UNDERGROUND CONSTRUCTION TECHNOLOGY
THE UNDERGROUND UTILITIES EVENT | JANUARY 25-27, 2022 | FORT WORTH, TEXAS

Open-Cut, Tunneling, Ground Condition in Construction Risk Assessment of Houston 108-inch Waterline

David Pineda
Aurora Technical Services, LLC

Aurora Technical Services, LLC
engineering + construction management

Surface Water Transmission Program

Construction Risk Assessment

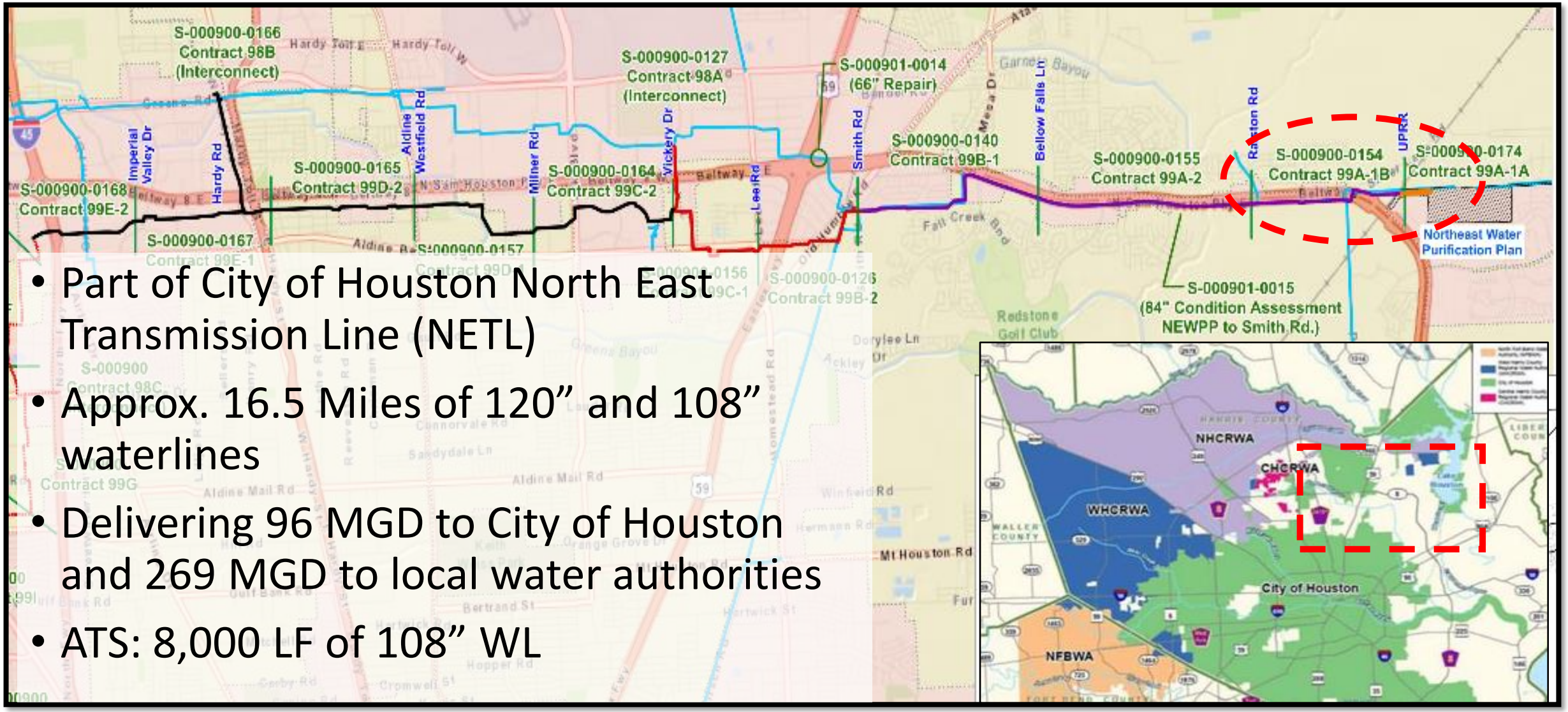
- **What is Risk?** Any uncertainty in the future that, if it occurs, can impact the schedule and costs of project

- **Construction Risk Assessment** is process of identifying, evaluating, and controlling risks in order to reduce the impact of risk.

