Performance Evaluation of the Narragansett Bay Commission's CSO Tunnel Odor Control System and Ancillary Facilities

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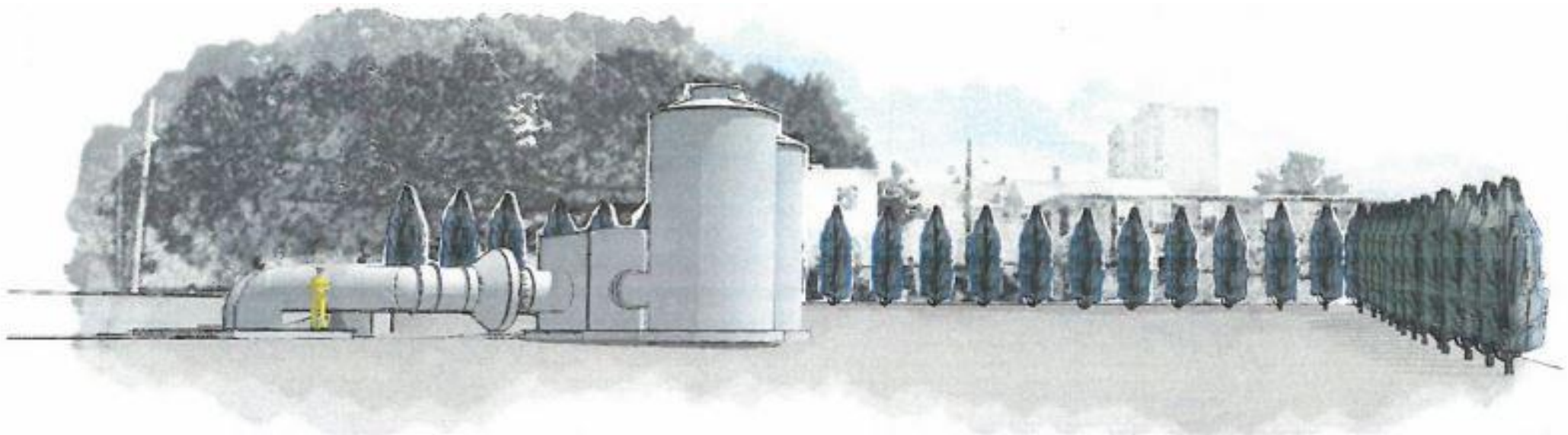

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Presentation Overview

Introduction/Background
CSO Tunnel Construction History
Phased Connections of CSO Overflow Interceptors
New Odor Control System Study
Conclusion

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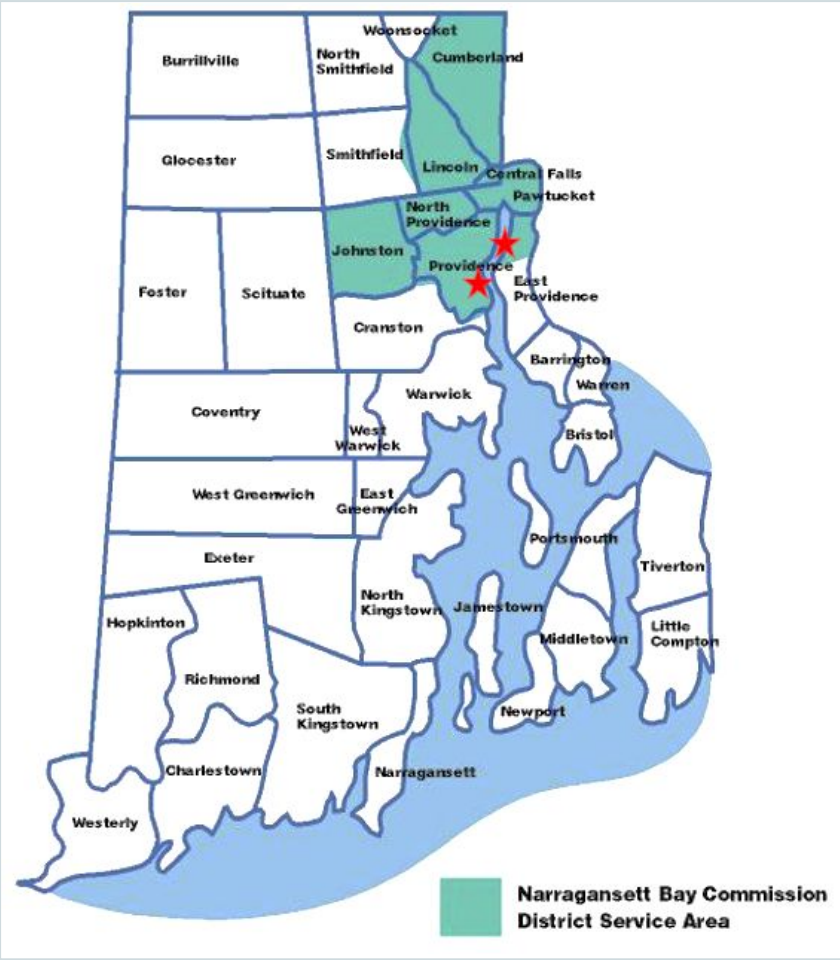

- Quasi-public agency
- Largest wastewater authority in RI
- Own, Operate and Maintain:
  - Two largest WWTFs
  - 110 miles of interceptor pipes
  - CSO tunnel
  - Six pumping stations
  - Septage Receiving Facility
- Ten Communities
  - ≈ 70,000 customers (34% RI)
- Operates an existing CSO tunnel in the Field's Point Service area that was completed in 2008 (Phase I)
- Currently constructing a second CSO tunnel for the Bucklin Point Service Area (Phase III)

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Field's Point Wastewater Treatment Facility Providence, RI

Fields Point WWTF Quick Stats

- Largest WWTF in RI
- Serves: Providence, Johnston, North Providence, Lincoln (Cranston, Smithfield)
- 77 MGD Advanced Secondary Treatment capacity
- Wet Weather Treatment for an additional 123 MGD
- (200 MGD total)
- 38 CSOs

