AOP Culvert Design-Construction

Day 3

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Water Resources Engineer

Road-Stream Crossing Workshop
UW-Platteville
Platteville, WI
April 12-14, 2016

Topics

- Background - WisDOT AOP Study
- Example 1 – STH 80/Little Platte River
  - Design Development
  - Lessons Learned
- Example 2 - STH 67/Unnamed Long Lake Trib
  - Design Development
  - Construction Issues

WisDOT AOP Study

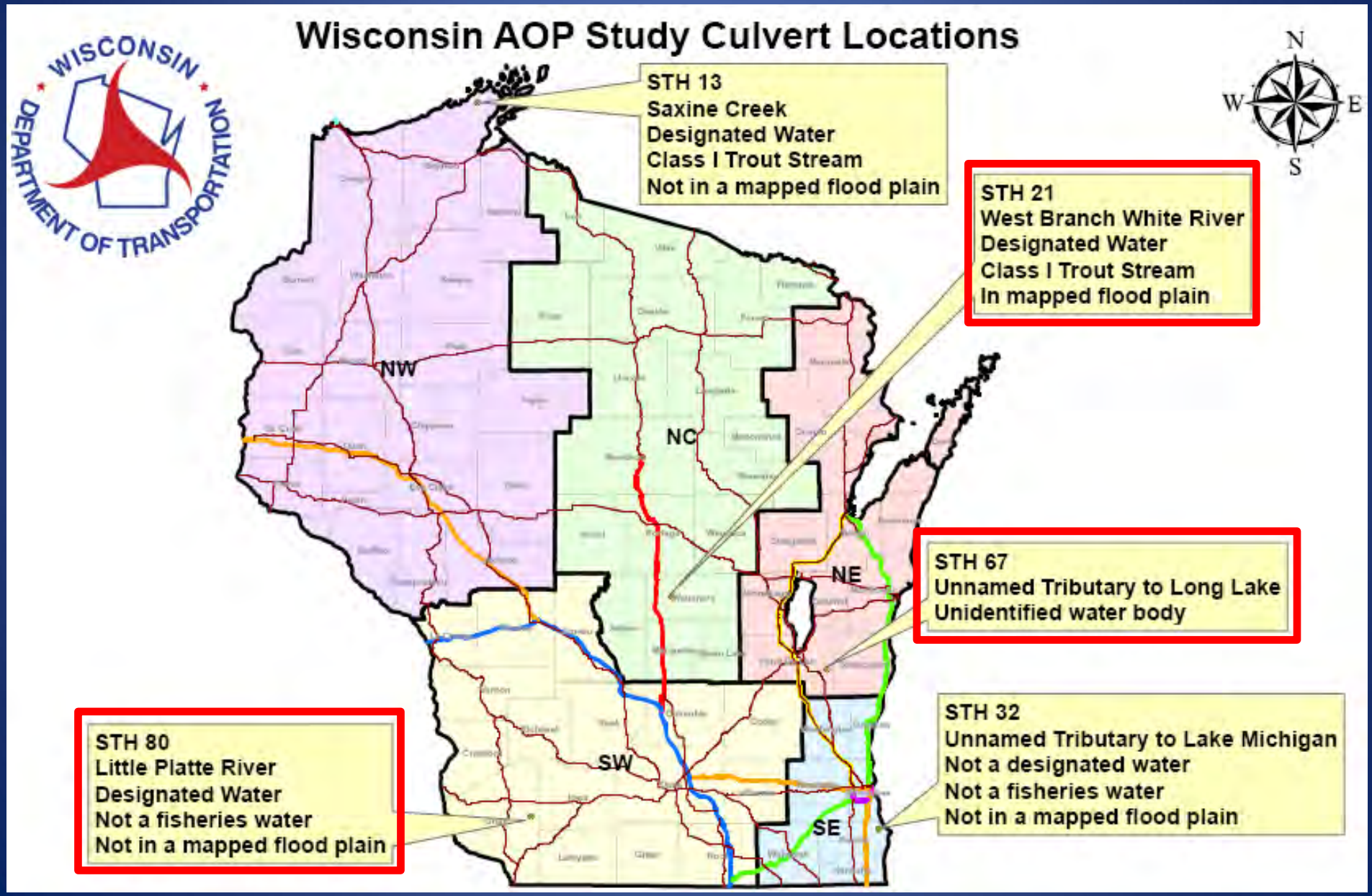
AOP Issues are Relatively New to WisDOT

- WisDOT has no procedure for AOP design
- AOP Considerations are Occurring More Frequently
- Study Purpose – Evaluate HEC-26 (*Culvert Design for Aquatic Organism Passage)* as an appropriate tool for AOP Design

WisDOT AOP Study

- Study results used to develop policy to define where AOP should be applied
- AOP design procedure will be developed based on results of the study
- Study site areas include . . . . .

WisDOT AOP Study



WisDOT AOP Study

Study Outline

- Introduction
- Site Locations
- Field Data Collection
  - Survey – Cross Sections (At least 3 US and DS)
  - Survey – Stream Thalweg (> 200 ft US and DS) and Existing Culvert Data
  - Particle Size Distribution
  - Stream Crossing Field Data
  - Site Photos
- Hydrology Analysis
  - Drainage Basin Mapping
  - USGS Regression and HydroCAD
  - Flow Selection
- HEC-RAS/HY-8 Modeling
- Stream Profile Analysis
- Particle Size Distribution Determination
- HEC-26 Analysis

WisDOT AOP Study

Study Results

Culvert Sized for AOP at each Site

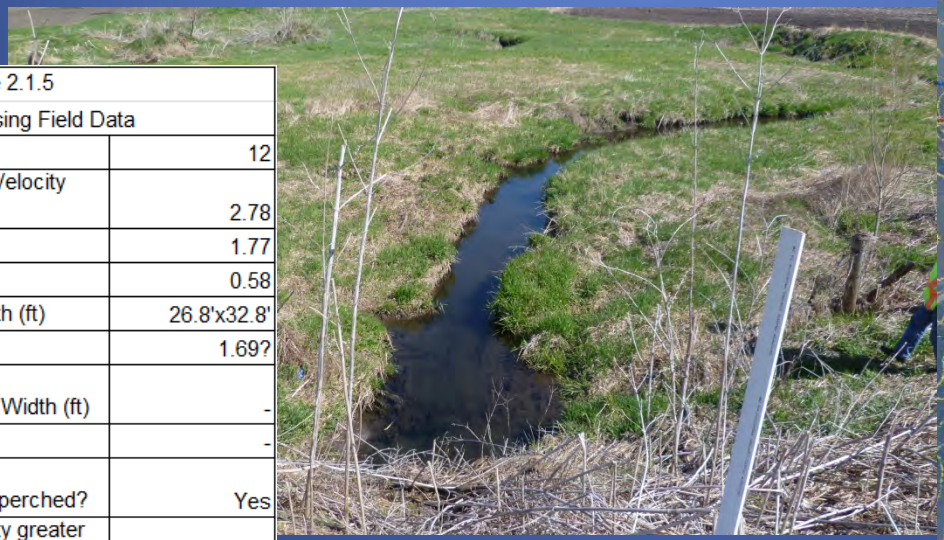
Table 2.2.5 Culvert Characteristic Comparisons			
Characteristic	**Existing Culvert**	**Proposed Standard Design Culvert**	**Proposed AOP Culvert**
Shape	Circular	Circular	Circular
Pipe Type/Material	Corrugated Metal Pipe	Corrugated Metal Pipe	Corrugated Metal Pipe
End Treatment	Pipe Projecting From Fill	Headwall	Headwall
Pipe Length	107.4	107.4	107.4
Upstream Invert Elevation	610.26	607.70	604.10
Downstream Invert Elevation	608.22	606.80	603.20
Diameter (ft)	8.0	8.0	12.0
Span (ft)	-	-	-
Height (ft)	-	-	-
Pipe slope (ft/ft)	0.019	0.0084	0.0083
Embedment Depth (ft)	0.0	0.0	3.6
Manning's n for Top	0.03	0.024	0.024
Manning's n for Bottom	n/a	n/a	0.040

