New Salem Street Culvert Replacement

A Unique Solution to a Culvert Replacement on Poor Soils

ENVIRONMENTAL PARTNERS

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ABOUT EP

Environmental Partners (EP) is an award-winning multidisciplinary engineering and consulting firm celebrating its 25th year in business.

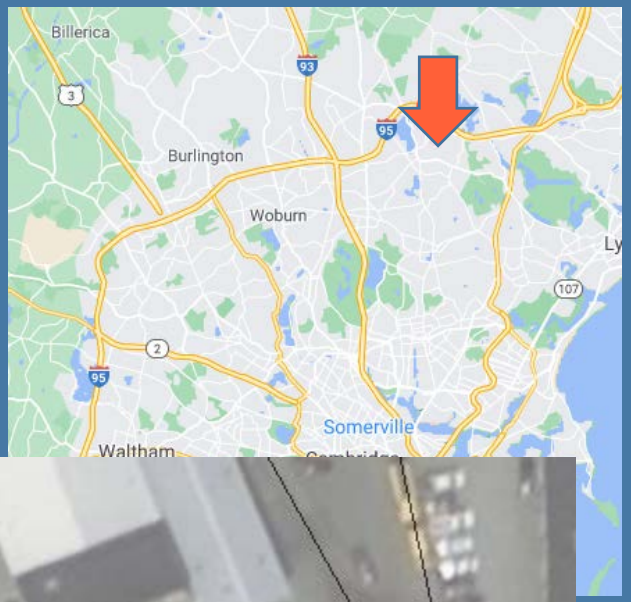
EP provides a broad range of services to municipal, commercial, industrial, and institutional clients.

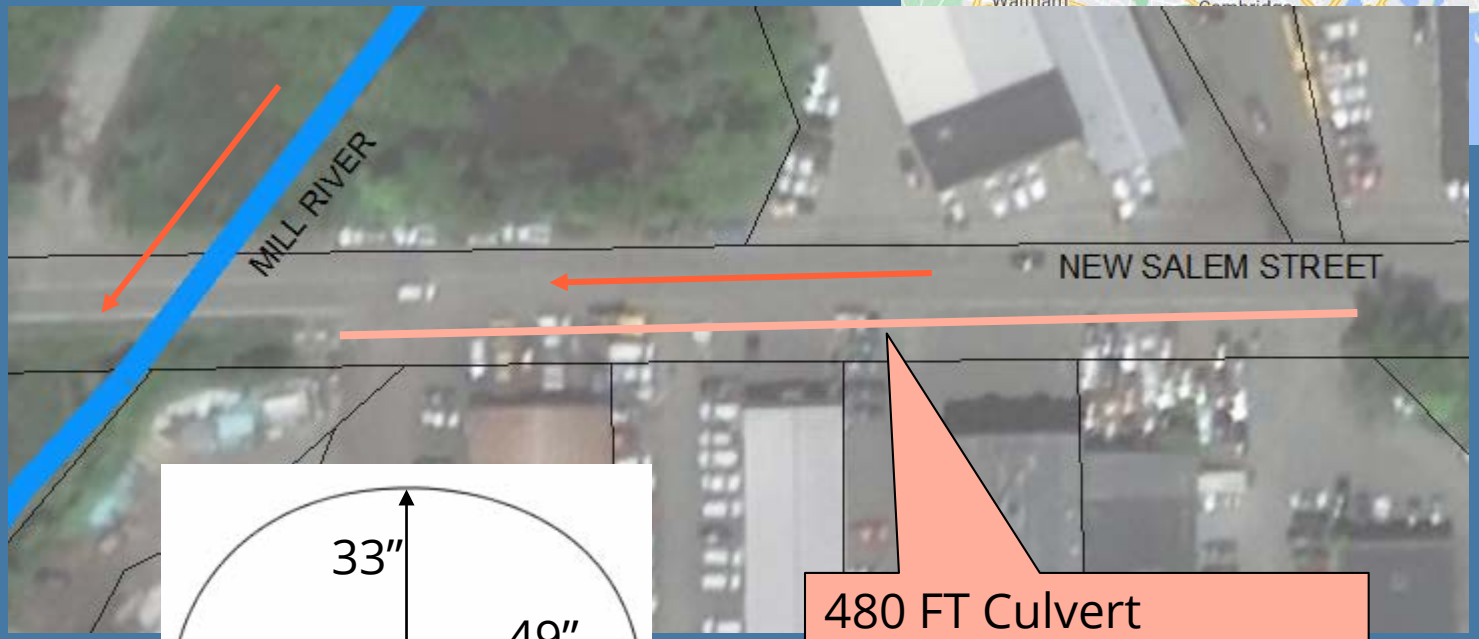
SERVICES INCLUDE

- Civil Engineering
- Construction Management
- Drinking Water
- Emergency Management Services
- Owner's Project Management (OPM)
- Environmental
- Infrastructure Asset Management
- Planning
- Stormwater
- Traffic & Transportation
- Wastewater

