River and Trails Task Force Minutes
March 4, 2024
Department of Public Works Building, 2439 County Hwy A, Stoughton, WI

Present: Sandra Black, Bob Diebel, Joni Dean, Larry Liebmann, Ralph Erickson, Jim Killian, Kurt Byfield, Will Clifton, Phil Caravello, Tony King.
Absent: Jim Lewis, Jim Wilcox.

CALL TO ORDER

1. Call to Order: The meeting was called at 1731.
2. Approval of November 7, 2023: Approved by Sandra with a second by Phil.
3. Communications: New member Will Clifton was introduced along with the Parks and Recreation Superintendent Tony King. Each task force member introduced themselves along with the length of time on the task force. Tony mentioned that all members with the exception of the newest member, Will, are due to commit to another term on April 1, 2024.
4. Member Communications: It was mentioned that patch work on the trail has been completed. There is a need for tree clean-up near the storage garage area. Discussed the observed tree loss along the swale near West Street and Page Street. Tony will report the reason. More bike path striping is needed on Page Street.
5. Project Updates:
   a) Mandt Park Update: Tony shared Phase 1 pictures of Mandt Park. This Phase also includes river trail pavement at the same time, starting in the summer of 2024.
   b) River Park Update: Tony shared pictures of drawings by Strand with the phased project. The project is moving forward with everything but the dam modification which needs a permit. It is imperative to start spending the money designated for this project, which will start after the Stoughton Fair this summer. The project will start downstream and then move upstream.
   c) Yahara River Trail: Jim discussed the letter regarding the lower River Trail connections to Stoughton, during Phase 3, which was sent to Dane County last week and without a response yet as of this meeting.

OLD BUSINESS

1. No items.

NEW BUSINESS

1. The Eggleson Woods trail needs to be named. Tony shared the location of a playground to be built this summer in Eggleson's Woods.
2. Spring Trail Clean-Up will occur on Saturday April 20, 2024 from 9:00-11:00 am. Tony will share this date without other groups who have approached him about a spring clean-up.

ADJOURNMENT:

The meeting was adjourned with a motion by Joni and a second by Sandra at 1908.

Respectfully submitted,
Joni Dean

Fish Passage Modeling Technical Memo – Stoughton 4th Street Multi-Use Trail Underpass

PREPARED FOR: Wisconsin Department of Natural Resources
ON BEHALF OF: City of Stoughton
381 E. Main Street
Stoughton, WI 53589
RE: Chapter 30 Comments #5, Received 10/10/2023
PREPARED BY: Recreation Engineering & Planning Inc.
485 Arapahoe Ave, Boulder, CO 80302
info@boaterparks.com | (303) 545-5883
DATE: February 28, 2024

Recreation
Engineering & Planning

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Introduction

Recreation Engineering and Planning (REP) submitted 60% Design Plans for the 4th Street Multi-Use Trail Underpass Project (project), dated 9/8/23, to the Wisconsin Department of Natural Resources (DNR). Review comments were received 10/10/2023 for Chapters 30 & 31. Chapter 30 comment #5 is as follows:

> There is concern that the flows within the culverts may be modified to a point that would impact fish movement at certain flows. Please provide modeling of fish crossing capabilities (burst speeds and continuous swimming speeds) for various species, including, but not limited to, muskellunge, white sucker, northern hog sucker, channel catfish, largemouth bass, freshwater drum, shorthead redhorse, walleye, northern pike. The U.S. Forest Service has an Aquatic Organism Passage Program with modeling software that can help to determine whether certain fish species will be able to pass through culverts: Aquatic Organism Passage Program (usda.gov).

The purpose of this memorandum is to serve as the response to Chapter 30 comment #5. The inputs and results of the fish passage modeling and recommendations are included herein.

Figure 1. Existing box culverts under 4th St. Date: October 22, 2019. Approximate discharge at Forton St gauge: 920 cfs.

Background

The 4th Street Yahara River Crossing is in Stoughton, Wisconsin. The crossing lies immediately downstream of an existing weir, approximately 5.8 Miles downstream of Lake Kegonsa Lock & Dam, and approximately three miles upstream of Dunkirk Dam. Further upstream lies the urban area of Madison, Wisconsin. The crossing consists of three parallel 12'-4" by 8'-6" concrete box culverts.

The Yahara River supports warm water fish species, and serves as a spawning area for white bass, walleye, crappie, sucker, and northern pike. Pollution, channelization, groundwater diversion, and the hydrologic effects of existing dams negatively affect water quality in the project area. The DNR "Wisconsin Water Search" website lists the condition of fish and aquatic life as "poor" for the reach of the Yahara River between Rock River and Lake Kegonsa.

The 4th Street Multi Use Trail Underpass project (Project) proposes to repurpose one of the three box culverts as a pedestrian trail underpass, providing grade-separated pedestrian crossing between adjacent river access and parkland improvements east and west of fourth street.

Fish Passage Modeling

Fish passage modeling was conducted using the U.S. Forest Service Aquatic Organism Passage Program modeling software, FishXing for the existing and proposed scenarios. Research did not yield specific DNR requirements for fish species inputs, hydrologic or hydraulic criteria. REP determined criteria based on prior project background, field monitoring, and available literature.

Design Species

Fish species considered for modeling include those listed in comment 5 (muskellunge, white sucker, northern hog sucker, channel catfish, largemouth bass, freshwater drum, shorthead redhorse, walleye, northern pike). Additionally, white bass and crappie were considered due to their spawning range in the project area. Table 1 includes all considered fish species, as well as pertinent swim performance data.

Typical culvert models select a design species based on swim performance and ecological significance. Typically, if multiple species are considered for modeling, the lowest performance species will be selected for design. Each of the species listed above was considered for modeling. Swim performance was evaluated for each species by reviewing available data for continuous and burst swim speeds. A combined "swim score" was assigned to each species based on continuous and burst swim speeds and durations (see Table 1). Northern Pike was found to be the species with the lowest swim score for the Project. However, initial culvert analysis results determined that due to high flow velocities in the existing culverts, achieving passage for the lowest performance species was not remotely possible. Instead, for this analysis hydraulic criteria were based on the highest swim speeds to determine whether there would be passage for *any* of the fish species. For the purposes of this analysis, the maximum flow velocity criterion was chosen to match the highest continuous swim speed of all the considered fish species, the white sucker with a continuous swim speed of 5.8ft/s.

Modeling results determined that velocity was the controlling criteria for passage, rather than outlet drop and minimum water depth. The results presented here therefore focus on the velocity criterion.

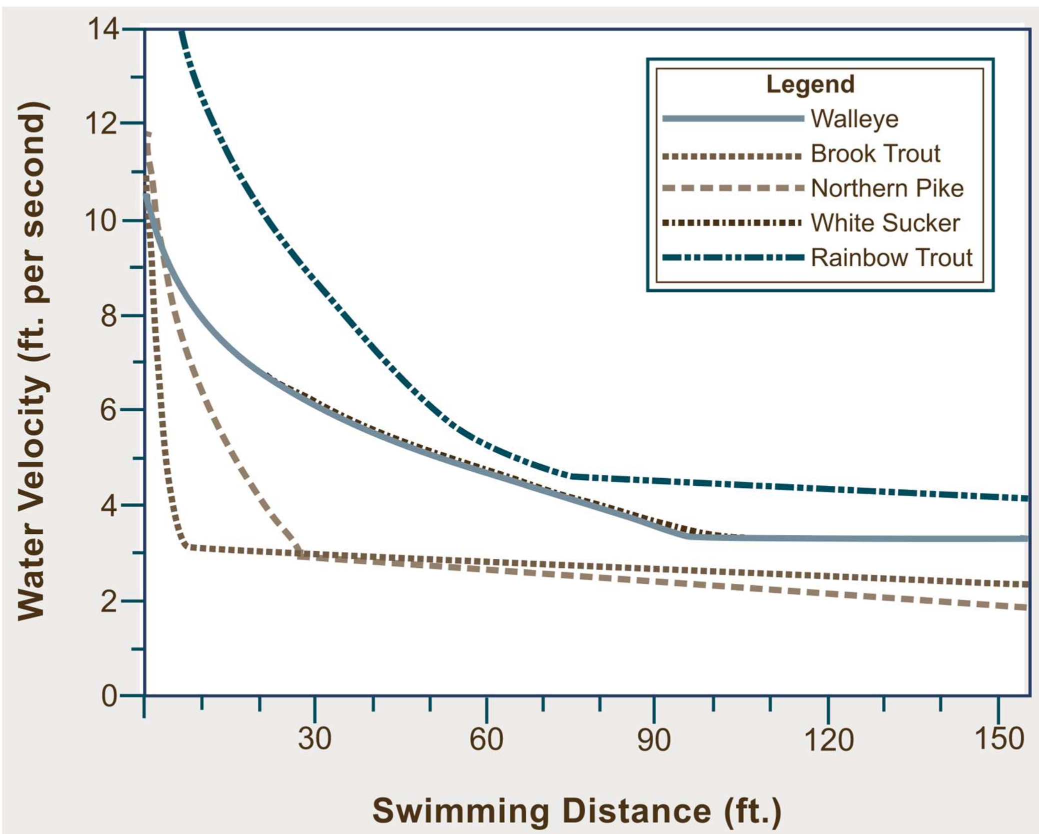

Figure 2. Typical curves of limiting flow velocity for fish passage.

Source: Fish Friendly Culverts: Proper design, installation, and maintenance can protect both roadways and fish, UW-Extension. Contact John Haack, St. Croix Basin Natural Resources Educator, 715/635-7406, john.haack@ces.uwex.edu.

Table 1. Fish Species and swim performance data.

Species Common Name	Mean Length (in)[1]	Continuous Speed (ft/s)	Duration (min)	Burst Speed (ft/s)	Burst Duration (s)	Swim Score[2]
White Sucker	10.0	5.8	10	6	10	3.54
Northern Hog Sucker	[6]	[6]	[6]	[6]	[6]	[6]
Shorthead Redhorse	7.7	1.9[3]	2.17[3]			[10]
Walleye	12.8	2.5	10	[7]	20	1.50
Channel Catfish	12.0	2.4[4]	10	5.4[4]	10	1.49
Crappie	7.0	1.7[4]	10	3.9[4]	10	1.07
Largemouth Bass	10.7	1.6	10	5.1[4]	10	1.01
White Bass[8]	8.3	4.3	10	3.5	10	2.62
Freshwater Drum	11.5	2.9[5]	10			1.73
Northern Pike	15.0	1.2	10	6.6	10	0.79
Muskellunge	[9]	[9]	[9]	[9]	[9]	[9]

Notes:

A. All data is sourced from FishXing's database unless otherwise noted.
B. Blank cells indicate unavailable or non-applicable data.

