NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

PRESENTATION:

Rehabilitation of Raw Water Conduit and Pedestrian Tunnel

PRESENTED BY:

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INTERNATIONAL CONCRETE REPAIR INSTITUTE
2014 Spring Convention - Infrastructure Repair

March 19, 2014

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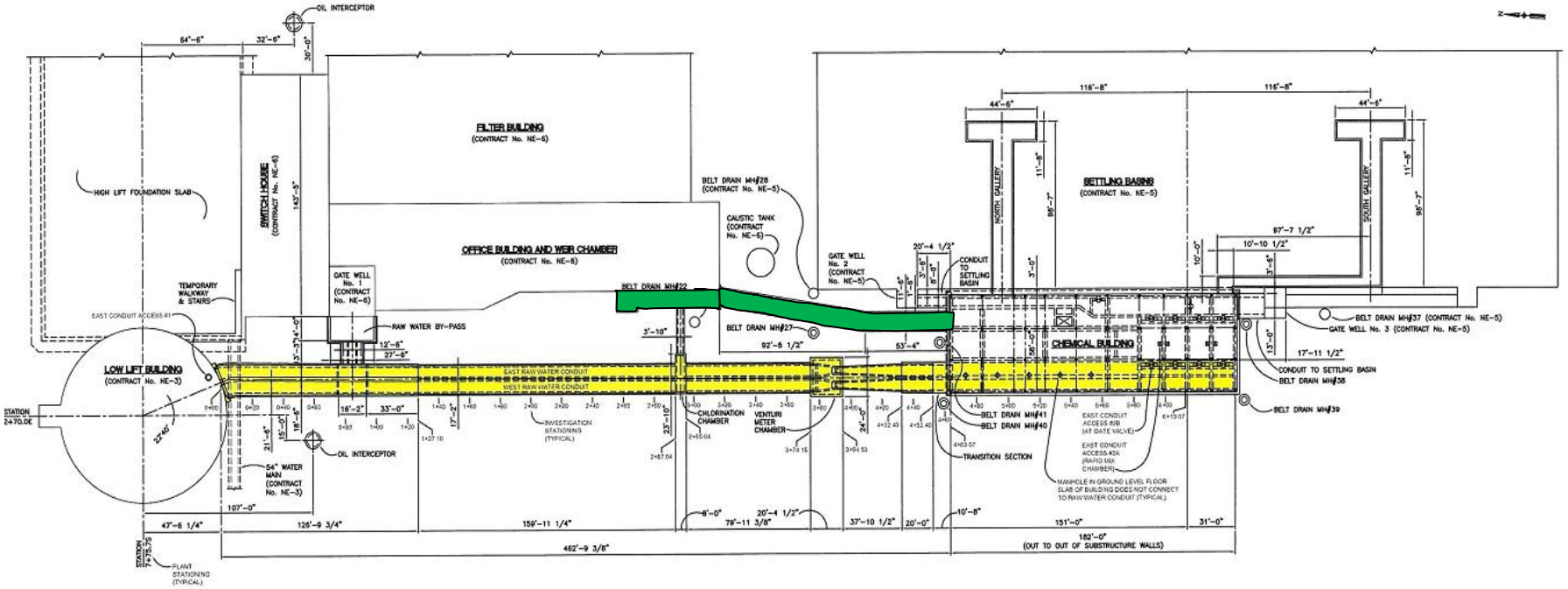
Presentation Outline

- Introduction
- Background
- Investigation
- Findings / Evaluations
- Repairs
- Challenges
- Questions

