Devin Powers
Civil Solutions
131 Albert Ave
East Lansing, MI 48823

Tuesday, November 26th, 2019
Department of Civil & Environmental Engineering
428 S. Shaw Lane, Room 3577
East Lansing, MI 48824

RE: Grand River Bridge, Museum, and Brewery

Dear Erik Carlson,

Attached are the final hydraulic analysis and the proposal of the storm drain system for the reconstruction of the Impression 5 site.

If any questions or concerns arise, please contact me at powers88@msu.edu. Thank you and hope to hear from you soon.

Sincerely,

Devin Powers

Executive Summary

This technical report outlines the proposed stormwater management system and hydraulic analysis of the new proposed pedestrian bridge in downtown Lansing. The stormwater management system and hydraulic analysis is a portion of the preliminary design proposed by Civil Solutions, in which includes other major design aspects for the future site. This report will identify each aspect of the stormwater management system and hydraulic analysis design, research, drainage system, best management practices and miscellaneous features. A full plan and profile drawing is included in the Appendix.

Introduction

Civil Solution is pleased to be hired by the city of Lansing to preliminarily engineer the site plan for the new pedestrian bridge located in downtown Lansing on land acquired by the city. The bridge will be a major development for both the city and the surrounding businesses located downtown Lansing. The site will be a major development for both the impression 5 museum and the local business both east and west of the Grand River downtown Lansing. Civil Solution has proposed a preliminary site plan design that include the transportation design, brewery runoff treatment design, structural design of the bridge, pavement design, hydraulic analysis of the bridge and stormwater management design. This technical report completed by Civil Solution will serve as the summary of the initial project research, regulations adhered to, method for calculating results and discussion.

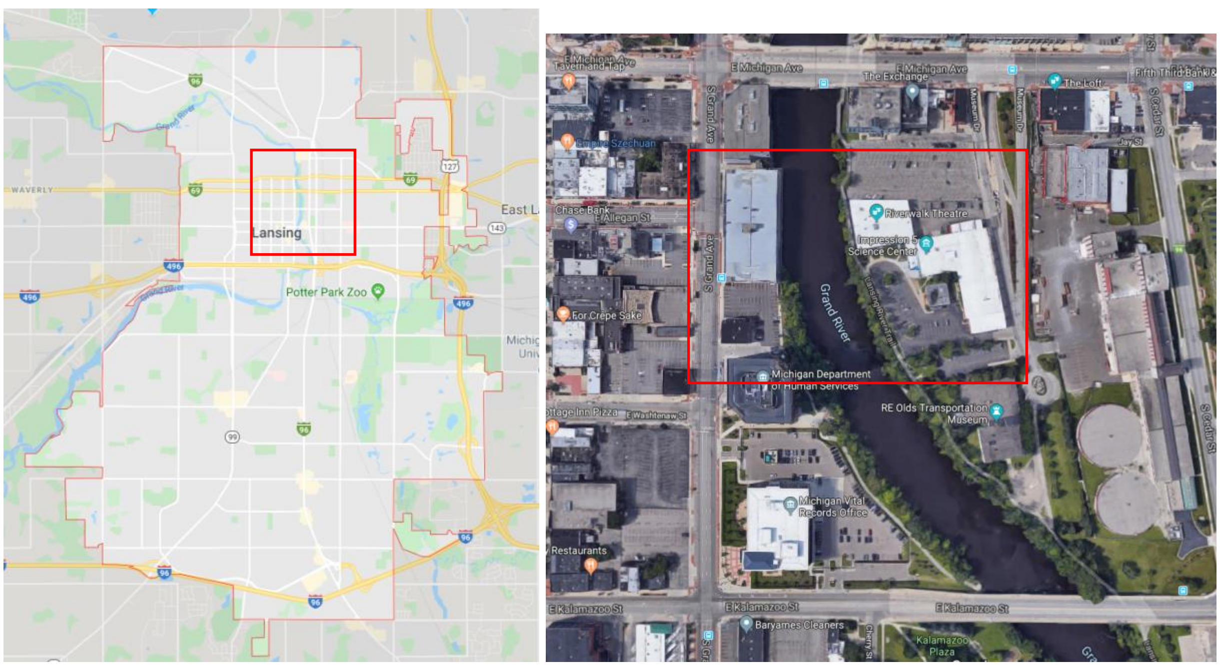

Figure 1: Project Location

Problem Statement

Motivated by finishing up my last semester, Civil Solution has proposed a preliminary design for the proposed pedestrian bridge in downtown Lansing. The contract for this preliminary design includes the following aspects:

- Show the hydraulic analysis report for where the new pedestrian bridge can be placed
- Design the storm water collection system
- Design the structural framing of the steel bridge
- Design the site circulation, including parking and driveways
- Design the paved surfaces for the roadway and parking lots
- Design the treatment for the brewery runoff
- Compute an itemized estimated cost based upon the proposed items of work

For all the preceding design aspects, Civil Solutions has sought to follow all applicable rules, regulations, company design and permits to present a design that is effective, safe, cost-effective, and environmentally considerate.

The hydraulic analysis and stormwater management system was designed to safeguard the site from destructive effects that could lead to threats to the public safety and welfare, destruction of property, and damage to the environment. The goals of the hydrology design were as follows:

- Prevent flooding
- Protected endangered species
- Pull permits

These goals were accomplished by social, environmental, and economic motives. The site location impacted each of these motives, and in turn, the goals. The location is in the City of Lansing and Ingham County, each of which have specific regulations related to the proposed types of infrastructure being built.

Scope

Civil solution design scope includes the aspects included in the preliminary design contract previously mentioned. The hydrology portion of this design includes the hydraulic analysis of the river and water drainage system. It also includes a cost estimate for the work to complete the construction of the system. The scope, however, does not include the final site plan specifics such as the grading plan for the site and the vegetation specification for the site. However, the design of the system took into consideration the existing grades and the anticipated changes due to building the bridge and updated parking lots. The scope of the design includes the general design of features, but not certain feature designs. Other scope exclusion will be presented throughout the report where necessary.

The following report will be broken into two parts. The first part will include the hydraulic analysis of the river. The second part of the report will include the proposed drainage design of the site. Following the two parts will be an appendix, which will include relevant permits, cost estimates, equations, and any extra figures.

PART ONE

HYDRAULIC REPORT

PREPARED BY:	**Devin Powers**
REVIEWED BY:	**Erik Carlson, P.E.** **Hydraulic Unit**
APPROVED BY:	**Dean Buch, Phd** **Head of Civil and Environmental Engineering** **Michigan State University**

SUMMARY

This hydraulic analysis was conducted to examine the backwater effect of the structure which carries a new proposed bridge over the Grand River in Ingham County. The new bridge in downtown Lansing is projected to be added within two years. The analysis found no harmful interference with the proposed conditions as compared with the existing condition for the 1% chance (100 year) flood event.

