

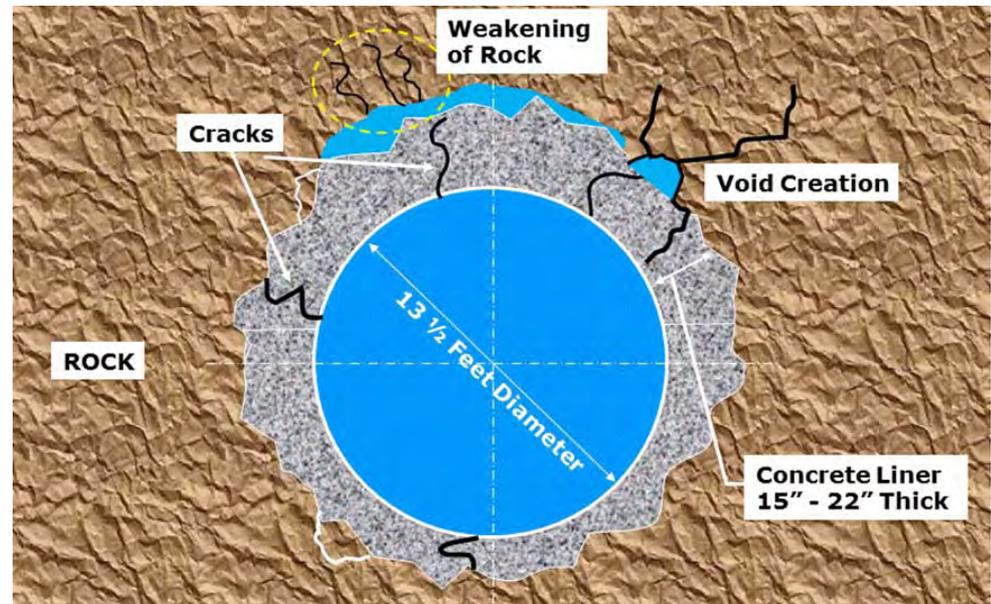


Delaware Aqueduct Leak Action Plan

Wawarsing Public Advisory Committee

November 19, 2010

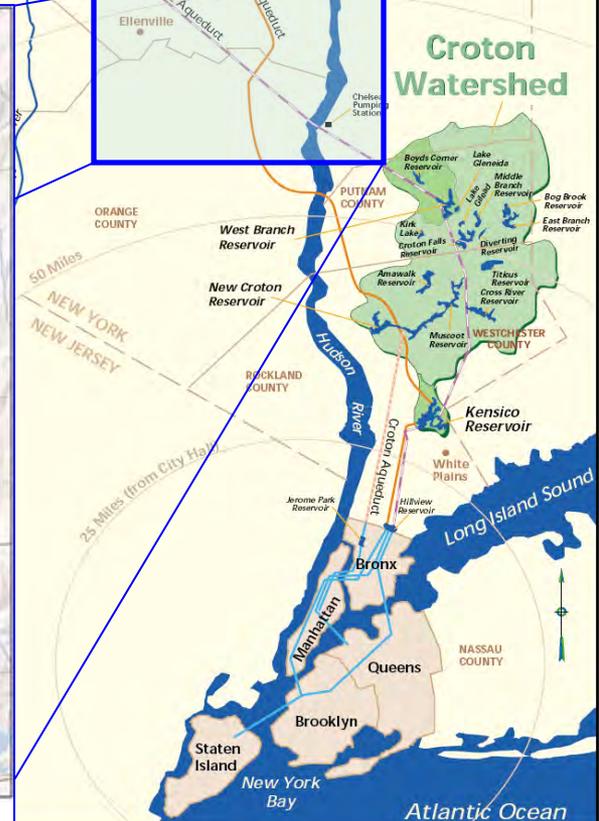
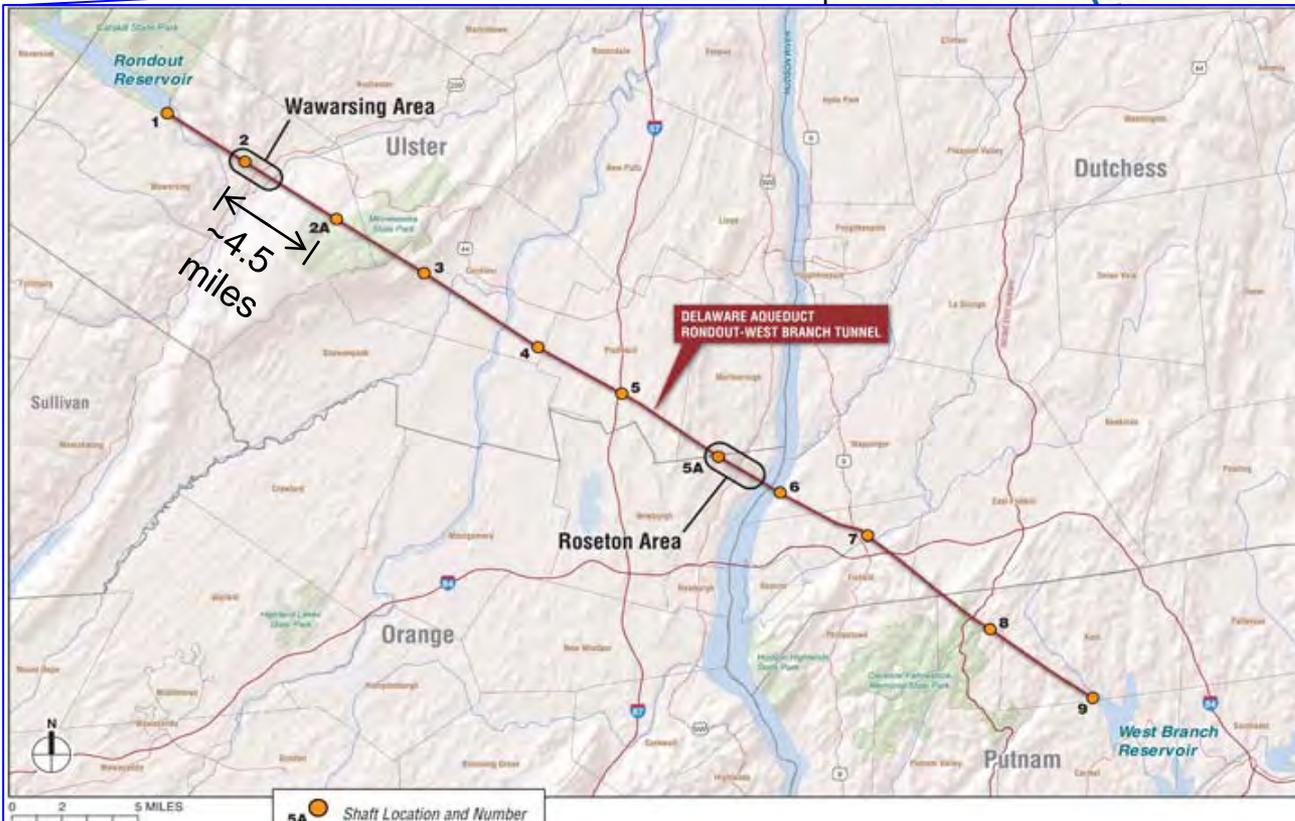
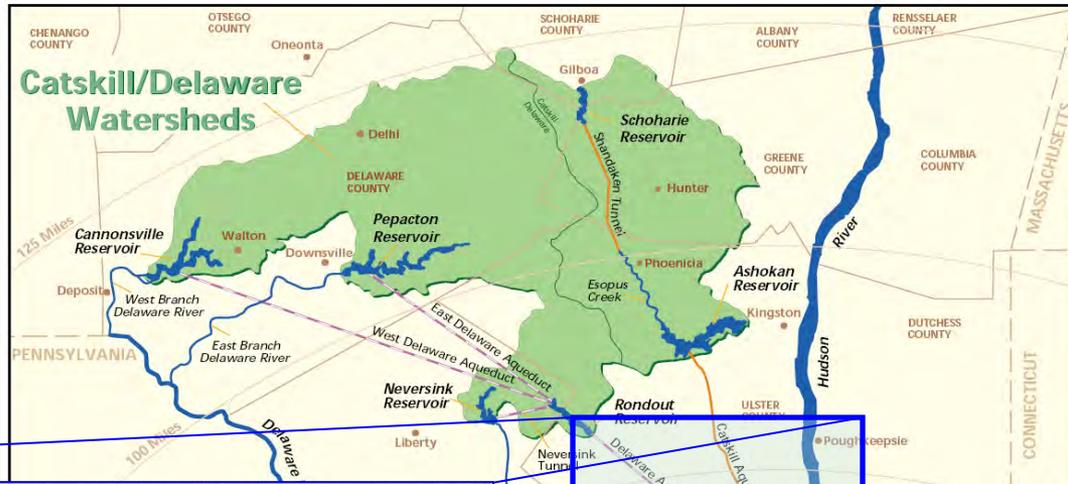
- ❖ System and Tunnel Overview
- ❖ Tunnel Condition and Leakage
- ❖ History of investigations and repair plans
- ❖ Solutions to Stop Leakage
- ❖ Ongoing Community Support
- ❖ Next Steps