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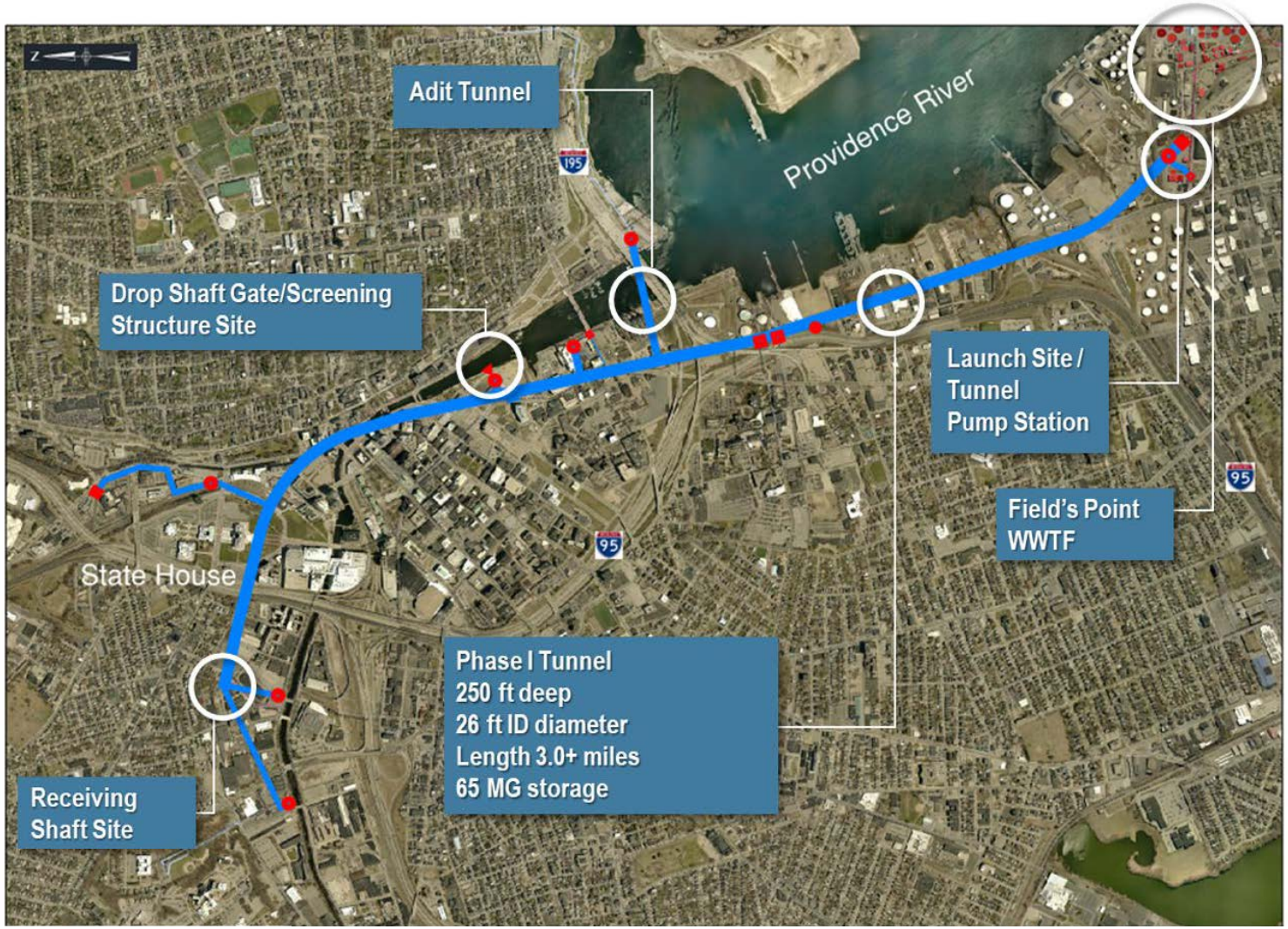
Existing CSO Tunnel (Phase I)



Fields Point Service Area

- Phase I Completed in 2008
- 26-ft diameter
- 3.2 miles
- 65-million-gallon storage capacity
- 7 drop shafts
- Two 26-ft diameter shafts:
  - Downstream
    - Shaft @ Tunnel Pump Station Site (for TBM launch)
    - Tunnel Mucking/Screening Facility
  - Upstream
    - Shaft @ Foundry/Calverley Street Site (for TBM removal / Ventilation)
    - Site of Odor Control System

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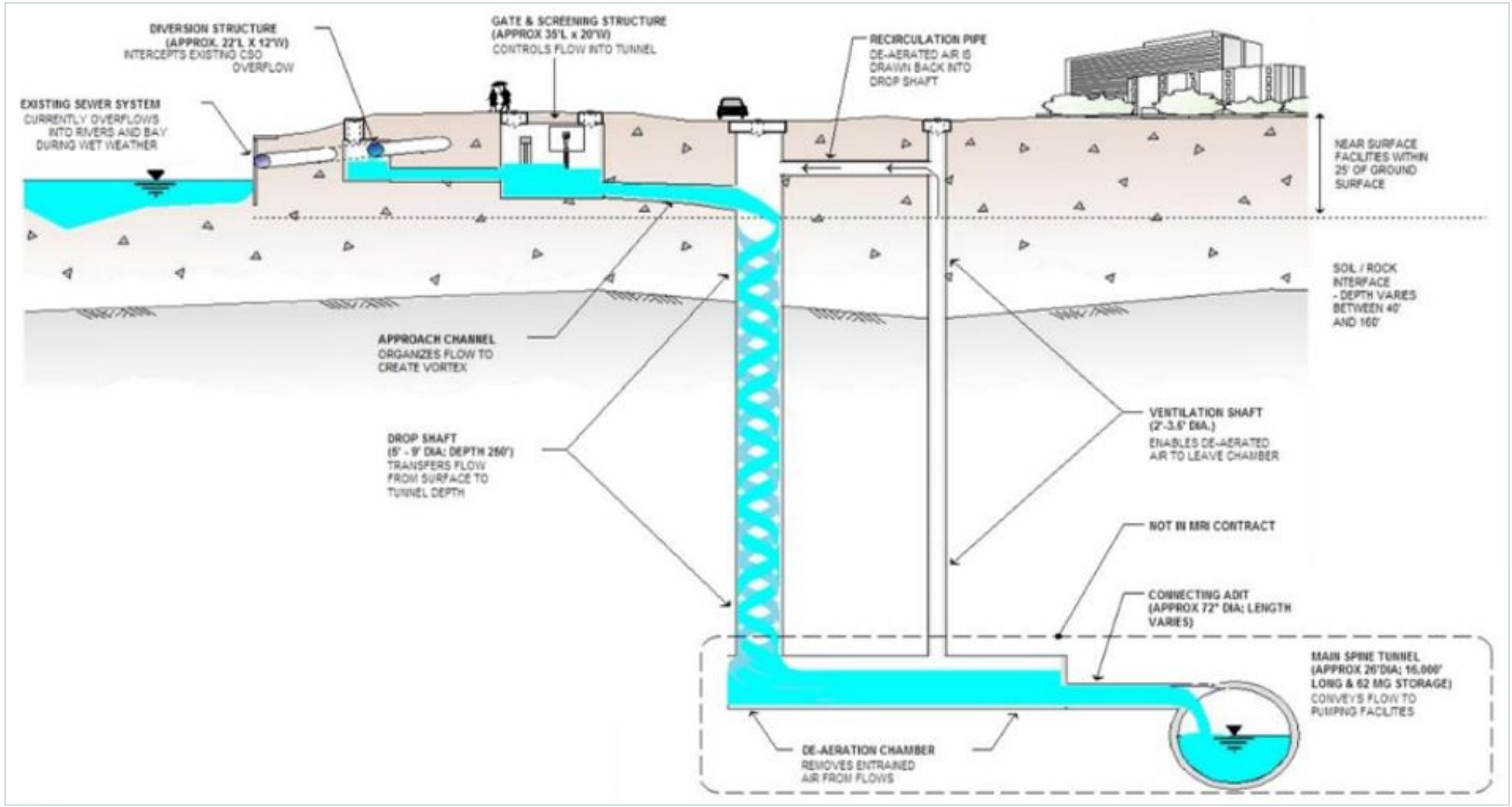
Existing CSO Tunnel (Phase I)