Project Location

New Salem Street, Wakefield MA

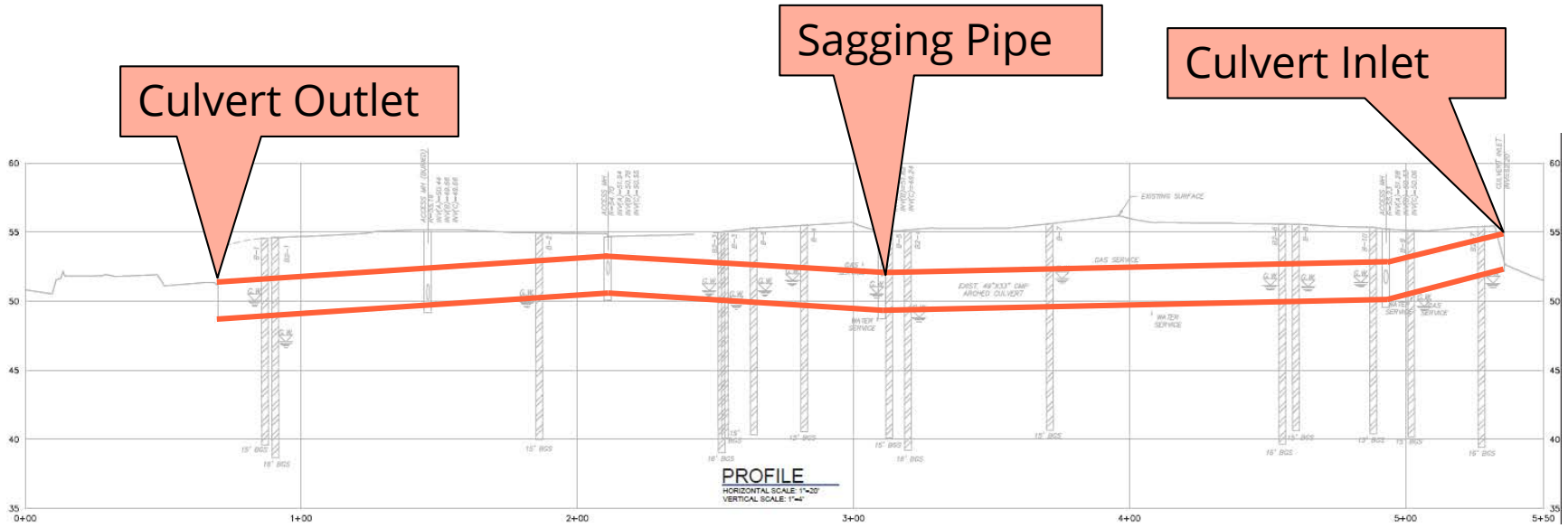




480 FT Culvert
across parking lots
Corrugated Metal Arch

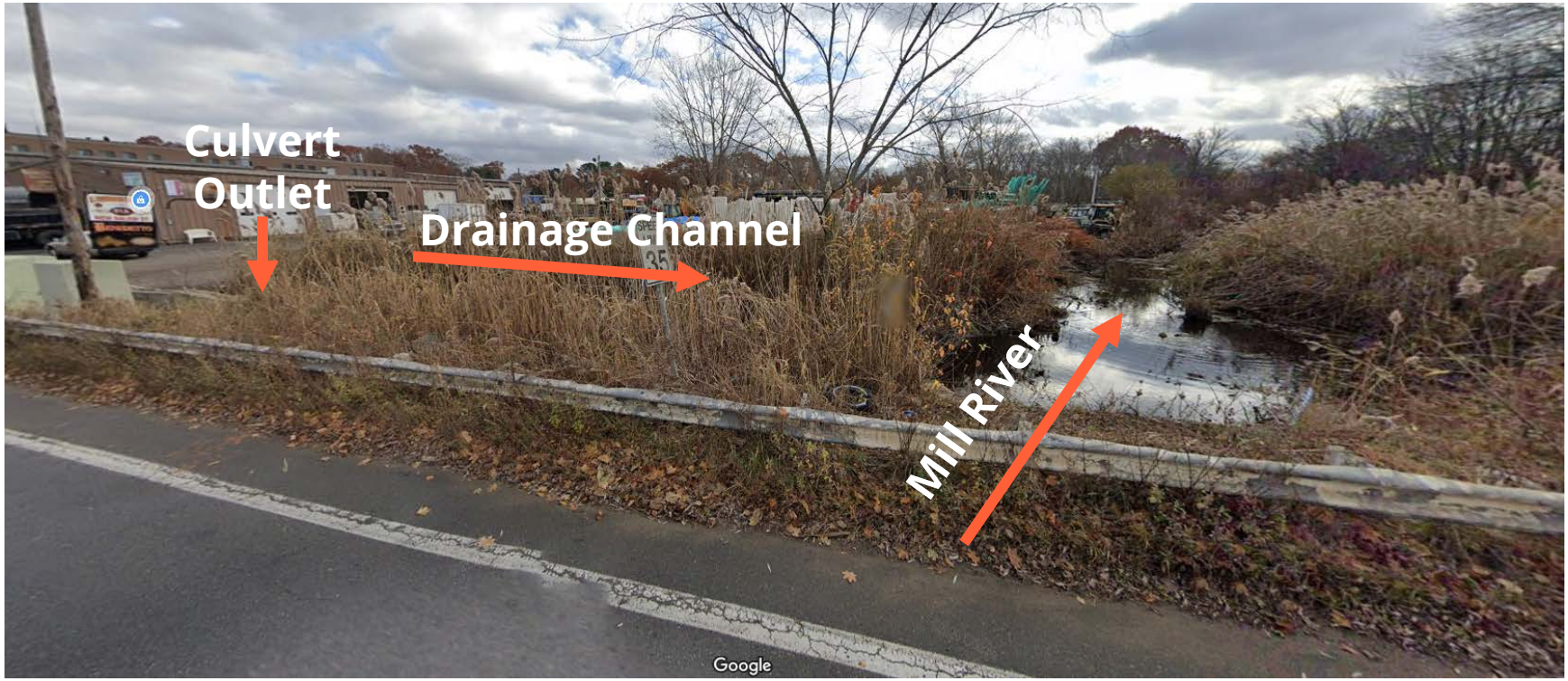
Sinkhole Late 2019

Profile – Sagging Pipe



Submerged Outlet and Sediment

Mill River – Tailwater

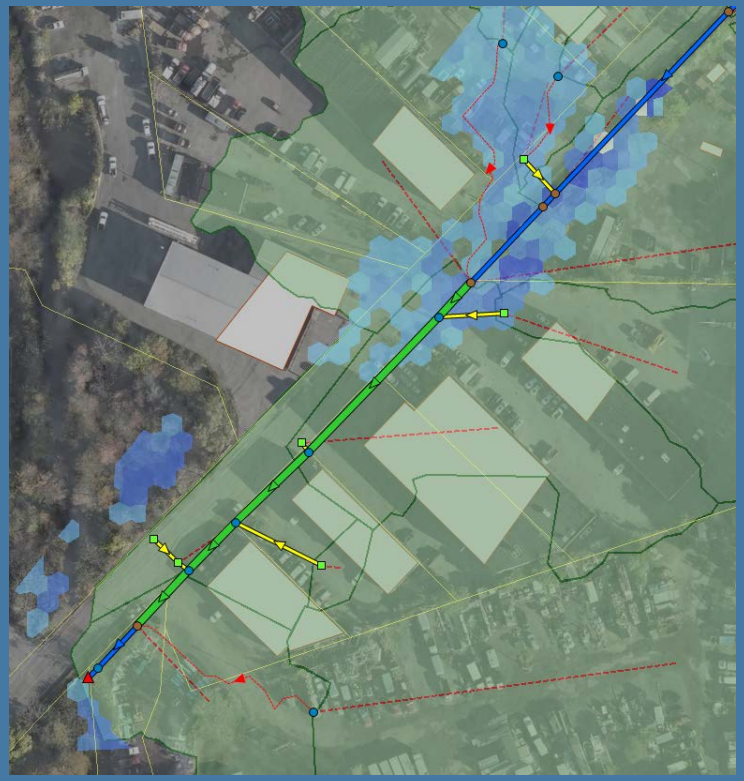


STORMWATER MODEL AND CULVERT SIZING

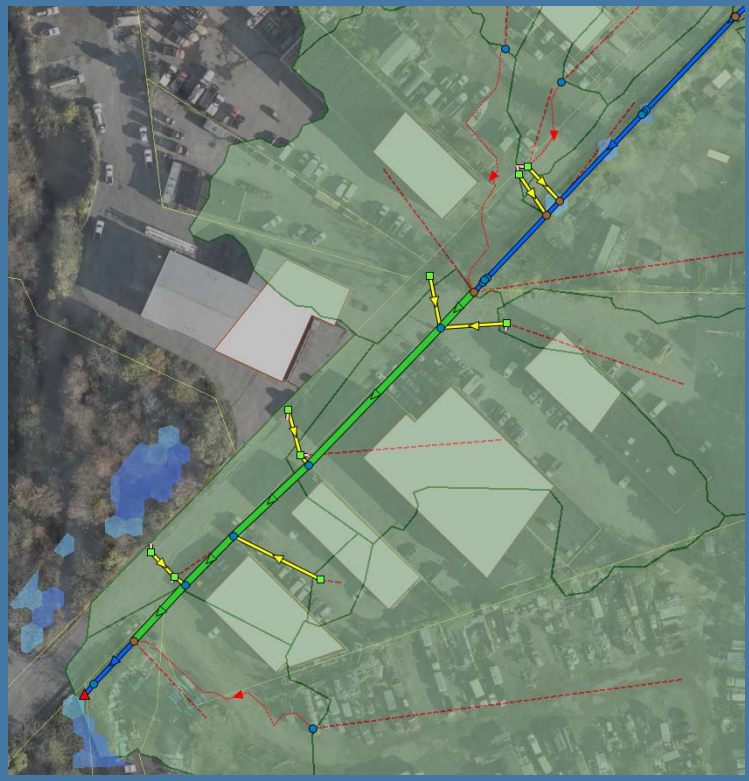
Culvert Design Parameters

- Tailwater Condition
- Flood zone – flooding may occur due to Mill River Flooding