1. Mean length at first spawning, source: https://fishprotectiontools.ca/lengthmaturity.html
2. Swim score used to determine analysis species taken as (continuous speed*duration + burst speed*burst duration)/1000.
3. Source: Hatry, Charles; Thiem, Jason D.; Binder, Thomas R.; Hatin, Daniel; Dumont, Pierre; Stamplecoskie, Keith M.; Molina, Juan M.; Smokorowski, Karen E.; and Cooke, Steven J., "Concurrent Sessions B: Fish Physiology and Fishway Passage Success - Comparative Physiology and Relative Swimming Performance of Three Redhorse (Moxostoma Spp.) Species: Associations with Fishways" (2013). International Conference on Engineering and Ecohydrology for Fish Passage. 35. https://scholarworks.umass.edu/fishpassage_conference/2013/June26/35
4. Source: Fish Swimming Performance Webtool, https://fishprotectiontools.ca/userguide.html.
5. Source: Laubach, Colin, "The swimming performance of Freshwater Drum (Aplodinotus grunniens) below Claiborne Lock and Dam and in various temperature and dissolved oxygen treatments" (2020). [Masters Thesis Auburn University]. https://etd.auburn.edu/bitstream/handle/10415/7389/Laubach%20Master%27s%20Thesis.pdf
6. Northern hog sucker assumed to be similar to white sucker.
7. Walleye may have burst speeds of 7.3 ft/s but are disinclined to switch from prolonged to burst swimming.
8. Data for white bass is taken from striped bass literature swim speeds.
9. Muskellunge assumed to be similar to northern pike.
10. Due to lack of applicable data, shorthead redhorse was removed from consideration as design species.

Hydraulics
FishXing inputs for hydraulics include culvert parameters, fish passage flowrates, and tailwater elevation data. Culvert parameters were input to match as-built data for the 4th street crossing. The crossing was modeled as a single culvert for model simplicity and stability. High flow was modeled as 675 cfs, which is equivalent to the 25% exceedance of the highest monthly average flow. The low fish passage flow was modeled as 130 cfs, which is equivalent to the 75% exceedance of the lowest monthly average flow. For modeling purposes, the input flows were the fractional amount of total flow for a single culvert relative to the total number of culverts present.

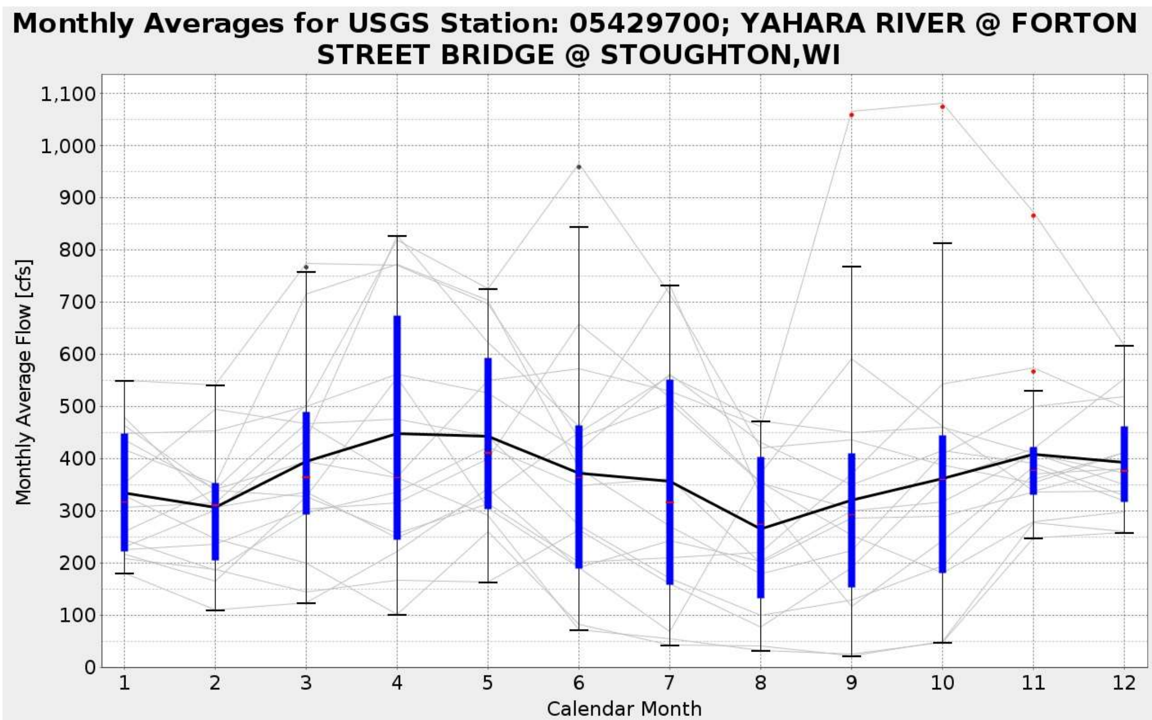

Figure 3. Monthly average flows connected by the bold black line. A box plot is shown for each month, with the blue bar representing the interquartile range. The monthly averages for each individual month of record are shown in light grey.

Tailwater elevation curves were generated based on field-measured water surface elevation (WSE). Tailwater elevation was collected using a HOBO water level Data Logger installed approximately 370 feet downstream of the crossing. Data was collected over a range of flows from June 15, 2022, through January 30, 2023. A 0.5-foot adjustment factor was applied to account for the elevation difference between the monitor location and the culvert exits.

Prior hydraulic analysis has determined that operations of the downstream Dunkirk Dam and seasonal aquatic vegetation growth have significant effects on the project tailwater. To minimize effects, available field data from spawning season (May 19 through June 30) was selected to generate the tailwater elevation/flowrate curve.

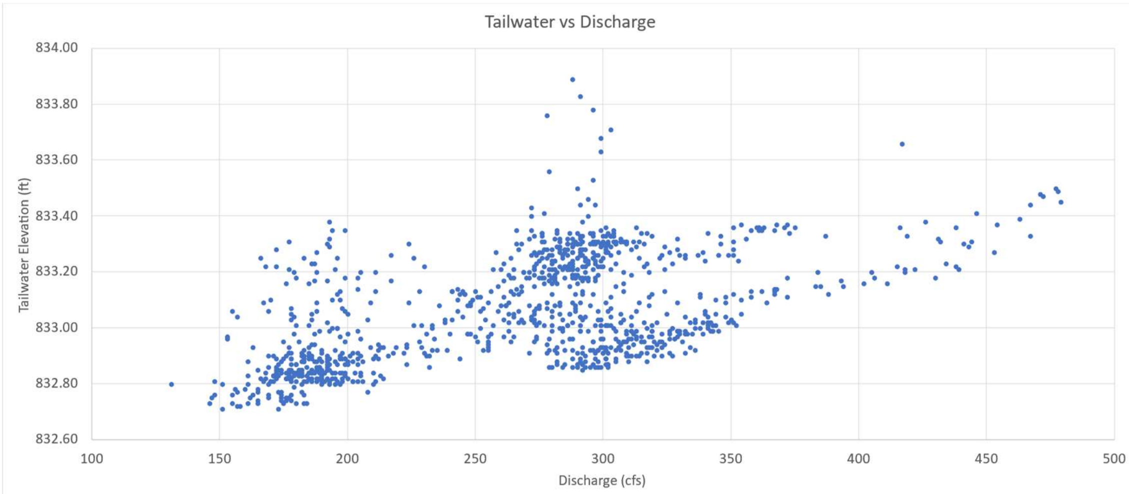

Figure 4. Tailwater elevation vs. discharge for the period from 5/19/22-6/30/22

Culvert Information

The existing crossing consists of three parallel 12’-4” by 8’-6” concrete box culverts. The culverts were field surveyed as part of the project topographic survey and are 57’-6” in length, with an inlet elevation of 832.5’ and an outlet of 831.0’. The culvert inverts are level with the river bottom at the inlet and outlet and are not embedded. 45° concrete wingwalls are present at the culvert entrance. The proposed crossing will eliminate flow through one of the three culverts at Yahara river flows below approximately 700cfs and modify the culvert entry geometry. Flood flows over approximately 700cfs will still pass through all three culverts.

Figure 5. Existing box culverts under 4th St. Date: May 18, 2022. Approximate discharge at Forton St gauge: 315 cfs, approximate single culvert flow 105 cfs.

Scenarios

Two scenarios were modeled for the crossing analysis. Scenario 1, Existing conditions and Scenario 2, Proposed conditions. Scenario 1 modeled a third of the flow in a single culvert and Scenario 2 modeled half of the flow in a single culvert. Input flows and tailwater elevations are included in Table 2. Both scenarios utilized the same fish passage hydraulic criteria.

Table 2. Discharge and tailwater elevation for existing and proposed conditions scenarios. Highlighted flows are the high and low fish passage flows for each scenario.

River Flow (cfs)	Tailwater WSE	Existing Conditions 1 of 3 Culvert Flow (cfs)	Proposed Conditions 1 of 2 Culvert flow (cfs)
0	833.12	0.0	0.0
130	833.34	43.3	65.0
200	833.45	66.7	100.0
250	833.53	83.3	125.0
300	833.62	100.0	150.0
350	833.70	116.7	175.0
400	833.78	133.3	200.0
450	833.87	150.0	225.0
500	833.95	166.7	250.0
550	834.03	183.3	275.0
600	834.11	200.0	300.0
675	834.24	225.0	337.0
700	834.28	233.3	350.0

Results

Scenario 1 (Existing)

Scenario 1 results are shown below. At low flow, a maximum average velocity of 7.86 ft/s occurs 20 feet from the culvert entrance. At high flow, a maximum average velocity of 13.71 ft/s occurs at the culvert exit. The high velocity is attributed to a hydraulic jump that occurs inside the culvert at all modeled flows. Upstream of the hydraulic jump, flow velocities create a barrier to fish passage. With increasing flows, the hydraulic jump and associated velocity barrier moves downstream.

