



Civil & Environmental
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Navigating Difficult Site Constraints to Facilitate Ecological Recovery of an Impaired Watershed

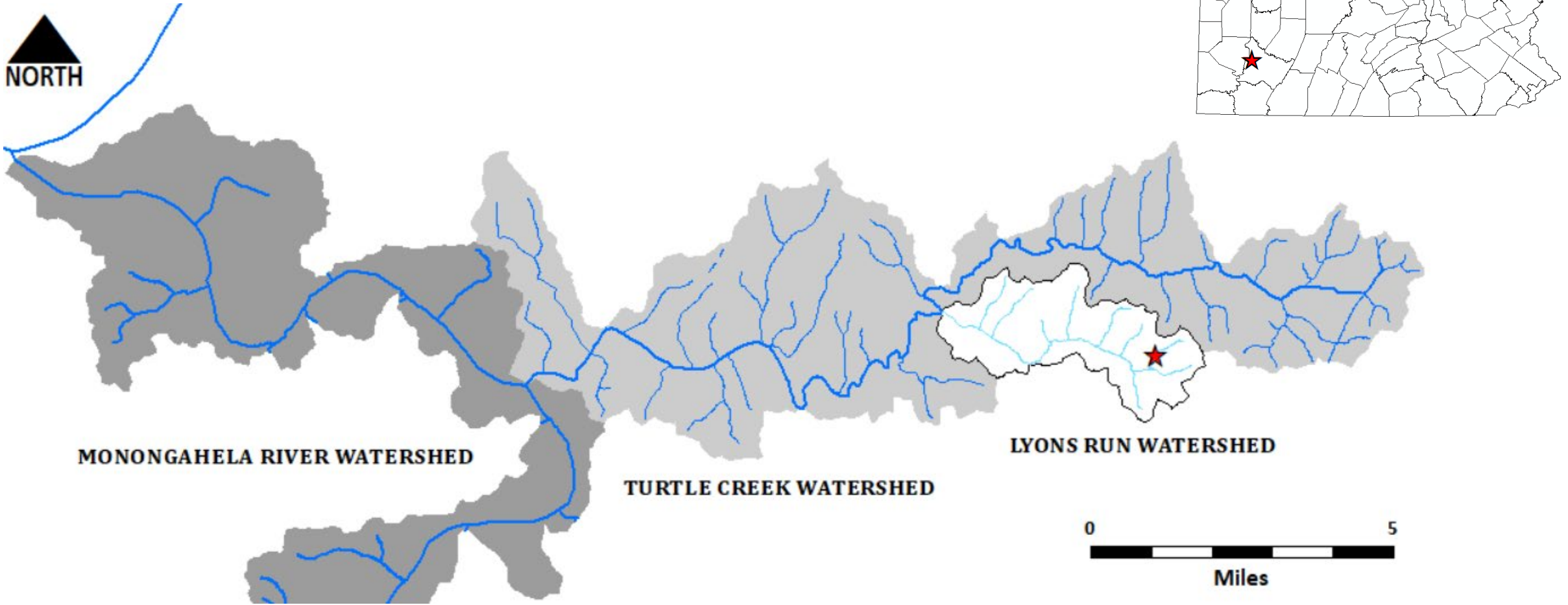
Presented By

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Civil & Environmental Consultants, Inc.

April 25, 2024

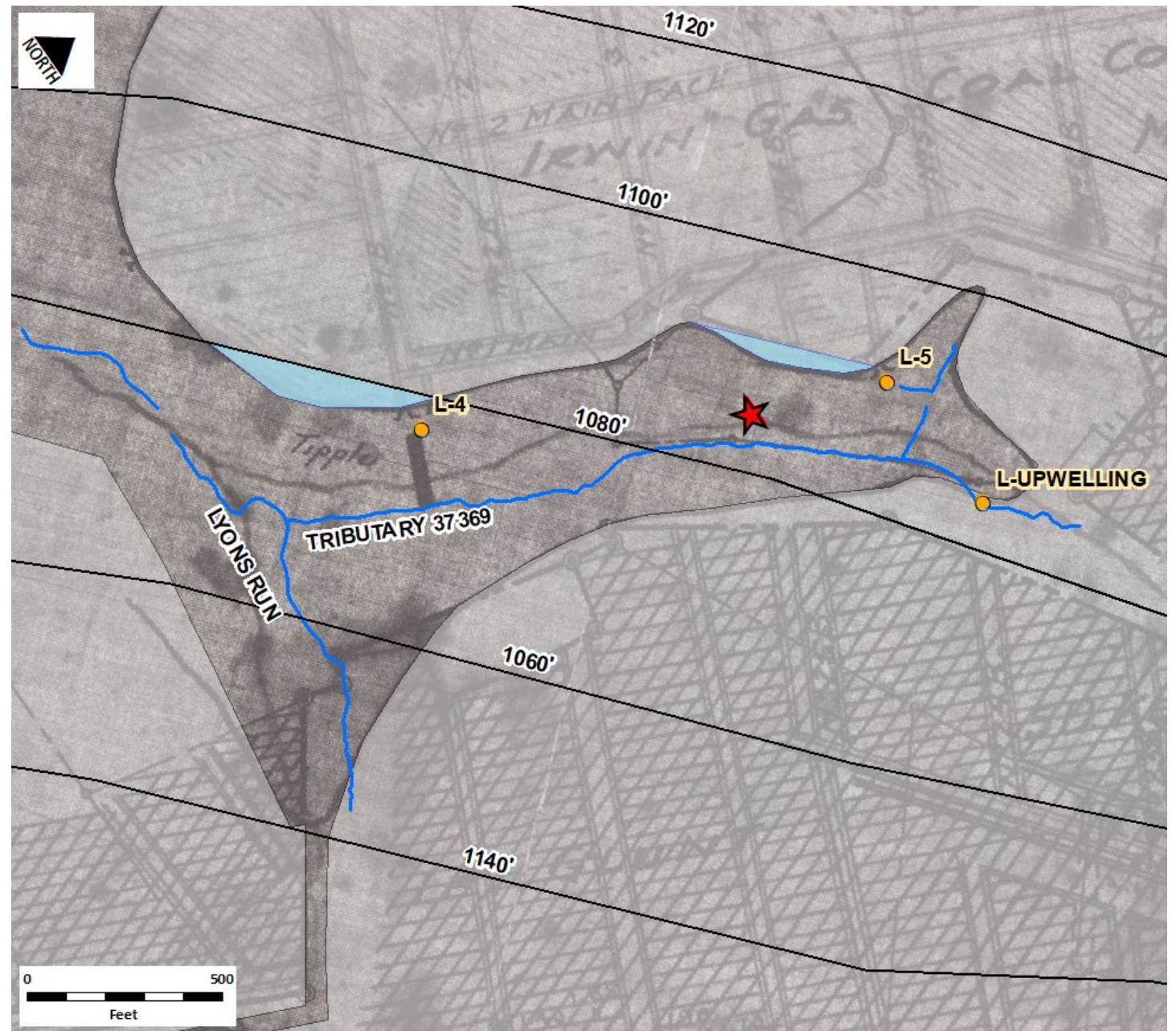
Watershed



- Lyons Run Watershed, Westmoreland County, Pennsylvania
 - 5.1 miles (8.2 km)
 - 5.7 mi² (14.7 km²)

Mining

- Irwin Gas Coal Company Mine No. 2
- Operated 1917 - 1924
- Perched above-drainage mine pools
- Three AMD Sources
 - High acidity
 - High iron and aluminum
 - Seasonally influenced



