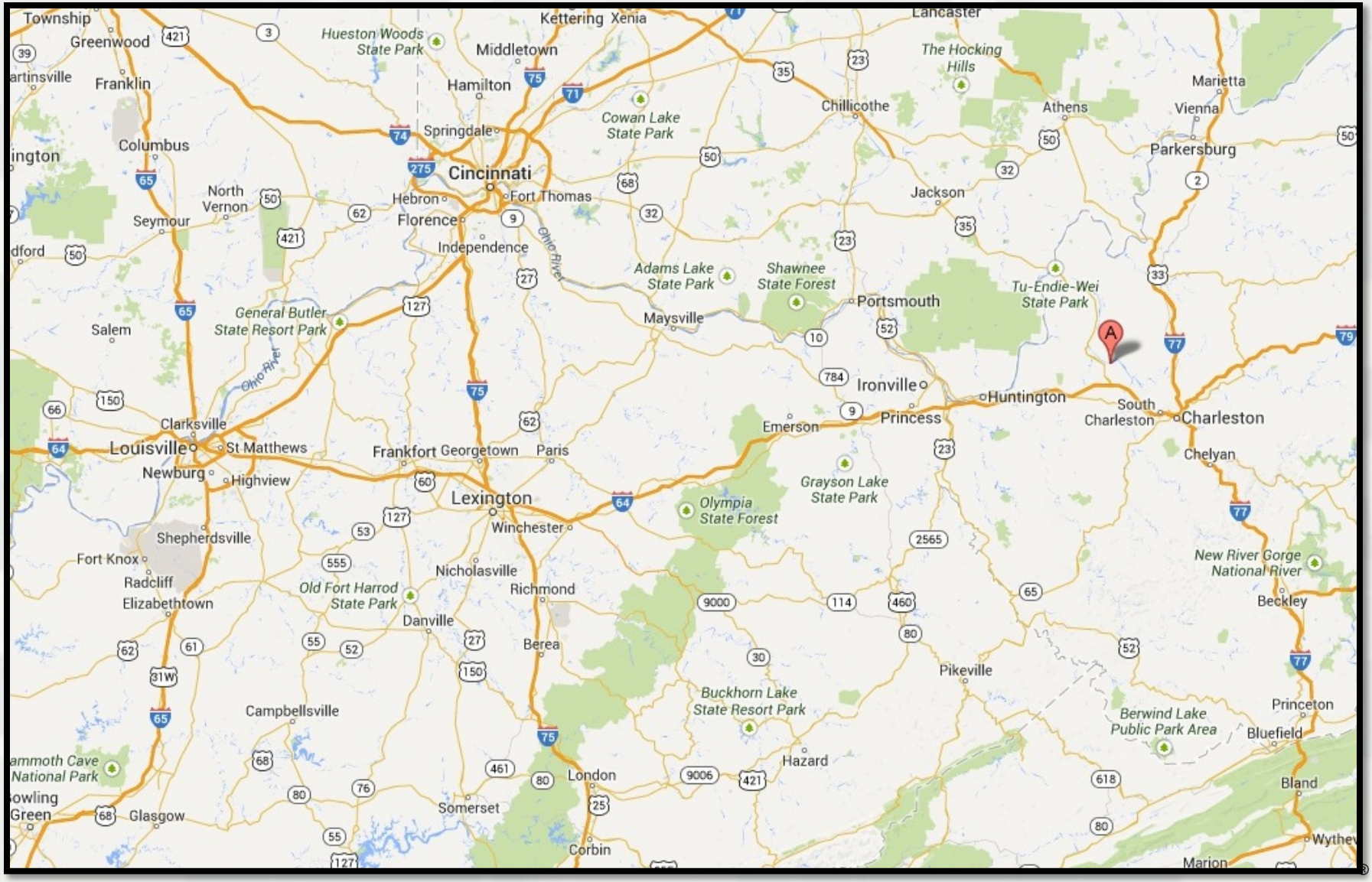
US Army Corps of Engineers

BUILDING STRONG®

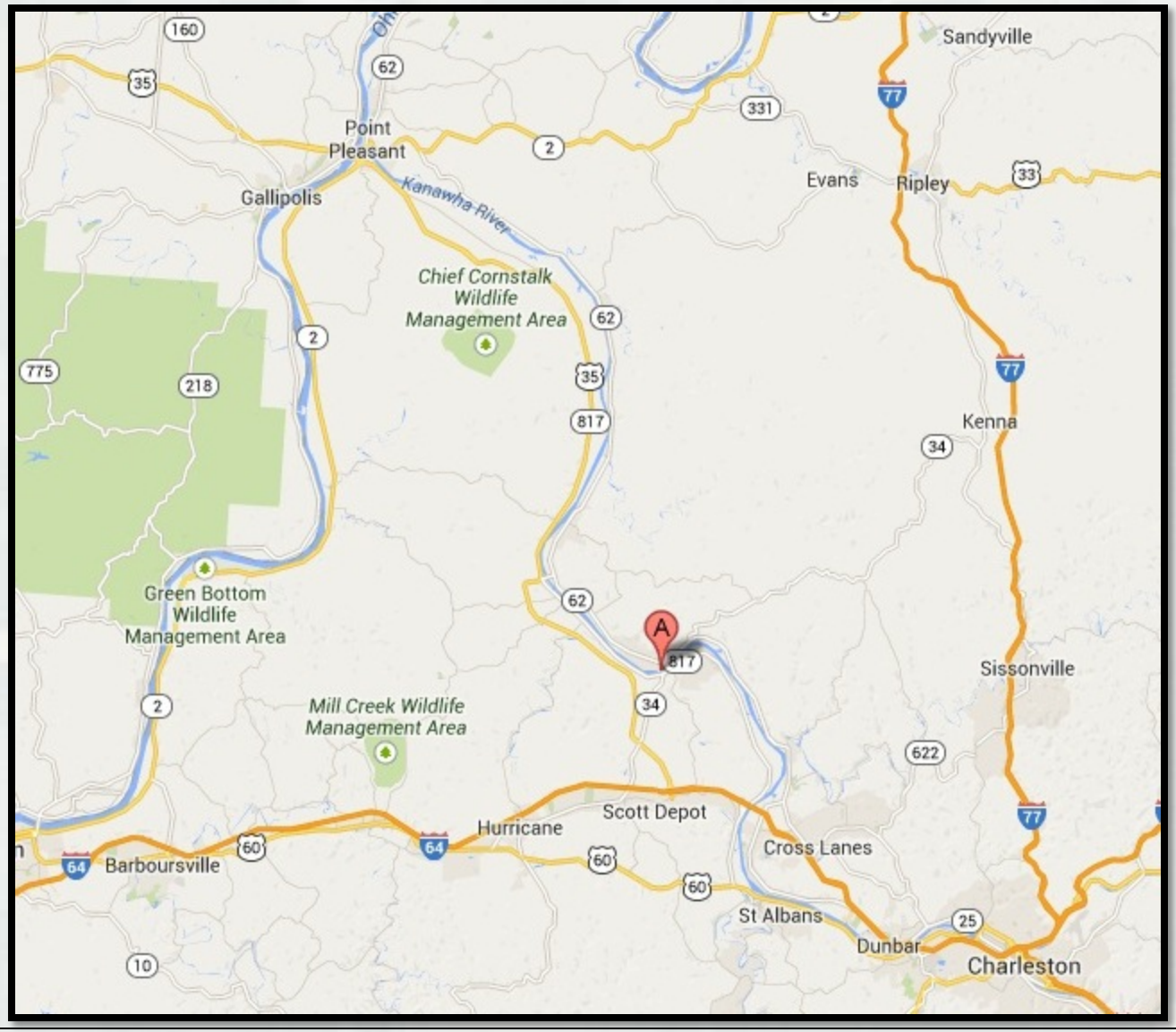
Presentation Outline

- Background Info & Purpose of the Repair
- Known Challenges
- Repair Process
- Future plans (Olmsted)
- Questions/Comments