PROJECT AREA:
East and West Raw Water Conduits and Tunnel



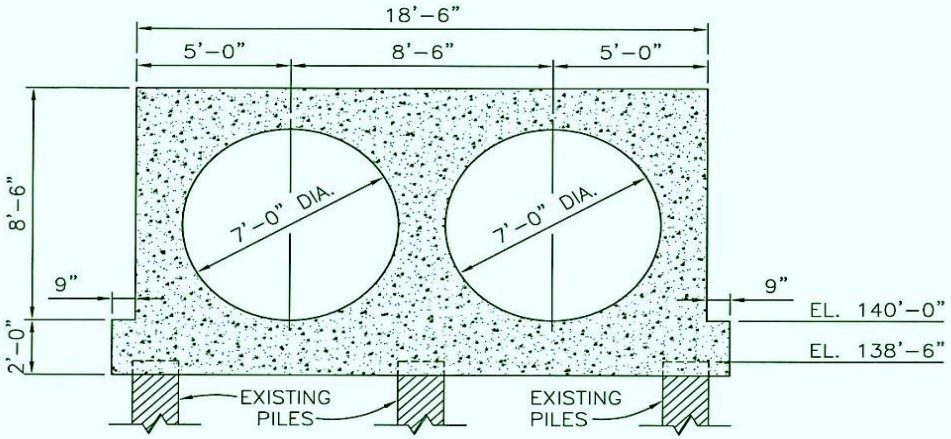
Project Background (from Owner's Report)

- Visible cracks in walls and ceiling in Chemical Building
- Water leakage through cracks
- Other areas not visible without dewatering system

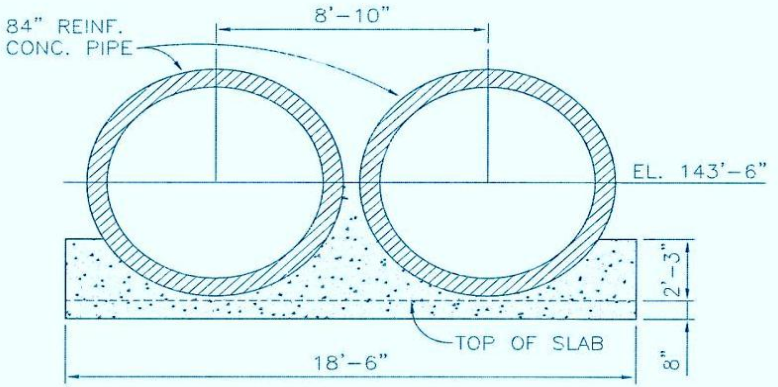
Raw Water Conduits

- Constructed in mid 1950s
- Dual Raw Water Conduits
  - 7 feet diameter
  - 7 feet square under Chemical Building
- Design Components
  - Cast-in-place Concrete
  - Reinforced Concrete Pipe
  - Steel-Plate Pipe
- Chlorination chamber
- Venturi Meters

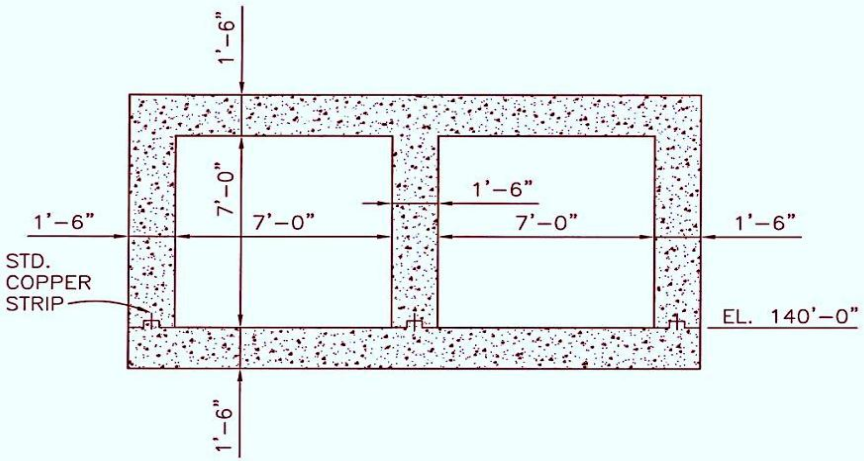
Details of As-Designed Conduits



SECTION "A"



SECTION "B"