- **Evaluation of Suitability of HEC-26 Process for WisDOT Highways**
- **Policy Recommendations to WisDOT for Addressing AOP Issues**

STH 80/Little Platte River

- Design Development
- Lessons Learned

STH 80 – Little Platte River in Grant County



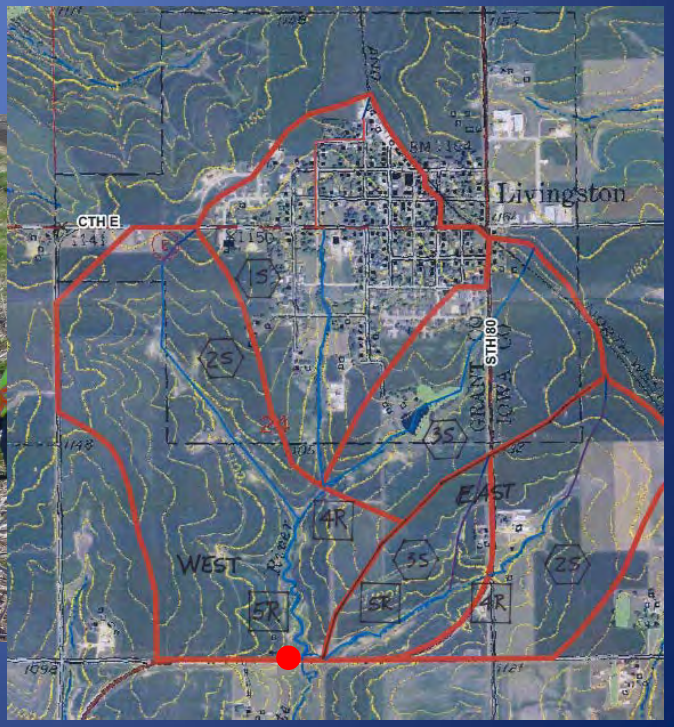
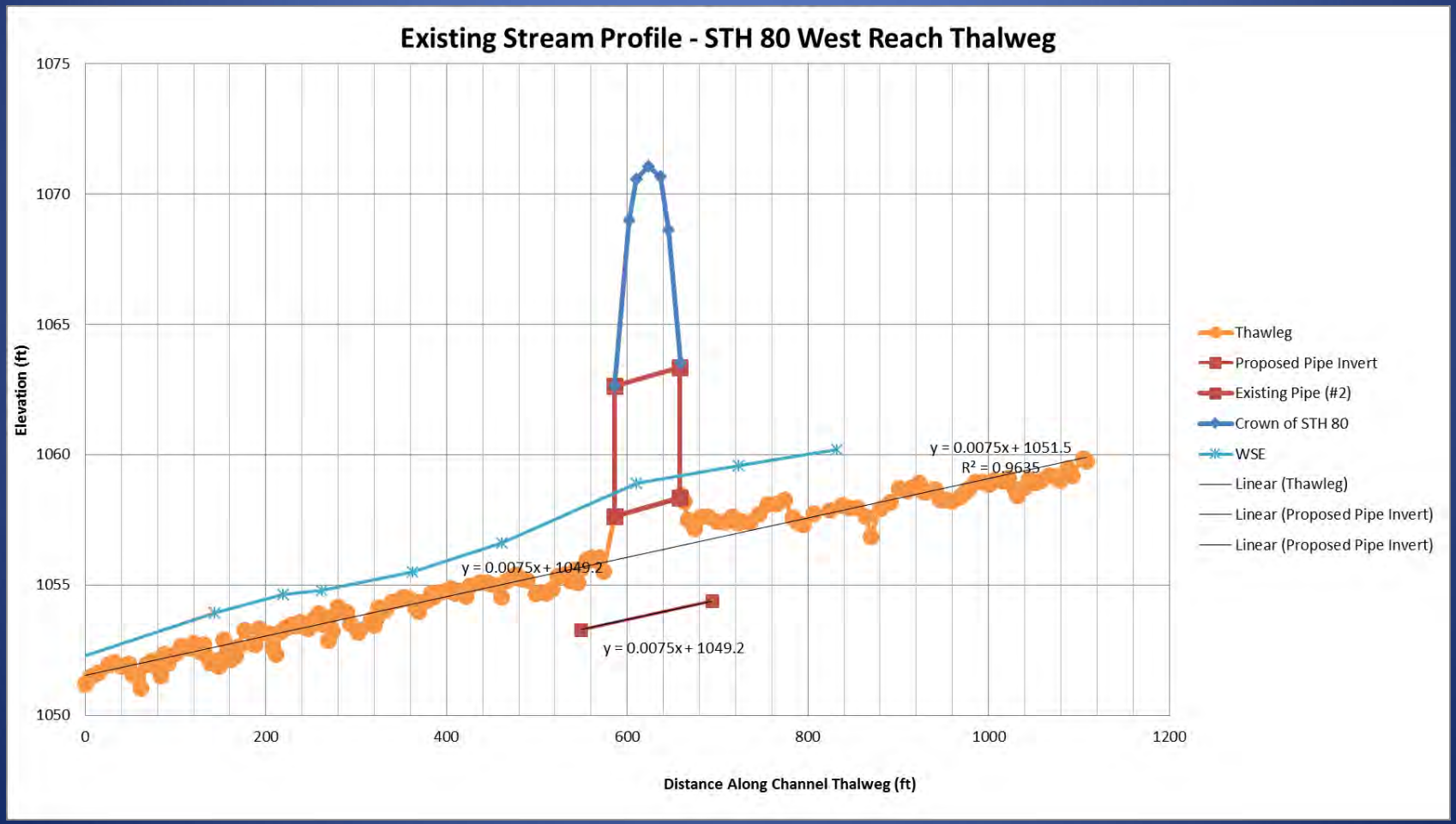