PROJECT DATA

STRUCTURE NUMBER	: A69		
CONTROL SECTION	: 42069		
JOB NUMBER	: 8008		
STREAM	: Grand River		
TOWNSHIP	: Lansing South		
COUNTY	: Ingham		
SECTION	: 69		
TOWN AND RANGE	: 04N02W/16		
DRAINAGE AREA	: 1227 sq. mi.		
DISCHARGE	:10-YEAR:	10700 cfs	
	50-YEAR:	16600 cfs	
	100-YEAR:	19400 cfs	
	500-YEAR:	26800 cfs	

METHOD OF ANALYSIS

The existing and proposed water surface profile were computed using the U.S. Army Corps of Engineers HEC-Ras Computer Program, Version 5.0.7.

SCOPE OF STUDY

The Grand River flows generally in western direction, eventually discharging into Lake Michigan in Grand Haven. The limits of this study approximately the existing subject crossing. Two other structures existed within the limits of the study.

The proposed structure is single span prestressed concrete box beam, with a span length (hydraulic width) of 218.25 feet. The proposed minimum bottom of beam elevation is 835 feet. The proposed structure will be skewed 0 degrees with the existing stream

GEOMETRY OF THE MODEL

A hydraulic survey of the cross-section of the river was obtained from F.I.S. for the City of Lansing. The survey data was recorded using a Total Station and a Data Collector. This data was converted to HEC-RAS .csv input file using a conversion program developed by the MDOT Design Support Unit.

The proposed structure and road information were entered based on proposed plans.

MANNING'S ROUGHNESS COEFFICIENT

Manning's roughness coefficient for the channel and floodplain were selected based on field inspection notes, photographs, and prior established values for similar floodplain conditions. These values were obtained from Table 5-6 Chow's Open-Channel Hydraulics (1959).

The channel, itself, consists primarily of sand with some brush overhanging into the channel. For the channel, a Manning's coefficient of 0.035 to 0.040 was employed in the model.

The left and right overbanks primarily consist of medium to tall trees with a medium to heavy brush. For the left and right overbanks, a Manning's coefficient of 0.100 to 0.120 was employed in the model.

EXPANSION AND CONTRACTION COEFFICIENTS

The range for the expression and contraction coefficient values in the model is listed on Table 1:

Table 1: Expansion and Contraction Coefficients

Cross-Section	Expansion	Contraction
Gradual Transition	0.5	0.3
Bridge Sections	0.5	0.3

STARTING WATER SURFACE ELEVATION

The downstream boundary conditions for the water surface elevations were taken from the F.I.S for the City of Lansing. A normal slope was computed by calculating the average slope of the left and right water surface elevations, provided by the hydraulic survey. The normal slope used in the model was 0.0003 feet/feet.

FINDINGS

The analysis performed indicates an improved condition with the proposed conditions for the 1% storm condition. The attached summary table describes this improvement.

APPENDICES

SUMMARY TABLE
LOCATION MAP AND MAP OF CROSS SECTION LOCATIONS
STREAM PROFILE
MDEQ DISCHARGE ESTIMATES
PHOTOGRAPHS
COMPUTER INPUT AND OUTPUT (FOLDER)

SUMMARY TABLE

50 - YEAR FLOOD FREQUENCY: EXISTING VS. PROPOSED CONDITION ELEVATION ARE IN NAVD88

SEC NO	**VELOCITY IN CHANNEL (FPS)**		**TOP WIDTH (FT)**		**ENERGY GRADE (FT)**		**CHANGE IN ENERGY (FT)**	**COMPUTED WSEL (FT)**		**CHANGE IN WSEL (FT)**
	EX	PROP	EX	PROP	EX	PROP		EX	PROP	
96	4.79	4.79	597.67	597.67	831.73	831.73	0	831.44	831.44	0
92.6	6.99	6.99	391.90	391.90	831.20	831.20	0	830.51	830.51	0
92	BRIDGE									
91.9	7.12	7.12	391.90	391.90	831.12	831.12	0	830.39	830.39	0
91	6.75	6.75	221.99	221.99	830.67	830.66	0.01	829.99	829.99	0

90.501	BRIDGE									
90.5	6.94	6.94	196.84	196.84	830.65	830.65	0	829.92	829.92	0
90	5.43	5.43	220.05	220.05	830.55	830.55	0	830.10	830.10	0
89.4	4.98	4.98	230.00	230.00	830.41	830.41	0	830.02	830.02	0
89.05	BRIDGE									
89	4.98	4.98	230.00	230.00	829.94	829.94	0	829.92	829.92	0
88.9	5.03	5.03	230.00	230.00	829.89	829.89	0	830.10	830.10	0