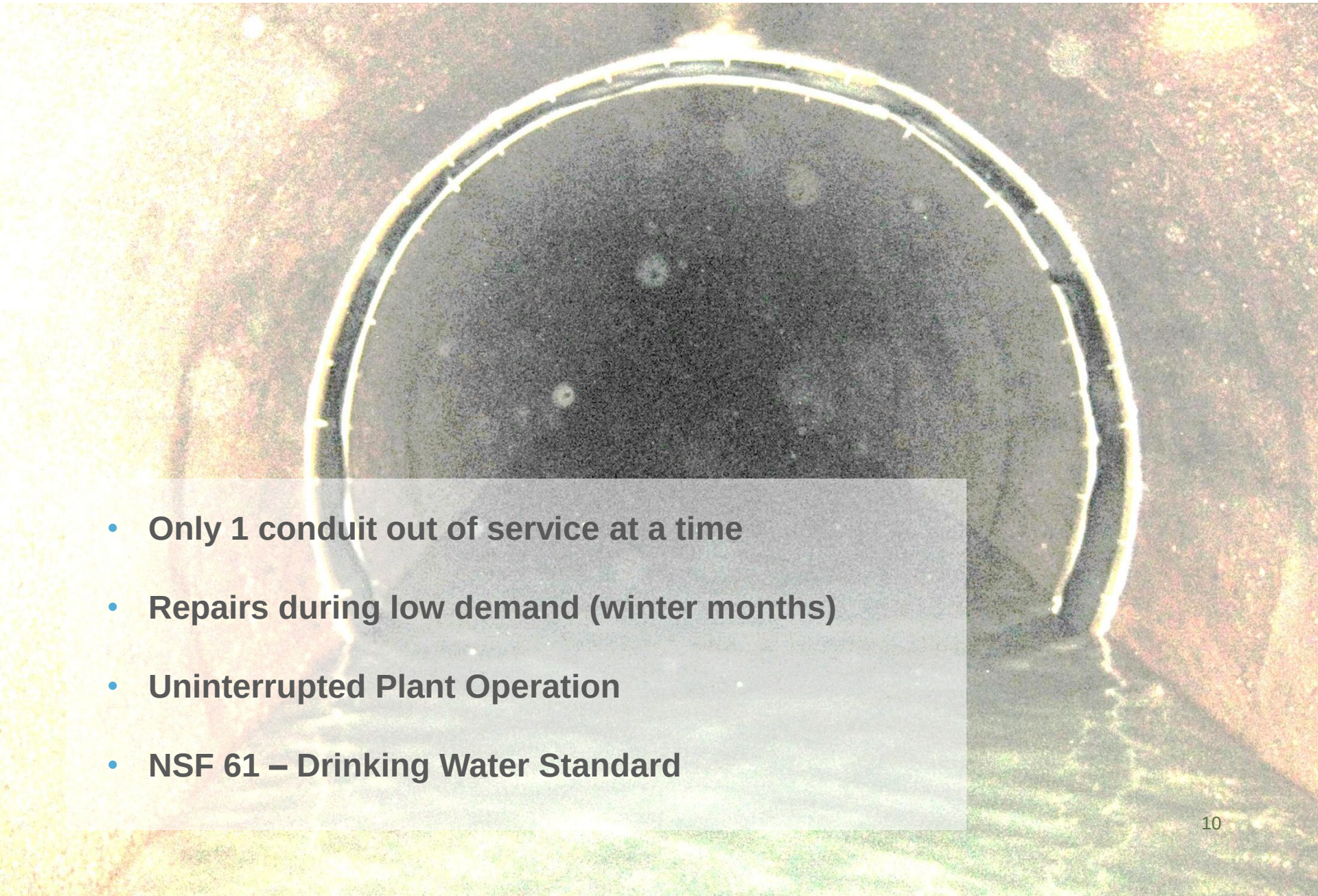
SECTION "C"

Site Access

- Permit required confined space
- Only 2 access points
  - Chemical Building
  - Low Lift Building
- Hazards
  - Chlorine
  - 36-inch bypass line
  - Venturi