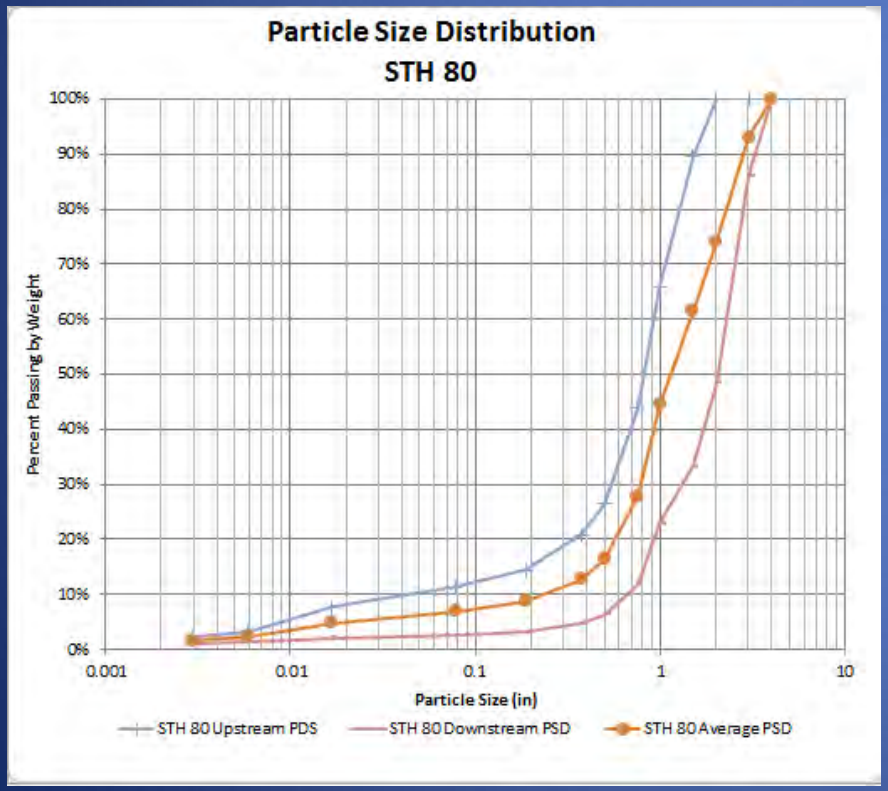
Table 2.1.5 Stream Crossing Field Data	
Bank Flow Width (ft)	12
Measured Structure Water Velocity (ft/sec)	2.78
Stream Velocity (ft/sec)	1.77
Stream Depth (ft)	0.58
Scour Pool Length and Width (ft)	26.8'x32.8'
Scour Pool Depth (ft)	1.69?
Upstream Pond Length and Width (ft)	-
Upstream Pond Depth (ft)	-
Is the outlet of the structure perched?	Yes
Is the structure water velocity greater than 3 feet/second during baseflow?	No
Is the depth ratio less than 0.1?	?

Stream Profile Data Collection



Design Development

Stream Bed Samples
Upstream and Downstream



Material Description: Poorly graded sand with silt
Date: 8/26/11
USCS Classification: SP-SM

Sieve Test Data

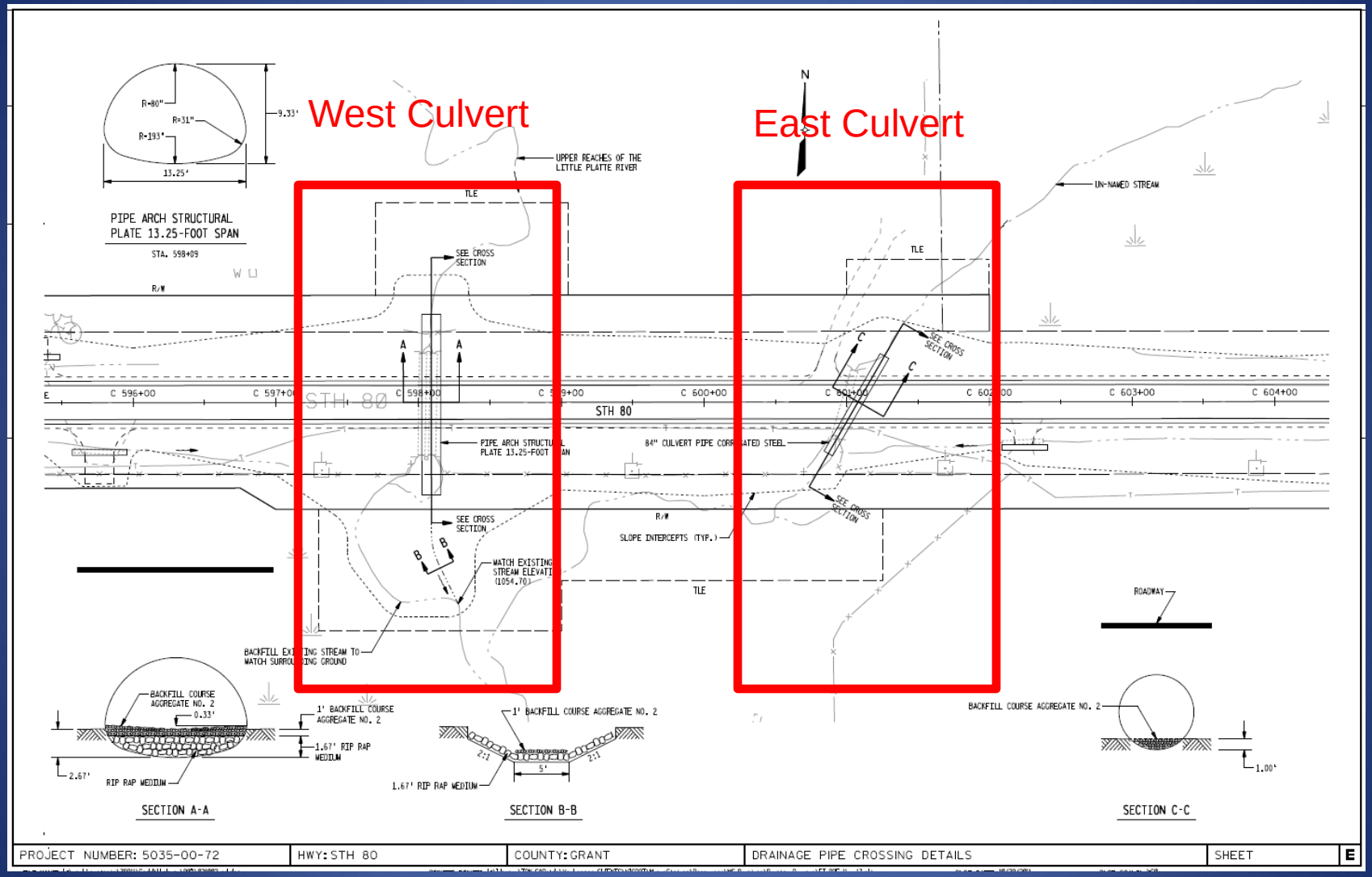
Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
12353.70	0.00	0.00	5	0.00	100.0
			.375	245.80	98.0
			#4	1331.60	89.2
			#8	2655.10	78.5
			#10	2846.30	77.0
			#16	3669.90	70.3
			#30	5052.60	59.1
			#40	6553.50	47.0
			#50	9347.80	24.3
			#100	11306.60	6.9
			#200	11620.40	5.9

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	10.8	10.8	12.2	30.0	41.1	83.3			5.9

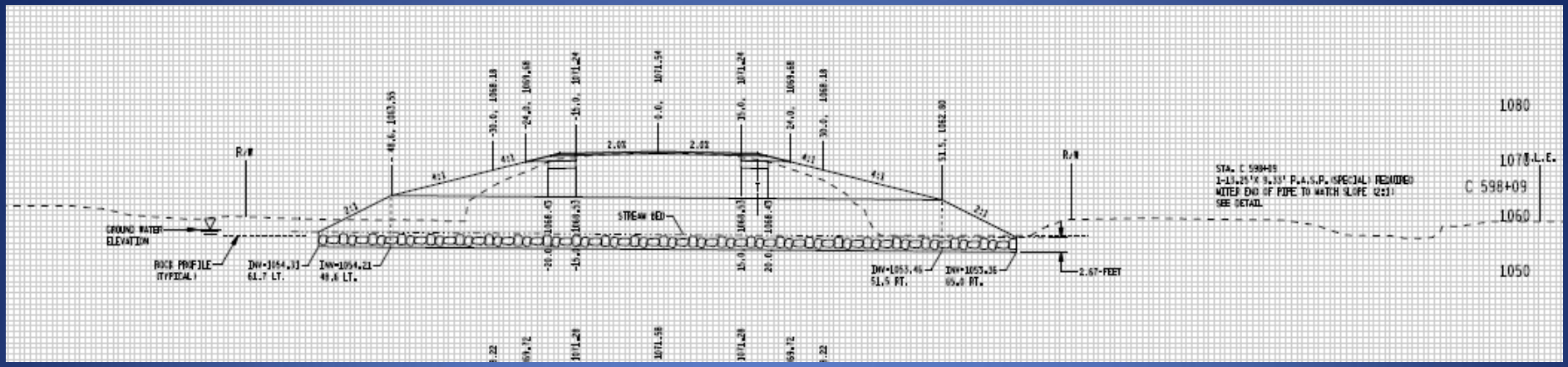
D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.2016	0.2447	0.2765	0.3281	0.4516	0.6246	2.6785	3.6994	4.9855	7.1070