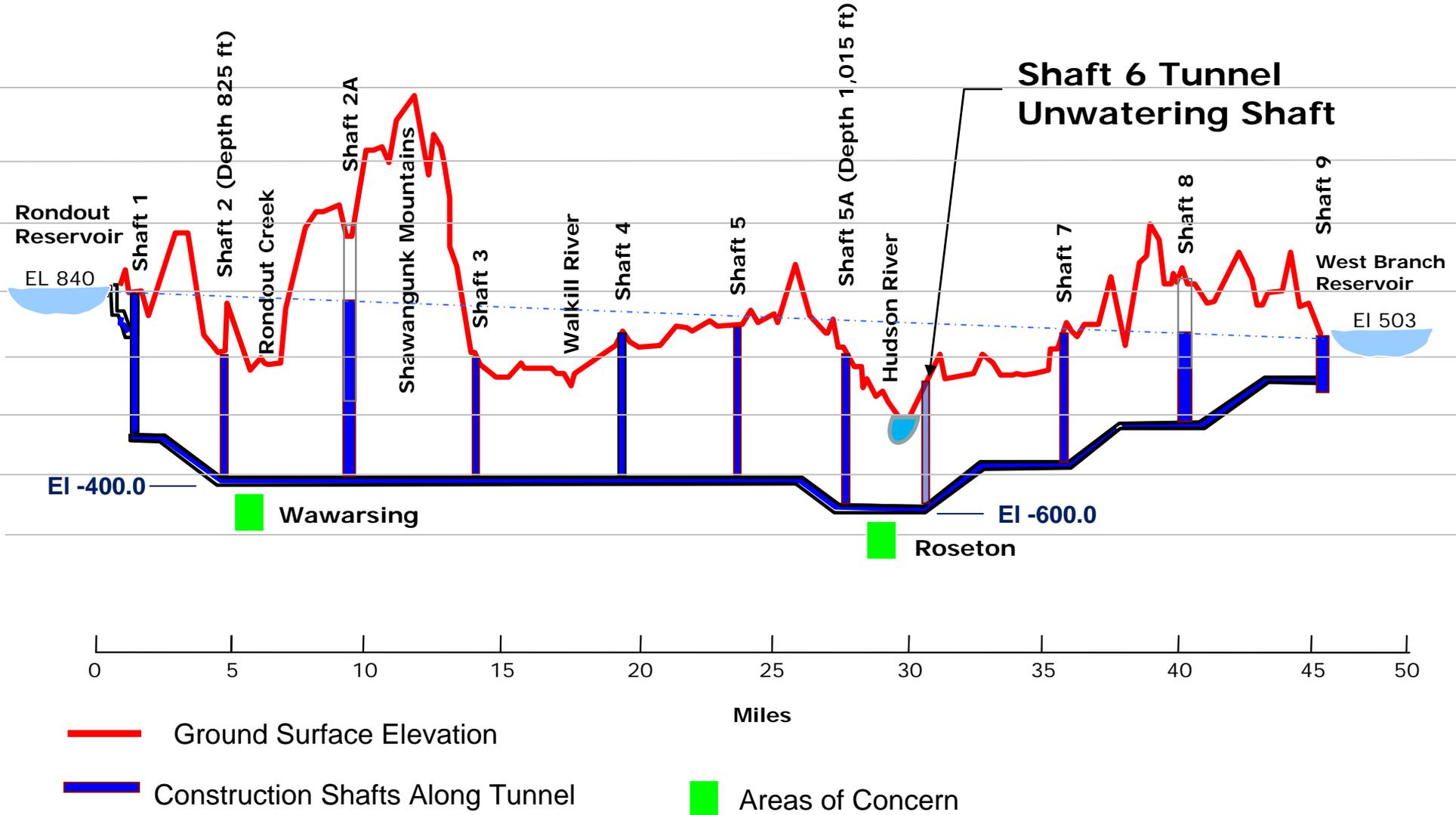
Sectional View of Tunnel and
Potential Leak Pathways

Delaware Aqueduct Leak

- ❖ 45 miles long, 13.5' in diameter
- ❖ Tunnel hundreds of feet below grade
- ❖ Delivers >50% of NYC water supply