Combined Sewage Overflow-Diversion and Storage

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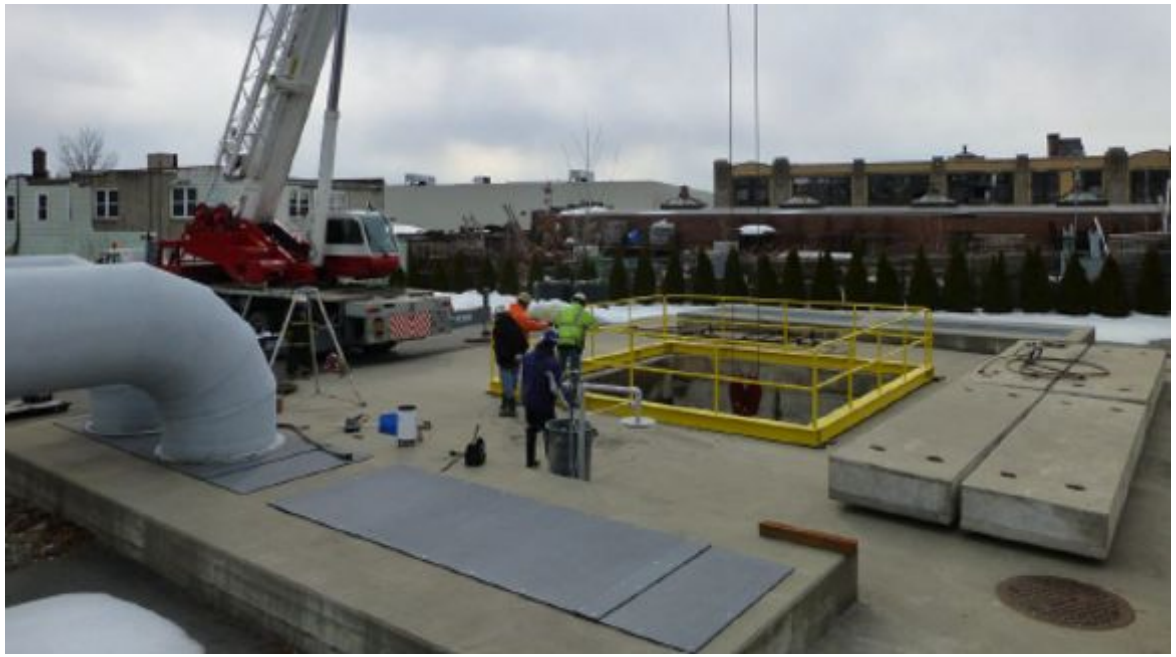
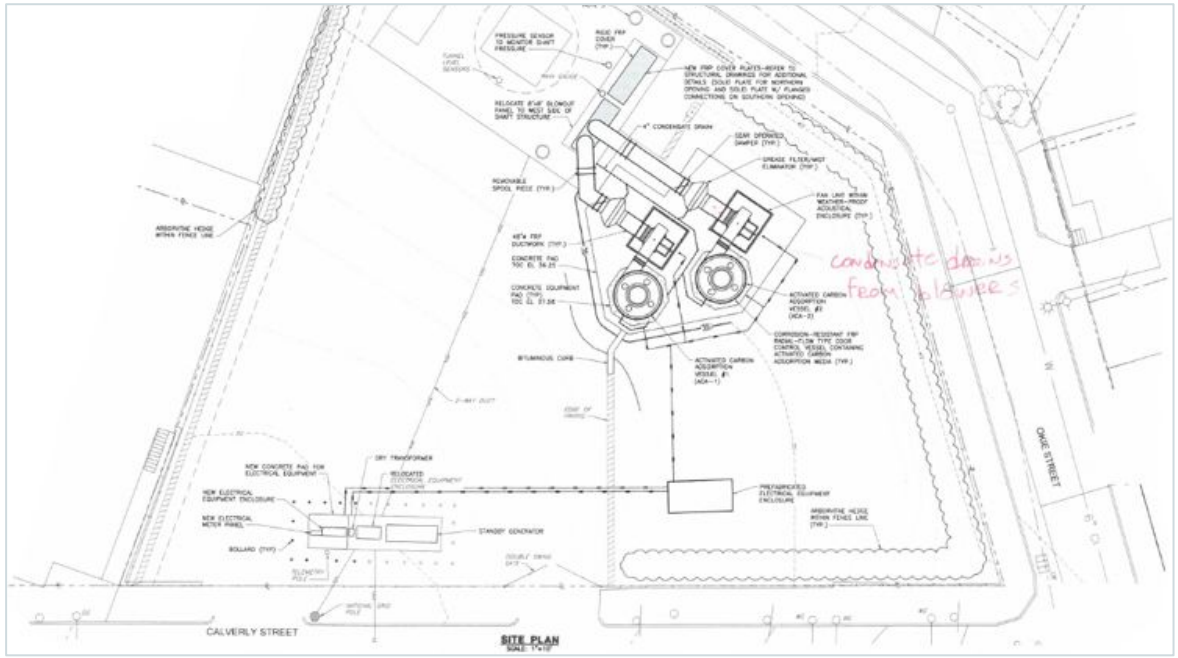
Existing CSO Tunnel (Phase I)