Fineness Modulus	C_u	C_c
2.74	3.10	0.85

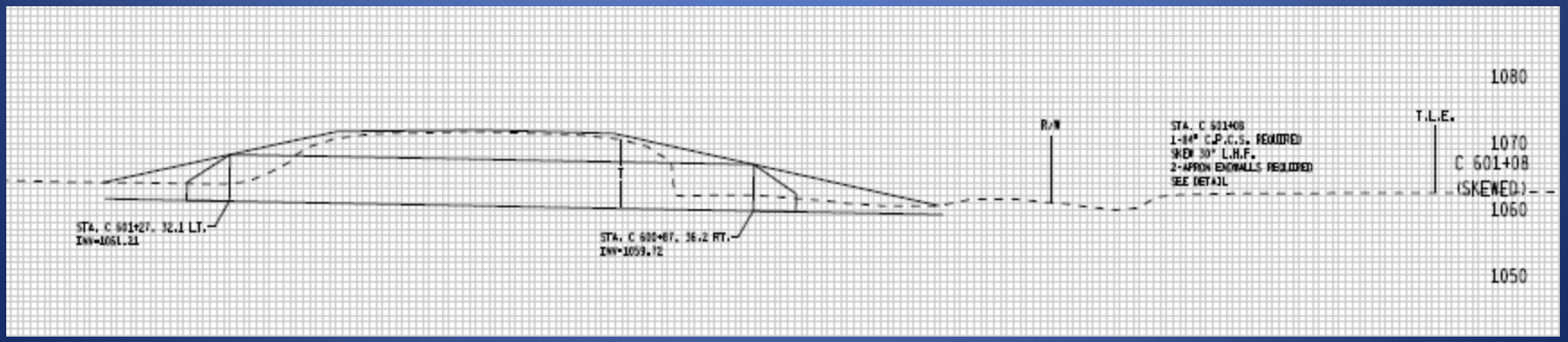


PROJECT NUMBER: 5035-00-72	HWY: STH 80	COUNTY: GRANT	DRAINAGE PIPE CROSSING DETAILS	SHEET	E

West Culvert Profile



East Culvert Profile




CAT

Potential Problems

Downstream Ponding

- Design Wider Downstream Channel or Investigate Further Downstream
- Add Rock Bands for Stream Stability – More Stream Work