- Shallow Bury – cover depth ranges from 1-foot to 3-feet
- Basis of design:
  - Connect drainage channels with new culvert. Culvert should not be the cause of backed up flow
  - Stabilize parking lot/roadway above the culvert
- Model
  - PCSWMM – dynamic modeling
  - Constant tailwater assumed – Mill River not modeled

PCSWMM Model



Existing Model



Proposed Model

Culvert Selection

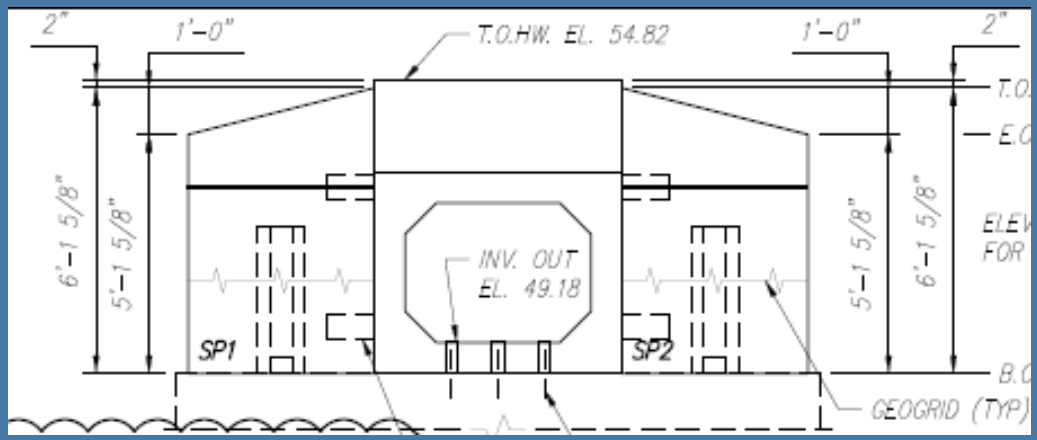
Culvert: 4’ Wide by 3’ Deep by 480’ Long Culvert

- Depth based on tailwater and existing surface.