VICINITY MAP

AND
MAP CROSS SECTION LOCATIONS

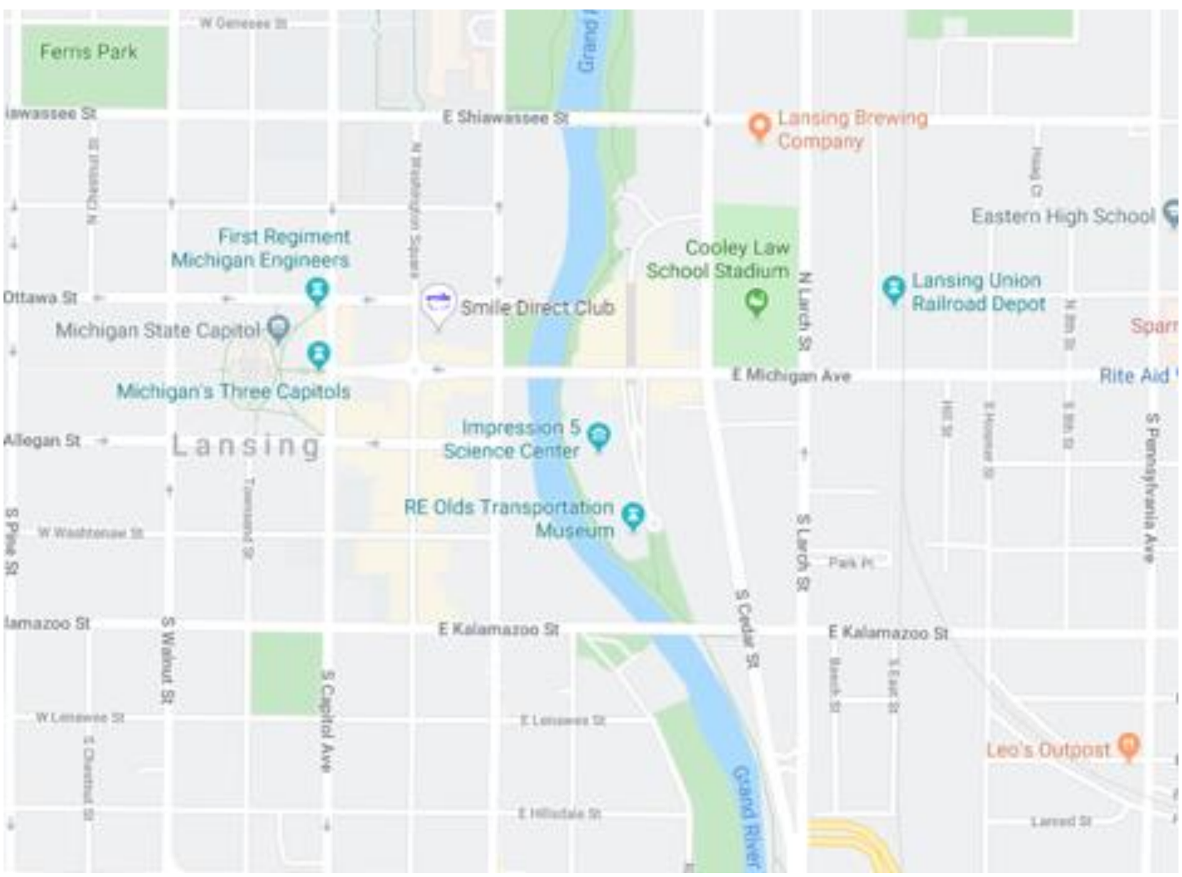

Figure 2: Vicinity Map

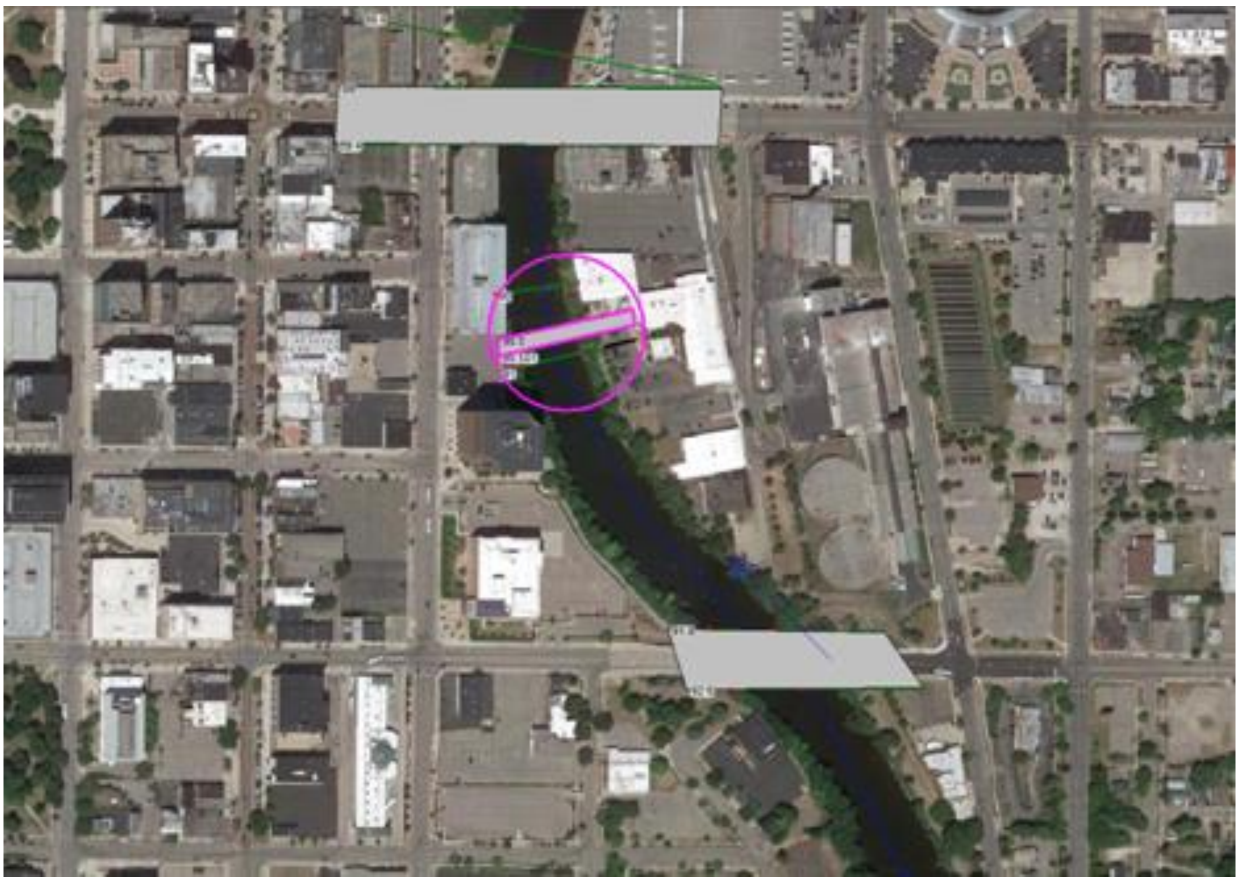

Figure 3: Aerial Photo Showing Approximate Cross-Section Locations

Figure 4: Existing Pan View

Figure 5: Proposed Bridge

STREAM PROFILE

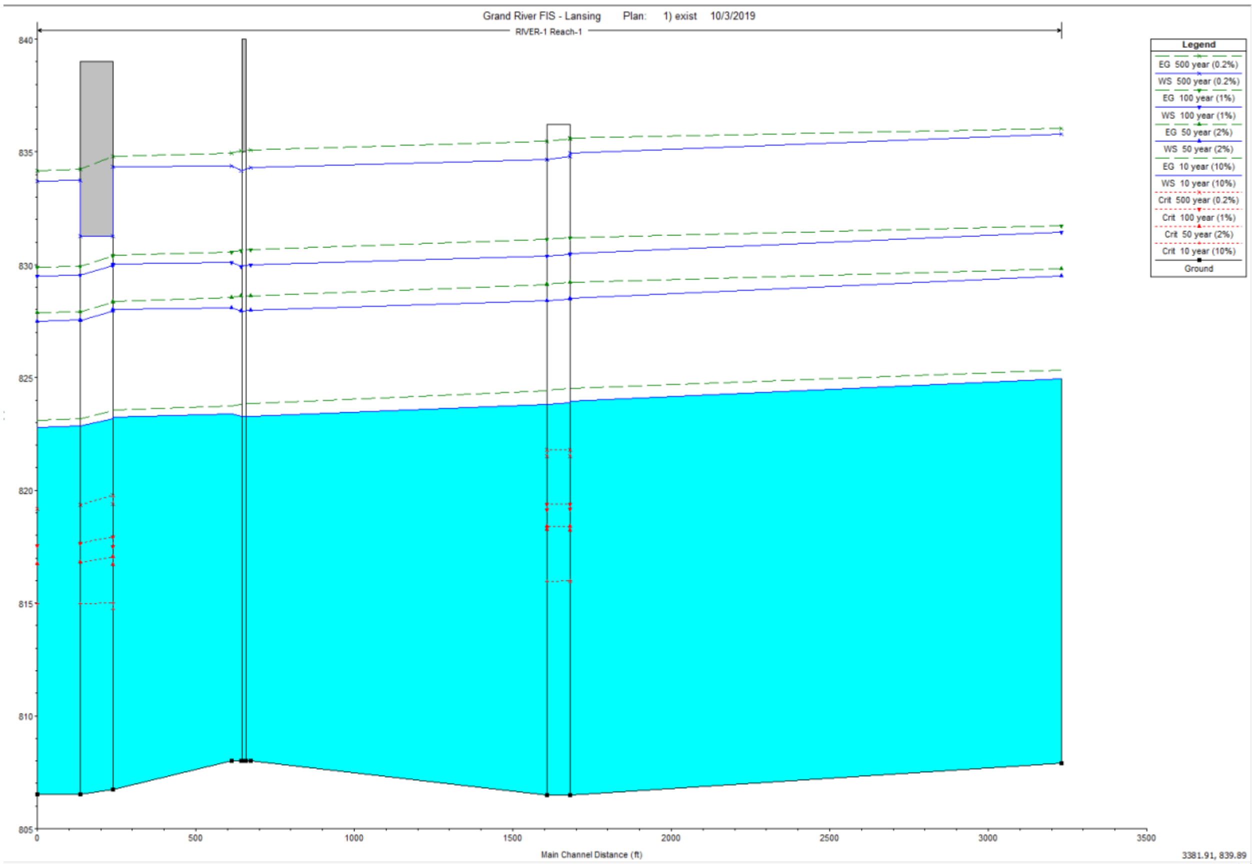

Figure 6: Existing Profile

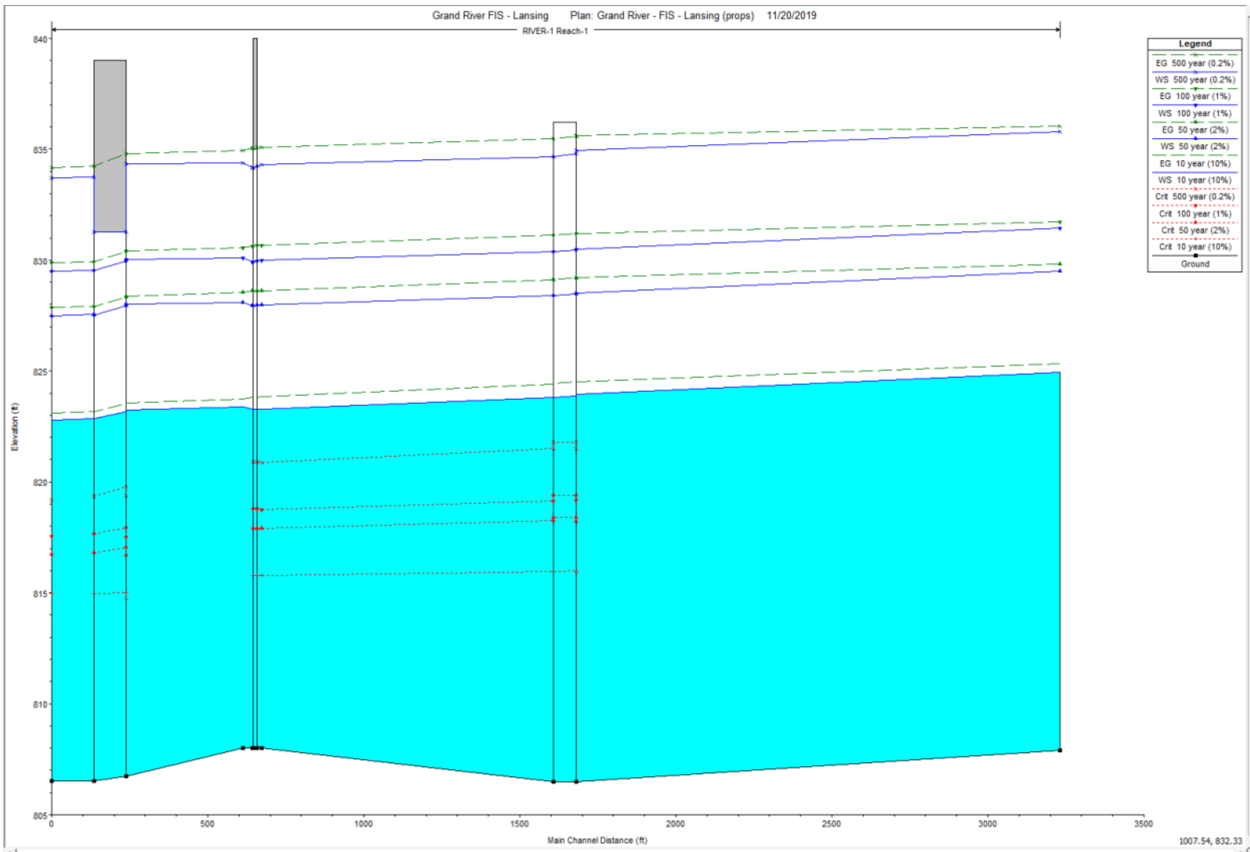

Figure 7: Proposed Profile

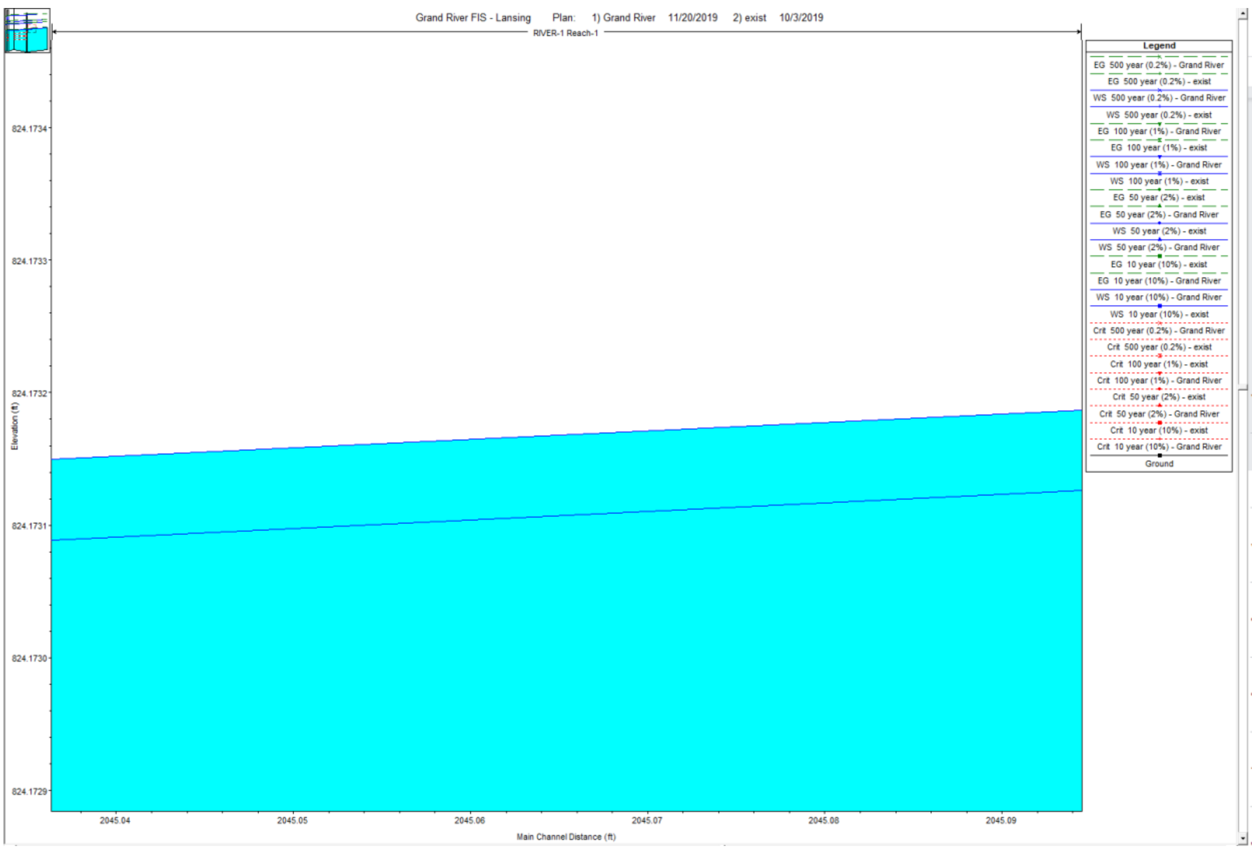

Figure 8: Difference in Elevation

PHOTOGRAPHS


Photo 1: Bridge on Michigan Street


Photo 2: Grand River


Photo 3: Beautiful flowers on ledge next to Grand Rivers

PART 2

Executive Summary

This report was prepared to examine the stormwater management of the redevelopment site project in downtown Lansing for the purposes of evaluating existing conditions and designing proposed drainage facilities including storm sewers and BMPs.

Introduction

The redevelopment site project is in Ingham County in the City of Lansing Michigan. The project extends in the parking lot of the Impression 5 museum on Museum Dr and across the Grand River in a parking lot on South Grand Ave.

Control Section: 4269
Job Number: 8008
Federal Project Number: 1234

The project includes designing a new pedestrian bridge, new reconstruction of pavements, and drainage system.

Basis of Design

List of Standards Followed:

- MDOT Drainage Manual
- MDOT BMP

Table 2 Summarizes the criteria used for determining the appropriate hydrologic modeling approach.

Table 2: Hydrology Design Criteria		
Item	Reference	Method