NORTH EAST PLANT
CAUTION
01/12/2012

Site Limitations



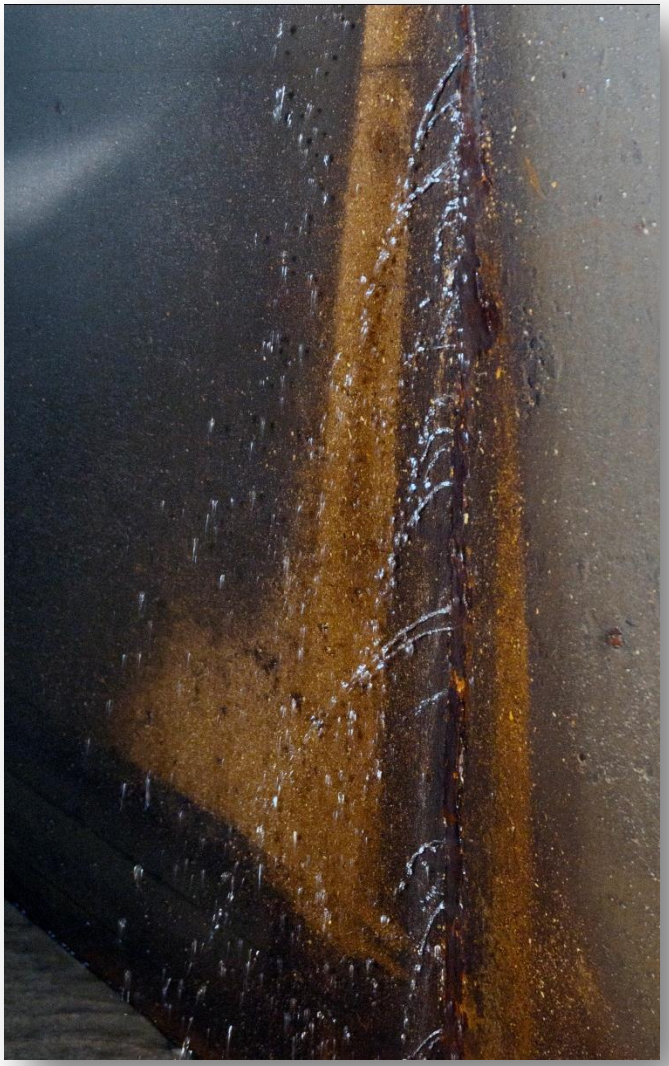
- **Only 1 conduit out of service at a time**
- **Repairs during low demand (winter months)**
- **Uninterrupted Plant Operation**
- **NSF 61 – Drinking Water Standard**

INVESTIGATION

Investigation

Panoramo Camera Inspection

- 360^0 Digital recording
- pan / tilt and zoom by reviewer
- Measurement of features



Investigation

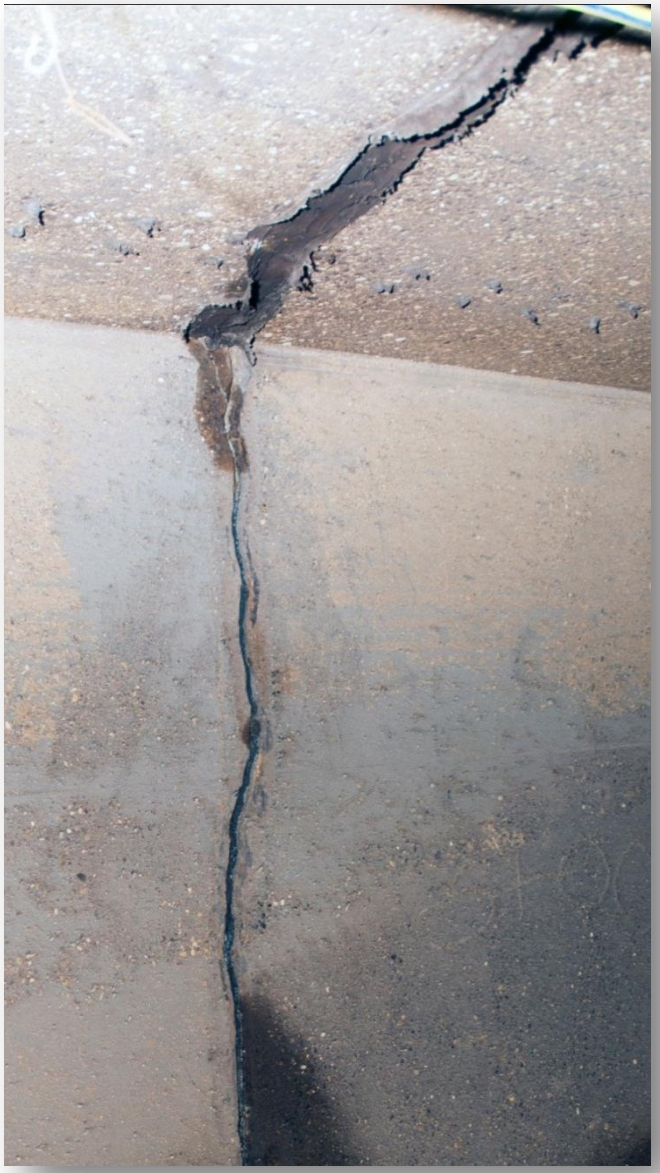
- Manned Entry
- Physical Measurements
- Concrete Cores
- Condition Assessment
- Sounding of Concrete