AMD Sources

L-4



L-5



L-UPWELLING



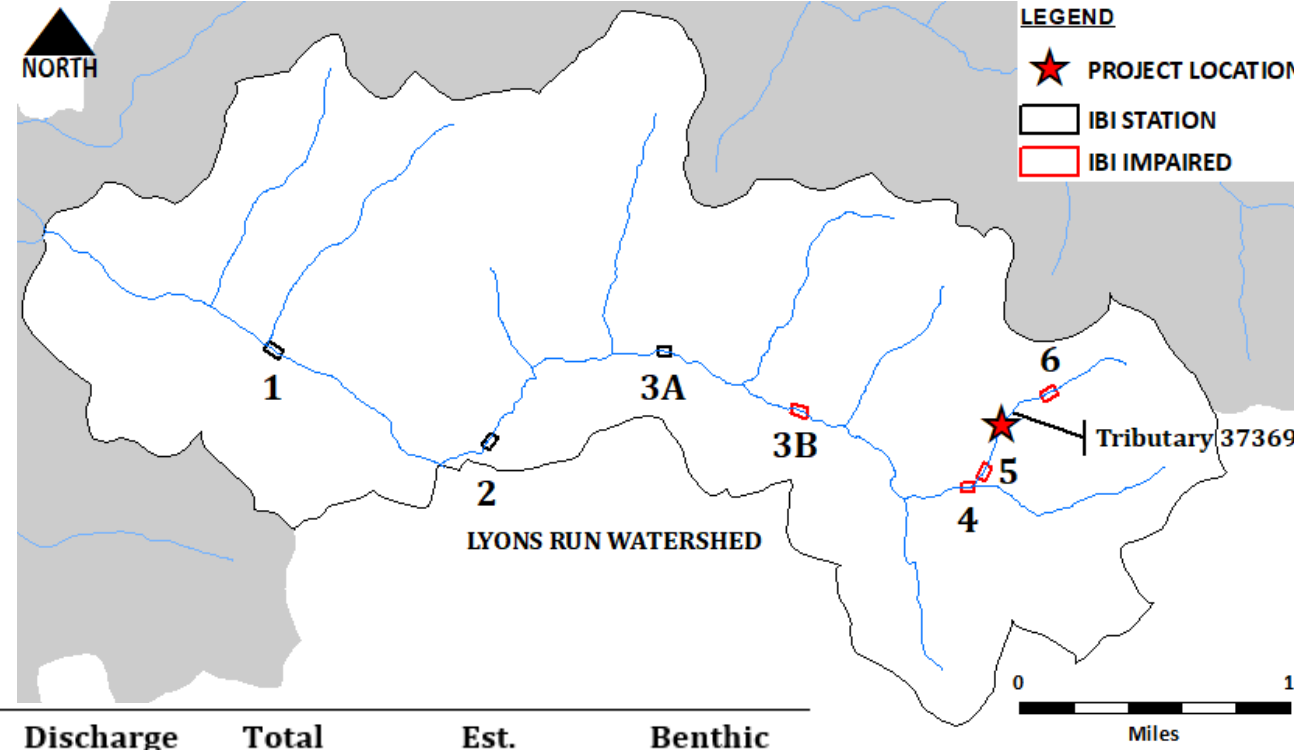
Water Quality

DATE	AMD Source	pH	Specific Conductance	Dissolved Oxygen	Discharge Q	Hot Acidity	Total Alkalinity	Ca Total	Fe Total	Fe Dis	Al Total	Al Dis	Mn Total	Mn Dis	Mg Total	SO4 Total
m/d/y			µS/cm	mg/L	L/s	mg/L as CaCO3		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3/1/2023	L-4	2.71	2017	9.14	1.20	336	0	97.3	28.6	28.7	32.7	33.1	3.1	2.9	32.3	816
3/1/2023	L-5	2.58	2809	9.69	1.78	490	0	83.1	42.8	41.9	49.3	48.0	4.5	4.4	28.5	988
3/1/2023	L-UPWELL	2.69	2190	7.13	1.80	335	0	65.4	30.9	29.7	31.0	36.1	3.2	3.0	22.9	732



Index of Biotic Integrity (IBI)

- Low score upstream (Site 6)
 - Intermittent and circum-neutral pH
- Low score below AMD (Sites 4, 5)
 - Perennial low pH
- Moderate score downstream mainstem (Site 3B)
 - Dilution and precipitation
- Good score lower watershed (Sites 1, 2, 3A)
 - Dilution, neutralization, attenuation



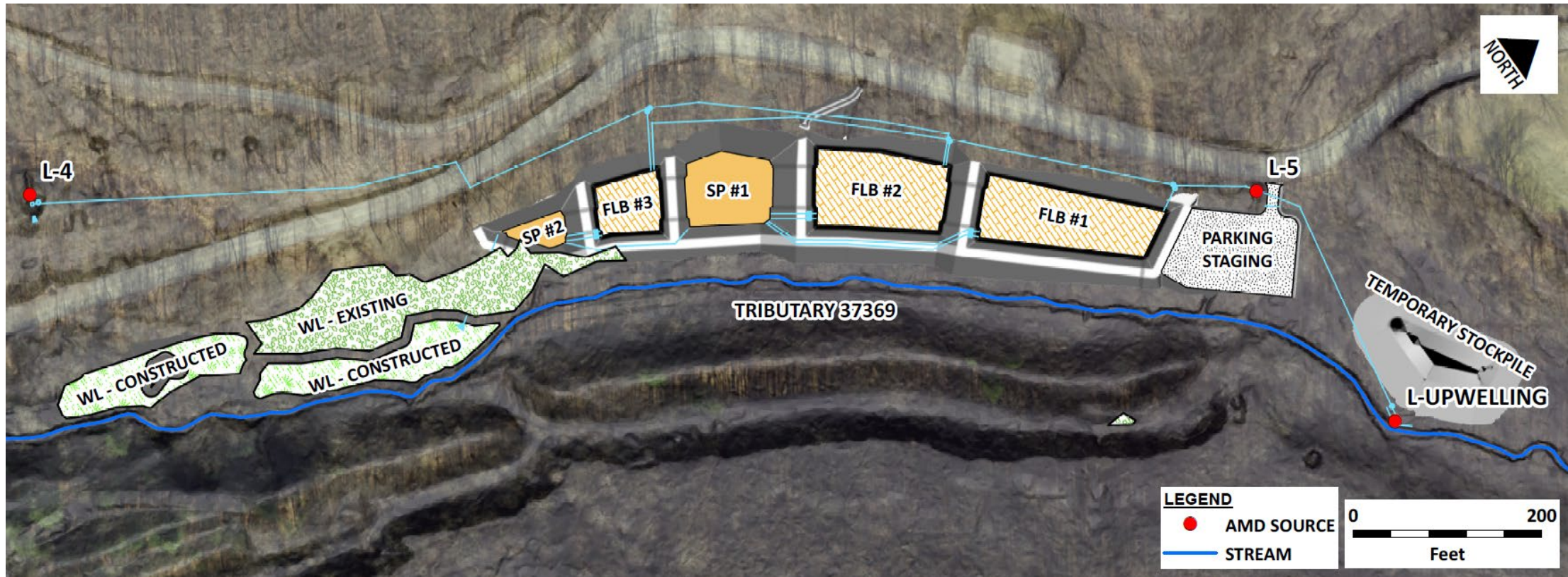
Station No.	pH	Specific Conductance μS/cm	Dissolved Oxygen mg/L	Discharge Q L/s	Total Taxa	Est. Density #Organisms/ m ²	Benthic IBI Score
1	8.49	568	15.5	73.69	25	409	60.9
2	8.24	390	14.5	38.23	33	280	68.7
3a	7.61	483	13.7	16.21	24	96	65.0
3b	5.23	595	13.9	9.72	13	28	44.5
4	2.78	1108	14.0	3.97	8	27	14.7
5	2.70	1065	13.9	3.91	4	265	11.3
6	6.03	295	13.7	1.89	11	124	24.6



Proposed Project

Successive alkalinity producing system (SAPS)

- Flushable limestone beds – compost over limestone
- Settling ponds
- Polishing wetlands



Water Quality Mitigation Bank

Reach	Length (ft)	IBI Score	Reference	Difference	USACE Guidance ¹		
					Length (ft)	Enhancement ²	Credits
1	4,302	60.9	68.7	7.8	0	2.5:1	
2	4,604	68.7	68.7	0.0	0	2.5:1	
3A	2,732	65.0	68.7	3.7	0	2.5:1	
3B	2,205	44.5	68.7	24.2	2,205	2.5:1	882
4	3,508	14.7	68.7	54.0	3,508	2.5:1	1,403.20
5	1,903	11.3	68.7	57.4	1,903	2.5:1	761.2
6	2,173	24.6	NA	NA			
						Total Credits	3,046.40

¹USACE. 2013. Draft Pittsburgh District Guidance Document for Mitigation Bank Sites in Pennsylvania.

²Enhancement is defined as improvement to an area that is currently stream or wetland and only one or two major functions are being restored/improved. Gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Reach	Length (ft)	Width (ft)	Area (sf)	Area (ac)	IBI Score	Reference	Difference	>11	% Diff/100 (Cldiff)	DEP Compensation Protocol ¹					
										AP	RV ²	CV ²	Cldiff	FCG	
1	4,302	13	55,926	1.284	60.9	68.7	7.8	No							0
2	4,604	7	32,228	0.740	68.7	68.7	0.0	No							0
3A	2,732	7	19,124	0.439	65.0	68.7	3.7	No							0
3B	2,205	8	17,640	0.405	44.5	68.7	24.2	Yes	0.352	0.405	2.5	2.5	0.352	0.89	
4	3,508	5	17,540	0.403	14.7	68.7	54.0	Yes	0.786	0.403	2.5	2.5	0.786	1.98	
5	1,903	4	7,612	0.175	11.3	68.7	57.4	Yes	0.836	0.175	2.5	2.5	0.836	0.91	
6	2,173	3	6,519	0.150	24.6	68.7	44.1	NA							0
											Total Credits	3.78			

¹PADEP. 2014. Draft Pennsylvania Function Based Compensation Protocol.

$$FCG = AP \times RV \times CV \times Cldiff$$

FCG = Functional Credit Gain

AP = Area of Project for each applicable function group (in acres, 0.00)