Drainage are less than or equal to 20 acres	MDOT DM 3.3.7	Rational Method
Drainage area between 20 acres and 2 square miles- Time of concentration less than 1 hour	MDOT DM 3.3.7	WinTR-55
Drainage area between 20 acres and 2 square miles – Time of concentration equal to or greater than 1 hour	MDOT DM 3.3.7	Michigan Department of Environmental Quality (MDEQ) "Computing Flood Discharges for Small Ungaged Watershed" Spreadsheet
Drainage area equal to or exceeding 2 square miles	MDOT DM 3.3.7	Request from MDEQ Hydrologic Studies Unit

Table 3 Summarizes the criteria used for determining the appropriate hydraulic modeling approach

Table 3: Hydraulics Design Criteria		
Item	Reference	Criteria
Culverts		
Design Storm	MDOT DM 5.3.2	50-year storm, no harmful interference for 100-year storm
Minimum size	Book 2,12.3.2.4	24". No Multiple Culverts Allowed
Manning's n	Book 2,12.3.2.4	Standard end sections: 0.5, Mitered end sections: 0.7, cast in place wing walls: 0.2
Allowable Headwater	Book 2,12.3.2.4 MDOT DM 5.3.4	Headwater at least 1.5' below edge of shoulder for 50 year storm and no pressure flow.
Outlet Velocity	MDOT DM 5.3.4	Provide riprap for culverts if outlet velocity is greater than 6 fps for 2 percent event.
Analysis Programs	MDOT DM 5.3.1	Culverts draining less than two (2) square miles using HY8 or HEC-RAS for analysis. Culvert and bridge
Storm Sewer		
Design Storm	MDOT DM 7.4.1	10-year storm

Inlet Spacing	MDOT DM 7.4.3.4 & 7.4.3.6	Contain spread within the shoulders for a 10-year storm for locations with shoulders. If no shoulders present, spread to be no greater than 3 feet into the travel lane.