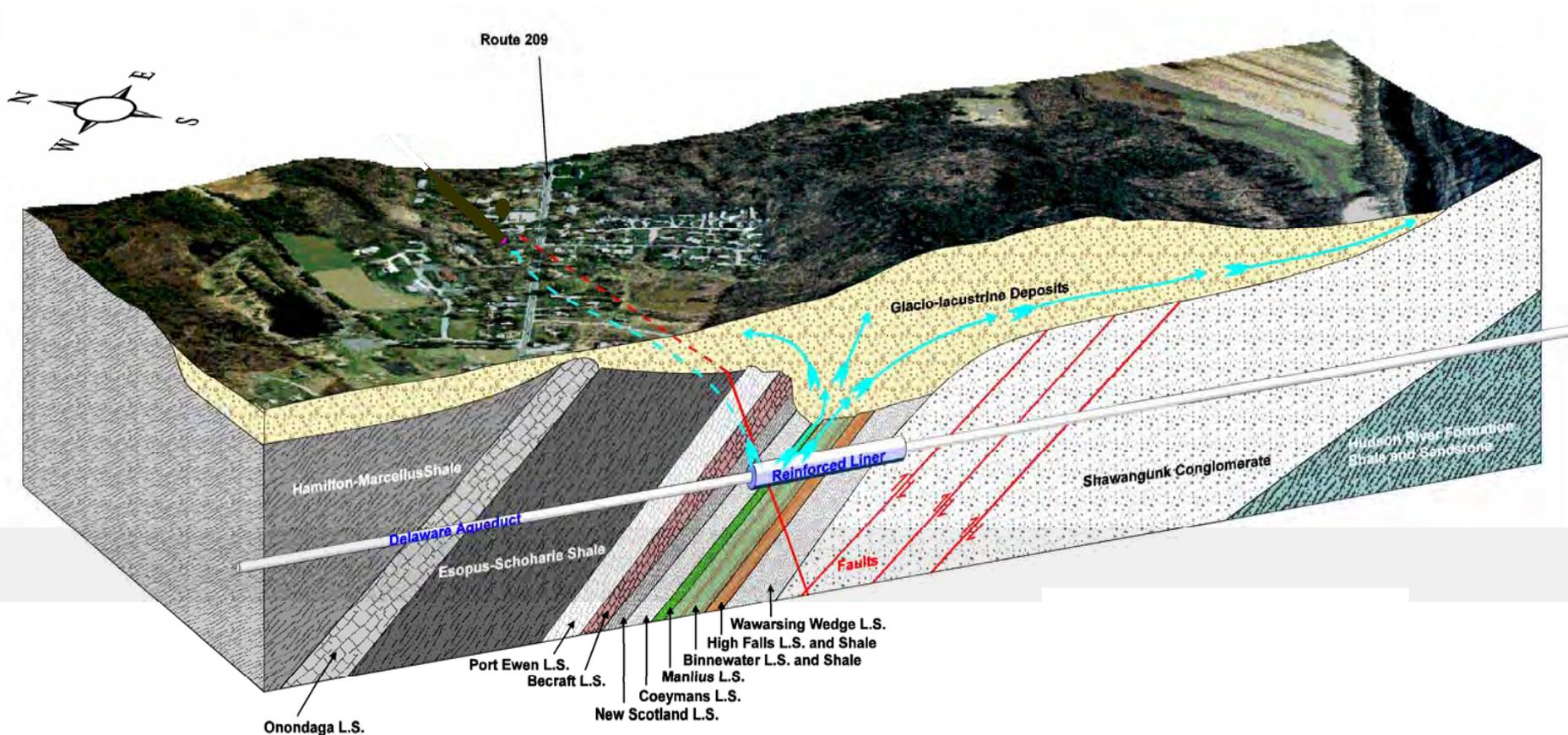


Delaware Aqueduct Profile



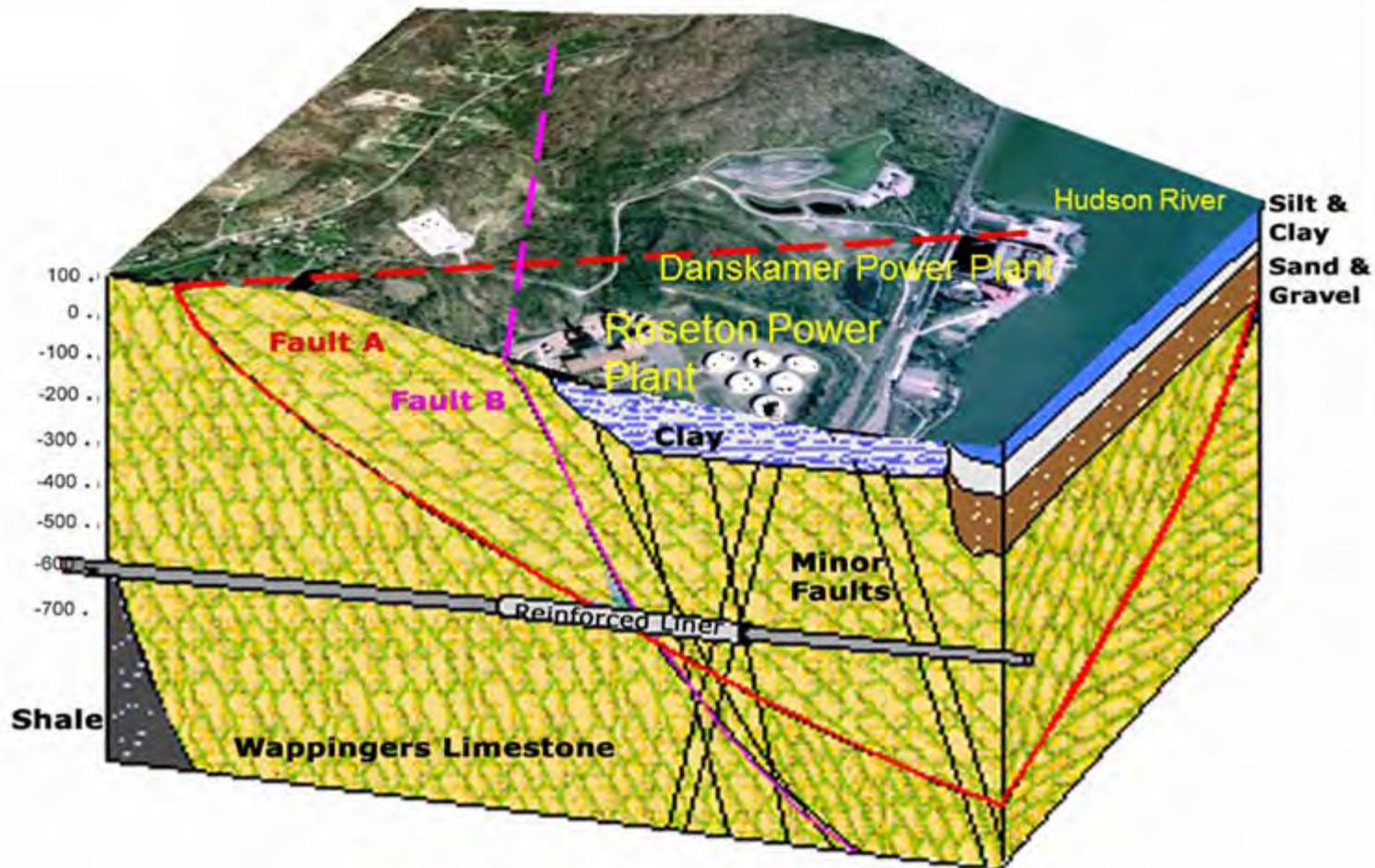
Tunnel in Wawarsing w/ Geology

- ❖ Deep buried glacial valley
- ❖ Seismic faults along alignment
- ❖ Series of shales, sandstones, and limestones, tilted at 30° and 90°



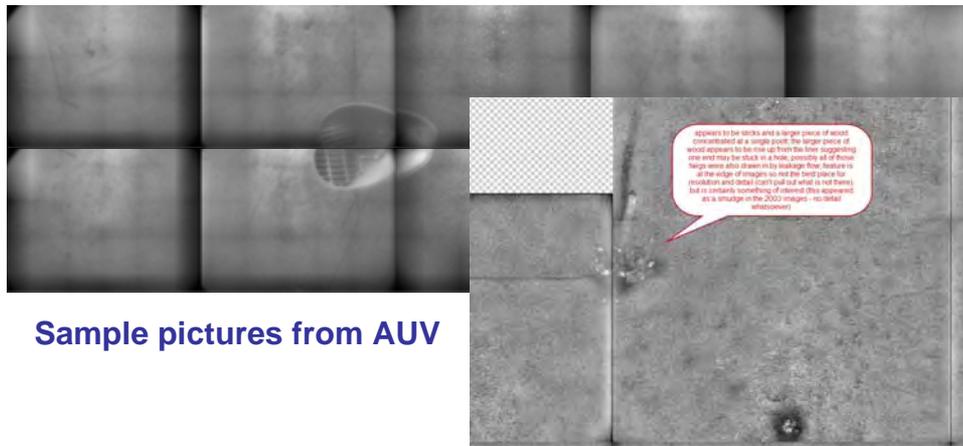
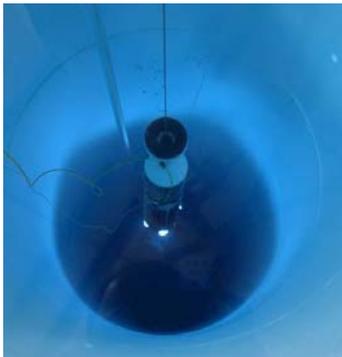
Tunnel in Roseton w/ Geology

- ❖ Primarily Wappinger Limestone, folded and faulted
- ❖ Traversed by two major fault systems



Tunnel Leak Investigations

- ❖ Over \$27 million of investigation work (1998-2010) including:
 - ❖ Geological investigations
 - ❖ Tunnel flow monitoring
 - ❖ Well monitoring
 - ❖ Monitoring of surface expressions
 - ❖ Automated Underwater Vehicle (AUV) inspections