Location of Winfield L&D

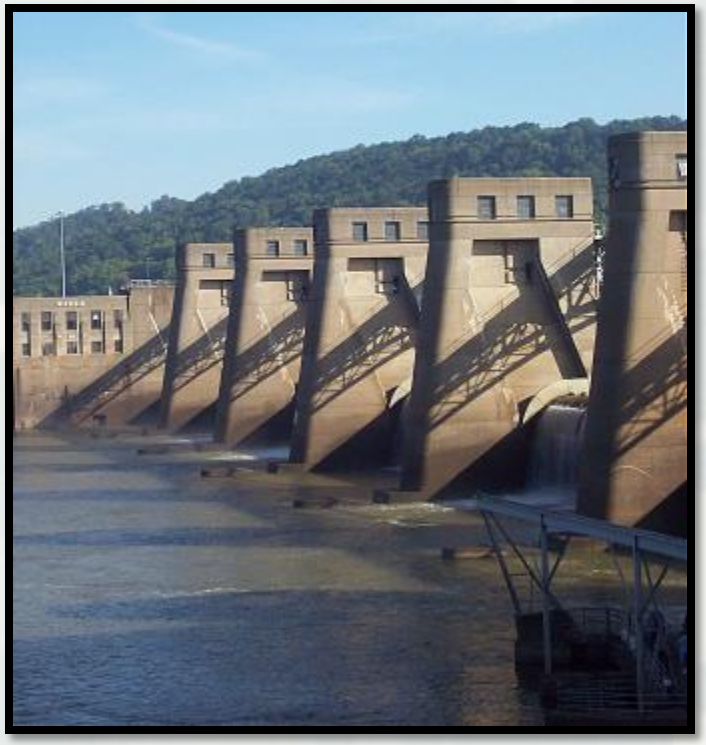


Location of Winfield L&D



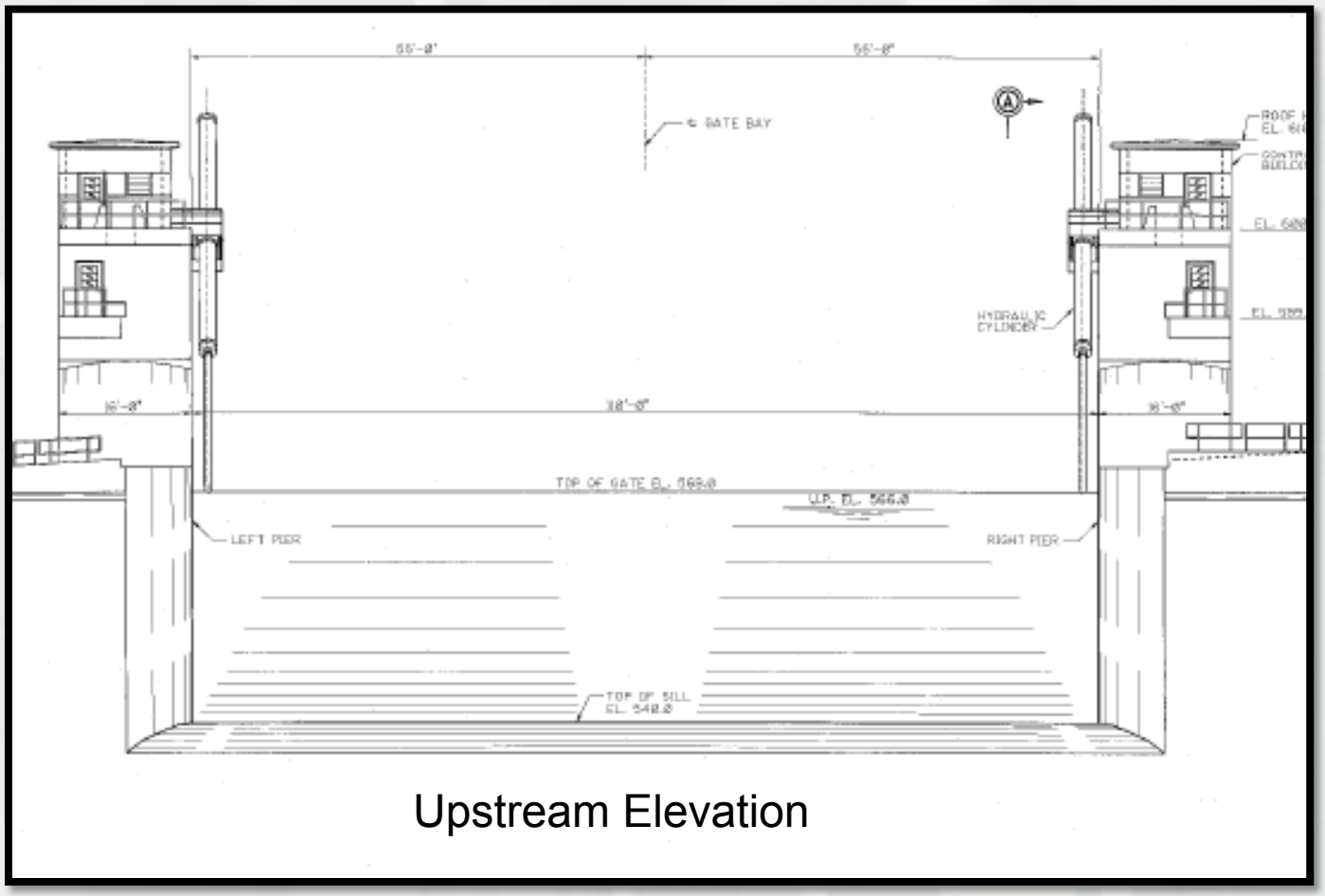
Winfield Locks and Dam

- Began Operation in 1935 as 6 Roller Gates and two 360’ Lock Chambers
- Hydroelectric Power Plant added around 1984
- 800’ chamber and Tainter Gate added in 1997