Table 3. Scenario 1 Results.

Results for 130 cfs (43.3 cfs per culvert)			
Dist Down Culvert (ft)	Depth (ft)	Velocity Average (ft/s)	Barrier Type
0	1.01	0.00	
3	0.57	7.50	Velocity
5	0.54	6.47	Velocity
8	0.51	6.87	Velocity
11	0.49	7.19	Velocity
14	0.47	7.45	Velocity
17	0.46	7.67	Velocity
20	0.45	7.86	Velocity
23	1.19	2.94	
26	1.29	2.72	
29	1.38	2.54	
32	1.47	2.39	
35	1.56	2.25	
38	1.64	2.14	
41	1.73	2.03	
44	1.81	1.94	
47	1.89	1.85	
50	1.98	1.78	
53	2.06	1.71	
56	2.14	1.64	
58	2.19	1.60	

Results for 675 cfs (225 cfs per culvert)			
Dist Down Culvert (ft)	Depth (ft)	Velocity Average (ft/s)	Barrier Type
0	3.32	0.00	
3	1.88	11.89	Velocity
5	1.81	10.07	Velocity
8	1.74	10.49	Velocity
11	1.68	10.85	Velocity
14	1.64	11.16	Velocity
17	1.60	11.43	Velocity
20	1.56	11.68	Velocity
23	1.53	11.91	Velocity
26	1.50	12.13	Velocity
29	1.48	12.33	Velocity
32	1.46	12.52	Velocity
35	1.44	12.69	Velocity
38	1.42	12.86	Velocity
41	1.40	13.02	Velocity
44	1.39	13.17	Velocity
47	1.37	13.31	Velocity
50	1.36	13.45	Velocity
53	1.34	13.58	Velocity
56	1.33	13.71	Velocity
58	2.49	7.33	Velocity

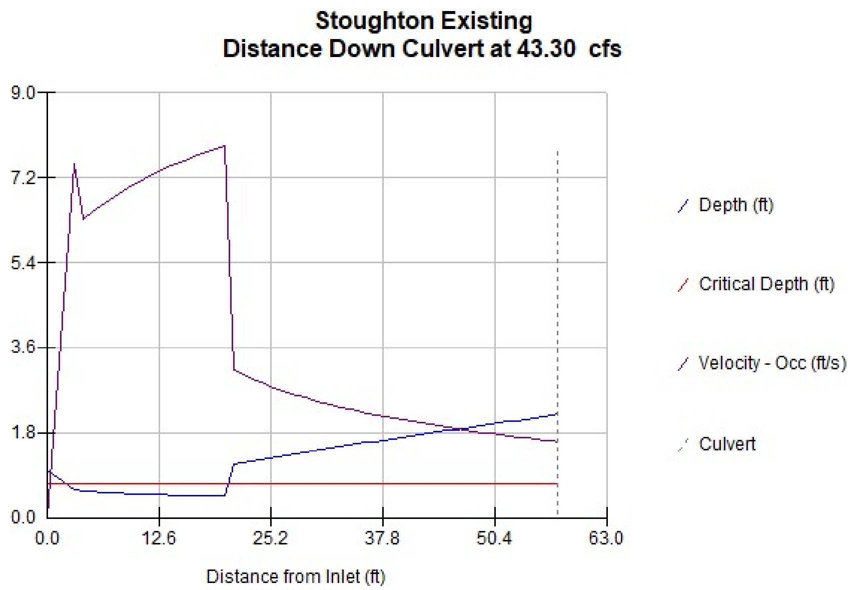

Figure 5. Depth and velocity graphs for Scenario 1, low flow. 43 cfs = 1/3 of 130 cfs river flow.

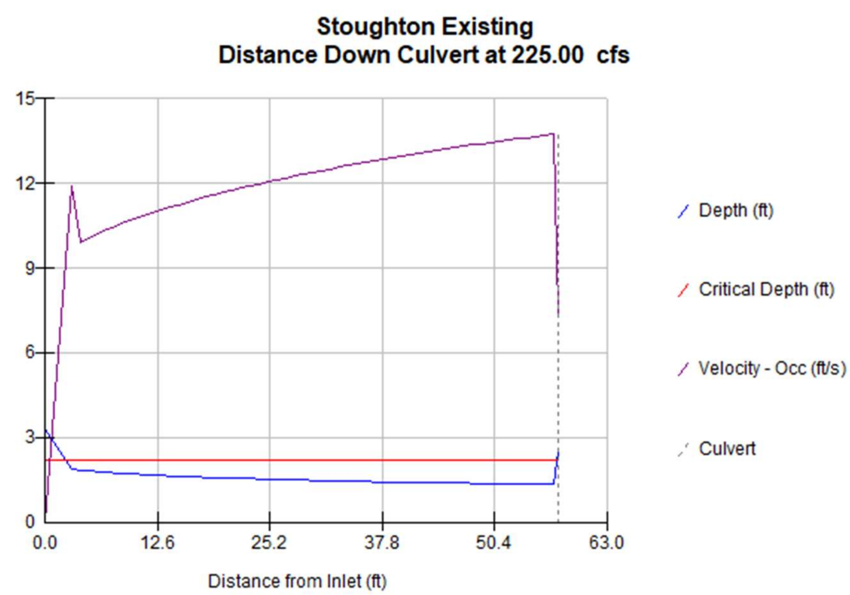

Figure 6. Depth and velocity graphs for Scenario 1, high flow. 225 cfs = 1/3 of 675 cfs river flow.

Scenario 2 (Proposed)
Scenario 2 results are shown below. At low flow, a maximum average velocity of 9.04 ft/s occurs 26 feet from the culvert entrance. At high flow, a maximum average velocity of 15.01 ft/s occurs at the exit of the culvert. Similar to scenario 1, a hydraulic jump is present in the culvert at all modeled flows.

Table 4. Scenario 2 Results.

Results for 130 cfs (65 cfs per culvert)			
Dist Down Culvert (ft)	Depth (ft)	Velocity Average (ft/s)	Barrier Type
0	1.48	0.00	
3	0.77	7.79	Velocity
5	0.73	7.19	Velocity
8	0.69	7.61	Velocity
11	0.66	7.94	Velocity
14	0.64	8.23	Velocity
17	0.62	8.47	Velocity
20	0.61	8.68	Velocity
23	0.59	8.87	Velocity
26	0.58	9.04	Velocity
29	1.47	3.57	
32	1.58	3.35	
35	1.67	3.15	
38	1.76	2.99	
41	1.85	2.84	
44	1.94	2.71	
47	2.03	2.60	
50	2.12	2.49	
53	2.20	2.40	
56	2.28	2.31	
58	2.34	2.25	

Results for 675 cfs (337 cfs per culvert)			
Dist Down Culvert (ft)	Depth (ft)	Velocity Average (ft/s)	Barrier Type
0	4.73	0.00	
3	2.50	12.47	Velocity
5	2.42	11.29	Velocity
8	2.33	11.71	Velocity
11	2.27	12.06	Velocity
14	2.21	12.37	Velocity
17	2.16	12.65	Velocity
20	2.12	12.90	Velocity
23	2.08	13.14	Velocity
26	2.05	13.36	Velocity
29	2.02	13.56	Velocity
32	1.99	13.76	Velocity
35	1.96	13.94	Velocity
38	1.94	14.11	Velocity
41	1.91	14.28	Velocity
44	1.89	14.44	Velocity
47	1.87	14.59	Velocity
50	1.85	14.74	Velocity
53	1.84	14.88	Velocity
56	1.82	15.01	Velocity
58	3.24	8.44	Velocity

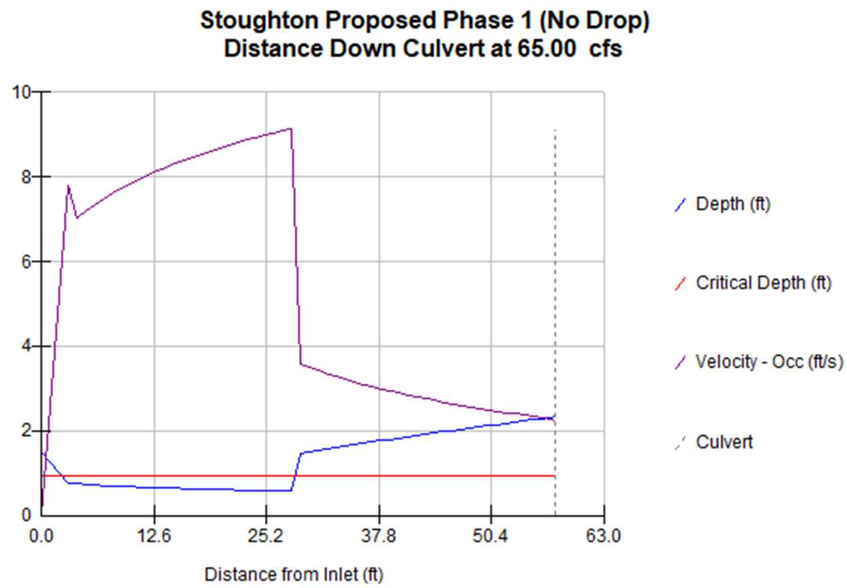

Figure 7. Depth and velocity graphs for Scenario 1, low flow. 65 cfs = 1/2 of 130 cfs river flow.