Investigation

Geophysical Survey

- Identify potential voids
- Comparison with historical soil information

FINDINGS / EVALUATIONS



Soundings

- No Delamination Observed

Concrete Cores

- Compressive Strength 7300 psi
- Tensile strength of Steel 60 ksi

Condition Assessment

- Fairly Good Condition
- Offset joints at Low Lift Bldg.
- Defects mainly in Chemical Bldg.
- Grout missing at some joints
- Visible Cracks and Fractures

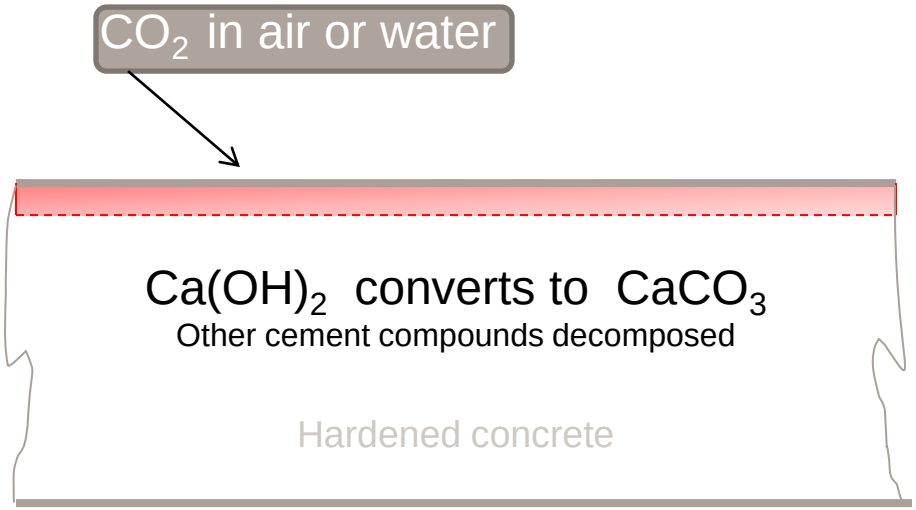
Condition Assessment

- 1 Gushing & 1 Running leak
- Dripping & weeping leaks
- Previously sealed fractures were reopened and leaking
- Rubber seals sound but distressed – bars placed to hold in place

Petrographic Analysis

- W/C ratio – 0.33 to 0.35 for CIP, 0.35 to 0.37 for steel plate pipe
- No air entrainment
- Water –soluble chloride 0.03 to 0.04 % (well within ACI range)
- Cement paste friable, soft and degraded at surface
- Carbonation to 5/16-inch at surface

Carbonation Process



* $CaCO_3$ dissolves in cold water – softens surface
** on dry surface $CaCO_3$ hardens and shrinkage may result

Structural Evaluation

- Conduits Structurally sound
- Cracking due to thermal movement
- Continued infiltration will impact durability

Sinkhole Evaluation

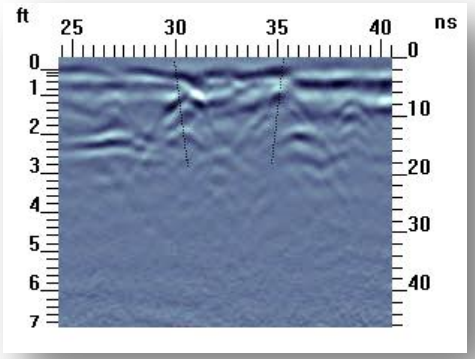
- Sinkhole developed near Low Lift Bldg. after returning East Conduit to service
- Owner re-drained East Conduit, replaced plug on drain line
- Owner filled sinkhole at surface
- NTH revisited site, performed supplemental GPR survey