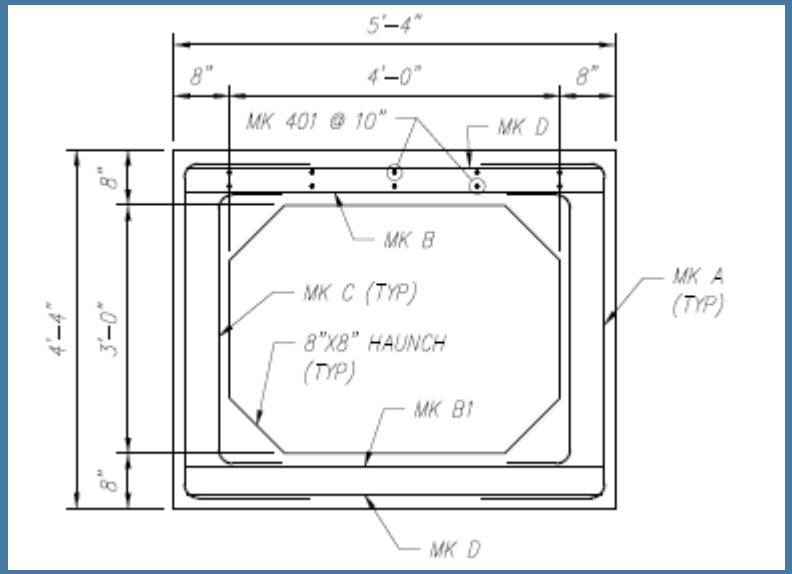
Headwall: Based on existing elevations and side slopes

Material: Reinforced Concrete

- Shallow bury required robust material for H-20 Loading.



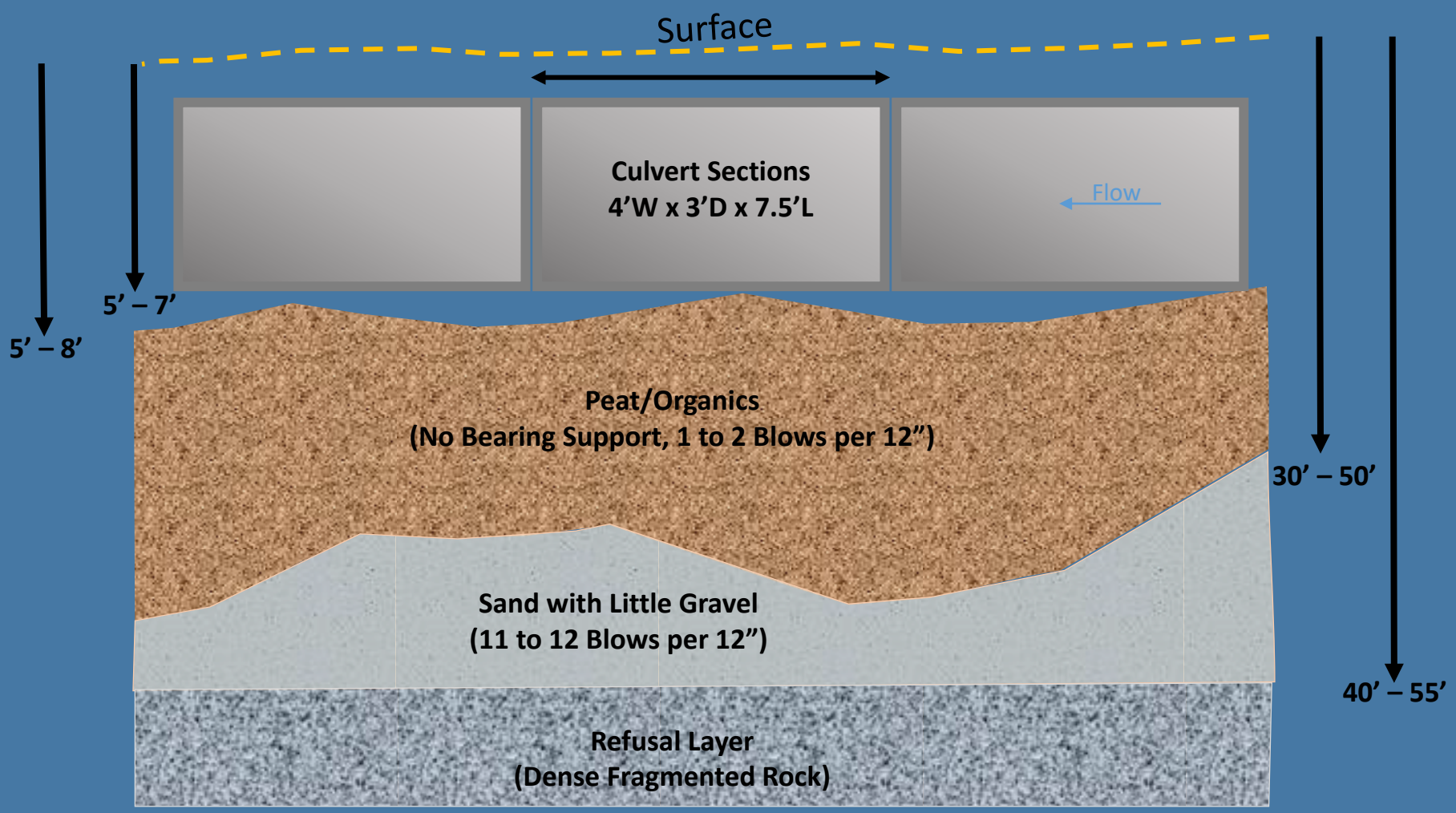
Drawings by Concrete Systems, Inc.