Construction Oversight by Designer

Don’t Rely on Sediment Transport – Incorporate Fines into Streambed

Low Flows are Through the Gravel Bed

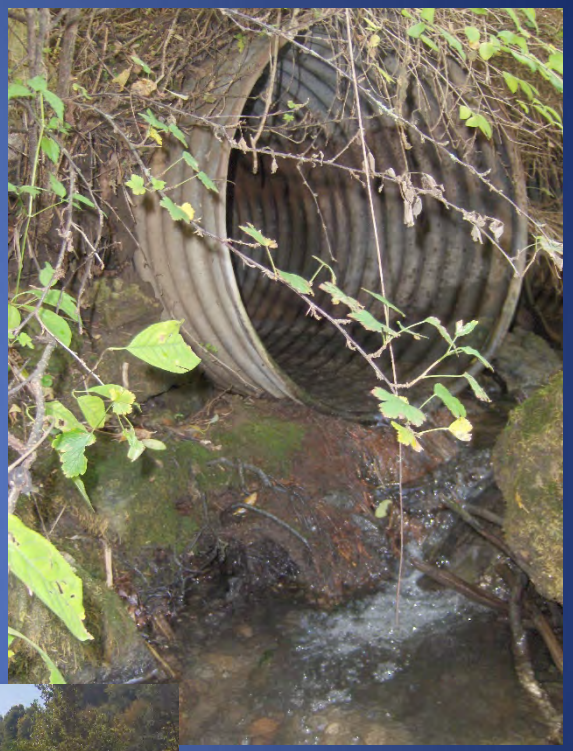
March 2016

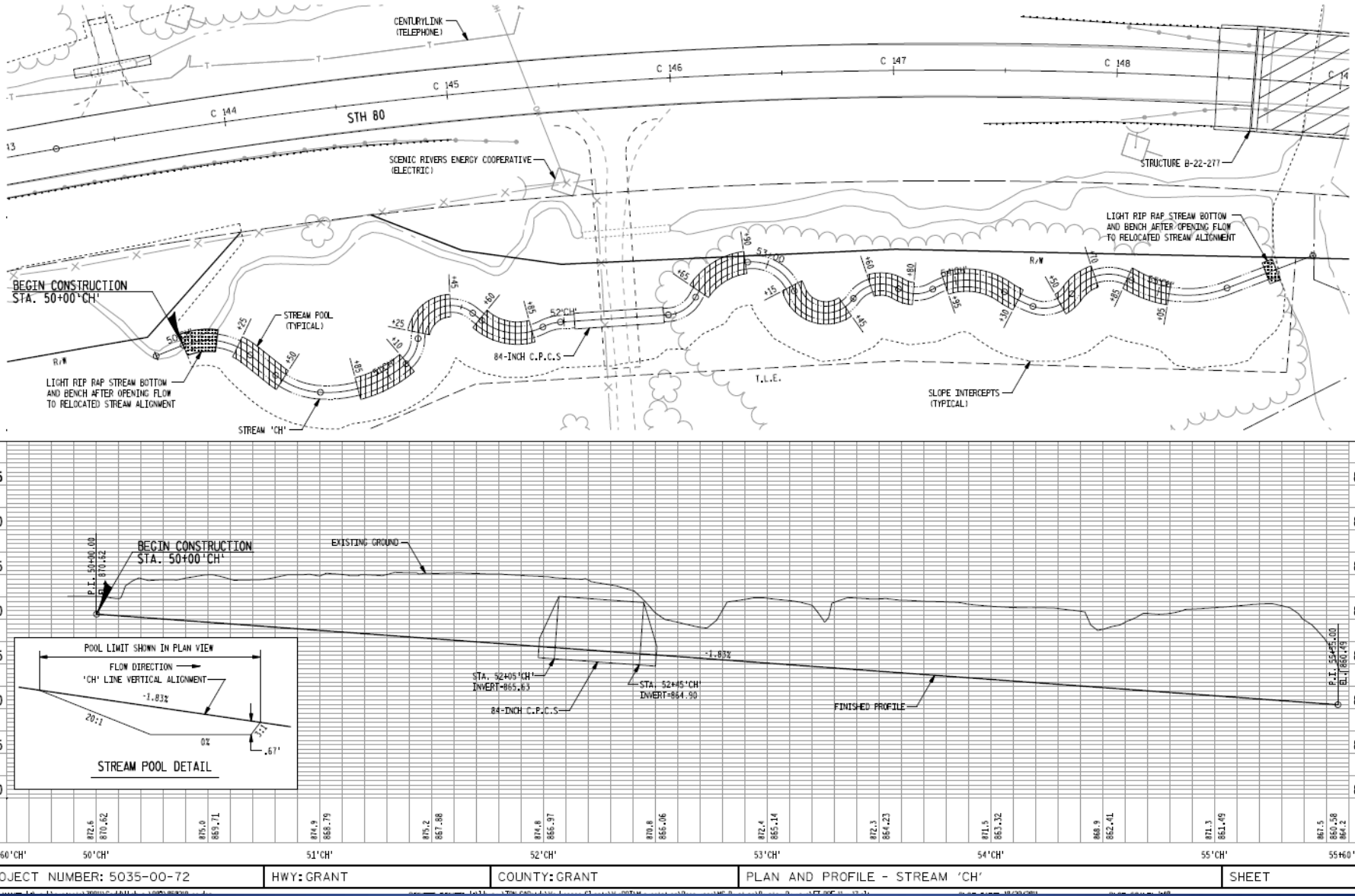
West

East

STH 80/Mound Creek Trib

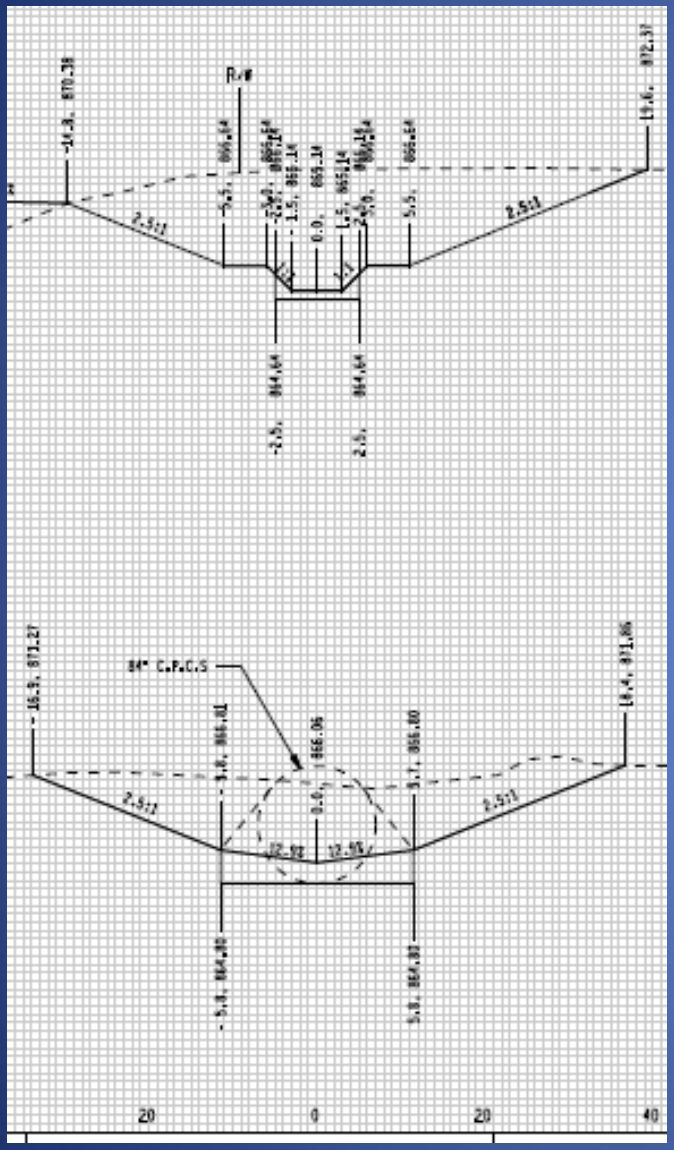
- Design Development
- Lessons Learned





PROJECT NUMBER: 5035-00-72	HWY: GRANT	COUNTY: GRANT	PLAN AND PROFILE - STREAM 'CH'	SHEET	E

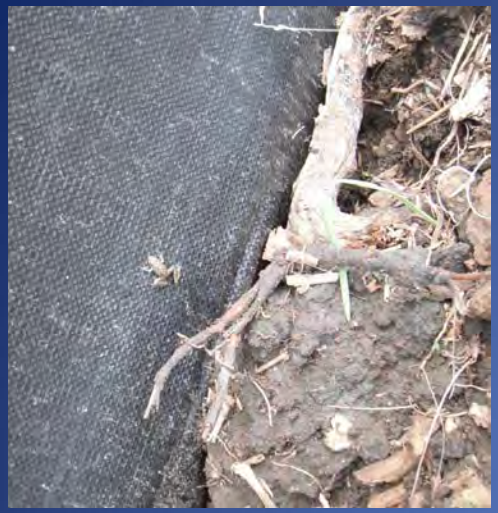
Potential Problems

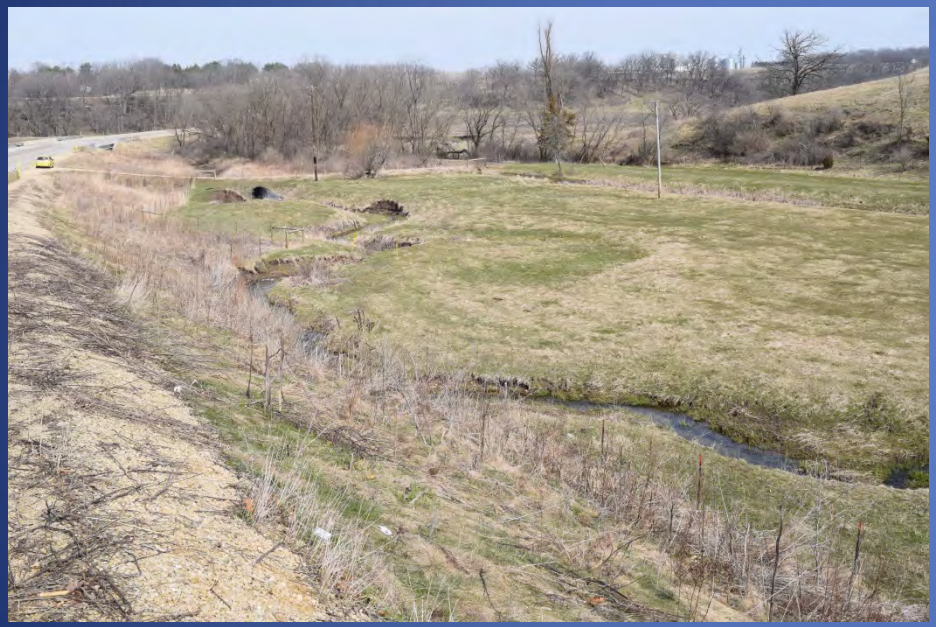


One Embankment Appears to be Closer to the Stream than it should be

Rock Armor at Channel Bends?