Ground Penetrating Radar

- Several anomalies detected
- Sloping reflectors and soil pocket
- No indication of voids
- Anomalies match construction features shown on plans

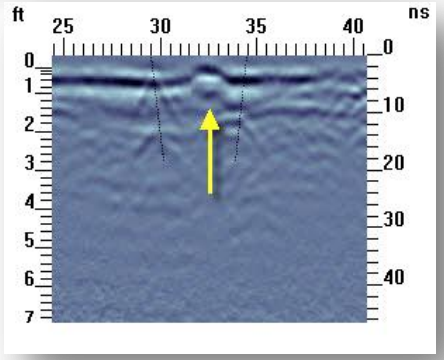
Supplemental GPR

Line 1



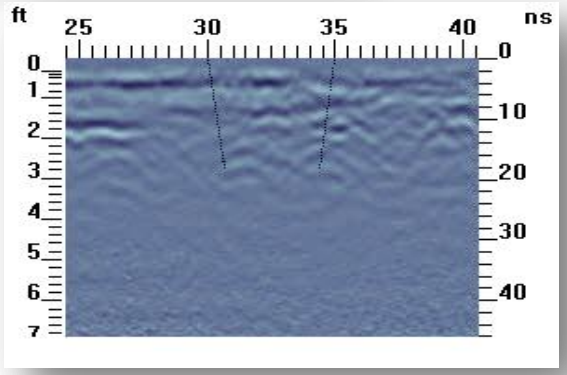
GPR Line Adjacent to Sinkhole,
Lines Indicate Limits of Observed Sinkhole Effects

Line 2



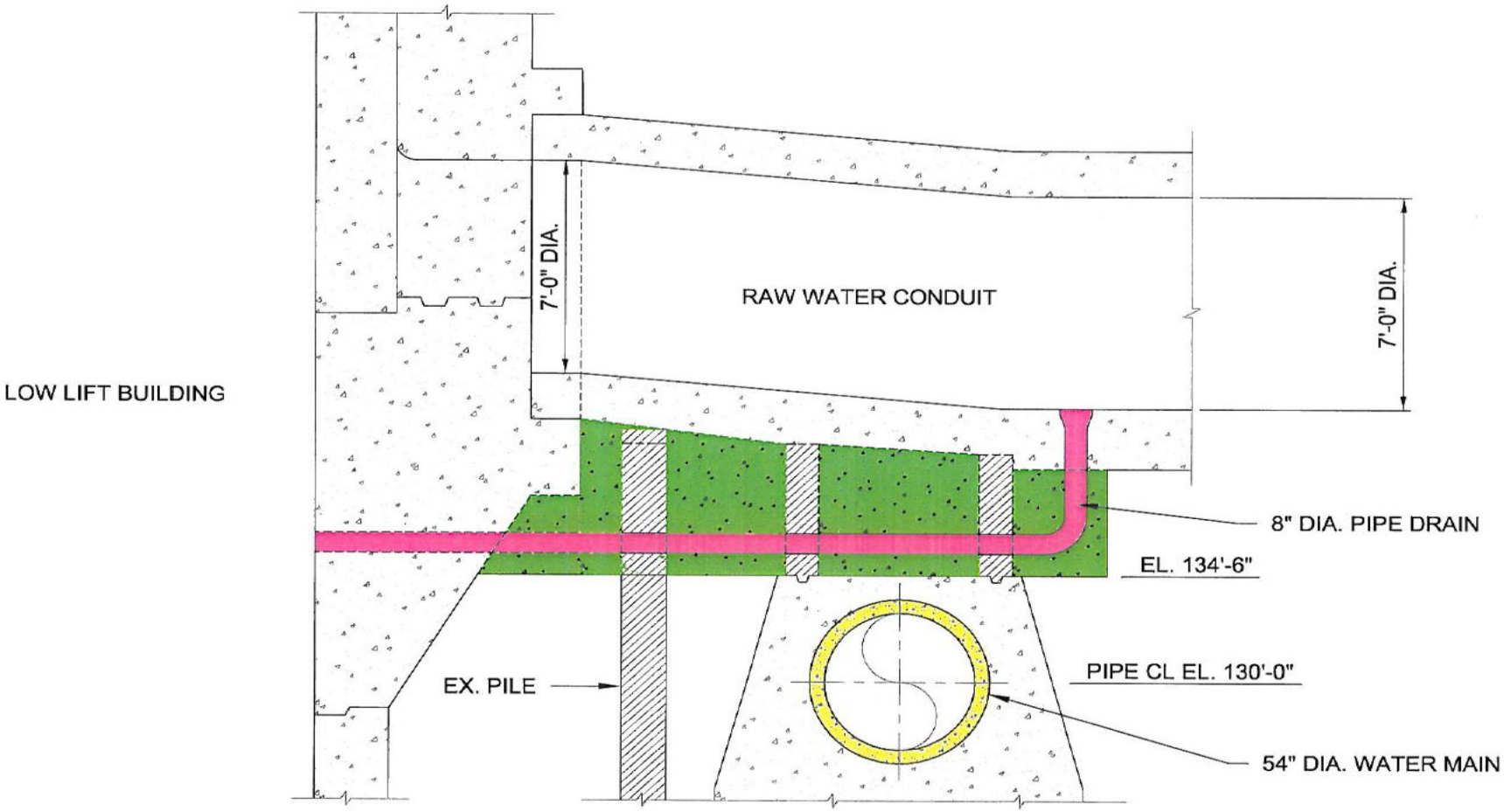
GPR Line Above Sinkhole (Surface Feature),
Arrow Indicates Small Depression
Observed at Ground Surface

