The National Academies of
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TRANSPORTATION RESEARCH BOARD

# Tunnel Operations Practices Featuring the MassDOT Tunnel

## Wednesday, December 11, 2019
## 2:00-3:30 PM ET

*The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.*

## Purpose

Provide an overview of the Massachusetts Department of Transportation (MassDOT) tunnel system, focusing on tunnel inventory and construction in Massachusetts

## Learning Objectives

At the end of this webinar, you will be able to:

- Describe the management of large, complex tunnel infrastructure systems

# Operations, Inspection at PennDOT's Pittsburgh Tunnels


Lou Ruzzi, PE
District Bridge Engineer

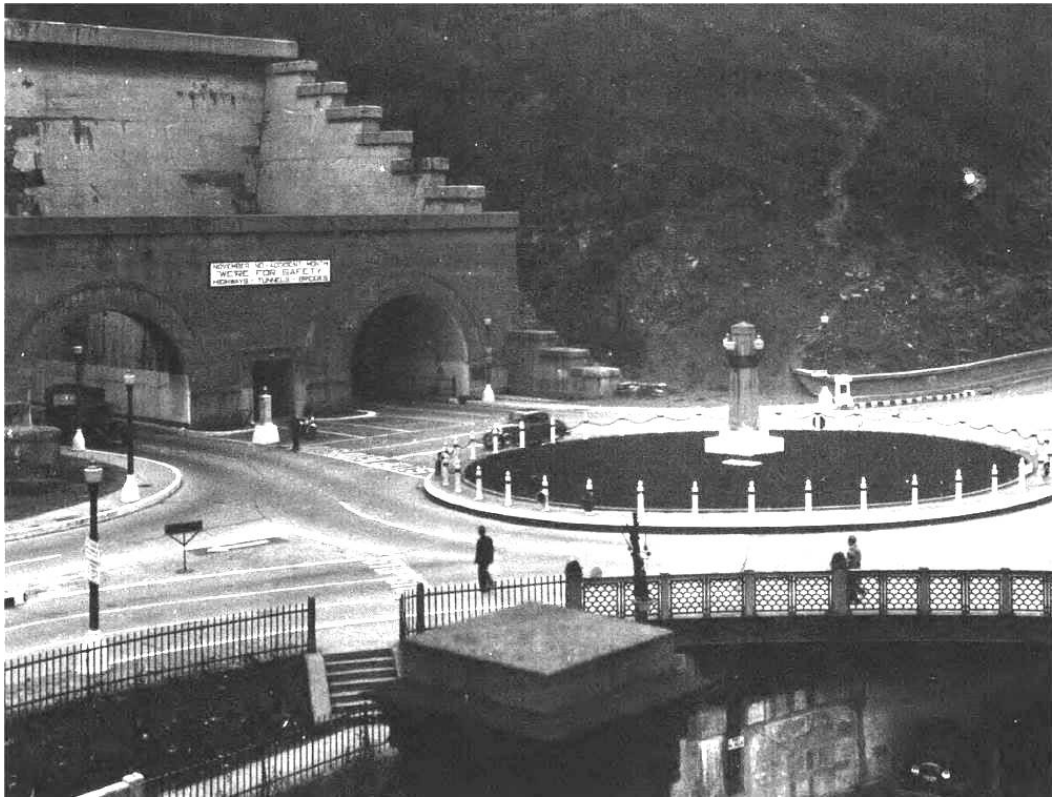
# Agenda

I. Introduction
II. Tunnel Maintenance & Operations
III. Traffic Incident Management
IV. Tunnel Projects
V. Tunnel Inspections
VI. Inspection Alerts
VII. Questions

# Liberty Tunnel

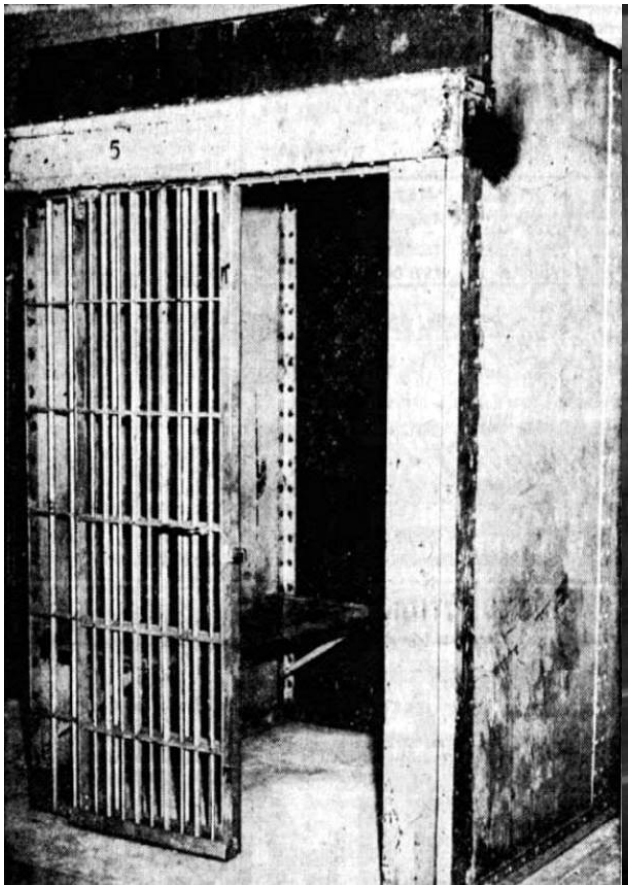
# Liberty Tunnel

- This tunnel featured a traffic circle when it opened.



# Liberty Tunnel

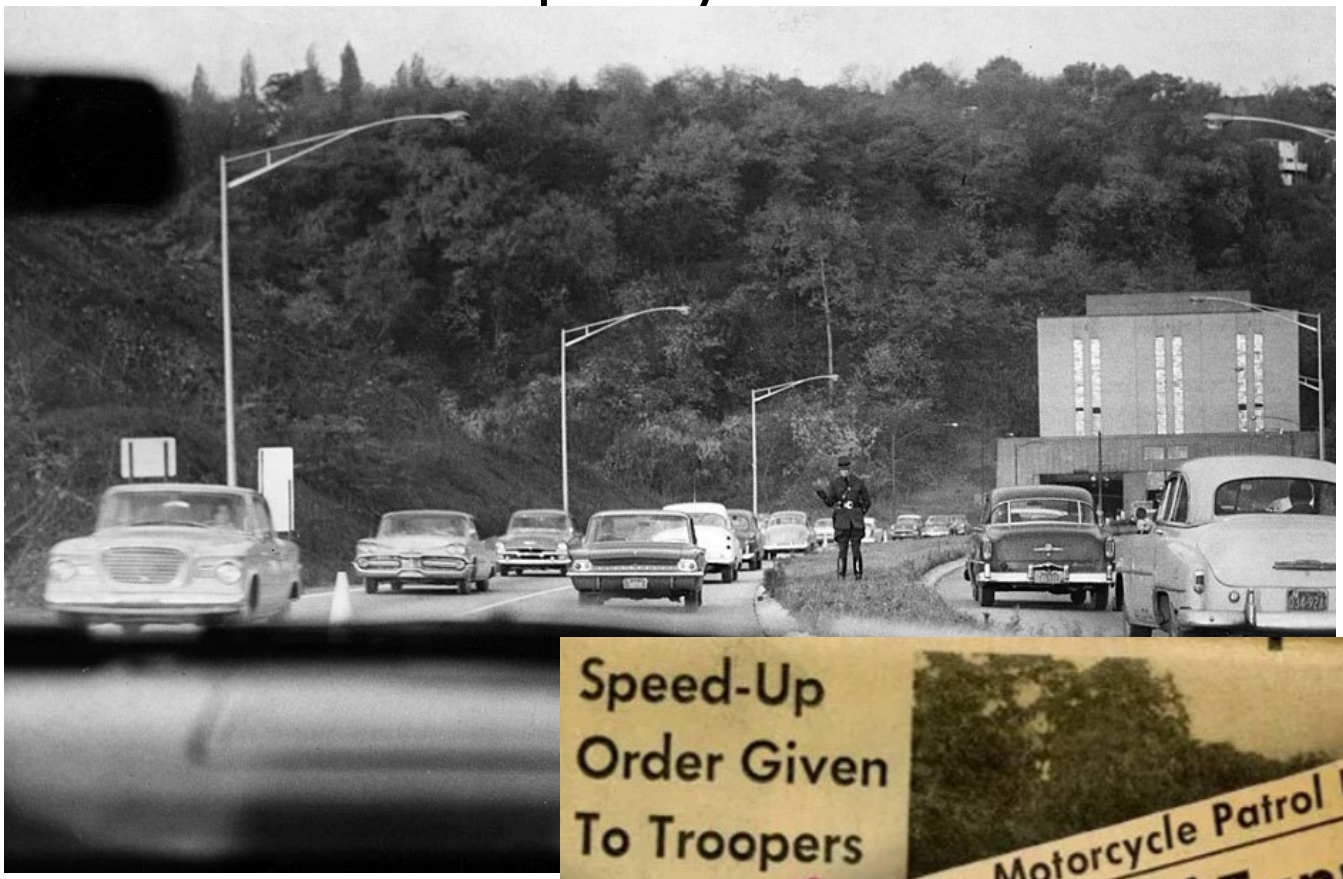
This tunnel features a walk-in safe and at one time had a jail cell.




# Squirrel Hill Tunnel

# Squirrel Hill Tunnel

This tunnel experimented with bidirectional traffic to increase capacity.



Speed-Up Order Given To Troopers

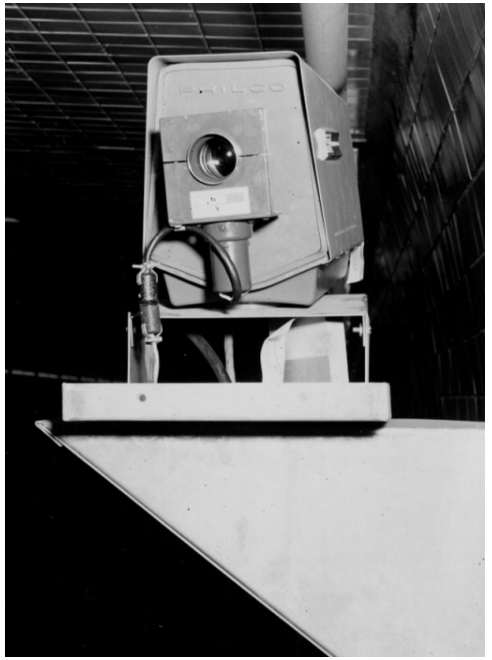
County Motorcycle Patrol Urged

Police Call Tunnel Plan Suicidal

# Fort Pitt Tunnel

# Ft Pitt Tunnel

This tunnel featured CCTV cameras to monitor traffic when it was opened.