Minimum Size	MDOT DM 7 .4.8.3	Storm sewers, including cross leads, shall have a minimum diameter of 12".
C Values	MDOT DM 3.4.1.4	0.9 for paved areas, 0.2 for grass
Time of Concentration	MDOT DM 7 3.7 and 3.4.1.4	Minimum 15 minutes at upper end of sewer for non-depressed roadway
Allowable Velocity	MDOT DM 7.4.8.4	Between 3 and 12 fps
Minimum Cover	MDOT DM 7.4.8.1	Storm sewer pipe should be placed below the pavement section or have a minimum of three feet of cover, whichever is greater
Minimum Slope	MDOT DM 7.4.8.4	12"- 0.48% 30"- 0.15% 15"- 0.36% 35"- 0.12% 18"- 0.28% 42"- 0.12% 24"- 0.17% 48"- 0.10%
Minimum Structure Size	MDOT DM 7 .4.7.3	The following apply for sewer deflections between 135 and 180 degrees and pipes 48" and less. For others, see MDOT DM 7.4.7.3 and MDOT DM Table 7 – 4 4' structure – sewer pipes 24" and under 5' structure – sewer pipes 30" to 36" 6' structure – sewer pipes 42" to 48"
Sizing and Spread Analysis	MDOT DM 7.4.9	Geopak Drainage
Other Drainage Feature		
Ditches	MDOT DM 4.4.1	Manning's Equation
Bridges	MDOT DM 5.3.1	HEC-RAS for Analysis
Detention Basins	MDOT DM 8.4.7	Hydrograph Routing Procedure
Water Quality	Book 2, 12.3.2.6, MDOT DM 8.4.3	90% Non-Exceedance Storms to be treated to remove 80% Total Suspended Solids Design

		of Stormwater Filtering Systems (MDEQ)

Evaluation of Existing Drainage

Two-existing Areas were identified where old drainage system was located, shown in figures 9 and 10 below. The current system is outdated and unsalvageable.

