TRANSPORTATION PROJECT REPORT

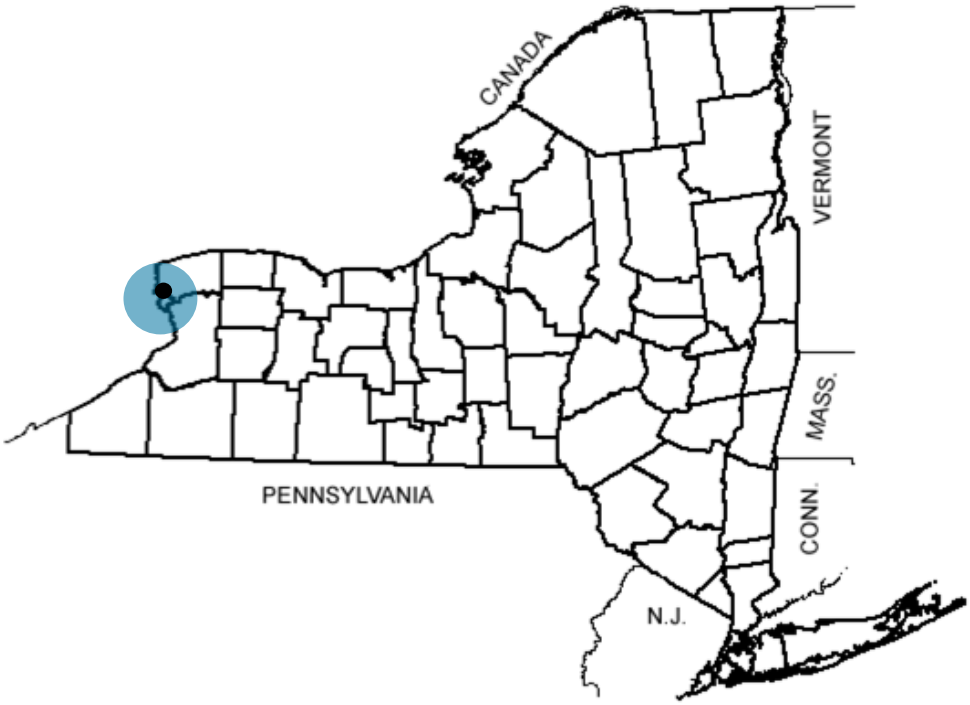
DRAFT DESIGN REPORT / DRAFT ENVIRONMENTAL IMPACT STATEMENT / DRAFT 4(f) EVALUATION

APPENDIX B5

Stormwater

November 2016

PIN 5470.22
NYS Route 198 (Scajaquada Expressway Corridor)
Grant Street Interchange to Parkside Avenue Intersection
City of Buffalo
Erie County



NEW YORK STATE OF OPPORTUNITY. Department of Transportation

ANDREW M. CUOMO
Governor

MATTHEW J. DRISCOLL
Commissioner

U.S. Department of Transportation
Federal Highway Administration

APPENDIX B5
Stormwater

TABLE OF CONTENTS

B5.1. Introduction

NYS Route 198 (the Scajaquada Expressway) within the project area is an Urban Principal Arterial Expressway on the National Highway System connecting Grant Street and Parkside Avenue with traffic volumes between 38,000 and 50,000 vehicles per day, a posted speed limit of 30 mph, and grade separated interchanges. While providing an important transportation function, the Scajaquada Expressway is out of context with much of its surroundings, which includes a nationally renowned art gallery, educational institutions, a historic cemetery, historic buildings, residential neighborhoods, the aesthetic and historic Olmsted-designed Delaware Park, and Scajaquada Creek.

The purpose of this action is to address transportation deficiencies, including:

- Geometric features that do not meet current expressway standards
- Traffic congestion that occurs at one or more locations during peak periods
- Disparity between vehicular operating speeds, the posted speed limit, and design speed
- Higher than expected accident rates, accident severity, and identifiable accident patterns
- Deteriorating drainage systems that no longer function as designed and release untreated storm water into Scajaquada Creek

Furthermore, this action is also to convert the Scajaquada Expressway into a feasible and prudent Urban Principal Arterial (non-expressway) transportation facility that operates in a safe manner and in greater harmony with the surrounding community character and natural environment. This involves providing improved visual and functional connectivity between the various features and resources throughout the adjacent area.

B5.2. Alternative Description

The Build Alternative addresses the needs of the Scajaquada corridor by transforming NYS Route 198 from an urban expressway into an urban boulevard with two travel lanes in each direction between Grant Street and Parkside Avenue, in its current location. Ramps at Grant Street, Elmwood Avenue, and Delaware Avenue would be replaced with connecting roadways. Roundabouts or signalized intersections would be constructed where each connecting roadway meets NYS Route 198. Parkside Avenue would remain a signalized intersection because a roundabout would not have adequate capacity to handle the expected volume of traffic, resulting in congestion and backups along both NYS Route 198 and Parkside Avenue. Transition zones would be developed using appropriate geometric and traffic calming features just west of Grant Street and just east of Parkside Avenue to encourage lower speeds and to signify entry to the corridor.

B5.3. Watershed Area

The watershed area identified within the project area is Scajaquada Creek, which also contains sub-watershed areas for the adjacent Mirror and Hoyt Lakes. It is noted that Scajaquada Creek and Hoyt Lake ("Delaware Park Lake") are listed on the Final New York State 2014 Section 303(d) List of Impaired Waters Requiring a TMDL. For the Build Alternative, approximately 34.2 acres (138,461 square meters) of post-construction disturbed impervious area would drain into Scajaquada Creek, Mirror Lake, and Hoyt Lake. The post-construction impervious area would be a reduction of 5.3% of the existing 36.1 acres (square meters) of impervious area. The preliminary values assume all roadways, sidewalks, and shared-use pathways as impervious surfaces.

B5.4. SPDES General Permit Requirements and Concepts

Site disturbance for the Build Alternative is calculated to be greater than 1 acre (0.4 hectare), therefore, a Stormwater Pollution Prevention Plan (SWPPP) would be required for compliance with the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity (Permit No. GP-0-15-002).

The project SWPPP document would include the following requirements: Erosion and Sediment Control (E&SC) Plans; description of the reduction in stream channel erosion, application of runoff reduction via green infrastructure techniques, prevention of overbank flooding and control of extreme flood events (water quantity controls), and stormwater management practices to provide for pollutant removal (water quality controls).

For the Build Alternative, E&SC measures would potentially include silt fence, drainage structure inlet protection, pipe inlet/outlet protection – pipe slope drain, stone check dams, stabilized construction entrances, seeding/soil stabilization operations and other practices as appropriate.

As this project involves disturbance and reconstruction of existing impervious surfaces, including realigning, replacing and removal of existing roadways with an overall reduction of impervious area, the entire project is being treated as redevelopment activities. Water quantity controls (Channel Protection Volume (Cpv), Overbank Flood (Qp), and Extreme Storm (Qf)) for the project that discharges into Scajaquada Creek, Mirror Lake, and Hoyt Lake would be waived. Redevelopment criteria in Chapter 9 of the NYS Stormwater Design Manual (SMDM 2015) state in Section 9.2.1 "Sizing Criteria" that if redevelopment activities result in no change to hydrology that increases the discharge rate from the project site, the 10-year and 100-year criteria do not apply. Discharge rates of stormwater runoff into Scajaquada Creek, Mirror Lake, and Hoyt Lake will not be increased because there is a proposed reduction in impervious cover within the project area.

For water quality control, the water quality volume (WQv) calculation assumes a disturbed area of approximately 65 acres (262,208 square meters). The actual disturbed area will be refined as the project details are developed during final design.

$$WQv = \frac{[(P)(Rv)(A)]}{12}$$

Where:
WQv = water quality volume in (acre-feet)
P = 90% rainfall event number (inches)
Rv = 0.05+0.009(I), where I % impervious cover
A = contributing area (acres)

It is assumed that the project will be constructed in two stages. It is typically required that for each stage of construction, stormwater management features be constructed in that stage, or possibly a prior stage that meets the requirements for that stage. The current proposed construction sequence includes: Contract 1 (Elmwood Avenue Section and Delaware Avenue to Parkside Avenue Section); and Contract 2 (Grant Street Section).

Required WQv's were calculated for each stage based on the amount of impervious surface and disturbed area in each stage. Both Contracts 1 and 2 have net impervious surface reduction. Exhibit A depicts the existing and redeveloped impervious areas. Within Contract 1, due to the constraints of the project, including lack of right-of-way, adjacent parkland, topography, etc., the WQv will be treated solely by non-standard underground hydrodynamic separators, a proprietary alternative device approved by NYSDEC as a method of water quality treatment. As such, the required treatment volume by alternative practices for Contract 1 is computed using the following calculation:

%WQv Treatment by Alternative Practices = {25 – (%Impervious Cover Reduction - % WQV treated by Standard Practices - % Runoff Reduction)} * 3

Contract 1 (Elmwood Avenue and Delaware Avenue to Parkside Avenue Sections) %WQv Treatment by Alternative Practices = {25 – (4 – 0 – 0)} x 3 = 63% of the WQv for redevelopment activities.

Contract 2 (Grant Street Section) will be treated by standard practice treatments, and thus is only required to provide 25% of the WQv for redevelopment activities.

Several potential water quality treatment areas have been identified within the project area to meet the water quality treatment volume requirements of the proposed activities. At this time, treatment areas have been identified to provide the necessary treatment within each stage. The proposed water quality treatments include wet swales, bioretention areas and hydrodynamic separators spread throughout the project corridor. Exhibit B depicts the approximate location of the potential water quality management areas.

The following table gives an approximate break up of water quality requirements and facilities provided assuming a three stage construction. Detailed calculations are located in Exhibit D.