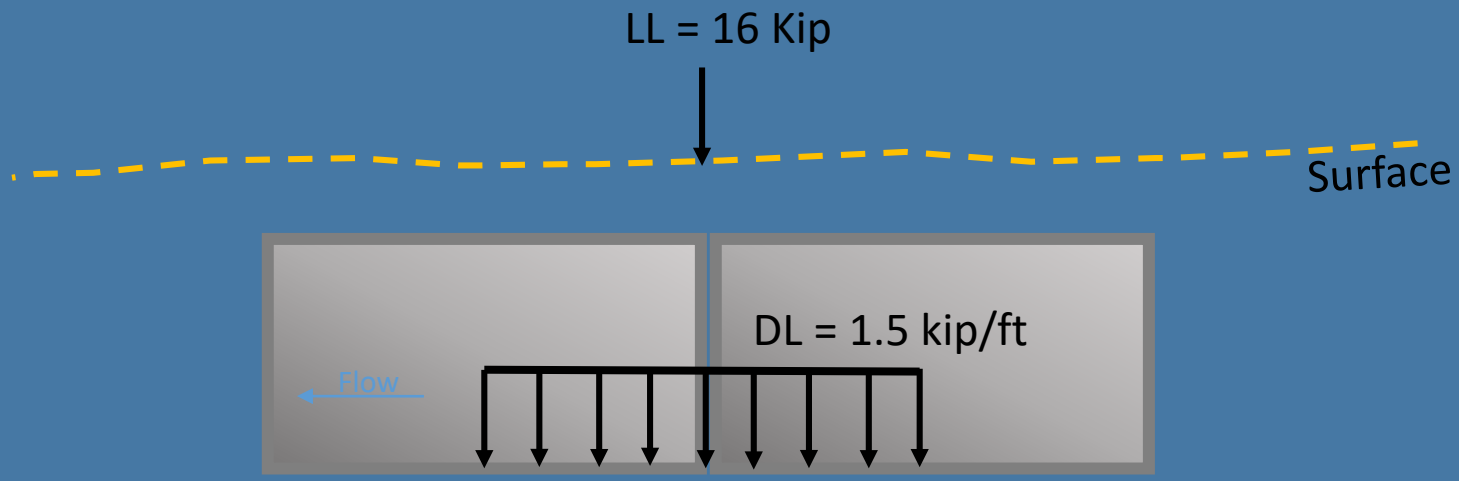
Drawings by Concrete Systems, Inc.

CULVERT FOUNDATION DESIGN

Unstable Subsurface Conditions



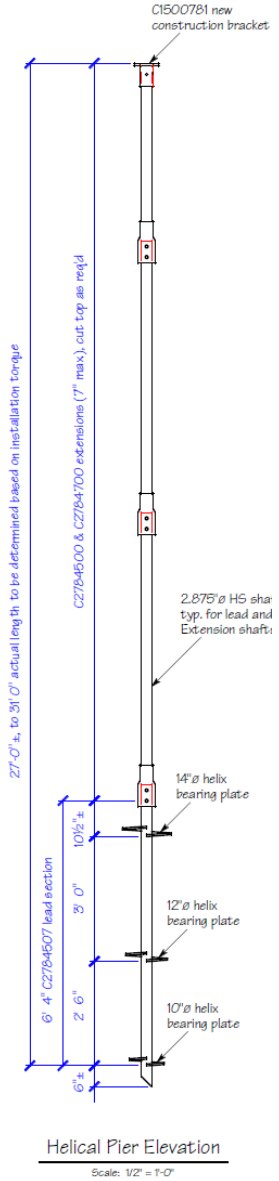
Foundation Design Loads



- Peat Soil Bearing Capacity: > 0.5-tsf
- Live Load: 16-Kip Load at Culvert Joint
- Dead Load: 1.5-Kip/ft over 8’ (or 14-kips at center)
- Working Load: 30-kips
- Ultimate Load: 30-kips x 2.0 Factor of Safety = 60-kips

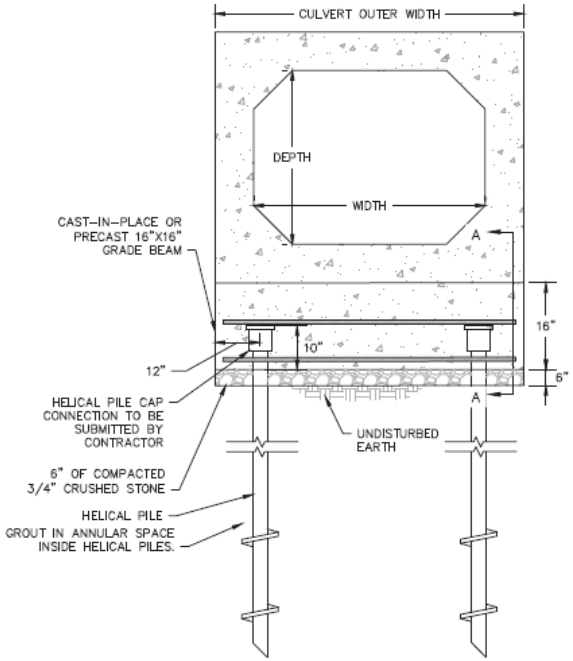
Initial Helical Pile Design

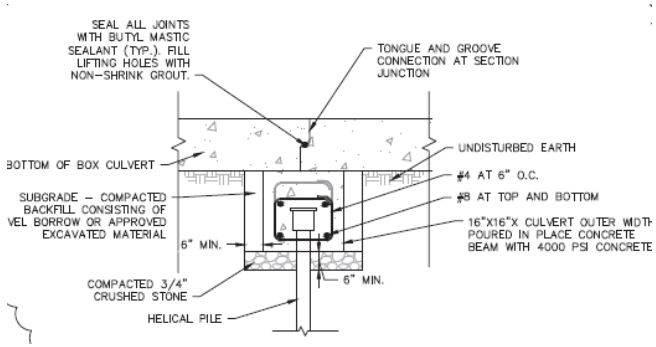
- “A.B. Chance” Piles Selected;
- 2x Helical Piles per joint;
- 132 total piles;
- Average depth of pile: 30’
- Working Load per Pile: 15-kip;
- Ult. Load Req. per Pile: 30-kip (2.0 SF);
- Torque Req.: 3,400-ft-lbs.