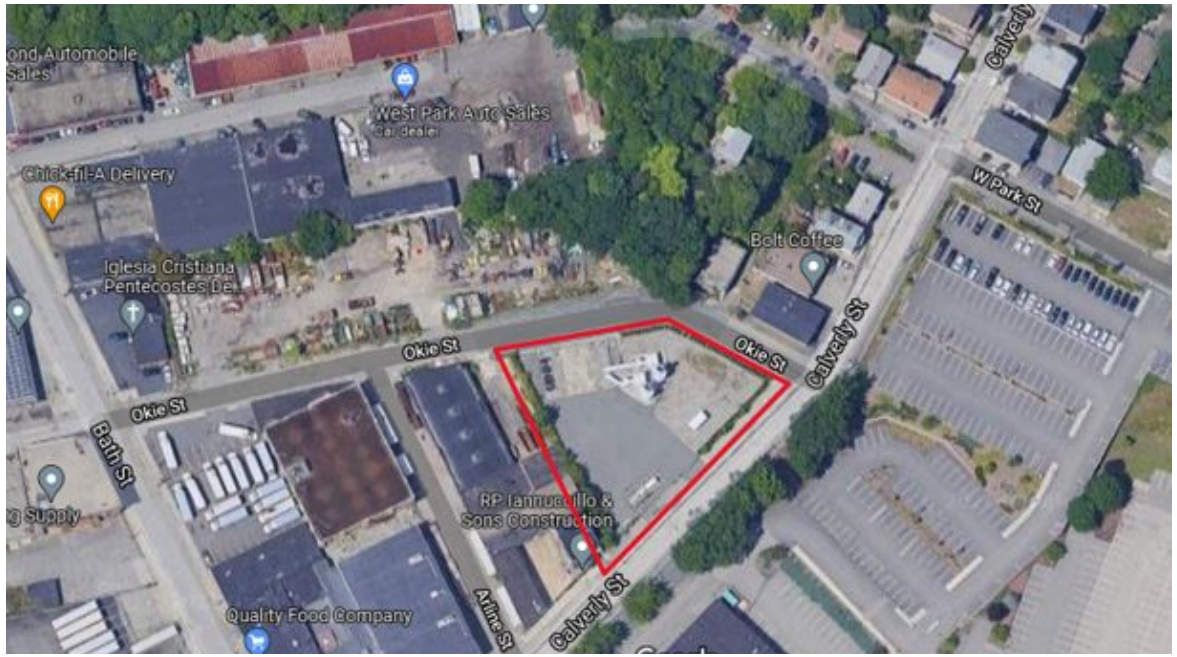


Last Inspected 2014

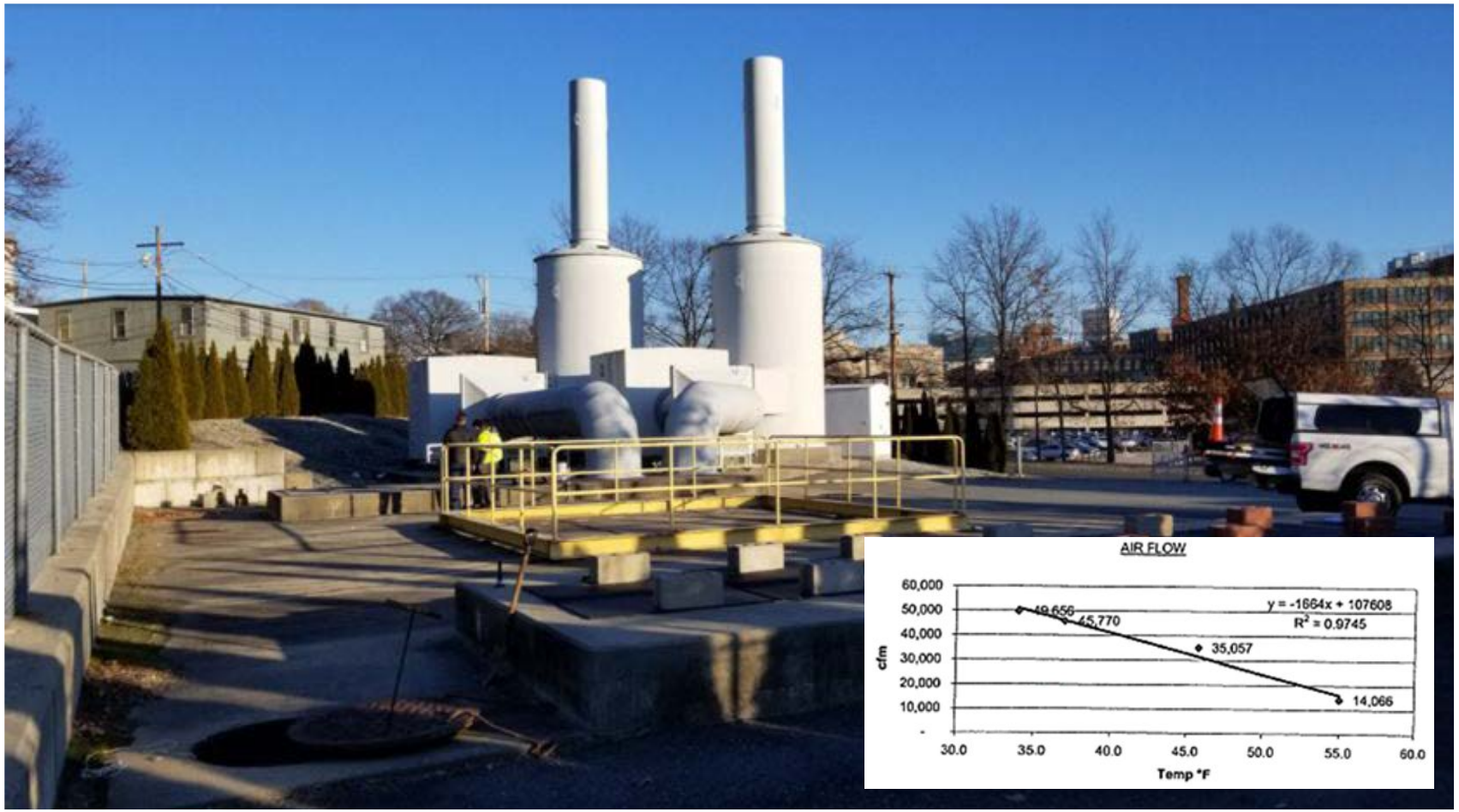
Odor Control – Round 1

Existing System – Site Plan





Odor Control – Round 1



Existing Odor Control System - Receiving Shaft Site (Upstream)

- Phase I completed in 2008
- The NBC began receiving odor control complaints associated with the Foundry Shaft shortly after it was placed into operation