Construction Oversight by Designer





STH 67/Unnamed Long Lake Trib

- Design Development
- Construction Issues

STH 67 – Unnamed Trib to Long Lake in Fond du Lac County

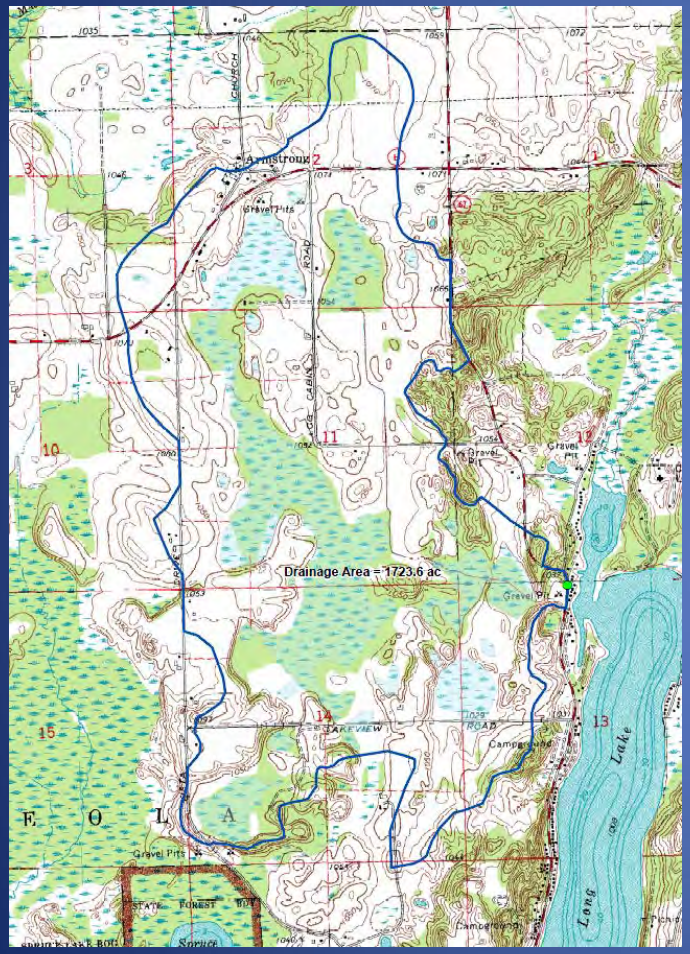
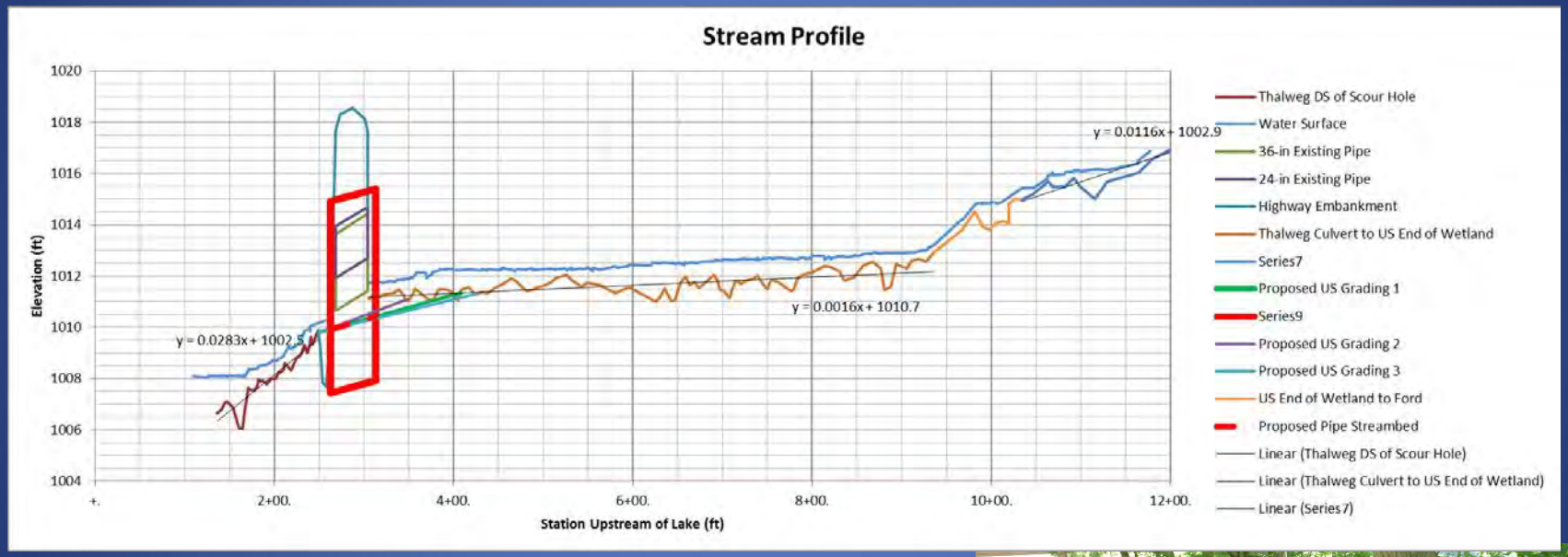


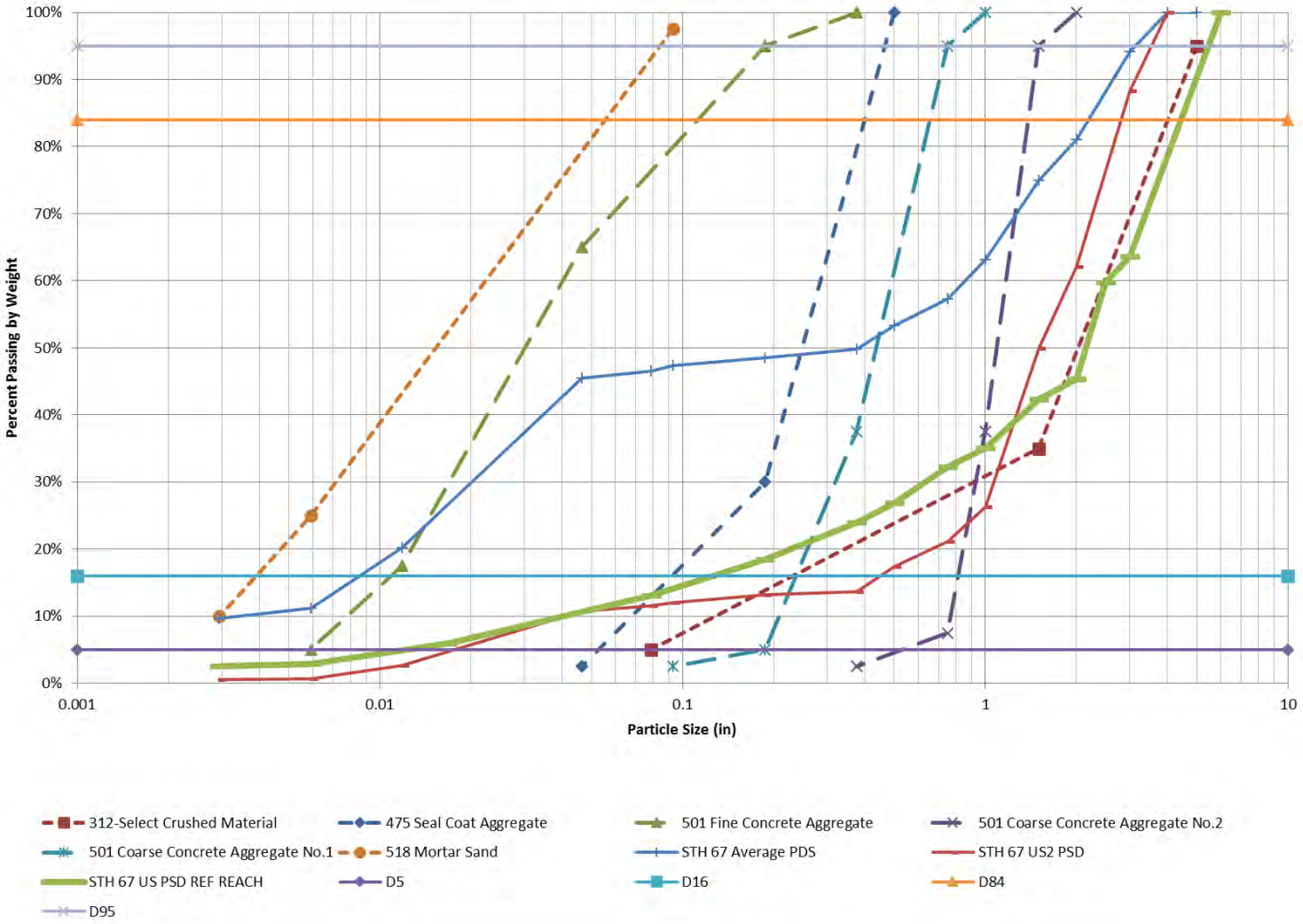
Table 2.1.5 Stream Crossing Field Data	
Bank Flow Width (ft)	11.16
Measured Structure Water Velocity (ft/sec)	1.1
Stream Velocity (ft/sec)	1.44
Stream Depth (ft)	0.1
Scour Pool Length and Width (ft)	13.4'x13.6'
Scour Pool Depth (ft)	1.0'
Upstream Pond Length and Width (ft)	43'x3.2'
Upstream Pond Depth (ft)	look at survey datat
Is the outlet of the structure perched?	Yes
Is the structure water velocity greater than 3 feet/second during baseflow?	No
Is the depth ratio less than 0.1?	No