RV = Resource Value

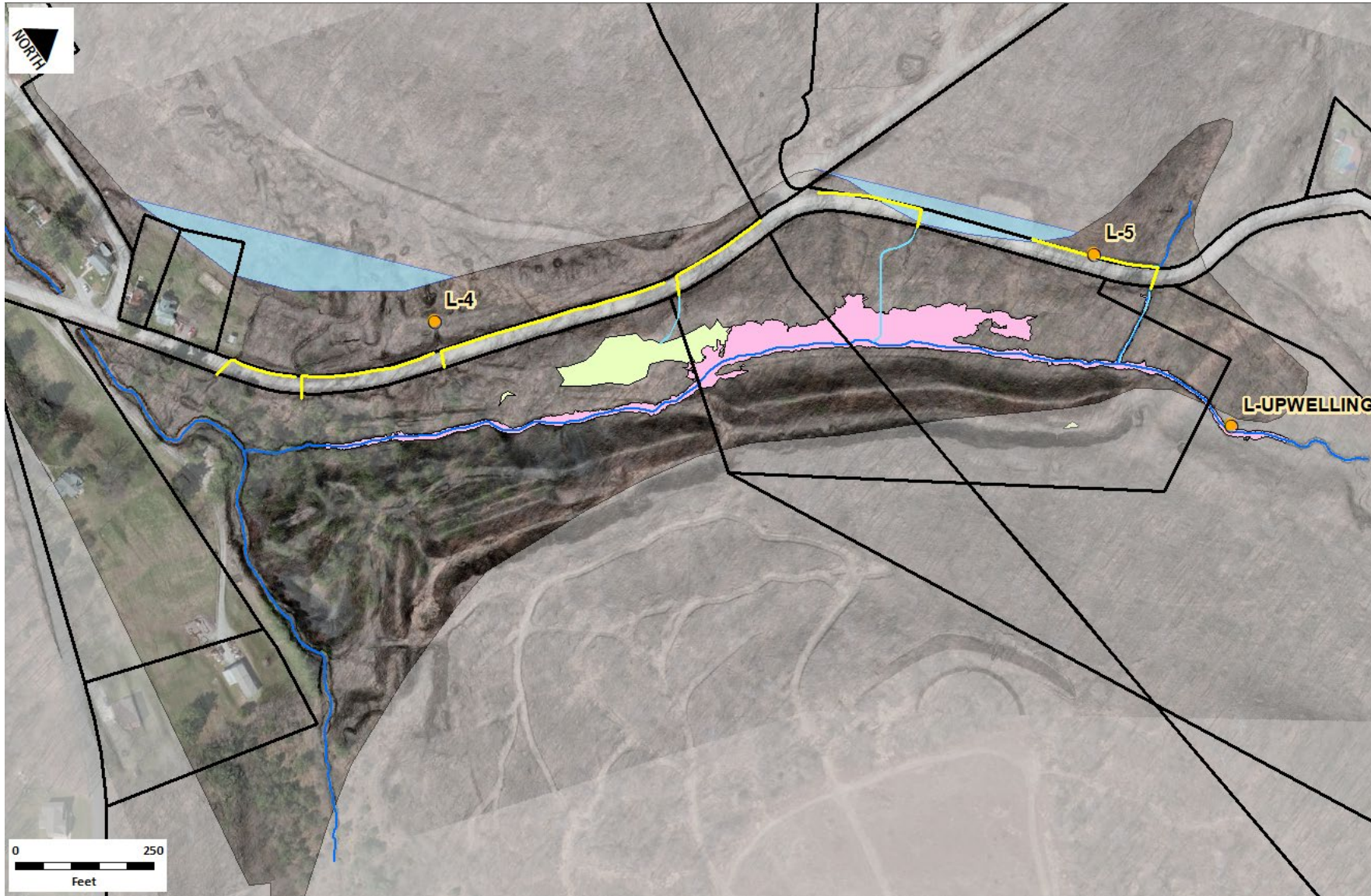
CV = Compensation Value

Cldiff = Condition Index Differential Value (0.00) (this is the difference between the existing condition and the projected/achieved condition post project implementation for each applicable function group)

²Values determined according to criteria in Goerman (2018)

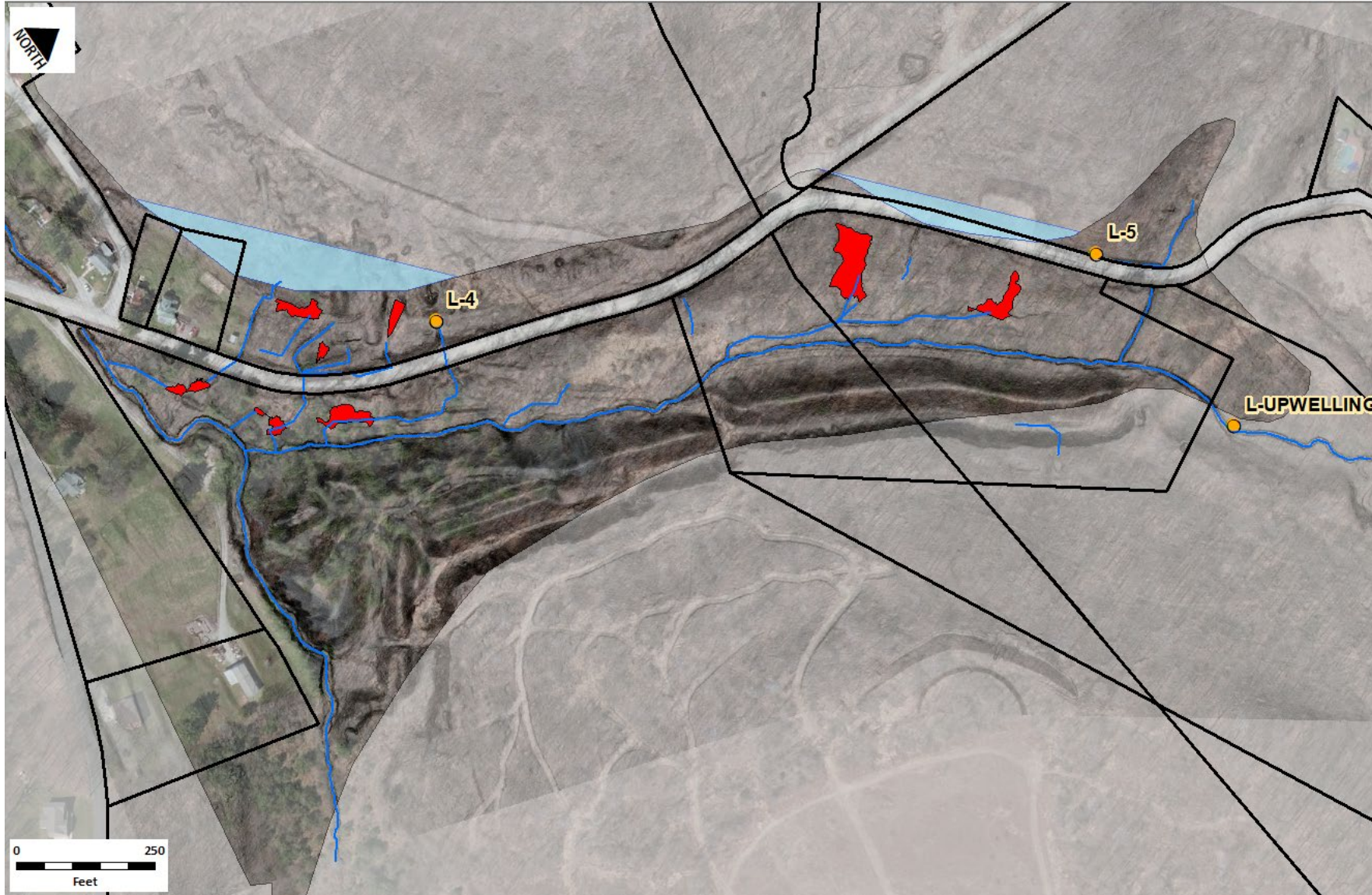


Constraints



- Roadway
- Stream
- Property boundaries
- Existing wetlands
- Modeled 100-yr floodway
- Stormwater management
- Relic spoil piles
- Minimum vertical relief
 - Extensive piping
 - County road crossing
- Regulatory
- Shallow hydrogeology
- Seasonal flow variation

Acidic Seeps



Seep Name	Acres	pH
Seep #1	0.001	2.70
Seep #2	NA	2.20
Seep #3A	0.057	2.82
Seep #3B	0.143	2.72
Seep #5	0.051	3.33
Seep #7	0.021	3.03
Seep #8	0.022	3.26
Seep #9	0.037	2.81
Seep #10	0.009	2.90
Seep #11	0.021	2.94

Roadside Ditches and Culverts



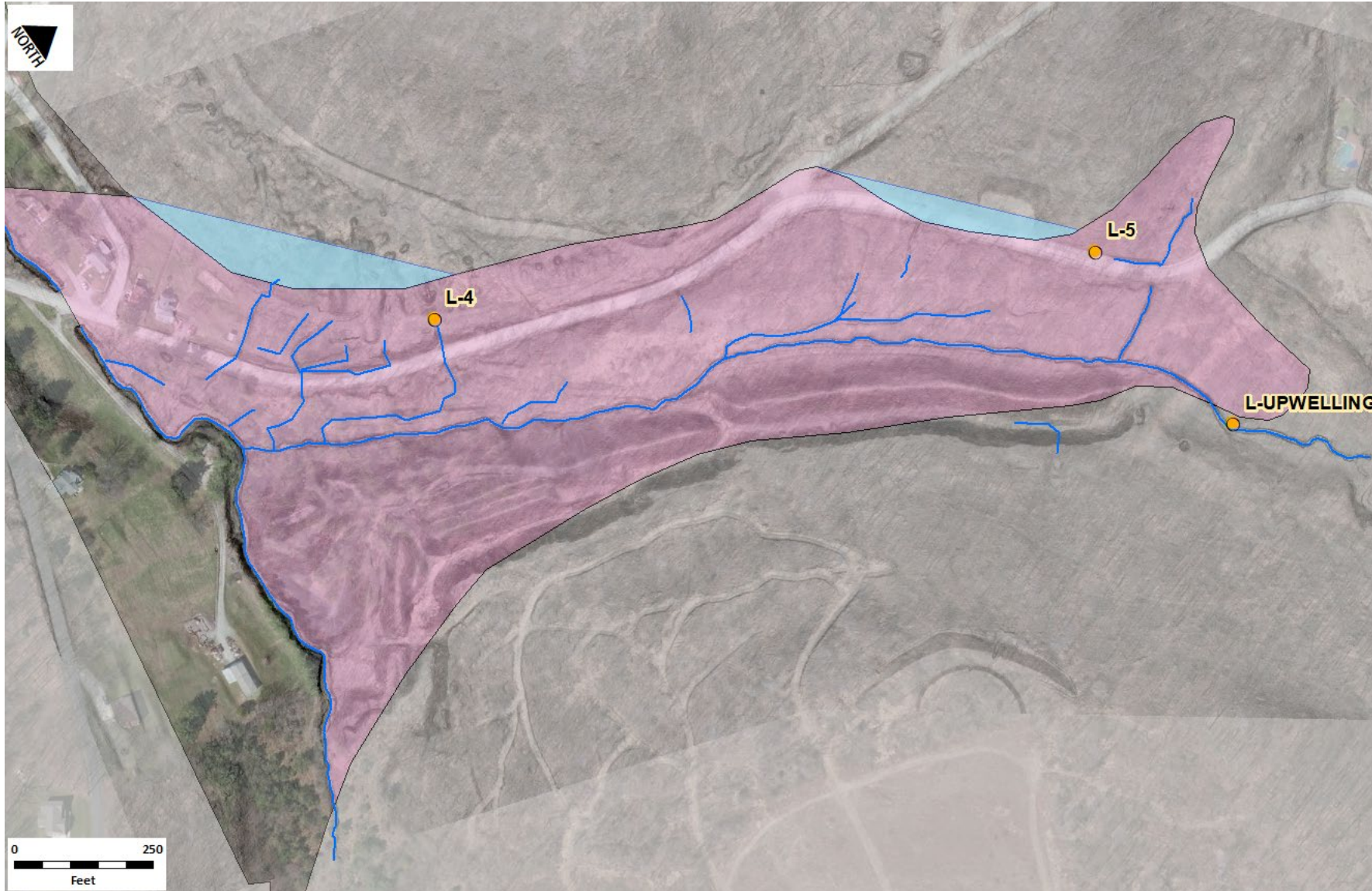
Shallow Clays



Undermining and Water Losses



Seasonal Variation and Aquifer Depletion



- Wet season
- Saturated watershed
- AMD sources at maximum discharge
 - Combined ~130 gpm
 - Higher concentrations and contaminate loads