- 2009: NBC procures Design-Build Services to construct the Odor Control System at Receiving Shaft (Calvary Street) site
- Two 30,000 cfm radial flow activated carbon units

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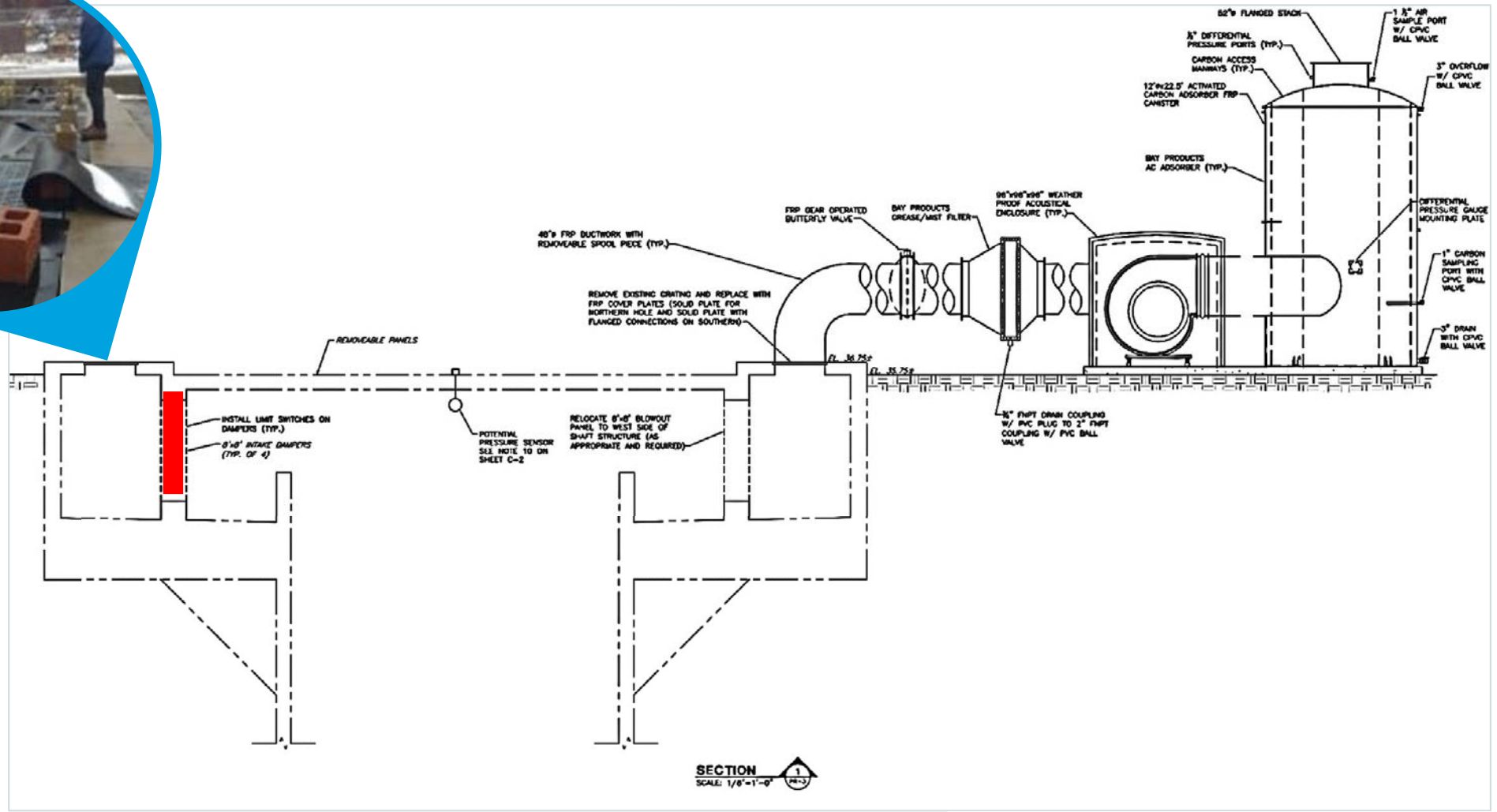
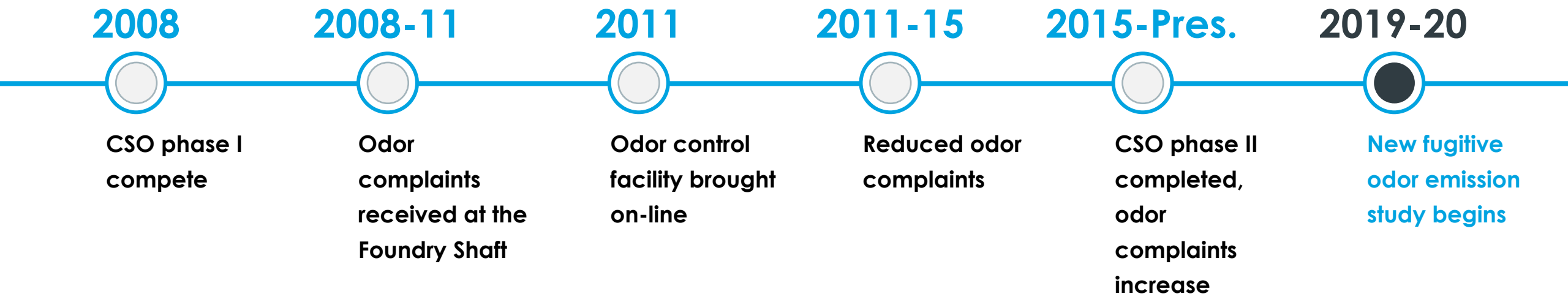
Odor Control – Round 1



Existing System Cross Section

CSO Timeline – Recap



2019-2020 New Odor Control Study

An Increase in Odors? Why?