Table B5.4-1
Summary of Water Quality Volumes by Stage

Stage	Contract 1	Contract 2
Approximate Limits	Elmwood Avenue and Delaware Avenue to Parkside Avenue Sections	Grant Street Section
Water Quality Volume Required	1.375 ac-ft (1,696 m^3)	0.164 ac-ft (202 m^3)
Number of Facilities Provided	9	4
Facility Types	Hydrodynamic Separators	Bioretention Wet Swales
Water Quality Volume Provided	1.686 ac-ft (2,080m^3)	0.342 ac-ft (422 m^3)
Net Water Quality Volume	+0.311 ac-ft (+384 m^3)	+0.178 ac-ft (+220 m^3)

The proposed hydrodynamic separators within Contract 1 will be designed to treat roadway runoff within the corridor and be placed beneath the roadway or adjacent to the roadway minimizing the need for additional right-of-way and impacts to the adjacent Delaware Park. The exact configuration of the devices will be determined during final design. The relatively high bedrock conditions in the project corridor (which is known to range between 7 and 14 feet below grade) is of concern for underground treatment. Borings and rock cores will be conducted during final design to ensure that the proposed locations of the underground facilities will be constructible. The effects associated with potential adjustments to the hydrodynamic separators will be determined during final design.

Additionally, all of the proposed shared-use paths throughout the corridor are currently assumed to be impervious surfaces. Conversion of portions of the shared-use paths to pervious surfaces including pervious pavement will be determined during final design. The conversion of these areas to pervious surfaces will further reduce the amount of stormwater treatment required.

Options for treating portions of impervious surfaces on the Buffalo State campus within the project corridor would be further investigated during final design. If reasonable, additional water quality treatment would be added to the western construction stage.

The project construction staging and sequencing has not yet been finalized, and as a result, the amount of disturbed area open at one time during construction has not been established. The E&SC Plan would include appropriate measures to address the final design. The NYSDEC has set regulations for Effluent Limitations for all projects covered under SPDES Permit No. GP-0-15-002 in New York State. These requirements are provided in Exhibit C.

B5.5. Lane-Miles of Roadway and Impervious Area Review

Post-construction activities of the Build Alternative would decrease the number of lane-miles (lane-kilometers) of roadways as well as decrease the amount of impervious surfaces in the project area (lane-miles are defined as the measure of the total length of traveled pavement surface, where lane-miles is the centerline length (in miles) multiplied by the number of lanes). Please note that even though there would be a reduction in lane-miles for the Build Alternative, the number of travel lanes would be the same as the No-Build Alternative and existing conditions. Lane-miles and impervious area are variables used in subsequent sections to determine water quality impacts in comparison to the No-Build Alternative. A detailed analysis during final design would determine ground disturbance values and other highway related factors. The No-Build and Build number of lane-miles and impervious roadway surface area values were calculated using project design files in Microstation CADD. Table B5.5-1 provides a summary of the roadway lane-miles and impervious area for Build Alternative.

Table B5.5-1
Summary of Roadway Lane Miles and Impervious Area

	Lane- Miles (Lane-Kilometers)	Net Impervious Area, ac (m^2)
No-Build Alternative	16.2 (26.1)	36.1 (146,090)
Build Alternative	15.9 (25.6)	30.2 (122,215)
Percent Difference	-1.9%	-16%

B5.6. Effects of De-Icing Chemicals

Sodium and calcium chloride salts are used to maintain safe travel conditions during winter months. These de-icing salts reach surface water in the form of highway runoff and can affect the overall water quality of the Scajaquada Creek and Hoyt Lake drainage basins. The Toler Method is a predictive methodology that can be used to determine potential chloride concentrations in surface water from existing and anticipated salt applications on adjacent roadways (Toler, 1973). It was assumed that all the applied salt is diluted by the runoff generated, and all salt enters the two waterbodies under consideration, the Scajaquada Creek and Hoyt Lake. The method requires, as input, the following variables:

T= Tons of salt per lane-mile, applied, per year
M= Number of lane miles
P= Annual Precipitation = 36.7 inches
I= Inches of surface runoff, per year = (runoff coefficient) x P
A= Drainage area, in square miles
K= Conversion factor to yield Chloride concentration in mg/L = 8.37

The deicing compounds and their application rates are dependent upon the practices of agencies responsible for operations of the various roadways in the project area. Published NYSDOT application information shows approximately 0.81 tons per lane mile per snow event. The NYSDOT applies rock salt to NYS Route 198 at a rate of 27 tons per lane-mile per year (Schick, June 2005); this value was used for NYS Route 198 and all associated access ramps and roadways. The average application rate for roadways is 10 tons per lane-mile per year (Toler 1975); this rate was used for all other local roads that anticipate construction within the project area.

The pavement surfaces from the project area, which extends from approximately 2,600 feet (790 meters) east of Interstate 190 to Main Street, discharge into both the Scajaquada Creek and Hoyt Lake. The drainage area to Hoyt Lake is approximately 25.8 square miles, approximately 0.11 square miles of which comes from the project site. The drainage area to Scajaquada Creek at the end of the project area is approximately 26.7 square miles, of which approximately 0.08 square miles comes from the project site. Calculations applying the Toler Method were performed for the Build Alternative and compared to the calculated No-Build Alternative, neglecting the base contribution from the remainder of the watershed. The values are only for comparison purposes and do not accurately reflect the full concentration of chloride entering the waterbodies. Results indicate that the annual average chloride concentrations in runoff from the total project area would be 8.1 mg/L for the No-Build Alternative and 7.8 mg/L for Build Alternative.

The Toler Method was also used to analyze runoff within the Hoyt Lake watershed, which receives runoff from the eastern end of the project corridor. Even though overall there are less lane-miles under the Build Alternative compared to the No-Build Alternative, the portion of the highway that drains to Hoyt Lake has 0.2 lane-miles under the Build Alternative; therefore, the annual average chloride concentrations of runoff to Hoyt Lake would be slightly higher under the Build Alternative (4.4 mg/L for the No-Build Alternative and 4.6 mg/L for the Build Alternative). Detailed calculations are provided in Exhibit E, and the summary results are presented in Table B5.6-1.

Table B5.6-1
Summary of Toler Method Chloride Concentrations

Site Condition	Average Annual Chloride Concentrations Scajaquada Creek – Entire Project Area (mg/L)	Average Annual Chloride Concentrations Sub Area Draining to Hoyt Lake (mg/L)
No-Build Alternative	8.1	4.4
Build Alternative	7.8	4.6
Percent Difference	-3.7%	4.5%

B5.7. Highway Runoff and Pollutant Loading Analysis

Urban highway runoff includes many vehicular by-products. Including metals, oil and grease, and soluble compounds formed by the combination of precipitation and vehicle exhausts. Potential water quality impacts may result from overland runoff that includes sedimentation, increased water temperatures and increased toxic substances, such as heavy metals, pesticides, oil and synthetic organic compounds. Many of these effects directly correspond to the amount of impervious paved road areas nearby. The “Simple Method” was utilized in providing gross analysis results of the No-Build Alternative and the Build Alternative (see Table B5.7-1 below). Detailed calculations are provided in Exhibit F. The pavement removal proposed for the Build Alternative would result in a 16% reduction of the pollutants analyzed for this project (not including shared-use paths within the impervious area calculations). The additional water quality treatment provided would further reduce the pollutant loadings associated with Build Alternative. This analysis demonstrates the pollutant loading differences between the No-Build Alternative and the Build Alternative, evaluated only with regard to the impervious areas within the project area, not including potential shared-use paths. The summary is provided as a method of comparison of the No-Build Alternative and the reduction of each known pollutant, assuming that the remainder of the watershed remains unchanged.

Table B5.7-1 Annual Pollutant Loading[(1)] Summary				
Pollutant	**No-Build Alternative**	**Build Alternative**	**Total Pollutants Removed By WQv Treatment**	**Total Reduction Of Build From No Build Alternative**
Total Suspended Solids (TSS)	37,244 lbs (16,894 kg)	31,106 lbs (14,109 kg)	18,121 lbs (8,219 kg)	65%
Total Phosphorus (TP)	84 lbs (38 kg)	70 lbs (32 kg)	43 lbs (19.5 kg)	68%
Total Nitrogen (TN)	787 lbs (357 kg)	657 lbs (298 kg)	138 lbs (62.6 kg)	34%
Copper (Cu)	14 lbs (6 kg)	12 lbs (5 kg)	2.3 lbs (1.0 kg)	32%
Lead (Pb)	105 lbs (48 kg)	88 lbs (40 kg)	--	16%
Zinc (Zn)	86 lbs (39 kg)	72 lbs (33 kg)	14 lb (6.3 kg)	33%

[(1)]Pollutant Concentrations are obtained from Table 2.1 "Natural Median Concentrations for Chemical Constituents in Stormwater," Chapter 2 of the New York State Stormwater Management Design Manual, 2015

Common impacts associated with road construction and maintenance include habitat disruption, hydrologic alterations, and pollutant runoff. Runoff from road construction can cause erosion, sedimentation, and other changes disrupting aquatic habitats such as fish spawning areas and river bottom sediments (USEPA, 1996). The preservation of existing natural vegetative buffer strips along stream corridors is one way of reducing the impacts of highway runoff on receiving waterbodies and helping to maintain pre-development surface water quality.

B5.8. References

Center for Watershed Protection 2015. New York State Stormwater Design Manual. New York State Department of Environmental Conservation.

Toler, L. 1973. Effect of De-Icing Chemicals on Surface and Ground Water (Preliminary Guidelines for Estimating Chlorides). Research Project R-18-0 Interim Report.