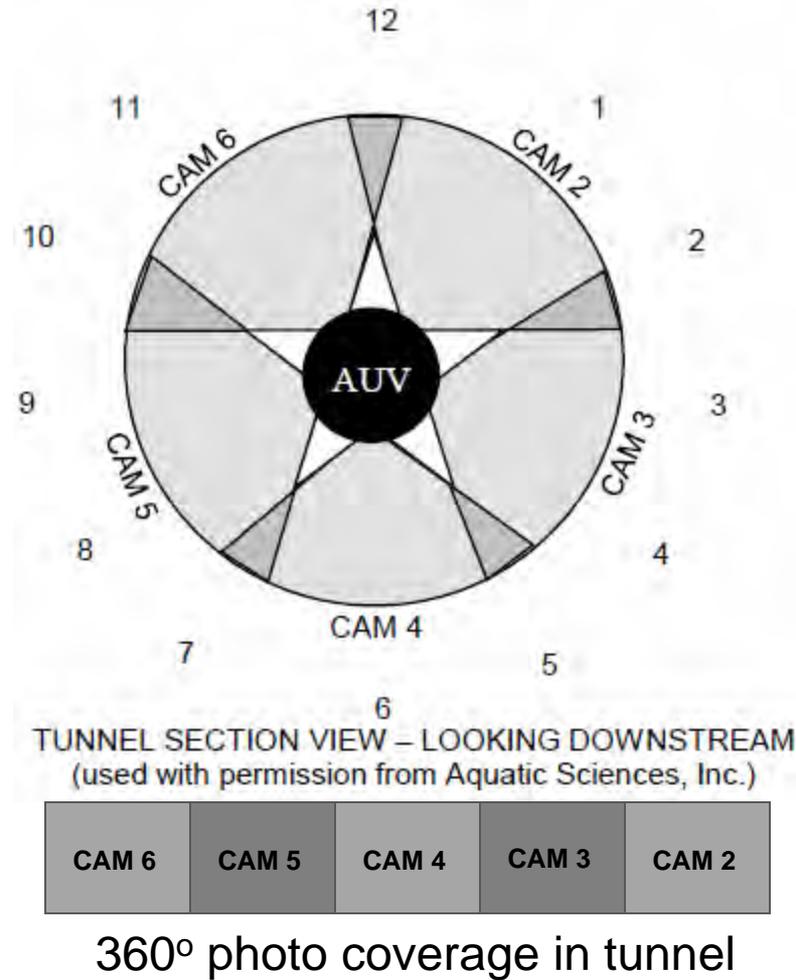
Sample pictures from AUV



AUV Investigation of Tunnel

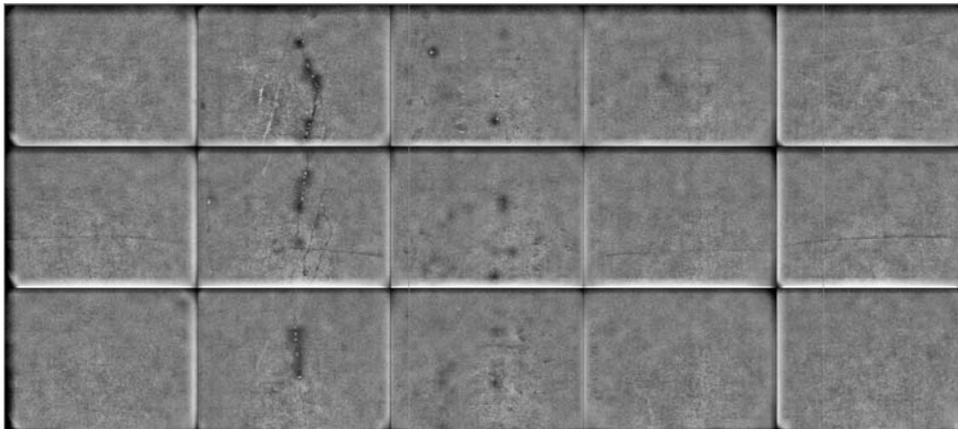


- ❖ AUV equipped with cameras, measured temperature, pressure, velocity, acceleration and position
- ❖ AUV runs conducted in 2003 and 2009
 - ❖ Shaft 1 to Shaft 9
 - ❖ 160,000 photos taken
 - ❖ No apparent collapse, partial collapse, or open holes in tunnel
 - ❖ Clarity of images increased between 2003 and 2009 runs

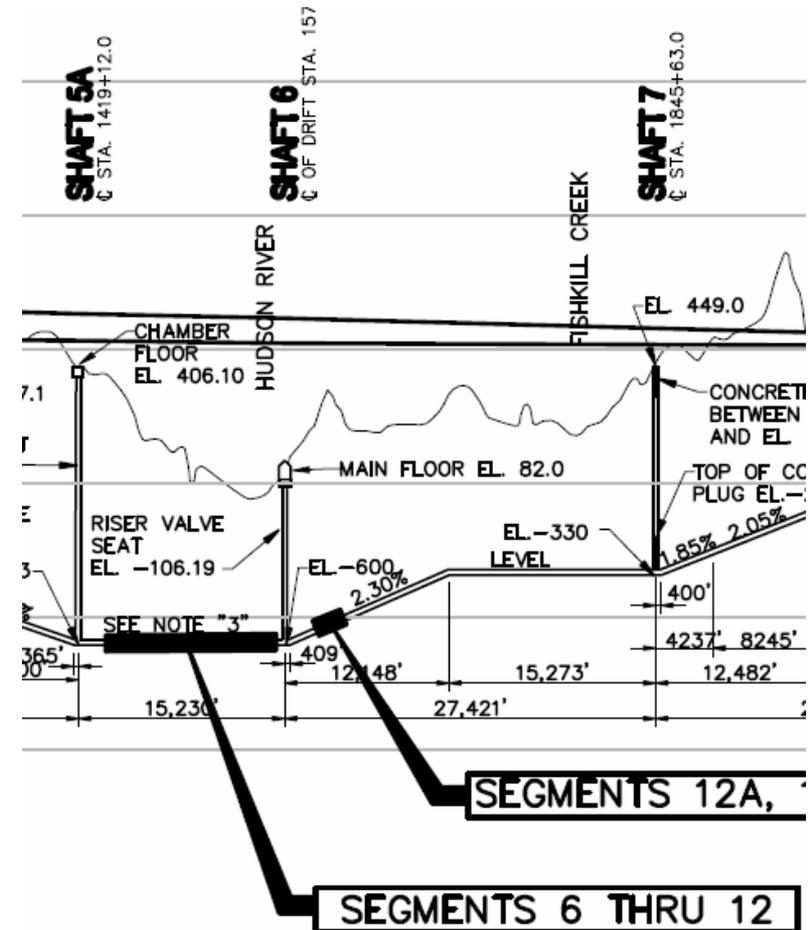


Roseton Tunnel Condition and Leakage

- ❖ 5,200 linear feet of cracking in Roseton; 485 linear feet of cracking in Wawarsing
- ❖ Cracking located in deepest segment of tunnel at EL -600
- ❖ Largest percentage of leakage as indicated in AUV investigations and backflow tests

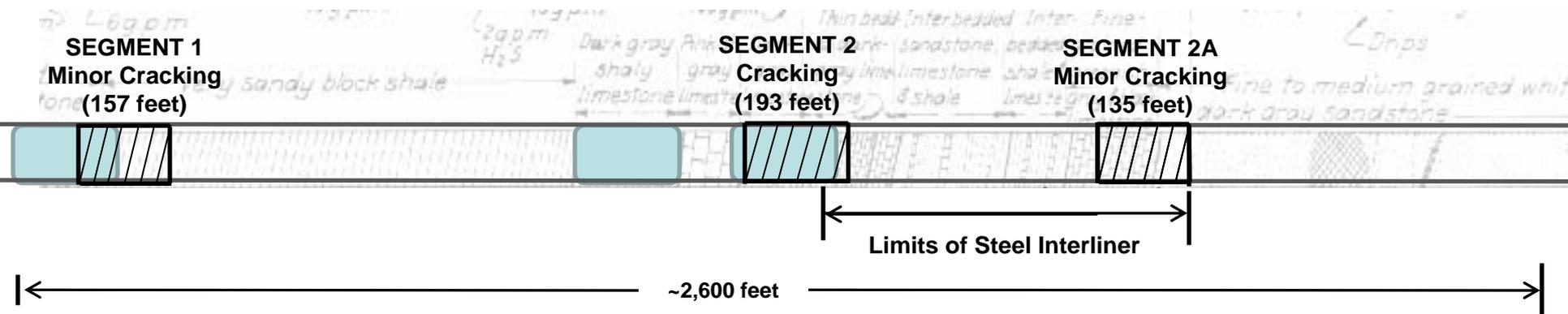


Example of Cracking in Roseton area



Areas of Interest in Wawarsing

 Areas of Tunnel Passing Through Limestone



- ❖ 485 linear feet of cracking in Wawarsing
- ❖ Cracking located in areas of poorest geology (i.e. limestone)