- Initial thought was there may be an issue with the odor control units
- Some reduction in fan capacity… but not that much, odor control was still within parameters

What else could it be….

- Did connection of Phase II induce unexpected airflow patterns?
- Degradation of filter units, media exhaustion?
- Debris accumulation?
- Leaks / Short-Circuiting?
- Other?

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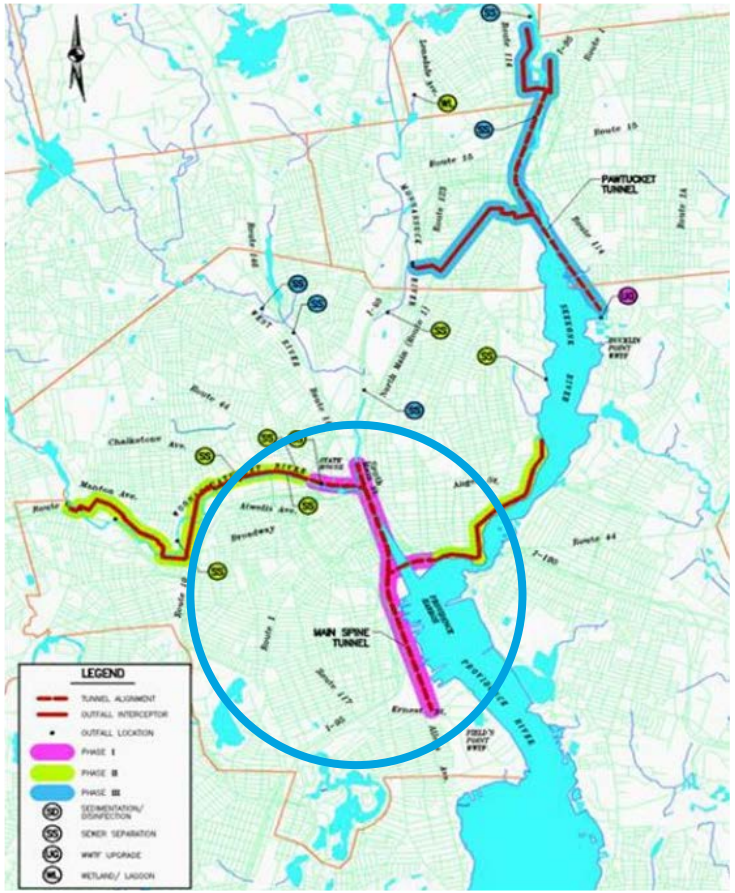
The CSO Tunnel Phase II



Connection of Phase II CSO Interceptors

- **Phase II – Completed in 2015**
  - **New Phase II CSO interceptors were connected to the tunnel**
  - **Combined Sewerage Overflow Interceptor connects directly to the Receiving Shaft**
  - **Odor complaints returned/increased after connection of Phase II facilities**

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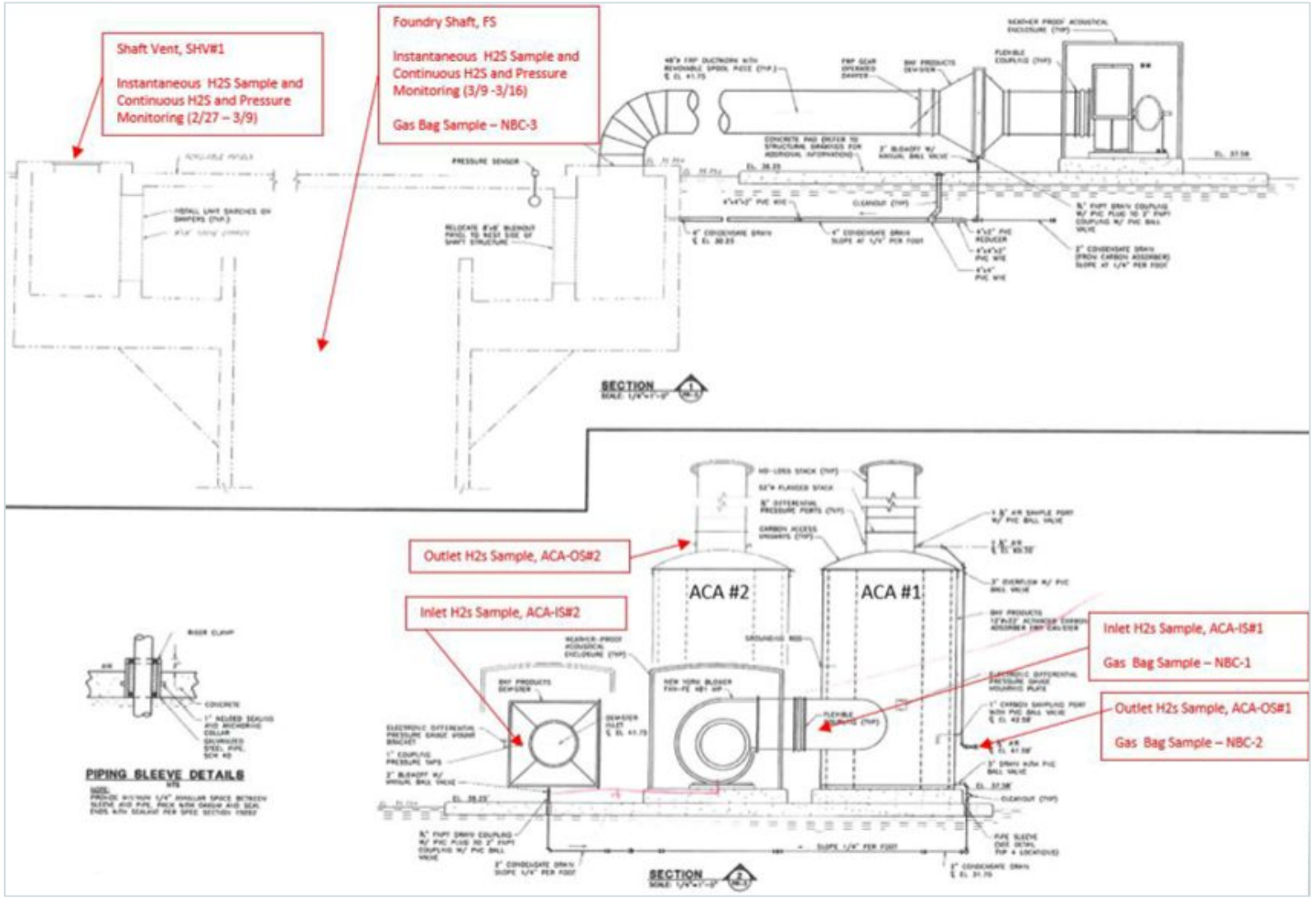
Sniffing Out the Odors