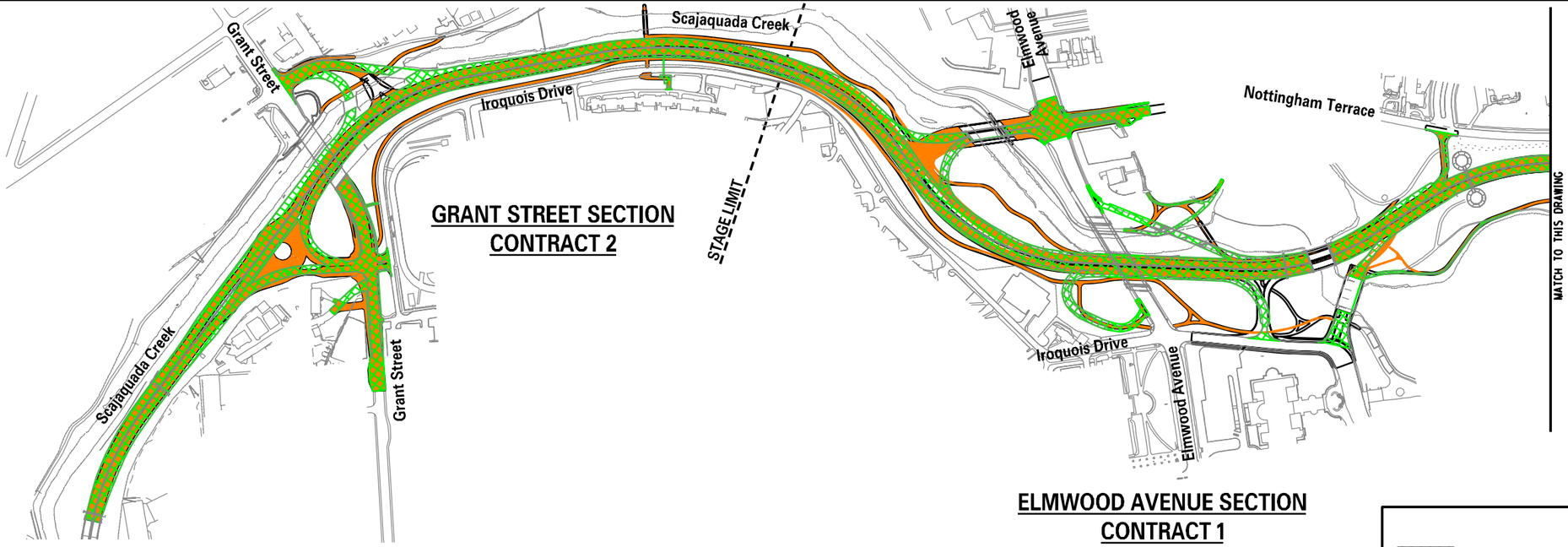
USEPA. 1996. Indicators of the Environmental Impacts of Transportation- Highway, Rail, Aviation and Maritime Transport. EPA 230-R-96-009.

National Pollutant Removal Performance Database, Version 3. September 2007. Center for Watershed Protection

New Hampshire Stormwater Manual, Volume 2. December 2008. New Hampshire Department of Environmental Services.

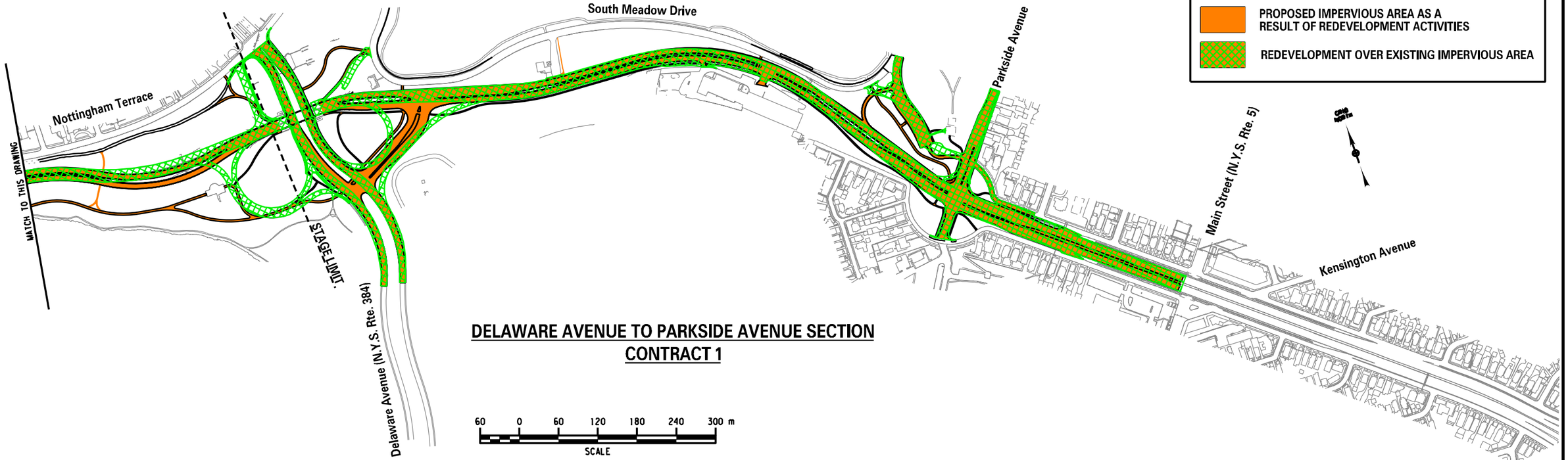
EXHIBIT A

EXISTING AND REDEVELOPED IMPERVIOUS AREAS FIGURE



GRANT STREET SECTION
CONTRACT 2

ELMWOOD AVENUE SECTION
CONTRACT 1



DELAWARE AVENUE TO PARKSIDE AVENUE SECTION
CONTRACT 1

LEGEND

- EXISTING IMPERVIOUS AREA REMOVED
- PROPOSED IMPERVIOUS AREA AS A RESULT OF REDEVELOPMENT ACTIVITIES
- REDEVELOPMENT OVER EXISTING IMPERVIOUS AREA

PROJECT MANAGER
CHECK
DRAFTING
DESIGN
CHECK
JOB MANAGER
DESIGN SUPERVISOR

FILE NAME = 5470Z2_PRS_PLN_ALT 2B_HYBRID_IMPERVIOUS AREAS.DGN
DATE/TIME = DGN$SYSTIME$DT23456
USER = DGN$USERNAME

AS-BUILT REVISIONS DESCRIPTION OF ALTERATIONS:	N.Y.S. ROUTE 198 (SCAJAQUADA EXPRESSWAY CORRIDOR) CITY OF BUFFALO COUNTY: ERIE	PIN 5470.22 OCTOBER 2016	BRIDGES	CULVERTS	ALL DIMENSIONS IN m UNLESS OTHERWISE NOTED EXISTING AND REDEVELOPED IMPERVIOUS AREAS ALTERNATIVE 2	CONTRACT NUMBER D031048-04 FIGURE NO. 1

Bergmann Associates
NEW YORK STATE OF OPPORTUNITY. Department of Transportation

EXHIBIT B

WATER QUALITY STORMWATER MANAGEMENT LOCATIONS

CHECKED BY _____ ESTIMATED BY _____ DRAFTED BY _____ CHECKED BY _____

DESIGN SUPERVISOR _____ JOB MANAGER _____ DESIGNED BY _____

FILE NAME = DGN$SYTIME0123456
DATE/TIME = DGN$USERNAME
USER = DGN$USERNAME

PREPARED BY: ON:	ALTERED BY: ON:

AS BUILT REVISIONS
DESCRIPTION OF WORK:

SIGNATURE _____ DATE _____

DOCUMENT NAME:

N.Y.S. ROUTE 198 (SCAJAQUADA EXPRESSWAY) CORRIDOR
I-190 TO N.Y.S. ROUTE 33
CITY OF BUFFALO
COUNTY: ERIE

PIN 5470.22

OCTOBER 2016

BRIDGES

CULVERTS

ALL DIMENSIONS IN m UNLESS OTHERWISE NOTED

POTENTIAL WATER QUALITY MANAGMENT AREAS

CONTRACT NUMBER

Bergmann associates

DRAWING NO.
SHEET NO.

NEW YORK STATE DEPARTMENT OF TRANSPORTATION REGION 5

EXHIBIT C

EFFLUENT LIMITATION GUIDELINES

FROM GP-0-15-002

Part I.B - Effluent Limitations Applicable to Discharges from Construction Activities

Discharges authorized by this permit must achieve, at a minimum, the effluent limitations in Part I.B.1. (a) – (f) of this permit. These limitations represent the degree f effluent reduction attainable by the application of best practicable technology currently available.

1. Erosion and Sediment Control Requirements – The *owner or operator* must select, design, install, implement and maintain control measures to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards.* The selection, design, installation, implementation, and maintenance of these control measures must meet the non-numeric effluent limitations in Part I.B.1.(a) – (f) of this permit and be in accordance with the New York State Standards and Specifications for Erosion and Sediment Control, dated August 2005, using sound engineering judgement. Where control measures are not designed in conformance with the design criteria included in the technical standard, the *owner or operator* must include in the Stormwater Pollution Prevention Plan ("SWPPP") the reason(s) for the deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the technical standard.
    a. **Erosion and Sediment Controls.** Design, install and maintain effective erosion and sediment controls to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards*. At a minimum, such controls must be designed, installed and maintained to:
        i. *Minimize* soil erosion through application of runoff control and soil stabilization control measure to *minimize pollutant discharges;*
        ii. Control stormwater *discharges* to *minimize* channel and streambank erosion and scour in the immediate vicinity of the *discharge* points;
        iii. *Minimize* the amount of soil exposed during *construction activity;*
        iv. *Minimize* the disturbance of *steep slopes;*
        v. *Minimize* sediment *discharges* from the site;
        vi. Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas and maximize stormwater infiltration to reduce *pollutant discharges*, unless *infeasible;*
        vii. *Minimize* soil compaction. Minimizing soil compaction is not required where the intended function of a specific area of the site dictates that it be compacted; and
        viii. Unless *infeasible*, preserve a sufficient amount of topsoil to complete soil restoration and establish a uniform, dense vegetative cover.
    b. **Soil Stabilization.** In areas where soil disturbance activity has temporarily or permanently ceased, the application of soil stabilization measures must be initiated by the end of the next business day and completed within fourteen (14) days from the date the current soil disturbance activity ceased. For construction sites that *directly discharge* to one of the 303(d) segments listing in Appendix E or is location in one of the watersheds listed in Appendix C, the application of soil stabilization measures must be initiated by the end of the next business day and completed within seven (7) days from the date the current soil disturbance activity ceased. See Appendix A for definition of *Temporarily Ceased.*
    c. **Dewatering.** *Discharges* from the dewatering activities, including *discharges* from dewatering of trenches and excavations, must be managed by appropriate control measures.

d. **Pollution Prevention Measures.** Design, install, implement, and maintain effective pollution prevention measures to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards.* At a minimum, such measures must be designed, installed, implemented and maintained to:
    i. *Minimize* the *discharge* of *pollutants* from equipment and vehicle washing, where wash water, and other wash waters. This applies to washing operations that use clean water only. Soaps, detergents and solvents cannot be used.
    ii. *Minimize* the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waster and other materials present on the site to precipitation and to stormwater. Minimization of exposure is not required in cases where the exposure to precipitation and to stormwater will not result in a *discharge* of *pollutants*, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use); and
    iii. Prevent the *discharge* of *pollutants* from spills and leaks and implement chemical spill and leak prevention and response procedures.
e. **Prohibited *Discharges.*** The following *discharges* are prohibited:
    i. Wastewater from washout of concrete;
    ii. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials;
    iii. Fuels, oils, or other *pollutants* used in vehicle and equipment operation and maintenance;
    iv. Soaps or solvents used in vehicle and equipment washing; and
    v. Toxic or hazardous substances from a spill or other release.
f. **Surface Outlets.** When discharging from basins and impoundments, the outlets shall be designed, constructed and maintained in such a manner that sediment does not leave the basin or impoundment and that erosion at or below the outlet does not occur.