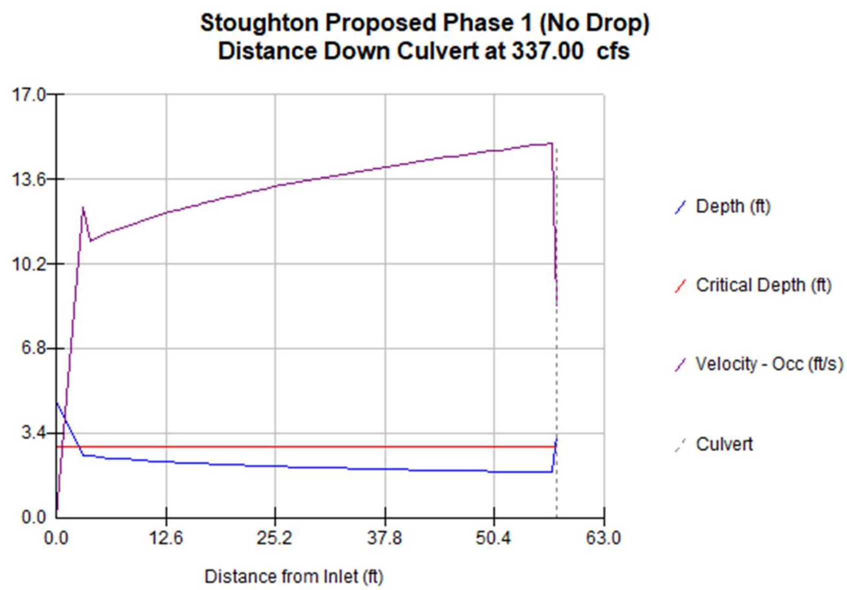

Figure 8. Depth and velocity graphs for Scenario 1, low flow. 337 cfs = 1/2 of 675 cfs river flow

Conclusions and Recommendations

Based on the modeling and analysis described in this report, the existing 4th St box culverts present a velocity fish passage barrier to all fish species and flows analyzed. The velocities modeled for existing low flow conditions (130cfs) present velocities that are higher than the fastest continuous swim speed and fastest burst speed of any of the fish species, and velocities increase as flows increase. The proposed project will increase velocities as compared to existing due to more flow per culvert at river discharges under 700cfs, but since the existing culverts already present a velocity fish passage barrier to all fish species, the project won't functionally change fish passage. The existing culverts are a barrier to all fish species analyzed and will continue to be post-project.

It should be noted that there is an existing fish passage barrier just upstream at the Stoughton Dam, and downstream at the Dunkirk Dam. If fish passage through the 4th St crossing is a desired outcome of the project, velocities in the culverts must be reduced to below those of existing conditions. The high velocities can be attributed to the hydraulic drop that occurs across the existing culverts at all flows. One method of reducing the hydraulic drop is to raise the tailwater elevation as compared to existing. Preliminary modeling indicates that a relatively small increase in tailwater elevation can reduce velocities as compared to existing, even while reducing the flow from three culverts to two.

The tailwater elevation could be raised by the installation of a boulder drop structure downstream of the existing crossing to reduce the hydraulic gradient through the culverts, allowing fish passage for some species at some flows. Further design and analysis would need to be performed to determine the extent of velocity reduction. REP has designed a boulder drop structure in this location that was submitted to the DNR as part of a separate permit application. The boulder structure can raise the tailwater during normal flows while still adhering to no-rise requirements for flood flow.

In summary, the existing culverts present a fish passage barrier which will continue to exist post-project. It is REP's recommendation that to improve fish passage, additional improvements should be included in the project such as a boulder structure downstream of 4th St that would reduce hydraulic gradient and velocities in the culverts as compared to existing. Additionally, fish passage should be considered at the Stoughton Dam immediately upstream of 4th St, as it too creates a barrier at all flows.

Attachments:
FishXing Output Report Scenario 1
FishXing Output Report Scenario 2

Attachment 1

FishXing Output Report Scenario 1

FishXing V3.0 2007

Crossing Report for Scenario 1 - Existing

Project: Stoughton FishXing Model

Table 1. Project Summary for Stoughton FishXing Model

File Name	Crossing Name	Stream Name	Culvert Length	QLP	QHP	% Passable
Stoughton Existing.xng	Stoughton Existing	Yahara River	57.5 ft	43.3 cfs	225 cfs	0.0%
Stoughton Phase 2.xng	Stoughton Phase 2	Yahara River	57.5 ft	65 cfs	337 cfs	28.5%
Stoughton Proposed Phase 1 (No Drop).xng	Stoughton Proposed Phase 1 (No Drop)	Yahara River	57.5 ft	65 cfs	337 cfs	0.0%

Crossing Location Information

Crossing Name: Scenario 1 - Existing

Stream Name: Yahara River

Road: 4th St.

Comments:
Model for the existing configuration with three culverts in place.
Tailwater curve taken from water level loggers installed June 2022.

Modeled as 1/3 flow in a single culvert due to fishXing stability limitations.

FishXing Results Scenario 1

Hydraulic Evaluation Criteria

Maximum Allowed Water Velocity = 5.38 ft/s
Minimum Required Depth = 0.225 ft
Maximum Allowed Outlet Drop = 0.1 ft

FishXing Results Scenario 1

FishXing V3.0 2007

Crossing Installation Data

Culvert Type: 12.33 X 8.5 ft Box
Material: Concrete
Installation: Not Embedded
Culvert Length: 57.5 ft
Culvert Slope: 2.61%
Culvert Roughness Coefficient: 0.013
Inlet Invert Elevation: 832.5 ft
Outlet Invert Elevation: 831 ft
Inlet Headloss Coefficient (Ke): 0.5

Design Flows

Low Passage Flow: 43.3 cfs
High Passage Flow: 225 cfs

Tailwater Information

Tailwater Option: User-defined Rating Curve
Outlet-Pool Bottom Elevation: 831 ft

Table 2. Tailwater Elevation/Discharge Data.

Discharge (cfs)	Elevation (ft)
0	833.12
130	833.34
200	833.45
250	833.53
300	833.62
350	833.7
400	833.78
450	833.87
500	833.95
550	834.03
600	834.11
675	834.24
700	834.28
750	834.36

FishXing Results Scenario 1

FishXing V3.0 2007

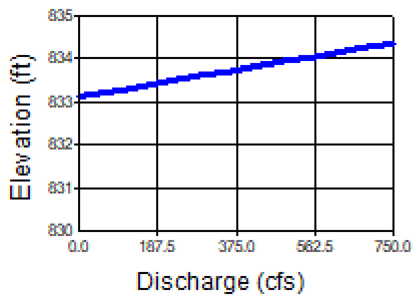

Table 3. Fish Passage Summary.

Fish Passage Summary	
Low Passage Design Flow	43.30 cfs
High Passage Design Flow	225.00 cfs
Percent of Flows Passable	0.0 %
Passable Flow Range	None
Depth Barrier	None
Outlet Drop Barriers	None
Velocity Barrier - V	43.3 cfs and Above
Pool Depth Barrier	None

Table 4. Culvert Summary for 43.3 cfs.

Summary for Q = 225.00 cfs	
Normal Depth (ft)	1.06
Critical Depth (ft)	2.18
Headwater Depth (ft)	3.32
HW/D	0.39
Inlet Velocity (ft/s)	11.89
Tailwater Depth (ft)	2.49
Burst Swim Time (s)	N/A
Prolonged Swim Time (min)	N/A
Barrier Code	V

FishXing Results Scenario 1

Table 5. Culvert Profiles for 43.3 cfs.

Profiles for Q = 43.30 cfs			
Dist Down (ft)	**Depth (ft)**	**Velocity Average (ft/s)**	**Barrier Type**
0	1.01	0.00	
3	0.57	7.50	
5	0.54	6.47	
8	0.51	6.87	
11	0.49	7.19	
14	0.47	7.45	
17	0.46	7.67	
20	0.45	7.86	Velocity
23	1.19	2.94	
26	1.29	2.72	
29	1.38	2.54	
32	1.47	2.39	
35	1.56	2.25	
38	1.64	2.14	
41	1.73	2.03	
44	1.81	1.94	
47	1.89	1.85	
50	1.98	1.78	
53	2.06	1.71	
56	2.14	1.64	
58	2.19	1.60	