An Increase in Odors?

- Conducted two Sampling Programs
- At the Odor Control Units
  - Media – to estimate remaining life
  - Inlet/Outlet - Bag samples – H2S / Mercaptans, etc.
- Facilities Wide:
  - Instantaneous greater accuracy/semi-portable
  - Acrulog PPB Hydrogen Sulfide Gas Monitor
  - Acrulog Differential Pressure

Sniffing Out the Odors II



- Instantaneous bag samples taken
- Velocity measurements across fans, mist eliminators, and carbon stacks
- All measurements within acceptable ranges, although some maintenance items were noted
- Some carbon bricking

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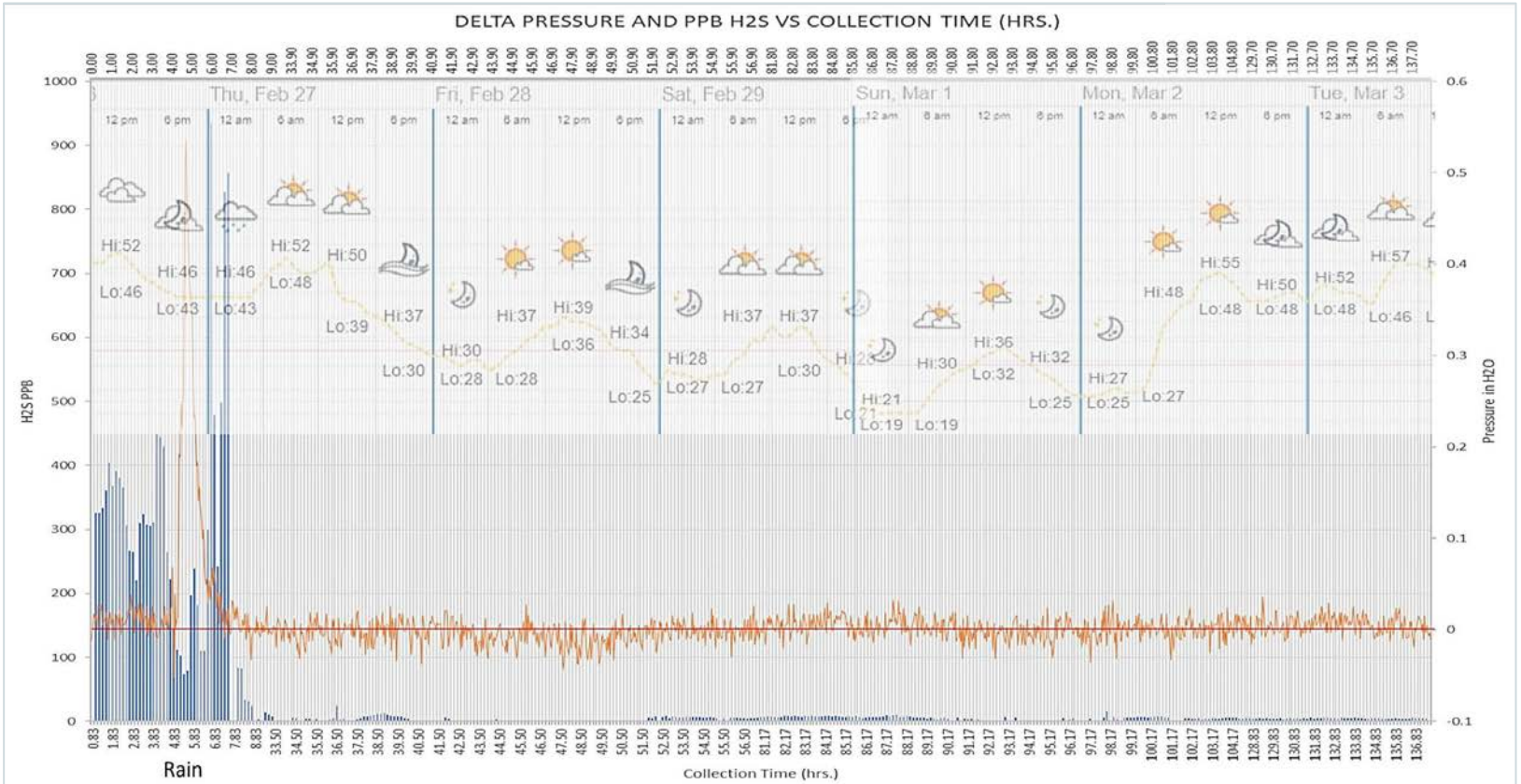
Sniffing Out the Odors III – Receiving Shaft

Continuous H2S and pressure monitoring result



Vent Chamber
Pressure vs H2S (Mar 3rd thru Mar 6th)

- **H2S ppb and differential pressure measured continuous at Foundry Shaft from February to March**
  - **H2S emission found to be detectable at the receiving shaft**
  - **H2S correlated well to rainfall (i.e., pressurizing events) and tunnel mucking operations**
  - **Steam constantly escaping from the louvered side of the Foundry Shaft**