Field Data Collection

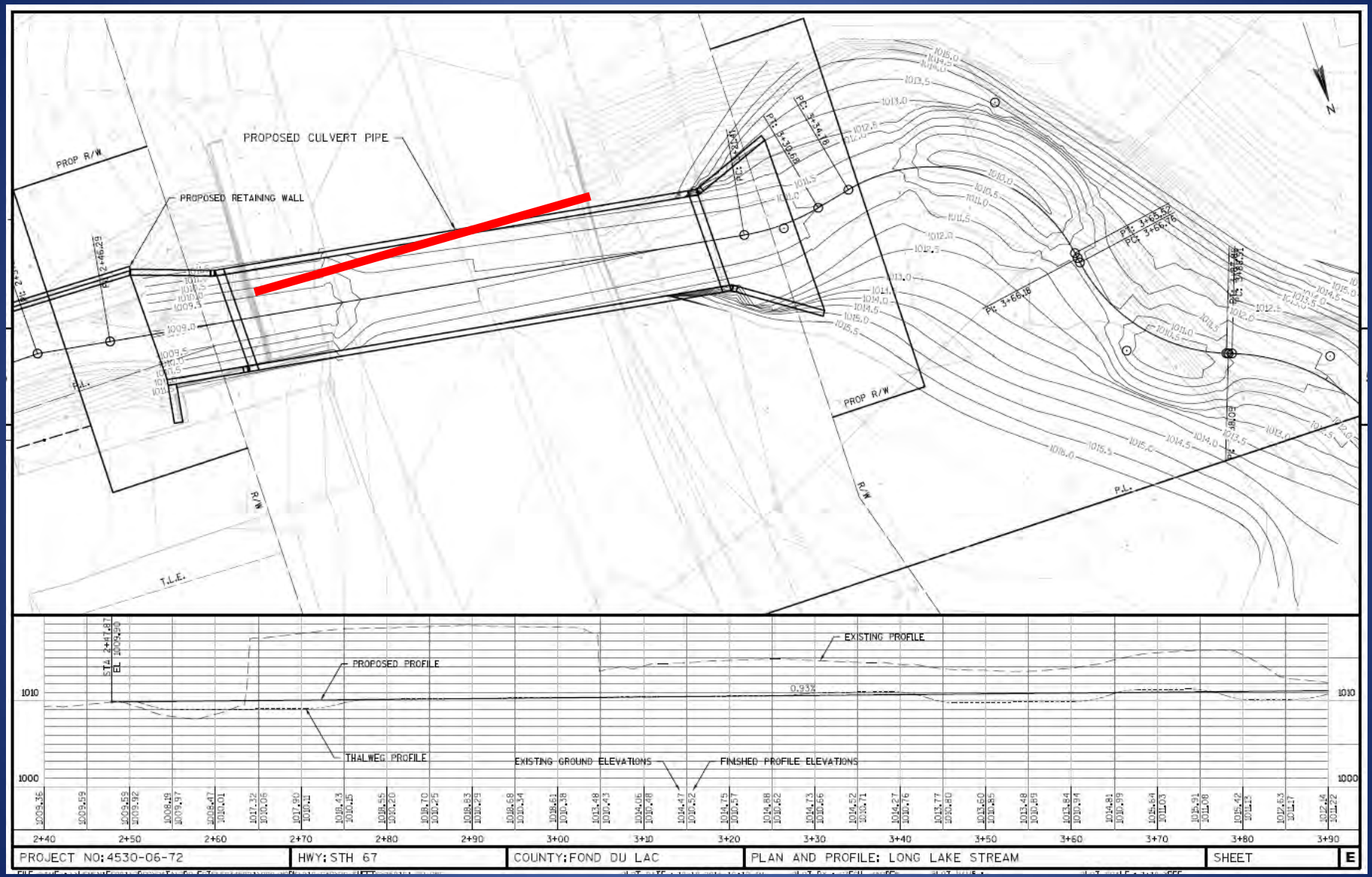
Survey – Stream Thalweg (> 200 ft US and DS) and Existing Culvert Data



Particle Size Distribution
Section 312 - Select Crush Material
Section 475 - Seal Coat Aggregate
Section 501 - Concrete Aggregate
Section 518 - Mortar Sand