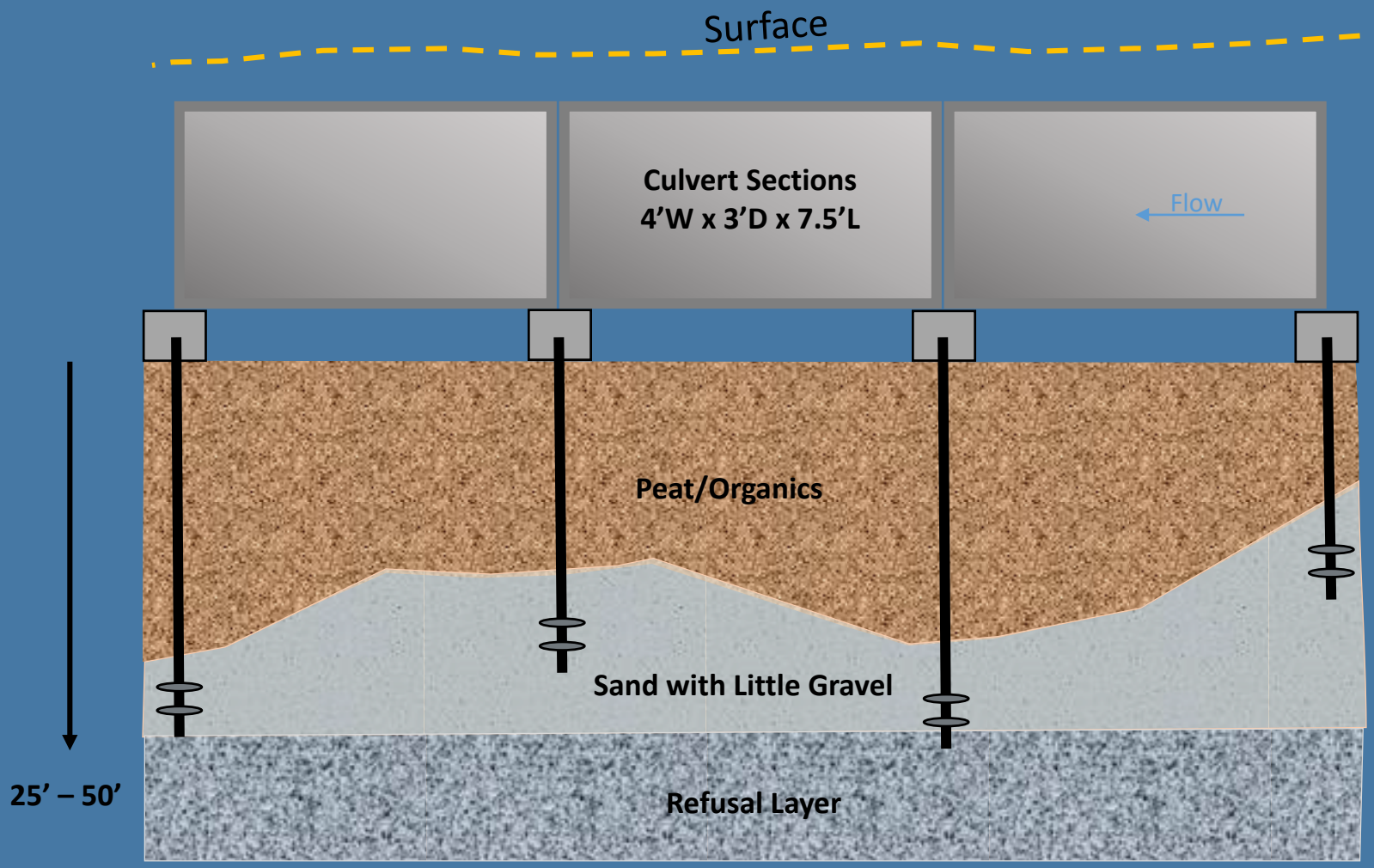
Helical Pile Beam Design

- Piles Embedded in 16” x 16” concrete grade beam;
- 63 Total Grade Beams;
- 2 large end beams for culvert headwalls with 4-embedded piles.