Seasonal Variation and Aquifer Depletion



Seasonal Variation and Aquifer Depletion



Seasonal Variation and Aquifer Depletion



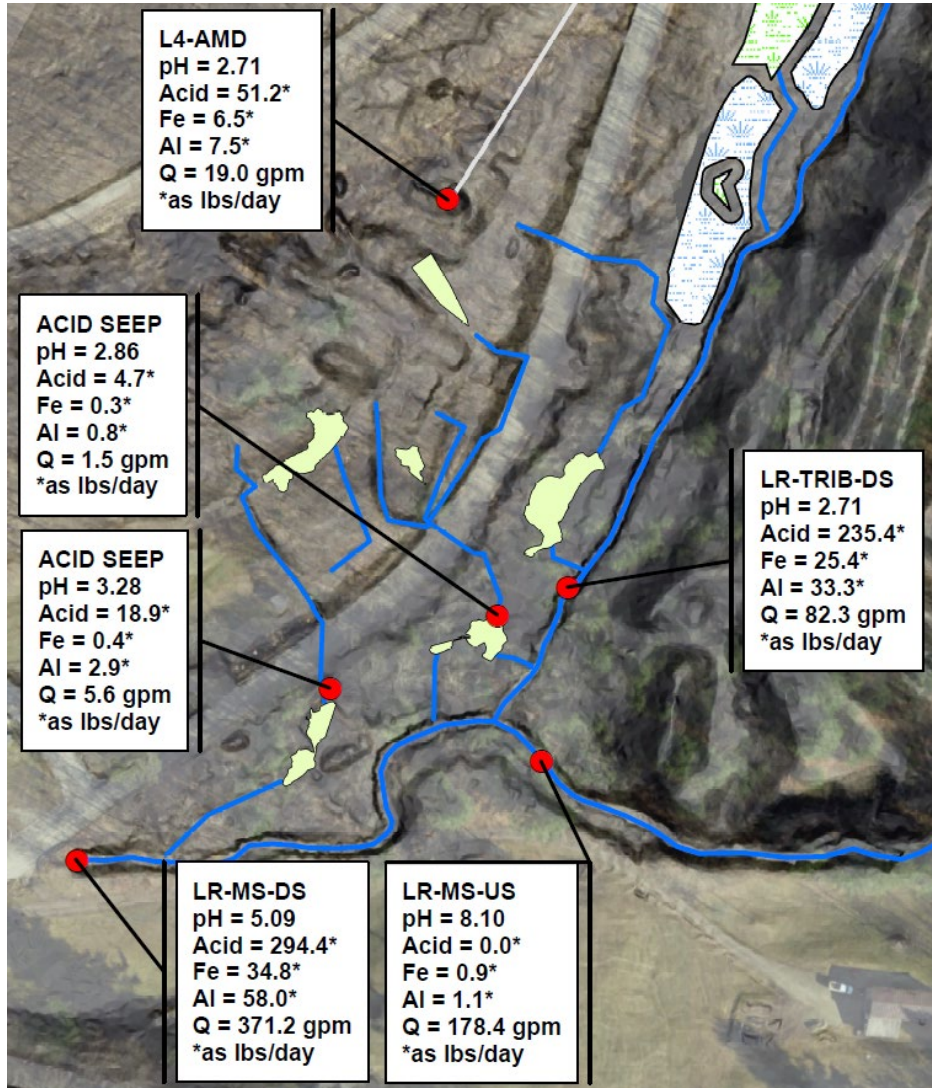
Seasonal Variation and Aquifer Depletion



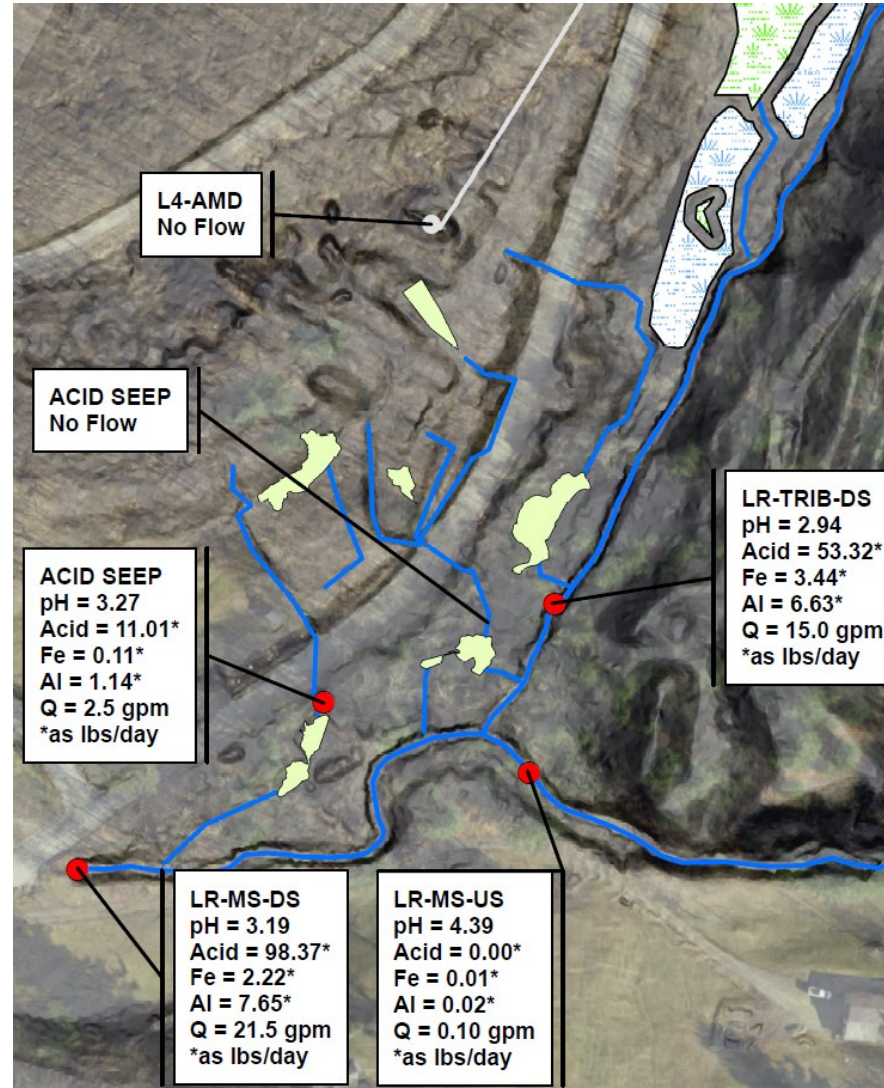
- Dry Season
- Dry AMD sources
- Dry upper watershed
- Saturated lower watershed
 - pH = 3.2
 - Acidity = 300 mg/L
 - Fe = 10 mg/L
 - Al = 40 mg/L

Contaminate Loads

Wet Season



Dry Season



Wet Season

Additional:

- Q: 103 gpm
- Acid: 35 lbs/day
- Fe: 8 lbs/day
- Al: 20 lbs/day

Dry Season

Additional:

- Q: 4 gpm
- Acid: 34 lbs/day
- Fe: -1.3 lbs/day
- Al: 0.14 lbs/day

Design – Site

BASELINE

- Lidar and survey
- Delineations
- Water quality
- Benthic macroinvertebrates
- Rapid Bioassessment Protocol
- Geotechnical
- Hydraulic modeling

DESIGN

- Utilized entire available area
- Oversized BMPs
- Considered stream relocation
 - Costly and unnecessary
 - Removal of spoil piles
- Tenth-foot tolerances on elevations
- Civil 3D
 - Earthwork mass balance (7500 CY)