- Risk Assessment should be on on-going cycle

Risk Assessment Approach

Case Study: NETL 108” WL Project 99A-1B

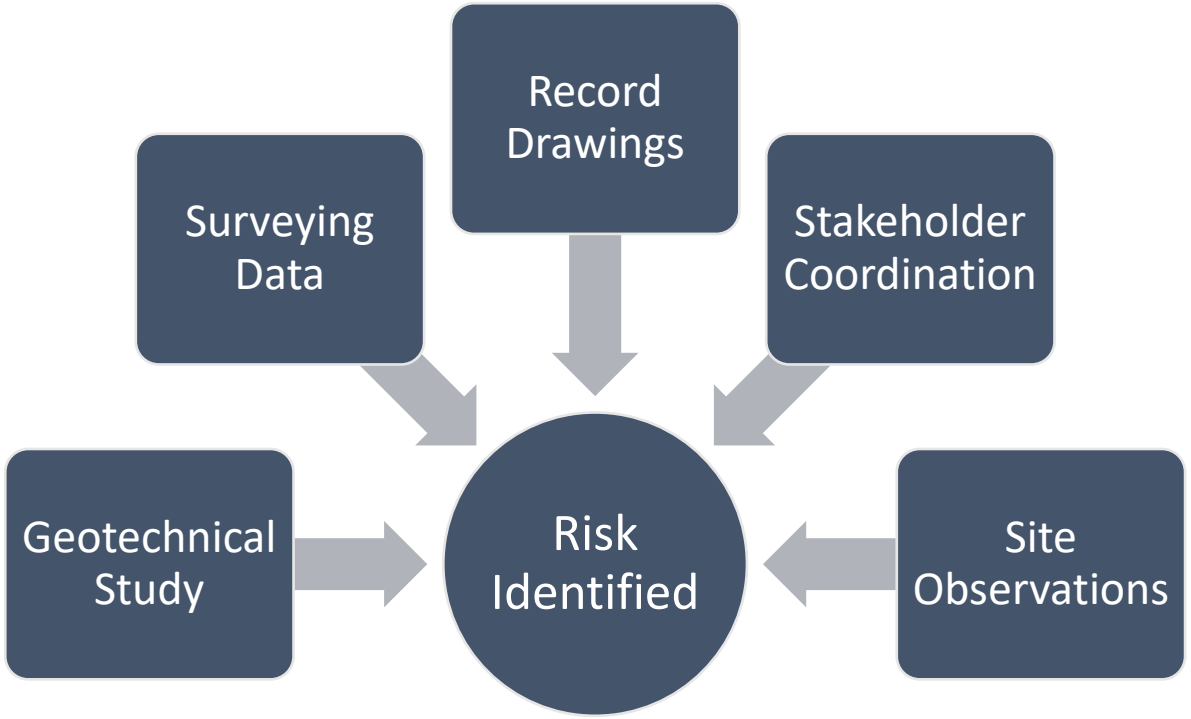


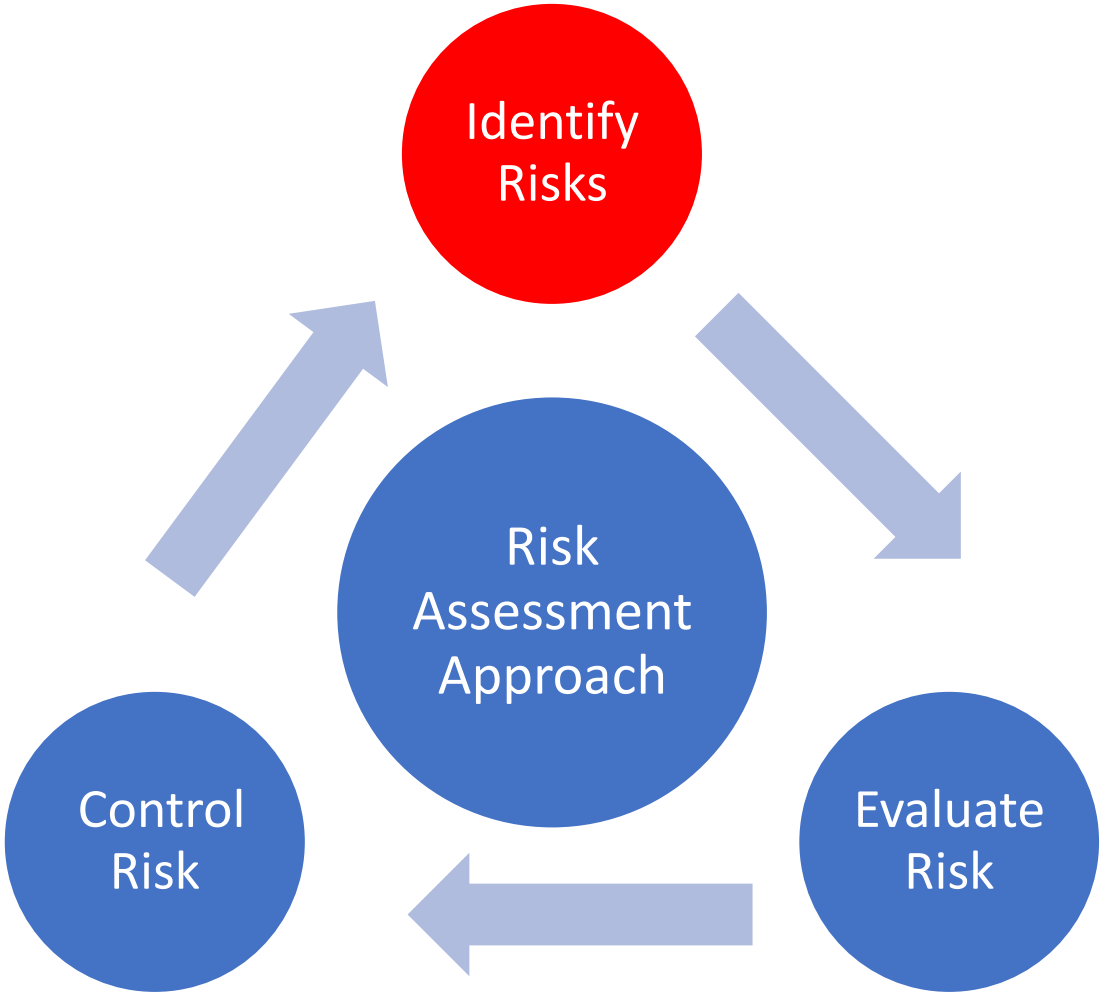
- Part of City of Houston North East Transmission Line (NETL)
- Approx. 16.5 Miles of 120” and 108” waterlines
- Delivering 96 MGD to City of Houston and 269 MGD to local water authorities
- ATS: 8,000 LF of 108” WL

Key Challenge: Crossing of Tollway Bridge

- 400 LF crossing TxDOT Frontage Roads and Harris County Toll Road Authority (HCTRA) Bridge