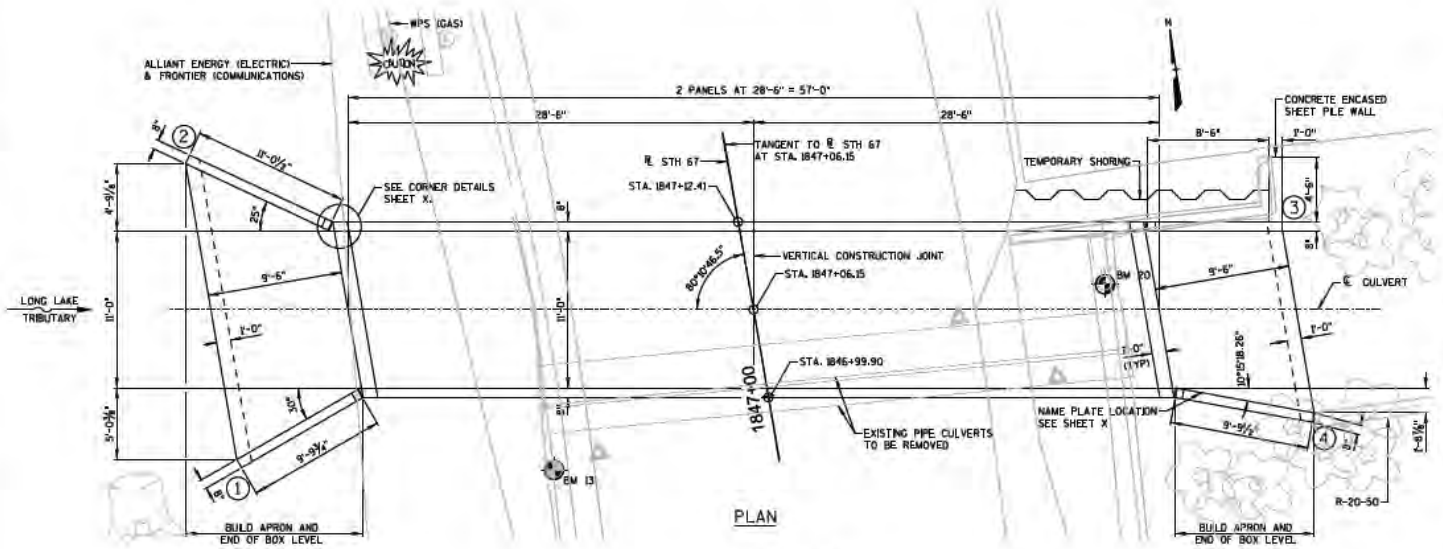
Bank Erosion

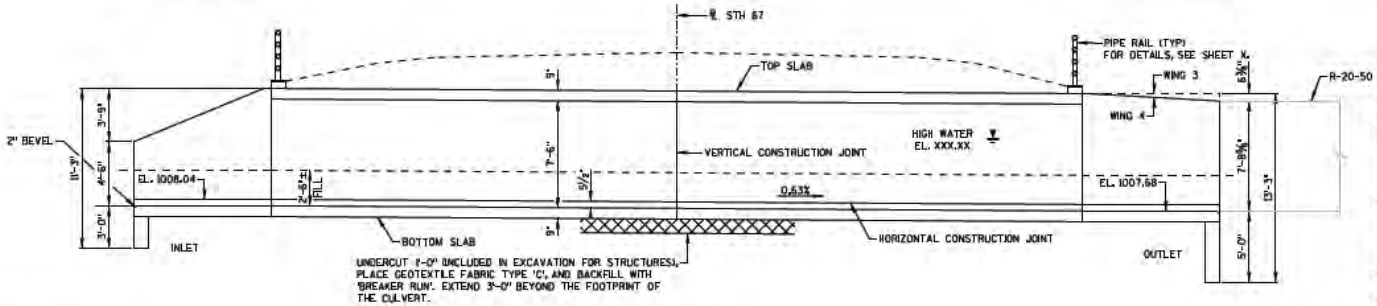

PROPOSED CULVERT PIPE
PROPOSED RETAINING WALL
PROP R/W
PROP R/W
R/W
R/W
P.L.
T.L.E.
N
PC: 3+34.18
PT: 3+38.68
PC: 3+65.52
PT: 3+66.18
PC: 3+66.18
PT: 3+68.09
STA 2+47.87
EL 1009.90
PROPOSED PROFILE
EXISTING PROFILE
THALWEG PROFILE
EXISTING GROUND ELEVATIONS
FINISHED PROFILE ELEVATIONS
0.93%
1010
1000
2+40
2+50
2+60
2+70
2+80
2+90
3+00
3+10
3+20
3+30
3+40
3+50
3+60
3+70
3+80
3+90
PROJECT NO: 4530-06-72
HWY: STH 67
COUNTY: FOND DU LAC
PLAN AND PROFILE: LONG LAKE STREAM
SHEET
E

LEGEND

(X) INDICATES WING NUMBER

DRAFT PRELIMINARY PLAN





ELEVATION

BENCH MARK TABLE

NO.	STATION	DESCRIPTION	ELEVATION
13	1846+97.38, 15.70' LT.	FD CHISELED 'X'	1017.62
20	1847+03.83, 24.65' RT.	FD CHISELED 'X'	1017.37

DESIGN DATA

LIVE LOAD
DESIGN LOADING: HL-93
INVENTORY RATING FACTOR: RF = 1.05
OPERATING RATING FACTOR: RF = 1.35
VEHICLE (WIS-SPV): 255 KIPS

EARTH LOAD
DESIGN FOR 2.5' OF FILL

MATERIAL PROPERTIES
CONCRETE MASONRY ——— f'c= 3,500 P.S.I.

HIGH-STRENGTH BAR STEEL
REINFORCEMENT, GRADE 60 ——— fy = 60,000 P.S.I.

STEEL SHEET PILING
(ASTM A328) ——— fy = 39,000 P.S.I.
MIN REQ'D SECTION MODULUS = XX IN^3/FT.

TRAFFIC VOLUME

STH 67
A.D.T. (2014) = 500
A.D.T. (2036) = 610
DESIGN SPEED = 40 MPH

HYDRAULIC DATA

100 YEAR FREQUENCY
Q100 ——— XXX CFS
Q100 THROUGH BOX CULVERT ——— XXX CFS
VELOCITY THROUGH BOX CULVERT ——— XX FPS
HIGH WATER ELEVATION ——— XXX.XX
DRAINAGE AREA ——— X.X SQ. MI.
ROAD OVERTOPPING ——— N/A

2 YEAR FREQUENCY
Q2 ——— XXX CFS
HIGH WATER 2 ELEVATION ——— XXX.XX

LIST OF DRAWINGS

1. GENERAL PLAN
2. GENERAL NOTES AND QUANTITIES
3. SUBSURFACE EXPLORATION

STRUCTURES DESIGN CONTACTS

BRIDGE OFFICE:
BILL DREHER (608) 266-8459

CONSULTANT:
MICHELLE HOWE (608) 828-6145

STATE PROJECT NUMBER
4530-06-72

NO.	DATE	REVISION	BY

AECOM

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

ACCEPTED
CHIEF STRUCTURES DESIGN ENGINEER ——— DATE

STRUCTURE C-20-162

STH 67 OVER LONG LAKE TRIBUTARY

COUNTY: FOND DU LAC
TOWN/CITY/VILLAGE: OSCEOLA

DESIGN SPEC: AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

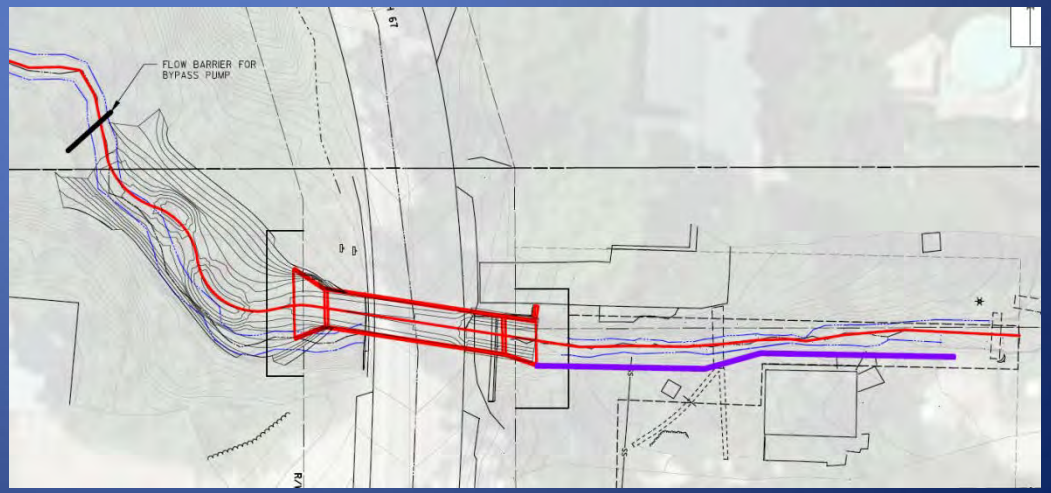
DESIGNED BY	DESIGN CKD.	DRAWN BY	PLANS CKD.
MAH		MES	MAH

GENERAL PLAN

SHEET 1 OF 3

Construction Issues

- Stream Bypass During Construction
- Placing Sediment in the Rock Stream Bed
- Rock Weir Placement
- Pool and Riffle Location
- Channel Cross Section
- Bank Seeding



Thank You for Your Time

Questions?