# Stowe Tunnel

# Tunnel Features

- SCADA system
- Ventilation
- CO detection
- Fire detection
- CCTV cameras
- Fire extinguishers
- Dry standpipe
- Adjustable lighting
- Emergency phones
- Cross passages between tubes
- Emergency exit marking
- Generator backup
- Cell phone reception


Coming to Liberty Tunnel in 2019

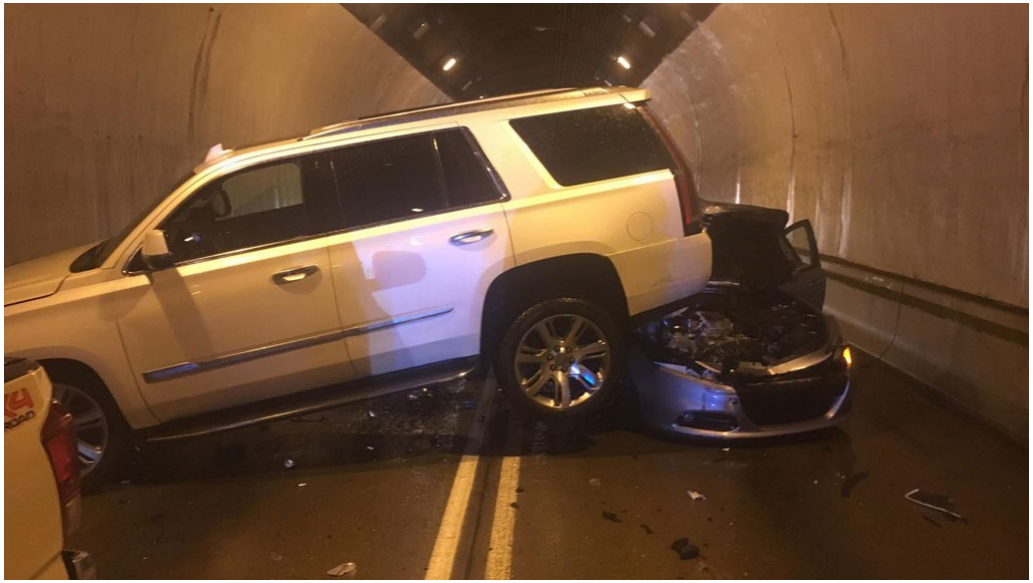
- Automated standpipe control
- AM/FM radio break-in
- Emergency Loudspeakers

# Tunnel Maintenance

- County Maintenance Organization
- Budget comes from Allegheny County
- 24/7/365
- 67 employees
- 5 tow trucks + 2 flatbeds
- 4 crash trucks
- 1 wash truck

Maintenance – but different!

# Tunnel Maintenance




# Tunnel Maintenance



# Tunnel Maintenance

- Electrical Maintenance
  - Maintain lighting, ventilation, and life-safety systems
  - Ensure the operation of tunnel systems that keeps the tunnels safe for the motoring public

# Tunnel Maintenance

- Waze Beacons
  - Installed September 2016
    - Liberty Tunnel
    - Fort Pitt Tunnel
  - Allows GPS to work without reception
  - Open source technology
  - 1st Tunnel in US to install
  - 2nd Tunnel worldwide

# Distributed Antenna System

- Cell Phone Service
  - Distributed Antenna System (DAS)
  - Shared system between AT&T, Sprint, T-Mobile, and Verizon
  - Carriers responsible for maintaining system
  - No taxpayer money included in project
  - $25k licensing fee per carrier per tunnel yearly
  - Service restored 2017

# Traffic Incident Management

- TIM consists of a planned and coordinated multidisciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible
- Effective TIM:
  - Improves the safety of emergency responders, crash victims, and motorists
  - Reduces the duration and impacts of traffic incidents


# Traffic Incident Management

- Pittsburgh Tunnels Traffic Incident Management (TIM) Team
  - Multi-disciplinary team of 1st responders, PennDOT, local municipalities, tow companies, PSP, utilities, and other stakeholders
  - Focus on Responder Safety, Quick Clearance, and Prompt, reliable, interoperable communications
  - Learn how to work together better
  - Joint Training
  - Conduct After Action Reviews
  - 3-4 Meetings/year

# Inspection Alerts

- 2018:  Fort Pitt – Car Fire after Steeler game

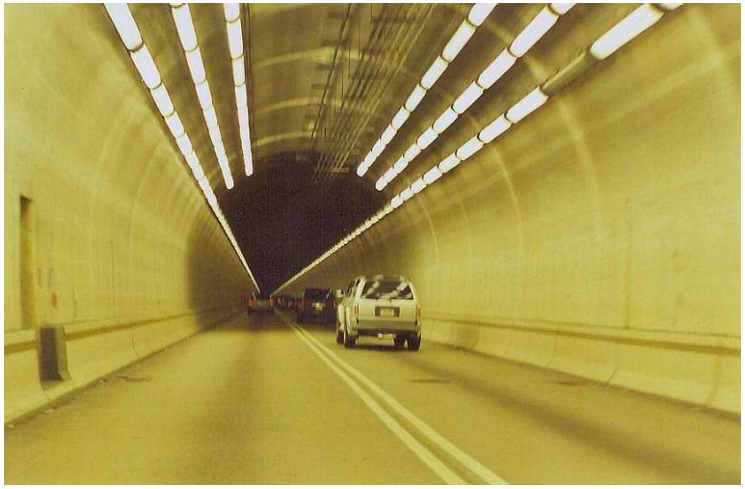
# Traffic Incident Management


# Tunnel Projects

| | |
|---|---|
| Fort Pitt Rehab (2002) | $20M |
| Liberty Phase 1 (2009) | $6M |
| Liberty Phase 2 (2009-11) | $12M |
| Liberty Phase 3 (2011) | $9M |
| Squirrel Hill Rehab (2011) | $50M |
| Liberty Phase 4 (2013) | $20M |
| Fort Pitt Ceiling Removal (2015) | $16M |
| Liberty Phase 5 (2017) | $30M |
| Total Cost | $163M |

# Liberty Tunnel

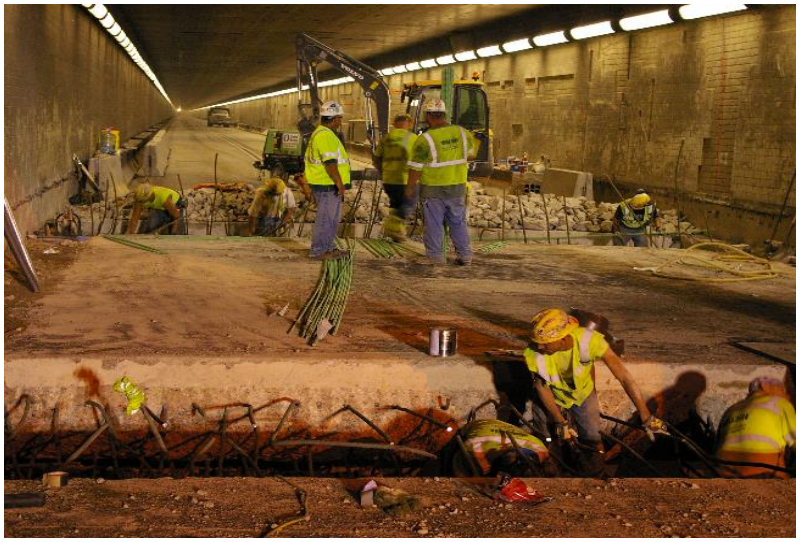
Before

After


# Liberty Tunnel

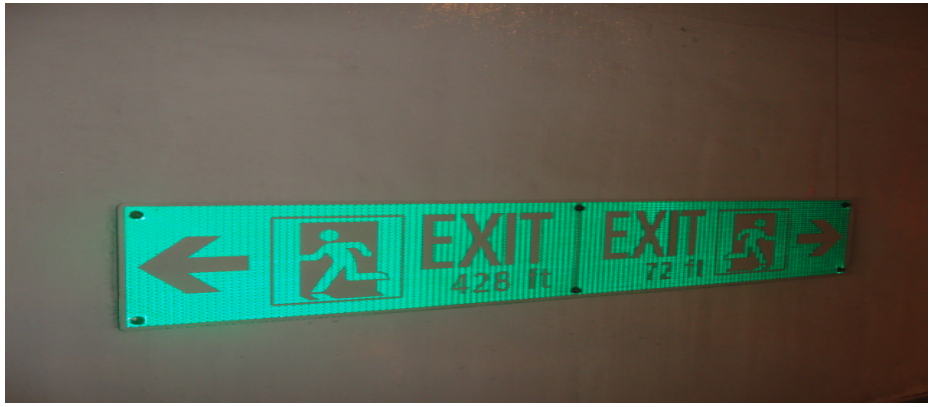
# Squirrel Hill Rehab



# Fort Pitt Ceiling Removal

# Emergency Signs and Marking Systems for Highway Tunnels





# Local Tunnel Involvement

- Allegheny County
  - Armstrong Tunnel
- City Of Pittsburgh
  - Corliss Tunnel
- Port Authority Tunnels
  - North Shore Connector(tunnel under Allegheny River)
  - Wabash Tunnel
  - Berry St Tunnel
- PA Turnpike
  - Tunnel Management Committee

# D11 Status on its Tunnel Inspections

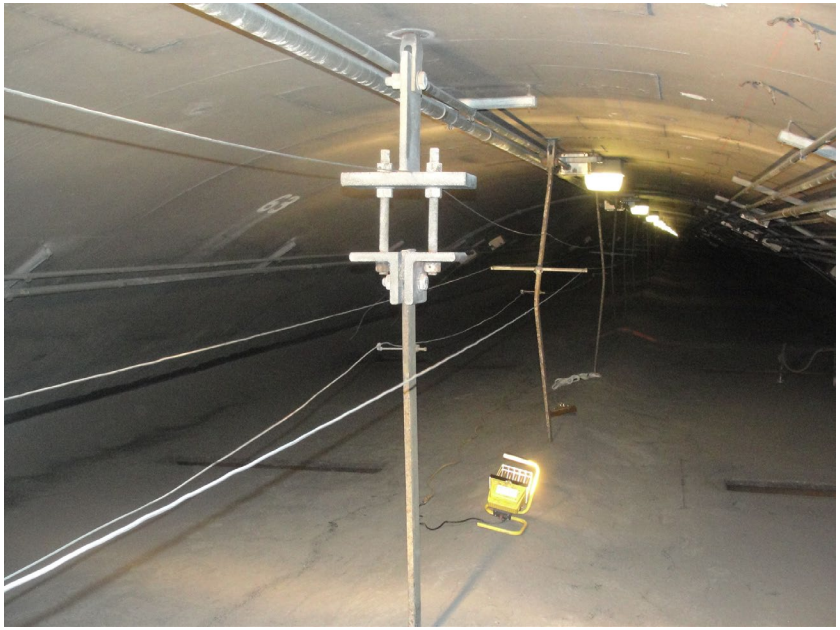
- 1st Round Completed 2016-17
  - Estimated repairs
    - Critical $0
    - Priority $1.2M
    - Routine $277k
- Next round began December 2018
  - 2018 Fort Pitt Completed
  - 2019 Squirrel Hill & Liberty
- Future rehab – Stowe Tunnel
  - Looking to add to TIP
  - Design by inhouse or consultant undetermined