FishXing Results Scenario 1

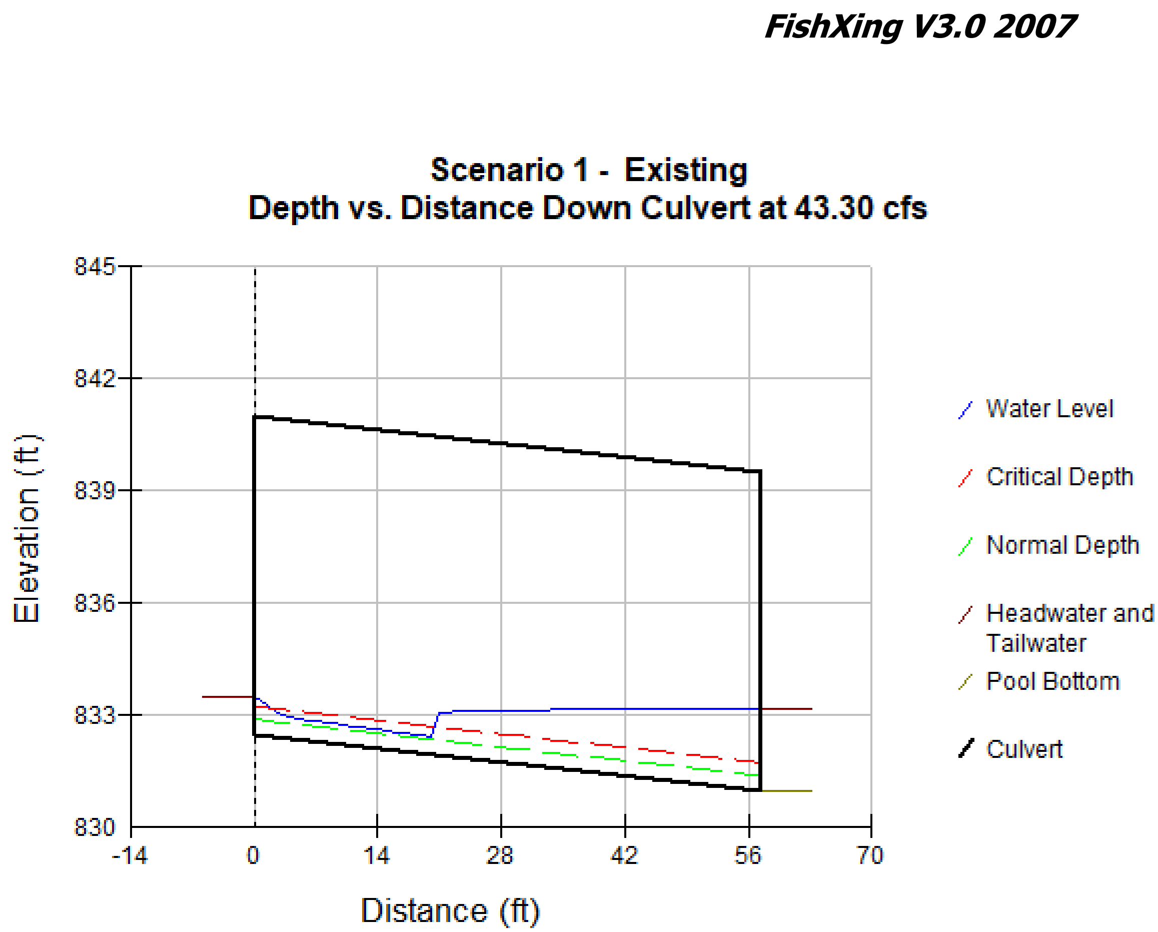

Figure 2. Water Surface Profile at 43.3 cfs

FishXing Results Scenario 1

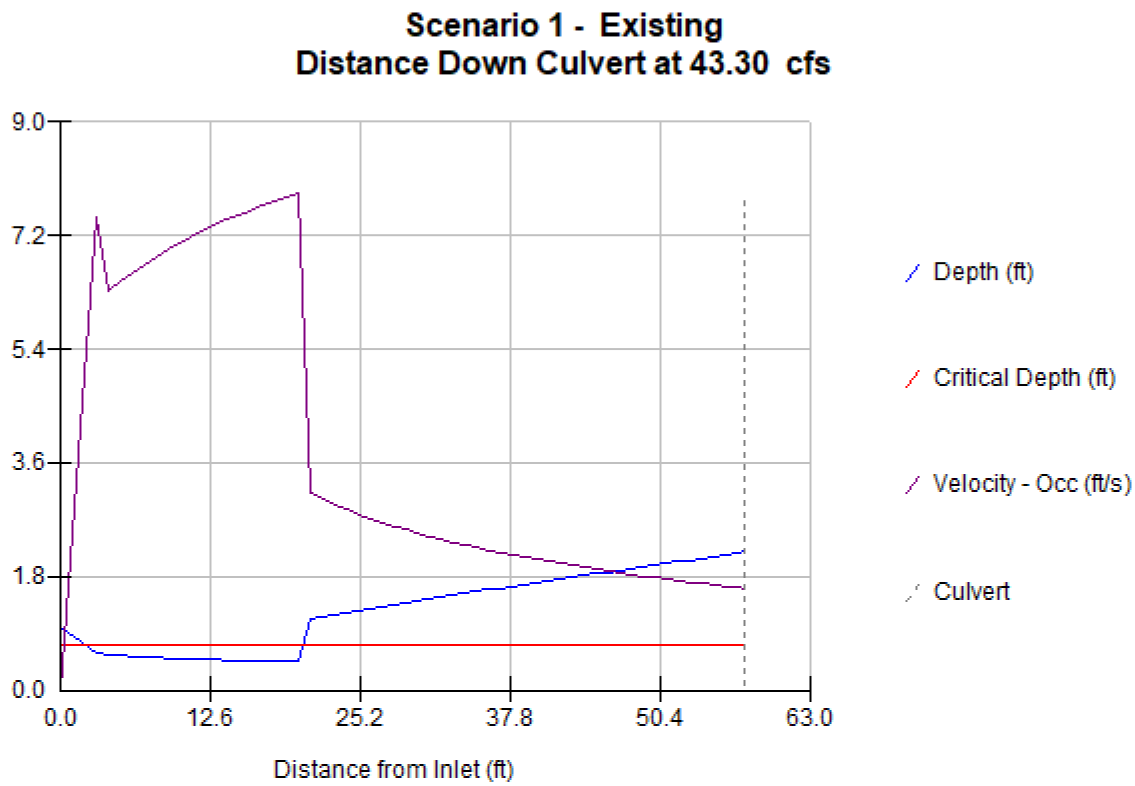

Figure 3. Culvert Profiles at 43.3 cfs

Table 6. Culvert Summary for 43.3 cfs.

Summary for Q = 225.00 cfs	
Normal Depth (ft)	1.06
Critical Depth (ft)	2.18
Headwater Depth (ft)	3.32
HW/D	0.39
Inlet Velocity (ft/s)	11.89
Tailwater Depth (ft)	2.49
Burst Swim Time (s)	N/A
Prolonged Swim Time (min)	N/A
Barrier Code	V

FishXing Results Scenario 1

Table 7. Culvert Profiles for 225 cfs.

Profiles for Q = 225.00 cfs			
Dist Down (ft)	**Depth (ft)**	**Velocity Average (ft/s)**	**Barrier Type**
0	3.32	0.00	
3	1.88	11.89	
5	1.81	10.07	
8	1.74	10.49	
11	1.68	10.85	
14	1.64	11.16	
17	1.60	11.43	
20	1.56	11.68	
23	1.53	11.91	
26	1.50	12.13	
29	1.48	12.33	
32	1.46	12.52	
35	1.44	12.69	
38	1.42	12.86	
41	1.40	13.02	
44	1.39	13.17	
47	1.37	13.31	
50	1.36	13.45	
53	1.34	13.58	
56	1.33	13.71	
58	2.49	7.33	Velocity

FishXing Results Scenario 1

FishXing V3.0 2007

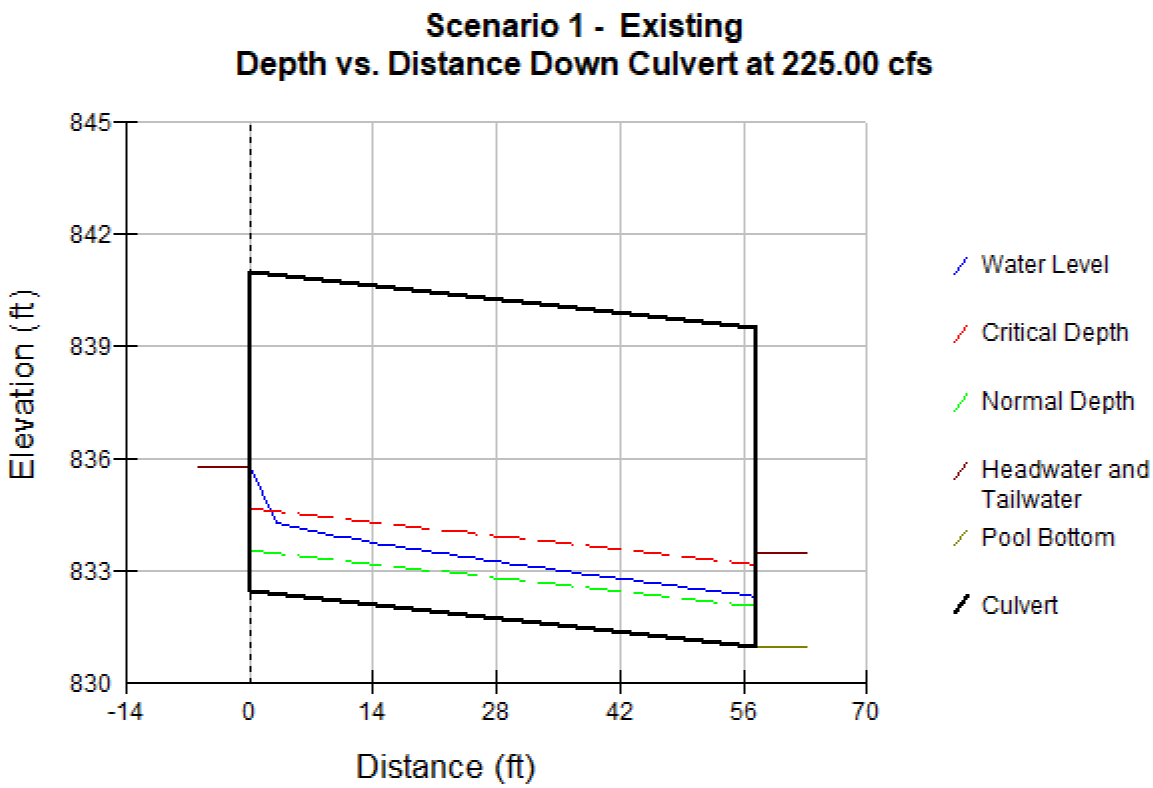

Figure 4. Water Surface Profile at 225 cfs

FishXing Results Scenario 1

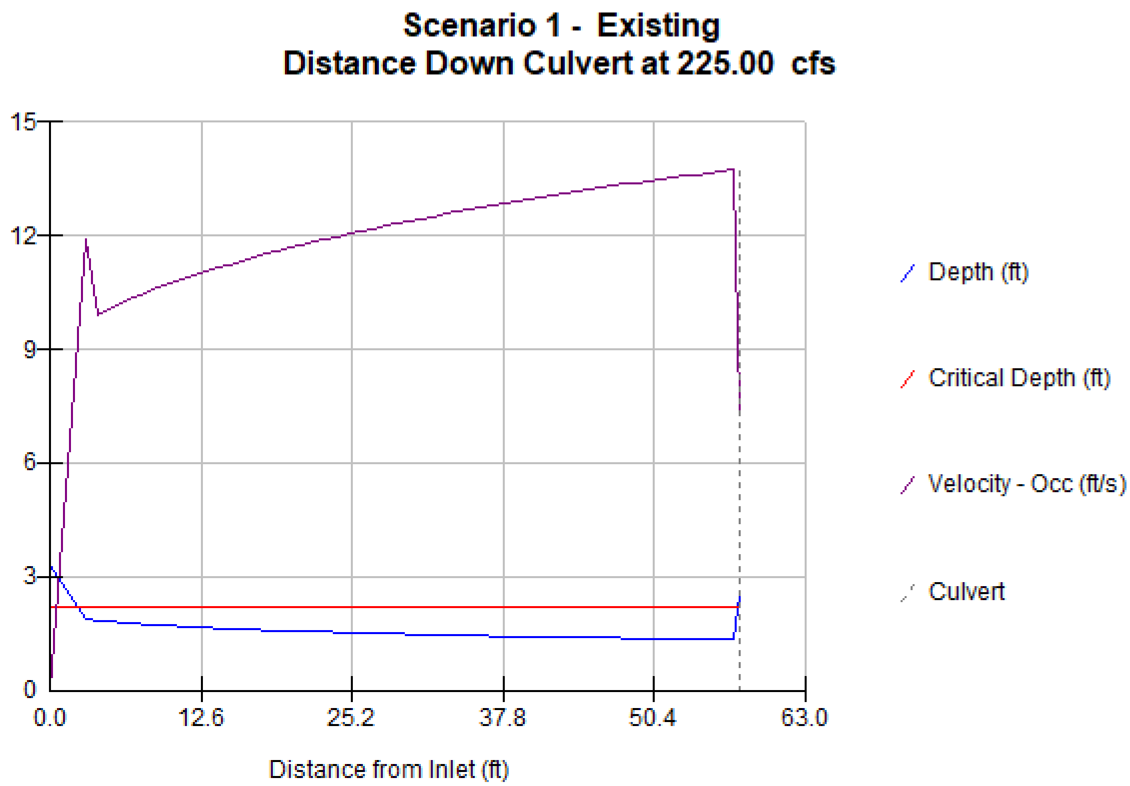

Figure 5. Culvert Profiles at 225 cfs

Table 8. Culvert Rating Table.