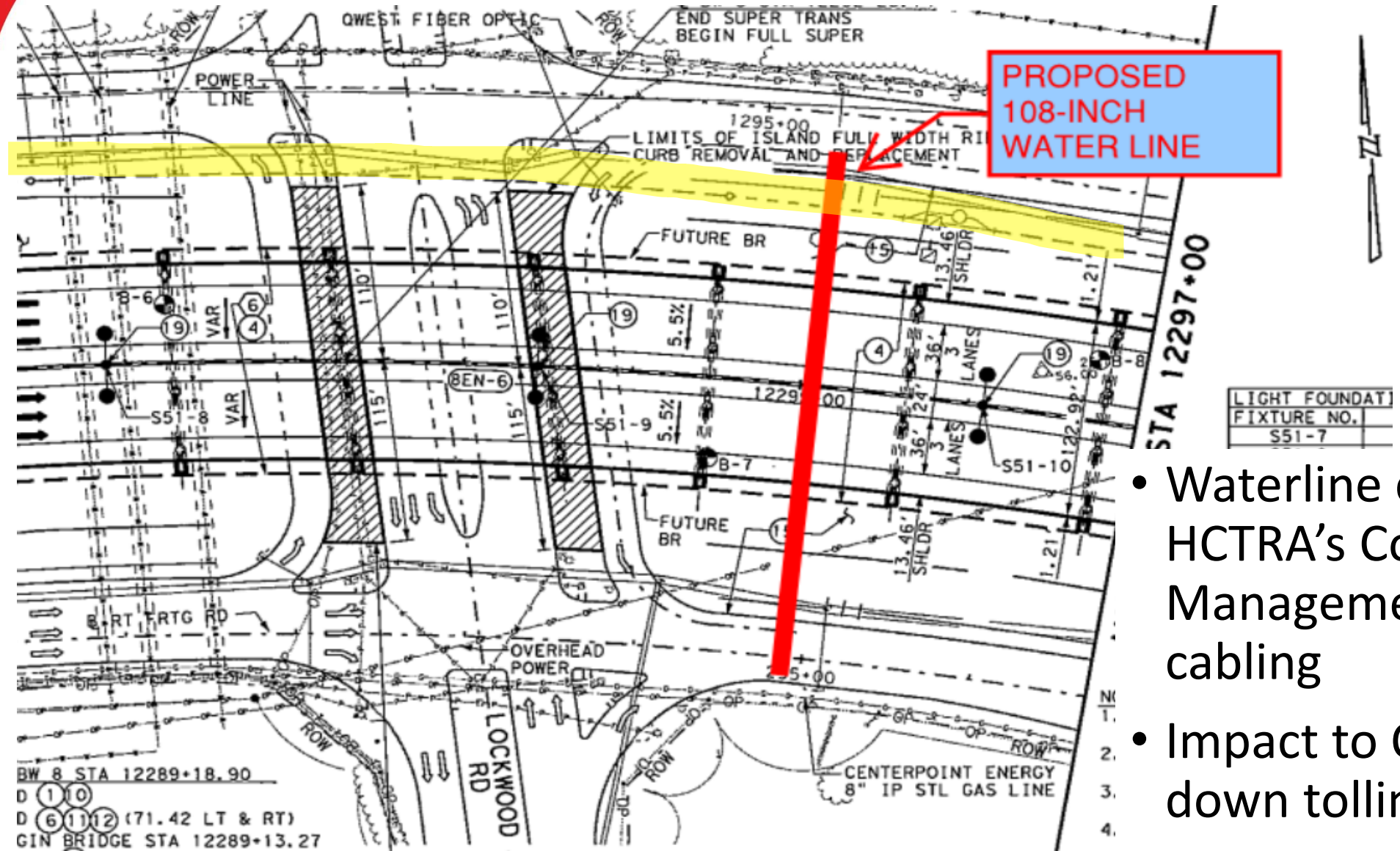
1. Identify Risks





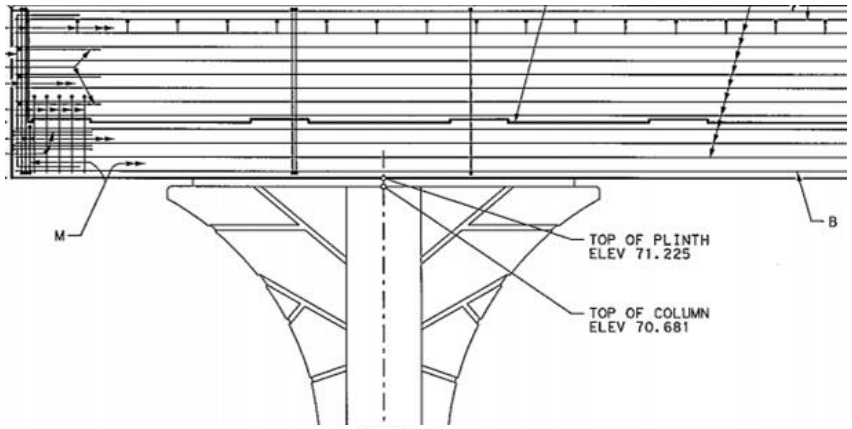
Risk Assessment Approach

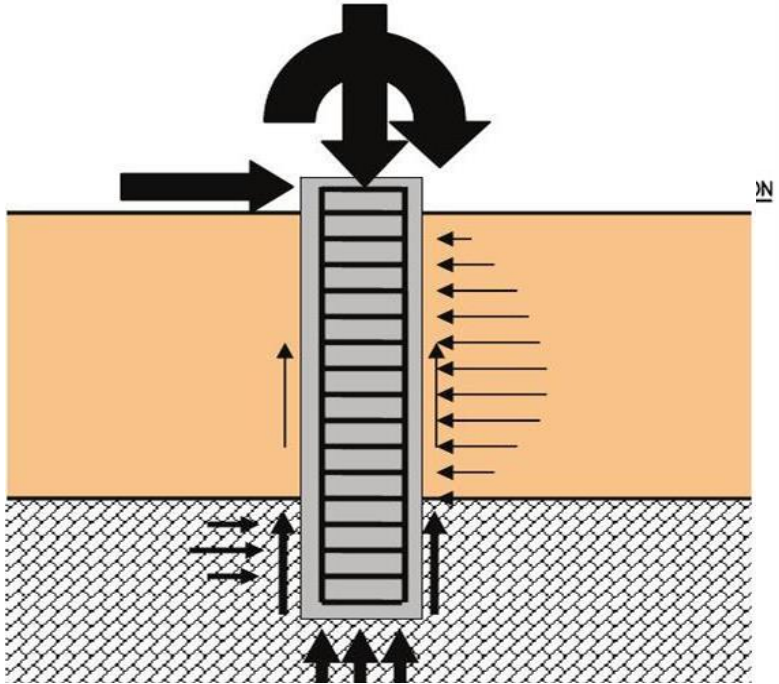
Record Information



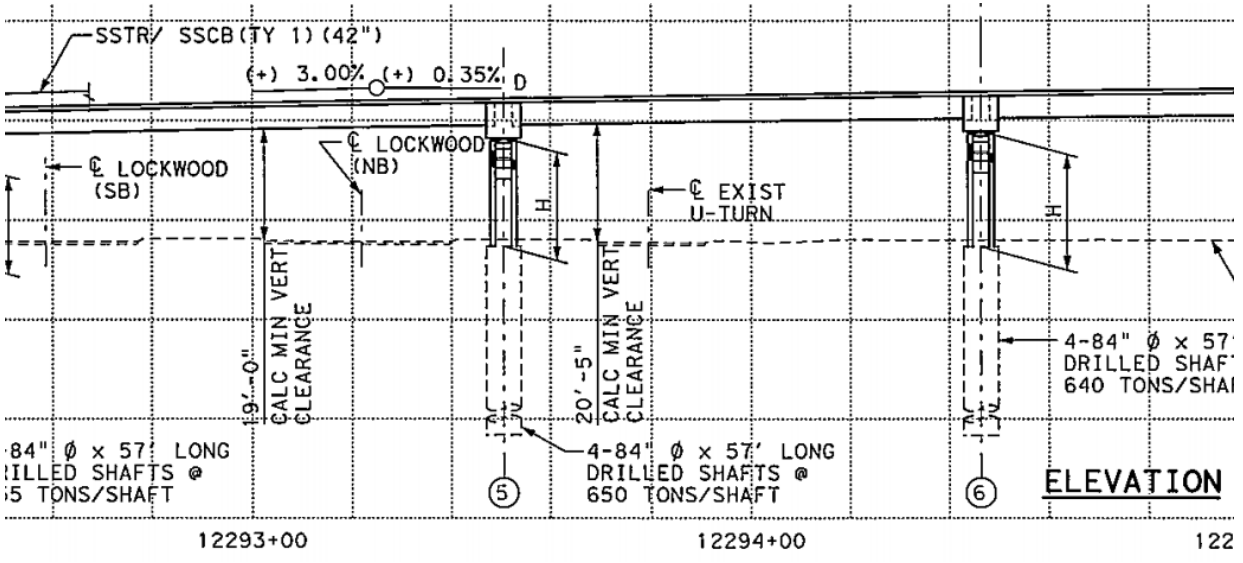
- Waterline crossed under HCTRA's Computerized Traffic Management System (CTMS) cabling
- Impact to CTMS could shut-down tolling operations