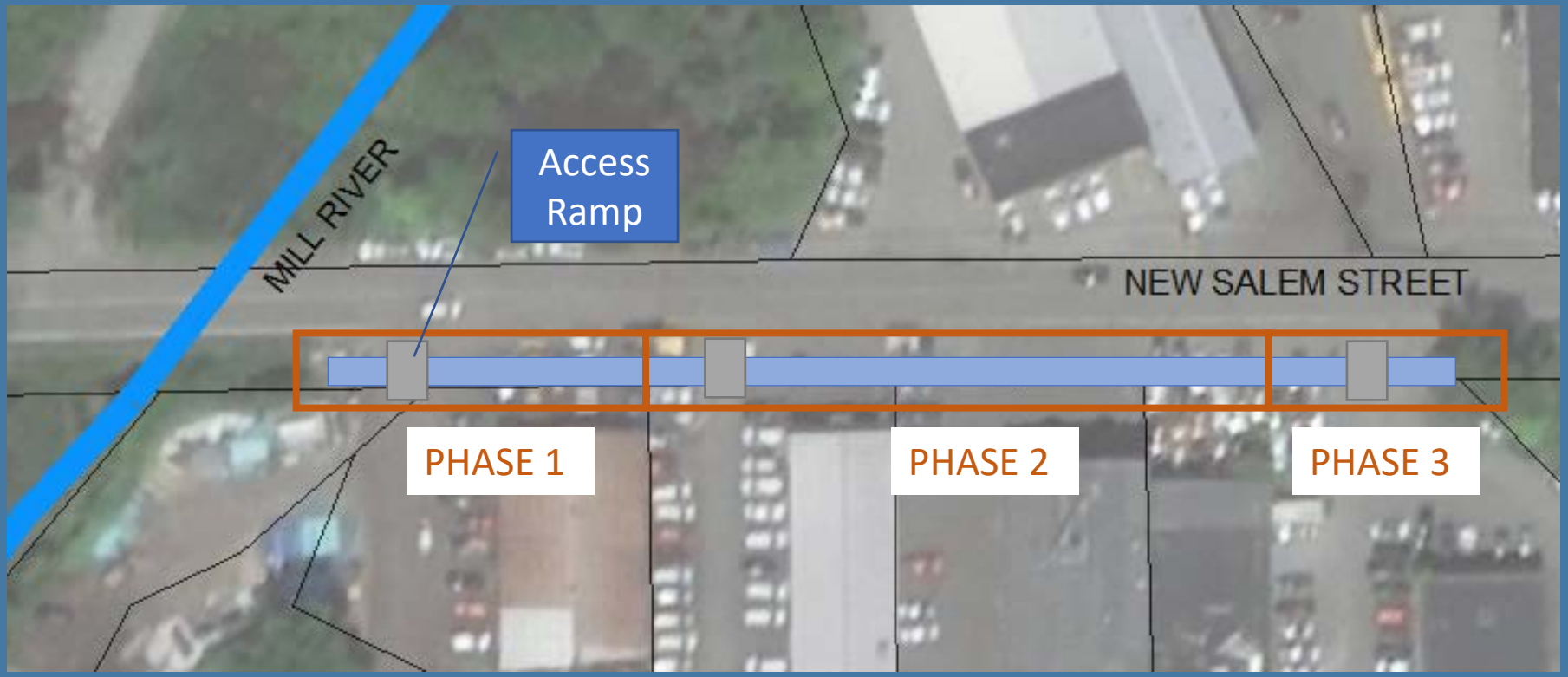
Helical Pile Installation



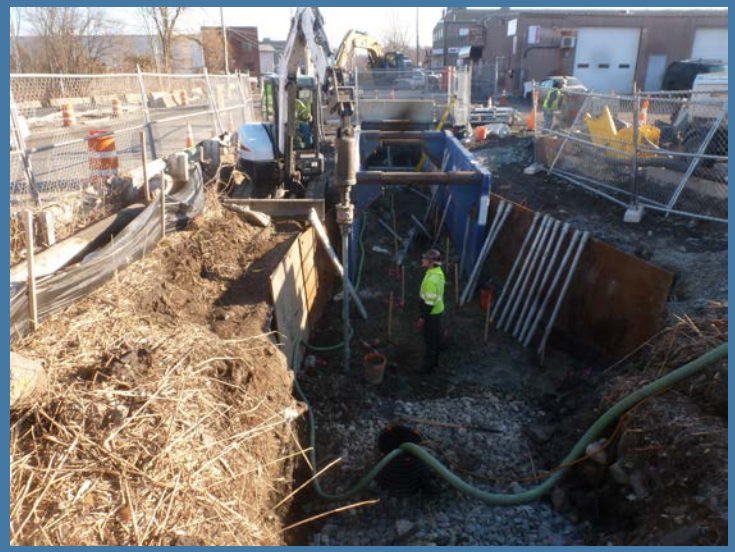
Helical Pile Load Testing

- 2 Pile Tests Conducted to verify design.
- Piles did not reach torque requirement in sand layer.
- Most piles required installation into refusal layer to reach load requirements.

Construction Phasing



Construction (Phase 1)



Construction (Phase 1)

Issues During Construction

- Obstacles during pile install (boulders, and old foundation);
- No torque resistance in sand layer;
- Roof drains and existing drainage not on record;
- Weather during winter and early spring.

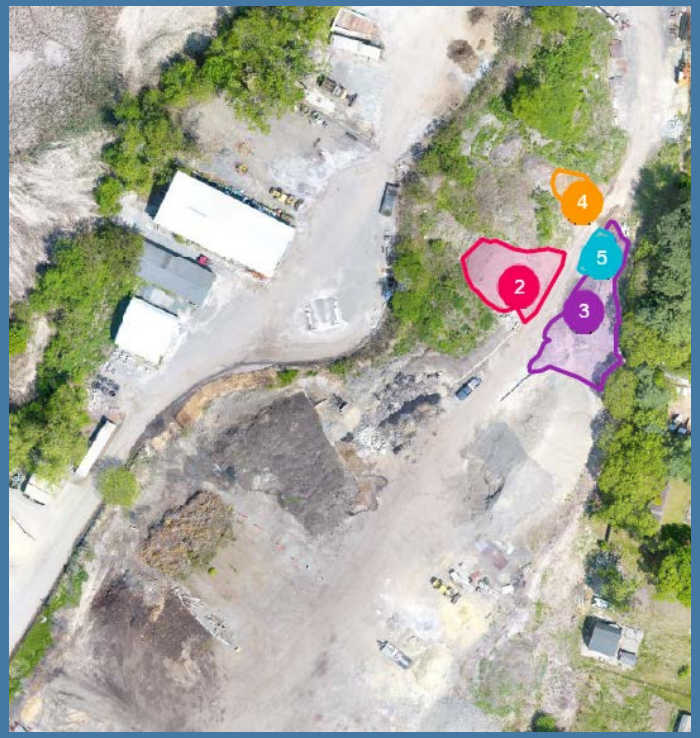
SOIL ABATEMENT

Soil Abatement

- EP conducted pre-characterization of the site
  - VOC's and Petroleum Hydrocarbons were present
- Work performed under MassDEP Utility-Related Abatement Measure (or URAM)
- Soil was not able to be reused on site and was required to be sent to an appropriate soil handling facility

Soil Management During Construction

- All soil was stockpiled at a Wakefield DPW Yard (Waiver accepted from MassDEP);
- Soil separated based on field observations and EP pre-characterization;
- Small concentrations of PCB's and Hydrocarbons found.



