ENVIRONMENTAL DESIGN
PARTNERSHIP, LLP

STORMWATER REPORT

REGATTA VIEW – AREA B – PHASE 3

CITY OF SARATOGA SPRINGS, NEW YORK

MAY 19, 2016

1.0 INTRODUCTION

Regatta View, LLC is proposing the development of an approximately 6.79 acre parcel located on the northeast corner at the intersection of Route 9P and Regatta View Drive in the City of Saratoga Springs. The proposed project will consist of 12 residential duplex units (24 total units), associated driveways and a private road. The project will result in approximately 4.7+/- acres of disturbance and 1.88 acres of new impervious area.

The total disturbance for the proposed project will be greater than 1.0 acre which requires the construction activity to be covered under the NYSDEC SPDES General permit. In accordance with the General Permit, the proposed project will require a full SWPPP with post-development stormwater management control designed in accordance with the NYSDEC Stormwater Management Design Manual (SMDM).

A stormwater management system has been designed to provide pollutant removal, reduce channel erosion, prevent overbank flooding, and safely convey extreme flood events in accordance with the NYSDEC SMDM. The proposed stormwater management system includes storm sewer conveyance structures, thirteen (13) Bioretention areas, porous pavement driveways and drywells and infiltration chambers providing a total WQv storage volume of approximately 20,682 cf.

The intent of this stormwater management narrative is to review the existing and proposed site drainage to assure that changes in the surface runoff characteristics, as a result of the proposed construction activities, will not adversely impact adjacent or downstream properties.

2.0 EXISTING CONDITIONS

The existing site is a vacant parcel with coverage including wooded areas and open grass/brush areas. The existing site drains to the roadside swale located along Route 9P which conveys runoff to an 18" storm culvert located at the intersection of Regatta View and Route 9P. The 18" culvert crosses Regatta View and discharges to a rip-rap swale which further convey storm runoff south along Route 9P. The topography of the site consist of gentle slopes, ranging from 1% to 5%, with elevations ranging from 257 to 263 feet above sea level.

2.1 Soil and Groundwater Conditions

The USDA Natural Resources Conservation Service Soil Survey identifies the primary soil group within the area of proposed development as Windsor loamy sand. The Soil Survey identifies the Windsor series as deep excessively drained soils with a hydrologic soil group (HSG) of A.

Soil test pits were performed at the site during April of 26 and were observed by Environmental Design. Results from the test pits found the soils to be consistent with Windsor Loamy sand. The typical soil profile consisted of light brown medium sand transitioning to grey medium-coarse sand at greater depths. Indications of soil dampness were noted at elevations ranging from 252.5+/- to 255.5+/-.

3.0 PREDEVELOPMENT STORMWATER ANALYSIS

A predevelopment stormwater analysis was performed for the existing conditions at the project site. The existing stormwater conditions, in the area to be disturbed as a result of the proposed construction, were modeled using Applied Microcomputer Systems' "HydroCAD" computer modeling program. The HydroCAD stormwater modeling program employs the United States Department of Agriculture's National Resources Conservation Service (NRCS) Technical Release 20 (TR-20) method for stormwater analysis. Using this modeling technique, the site is divided into "subcatchments" that represent specific areas contributing stormwater runoff to an existing or proposed drainage feature. The subcatchments typically flow through "reaches" (i.e., swales, channels, or pipes) that convey the stormwater to storm basins or discharge areas.

A HydroCAD model was developed to establish the predevelopment runoff characteristics of the site with the results included in Appendix B. The existing site was modeled as 2 subcatchments (Figure 2) and the predevelopment stormwater discharge was evaluated for several design storms at the Design Point. Design Point A consists of the existing 18" storm culvert which receives stormwater runoff from the entire parcel, the southern side of Dyer Switch Road, the northern side of Regatta View Drive and the entire pavement portion of Route 9P adjacent to the site.

Table 1 presents a summary of the predevelopment stormwater peak discharge at Design Point A (refer to Figure 2). As will be discussed in subsequent sections, the post development stormwater

discharge rates have been limited to the predevelopment discharges rates for the 1-yr, 10-year, and 100-year storm events.

Table 1: Predevelopment Stormwater Peak Discharge Rate

Storm Event	Design Point A Runoff (cfs)
1-Year (2.15")	0.38
10-Year (3.9")	1.97
100-Year (6.25")	4.79

The existing open grass and wooded arears were categorized as HSG A and were modeled with Curve Numbers (CN) of 43 and 30, respectively. The pavement and impervious cover in the offsite area were modeled with a CN of 98. The weighted CN for the predevelopment site (excluding offsite) was calculated to be 30.

4.0 STORMWATER SITE PLANNING AND PRACTICE SELECTION

The site layout and stormwater design for this project was completed primarily with regard to the existing topography, drainage patterns and potential impacts on the site hydrology. Various measures were taken to aid in assuring that post development hydrology of the site will continue to resemble predevelopment hydrologic condition. The existing site has a greater tendency to have rainfall infiltrate rather than runoff from the site; therefore the proposed stormwater practices have been designed to completely infiltrate stormwater runoff. Additional stormwater planning measures for the site include soil restoration and reduction of clearing and grading.