EXHIBIT D

WATER QUALITY VOLUME PRELIMINARY SIZING COMPUTATIONS

BERGMANN associates

Project: Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 1 of 8

Contract 1

~630 ft West of Elmwood to East End of Project

Existing Impervious	110670	sm
	27.3	ac
Proposed Impervious	106750	sm
	26.4	ac
New Impervious	0	sm
	0.0	ac
	0%	%
Redev. Impervious	106750	sm
	26.4	ac
	100%	%
Removed Impervious	3920	sm
	1.0	ac
	4%	%
Est. Disturbed Area	198875	sm
	49.1	ac
I = ((NA+RA)/A)*100 =	54	%
Rv = 0.05 + 0.009(I) =	0.533	
$WQv_{(initial)}$ =	2.183	ac-ft
	2693	cm
% Treamtent Req'd	25%	
WQv from Pavement Reduction	95	cm
	4%	
%WQv Req'd by Alt. Practices	63%	
WQv Req'd by Alt. Practices	1.375	ac-ft
	1696	cm

Practices In Contract 1	**RRv**	**WQv**	
HDS #12		2,080	cm
			cm
Sum	**0**	**2,080**	cm

Total WQv Provided - Contract 1	2,080	cm
Net WQv	-383	cm

Contract 2

West End of Project to ~630 ft West of Elmwood

Existing Impervious	35355	sm
	8.7	ac
Proposed Impervious	31822	sm
	7.9	ac
New Impervious	0	sm
	0.0	ac
	0%	%
Redev. Impervious	31822	sm
	7.9	ac
	100%	%
Removed Impervious	3533	sm
	0.9	ac
	10%	%
Est. Disturbed Area	63357	sm
	15.7	ac
I = ((NA+RA)/A)*100 =	50	%
Rv = 0.05 + 0.009(I) =	0.502	
$WQv_{(initial)}$ =	0.655	ac-ft
	808	cm
% Treamtent Req'd	25%	
$WQv_{(target)}$ =	0.164	ac-ft
	202	cm
WQv from Pavement Reduction	20	cm

Practices In Contract 2	**RRv**	**WQv**	
Wet Swale #1	0	39	cm
Bio Area #2	122	182	cm
Wet Swale #3A	0	37	cm
Wet Swale #3B	0	22	cm
Sum	**122**	**280**	cm

Total WQv Provided - Contract 2	402	cm
Net WQv	-220	cm

Bergmann associates
architects // engineers // planners

Project: Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 2 of 8

TITLE: **Impervious Areas**

DESCRIPTION: Impervious ares heading east from BIN 1039989 along Scajaquada Expressway NYS Route 198

Section	New Impervious Area (m²)
Roadway, Etc.	122001
Pathways	16460

Total (m²)	**138461**
Total (sf²)	**1490382**
Total (acres)	**34.2**

Total Impervious Existing = 36.1 Acres

Total Impervious Proposed = 34.2 Acres

Total Impervious Removed = **1.9** Acres

Total New Impervious = **0.0** Acres

Total Redeveloped Impervious = **34.2** Acres

Total Disturbed Area = 65 Acres

53% Impervious

BERGMANN associates

Project:
Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 3 of 8

TITLE: **WATER QUALITY STORAGE VOLUME**

Water Quality Volume

DESCRIPTION: Index 1

STA EB 10+580 to 10+800
Wet Swale #1

Formula for calculating the Water Quality storage volume (WQv) = $\frac{(P)\,(Rv)\,(A)}{12}$

DA (ac)	%IA %	Rv	P (in)	WQv (ac-ft)	WQv (m^3)
3.65	80%	0.77	1.00	0.23	**288.6**

Design Parameters

Bottom Width, m	0.6	Media Depth, m	0	Check Dams?	Y
Side Slopes	2.5	Media Porosity, n	0.25	Dam Height, m	0.3048
Slope, m/m	0.0160	Gravel Depth, m	0.0	Dam Spacing, m	19.1
Length, m	187	Gravel Porosity, n	0.4		
Manning's n	0.06				

Water Quality Volume Event

Q in	CN	Tc hr	Ia	Ia/P	qu (cfs/mi^2/in)	Qp cfs	Qp cms
0.769	98	0.2	0.041	0.041	1100	4.8	**0.137**

Assuming No Check Dams

Velocity, m/s	0.56
Normal Depth, m	0.21
Detention Time, min	5.5

Storage Volume

Area behind Check Dam, m^2	0.42	Surface Storage Volume, m^3	**39.1**
Subsurface Area, m^2	**0**	Subsurface Storage Volume, m^3	**0**
Length Provided, m	187	Total Storage Volume, m^3	**39**

Treatment Volumes

RRv Treatment Percentage,%	0%
RRv Treatment Volume, m^3	**0**
WQv Treatment Volume, m^3	**39**

25-YR Storm Event

A ac	C	Tc hr	I in/hr	Q_{25} cfs	*V_{25} ft/s	*Depth ft	Required Swale Depth ft	Required Swale Depth m
3.65	**0.60**	0.20	**4.16**	**9.2**	2.65	0.88	**1.7**	**0.5**

**Assumes storage volume behind check dams is completely full prior to event.*

BERGMANN associates

Project:
Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 4 of 8

TITLE: **WATER QUALITY STORAGE VOLUME**

Water Quality Volume Index 7

DESCRIPTION:
Bio Area #2
Gore near W roundabout - completely assumed drainage

Formula for calculating the Water Quality storage volume (WQv) = $\frac{(P)\,(Rv)\,(A)}{12}$

P = 90% Rainfall Event = 1.0

I = percent Impervious Cover = 100%

Rv = 0.05 + 0.009(I) = 0.95

A = Acres = 3

Water Quality Storage Volume (acre-feet) = 0.25 **304 Cubic-meters**

Prelimnary Bioretention Sizing

A_f	7807	sf	725.34	sm
d_f	2	ft		
k	0.5	ft/day		
h_f	0.75	ft		
t_f	2	days		

A_f surface area of filter bed (sf)
d_f filter bed depth (ft)
k coefficient of permeability of filter media (ft/day)
h_f average height of water above filter bed (ft)
t_f design filter bed drain time (days)

Need to store 75% of WQv in prior to filtration

228.0	cm = 75% of WQv
0.23	m = ponding depth
996.9	sm = surface area

Forebay Sizing

As = 87.0 sf
8.1 sm

76.0	cm = 25% of WQv	
19.5	=L (m)	253.3 =Area, sm
13.0	=W (m)	
0.3	=D (m)	

Areas Provided

Forebay Area Provided, cm = 152 ✔

Storage Area Provided, sm = 998 ✔

RRV Treatment Percentage, % 40%

RRv Treatment Volume Provided, m^3 122

WQv Treament Volume Provided, m^3 182

BERGMANN associates

Project:
Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 5 of 8

TITLE: **WATER QUALITY STORAGE VOLUME**

Water Quality Volume

DESCRIPTION: Index 3

STA EB 11+000 to 11+180
Wet Swale #3A

Formula for calculating the Water Quality storage volume (WQv) = $\frac{(P)\,(Rv)\,(A)}{12}$

DA (ac)	%IA %	Rv	P (in)	WQv (ac-ft)	WQv (m^3)
2.50	58%	0.57	1.00	0.12	**146.4**

Design Parameters

Bottom Width, m	0.61	Media Depth, m	0	Check Dams?	Y
Side Slopes	2.5	Media Porosity, n	0.25	Dam Height, m	0.3048
Slope, m/m	0.0040	Gravel Depth, m	0.0	Dam Spacing, m	76.2
Length, m	175	Gravel Porosity, n	0.4		
Manning's n	0.07				

Water Quality Volume Event

Q in	CN	Tc hr	Ia	Ia/P	qu (cfs/mi^2/in)	Qp cfs	Qp cms
0.569	95	0.2	0.105	0.105	800	1.8	**0.050**

Assuming No Check Dams

Velocity, m/s	0.23
Normal Depth, m	0.20
Detention Time, min	12.6

Storage Volume

Area behind Check Dam, m^2	0.42	Surface Storage Volume, m^3	**36.6**
Subsurface Area, m^2	**0**	Subsurface Storage Volume, m^3	**0**
Length Provided, m	175	Total Storage Volume, m^3	**37**

Treatment Volumes

RRv Treatment Percentage,%	0%
RRv Treatment Volume, m^3	**0**
WQv Treatment Volume, m^3	**37**

25-YR Storm Event

A ac	C	Tc hr	I in/hr	Q_{25} cfs	*V_{25} ft/s	*Depth ft	Required Swale Depth ft	Required Swale Depth m
2.50	**0.60**	0.20	**4.16**	**6.3**	1.12	0.91	**1.7**	**0.5**