Wawarsing AUV Images

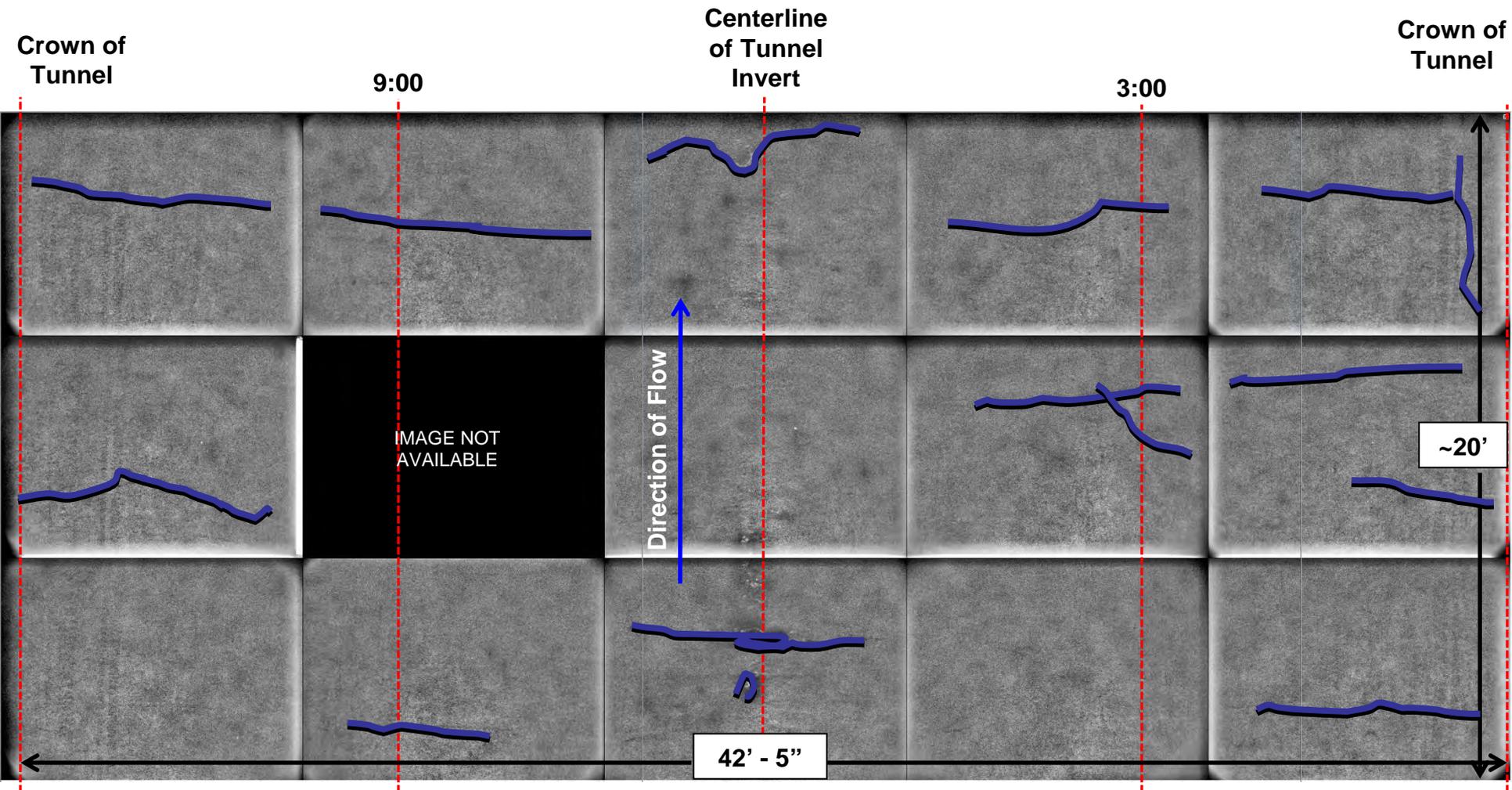
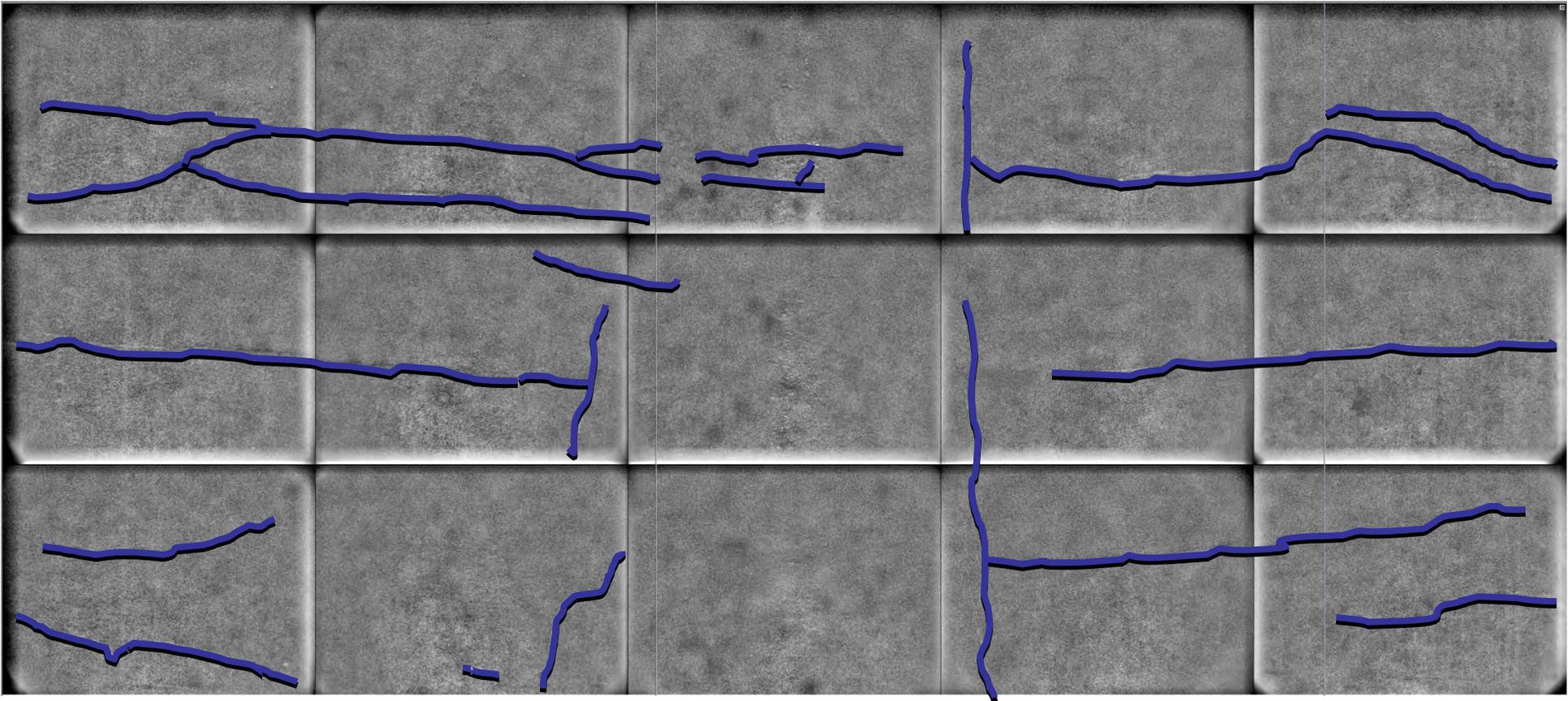


PHOTO TAKEN JUNE 5, 2009

Sta. 281+88 (1.3 miles south along tunnel from Shaft 2)