Line 3



GPR Line Adjacent to Sinkhole,
Anomaly Barely Discernable

Raw Water Conduit at Low Lift Building – area of sinkhole



Pedestrian Tunnel

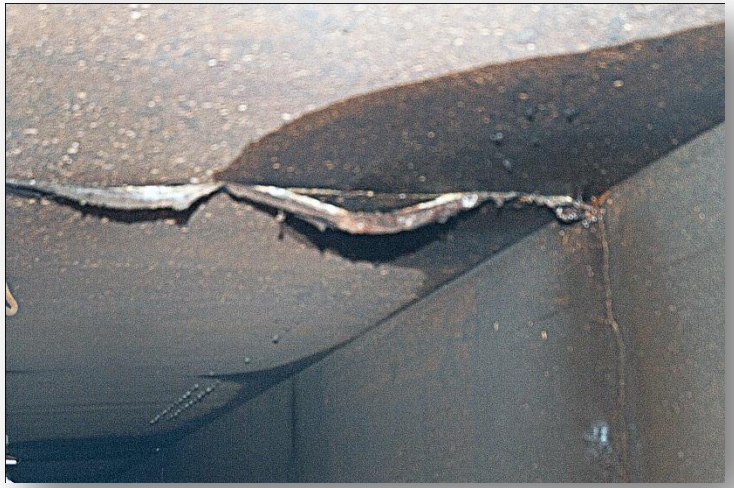
Pedestrian Tunnel

Distress discovered while looking at exterior of East Conduit

- Fractures in wall
- Bowing of concrete
- Delamination in floor near Chemical Bld.
- Leak in Wall at Chemical Bld.