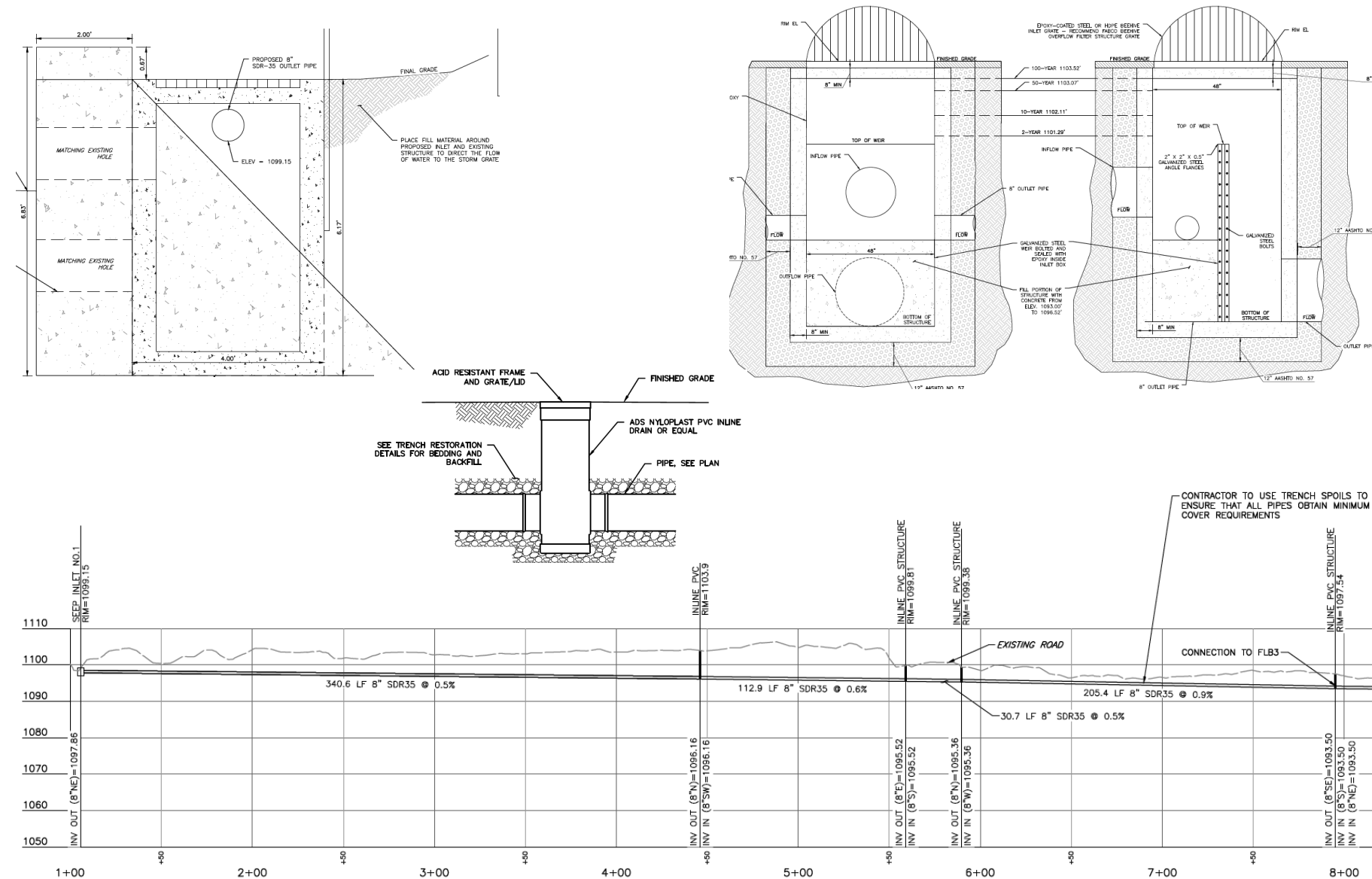
Design – Collection and Conveyance

Catch Basins

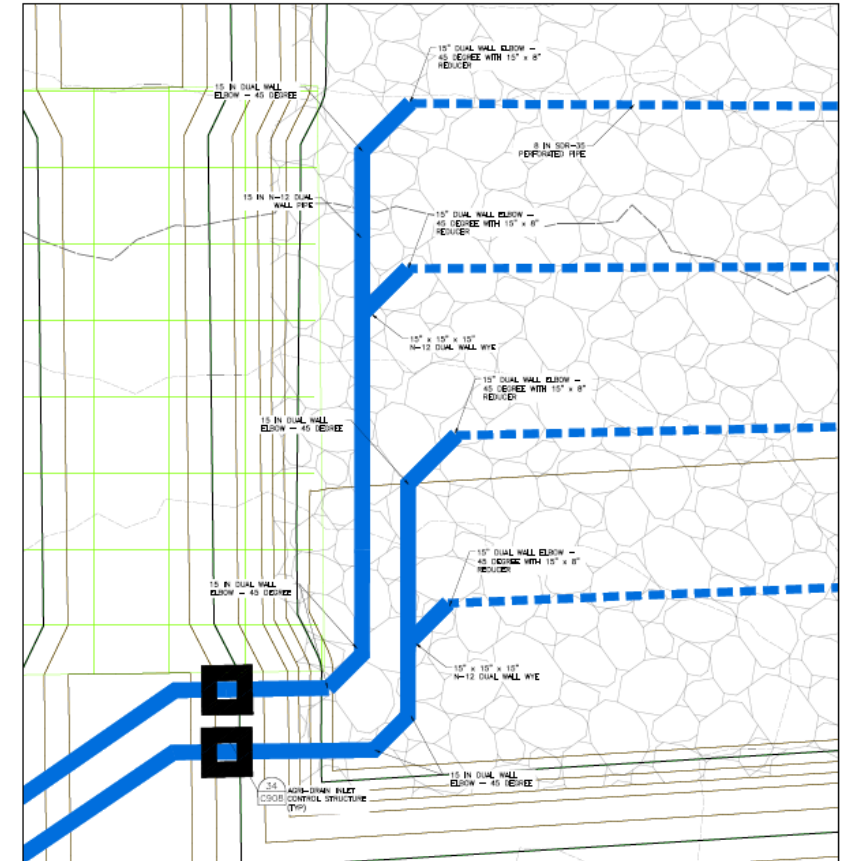
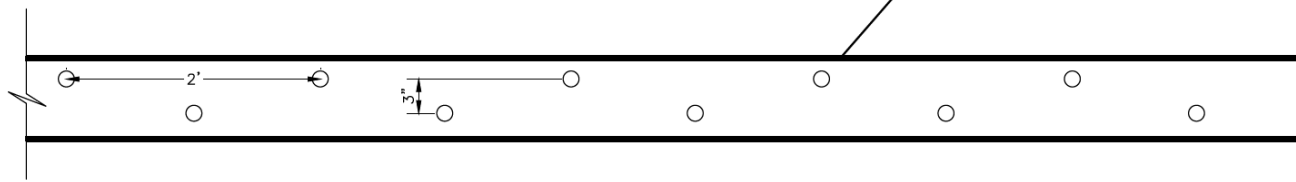
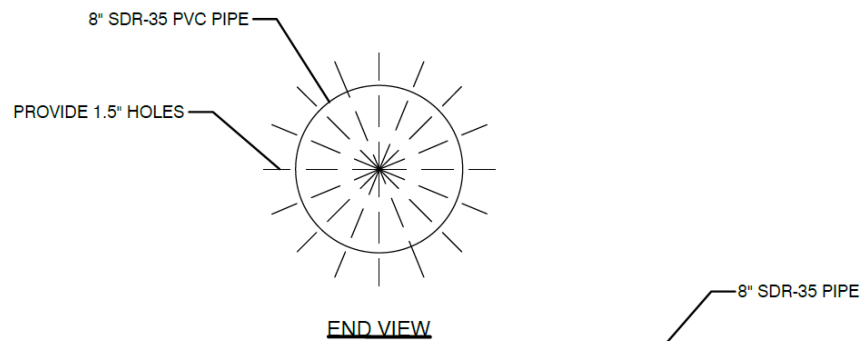
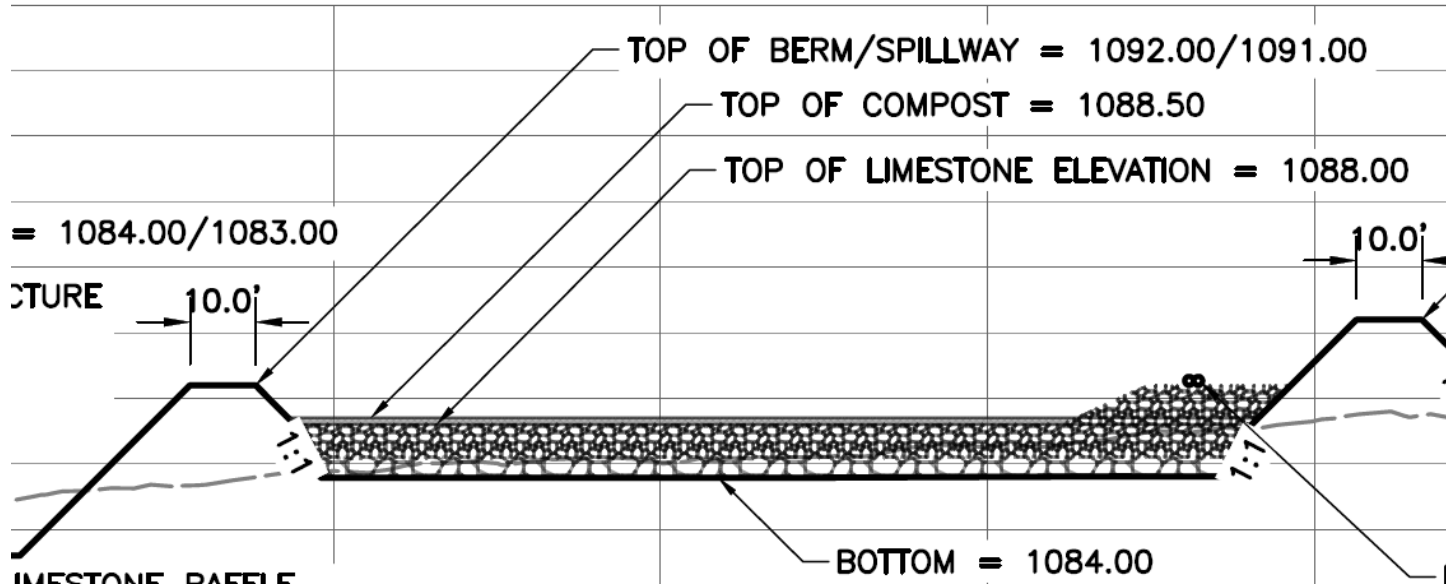
- L4 – maintains water elevation from multiple inlets
- L5 – bypasses >2-year storm event
- Bypass flows are large and dilute

Piping

- Civil 3D Pipe Networks
- Maintain ground cover
- Assess conflicts
- Inline access structures