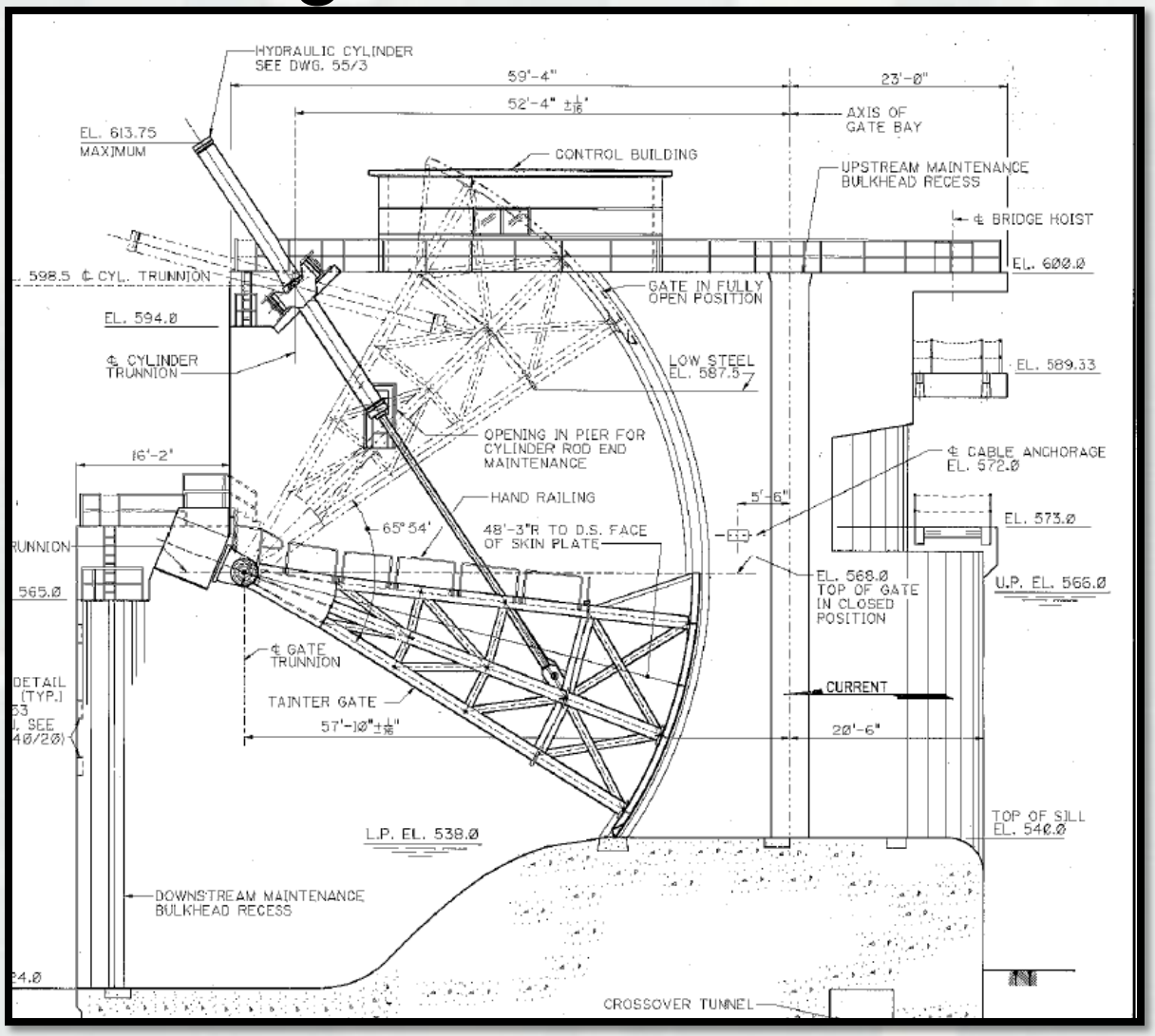
Layout of Winfield L&D

Background Information



Upstream Elevation

Background Information



Background Information

•Cylinders remain extended the majority of the year.

•Cylinders were installed with ceramic coated rods

Why Ceramic?

- Cost
- Position Sensing System
- Promoted as Superior to other coatings

Cylinder Details

- ~34,000lbs
- ~39ft Long (retracted)
- 31ft Stroke
- 20.47” Bore Diameter
- 6.66” Rod Diameter
- $735,000.00 (replacement)

Background Information

Flood Conditions 2003

•Cylinders rotate about trunnion as they retract.

•Never fully retract

Purpose of Replacement

- New Lock Chamber/Tainter Gate were commissioned in 1997
- By 2005 ceramic coating was visibly failing

May 2005

Purpose of Replacement

• Failed ceramic coating prevented raising of gate for fear of damaging seals.

2008

2013

Failure of Ceramic Coating

- Corrosion was caused by water penetration through the porous ceramic coating

- Water penetration occurred after the rod lost its coating of hydraulic oil due to never being retracted

- Contributing factors were sunlight and maybe natural bending of the rod

- The rods are not salvageable

Replacement Cylinders

- Chrome Plated Stainless Steel Rods
- Ordered by LRH – on site at Winfield

Known Challenges

- Cylinders were installed in the dry via cofferdam and hydraulic crawler crane below tainter gate