Wawarsing AUV Images



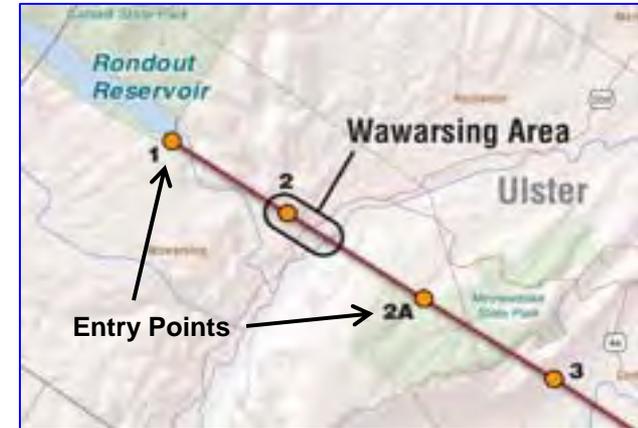
Sta. 282+60 (1.3 miles south along tunnel from Shaft 2)

- ❖ Repair from Exterior – not reliable
- ❖ Parallel Tunnel –unnecessary, very expensive (~\$10B), and decades- long construction schedule
- ❖ Repair from Interior – feasible but schedule risk was significant (1 to 4 year range depending on ability to pressure grout cracks)
- ❖ Build Bypass – feasible but exact locations of leakage were unknown and no guarantee of spanning leakage area

Leak Solution for Each Section

❖ Wawarsing:

- ❖ Better access
- ❖ No risk of tunnel flooding
- ❖ Leads to internal grout repair

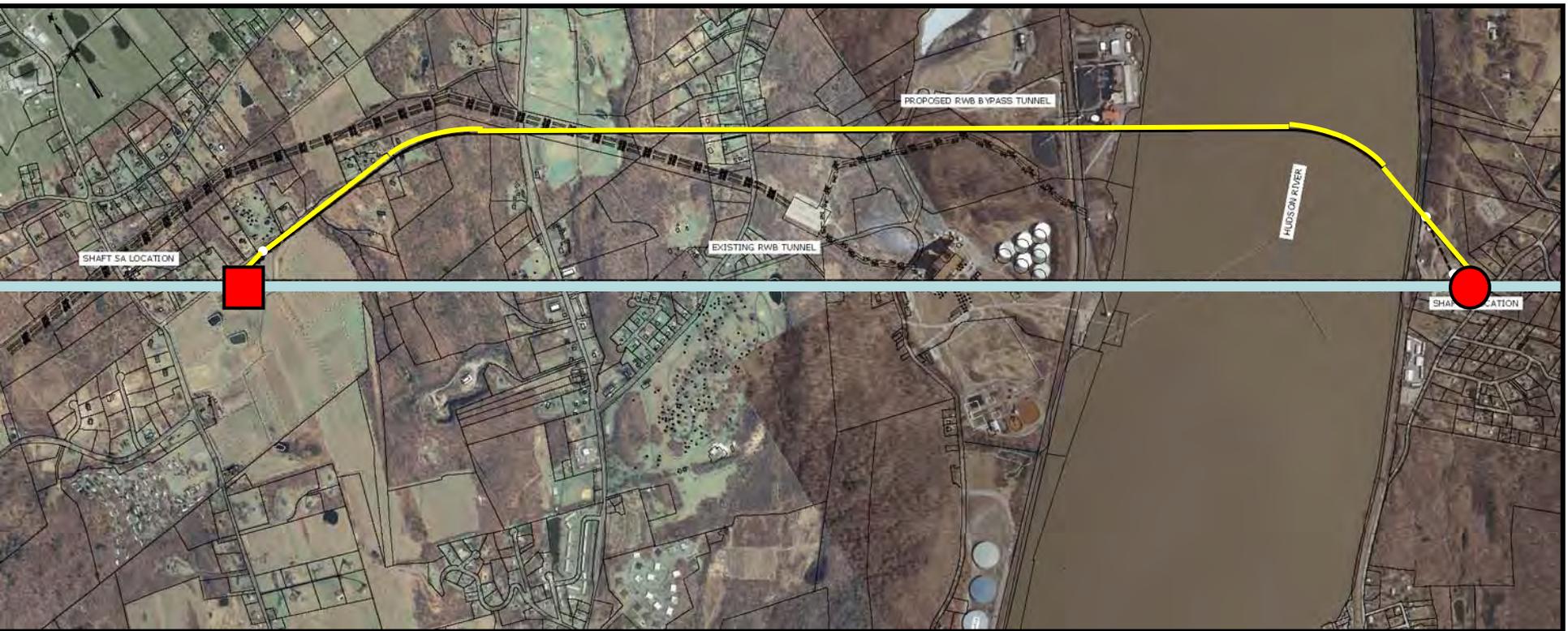


❖ Roseton:

- ❖ Poor tunnel access
- ❖ Risk of tunnel flooding (low point in tunnel)
- ❖ Water supply needs eliminates grouting repair due to extended tunnel shutdown
- ❖ Leads to bypass tunnel solution