Depth Min (ft)	V(occ) Max (ft/s)	Depth TW (ft)	Outlet WS Drop (ft)	Depth Pool (ft)	Barrier Type
0.62	0.00	2.12	0.00	2.12	NONE
0.62	1.75	2.14	0.00	2.14	NONE
0.35	6.27	2.16	0.00	2.16	V
0.40	7.03	2.18	0.00	2.18	V
0.45	7.86	2.19	0.00	2.19	V
0.52	8.82	2.21	0.00	2.21	V
0.58	9.57	2.24	0.00	2.24	V
0.63	10.14	2.25	0.00	2.25	V
0.68	10.66	2.27	0.00	2.27	V
0.73	11.15	2.29	0.00	2.29	V
0.79	11.57	2.31	0.00	2.31	V
0.84	11.96	2.33	0.00	2.33	V
0.90	12.21	2.35	0.00	2.35	V
0.95	12.44	2.37	0.00	2.37	V
1.01	12.67	2.38	0.00	2.38	V

FishXing Results Scenario 1

1.06	12.87	2.40	0.00	2.40	V
1.12	13.07	2.42	0.00	2.42	V
1.17	13.25	2.44	0.00	2.44	V
1.22	13.41	2.45	0.00	2.45	V
1.28	13.59	2.47	0.00	2.47	V
1.33	13.75	2.49	0.00	2.49	V
1.38	13.90	2.51	0.00	2.51	V
1.43	14.05	2.53	0.00	2.53	V
1.48	14.19	2.55	0.00	2.55	V
1.53	14.35	2.57	0.00	2.57	V
1.57	14.47	2.59	0.00	2.59	V
1.62	14.60	2.61	0.00	2.61	V
1.67	14.73	2.63	0.00	2.63	V
1.72	14.85	2.64	0.00	2.64	V
1.77	14.97	2.66	0.00	2.66	V
1.81	15.08	2.68	0.00	2.68	V

FishXing Results Scenario 1

FishXing V3.0 2007

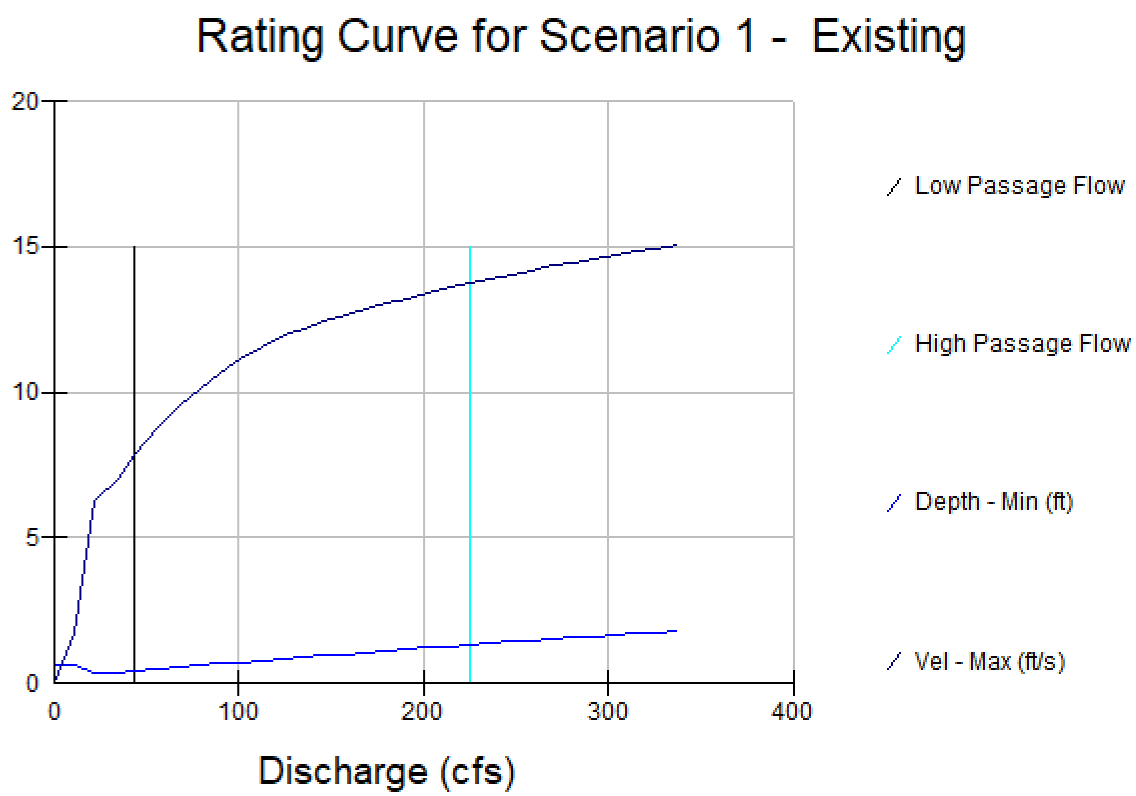

Figure 6. Culvert Rating Curve

<u>Barrier Codes</u>

V = Strict Velocity Barrier
EB = Fish Exhausted at Burst Speed
Long = Fish Exhausted at Prolonged Speed
Leap = Excessive leap at outlet
Drop = Excessive drop at outlet
Depth = Too shallow for substantial distance
Pool = Leap Pool too shallow
NONE = Not a barrier

Attachment 2

FishXing Output Report Scenario 2

FishXing Output Report Scenario 2

FishXing V3.0 2007

Crossing Report for Scenario 2 - Proposed

Project: Stoughton FishXing Model

Table 1. Project Summary for Stoughton FishXing Model

File Name	Crossing Name	Stream Name	Culvert Length	QLP	QHP	% Passable
Stoughton Existing.xng	Scenario 1 - Existing	Yahara River	57.5 ft	43.3 cfs	225 cfs	0.0%
Stoughton Phase 2.xng	Stoughton Phase 2	Yahara River	57.5 ft	65 cfs	337 cfs	28.5%
Stoughton Proposed Phase 1 (No Drop).xng	Stoughton Proposed Phase 1 (No Drop)	Yahara River	57.5 ft	65 cfs	337 cfs	0.0%

Crossing Location Information

Crossing Name: Scenario 2 - Proposed

Stream Name: Yahara River

Road: 4th St

Comments:
Model for the Proposed phased construction configuration with two culverts passing flows
Tailwater curve taken from water level loggers installed June 2022.

Modeled as 1/2 flow in a single culvert due to fishXing stability limitations.

FishXing Output Report Scenario 2

Hydraulic Evaluation Criteria

Maximum Allowed Water Velocity = 5.8 ft/s
Minimum Required Depth = 0.225 ft
Maximum Allowed Outlet Drop = 0.01 ft

FishXing Output Report Scenario 2

FishXing V3.0 2007

Crossing Installation Data

Culvert Type: 12.33 X 8.5 ft Box
Material: Concrete
Installation: Not Embedded
Culvert Length: 57.5 ft
Culvert Slope: 2.61%
Culvert Roughness Coefficient: 0.013
Inlet Invert Elevation: 832.5 ft
Outlet Invert Elevation: 831 ft
Inlet Headloss Coefficient (Ke): 0.3

Design Flows

Low Passage Flow: 65 cfs
High Passage Flow: 337 cfs

Tailwater Information
Tailwater Option: User-defined Rating Curve
Outlet-Pool Bottom Elevation: 830.9 ft

Table 2. Tailwater Elevation/Discharge Data.

Discharge (cfs)	Elevation (ft)
0	833.12
65	833.34
100	833.45
125	833.53
150	833.62
175	833.7
200	833.78
225	833.87
250	833.95
275	834.03
300	834.11
337.5	834.24

350	834.28
375	834.36

FishXing Output Report Scenario 2

FishXing V3.0 2007

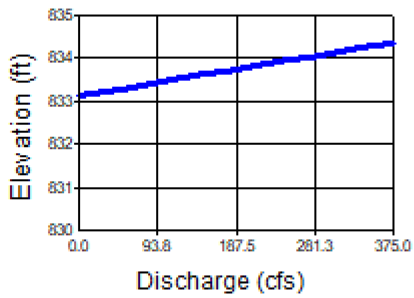

Table 3. Fish Passage Summary.

Fish Passage Summary	
Low Passage Design Flow	65.00 cfs
High Passage Design Flow	337.00 cfs
Percent of Flows Passable	0.0 %
Passable Flow Range	None
Depth Barrier	None
Outlet Drop Barriers	None
Velocity Barrier - V	65.0 cfs and Above
Pool Depth Barrier	None

Table 4. Culvert Summary for 65 cfs.

Summary for Q = 65.00 cfs	
Normal Depth (ft)	0.49
Critical Depth (ft)	0.95
Headwater Depth (ft)	1.48
HW/D	0.17
Inlet Velocity (ft/s)	7.79
Tailwater Depth (ft)	2.34
Burst Swim Time (s)	N/A
Prolonged Swim Time (min)	N/A
Barrier Code	V

FishXing Output Report Scenario 2

Table 5. Culvert Profiles for 65 cfs.