Bridge Foundation

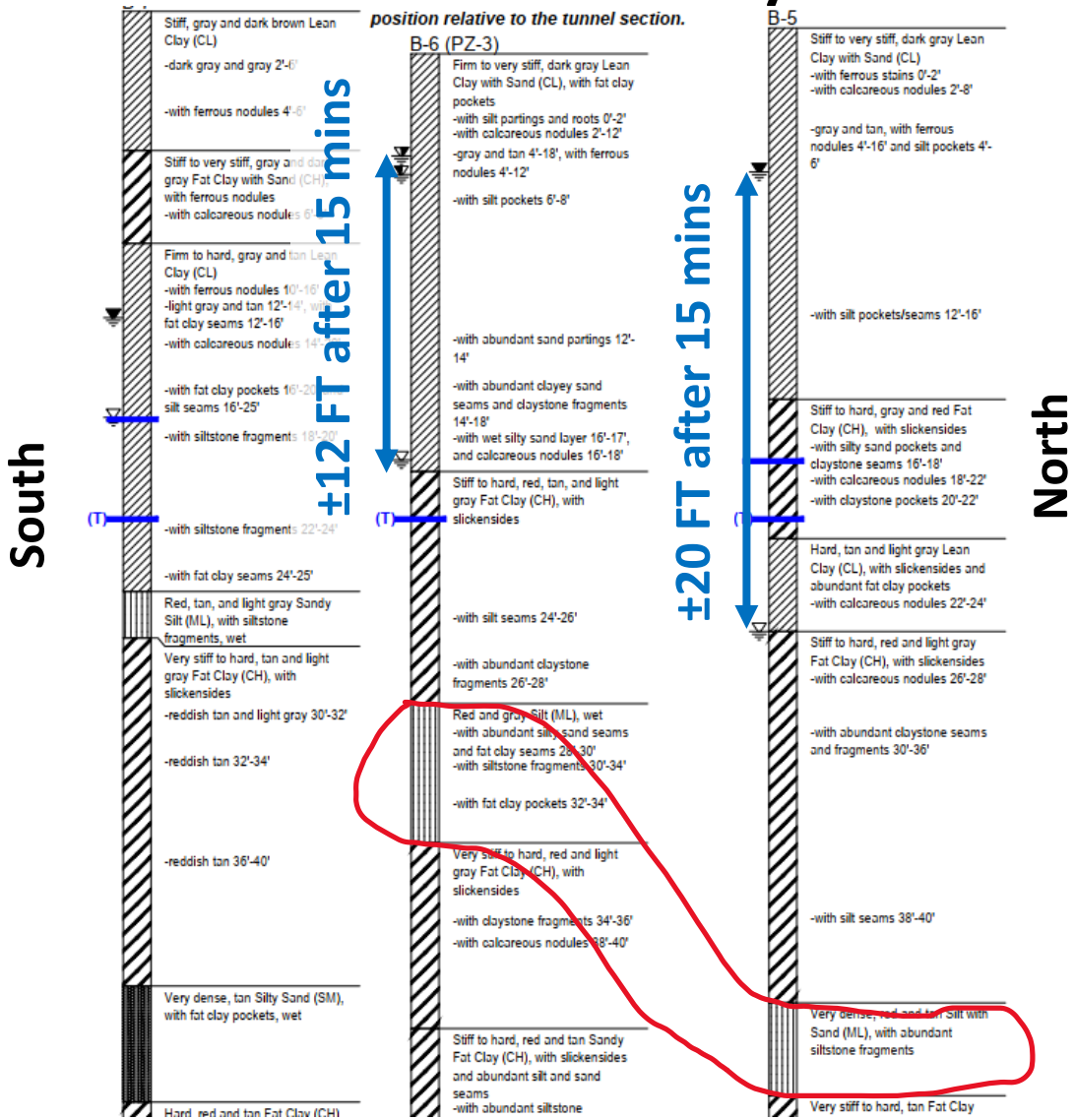




- Bridge drill shafts relied on soil friction to support load
- HCTRA did not allow any permanent settlement on bridge structure