**Assumes storage volume behind check dams is completely full prior to event.*

BERGMANN associates

Project:
Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 6 of 8

TITLE: **WATER QUALITY STORAGE VOLUME**

Water Quality Volume

DESCRIPTION: Index 4

STA EB 11+200 to 11+300
Wet Swale #3B

Formula for calculating the Water Quality storage volume (WQv) = $\frac{(P)\,(Rv)\,(A)}{12}$

DA (ac)	%IA %	Rv	P (in)	WQv (ac-ft)	WQv (m^3)
0.85	69%	0.67	1.00	0.05	**58.5**

Design Parameters

Bottom Width, m	0.61	Media Depth, m	0	Check Dams?	Y
Side Slopes	2.5	Media Porosity, n	0.25	Dam Height, m	0.3048
Slope, m/m	0.015	Gravel Depth, m	0.0	Dam Spacing, m	20.3
Length, m	105	Gravel Porosity, n	0.4		
Manning's n	0.15				

Water Quality Volume Event

Q in	CN	Tc hr	Ia	Ia/P	qu (cfs/mi^2/in)	Qp cfs	Qp cms
0.673	97	0.1	0.062	0.062	900	0.8	**0.023**

Assuming No Check Dams

Velocity, m/s	0.11
Normal Depth, m	0.07
Detention Time, min	15.9

Storage Volume

Area behind Check Dam, m^2	0.42	Surface Storage Volume, m^3	**21.9**
Subsurface Area, m^2	**0**	Subsurface Storage Volume, m^3	**0**
Length Provided, m	105	Total Storage Volume, m^3	**22**

Treatment Volumes

RRv Treatment Percentage,%	0%
RRv Treatment Volume, m^3	**0**
WQv Treatment Volume, m^3	**22**

25-YR Storm Event

A ac	C	Tc hr	I in/hr	Q_{25} cfs	*V_{25} ft/s	*Depth ft	Required Swale Depth ft	Required Swale Depth m
0.85	**0.60**	0.10	**5.50**	**2.8**	0.83	0.55	**1.4**	**0.4**

**Assumes storage volume behind check dams is completely full prior to event.*

BERGMANN associates

Project:
Scajaquada Expressway NYS Route 198

Project No.	6861.00
Date:	10/10/2016
By:	KMG
Checked:	JAV
Sheet:	7 of 8

TITLE: **WATER QUALITY STORAGE VOLUME**

Water Quality Volume

DESCRIPTION: Index 15

Hydrodynamic Separators		Assumed Vortechs NYSDOT Sizing Criteria	

HDS #12

Contract 1A

DA Captured = 12.6 ac

I	100
Rv	0.95
P	1

WQv **0.9973** ac-ft **43441** cf **1230** cm

**Actual treatment, sizing, and locations to be coordinated with final drainage during final design.

Will be able to caputre required drainage area, number/size/location of facilities will vary.

Contract 1B

DA Captured = 8.7 ac

I	100
Rv	0.95
P	1

WQv **0.6888** ac-ft **30002** cf **850** cm

**Actual treatment, sizing, and locations to be coordinated with final drainage during final design.

Will be able to caputre required drainage area, number/size/location of facilities will vary.

BERGMANN associates

Project: Scajaquada Expressway NYS Route 198

Project No. 6861.00
Date: 10/10/2016
By: KMG
Checked: JAV
Sheet: 8 of 8

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

ID Number	Swale Name	Drainage Area (sm)	Drainage Area (ac)	Impervious Area (sm)	% Impervious	Rv	P (in)	WQv (ac-ft)	Q (in)	CN	Tc (hr)	Ia	Ia/P	qu (cfs/mi^2/in)	Qp (cfs)	Qp (cms)
1	Wet Swale #1	14776	3.65	11804	80%	0.769	1	0.234	0.77	98	0.2	0.041	0.041	1100	4.8	0.137
~~2~~	~~Swale #6~~	~~8114~~	~~2.01~~	~~4986~~	~~61%~~	~~0.603~~	~~1~~	~~0.101~~	~~0.60~~	~~96~~	~~0.1~~	~~0.083~~	~~0.083~~	~~1000~~	~~1.9~~	~~0.053~~
3	Wet Swale #3A	10133	2.50	5840	58%	0.569	1	0.119	0.57	95	0.2	0.105	0.105	800	1.8	0.050
4	Wet Swale #3B	3422	0.85	2368	69%	0.673	1	0.047	0.67	97	0.1	0.062	0.062	900	0.8	0.023
~~5~~	~~Swale #3C~~	~~3347~~	~~0.83~~	~~2150~~	~~64%~~	~~0.628~~	~~1~~	~~0.043~~	~~0.63~~	~~96~~	~~0.1~~	~~0.083~~	~~0.083~~	~~1000~~	~~0.8~~	~~0.023~~
~~6~~	~~Swale #3D~~	~~3052~~	~~0.75~~	~~2123~~	~~70%~~	~~0.676~~	~~1~~	~~0.042~~	~~0.68~~	~~97~~	~~0.1~~	~~0.062~~	~~0.062~~	~~1200~~	~~1.0~~	~~0.027~~
7	Bio Area #2	12598	3.11	12598	100%	0.950	1	0.246	0.95	100		0.041	0.041		0.0	0.000
~~8~~	~~Swale #5~~	~~3362~~	~~0.83~~	~~1670~~	~~50%~~	~~0.497~~	~~1~~	~~0.034~~	~~0.50~~	~~94~~	~~0.2~~	~~0.128~~	~~0.128~~	~~850~~	~~0.5~~	~~0.016~~
~~9~~																
~~10~~	~~Bio Area #4~~	~~8226~~	~~2.03~~	~~6372~~	~~77%~~	~~0.747~~	~~1~~	~~0.127~~	~~0.75~~	~~98~~	~~0.1~~	~~0.041~~	~~0.041~~	~~1300~~	~~3.1~~	~~0.087~~
~~11~~	~~Swale #7~~	~~2677~~	~~0.66~~	~~2348~~	~~88%~~	~~0.839~~	~~1~~	~~0.046~~	~~0.84~~	~~99~~	~~0.1~~	~~0.041~~	~~0.041~~	~~1300~~	~~1.1~~	~~0.032~~
~~12~~	~~Swale #8~~	~~6684~~	~~1.65~~	~~5539~~	~~83%~~	~~0.796~~	~~1~~	~~0.110~~	~~0.80~~	~~98~~	~~0.1~~	~~0.041~~	~~0.041~~	~~1300~~	~~2.7~~	~~0.076~~
~~13~~	~~UG Sand Filter #9~~	~~10176~~	~~2.51~~	~~10176~~	~~100%~~	~~0.950~~	~~1~~	~~0.199~~	~~0.95~~	~~100~~	~~0.1~~	~~0.041~~	~~0.041~~	~~1100~~	~~4.1~~	~~0.116~~
~~14~~	~~Perm Pave #10~~	~~3000~~	~~0.74~~	~~3000~~	~~100%~~	~~0.950~~	~~1~~	~~0.059~~	~~0.95~~	~~100~~	~~0.1~~	~~0.041~~	~~0.041~~			
~~15~~	~~Dry Swale #11~~	~~1419~~	~~0.35~~	~~1419~~	~~100%~~	~~0.950~~	~~1~~	~~0.028~~	~~0.95~~	~~100~~	~~0.1~~	~~0.041~~	~~0.041~~	~~1300~~	~~0.7~~	~~0.019~~

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

ID Number	Swale No. Location	Bottom Width		Target Length		Slope	Side Slope	Mannings N	Normal Depth		Velocity		Detention Time	Needs Check Dam?	Check Dam Height	Check Dam Spacing	No. of Check Dams	Flow Area w/ Dam	Length Required (surface only)
		m	ft	m	ft	m/m	m/m		m	ft	m/s	fps	min		m	m		m^2	m
1	Wet Swale #1	0.61	2	187	614	0.016	2.5	0.06	0.21	0.70	0.56	1.85	5.5	Y	0.3048	19.05	10	0.42	1380.7
~~2~~	~~Swale #6~~	~~2.44~~	~~8~~	~~216~~	~~709~~	~~0.008~~	~~4~~	~~0.15~~	~~0.13~~	~~0.43~~	~~0.14~~	~~0.46~~	~~25.7~~	~~Y~~	~~0.3048~~	~~38.10~~	~~6~~	~~1.11~~	~~223.0~~
3	Wet Swale #3A	0.61	2	175	574	0.004	2.5	0.07	0.20	0.65	0.23	0.76	12.6	Y	0.3048	76.20	2	0.42	700.2
4	Wet Swale #3B	0.61	2	105	344	0.015	2.5	0.15	0.07	0.23	0.11	0.36	15.9	Y	0.3048	20.32	5	0.42	279.8
~~5~~	~~Swale #3C~~	~~0.61~~	~~2~~	~~139~~	~~456~~	~~0.0036~~	~~2.5~~	~~0.1~~	~~0.11~~	~~0.36~~	~~0.23~~	~~0.76~~	~~10.0~~	~~Y~~	~~0.3048~~	~~84.67~~	~~2~~	~~0.42~~	~~255.5~~
~~6~~	~~Swale #3D~~	~~0.61~~	~~2~~	~~136~~	~~446~~	~~0.007~~	~~2~~	~~0.1~~	~~0.16~~	~~0.52~~	~~0.19~~	~~0.63~~	~~11.8~~	~~Y~~	~~0.3048~~	~~43.54~~	~~3~~	~~0.37~~	~~282.1~~
7	Bio Area #2	0.00			0				0.00		0.00		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	0.00	#DIV/0!
~~8~~	~~Swale #5~~	~~0.61~~	~~2~~	~~257~~	~~843~~	~~0.006~~	~~2.5~~	~~0.12~~	~~0.12~~	~~0.40~~	~~0.13~~	~~0.42~~	~~33.5~~	~~N~~	~~0.3048~~	~~N/A~~	~~N/A~~	~~0.42~~	~~Error~~
~~9~~	~~0~~	~~0.00~~			~~0~~				~~0.00~~		~~0.00~~		~~#DIV/0!~~	~~#DIV/0!~~		~~#DIV/0!~~	~~#DIV/0!~~	~~0.00~~	~~#DIV/0!~~
~~10~~	~~Bio Area #4~~	~~1.52~~	~~5~~	~~27~~	~~89~~	~~0.065~~	~~3~~	~~0.15~~	~~0.03~~	~~0.09~~	~~0.15~~	~~0.50~~	~~3.0~~	~~Y~~	~~0.3048~~	~~4.69~~	~~6~~	~~0.74~~	~~420.1~~
~~11~~	~~Swale #7~~	~~0.61~~	~~2~~	~~104~~	~~341~~	~~0.003~~	~~4~~	~~0.1~~	~~0.21~~	~~0.70~~	~~0.16~~	~~0.52~~	~~10.9~~	~~Y~~	~~0.3048~~	~~101.60~~	~~1~~	~~0.56~~	~~204.8~~
~~12~~	~~Swale #8~~	~~2.44~~	~~8~~	~~75~~	~~246~~	~~0.009~~	~~3~~	~~0.12~~	~~0.14~~	~~0.46~~	~~0.19~~	~~0.63~~	~~6.5~~	~~Y~~	~~0.3048~~	~~33.87~~	~~2~~	~~1.02~~	~~264.4~~
~~13~~	~~UG Sand Filter #9~~	~~0.00~~			~~0~~				~~0.00~~		~~0.00~~		~~#DIV/0!~~	~~#DIV/0!~~		~~#DIV/0!~~	~~#DIV/0!~~	~~0.00~~	~~#DIV/0!~~
~~14~~	~~Perm Pave #10~~	~~0.00~~			~~0~~				~~0.00~~		~~0.00~~		~~#DIV/0!~~	~~#DIV/0!~~		~~#DIV/0!~~	~~#DIV/0!~~	~~0.00~~	~~#DIV/0!~~