Profiles for Q = 65.00 cfs			
Dist Down (ft)	**Depth (ft)**	**Velocity Average (ft/s)**	**Barrier Type**
0	1.48	0.00	
3	0.77	7.79	
5	0.73	7.19	
8	0.69	7.61	
11	0.66	7.94	
14	0.64	8.23	
17	0.62	8.47	
20	0.61	8.68	
23	0.59	8.87	
26	0.58	9.04	Velocity
29	1.47	3.57	
32	1.58	3.35	
35	1.67	3.15	
38	1.76	2.99	
41	1.85	2.84	
44	1.94	2.71	
47	2.03	2.60	
50	2.12	2.49	
53	2.20	2.40	
56	2.28	2.31	
58	2.34	2.25	

FishXing Output Report Scenario 2

FishXing V3.0 2007

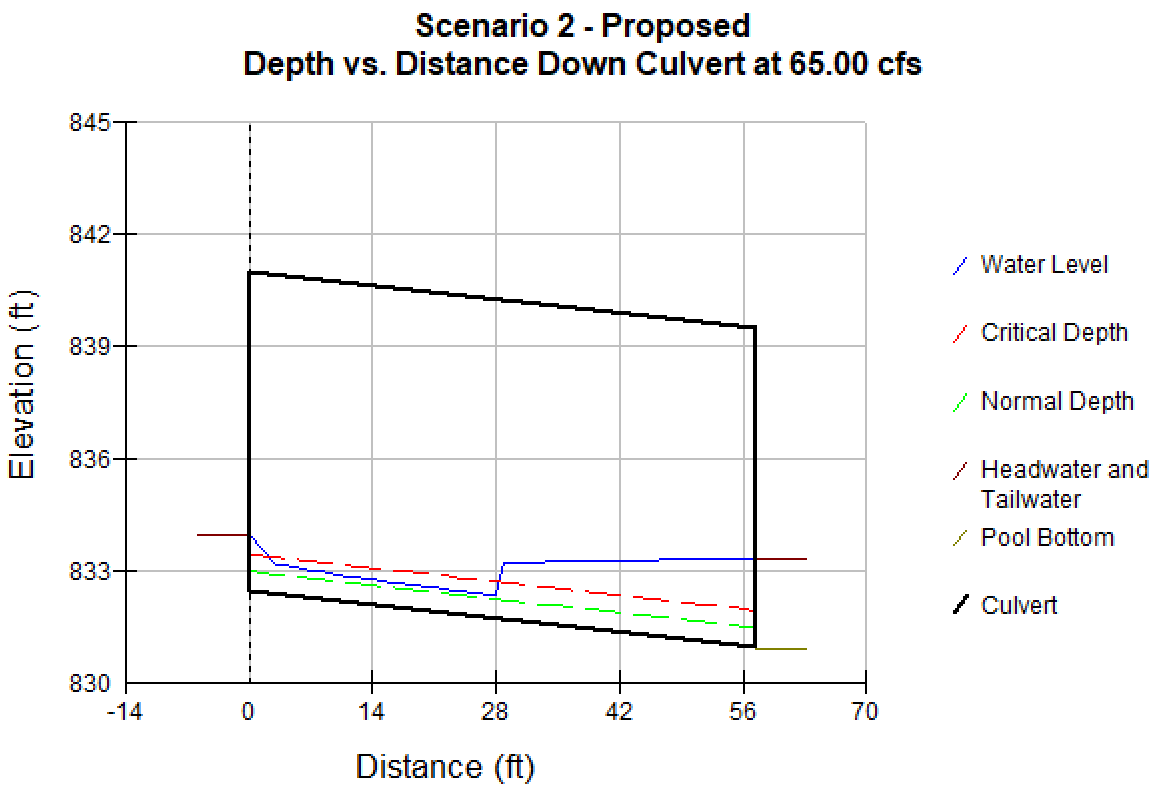

Figure 2. Water Surface Profile at 65 cfs

FishXing Output Report Scenario 2

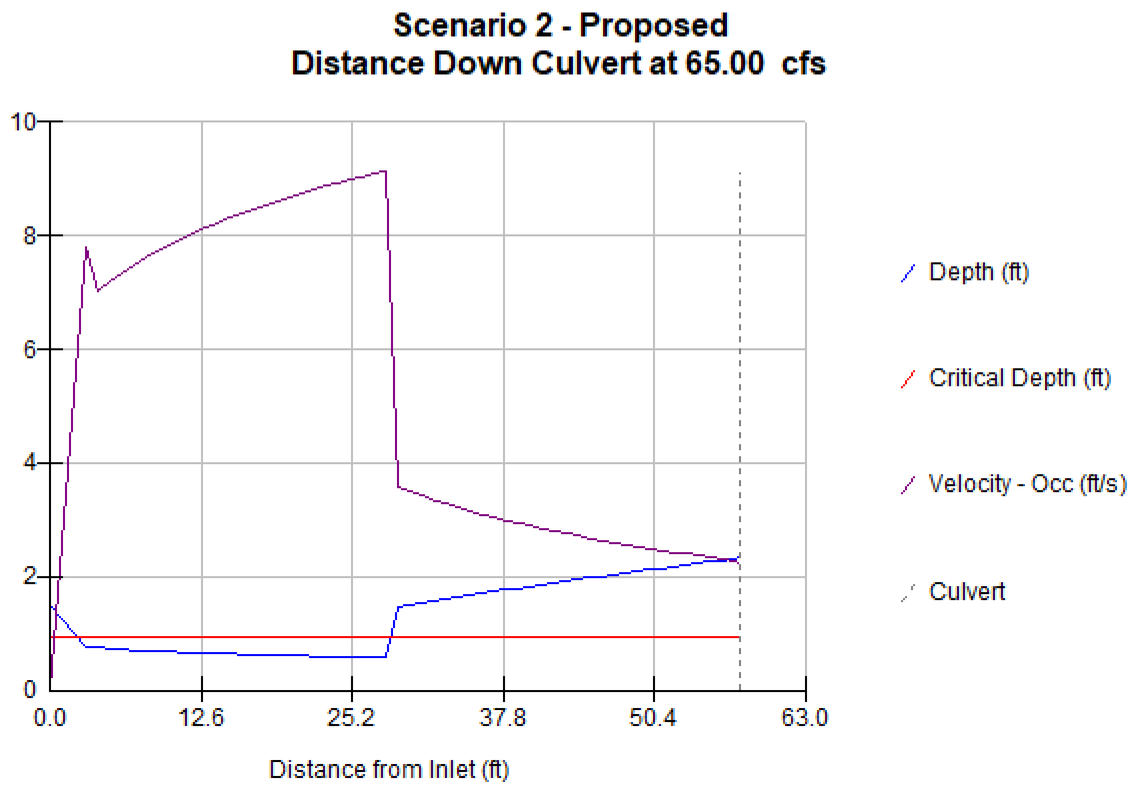

Figure 3. Culvert Profiles at 65 cfs

Table 6. Culvert Summary for 65 cfs.

Summary for Q = 65.00 cfs	
Normal Depth (ft)	0.49
Critical Depth (ft)	0.95
Headwater Depth (ft)	1.48
HW/D	0.17
Inlet Velocity (ft/s)	7.79
Tailwater Depth (ft)	2.34
Burst Swim Time (s)	N/A
Prolonged Swim Time (min)	N/A
Barrier Code	V

Table 7. Culvert Profiles for 337 cfs.

Profiles for Q = 337.00 cfs			
Dist Down (ft)	**Depth (ft)**	**Velocity Average (ft/s)**	**Barrier Type**
0	4.73	0.00	
3	2.50	12.47	
5	2.42	11.29	
8	2.33	11.71	
11	2.27	12.06	
14	2.21	12.37	
17	2.16	12.65	
20	2.12	12.90	
23	2.08	13.14	
26	2.05	13.36	
29	2.02	13.56	
32	1.99	13.76	
35	1.96	13.94	
38	1.94	14.11	
41	1.91	14.28	
44	1.89	14.44	
47	1.87	14.59	
50	1.85	14.74	
53	1.84	14.88	
56	1.82	15.01	
58	3.24	8.44	Velocity