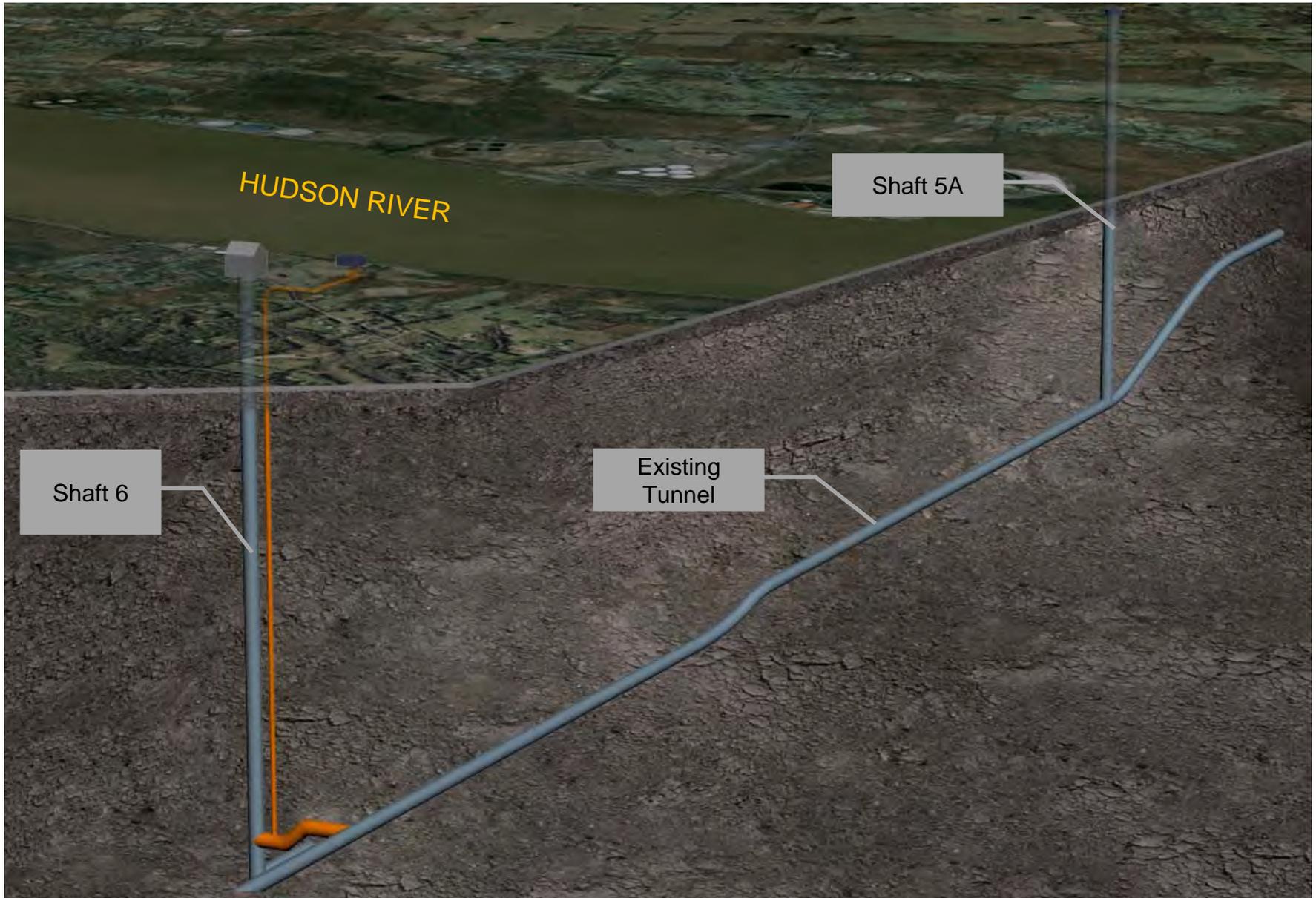


Proposed Bypass Spans Roseton Area

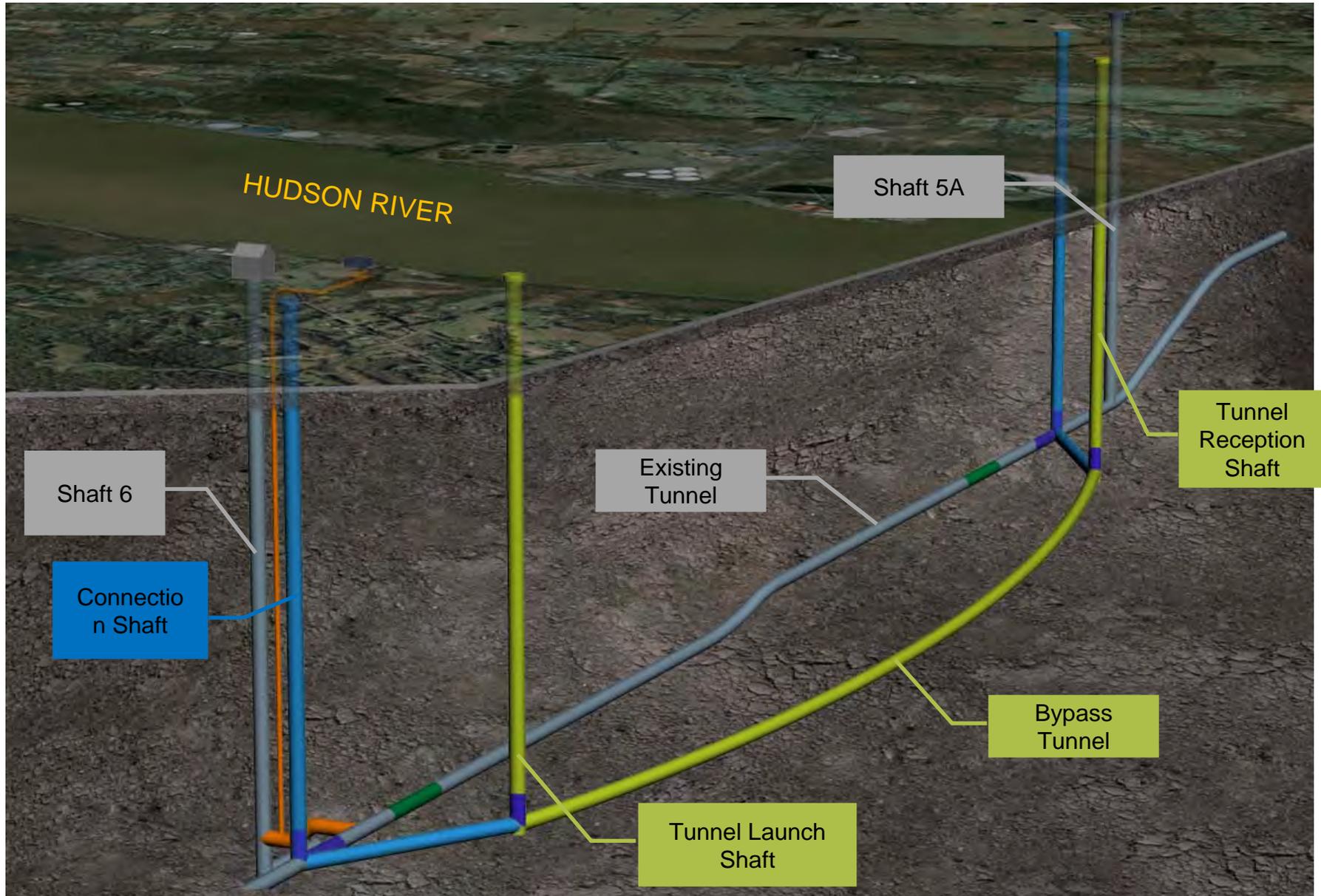


New Bypass Tunnel	Shaft 5 Connection
Existing Tunnel	Shaft 6 Connection

3D Rendering of Bypass Concept

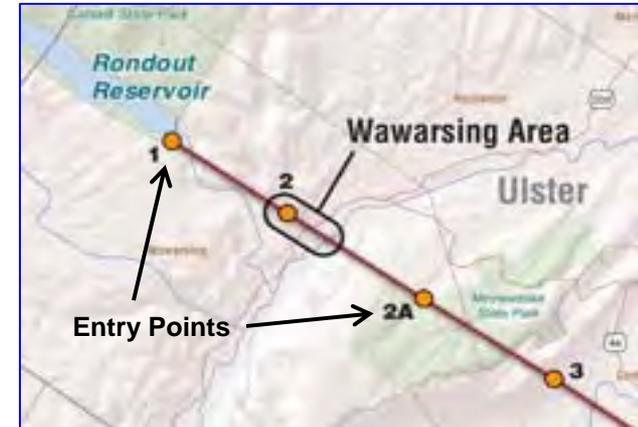


3D Rendering of Bypass Concept

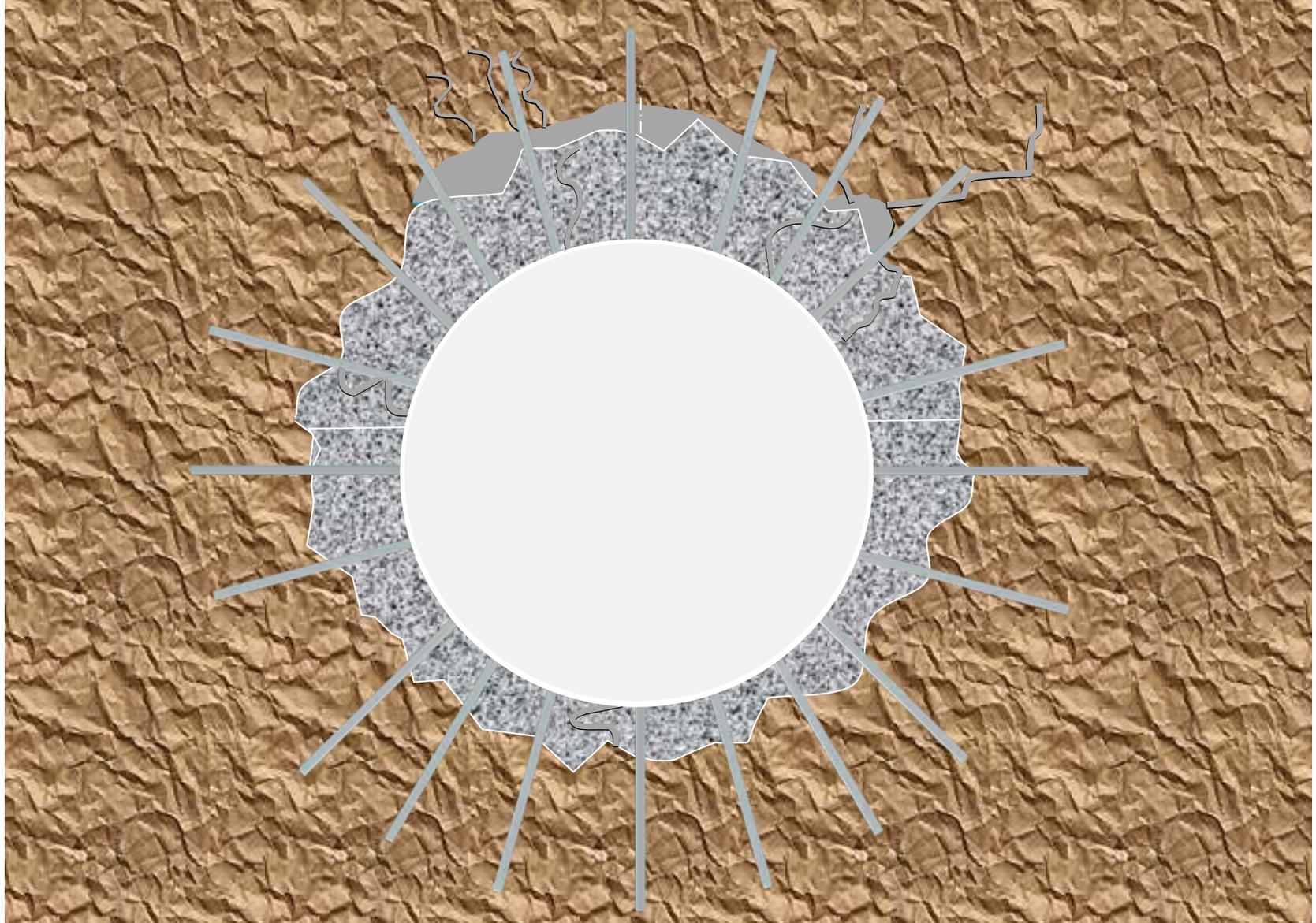


Wawarsing Tunnel Repair

- ❖ Wawarsing:
 - ❖ Inspect Tunnel Interior
 - ❖ Repair Options include:
 - ❖ Grout from within the tunnel
 - ❖ Steel liner installation if necessary
 - ❖ Enter from Shaft 1 and 2A (8 miles apart, on either side of Wawarsing)



Planned Repair - Grouting



❖ Unwater Tunnel

❖ Drill Grout Holes

❖ Inject Grout

Pressure Grouting Operation



“On-Shelf” Tunnel Repair Equipment

- ❖ Over \$35 M in long lead item equipment purchased and in storage



Drilling Rig for use inside Tunnel



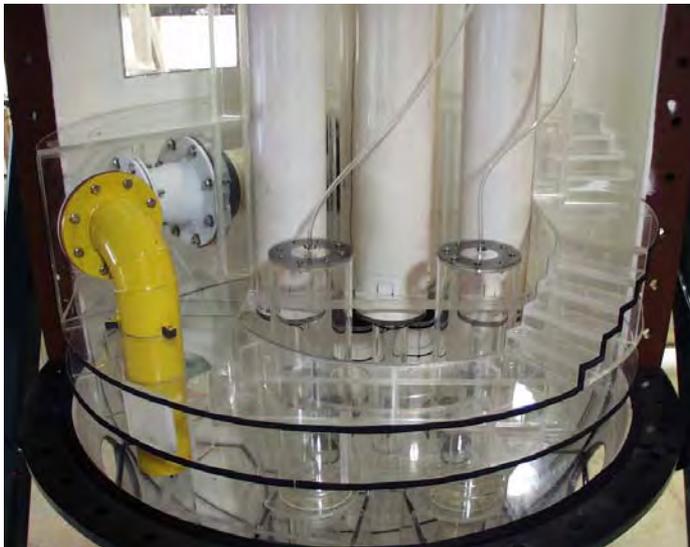
Liner Sections and Carriers



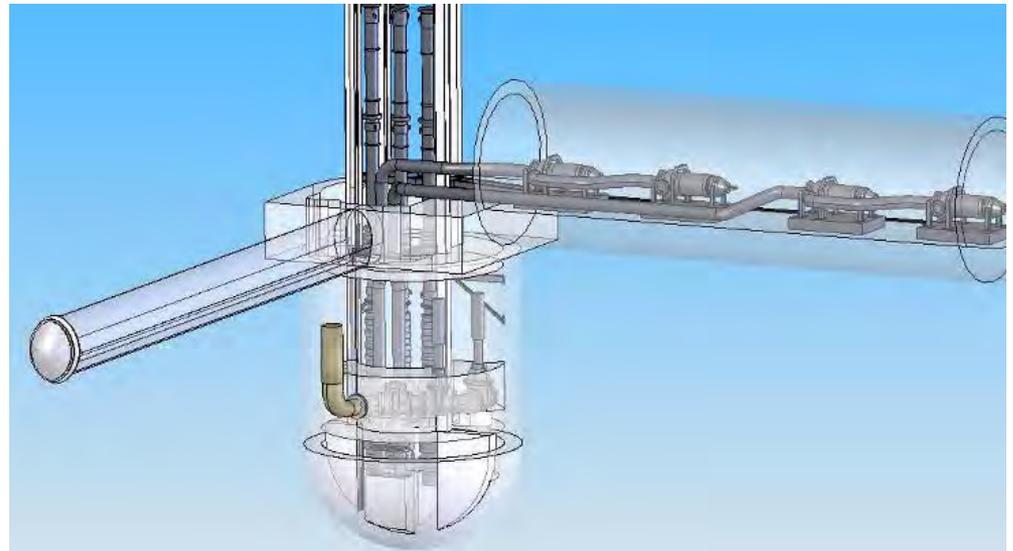
Recap and Investments

Year	Investment/Event	Cost (\$M)
1998	Begin Investigations and Design Contracts	\$35
2002	AUV inspections of RWBT	\$3
2003	USGS Investigations of Geology	\$6M
2004	Emergency tunnel repair documents “on-the-shelf”	Incl. in \$35M above
2004	Dependability Contract Initiated to investigate alternate water supplies during tunnel repair	\$35
2007	RWB Tunnel and Shaft Rehabilitation contract	\$280
2009	AUV inspections of RWBT	\$2
2009	Beginning of the design of the Bypass Tunnel	\$30.5
Total		\$391.5

- ❖ Purchased equipment and supplies (~\$35M) to expedite repair in event of unplanned failure