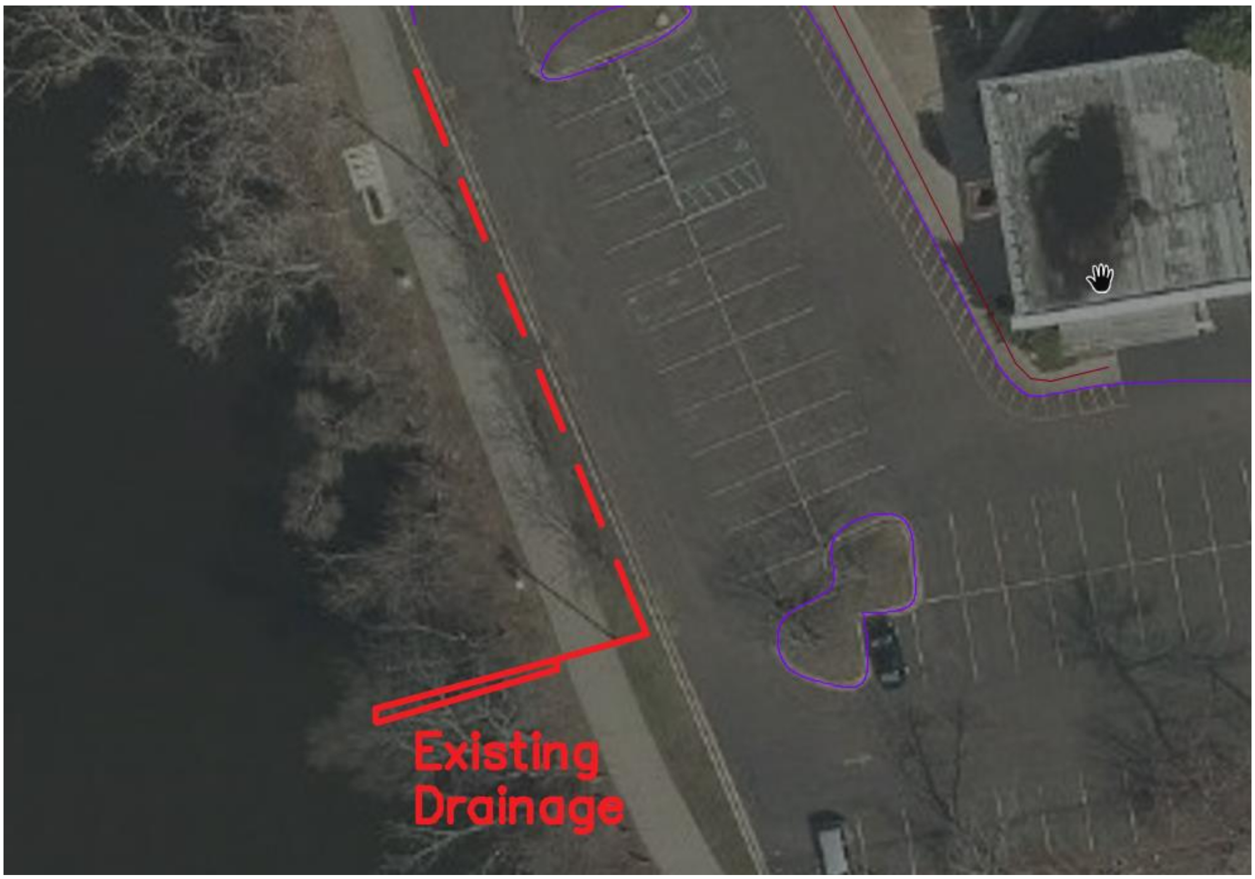

Figure 9: Existing Drainage System at Site on East Side

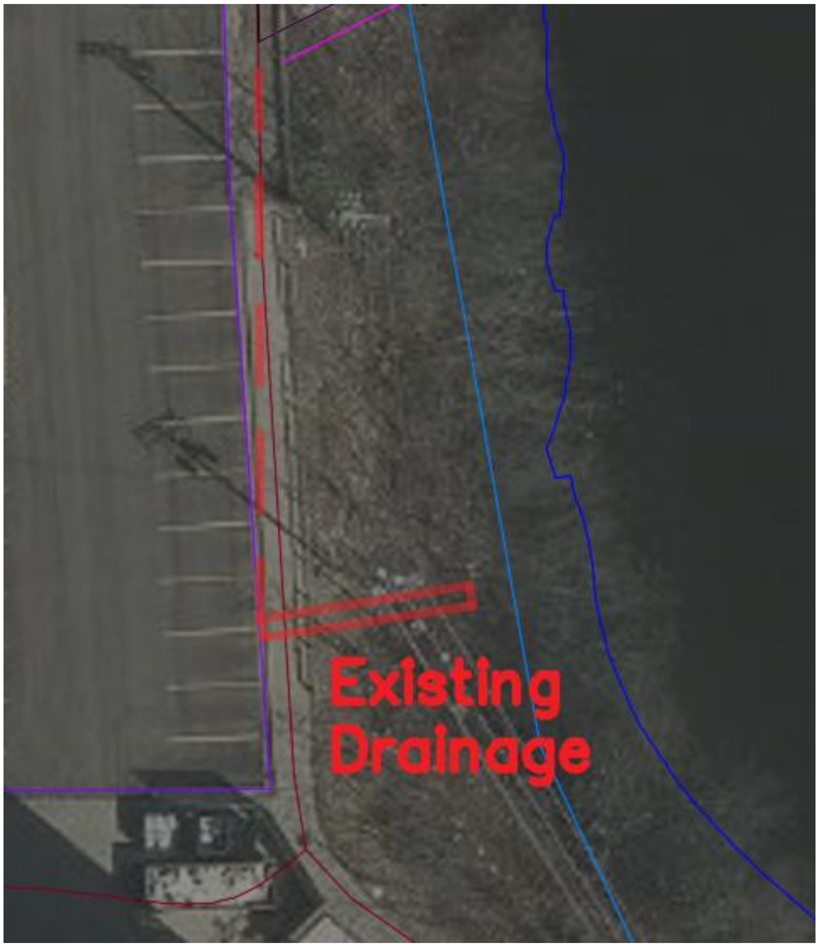

Figure 10: Existing Drainage System at Site on West Side

Evaluation of Proposed Drainage

The proposed recommendation for addressing storm water management for the proposed bridge is to maintain flow patterns outlets and provide attenuation for any increase in peak discharge values over existing conditions. The new proposed drainage system is broken into 6 different catchment areas, the coefficients inlet times along with the runoff coefficients are shown in table X below. The proposed drainage design is shown in figure 11. The new proposed drainage system consists of six 36" and one 48" drainage manholes. The rational method was used to calculate the peak flow and then Manning's equation was used to find the diameter of the concrete pipes. Tables 4 and 5 show the length, diameter, velocity and peak Q at the inlets.

Figure 11: New Proposed Drainage System

Catchment Characteristics				
Unit #	Area (acres)	Runoff Coefficent	Inlet Time (min)	Ac
1	0.41877542	0.97	15	0.4062121574
2	0.673257517	0.93	15	0.6261294908
3	0.816572962	0.97	15	0.7920757731
4	0.767919193	0.97	15	0.7448816172
5	0.160831209	0.8	15	0.1286649672
6	0.362997283	0.95	15	0.3448474189

Table 4: Catchment Characteristics

Pipeline	Length (ft)	Diameter (in)	Velocity (ft/s)
Inlet 1 to Inlet 2	159	12	2.313
Inlet 2 to Inlet 3	63	12	5.748
Inlet 4 to inlet 3	178	12	4.511
inlet 5 to inlet 3	126	12	0.7329
inlet 3 to Outlet	43	18	6.044
Inlet 7 to Inlet 6	87	12	0.9826
Inlet 6 to Outlet	38	12	0.9355

Table 5: Proposed Pipe Network Sizes

Inlet	Peak Q (ft^2/s)
1	1.817
2	4.515
3	11.202
4	1.142
5	0.576
6	0.771
7	0.734

Table 6: Discharge in Each Pipe Segment

Best Management Practices

Best Management Practices are for providing the most effective and practical means of preventing and reducing non-point pollutants into the watershed. BMPS reduce runoff volume, filter pollutants, provide habitat for endangered turtles, recharge groundwater and enhance site aesthetics. Four proposed rain gardens are proposed, shown in figure 4. Calculations for the Bioretention without an underdrain is shown in tables XX and XX.