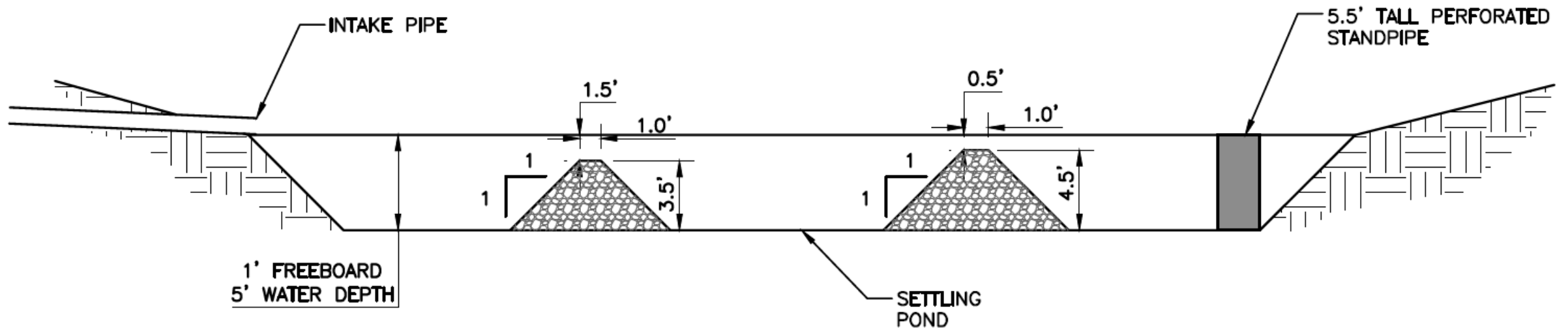
Design – Limestone Beds



- Rip-rap limestone near piping
- Four main trunk lines
- Custom pipe perforation pattern

Design – Settling Ponds

- Settling pond sized for full flush volume of FLBs
- Gravel baffles
 - Velocity reduction
 - Zone of settling – Western Regional Agricultural Center (WRAC) publication
 - Robust structure
- Perforated standpipe outlet



Design – Polishing Wetlands

- Earthen baffles
- 1-foot drops every 50-feet
- Native revegetation

Permenant Seeding		
EASTERN NATIVE HABITAT & CREP MIX (ERNMX-173)		
Plant Species		Seed Mix Composition
Scientific Name	Common Name	
<i>Andropogon gerardii</i>	Big Bluestem	40%
<i>Elymus virginicus</i>	Virginia Wildrye	25%
<i>Panicum virgatum</i>	Switchgrass	15%
<i>Chamaecrista fasciculata</i>	Partridge Pea	8%
<i>Sorghastrum nutans</i>	Indiangrass	5%
<i>Rudbeckia hirta</i>	Blackeyed Susan	3%
<i>Echinacea purpurea</i>	Purple Coneflower	2%
<i>Heliopsis helianthoides</i>	Oxeye Sunflower	2%
Temporary Seeding		
<i>Secale cereale</i>	Winter rye	Aug 15-Feb 28
<i>Lolium multiflorum</i>	Annual Ryegrass	Spring or Fall

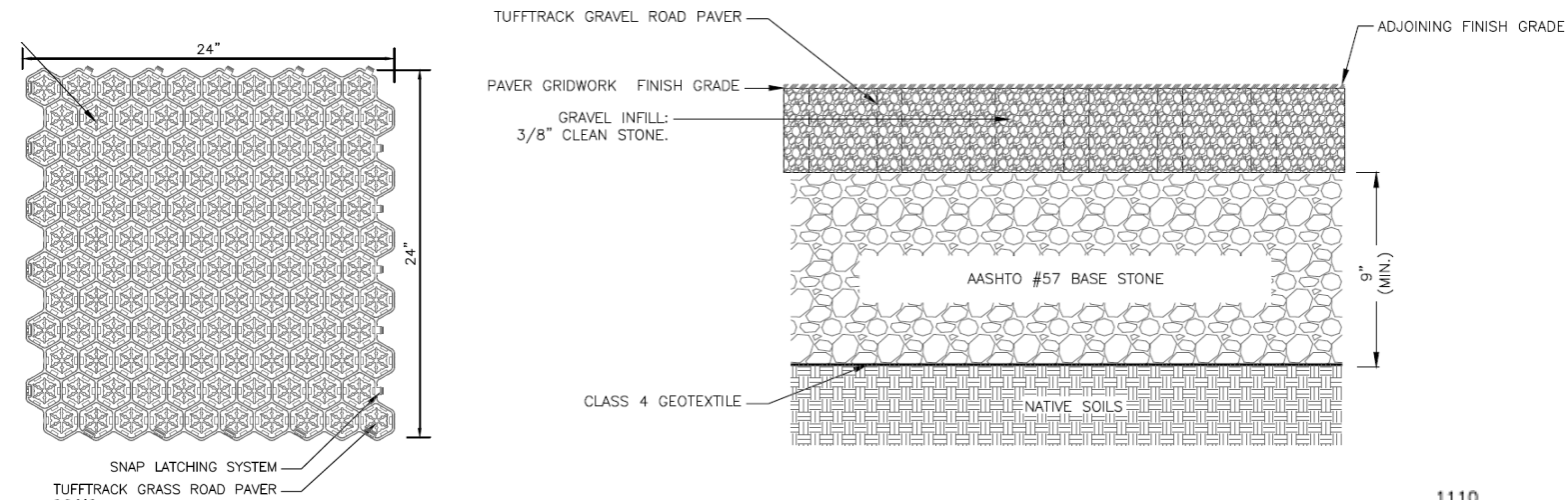
FACW WETLAND MEADOW MIX (ERNMX-122)*		
Plant Species		Seed Mix Composition
Scientific Name	Common Name	
<i>Carex vulpinoidea, PA Ecotype</i>	Fox Sedge	29.8%
<i>Elymus virginicus, Madison-NY Ecotype</i>	Virginia Wildrye	16.0%
<i>Carex lupulina, PA Ecotype</i>	Hop Sedge	11.0%
<i>Carex scoparia, PA Ecotype</i>	Blunt Broom Sedge	11.0%
<i>Carex lurida, PA Ecotype</i>	Lurid Sedge	8.5%
<i>Cinna arundinacea, PA Ecotype</i>	Wood Reedgrass	5.2%
<i>Verbena hastata, PA Ecotype</i>	Blue Vervain	4.0%
<i>Juncus effusus</i>	Soft Rush	3.0%
<i>Asclepias incarnata, PA Ecotype</i>	Swamp Milkweed	2.0%
<i>Heliopsis helianthoides, PA Ecotype</i>	Oxeye Sunflower	2.0%
<i>Bidens cernua, PA Ecotype</i>	Nodding Bur Marigold	1.0%
<i>Onoclea sensibilis</i>	Sensitive Fern	1.0%
<i>Eupatorium perfoliatum, PA Ecotype</i>	Boneset	0.8%
<i>Helenium autumnale, PA Ecotype</i>	Common Sneezeweed	0.8%
<i>Iris versicolor</i>	Blueflag	0.8%
<i>Zizia aurea</i>	Golden Alexanders	0.7%
<i>Aster novae-angliae, PA Ecotype</i>	New England Aster	0.3%
<i>Aster prenanthoides, PA Ecotype</i>	Zigzag Aster	0.3%
<i>Eupatorium fistulosum, PA Ecotype</i>	Joe Pye Weed	0.3%
<i>Lobelia siphilitica, PA Ecotype</i>	Great Blue Lobelia	0.3%
<i>Scirpus cyperinus, PA Ecotype</i>	Woolgrass	0.3%
<i>Aster puniceus, PA Ecotype</i>	Purplestem Aster	0.2%
<i>Aster umbellatus, PA Ecotype</i>	Flat Topped White Aster	0.2%
<i>Penthorum sedoides, PA Ecotype</i>	Ditch Stonecrop	0.2%
<i>Solidago rugosa, PA Ecotype</i>	Wrinkleleaf Goldenrod	0.2%
<i>Mimulus ringens, PA Ecotype</i>	Square Stemmed Monkeyflower	0.1%

*application rate 20 lb./acre

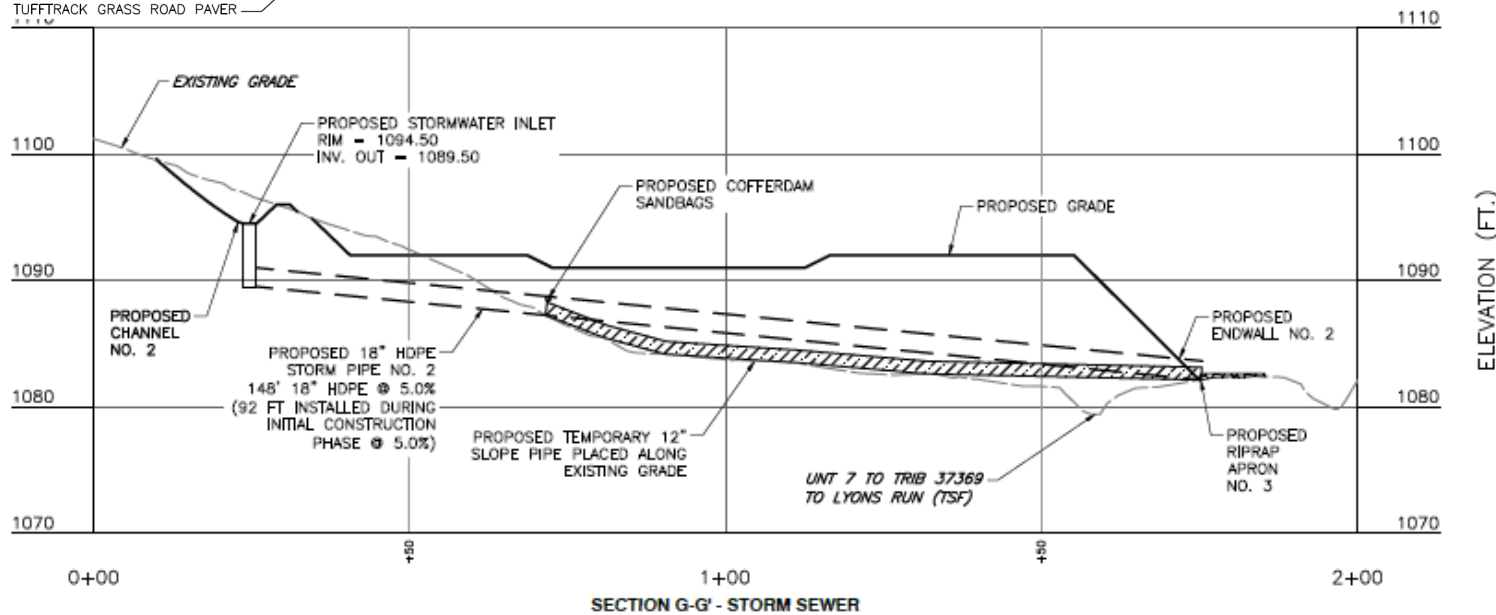
WETLAND PLANTING SPECIFICATIONS						
Plant Community	Plant Species		Type of Plant Material	Unit	Planting Density (units/acre)	Stem Spacing (feet)
	Scientific Name	Common Name				
Shrub and Sedge Wetland Establishment	<i>Salix interior</i>	Sandbar Willow	Live Stake	plant	545	4 X 4
	<i>Salix sericea</i>	Silky Willow	Live Stake	plant	545	
	<i>Comus amomum</i>	Silky Dogwood	Live Stake	plant	545	
	<i>Cephalanthus occidentalis</i>	Button Bush	Live Stake	plant	545	
	<i>Sambucus</i>	Elderberry	Live Stake	plant	545	
	FACW Wetland Meadow Mix (ERNMX-122)		seed	pound	20	