# Inspection Alerts

- 2007: Fort Pitt - Suspended ceiling failure

# Inspection Alerts

- 2012:  Fort Pitt - 70 ceiling hangers in compression



# Inspection Alerts

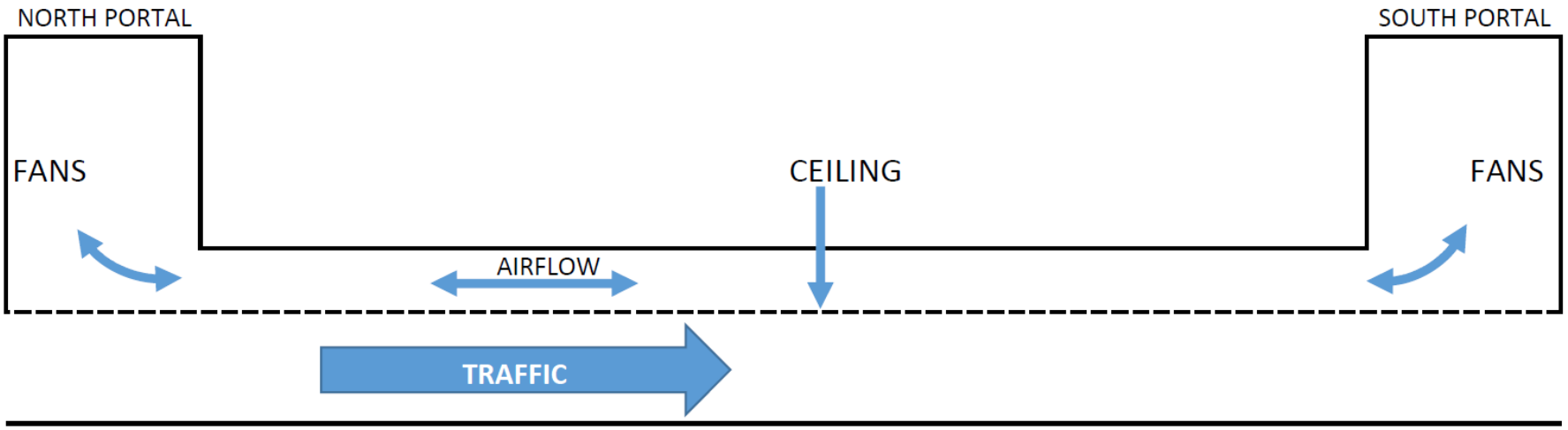
- 2012: Fort Pitt - Light fixture failure due to dissimilar metals(luminaire vs support)

# Inspection Alerts

2016: Fort Pitt moving wall

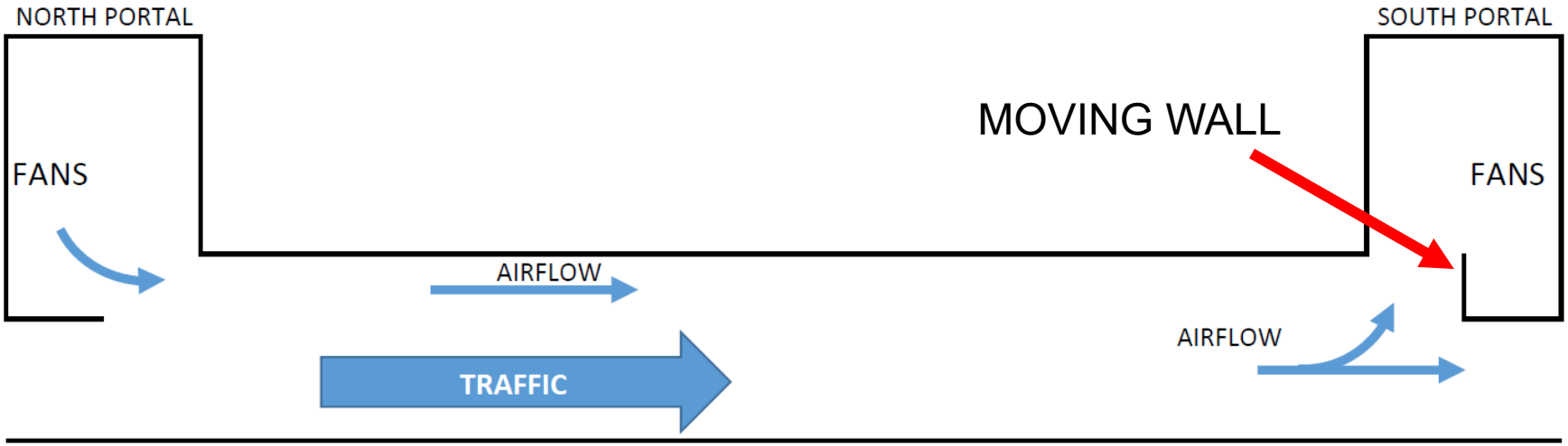
# Inspection Alerts

Prior to ceiling removal:



# Inspection Alerts

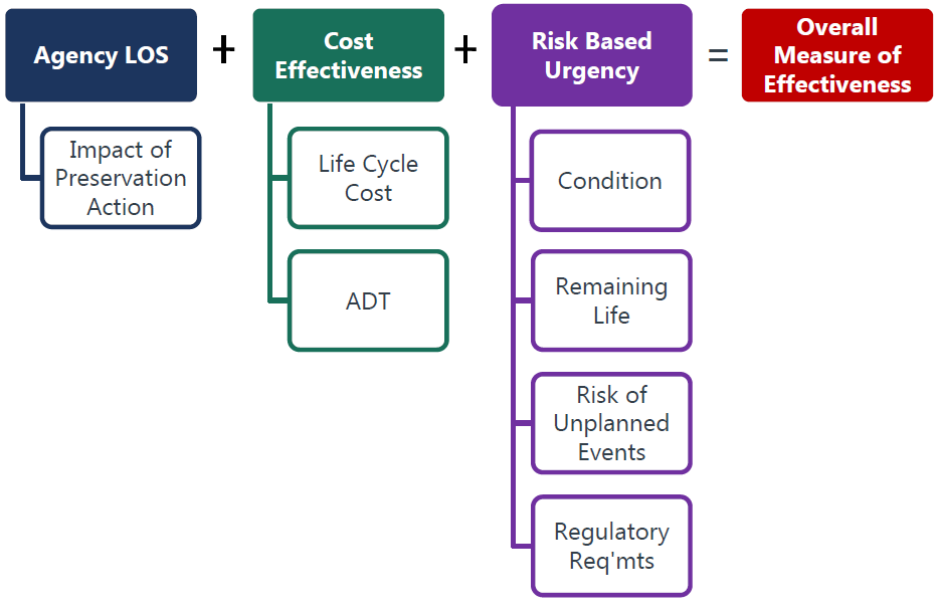
After ceiling removal:



# Inspection Alerts

Repair:

# Where Does D11 Stand?

# Kudos!

**mwithrow02**

10:33am via Twitter for iPhone

@PennDOTNews Thank u for bringing a dog your guys rescued from Parkway W by Ft Pitt Tunnels! Someone deserves a bonus! Dog @westernpahumane

**Peggy Shields**
@peggy_s

Hey @PennDOTNews Big shout out to the PennDot driver who helped me on the Fort Duq Bridge ramp in Pgh tonight. Stayed with me waiting for AAA @AAAnews who couldn't found me.

11:17pm · 10 Sep 2018 · Twitter for iPhone
West View, PA, United States

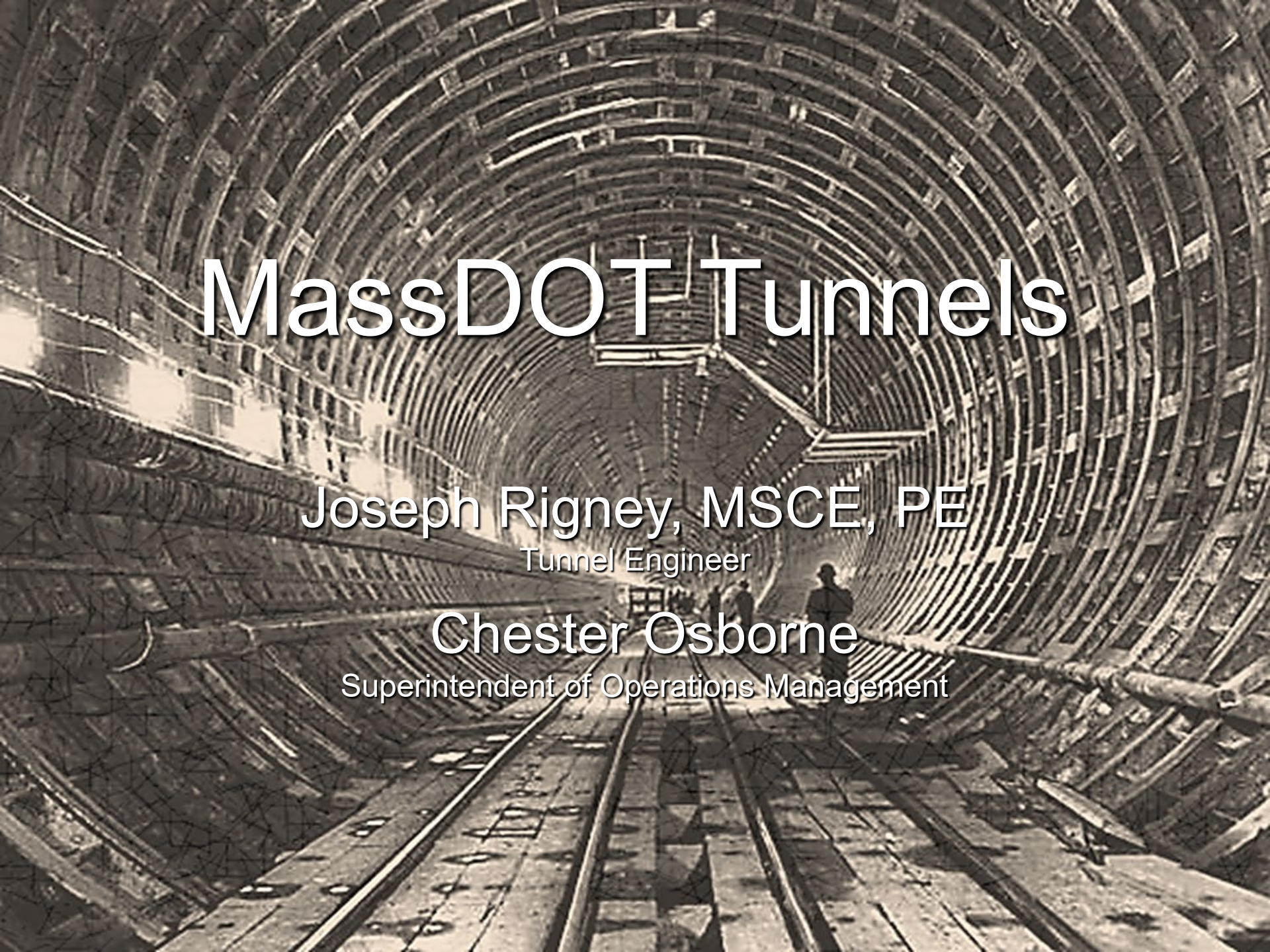
1 REPLY 1 LIKE

**PA Department of Transportati...** 19s
Replying to @peggy_s @AAAnews
Hi Peggy,
Thank you. We are glad you are safe.
#SafeTravels

Mr Ed was very helpful when I was involved in a multi Vehicle accident today. This was my first accident and he was calm and helped me and made sure I was okay. It was a very chaotic night due to the multiple accidents that were occurring at the same time, but he kept his composure and handled all of them flawlessly. Mr Ed along with His co workers do not get enough credit for the job they do every single day. Without him, the situation would have been way worse and he handled it like a pro. These men helped get all our cars off the parkway and onto the median to keep traffic flowing. This man is a true asset to your team, and I'm very grateful he helped me tonight.