Geotechnical Study

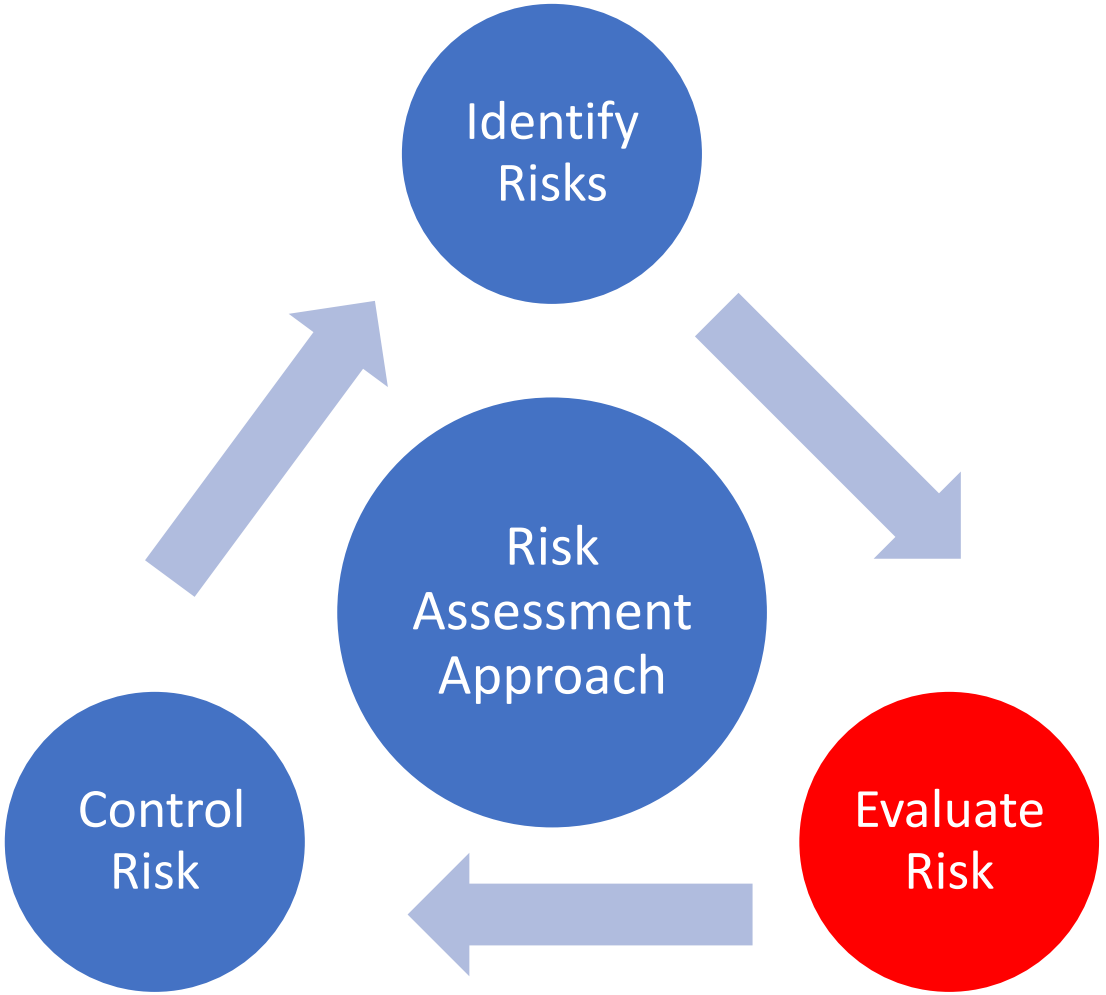


- Hydrostatically charged silt layer with more than 20 feet of water head encountered near the bottom of excavation

2. Evaluation of Risk

Severity of Risk = Likelihood x Impact

Likelihood \ Impact	Negligible	Minor	Moderate	Significant	Severe
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

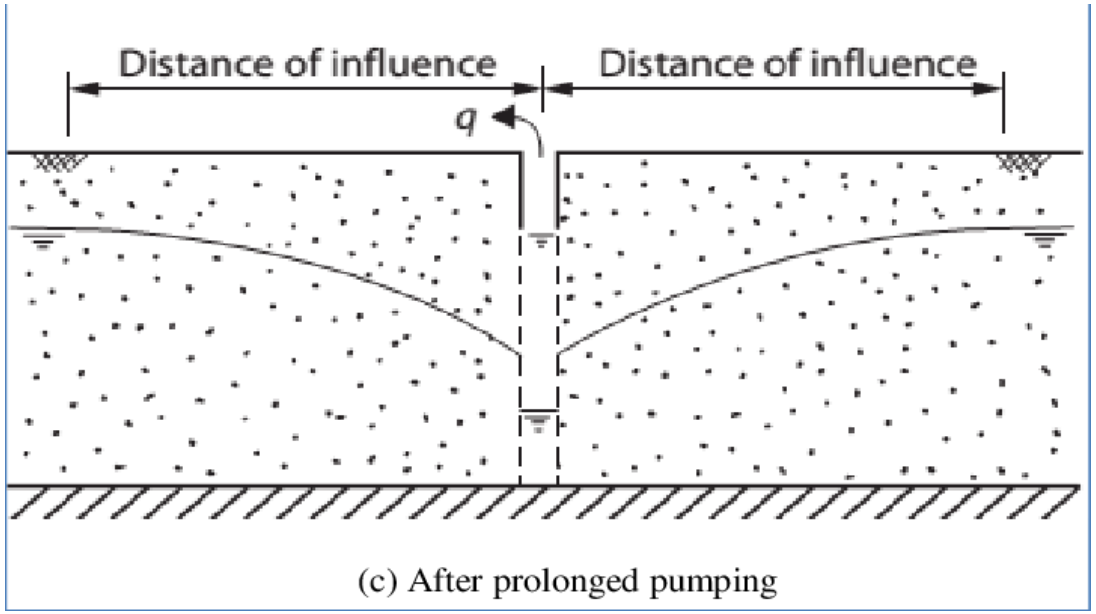


Risk Assessment Approach

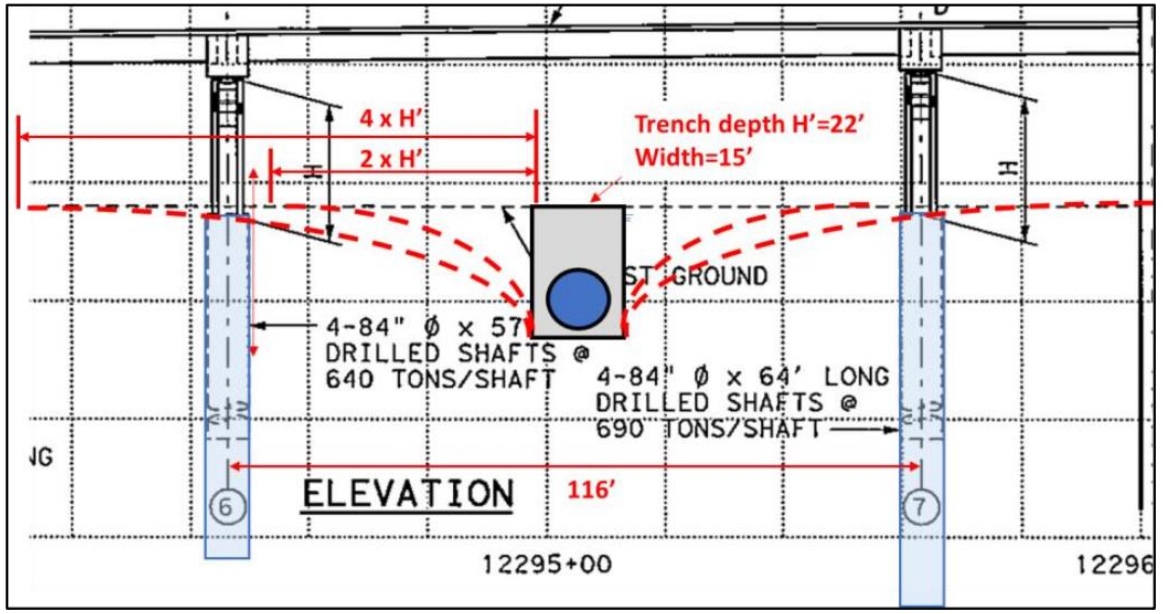
Evaluation of Risk Items

Risk Description	Before Controls		Impact Level
	Impact	Likelihood	
Settlement of Bridge	Severe	?	?
Pressurized Groundwater	Significant	?	?
Conflict w/ CTMS	Moderate	?	?