- No access on upstream side of gate

- Work access platform for rod/ gate connection

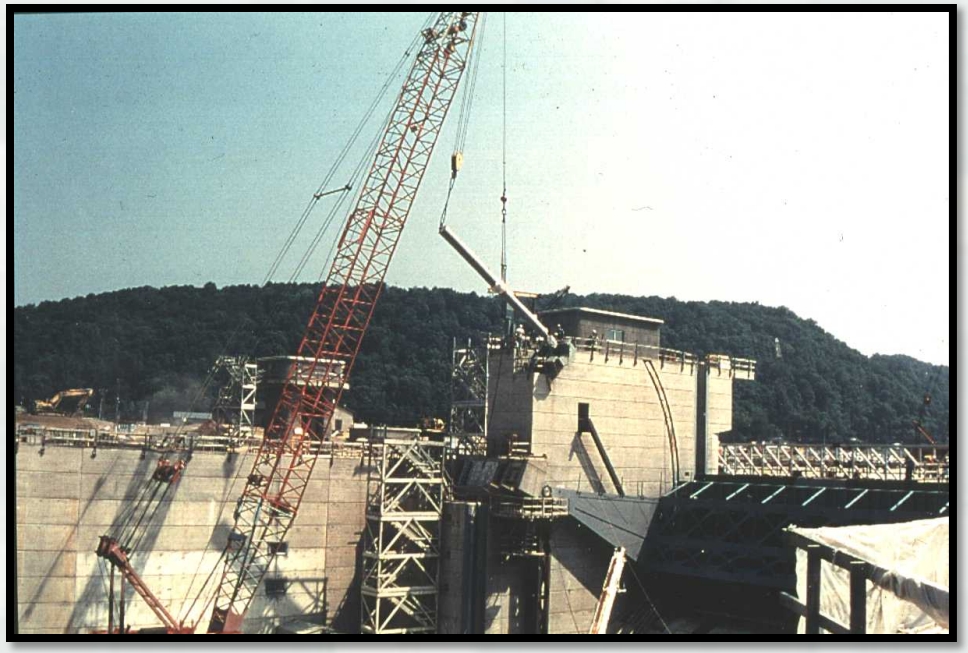
- Removing connection pins/ installing new pins

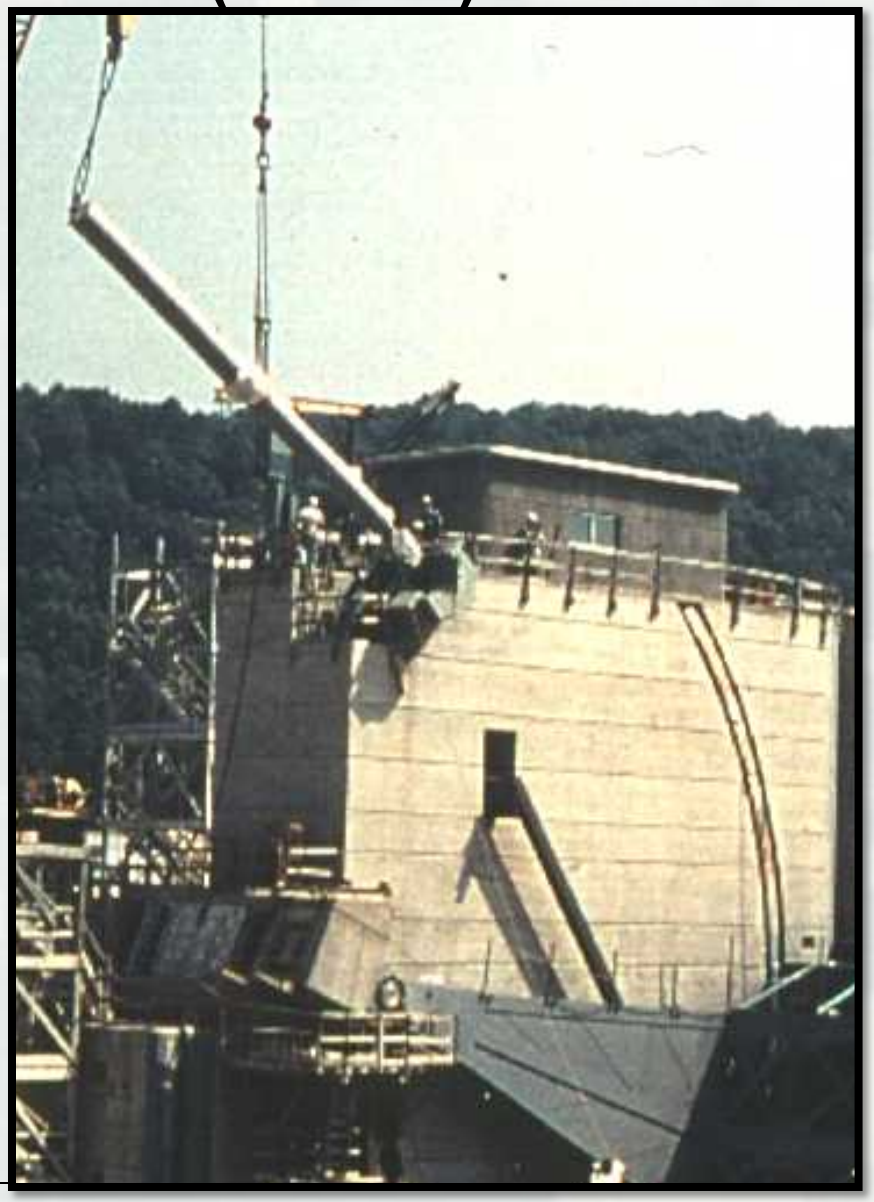
- Cylinders must be lifted in/ out through trunnion mount
    - Two crane lift, with primary crane using both hoists.