10/27/2018 4:44 AM

# Questions?



# MassDOT Tunnels


Joseph Rigney, MSCE, PE

Tunnel Engineer

Chester Osborne

Superintendent of Operations Management

# Joseph Rigney, MSCE, PE

- Tunnel Design in California, DC, Miami
- Professional Engineer in MA, DC, RI
- Nationally Certified Tunnel Inspector
- AASHTO Tunnel Committee (T-20) Member
- Been with MassDOT for 4.5 years (at the start of the tunnel group)

# Chester Osborne MPA, USA Ret.

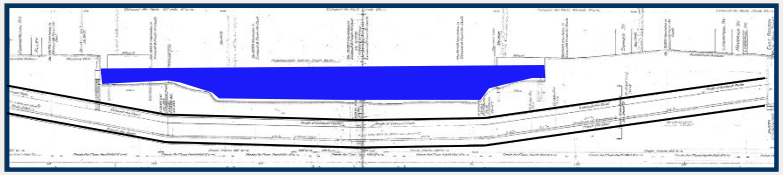
- 7 years experience with MassDOT (not an engineer!)
- 20 years military; to include managing Ops Centers, target officer duties and tactical operations
- Started at MassDOT as a Tele-Com Tech.in the tunnels, now at the HOC/TMC
- MPA, Grad Cert in Transportation & Urban Systems
- Graduate of both the I-95 Corridor Coalition Operations and Freight Academy

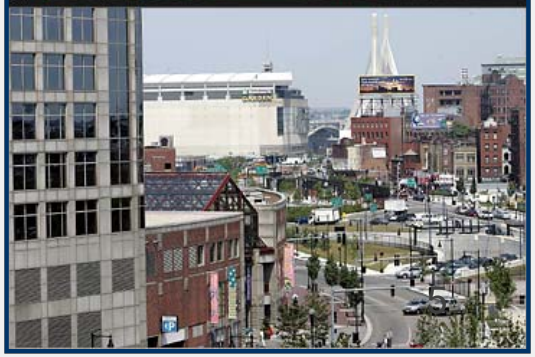

# Agenda

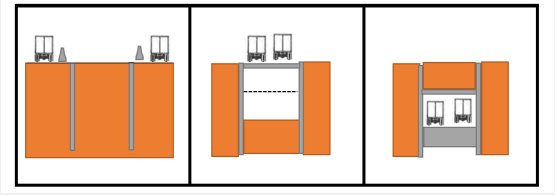
- **Why Tunnel?**
- **MassDOT Tunnel Inventory**
- **Construction of Tunnels**
- **Systems**
- **Operations** (facilities, traffic and emergency)
- **Inspections**
- **Maintenance**
- **Capital Planning**

# Why Tunnel?

- **Get to the other side of the mountain (or river)**
- **Keep Real Estate that would be lost with a bridge**
- **Better protection from the elements**
- **Minimize surface disruption**
- **MassDOT Definition:** enclosed roadways with vehicle access that is restricted to portals regardless of type of structure or method of construction. Tunnels in the MassDOT Tunnel Inventory **have a ventilation system** and/or are **more than 300-ft long** and are covered on all sides with soil. The crown or roof also contains **more than 5-ft of soil cover** for more than 50% of the total structure length or for a 200-ft length (whichever is less).







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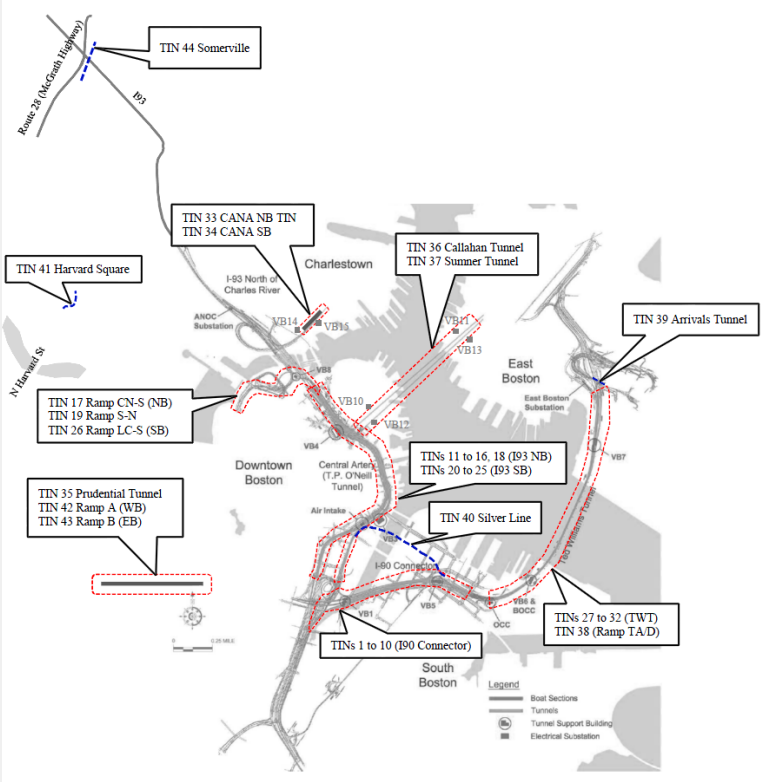
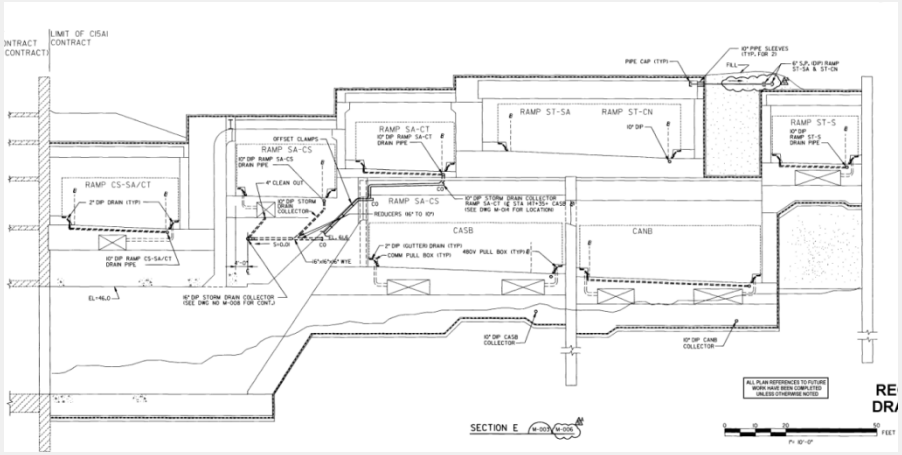
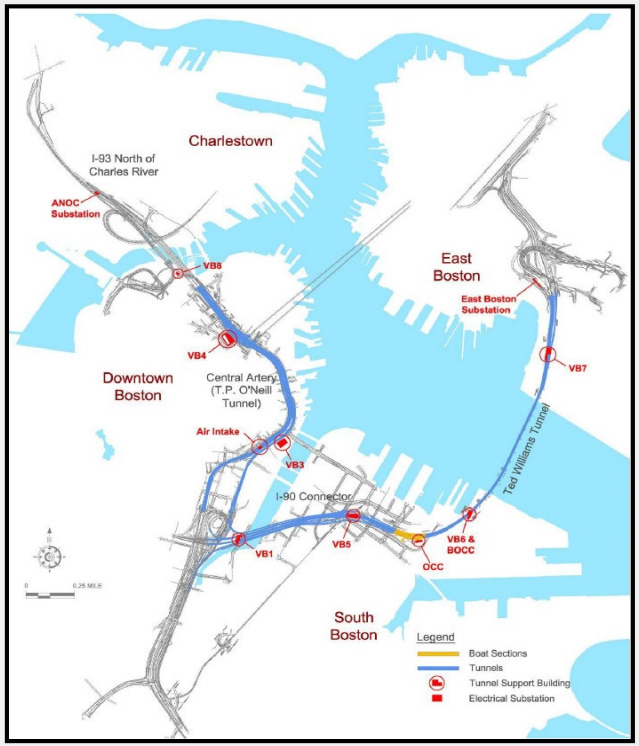
# Tunnel Layout




- **7 General (27 miles)**
  - Sumner (30,000 +/- ADT)
  - Callahan (30,000 +/- ADT)
  - Prudential (120,000 +/- ADT)
  - CANA (80,000 +/- ADT)
  - Ted Williams Tunnel (70,000 +/- ADT)
  - I93 Tip O'Neill (180,000 +/- ADT)
  - I90 Connector (160,000 +/- ADT)
- **45 T.I.N.s**

# Tunnel Ventilation & Assoc. Bldgs




- Total of 13 Vent Buildings
  - 7 CA/T (w/ Additional Air Intake Structure)
  - 2 Sumner Tunnel
  - 2 Callahan Tunnel
  - 2 CANA
- Main Tunnel Systems w/in each VB
  - SWGR and USS
  - Light panels feed 30,000 +/- lights
  - Pump stations (14 total on system)
- 230 Fans
  - 168 Centrifugal (located in Vent Buildings)
  - 35 Jet Fans (located in tunnel ramps)
- Multiple Ventilation Types
  - Full Transverse (most typical)
  - Semi-Transverse
  - Longitudinal (often with Jet Fans)
  - Natural (Ramp S-N)
- Ventilation Purposes
  - Maintain safe CO levels
  - Control smoke & reduce temperatures in a fire event