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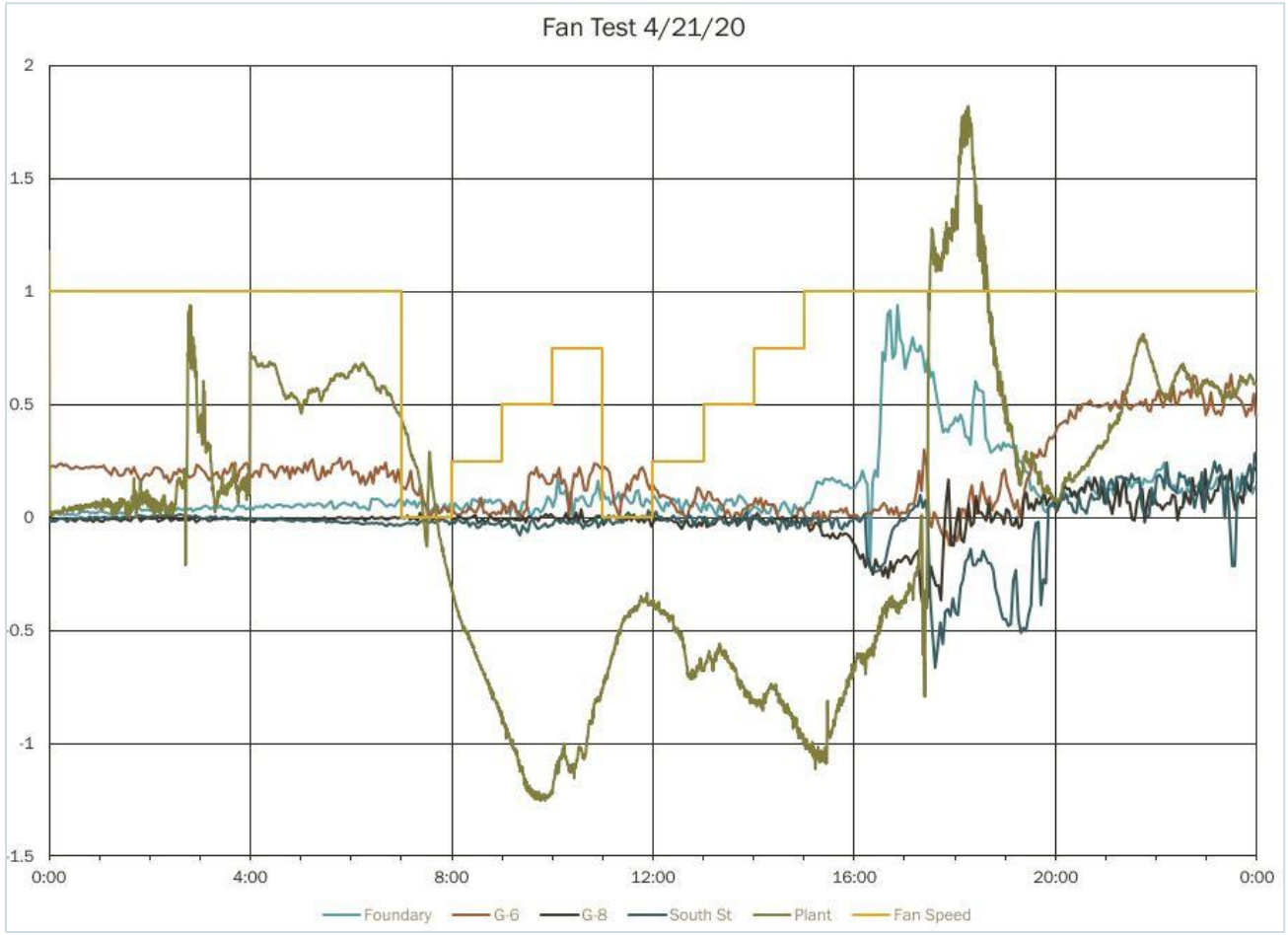
Short-Circuiting Airflows and Fan Influence



System wide multi speed fan test with continuous differential monitoring

- Existing odor control fans were varied from 0% to 100% while continuously monitoring pressure at:
  - Foundry Shaft
  - G-6 and G-8
  - South Street
  - Fields Point
- Test conducted on multiple days with varying ambient temperatures
- No strong correlations between fan speeds and pressures

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Sniffing Out the Odors IV

Modeling Approach

- **Ventilation Analysis conducted by:**
  - **V&A Consulting Engineers LLC.**
  - **Friction Drag Airflow Modeling (Pescod & Price method)**
  - **Empirical Buoyancy Model**
- **Ventilation modeling indicated:**
  - **Dampers at vents are not operating as designed allowing air to short-circuit**
  - **The Phase II interceptors may be providing air to the odor control unit instead of the Phase I tunnel**
  - **Headspace temperatures may be different than initially used resulting in greater airflows**

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Sniffing Out the Odors V

Source of the Odors?

- H2S is detectable especially following tunnel pressurizing events
- The existing odor control units are operating within their expected parameters
- The WCSOI may influence airflow, but only under a certain set of conditions

What's left???

- Air may be short circuiting the tunnel via the interceptors and the original Gate and Screening Structures (a materials issue)

Short-Circuiting Airflows and Dampers

Gate and Screening Structures

- Wright-Pierce conducted a site investigation of each gate and screening structure
- All equipped with intake and exhaust dampers
- If dampers are damaged/corroded, out of balance, air may short circuit

- Resulting H2S induced corrosion found to hinder damper functionality. For example, the blades get stuck, require higher pressure to open, and do not fully close
- Dampers found to have varying degrees of deterioration, contributes to air short-circuiting, may enhance “chimney effect”

Short-Circuiting Airflows and Dampers

Receiving Shaft

- Fugitive emissions suspected to escape through defects
- Large plenum dynamic air pattern / zone of influence of blower suction

Conclusion and Moving Forward

Phased Approach:

- Damper replacement / miscellaneous maintenance work (construction scheduled for Spring/Summer 2022)
  - Monitor odor complaints if/when received:
- Media replacement / Carbon Vessel Modifications (future construction contract)
- Re-assess dispersion / evaluate discharge stack height
- Expand Capacity of System (most costly option)

Other:

- Inspection and cleaning of CSO Tunnel & related facilities (future contract part of Phase III)

Additional Assessment Tools

NBC Installed an Airflow Meter

- NBC installed air flow monitoring equipment to confirm model results
- Ultrasonic Transit-Time Meter
  - Frequently utilized in the Mining Industry
- Meter data found to agree with theoretical model

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THANK YOU

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