EXHIBIT E

TOLER METHOD CALCULATIONS

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Method - SCAJAQUADA CREEK

C= ((TxM)/(IxA))xK

where:

C= Annual Average Concentration of Cl (mg/L)
T= Tons of salt per Lane-mile
M=Number of Lane-miles
I= Inches of Runoff (annual inches of rain {37.6 in} x 0.7)
A=Drainage Area in square miles
K=8.37

Determine No Build Conditions AND Build Alternative Chloride Concentraions (C).

Assumptions

1) This analysis uses the overall drainage area to Scajaquada Creek. In addition, the overall upstream watershed area is assumed to have the same land use and roadway characteristics in both existing and proposed conditions. The preferred alternative lane-miles are applied to the Toler Method, but no base T*M value was added for the remainder of the watershed. The values are only good for comparative purposes, not for actual values of concentration at the waterbodies.

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - No Build

	Project Area	Scajaquada Cre
	Total watershed	
Drainage Area	0.19 sq. miles	26.7

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
State Roads (T= 27 tons/lane-mile)					meters	
EASTBOUND						
Route 198-EB	EB 10+478	EB 12+385	2	1896	3792	2.36
Route 198-EB	EB 12+385	EB 14+000	2	1603	3206	1.99
Route 198-EB	EB 14+000	EB 14+455	3	254	762	0.47
Route 198-EB	EB 14+455	EB 14+532	4	79	316	0.20
Route 198-EB	EB 14+532	EB 14+502	3	171	513	0.32
Ramp to Grant Street	EB 10+720	GSE 1+090	2	237	474	0.29
Ramp from Grant Street	GSW 1+802	EB 11+000	1	174	174	0.11
Ramp at Elmwood	E 1+180	IC 1+000	1	432	432	0.27
Off Ramp at Delaware South	EB 12+880	DS 1+180	1	268	268	0.17
On Ramp from Delaware South	EB 12+970	DS 12+248	1	254	254	0.16
Off Ramp at Delaware North	EB 13+150	DN 1+220	1	163	163	0.10
On Ramp from Delaware North	DN 1+060	EB 13+330	1	310	310	0.19
WESTBOUND						
Route 198-WB	WB 10+478	WB 12+395	2	1917	3834	2.38
Route 198-WB	WB 12+395	WB 14+000	2	1660	3320	2.06
Route 198-WB	WB 14+000	WB 14+505	3	445	1335	0.83
Ramp to Parkside	P 1+030	WB 14+320	1	189	189	0.12
Ramp from Parkside	P 1+040	WB 14+002	1	130	130	0.08
Connector to Nottingham Terrace	WB 13+000		2	104	208	0.13
Nottingham / Elmwood Connector	L 1+050	E 12+290	1	510	510	0.32
Off Ramp to Elmwood	WB 11+920	EC 1+180	1	268	268	0.17
On Ramp from Elmwood	EC 1+160	WB 11+650	1	277	277	0.17
Off Ramp to Grant	WB 11+220	GN 1+090	1	248	248	0.15
On Ramp from Grant	GN 1+090	WB 10+755	1	415	415	0.26
Total					**21398**	**13.3**

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
					Meters	
Local Roads (T= 10 tons/lane-mile)						
Grant Street	G 1+211	G 1+375	3	163	489	0.30
Grant Street	G 1+375	G 1+411	5	38	190	0.12
Grant Street	G 1+411	G 1+466	4	56	224	0.14
Nottingham Terrace	NT 1+112	NT 1+000	2	112	224	0.14
Delaware South	DS 1+010	DS 1+060	2	50	100	0.06
Delaware South	DS 1+060	DS 1+180	3	115	345	0.21
Delaware South	DS 1+180	DS 1+250	2	68	136	0.08
Delaware South	DS 1+250	DS 1+138	3	189	567	0.35
Delaware North	DN 1+010	DN 1+220	2	211	422	0.26
Delaware North	DN 1+220	DN 1+444	3	226	678	0.42
Agassazi	M 1+007	M 1+072	2	56	112	0.07
Parkside	P 1+000	P 1+048	4	41	164	0.10
Parkside	P 1+048	P 1+140	5	92	460	0.29
Parkside	P 1+140	P 1+175	4	34	136	0.08
Humboldt Pkwy	HP 1+002	HP 1+137	1	129	129	0.08
Lincoln Pkwy Bridge	N 1+006	N 1+091	2	85	170	0.11
Lincoln Pkwy Bridge	N 1+091	N 1+160	1	69	69	0.04
Total					**4615**	**2.9**

Chloride Concentration	**8.1**	**mg/L**

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - No Build

Drainage Area

Project Area 0.11 sq. miles

Hoyt Lake Total watershed 25.8

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
State Roads (T= 27 tons/lane-mile)					meters	
EASTBOUND						
Route 198-EB	EB 10+478	EB 12+385	2			
Route 198-EB	EB 12+385	EB 14+000	2	1603	3206	1.99
Route 198-EB	EB 14+000	EB 14+455	3	254	762	0.47
Route 198-EB	EB 14+455	EB 14+532	4	79	316	0.20
Route 198-EB	EB 14+532	EB 14+502	3	172	516	0.32
Ramp to Grant Street	EB 10+720	GSE 1+090	2			
Ramp from Grant Street	GSW 1+802	EB 11+000	1			
Ramp at Elmwood	E 1+180	IC 1+000	1			
Off Ramp at Delaware South	EB 12+880	DS 1+180	1	268	268	0.17
On Ramp from Delaware South	EB 12+970	DS 12+248	1	254	254	0.16
Off Ramp at Delaware North	EB 13+150	DN 1+220	1	163	163	0.10
On Ramp from Delaware North	DN 1+060	EB 13+330	1	310	310	0.19
WESTBOUND						
Route 198-WB	WB 10+478	WB 12+395	2			
Route 198-WB	WB 12+395	WB 14+000	2	1660	3320	2.06
Route 198-WB	WB 14+000	WB 14+505	3	445	1335	0.83
Ramp to Parkside	P 1+030	WB 14+320	1	189	189	0.12
Ramp from Parkside	P 1+040	WB 14+002	1	130	130	0.08
Connector to Nottingham Terrace	WB 13+000		2	104	208	0.13
Nottingham / Elmwood Connector	L 1+050	E 12+290	1			
Off Ramp to Elmwood	WB 11+920	EC 1+180	1			
On Ramp from Elmwood	EC 1+160	WB 11+650	1			
Off Ramp to Grant	WB 11+220	GN 1+090	1			
On Ramp from Grant	GN 1+090	WB 10+755	1			
Total				**5631**	**10977**	**6.8**

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
					Meters	
Local Roads (T= 10 tons/lane-mile)						
Grant Street	G 1+211	G 1+375	3			
Grant Street	G 1+375	G 1+411	5			
Grant Street	G 1+411	G 1+466	4			
Nottingham Terrace	NT 1+112	NT 1+000	2			
Delaware South	DS 1+010	DS 1+060	2	50	100	0.06
Delaware South	DS 1+060	DS 1+180	3	115	345	0.21
Delaware South	DS 1+180	DS 1+250	2	68	136	0.08
Delaware South	DS 1+250	DS 1+138	3	189	567	0.35
Delaware North	DN 1+010	DN 1+220	2	211	422	0.26
Delaware North	DN 1+220	DN 1+444	3	226	678	0.42
Agassazi	M 1+007	M 1+072	2	56	112	0.07
Parkside	P 1+000	P 1+048	4	41	164	0.10
Parkside	P 1+048	P 1+140	5	92	460	0.29
Parkside	P 1+140	P 1+175	4	34	136	0.08
Humboldt Pkwy	HP 1+002	HP 1+137	1	129	129	0.08
Lincoln Pkwy Bridge	N 1+006	N 1+091	2			
Lincoln Pkwy Bridge	N 1+091	N 1+160	1			
Total				**1211**	**3249**	**2.0**