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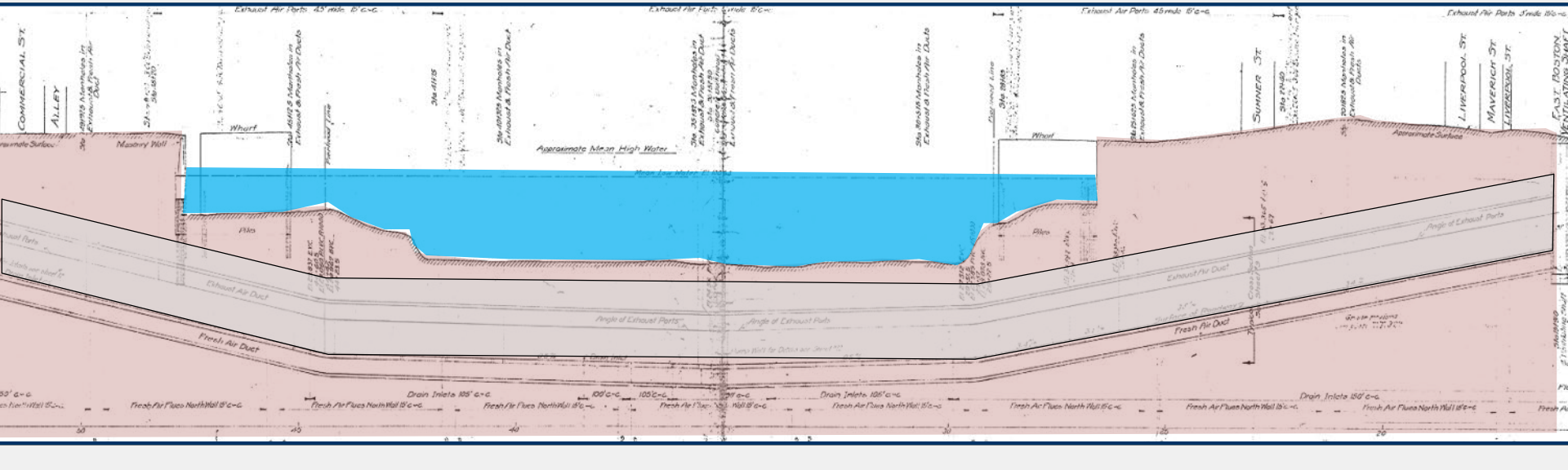
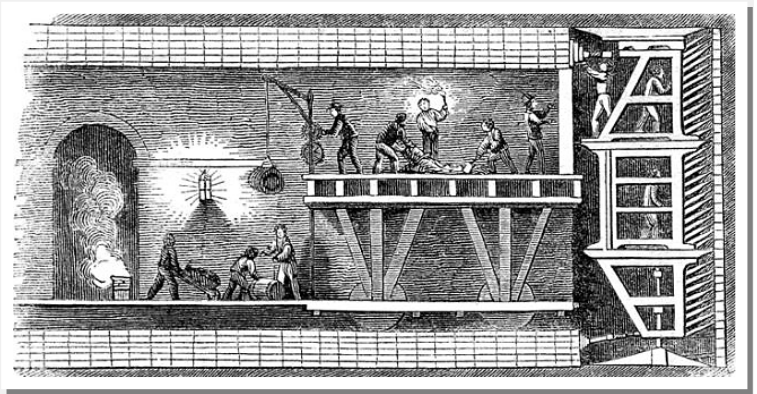
# Construction
# Sumner & Callahan Tunnel



# Construction: Air Rights Tunnels

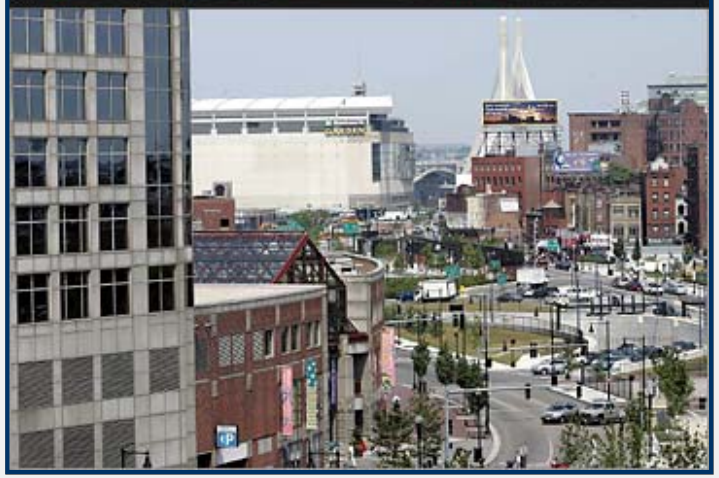
(No cut, just cover)