FishXing Output Report Scenario 2

FishXing V3.0 2007

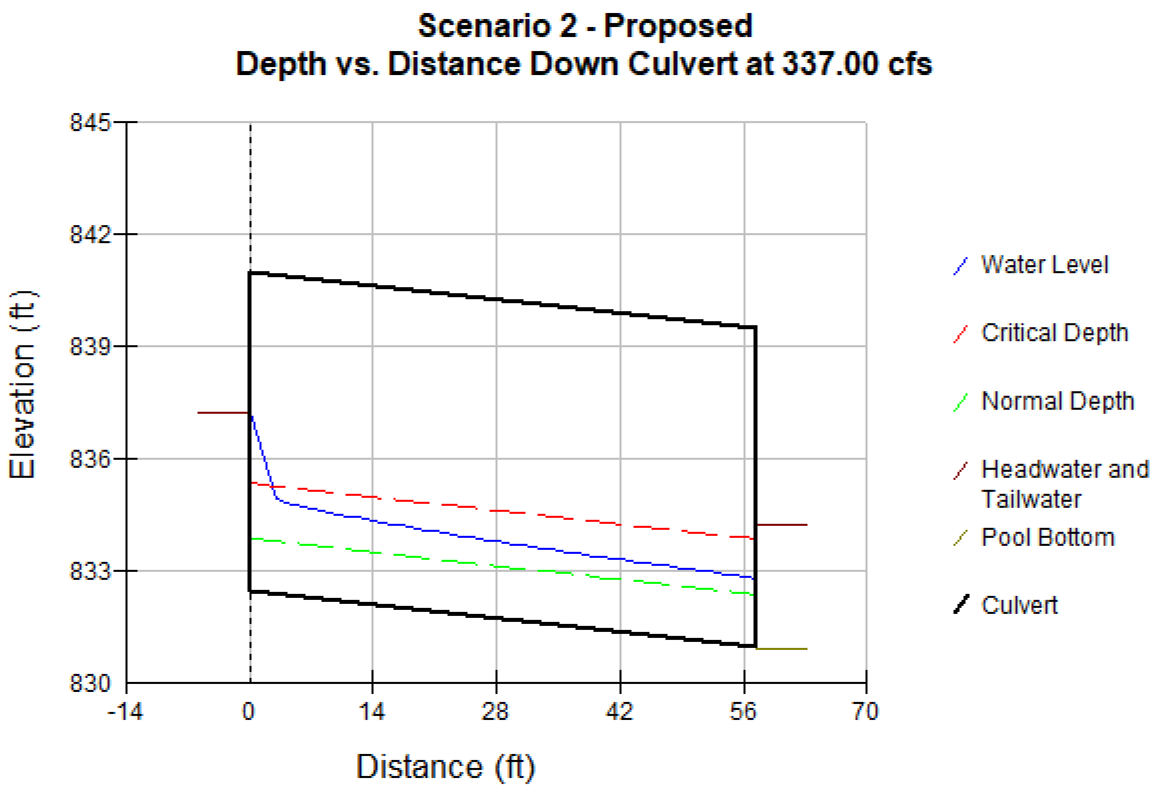

Figure 4. Water Surface Profile at 337 cfs

FishXing Output Report Scenario 2

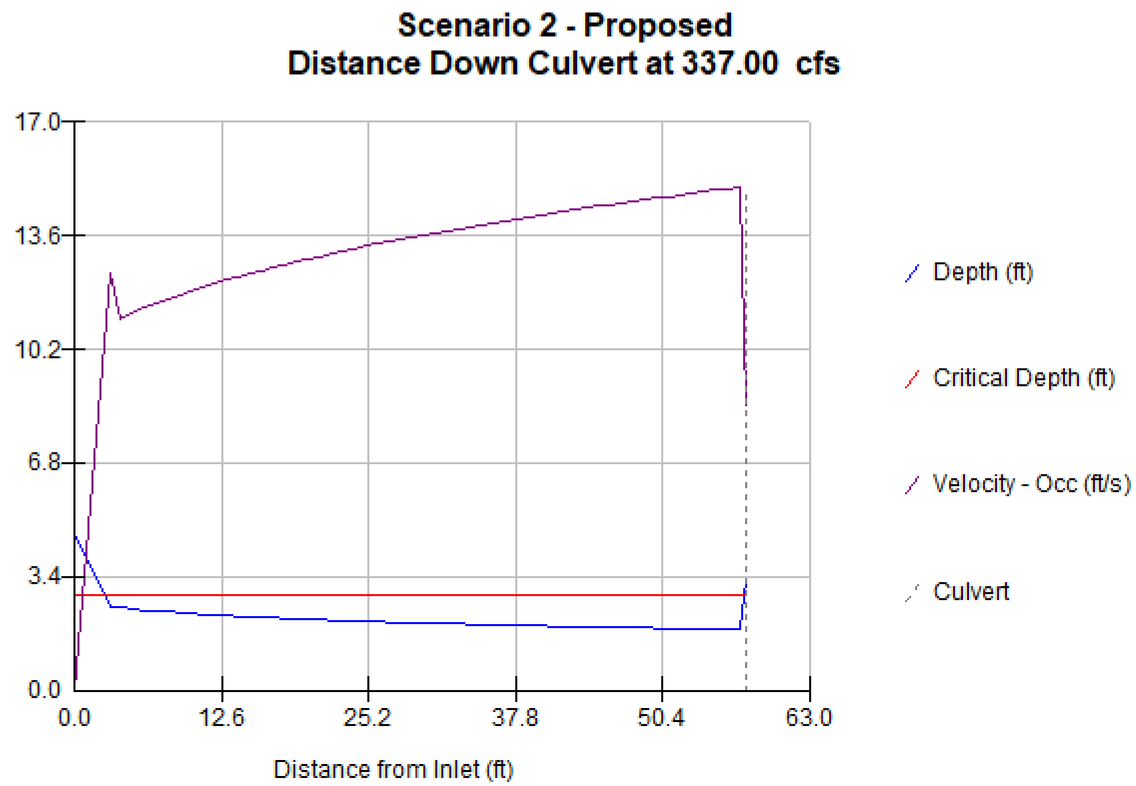

Figure 5. Culvert Profiles at 337 cfs

Table 8. Culvert Rating Table.

Depth Min (ft)	V(occ) Max (ft/s)	Depth TW (ft)	Outlet WS Drop (ft)	Depth Pool (ft)	Barrier Type
0.62	0.00	2.12	0.00	2.22	NONE
0.63	2.50	2.18	0.00	2.28	NONE
0.41	6.68	2.24	0.00	2.34	V
0.50	8.25	2.29	0.00	2.39	V
0.58	9.15	2.34	0.00	2.44	V
0.67	10.17	2.40	0.00	2.50	V
0.75	10.93	2.45	0.00	2.55	V
0.83	11.54	2.51	0.00	2.61	V
0.90	12.10	2.57	0.00	2.67	V
0.98	12.56	2.63	0.00	2.73	V
1.06	12.87	2.68	0.00	2.78	V
1.14	13.15	2.73	0.00	2.83	V
1.22	13.41	2.79	0.00	2.89	V
1.30	13.66	2.85	0.00	2.95	V
1.38	13.90	2.91	0.00	3.01	V

1.45	14.12	2.96	0.00	3.06	V
1.53	14.32	3.01	0.00	3.11	V
1.60	14.51	3.07	0.00	3.17	V
1.67	14.70	3.12	0.00	3.22	V
1.74	14.88	3.18	0.00	3.28	V
1.82	15.05	3.24	0.00	3.34	V
1.89	15.22	3.29	0.00	3.39	V
1.96	15.38	3.35	0.00	3.45	V
2.03	15.54	3.40	0.00	3.50	V
2.09	15.68	3.45	0.00	3.55	V
2.16	15.82	3.51	0.00	3.61	V
2.22	15.99	3.56	0.00	3.66	V
2.29	16.12	3.62	0.00	3.72	V
2.35	16.26	3.67	0.00	3.77	V
2.42	16.39	3.72	0.00	3.82	V
2.48	16.51	3.78	0.00	3.88	V

FishXing V3.0 2007

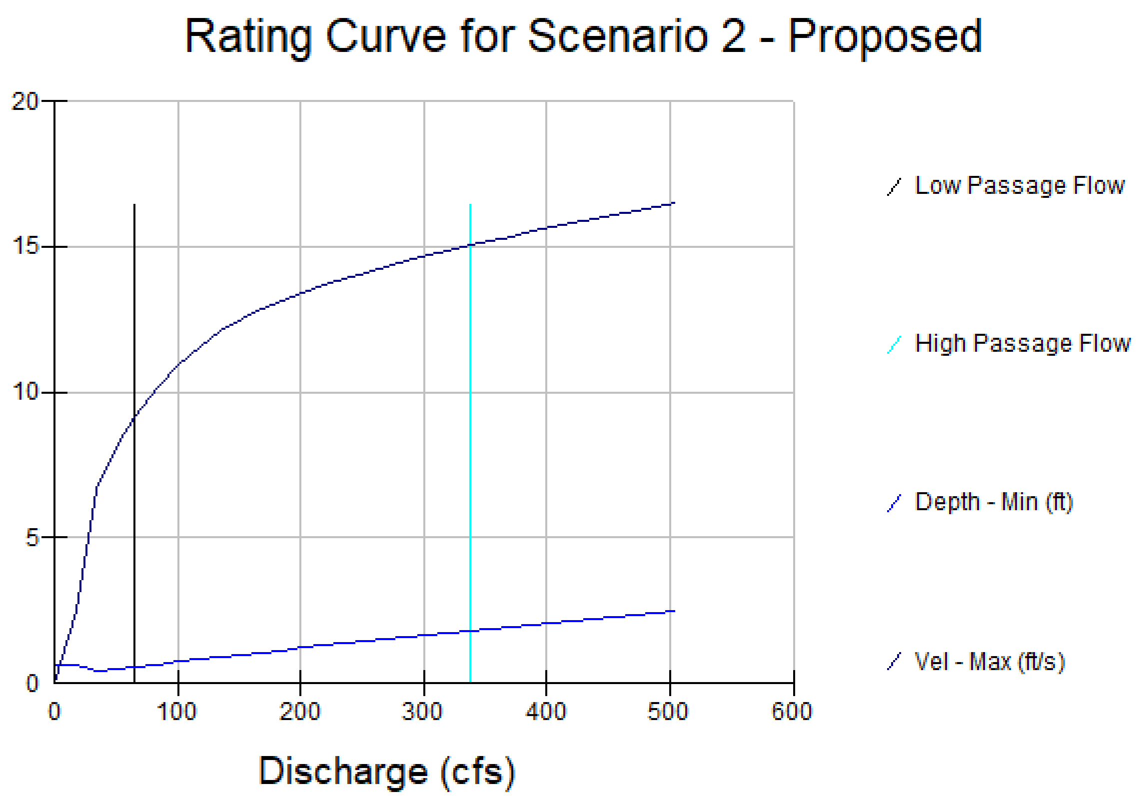

Figure 6. Culvert Rating Curve

<u>Barrier Codes</u>

V = Strict Velocity Barrier
EB = Fish Exhausted at Burst Speed
Long = Fish Exhausted at Prolonged Speed
Leap = Excessive leap at outlet
Drop = Excessive drop at outlet
Depth = Too shallow for substantial distance
Pool = Leap Pool too shallow
NONE = Not a barrier

EXHIBIT NOTES:

1. THE PURPOSE OF THIS EXHIBIT IS TO IDENTIFY THE WETLAND AREAS IMPACTED BY THE PROPOSED PUBLIC IMPROVEMENTS ALONG COOPERS CAUSEWAY.
2. ACTUAL WETLAND AREAS IMPACTED BY PRIVATE IMPROVEMENTS TO BE CONFIRMED BY OTHERS.

EXHIBIT LEGEND:

WETLANDS AREAS IMPACTED BY PUBLIC IMPROVEMENTS (1,104 SF)

0 20 40 80

NO.	REVISIONS	DATE:

COOPERS CAUSEWAY WETLAND IMPACTS

COOPERS CAUSEWAY RECONSTRUCTION
FOR THE
CITY OF STOUGHTON
DANE COUNTY, WISCONSIN

JOB NO.
1040.163

PROJECT MGR.
MAF

STRAND ASSOCIATES®

SHEET
EXHIBIT 1

File: S:\MAD\1000--1099\1040\163\Drawings\CAD\Civil 3d\SheetsOther\Coopers Causeway - Wetland Impacts.dwg Time: Mar 21, 2024 - 1:05pm