REPAIRS

Surface Preparation is KEY



Surface Preparation

1. Seal Leaks
2. Repair joints
3. Remove softened / carbonated layer
4. Repair fractures and cracks
   - Rout and seal with urethane
   - Inject with epoxy
5. Coat interior with Crystalline Waterproofing
6. Replace rubber seals

7. Repeat for opposite Conduit

8. Repair Pedestrian Tunnel
   - Install new wall section
   - Grout fractures/cracks
   - Repair spalls/delaminations

CHALLENGES

Working in cold weather

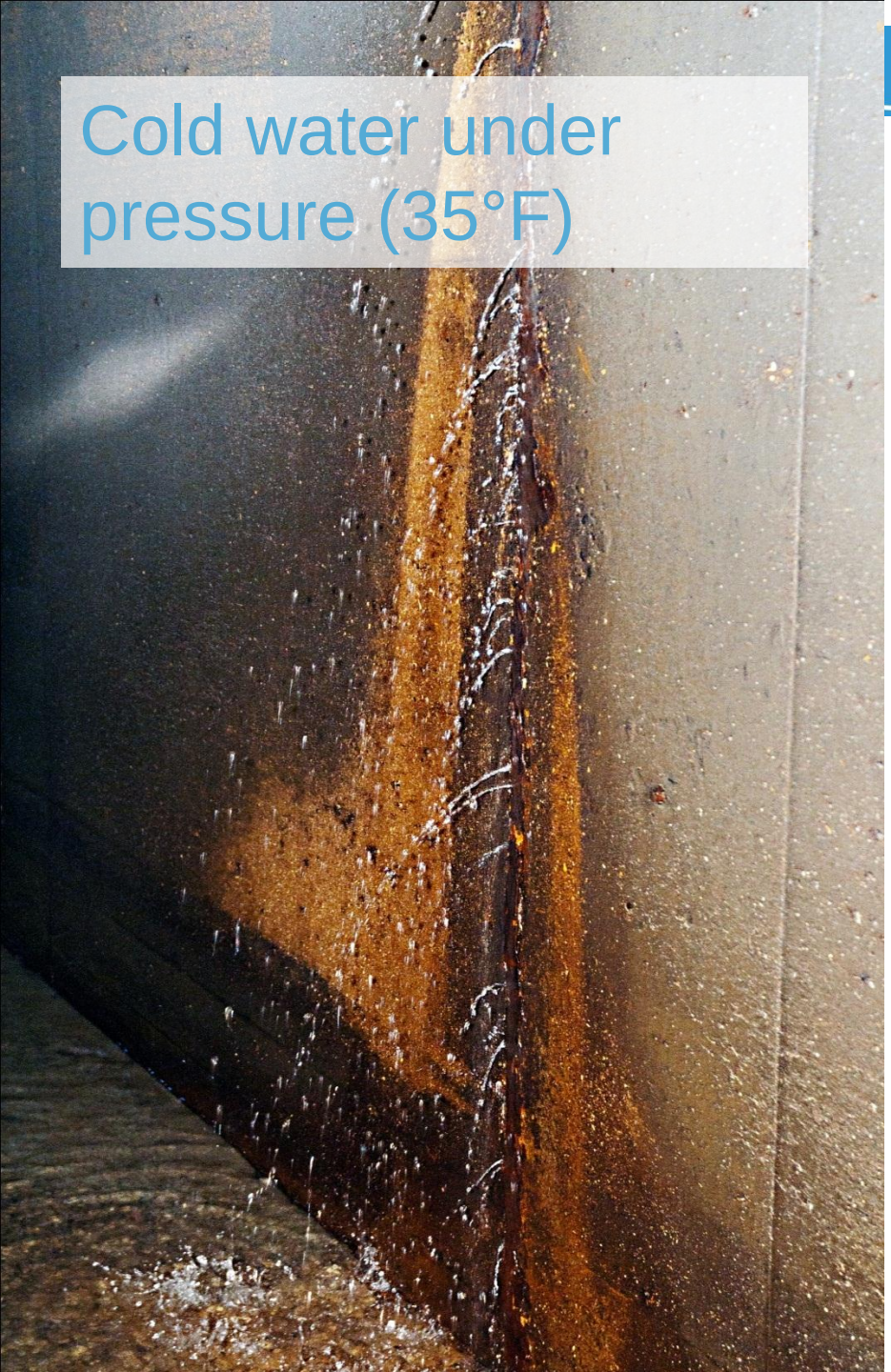
Limited Site Access


Reinforcement on inside of Pedestrian Tunnel without effecting conduits

Working around conduits


Original rubber not available

Cold water under pressure (35°F)




Interpretation from Owner's Representative

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QUESTIONS?