- Support for new cylinder rod as it extends to connection point

- Tolerances on new pins and spherical bushings

Original Installation (1997)





- Use of Main and Aux hoists to control angle
- Rigged around cylinder body just below trunnion
- Rod Support mounted to pier

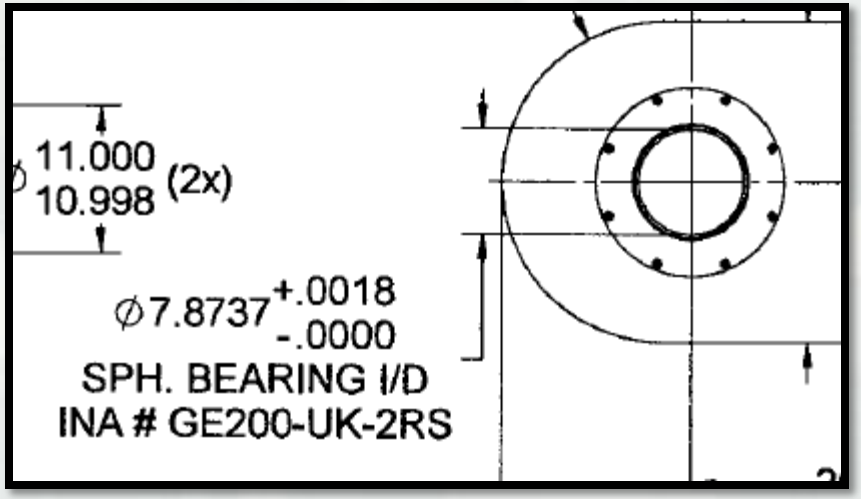
Original Installation (1997)

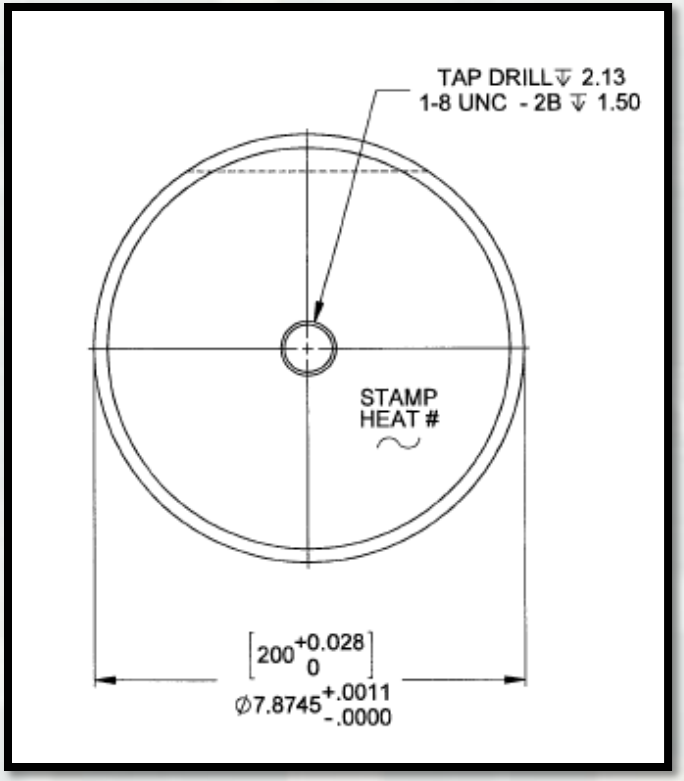
- Unable to sit pins into journals due to interference of rigging with framing
- A second crane was used to finish the lift

No Upstream Access

Work Access to Pin Connection

Removing Connecting Pins





- Largest Clearance
  Bearing 7.8755” & Pin 7.8745” = +.001”