Evaluation of Risk – Settlement of Bridge



(c) After prolonged pumping



Zone of Impact for Crossing for Cut and Cover Excavation

Table 2. Impact to Bridge Foundation Due to Dewatering

	Bent 6 (B-7)	Bent7 (B-8)
Service Load (Tons)	614	658
Original Design Capacity Without Dewatering (Tons)	698	707
Original F.S.	2.3	2.2
Reduced Design Capacity Due to Dewatering (Tons)	438	509
Reduced F.S.	1.4	1.5

- Dewatering for prolonged period of time could potentially reduce the load carrying capacity of bridge foundation due to down-drag
- 60% Reduction in Factor of Safety due to De-watering

Evaluation of Risk – Pressurized Groundwater

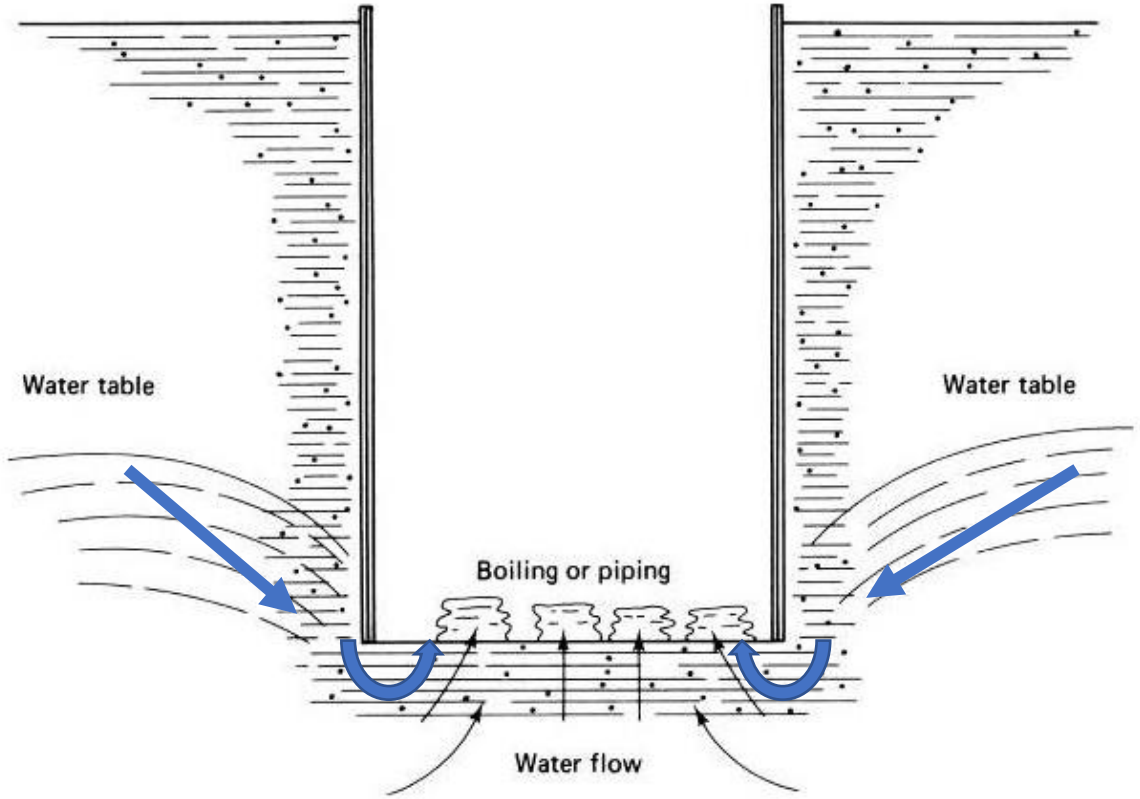


FIGURE 10-16. Boiling and piping of cut bottom.

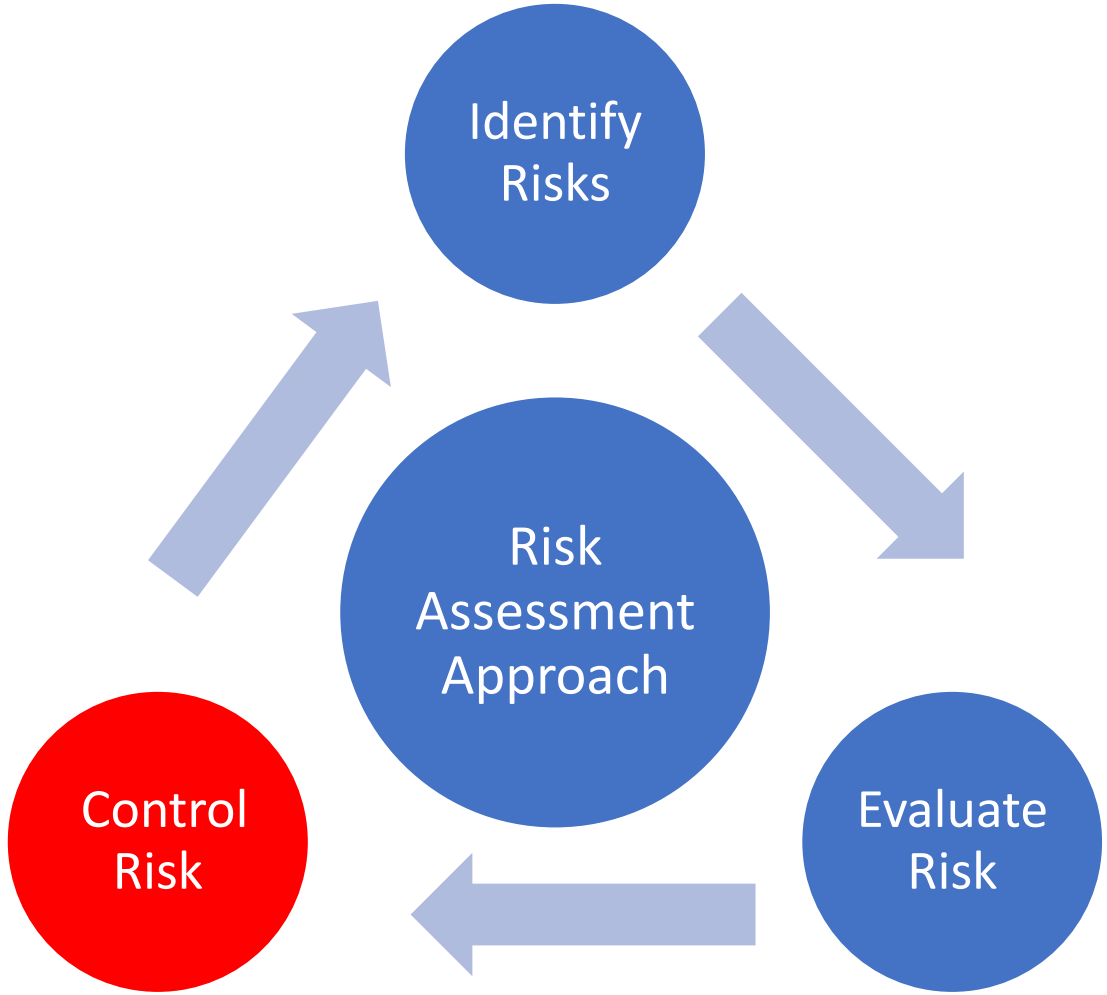
- Geotech engineer identified potential for bottom boiling of excavation
- Pressure groundwater could cause excavation bottom boiling