Drone imagery by Onyx Corporation

Aroclor 1262	1					mg/kg	0.04	U	0.19	U	0.0427	U	0.0436	U
Aroclor 1268	1					mg/kg	0.04	U	0.19	U	0.0427	U	0.0436	U
PCBs, Total	1					mg/kg	0.04	U	0.637		0.109		0.0685	
MCP Semivolatile Organics														
Acenaphthene	4	4	5			mg/kg	0.3		0.16	U	0.17	U	0.18	U
1,2,4-Trichlorobenzene						mg/kg	0.2	U	0.2	U	0.22	U	0.23	U
Hexachlorobenzene	0.7					mg/kg	0.085	U	0.084	U	0.091	U	0.097	U

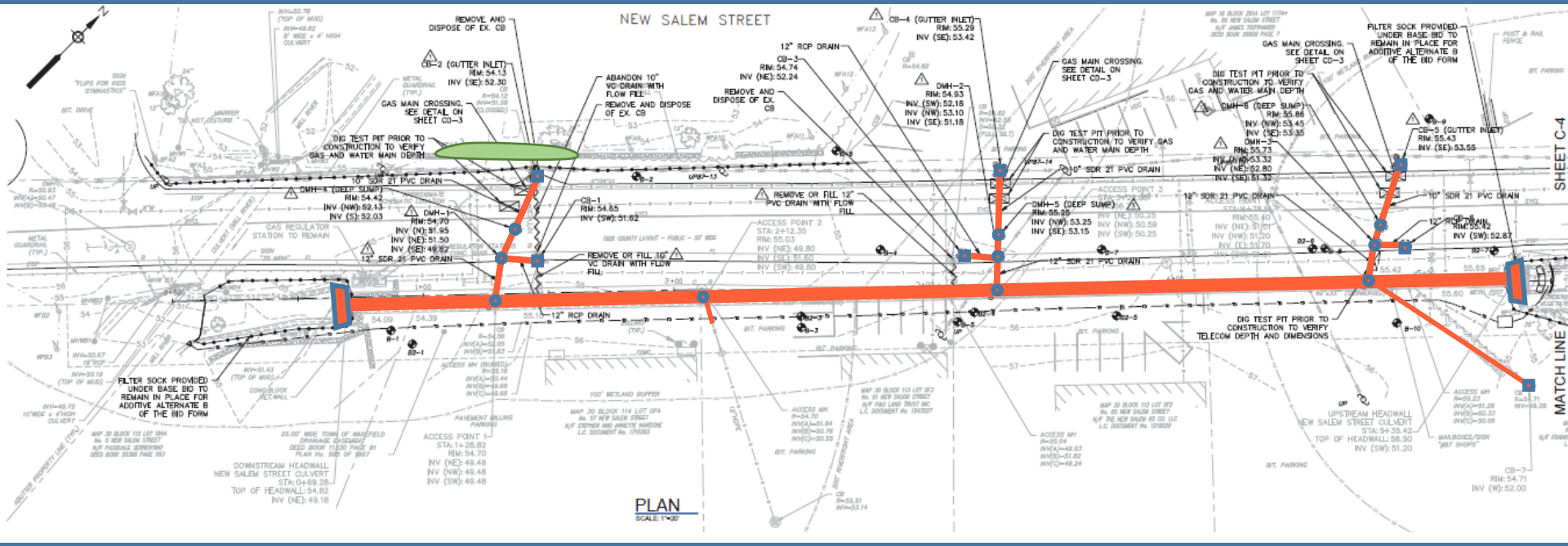
1,4-Dioxane						mg/kg	0.077	U	0.084	U	0.11	U	0.09	U
Total VOCs				4	10	mg/kg	0.0308		ND		ND		0.141	
Petroleum Hydrocarbon Quantitation														
TPH (C10-C36)	1000			2500	5000	mg/kg	689		577		464		343	

* Comparison is not performed on parameters with non-numeric criteria

Final Soil Disposal

- Currently 5-piles of utility trench soil material stockpiled
- Total Soil Stockpiled: Approximately 2,000-cy
- Soil was categorized as “Impacted Soil,” but did not exceed MassDEP RSC-1 contaminant levels.
- All soil is anticipated to be hauled to a lined landfill by the end of June 2021.

Final Completed Project



- 480 LF of Culvert
- Local drainage
- Headwalls and Wingwalls
- Wetland Replication

Final Construction Photos

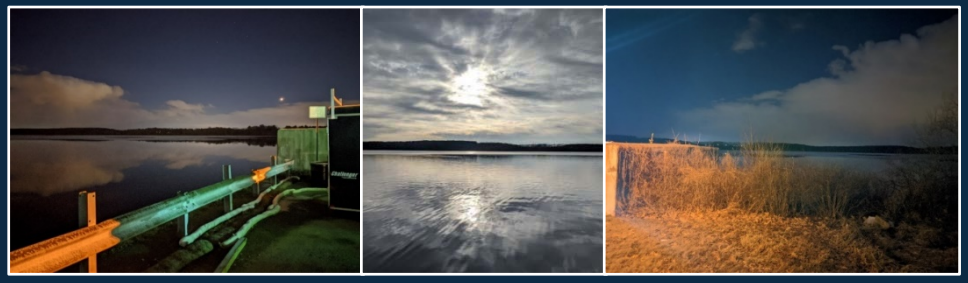
Permitting Summary

- Conservation Commission Notice of Intent
- Army Corps of Engineers (USACE) MA General Permit
- URAM – Soil Disposal
  - Submitted by Contractor's LSP before construction
  - Details handling, storage, and disposal plan

Construction Costs Summary

Culvert	$718,000
Helical Piles and Grade Beams	$190,000
Soil Disposal	$142,000
Local Drainage System	$180,000
Total	$1,230,000

THANK YOU



ENVIRONMENTAL
PARTNERS

Acknowledgements

- Joseph Conway – Town of Wakefield DPW Superintendent
- William Renault, PE - Town of Wakefield Engine

- Onyx Corporation – General Contractor

- All Environmental Partners Staff