# Construction

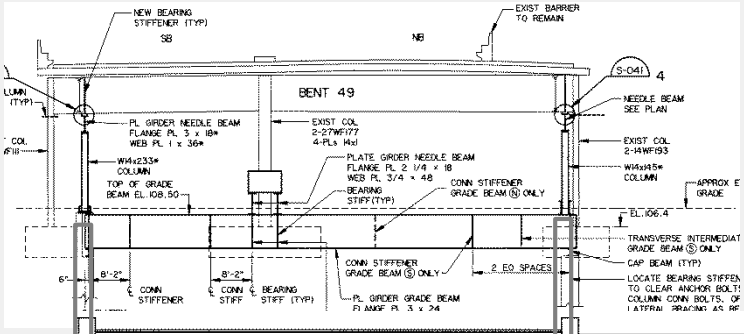
## C/A-T Before & After

**Before**

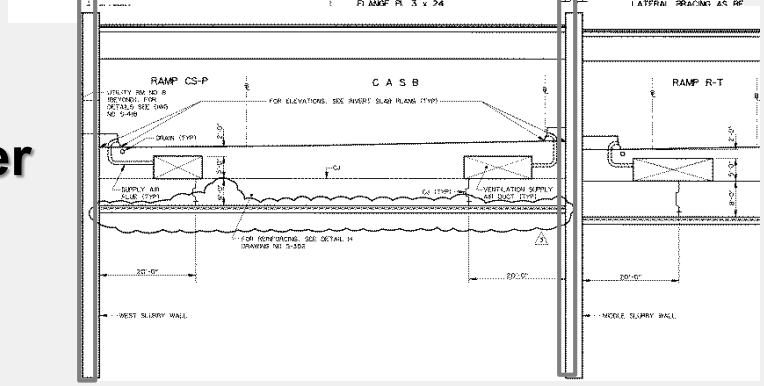
**After**



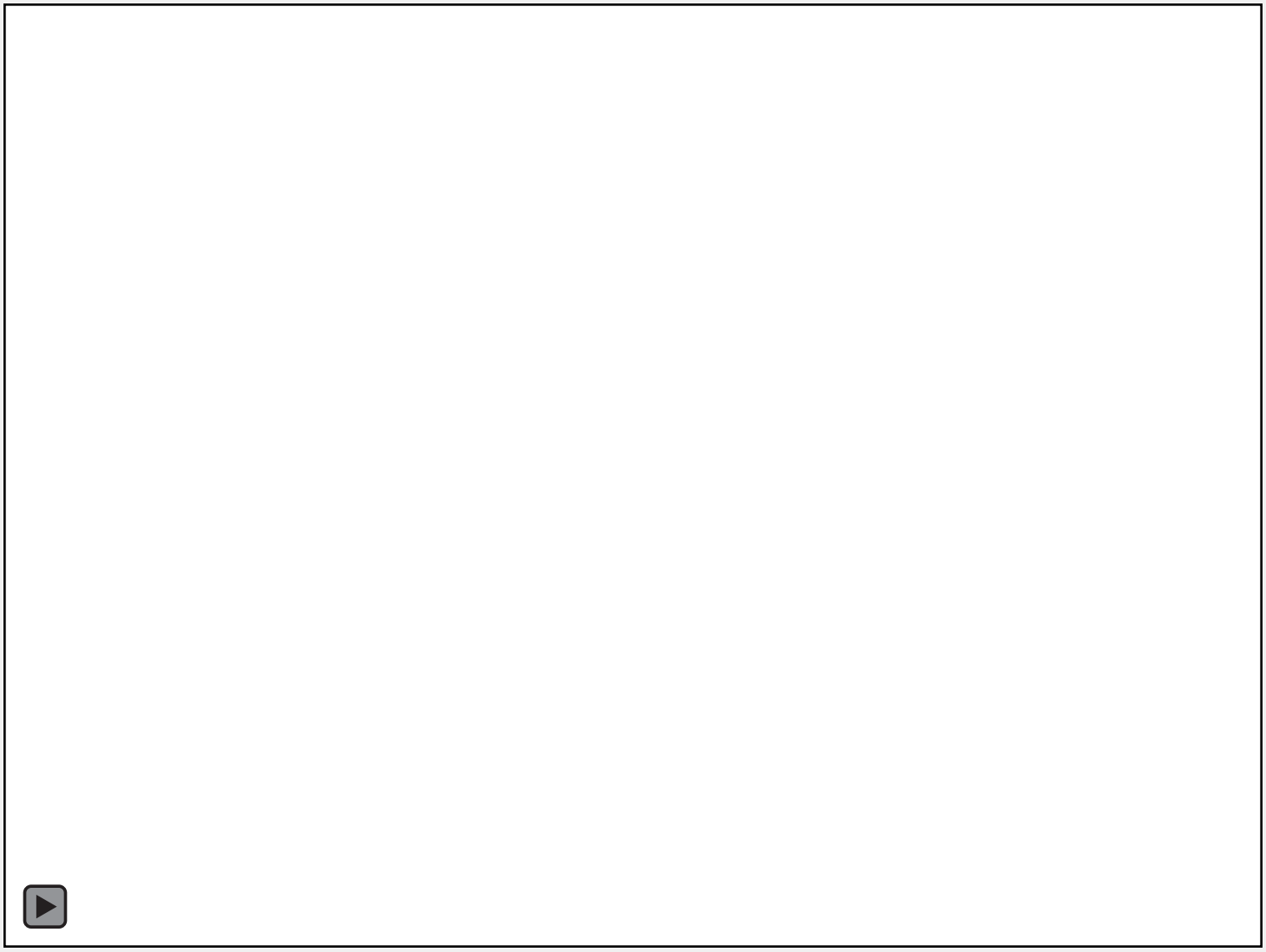
**Before**



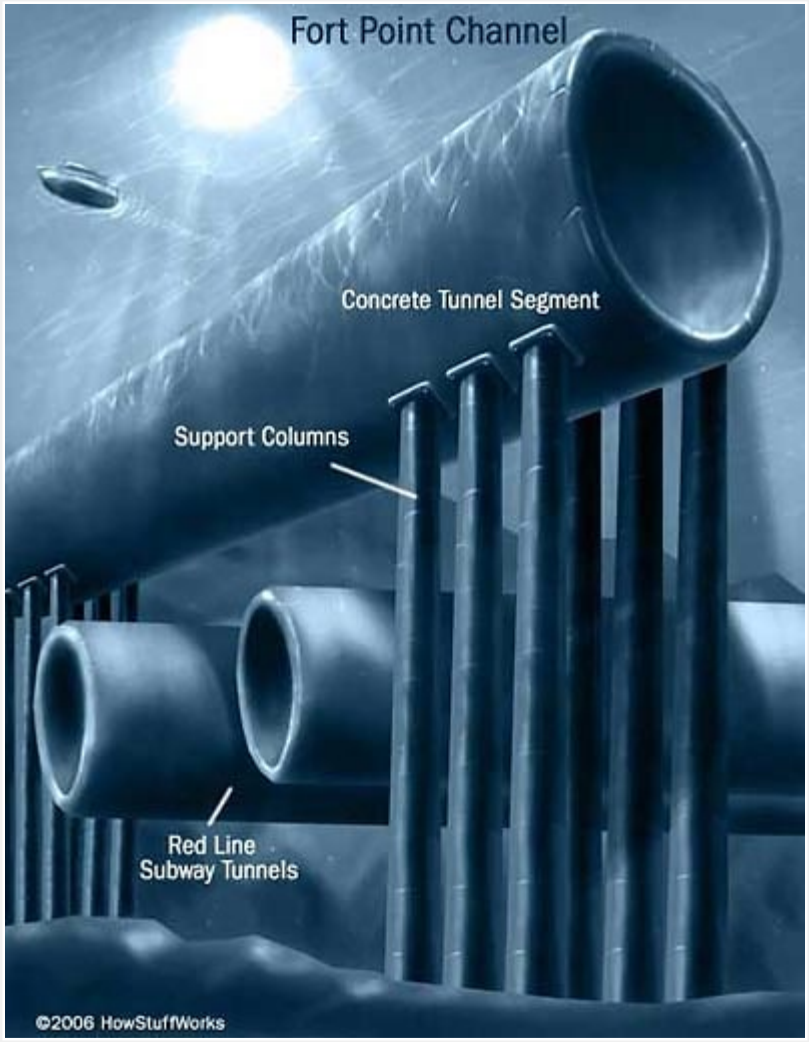

**After**

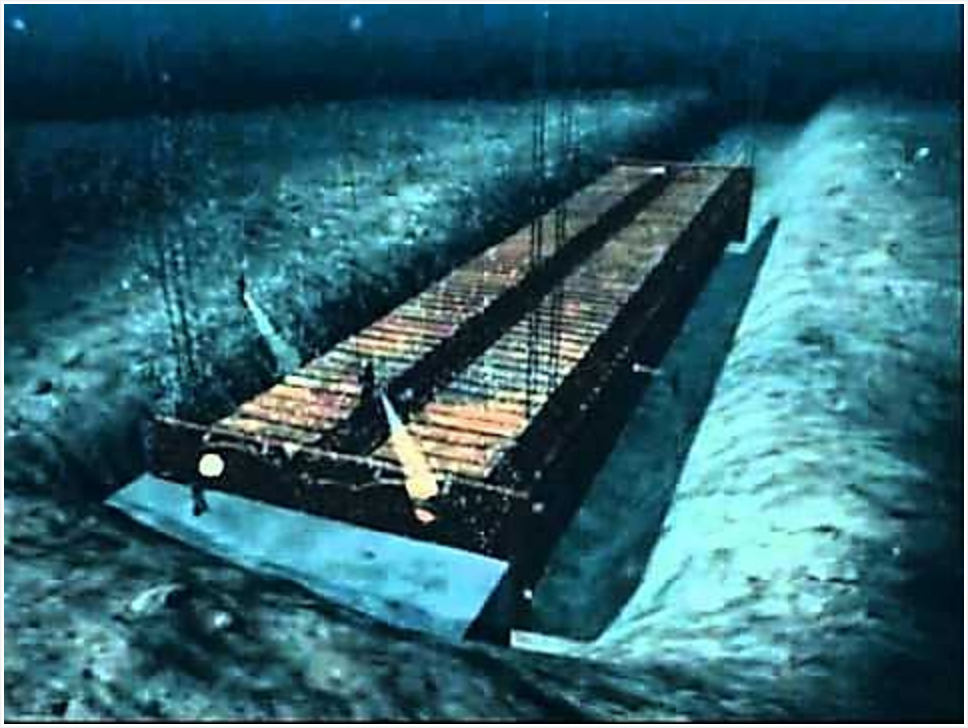



# Construction Types : Jacked Tunnel



# Construction Type: Immersed Tube



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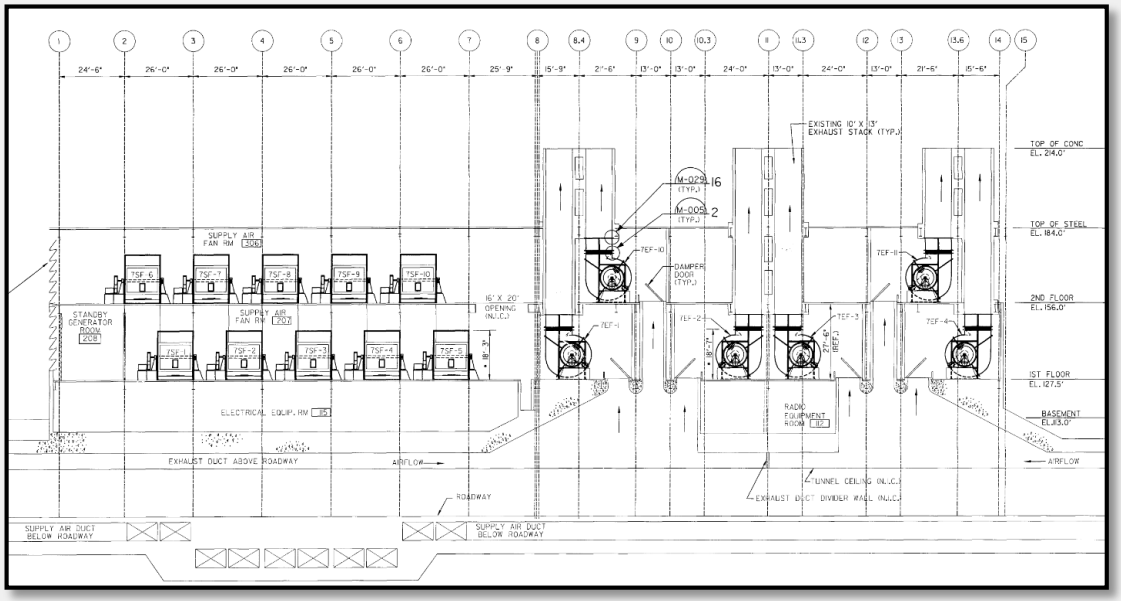
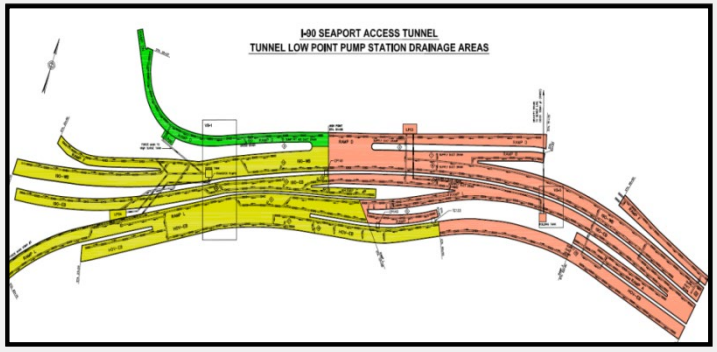
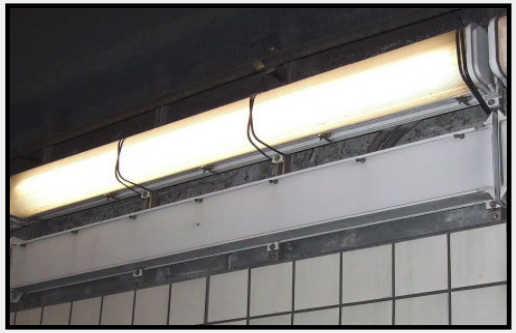
# Tunnel Systems