Evaluation of Risk Items

Risk Description	Before Controls		Impact Level
	Impact	Likelihood	
Settlement of Bridge	Severe	Very Likely	High
Pressurized Groundwater	Significant	Likely	High
Conflict w/ CTMS	Moderate	Possible	Medium

Controlling Risks

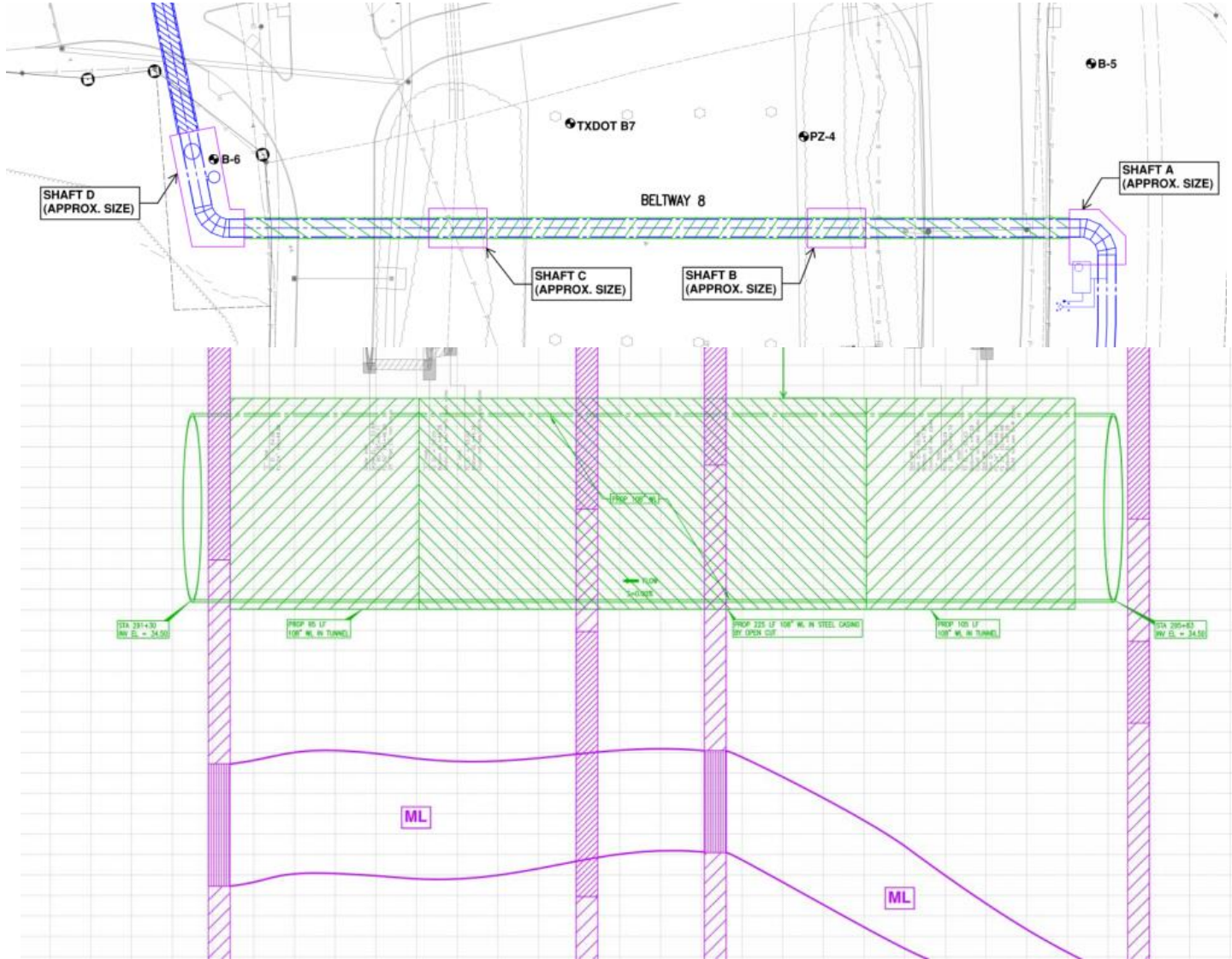
- Implementing designs that minimize risk
- Communicate risks and risk management strategies to client, stakeholders and contractor



Risk Assessment Approach

Controlling Risk – Design

- Minimize Complexity to extend possible
- Tunnel Frontage Road, Open-Cut under Bridge
- Implement Soil Treatment measures or Cut-Off Sheet Piling to avoid need to De-water