Chloride Concentration	**4.4**	**mg/L**

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - No Build

Scajaquada Cre

Project Area
Total watershed

Drainage Area
0.08 sq. miles
26.7

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
State Roads (T= 27 tons/lane-mile)					meters	
EASTBOUND						
Route 198-EB	EB 10+478	EB 12+385	2	1896	3792	2.36
Route 198-EB	EB 12+385	EB 14+000	2	1603		
Route 198-EB	EB 14+000	EB 14+455	3	254		
Route 198-EB	EB 14+455	EB 14+532	4	79		
Route 198-EB	EB 14+532	EB 14+502	3	171		
Ramp to Grant Street	EB 10+720	GSE 1+090	2	237	474	0.29
Ramp from Grant Street	GSW 1+802	EB 11+000	1	174	174	0.11
Ramp at Elmwood	E 1+180	IC 1+000	1	432	432	0.27
Off Ramp at Delaware South	EB 12+880	DS 1+180	1	268		
On Ramp from Delaware South	EB 12+970	DS 12+248	1	254		
Off Ramp at Delaware North	EB 13+150	DN 1+220	1	163		
On Ramp from Delaware North	DN 1+060	EB 13+330	1	310		
WESTBOUND						
Route 198-WB	WB 10+478	WB 12+395	2	1917	3834	2.38
Route 198-WB	WB 12+395	WB 14+000	2	1660		
Route 198-WB	WB 14+000	WB 14+505	3	445		
Ramp to Parkside	P 1+030	WB 14+320	1	189		
Ramp from Parkside	P 1+040	WB 14+002	1	130		
Connector to Nottingham Terrace	WB 13+000		2	104		
Nottingham / Elmwood Connector	L 1+050	E 12+290	1	510	510	0.32
Off Ramp to Elmwood	WB 11+920	EC 1+180	1	268	268	0.17
On Ramp from Elmwood	EC 1+160	WB 11+650	1	277	277	0.17
Off Ramp to Grant	WB 11+220	GN 1+090	1	248	248	0.15
On Ramp from Grant	GN 1+090	WB 10+755	1	415	415	0.26
Total					**10424**	**6.5**

	Station		No. of lanes	Length	Total	Lane Miles
	Start	End		meters	Length	miles
					Meters	
Local Roads (T= 10 tons/lane-mile)						
Grant Street	G 1+211	G 1+375	3	163	489	0.30
Grant Street	G 1+375	G 1+411	5	38	190	0.12
Grant Street	G 1+411	G 1+466	4	56	224	0.14
Nottingham Terrace	NT 1+112	NT 1+000	2	112	224	0.14
Delaware South	DS 1+010	DS 1+060	2	50		
Delaware South	DS 1+060	DS 1+180	3	115		
Delaware South	DS 1+180	DS 1+250	2	68		
Delaware South	DS 1+250	DS 1+138	3	189		
Delaware North	DN 1+010	DN 1+220	2	211		
Delaware North	DN 1+220	DN 1+444	3	226		
Agassazi	M 1+007	M 1+072	2	56		
Parkside	P 1+000	P 1+048	4	41		
Parkside	P 1+048	P 1+140	5	92		
Parkside	P 1+140	P 1+175	4	34		
Humboldt Pkwy	HP 1+002	HP 1+137	1	129		
Lincoln Pkwy Bridge	N 1+006	N 1+091	2	85	170	0.11
Lincoln Pkwy Bridge	N 1+091	N 1+160	1	69	69	0.04
Total					**1366**	**0.8**

Chloride Concentration	**3.8**	**mg/L**

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - Build Alternative

Drainage Area

Project Area
0.19 sq. miles

Scajaquada Creek
Total watershed
26.7 sq. miles

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed
198 Roadways (T = 27 tons/lane-mile)						
EB 198	EB 10+478	EB 10+773	2	293	586	0.36
EB 198 TO ROUNDABOUT	EB 10+773	GSE 1+000	3	95	285	0.18
Roundabout	GR 1+000	GR 1+040	1	150	150	0.09
EB 198	EB 10+900	EB 12+385	2	1485	2970	1.85
EB 198	EB 12+385	EB 13+120	2	738	1476	0.92
EB 198	EB 13+120	EB 13+212	3	89	267	0.17
EB 198	EB 13+212	EB 13+910	2	692	1384	0.86
EB 198	EB 13+910	EB 13+975	3	67	201	0.12
EB 198	EB 13+975	EB 14+130	4	155	620	0.39
EB 198	EB 14+130	EB 14+200	3	72	216	0.13
EB 198	EB 14+200	EB 14+340	4	136	544	0.34
EB 198	EB 14+340	EB 14+505	3	167	501	0.31
WB 198	WB 10+478	WB 11+785	2	1311	2622	1.63
WB 198	WB 11+785	WB 11+910	3	122	366	0.23
WB 198	WB 11+910	WB 12+395	2	486	972	0.60
WB 198	WB 12+395	WB 13+240	2	844	1688	1.05
WB 198	WB 13+240	WB 13+400	4	160	640	0.40
WB 198	WB 13+400	WB 13+790	2	388	776	0.48
WB 198	WB 13+790	WB 13+860	3	72	216	0.13
WB 198	WB 13+860	WB 13+935	2	76	152	0.09
WB 198	WB 13+935	WB 14+140	3	202	606	0.38
WB 198	WB 14+140	WB 14+270	5	129	645	0.40
WB 198	WB 14+270	WB 14+320	4	54	216	0.13
WB 198	WB 14+320	WB 14+508	3	184	552	0.34
Grant Street East Connector	GSE 1+00	GSE 1+074	3	75	225	0.14
Grant Street West Connector	GSW 1+00	GSW 1+065	2	62	124	0.08
Ramp DC	DC 1+000	DC 1+160	5	158	790	0.49
Ramp L	L 1+010	L 1+070	1	61	61	0.04
Grant Street North Connector	GN 1+220	GN 1+135	2	84	168	0.10
Grant Street North Connector	GN 1+135	GN 1+070	3	66	198	0.12
Parkside Ramp	P 1+040	WB 14+100	1	35	35	0.02
Total					**20252**	**12.6**

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed	
Local Roads (T = 10 tons/lane-mile)							
Agassai	M 1+008	M 1+063	3	55	165	0.10	
Parkside	P 1+008	P 1+100	4	59	236	0.15	
Parkside	P 1+100	P 1+170	3	73	219	0.14	
Humboldt Pkwy	HP 1+138	HP 1+010	1	130	130	0.08	
Ramp from Parkside	P 1+140	P 1+040	1	98	98	0.06	
Delaware North	DN 1+010	DN 1+095	2	85	170	0.11	
Delaware North	DN 1+095	DN 1+175	3	84	252	0.16	
Delaware North	DN 1+175	DN 1+395	2	217	434	0.27	
Delaware North	DN 1+395	DN 1+442	3	50	150	0.09	
Delaware South	DS 1+438	DS 1+345	2	88	176	0.11	
Delaware South	DS 1+442	DS 1+295	3	52	156	0.10	
Delaware South	DS 1+295	DS 1+170	4	130	520	0.32	
Delaware South	DS 1+170	DS 1+010	2	154	308	0.19	
Nottingham Terrace	NT 1+010	NT 1+112	3	112	336	0.21	
Grant Street	G 1+210	G 1+270	3	56	168	0.10	
Grant Street	G 1+270	G 1+350	4	105	420	0.26	
Grant Street	G 1+350	G 1+425	5	53	265	0.16	
Grant Street	G 1+425	G 1+465	4	43	172	0.11	
New Elmwood Connector Street	EC 1+005	EC 1+060	4	55	220	0.14	** Previously as state
New Elmwood Connector Street	EC 1+060	EC 1+180	5	121	605	0.38	
Lincoln Pkwy Bridge	N 1+006	N 1+160	1	155	155	0.10	
Total					**5,355**	**3.3**	

Chloride Concentration	**7.8**	**mg/L**

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - Build Alternative

Drainage Area

Project Area
0.11 sq. miles

Hoyt Lake
Total watershed
25.8 sq. miles

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed
198 Roadways (T = 27 tons/lane-mile)						
EB 198	EB 10+478	EB 10+773	2			
EB 198 TO ROUNDABOUT	EB 10+773	GSE 1+000	3			
Roundabout	GR 1+000	GR 1+040	1			
EB 198	EB 10+900	EB 12+385	2			
EB 198	EB 11+640	EB 11+770	2			
EB 198	EB 12+385	EB 13+120	2	737	1474	0.92
EB 198	EB 13+120	EB 13+212	3	88	264	0.16
EB 198	EB 13+212	EB 13+910	2	691	1382	0.86
EB 198	EB 13+910	EB 13+975	3	66	198	0.12
EB 198	EB 13+975	EB 14+130	4	154	616	0.38
EB 198	EB 14+130	EB 14+200	3	71	213	0.13
EB 198	EB 14+200	EB 14+340	4	135	540	0.34
EB 198	EB 14+340	EB 14+505	3	166	498	0.31
WB 198	WB 10+478	WB 11+785	2			
WB 198	WB 11+785	WB 11+910	3			
WB 198	WB 11+910	WB 12+395	2			
WB 198	WB 12+395	WB 13+240	2	843	1686	1.05
WB 198	WB 13+240	WB 13+400	4	160	640	0.40
WB 198	WB 13+400	WB 13+790	2	387	774	0.48
WB 198	WB 13+790	WB 13+860	3	72	216	0.13
WB 198	WB 13+860	WB 13+935	2	76	152	0.09
WB 198	WB 13+935	WB 14+140	3	201	603	0.37
WB 198	WB 14+140	WB 14+270	5	128	640	0.40
WB 198	WB 14+270	WB 14+320	4	54	216	0.13
WB 198	WB 14+320	WB 14+508	3	184	552	0.34
Grant Street East Connector	GSE 1+00	GSE 1+074	3			
Grant Street West Connector	GSW 1+00	GSW 1+065	2			
Ramp DC	DC 1+000	DC 1+160	5	158	790	0.49
Ramp L	L 1+010	L 1+070	1	61	61	0.04
Grant Street North Connector	GN 1+220	GN 1+135	2			
Grant Street North Connector	GN 1+135	GN 1+070	3			
Parkside Ramp	P 1+040	WB 14+100	1	35	35	0.02
Total				**4467**	**11550**	**7.2**