- ❖ Shaft 6 upgrades (\$280M) to allow dewatering so that aqueduct can be accessed for repair
- ❖ Other water supply infrastructure under repair to support extended tunnel outage



Scaled model of Shaft 6 Dewatering Pump Shaft Configuration



3D Model of Shaft 6 Configuration with Dewatering Pumps Installed

Bypass Tunnel & Repair Cost and Schedule

Phase	Cost (\$M)	Schedule
Bypass & Repair Design	\$40	Aug. 2009 – May 2014
Property Acquisition	\$2	June 2010 – August 2012
Environmental Review	Incl. in Design	July 2010 – Apr. 2012
Break Ground	--	June 2013
Construction Management	\$84.5	Mar.2013 – Jan. 2019
Shaft Construction	\$511	Mar. 2013- June 2016
Tunnel Repair & Bypass Tunnel Construction	\$552	Feb. 2015 – Jan. 2018
Connect Bypass Tunnel	Incl. above	Oct. 2018 – Oct. 2019
Wawarsing Tunnel Repair	Incl. above	Oct. 2018 – Feb. 2019
Total Cost	\$1.19B	

- ❖ Continue to process and settle legitimate claims against the City
- ❖ Funding a storm water project as selected by the PAC and Town consistent with the Drainage Analysis
- ❖ 2nd Contract with the Town of Wawarsing to include:
 - ❖ Funds for replacement of UV systems and sump pumps as necessary
 - ❖ UV bulbs, filters, maintenance and repair as necessary
 - ❖ Additional funds for storm water design and construction

- ❖ Select and design the storm water management project
- ❖ Continue to investigate tunnel and surface conditions
- ❖ Anticipate receiving USGS Preliminary Report in June 2011
- ❖ City to reevaluate level of support dependent on USGS findings
- ❖ Implement Action Plan Program as scheduled

Thank-you
Questions?