Design – Stormwater



- Tuff-Track infiltration pavers
 - Reduce stormwater runoff to maintain permit compliance
- Stormwater collection and diversion through earthwork

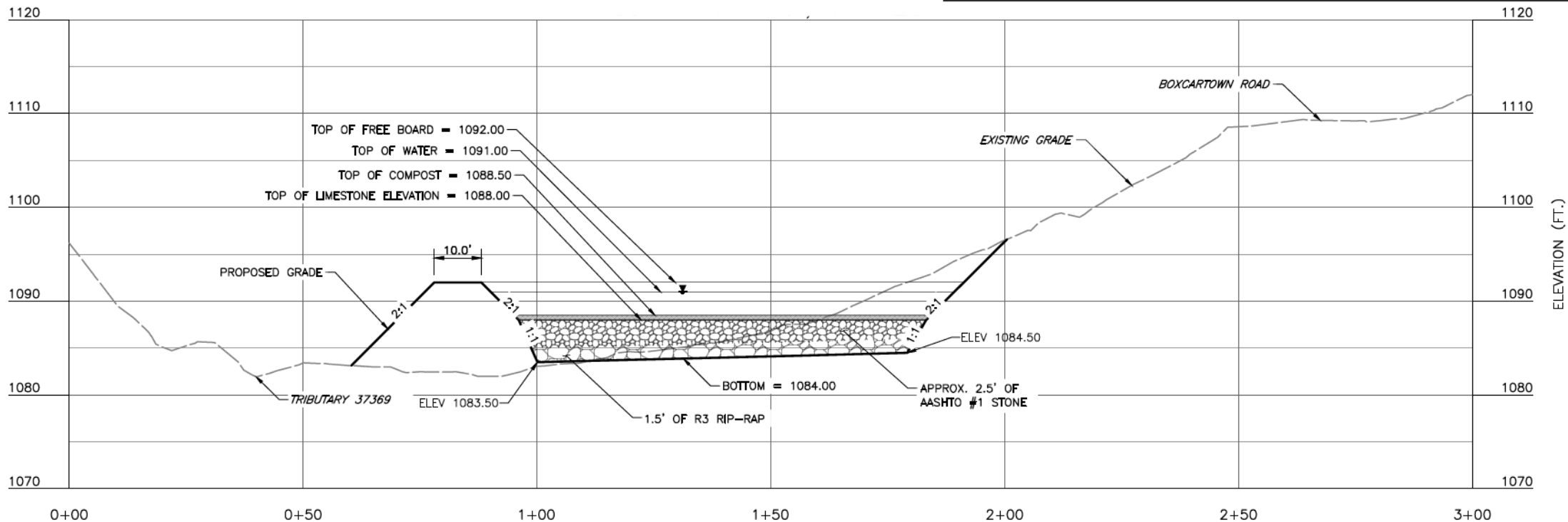


Approach - Maintenance

- Large permanent staging area
- 10-foot earthen berm width for construction access
- 4:1 slopes on transitions
- Sloped FLB bottoms
- Change in rock type around flush plumbing

HIGH RISK

Risk Analysis Matrix				
Summation of Fe and Al Concentration	Design Flow Rate for each treatment cell			
	< 25 gpm	> 25 < 50 gpm	> 50 < 100 gpm	> 100 < 200 gpm
< 5 mg/L	Low	Low	Low	Low
≥ 5 but < 15 mg/L	Low	Medium	Medium	Medium
≥ 15 < 25 mg/L	Low	Medium	Medium	Medium
≥ 25 < 50 mg/L	Medium	Medium	Medium	High
≥ 50 mg/L	High*	High*	High	High
Summation of Fe and Al Concentration	Design Flow Rate for each treatment cell			
	> 200 < 400 gpm	> 400 < 800 gpm	> 800 < 1600 gpm	> 1600 gpm
< 5 mg/L	Medium	Medium	Medium	High
≥ 5 but < 15 mg/L	Medium	High	High	High
≥ 15 < 25 mg/L	High	High	High	High
≥ 25 < 50 mg/L	High	High	High	High
≥ 50 mg/L	High	High	High	High

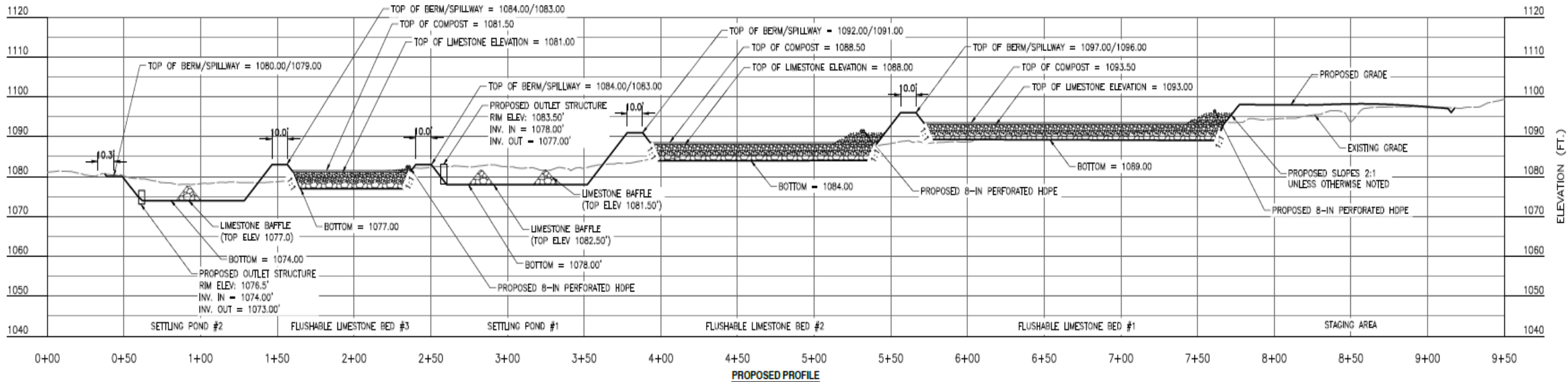
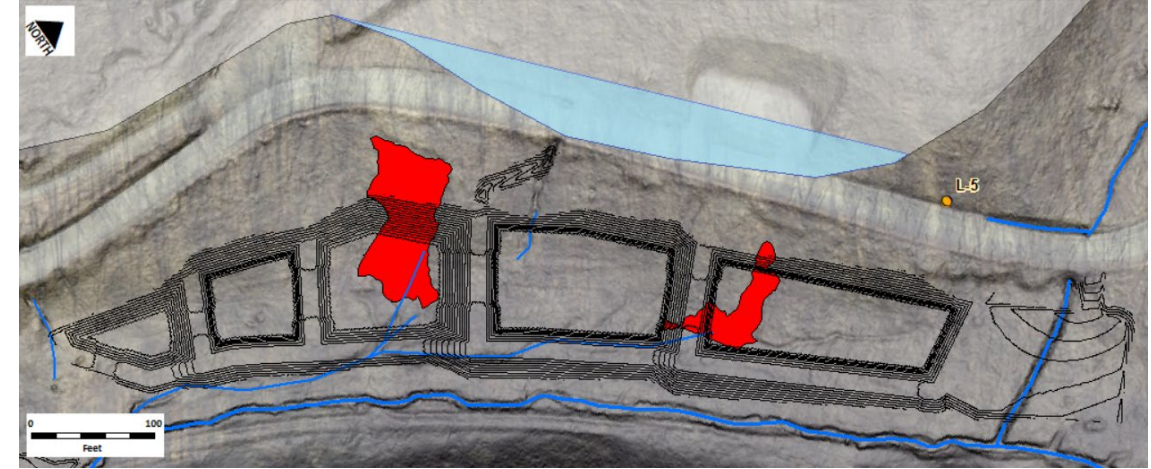