Ventilation



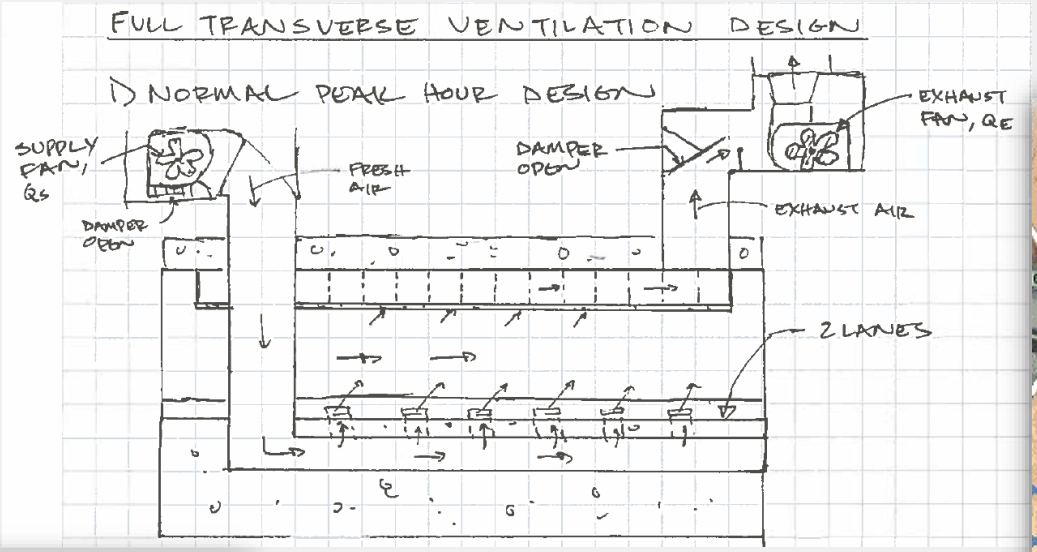

Drainage

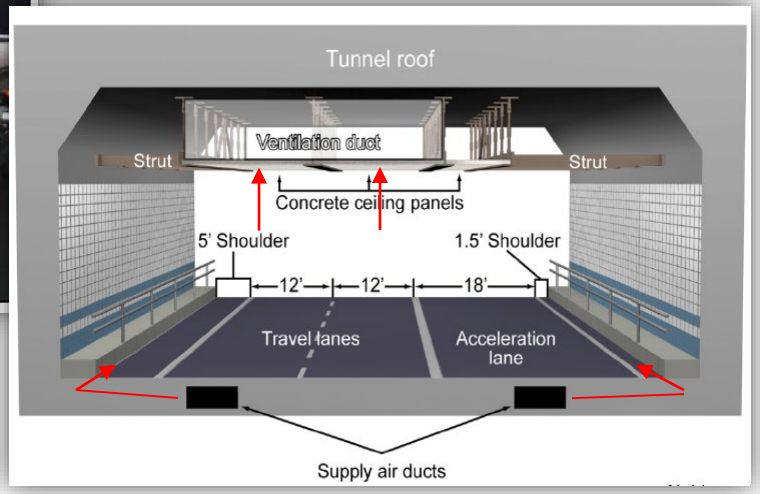


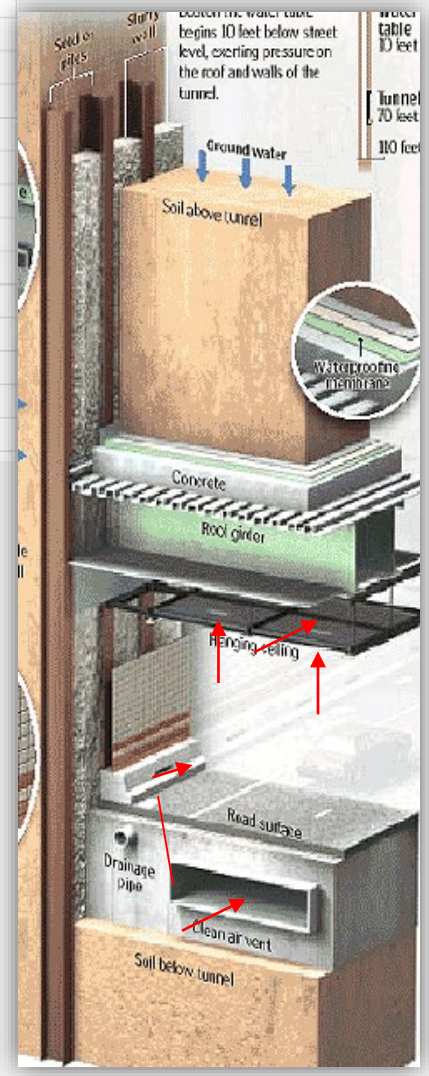
Lighting

Electrical

# Tunnel Ventilation



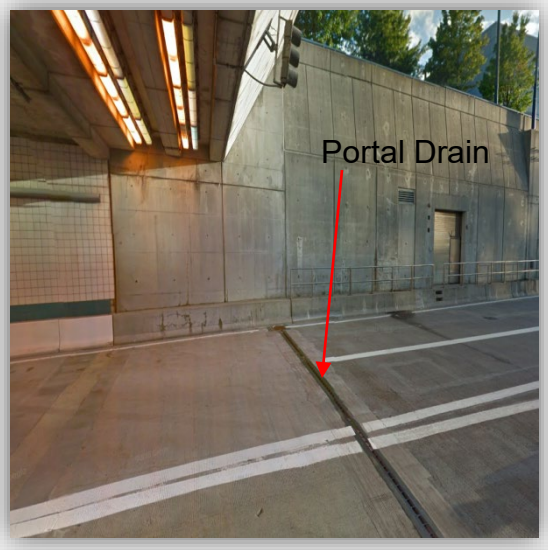



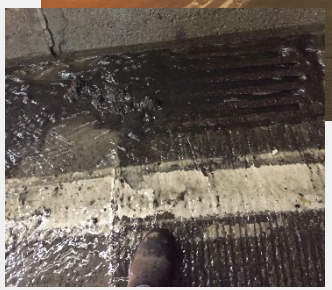



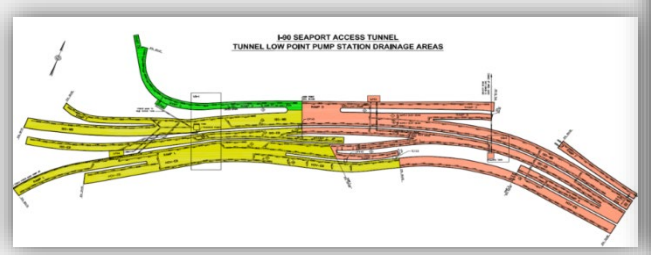
# Exhaust Plenum (Above the Roadway)

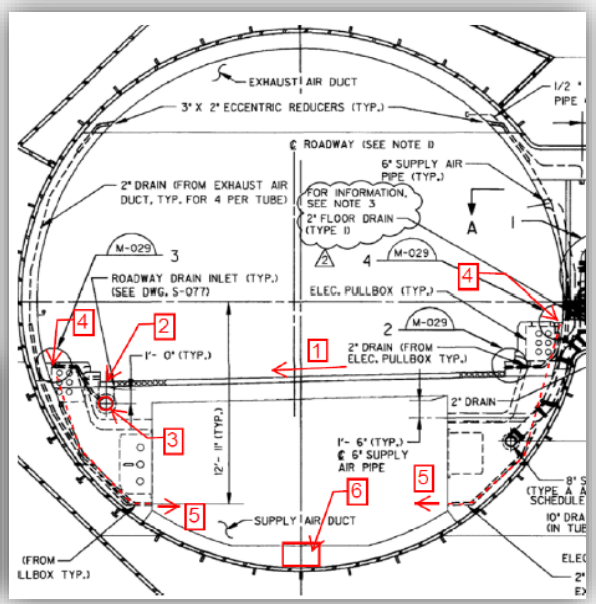
# Drainage

- Water outside the tunnels “should” go from portal drains to storm water outfalls
- 51 Portal Drains at Tunnel Entrances and Exits
- Water inside the tunnels goes to pump stations
- 14 total low point pump stations
  - CA/T Tunnel has 12 pump stations
  - Sumner & Callahan Tunnel each have 1 pump station
- Sources of water include:
  - Leaks in Tunnel (cracks, conduits, joints)
  - Tunnel Washing
  - Rainfall by-passing portal drains
  - Snow melt off cars
  - Firefighting activities





# Electrical Distribution/Lighting

1. 15 KV into SWGR at Venting Buildings and Electrical Substations
2. SWGR feeds two transformers at each USS
3. Transformers that step down 15 KV to 480V
4. 480V feeds tunnel lights, fans, pump stations, utility rooms, etc.

- Note: STBY system and lots of redundancy exist.

SWGR Photo

USS Photo

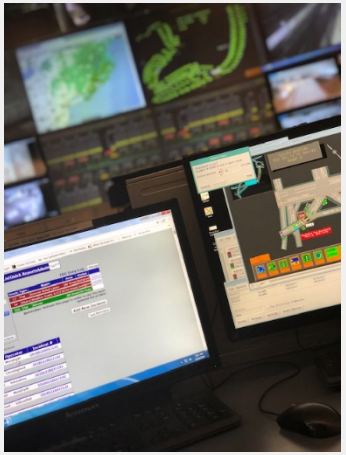
Lighting Panel

# Agenda

- Why Tunnel?
- MassDOT Tunnel Inventory
- Construction of Tunnels
- Systems
- **Operations** (facilities, traffic and emergency)
- Inspections
- Maintenance
- Capital Planning

# Tunnel Operations

Traffic Operations
Facility Operations
Emergency Operations



# Traffic Operations

- **Monitoring for Fire/Life Safety**
- Roadway Monitoring
  - Via Patrol
    - LEO
    - DOT Incident Response Offers
  - Via Camera
    - Via Algorithm
- MSP-ERS Posts
  - TIM
  - ERP/URM
- Fire Response
  - Training

Sumner Tunnel Response Training

# Facility Operations

– **Monitoring for Fire/Life Safety**

– Monitor 100K points via SCADA Receive and document alarms
– Dispatch to fix issues
  • Smart techs and engineers
– Operations plans to support cutovers
– Aging of Equipment

Pump Obstruction Removal

In-field pump controller alarm

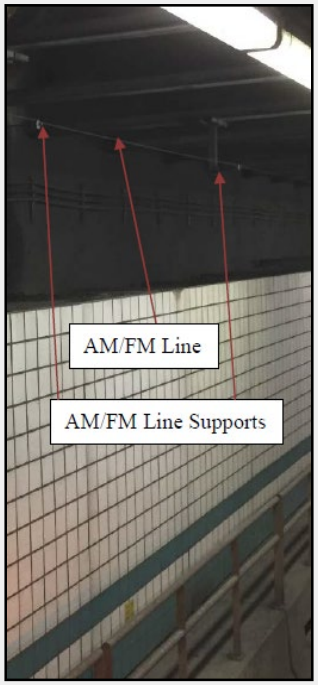
# Emergency Operations

- **Monitoring for Fire/Life Safety**
- Evacuations
- Flooding
- Security Sensitive events/operations
- Back up HOC
- Drills and training

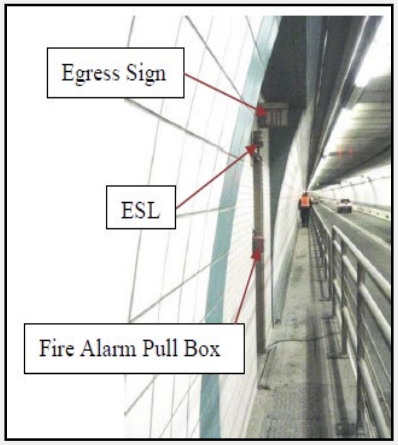
Drill from within HOC

# Emergency/Incident Response

- Response Plans & Procedures Developed (Fire, IRO)
- Fire Department Exercises
- Audio and Visual Communications (AM/FM, ESL, VMS, Lane Signals)
- Fire Detection: CCTV, Alarm Pull Boxes
- Fire Suppression Systems
- Fire Extinguishers located throughout tunnel
- Many Egress Locations Throughout Tunnels

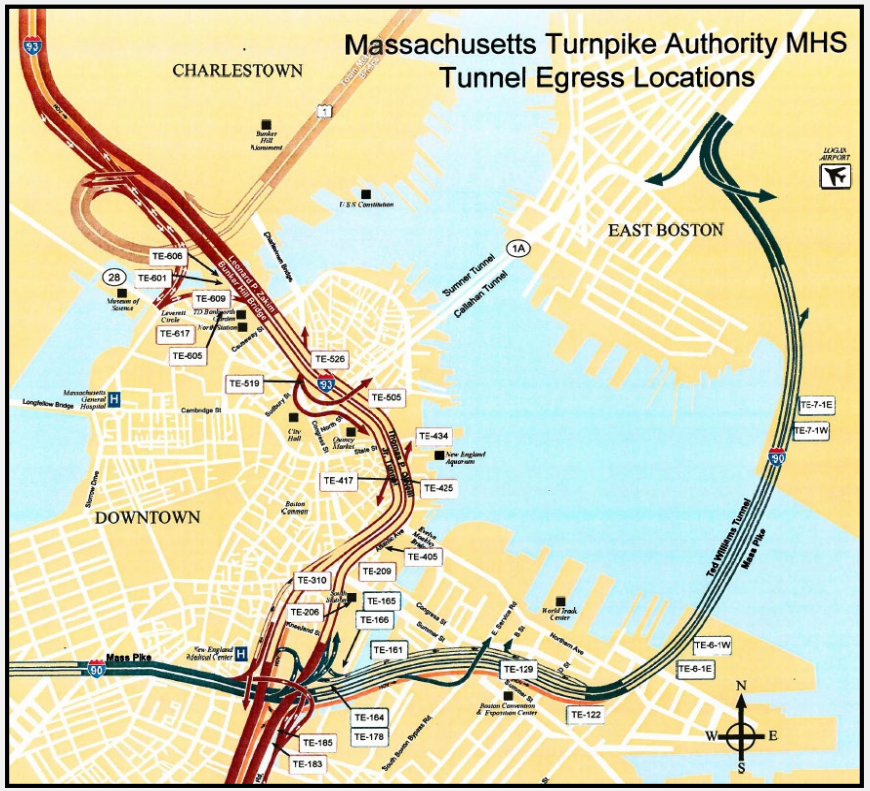







# Tunnel Egress

- Open Roadway and Shafts

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# Inspection Policies

- Required to do Over-head inspections every year
- Required to inspect all tunnel related elements every 2 years (civil, structural, mechanical, electrical, fire/life safety)
- Perform special member inspections as required
- Perform damage inspections as required
- Report critical findings within 24 hours
- Reports must go through QA/QC process