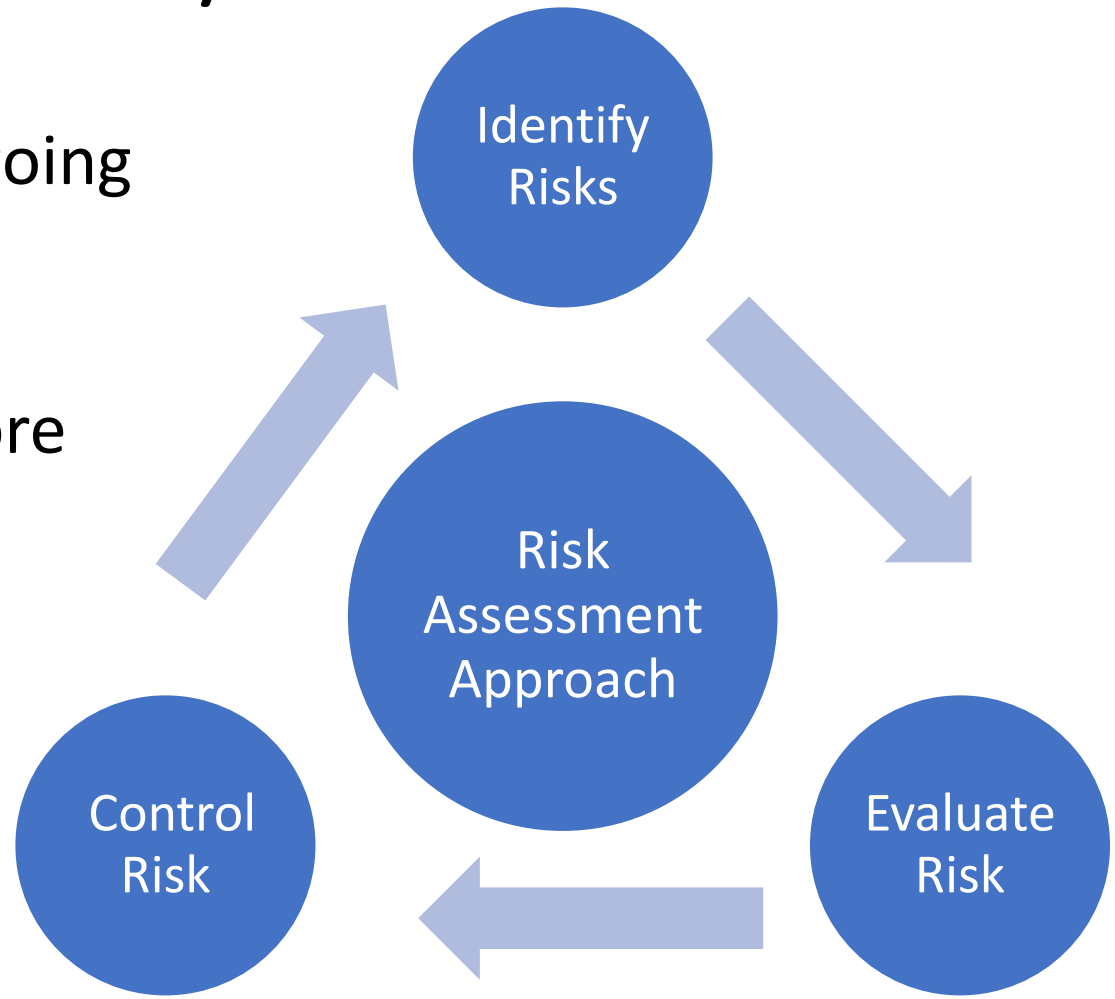


Controlling Risks

Risk Description	Before Controls				After Controls	
	Impact	Likelihood	Impact Level		Likelihood	Impact Level
Settlement of Bridge	Severe	Very Likely	High		Unlikely	Med High
Pressurized Groundwater	Significant	Likely	High		Possible	Med High
Conflict w/ CTMS	Moderate	Possible	Medium		Unlikely	Low

Construction Risk Assessment Cycle

- Risk Assessment should be on on-going cycle
- Risk need to be re-evaluated as more information becomes available



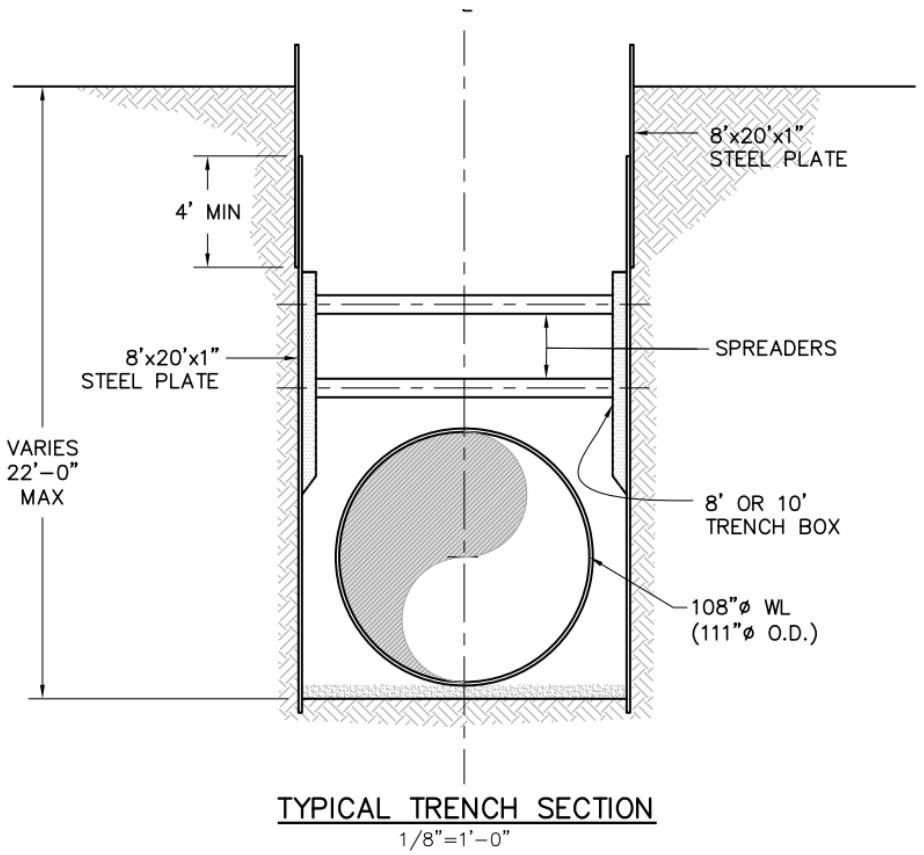
Risk Assessment Approach

Construction Field Verification

- "Test" Excavation Pits perform near bridge to the same depth as proposed Open-Cut Segment
- Lower groundwater table and dry soils at excavation limits encountered.
- Additional Boring Logs and Piezometer confirmed site conditions

Control Risk

- Open-Cut Construction with Trench Boxes and Sheet Plates to 22 Feet Deep Max



Control Risk – Defining Requirements

- Each Pipe backfilled immediately after installation
- Installation continued daily, without stopping, until crossing complete
- Continually monitoring of groundwater, ground and bridge movements

Controlling Risks – During Construction

Risk Description	Before Controls				After Controls	
	Impact	Likelihood	Impact Level		Likelihood	Impact Level
Settlement of Bridge	Severe	Very Likely	High		Unlikely	Med High
Pressurized Groundwater	Significant	Likely	High		Unlikely	Medium
Conflict w/ CTMS	Moderate	Possible	Medium		Unlikely	Low

Summary/ Lessons Learned

- Risks Assessment does not stop once design is complete. It continues and evolves during construction.
- Identify, evaluate and control risk with the input of contractor, construction manager, stakeholders and client.
- Guidelines, Expectation and Requirements must be communicated to all concern parties prior to construction

QUESTIONS?