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed	
Local Roads (T = 10 tons/lane-mile)							
Agassai	M 1+008	M 1+063	3	56	168	0.10	
Parkside	P 1+008	P 1+100	4	59	236	0.15	
Parkside	P 1+100	P 1+170	3	73	219	0.14	
Humboldt Pkwy	HP 1+138	HP 1+010	1	129	129	0.08	
Ramp from Parkside	P 1+140	P 1+040	1	98	98	0.06	
Delaware North	DN 1+010	DN 1+095	2	85	170	0.11	
Delaware North	DN 1+095	DN 1+175	3	84	252	0.16	
Delaware North	DN 1+175	DN 1+395	2	217	434	0.27	
Delaware North	DN 1+395	DN 1+442	3	50	150	0.09	
Delaware South	DS 1+438	DS 1+345	2	88	176	0.11	
Delaware South	DS 1+442	DS 1+295	3	52	156	0.10	
Delaware South	DS 1+295	DS 1+170	4	130	520	0.32	
Delaware South	DS 1+170	DS 1+010	2	153	306	0.19	
Nottingham Terrace	NT 1+010	NT 1+112	3				
Grant Street	G 1+210	G 1+270	3				
Grant Street	G 1+270	G 1+350	4				
Grant Street	G 1+350	G 1+425	5				
Grant Street	G 1+425	G 1+465	4				
New Elmwood Connector Street	EC 1+005	EC 1+060	4				** Previously as state
New Elmwood Connector Street	EC 1+060	EC 1+180	5				
Lincoln Pkwy Bridge	N 1+006	N 1+160	1				
Total				**1274**	**3,014**	**1.9**	

Chloride Concentration	**4.6**	**mg/L**

NYS Rte 198 Scajaquada Corridor
PIN 5470.14
City of Buffalo, Erie County, NY

Toler Analysis - Build Alternative

Drainage Area

Project Area
0.08 sq. miles

Scajaquada Creek
Total watershed
26.7 sq. miles

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed
198 Roadways (T = 27 tons/lane-mile)						
EB 198	EB 10+478	EB 10+773	2	293	586	0.36
EB 198 TO ROUNDABOUT	EB 10+773	GSE 1+000	3	95	285	0.18
Roundabout	GR 1+000	GR 1+040	1	150	150	0.09
EB 198	EB 10+900	EB 12+385	2	1485	2970	1.85
EB 198	EB 11+640	EB 11+770	2	130	260	0.16
EB 198	EB 12+385	EB 13+120	2	738		
EB 198	EB 13+120	EB 13+212	3	89		
EB 198	EB 13+212	EB 13+910	2	692		
EB 198	EB 13+910	EB 13+975	3	67		
EB 198	EB 13+975	EB 14+130	4	155		
EB 198	EB 14+130	EB 14+200	3	72		
EB 198	EB 14+200	EB 14+340	4	136		
EB 198	EB 14+340	EB 14+505	3	167		
WB 198	WB 10+478	WB 11+785	2	1311	2622	1.63
WB 198	WB 11+785	WB 11+910	3	122	366	0.23
WB 198	WB 11+910	WB 12+395	2	486	972	0.60
WB 198	WB 12+395	WB 13+240	2	844		
WB 198	WB 13+240	WB 13+400	4	160		
WB 198	WB 13+400	WB 13+790	2	388		
WB 198	WB 13+790	WB 13+860	3	72		
WB 198	WB 13+860	WB 13+935	2	76		
WB 198	WB 13+935	WB 14+140	3	202		
WB 198	WB 14+140	WB 14+270	5	129		
WB 198	WB 14+270	WB 14+320	4	54		
WB 198	WB 14+320	WB 14+508	3	184		
Grant Street East Connector	GSE 1+00	GSE 1+074	3	75	225	0.14
Grant Street West Connector	GSW 1+00	GSW 1+065	2	62	124	0.08
Ramp DC	DC 1+000	DC 1+160	5	158		
Ramp L	L 1+010	L 1+070	1	61		
Grant Street North Connector	GN 1+220	GN 1+135	2	84	168	0.10
Grant Street North Connector	GN 1+135	GN 1+070	3	66	198	0.12
Parkside Ramp	P 1+040	WB 14+100	1	35		
Total					**8926**	**5.5**

	From STA	To STA	No. of lanes	Length meters Proposed	Total Length Meters	Lane Miles miles Proposed	
Local Roads (T = 10 tons/lane-mile)							
Agassai	M 1+008	M 1+063	3	55			
Parkside	P 1+008	P 1+100	4	59			
Parkside	P 1+100	P 1+170	3	73			
Humboldt Pkwy	HP 1+138	HP 1+010	1	130			
Ramp from Parkside	P 1+140	P 1+040	1	98			
Ramp to Parking Area	DPA 1+012	DPA 1+100	1	83			
Delaware North	DN 1+010	DN 1+095	2	85			
Delaware North	DN 1+095	DN 1+175	3	84			
Delaware North	DN 1+175	DN 1+395	2	217			
Delaware North	DN 1+395	DN 1+442	3	50			
Delaware South	DS 1+438	DS 1+345	2	88			
Delaware South	DS 1+442	DS 1+295	3	52			
Delaware South	DS 1+295	DS 1+170	4	130			
Delaware South	DS 1+170	DS 1+010	2	154			
Nottingham Terrace	NT 1+010	NT 1+112	3	112	336	0.21	
Grant Street	G 1+210	G 1+270	3	56	168	0.10	
Grant Street	G 1+270	G 1+350	4	105	420	0.26	
Grant Street	G 1+350	G 1+425	5	53	265	0.16	
Grant Street	G 1+425	G 1+465	4	43	172	0.11	
New Elmwood Connector Street	EC 1+005	EC 1+060	4	55	220	0.14	** Previously as state
New Elmwood Connector Street	EC 1+060	EC 1+180	5	121	605	0.38	
Lincoln Pkwy Bridge	N 1+006	N 1+160	1	154	154	0.10	
Total					**2,340**	**1.5**	

Chloride Concentration	**3.4**	**mg/L**

EXHIBIT F

POLLUTANT LOADING CALCULATIONS

The Simple Method- from the NYS Stormwater Design Manual (2001)

$L = 0.226 * R * C * A$

where:
- L= Annual Load in lbs.
- R= Annual Runoff in inches*
- C= Pollutant Concentration (mg/L)
- A= Area (acres)
- 0.226= unit conversion factor

Runoff: $R = Rv * P * Pj$

where:
- R= Annual Runoff (inches)
- P= Annual Rainfall (inches)
- Pj = Fraction of events that produce runoff, usually 0.9
- R_v= Runoff Coefficient

and $R_v = (0.05)+(0.009*I_a)$

where:
- I_a=Impervious Fraction**

* Annual rainfall was taken from USGS Stream Stats = 37.6"
** Areas include only the existing and proposed impervious areas (not including pathways) giving you a total of 100% imprevious area.

Pollutant Concentrations from Urban Highway

Pollutant	Units	Concentration
TSS	mg/L	142.00
TP	mg/L	0.32
TN	mg/L	3.00
Cu	mg/L	0.05
Pb	mg/L	0.40
Zn	mg/L	0.33

* Concentrations taken from p. A-3 from the NYS Stormwater Management Design Manual (2001)

No Build Alternative

a. Area	36.10	acres		
b. Percent Impervious, Ia	100%			
c. Runoff Coefficient, Rv	0.95	dimensionless		
d. Runoff, R	32.1	inches		
e. Annual load				
TSS	37,244	lbs.	16,894	kgs
TP	84	lbs.	38	kgs
TN	787	lbs.	357	kgs
Cu	14	lbs.	6	kgs
Pb	105	lbs.	48	kgs
Zn	86	lbs.	39	kgs

Pollutant Concentrations from Urban Highway

Pollutant	Units	Concentration
TSS	mg/L	142.00
TP	mg/L	0.32
TN	mg/L	3.00
Cu	mg/L	0.05
Pb	mg/L	0.40
Zn	mg/L	0.33

* Concentrations taken from p. A-3 from the NYS Stormwater Management Design Manual

Build Alternative

a. Area	30.15	acres	(does not include walkways)	
b. Percent Impervious, Ia	100%	ratio		
c. Runoff Coefficient, Rv	0.95	dimensionless		
d. Runoff, R	32.1	inches		
e. Annual load				
TSS	31,106	lbs.	14,109	kgs
TP	70	lbs.	32	kgs
TN	657	lbs.	298	kgs
Cu	12	lbs.	5	kgs
Pb	88	lbs.	40	kgs
Zn	72	lbs.	33	kgs

Anticipated Pollutant Removal Based on Stormwater Management

			TSS		TP		TN		Cu		Pb		Zn	
Facility	IA Treated (ac)	% of Total DA	Efficiency (%)	Removed (lbs)	Efficiency (%)	Removed (lbs)	Efficiency (%)	Removed (lbs)	Efficiency (%)	Removed (lbs)	Efficiency (%)	Removed (lbs)	Efficiency (%)	Removed (lbs)
Swale #1	2.9	10%	81%	2440	24%	1.6	56%	36	65%	0.7		0	71%	5.0
Bio Area #2	3.1	10%	59%	1893	5%	0.4	46%	31	81%	1.0		0	79%	5.9
Swale #3A	1.5	5%	81%	1212	24%	0.8	56%	18	65%	0.4		0	71%	2.5
Swale #3B	0.6	2%	81%	490	24%	0.3	56%	7	65%	0.1		0	71%	1.0
Hydrodynamic	21.3	71%	55%	12086	81%	40.1	10%	46		0.0		0		0.0
Total Removed from SWM	29.4	97%		18121		43		138		2.3		0		14
Total Removed from Pavement Removal				6139		14		130		2.3		17		14
Toal Removed				24260		57		268		4.6		17		29
Total Reduction %				65%		68%		34%		32%		16%		33%

**Removal efficiencies from various sources including:

National Pollutant Removal Performance Database, Version 3. September 2007. Center for Watershed Protection.
NYS Stormwater Design Manual. January 2015. New York State Department of Environmental Conservation.
New Hampshire Stormwater Manual, Volume 2. December 2008. New Hampshire Department of Environmental Services.

Some pollutant removal efficiency values for varies treatment practices were unable to be found in cited literature.