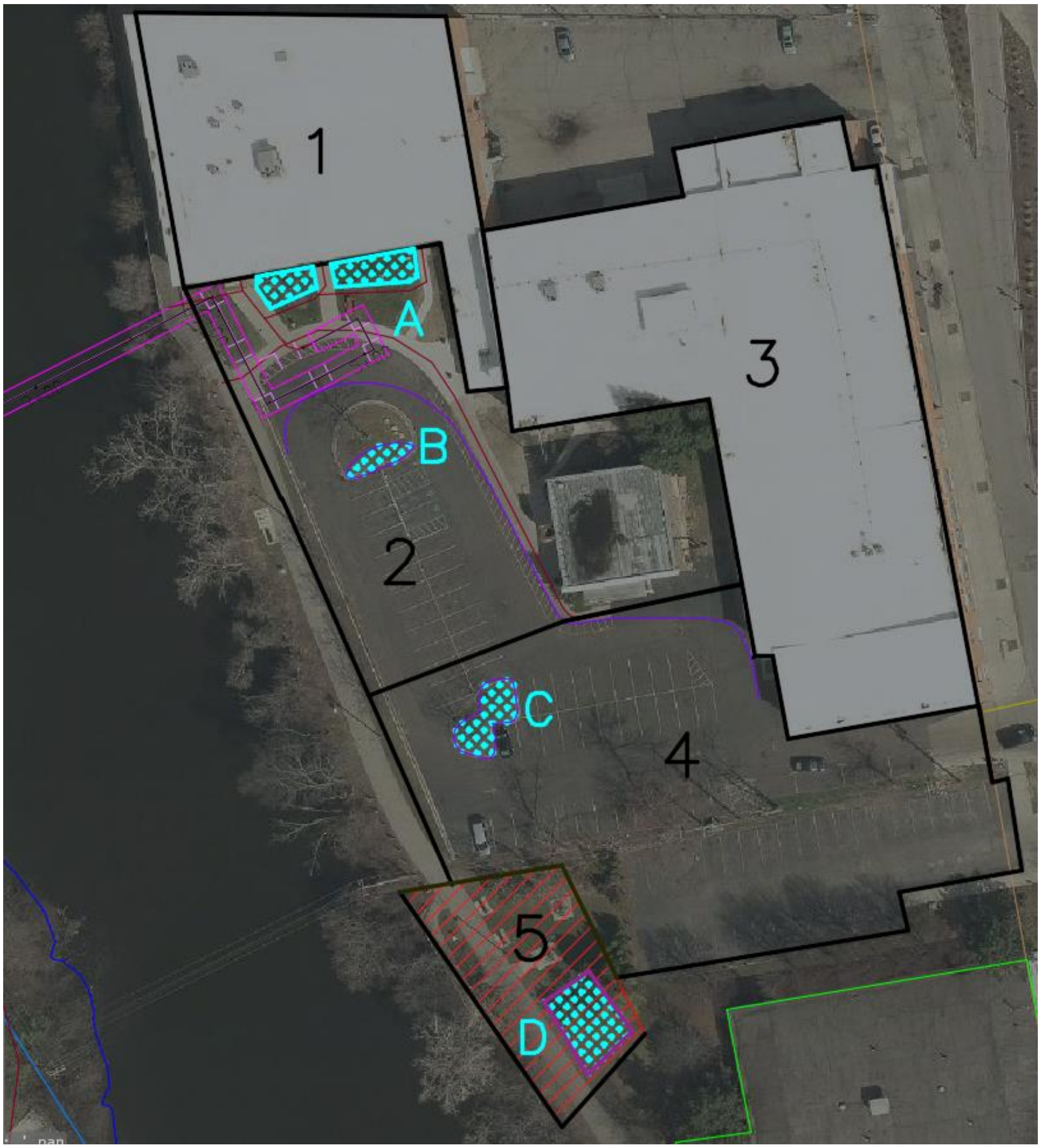

Figure 12: Best Management Process (Rain Gardens)

Bioretention Sizing		
	Impervious	Pervious
%	90%	10%
CN	98	75
S	0.204081633	3.333333333
Q (in)	0.69427318	0.015264798
V(ft^3)	7259.797261	17.73546757

Table 7: Bioretention Sizing

Sizing of Bioretention	
V(ft^3)	7277.532729
k(ft/day)	2.2
hf (ft)	0.5
df (ft)	2
tf (day)	2
Af (ft^2)	1323.187769

Table: 8: Sizing of the Bioretention

Rain Gardens	Area (ft2)
A	847.61
B	255.54
C	552.07
D	975.64
Total Area(ft2)	2630.86

Table 9: Size of the Proposed Rain Gardens

The bioretention area was calculated using a two-step process. The first process calculated the initial sizing, shown in tables 7 and 8. Then the size of the bioretention was compared with the size of the proposed rain gardens. Since the size of the proposed rain gardens in table 9 is larger than the bioretention sizing (1323.18 ft2), the proposed bioretention will work for the site.

<u>Cost of Drainage System and Rain Gardens</u>

The cost of the drainage system and the rain gardens are determined in tables 10 and 11 shown below. The estimated cost of the materials is $85,750.70.

Pay Item	Unit	Unit Cost	Quantity	Total Cost
12" Concrete Pipe, Trench Type B	ft	$43.17	613	$26,463.21
18" Concrete Pipe, Trench Type B	ft	$64.30	43	$2,764.90
48" Manhole	Each	$7,744.00	1	$7,744.00
36" Drainage Structure	Each	$1,750.00	6	$10,500.00
Cover Type R for 36" Drainage	Each	$656.10	6	$3,936.60
Cover for 48" Manhole	Each	$7,744.00	1	$7,744.00
			Total	$59,152.71

Table 10: Cost of Drainage System

Pay Item	Unit	Unit Cost	Quantity	Total Cost
Geotexitile Fabric	square feet	$2.49	2630.86	$6,550.84
Topsoil (12 inches)	square feet	$7.50	2630.86	$19,731.45
Mulch	square feet	$0.12	2630.86	$315.70
			Total	$26,597.99

Table 11: Cost of Rain Gardens

Appendix

Permits

For the River:

NREPA Part 13
Floodplains and Floodways
- 100 -year flood
- the channel must not cause any harmful interference
- must apply for a permit
- A hydraulic report, based on the water surface profile computations shall be prepared and sealed by an engineer licensed in the state of Michigan
- A site development plan showing the existing and proposed conditions must be included

Part 301 (For Inland Lakes and Streams)
- Applies when bottomland dredging (removing or adding of rock)
- Placement of a structure (bridge)
- A permit shall provide the work authorized shall be completed within a specific term, normally not more than a year
- In each application for a permit, all existing and potential adverse environmental effects shall be determined and the department shall not issue a permit unless the department determines the environmental impact to be minimal
- Riprap shore protection structures, if original materials have been displaced by erosion or ice damage and the placement of earthen

For the Drainage System:

NREPA Part 31

MS4 Permit
- To reduce the discharge of pollutants to surface waters of the State
- MS4 is a drainage system of drainage (including roads, storm drains, pipes, and ditches, etc.)