SECTION B-B' - FLUSHABLE LIMESTONE BED #2



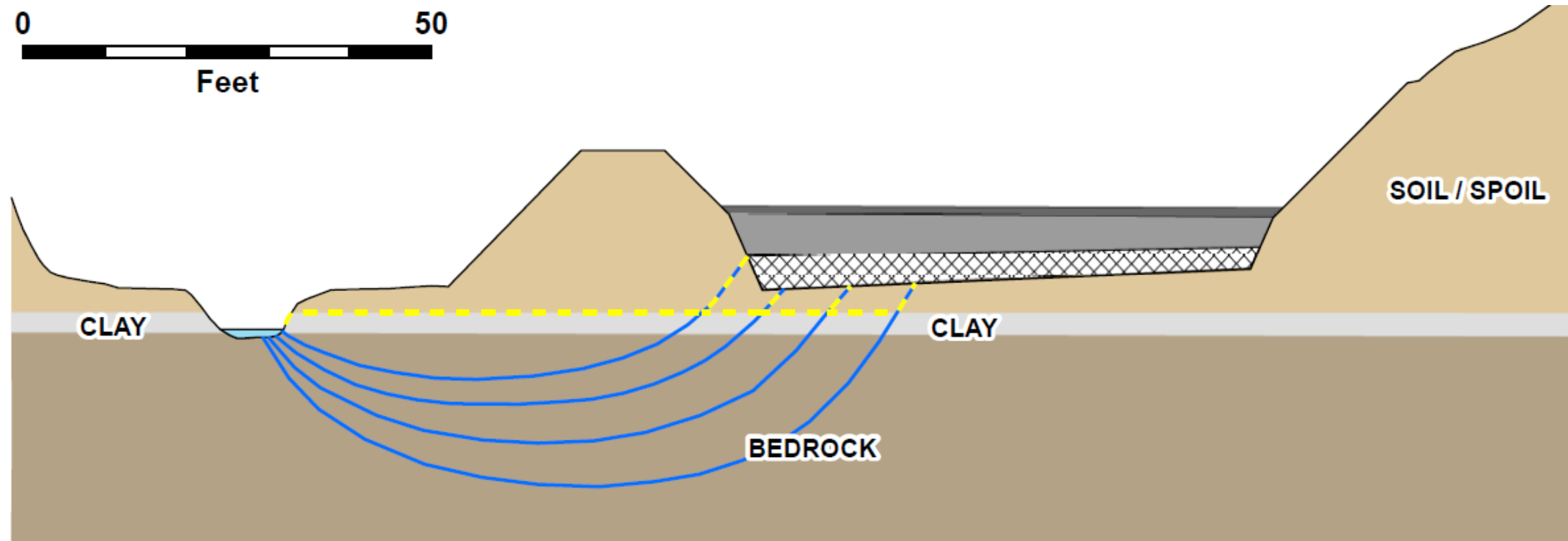
Approach - Hydrogeology

- Seasonal water quality monitoring
- Unlined flushable limestone beds and wetlands
 - Allows for collection of unconsolidated seeps collection

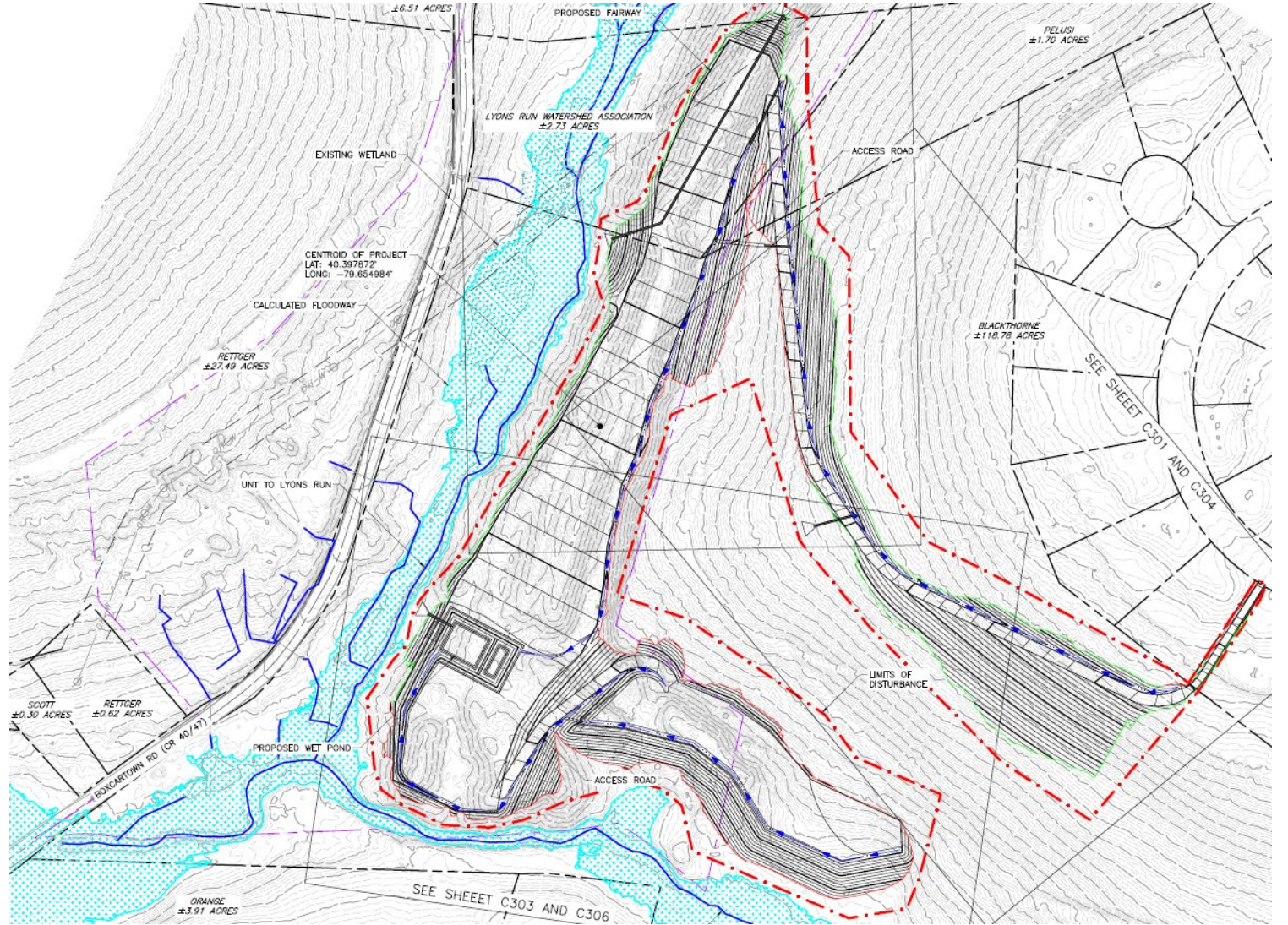
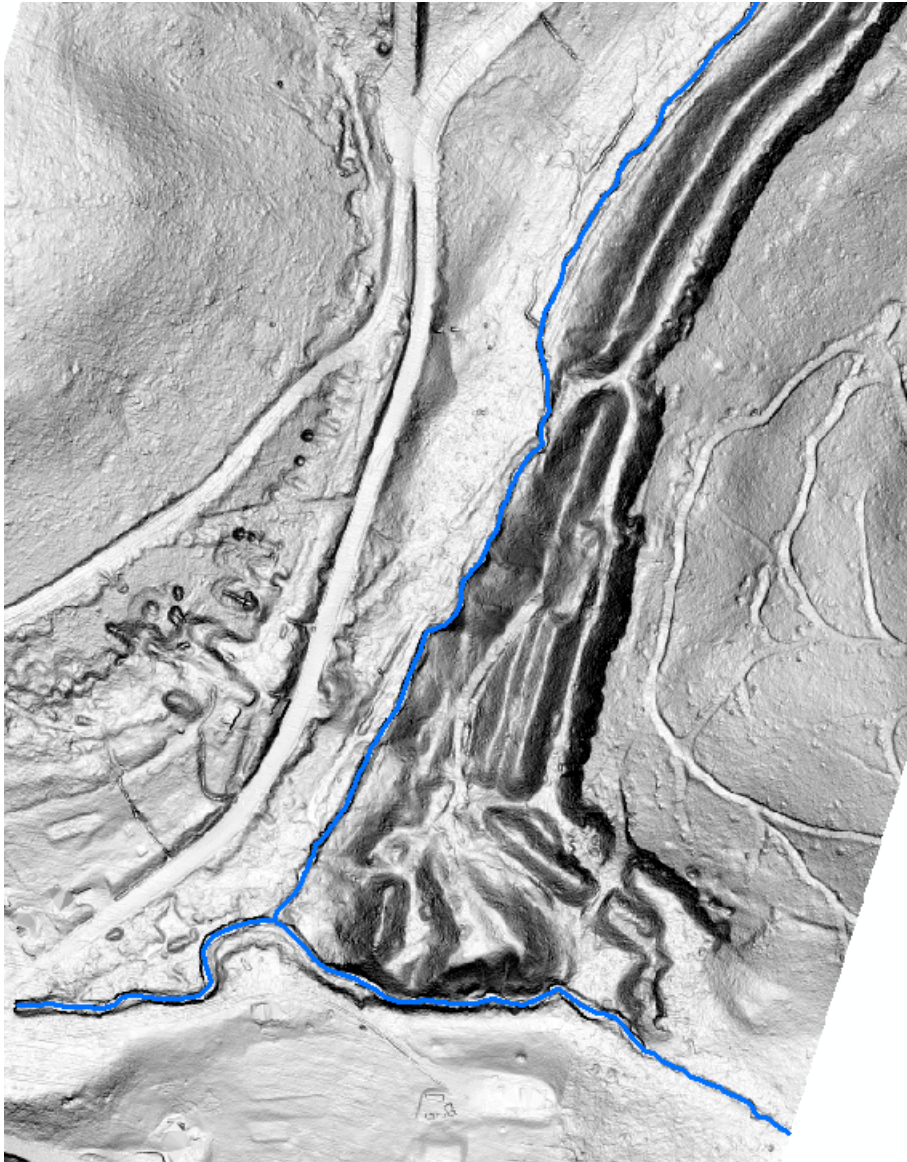


Approach – Hydrogeology

- Unlined flushable limestone beds and wetlands
 - Leaches alkaline water into shallow groundwater
- Seasonally controlled releases from treatment
 - Full capacity ~1.5 million gallons
 - Allows for 11.5 gpm treated water discharge for three months



Approach – Spoil Piles



Outcomes and Lessons

OUTCOMES

- Improved water quality
- Improved IBI scores
- Functional uplift of Lyons Run mainstem
- Functional uplift of Tributary 37369
 - Alkaline leachate
 - Restored stormwater flow from upper watershed
- Improved aesthetics
- Signage and recreational greenway

LESSONS

- No cookie cutter sites
- Intimate and thorough site knowledge
- Seasonal observations
- Innovative approach





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Thank You

Lyons Run Watershed Association

April 25, 2024