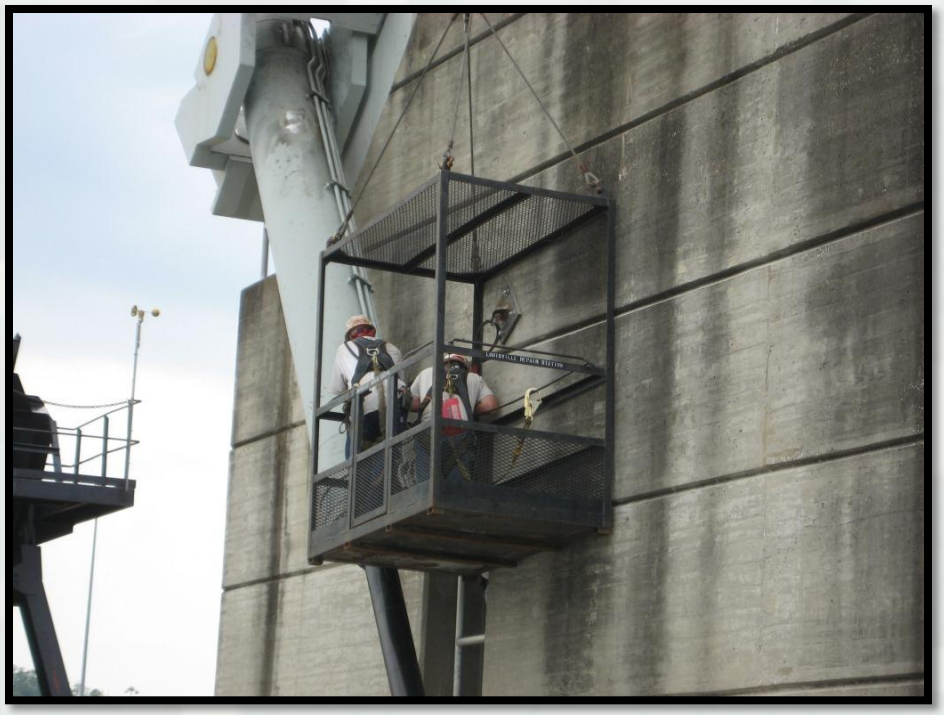
- Smallest Clearance
  Bearing 7.8737” & Pin 7.8756” = -.002”

  Gate Ear Design 7.876”+.002 vs. Actual 7.872”

Condensed Repair Process

- Construct safe work access to rod/gate connection, secure cylinders, lifting lugs added to cylinders
- Attempt to push/pull pin
- Cut and remove cylinder rod
- Cut rod eye away from pin
- Cut and remove pin
- Remove old cylinders
- Construct support for extending new cylinder rod
- Install new cylinder/extent rod/make connection to gate
- Repeat for 2nd cylinder