Equations

Rational Equation:

$$Q = C_f C i A$$

Where:

Q = Peak Discharge (ft3/s)
C = Rational Method Runoff Coefficient
i = Average RainFall Intensity (inch/hr)
A = Drainage Area (Acres)
C_f = Frequency Correction Factor

Manning's Equation:

$$Q = \frac{1.49}{n} * A * R^{\frac{2}{3}} * S^{\frac{1}{2}}$$

Where,
Q = Peak Discharge (ft3/s)
n = Manning's Roughness Coefficient (unitless)
A = Flow Area (ft2)
R = Hydraulic Radius (ft)
S = Slope of Energy Gradient (ft/ft)
n = 0.014 for concrete pipes

Bernoulli (Energy) Equation:

$$\boldsymbol{Z_1 + \frac{P_1}{pg} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{pg} + \frac{V_2^2}{2g} + h_L}$$

Z = Elevation
P = Pressure
p = density of water
g = gravity
V = velocity
h_L= Head Loss

Bioretention Calculations:

$$S = \frac{1000}{RCN} - 10$$

Where:

RCN = Runoff Curve Number

$$SRO = \frac{(P - 0.2S)^2}{P + 0.8S}$$

Where:

P = 90 percent non exceedance storm value (0.90 for Lansing)

Without an underdrain:

$$A_f = Vd_f \ / \ [i \ + (h_f + d_f)t_f]$$

where:
A_f = surface area of filter bed (ft^2)
V = required storage volume (ft^3)
d_f =filter bed depth (ft)
k =coefficient of permeability of filter media (ft/day)
i - infiltration rate of underlig soils (ft/day)
h_f = average height of water above filter bed (ft)
t_f = design filter bed drain time (days)

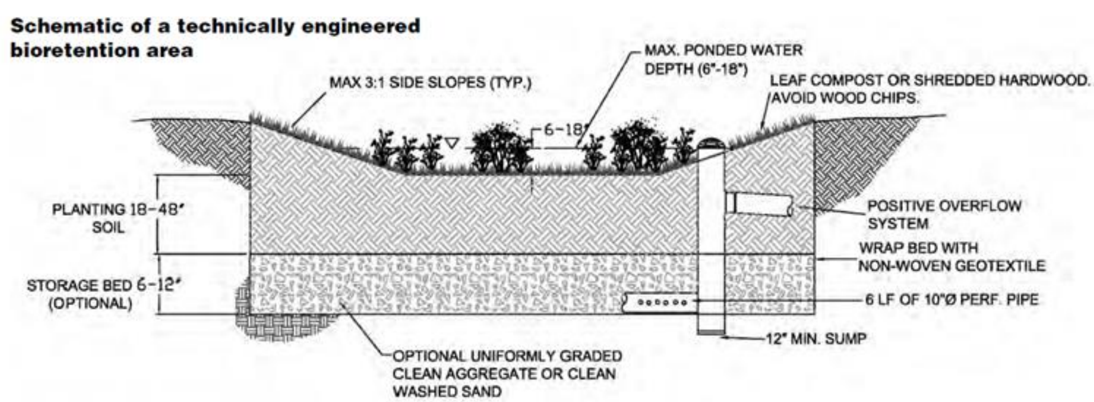

Figure 13: Proposed Bioretention Area

Additional Photos

Figure 14: Pipe Sizes on Proposed Design

Drainage System 1				
Pipe ID	Length (ft)	Ground Slope	Velocity (ft/s)	Time(min)
Inlet 1 to Inlet 2	159	0.03	5	0.53
Inlet 2 to Inlet 3	63	0.03	5	0.21
Inlet 4 to inlet 3	178	0.03	5	0.593333333
inlet 5 to inlet 3	126	0.03	5	0.42
inlet 3 to Outlet	43	0.03	5	0.143333333

Iteration 1				
Manhole	Highest tc	tc (min)	I (in/min)	Peak Q (ft^2/s)
Inlet 1	Area 1	15	4.473684211	1.817264915
Inlet 2	Area 2 + (Inlet 1 to Inlet 2)	15.53	4.412146379	4.554842465
Inlet 3	Area 4 +(1 to 2 + 2 to 3 + 5 to 3 + 4 to 3)	16.75333333	4.276370954	11.53749491
Inlet 4	Area 3	15	4.473684211	3.33236513
Inlet 5	Area 5	15	4.473684211	0.575606432

Pipeline	Length (ft)	Ground Slope	Velocity (ft/s)	Time (min)	Diameter (ft)	Diameter (in)	Commerical Pipe (in)	Velocity Check (ft/s)
Inlet 1 to Inlet 2	159	0.03	5	0.53	0.667114789	8.005377468	12	2.313815507
Inlet 2 to Inlet 3	63	0.03	5	0.21	0.94155618	11.29867416	12	5.799410446
Inlet 4 to inlet 3	178	0.03	5	0.593333333	0.837434687	10.04921625	12	4.242902644
inlet 5 to inlet 3	126	0.03	5	0.42	0.433476784	5.201721402	12	0.732885491
inlet 3 to Outlet	43	0.03	5	0.143333333	1.334168088	16.01001706	18	6.528892078

Iteration 2				
Manhole	Highest tc	tc (min)	I (in/min)	Peak Q (ft^2/s)
Inlet 1	Area 1	15	4.473684211	1.817264915
Inlet 2	Area 2 + (Inlet 1 to Inlet 2)	15.87313793	4.373199826	4.514636316
Inlet 3	Area 4 +(1 to 2 + 2 to 3 + 5 to 3 + 4 to 3)	23.17557096	3.681600388	11.20241572
Inlet 4	Area 3	15	1.533333333	1.142151813
Inlet 5	Area 5	15	4.473684211	0.575606432

Pipeline	Length (ft)	Ground Slope	Velocity (ft/s)	Time (min)	Diameter (ft)	Diameter (in)	Commerical Pipe	Velocity Check
Inlet 1 to Inlet 2	159	0.03	2.313815507	0.873137927	0.667114789	8.005377468	12	2.313881795
Inlet 2 to Inlet 3	63	0.03	5.799410446	5.523248043	0.938430829	11.26116995	15	3.678965134
Inlet 4 to inlet 3	178	0.03	4.242902644	1.430191903	0.560486511	6.725838136	18	0.646344775
inlet 5 to inlet 3	126	0.03	0.732885491	0.348993091	0.433476784	5.201721402	12	0.732906487
inlet 3 to Outlet	43	0.03	6.528892078	9.110081969	1.319503692	15.83404431	18	6.339457498

Iteration 3				
Manhole	Highest tc	tc (min)	I (in/min)	Peak Q (ft^2/s)
Inlet 1	Area 1	15	4.473684211	1.817264915
Inlet 2	Area 2 + (Inlet 1 to Inlet 2)	15.87316294	4.373197011	4.514633411
Inlet 3	Area 4 +(1 to 2 + 2 to 3 + 5 to 3 + 4 to 3)	19.94381137	3.958661203	10.68032544
Inlet 4	Area 3	15	4.473684211	3.54349688
Inlet 5	Area 5	15	4.473684211	0.575606432

Figure 15: Pipe Sizes Calculations