# May 12, 2016 – Fire Inspection

# May 12, 2016 – Fire Inspection cont'd

- Inspection performed on tunnel elements
- Note motoring public reaction

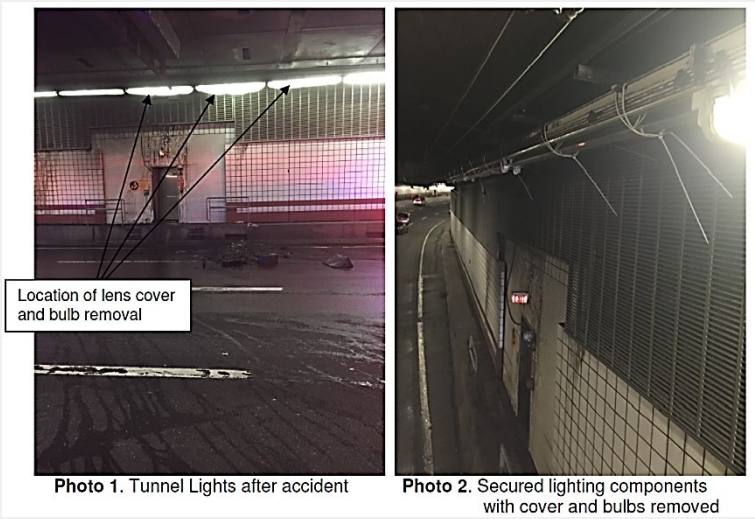



**Photo 1.** Tunnel Lights after accident

**Photo 2.** Secured lighting components with cover and bulbs removed

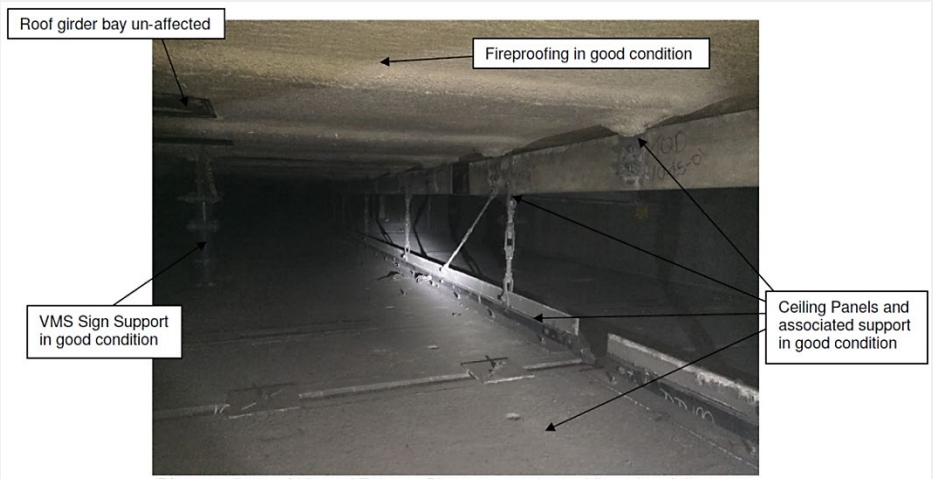


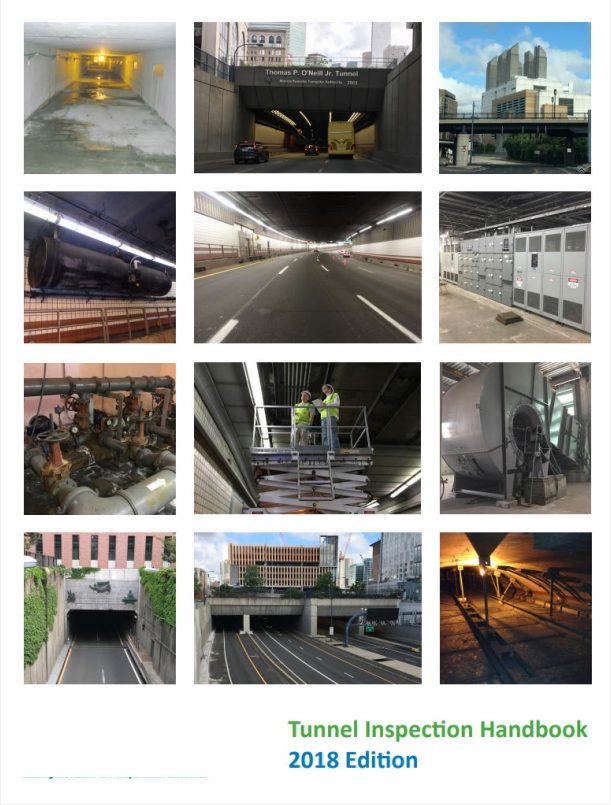

**Photo 3.** General View of Exhaust Plenum – no signs of fire related dis-stress

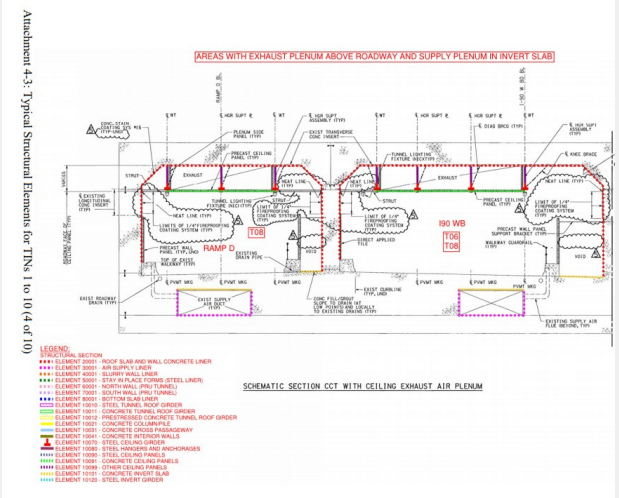

**Photo 7.** Checking wall grating and panels for stability

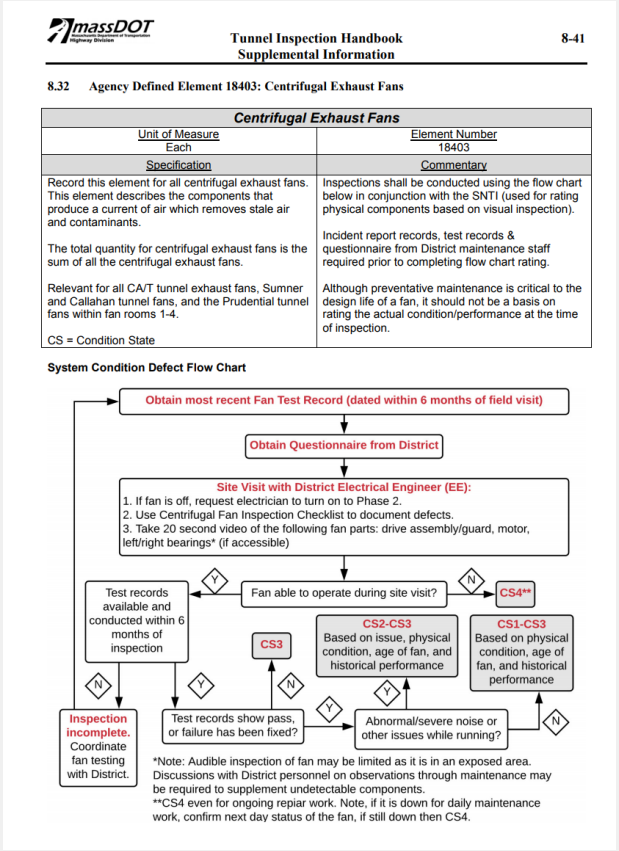
# MassDOT Tunnel Inspection Handbook

- Supplemental to the SNTI and TOMIE
- Enhances inspection criteria (flow chart or more direct guidance on how/what to inspect – including Agency Defined Elements)
- Contains standard inspection form templates

https://www.mass.gov/files/documents/2018/06/28/tunnel-inspection-handbook.pdf



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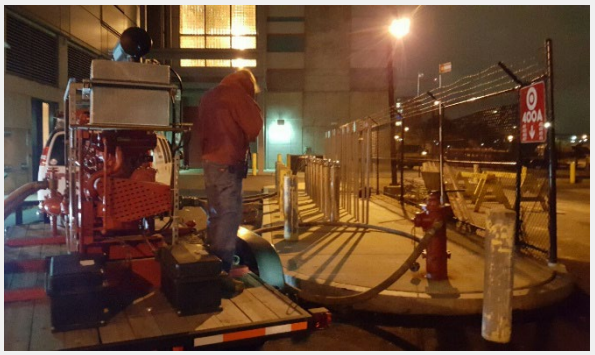
# Maintenance

## Standard/Routine

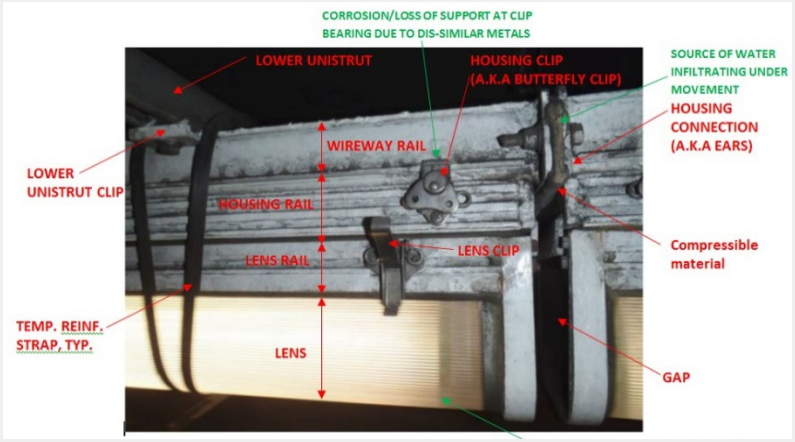
- **Tunnel Washing** (twice a season – includes drain clr)
- **Fan Testing/Plenum Cleaning** (twice a year)
- **Fan Maintenance** (exercise dampers, check belts, grease bearings – quarterly)
- **Pump Station clean-out**
- **Generator Testing** (once a month; full load every 5 yr)
- **Standpipe Testing** (every 5 years)
- **Leak Sealing** (every night – contracted; mostly I93)



# Maintenance cont'd

**Non-Standard/Routine**

- **Deficient supports** (lighting, CCTV, Wall Panel, etc)
- **Lights out**
- **Doors not opening**
- **Standpipe issues**
- **Non-functioning pumps**
- **Water collection in Air Supply's**
- **Ice buildup in winter** (roadway and overhead)
- **Fan alarm tripped**



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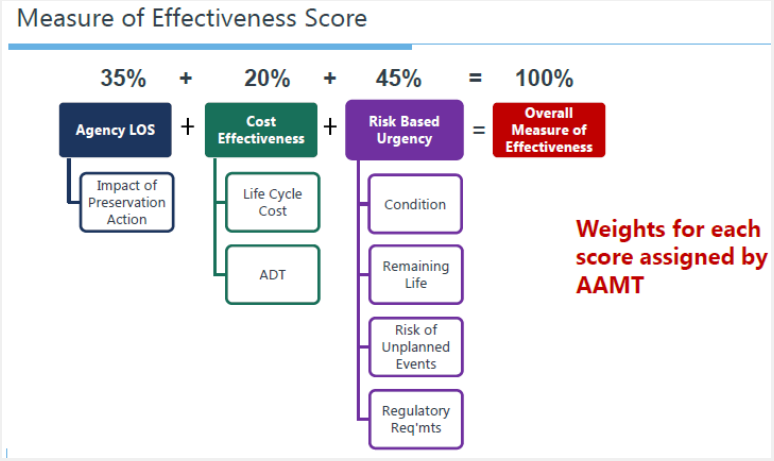
# Asset Management

- Similar to NCHRP 816 - Guide for the Preservation of Highway Tunnel Systems
- Use Inspection Data to develop needs (preservation projects – outside of immediate needs, on-call contracts, evaluations, etc)
- Review with Maintenance and Facilities
- Score based on safety, cost/benefit, etc – sim. to household



# Questions & Comments

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- Louis Ruzzi, *Pennsylvania Department of Transportation*, LRUZZI@pa.gov
- Bill Bergeson, *Federal Highway Administration (FHWA)*, william.bergeson@dot.gov

# Panelists Presentations

http://onlinepubs.trb.org/onlinepubs/webinars/191211.pdf

*After the webinar, you will receive a follow-up email containing a link to the recording*

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