Repair Process



Left: Placing 100T mobile crane

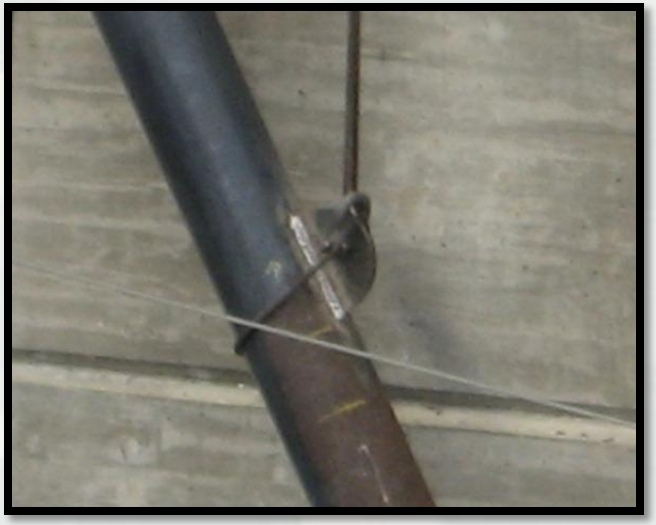
Right: Man basket access

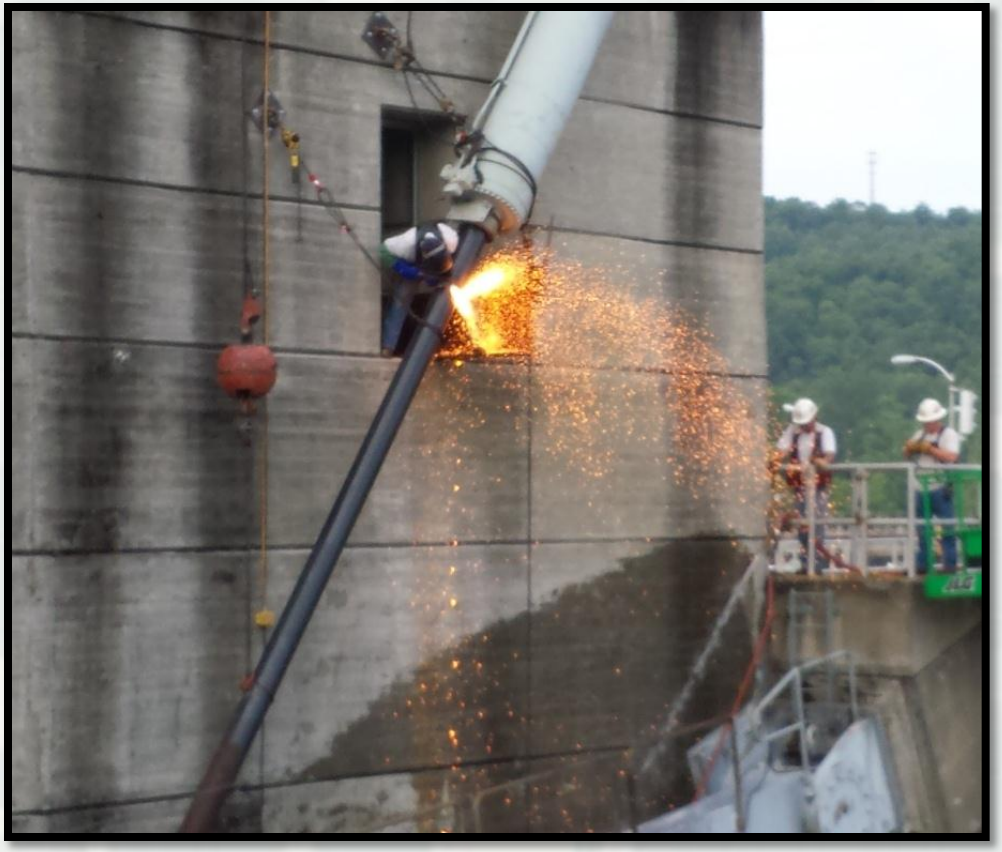
Repair Process

- Fabricated pad eyes to secure cylinder and rod
- Added lifting lugs

Repair Process

- Failed to remove pin using hydraulic rams.
- Proceeded to remove cylinder rod to allow for removing rod eye from pin.





Repair Process

•With rod removed, the rod eye was cut from the pin and area prepped for new pin

Repair Process

Repair Process

Repair Process

Repair Process

•With cylinder removed a support ramp was fabricated to support the rod as it extended

Repair Process

- Installation of new cylinder with same technique as removal

Repair Process

•The same process was then performed on the opposite cylinder

•Once both cylinders were hooked up and ready the rods were extended down the support beam.

Repair Process

•New pins were installed by freezing them in liquid nitrogen, and making sure all component diameters were at the end range of tolerance.

Repair Process

•Rod support ramp then had to be removed from under cylinder

New Cylinder Installed

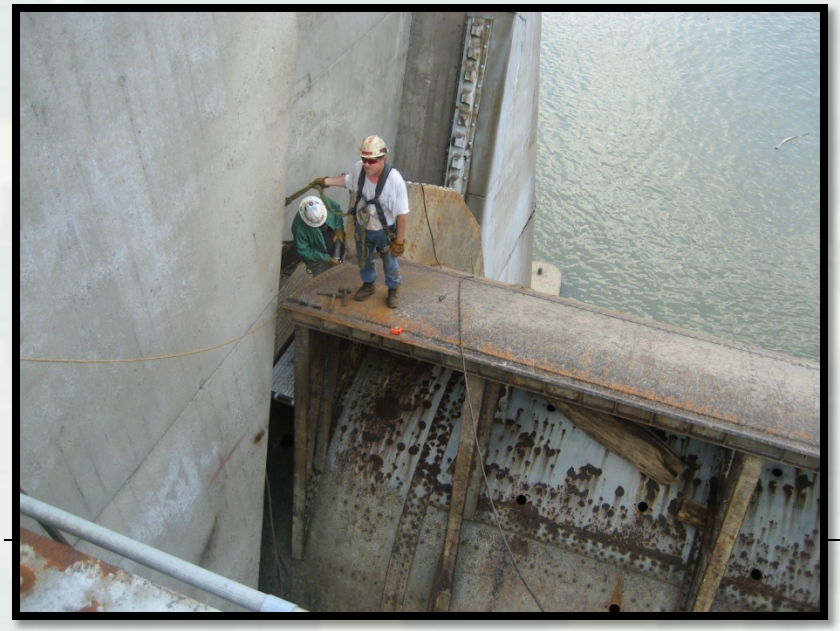
- Tested cylinders as much as High Pool would allow
- Scheduled Duration 30 Days
- Actual Duration 21 Days
- Allowed for Additional Work on Roller Gate

Future Plans

• A very similar direct connect design is being implemented at Olmsted Lock and Dam.

- •Normal low pool will have pin connection submerged
- •Cylinders would have to be replaced with bulkheads set and tainter gate in top position (limiting clearance around cardan ring)
- •Multiple gates in a row removes ability to use lock walls for mobile crane
- •Addition of lifting lugs to trunnion casting
- •Method of removal without multiple cranes? (lifting beam/eliminate need to lower through cardan ring & support framing)
- • Tolerance of pin connection: Will the cylinder rods and rod eye have to be scrapped any time a cylinder is replaced?

Work on Roller Gate



Questions