Soil restoration has been called for throughout the site in accordance with Chapter 5 of the NYS Stormwater Management Design Manual. The soils on the site are classified as HSG. Restoration requirements for HSG A soils calls for full restoration by tilling compost into the sub-soils prior to applying topsoil and vegetating. In high traffic areas that are to remain pervious, especially around the proposed building and equipment storage areas, the soils shall be fully restored by tilling compost into the sub-soils prior to applying topsoil and vegetating. Any accumulated sediments within the stormwater management areas will be removed prior to application of topsoil and seeing. By applying these methods to the soils on the site the original properties and porosity of the soils will be recovered, which will allow for an improvement in the soil infiltration as well as lawn and landscaping sustainability.

The proposed layout for the site will result in the clearing and grading to be centrally located and limited to the private road and duplex units. The duplex buildings have been positioned in close proximity to the road and the proposed stormwater practices will be located between the units

and road as well as adjacent to the units. The grading behind the units will be limited to providing drainage conveyance. The existing vegetation along the east and west property lines will not be cleared in order to maintain privacy and enhance screening.

5.0 POST-DEVELOPMENT STORMWATER ANALYSIS

A post-development stormwater analysis was performed for the proposed conditions at the project site. The proposed stormwater conditions, in the area to be disturbed as a result of the proposed construction, were modeled using Applied Microcomputer Systems' "HydroCAD" computer modeling program. The HydroCAD stormwater modeling program employs the United States Department of Agriculture's National Resources Conservation Service (NRCS) Technical Release 20 (TR-20) method for stormwater analysis. Using this modeling technique, the site is divided into "subcatchments" that represent specific areas contributing stormwater runoff to an existing, or proposed drainage feature. The subcatchments typically flow through "reaches" (i.e., swales, channels, or pipes) that convey the stormwater to storm basins or discharge areas.

Stormwater runoff will be managed within a combination of porous pavement driveways, roadside bioretention areas, drywells and infiltration chambers. Stormwater runoff from the paved portions of the site shall either flow directly or be piped into the proposed stormwater management areas. These post-development measures will provide complete storage and infiltration capacity of the on-site runoff.

A post development curve number (CN) of 98 was assigned to all impervious surfaces within the proposed site. A post development CN of 39 was assigned to all proposed "green" areas and all existing wooded areas were modeled with a CN of 30. The weighted CN for the post development site conditions was calculated to be approximately 50. The HydroCAD model results for the post development conditions are included within Appendix B.

5.1 Stormwater Management Area #1 - #13 (Bioretention Areas)

Stormwater Management Areas #1 through #13 will provide treatment of stormwater runoff from the proposed private road and the front portions of the duplex buildings and yards. The stormwater runoff from the road will flow along the curb line and enter a gravel diaphragm through a curb break. The gravel diaphragm will aid in reducing erosion of the planting area, mitigating the velocity of incoming runoff and promoting sheetflow to the bioretention areas. Refer to Table 2 for the respective contributing area and storage volume for each stormwater management area.

These SMA's have been designed as Bioretention Areas (F-5). The NYSDEC Stormwater Design Manual (Design Manual) selection matrix recognizes the use of bioretention areas as a suitable method for commercial projects with less than 5 acres of contributing drainage area

under most conditions. Pretreatment will be provided via a gravel diaphragm and sheet flow down the grassed slopes prior to entering the stormwater management area. The bioretention area was designed without an underdrain due to the presence of HSG "A" soils with infiltration rates on the order of 10 in/hr to 20 in/hr. The elimination of the underdrain will allow for additional runoff reduction through infiltration, as per Table 5.3 of the Design Manual. Drainage entering the bioretention area will be filtered through the plants and planting soil and will infiltrate in the ground. While infiltration was not used in the modeling of this design, the relatively high infiltration rates of the existing soils will be able to fully attenuate and infiltrate the runoff from 1-year and 10-year events.

The SMA's will be located immediately adjacent to the private road. The bioretention areas have been designed with a beehive grated standpipe installed at an elevation to allow for 6" of ponding. Hydrologic modelling indicates the elevation of the standpipes may be exceeded for the 100-year storm event. To convey the excess runoff during these large storm events, the standpipe will discharge runoff to downstream drywells or infiltration chambers. The drywells or chambers will provide additional storage for storm runoff, as well as infiltration capacity.

The bioretention area was designed to operate during frozen conditions. The planting soils was designed with a higher percent of sand and without any peat or compost material, both of which are susceptible to freezing, as per section 6.4.7 of the Design Manual. The bottom of the bioretention system will also be 4 feet below grade in order to keep the existing soils from freezing and to allow for infiltration during the winter months.

5.2 Stormwater Management Areas (Porous Pavement Driveways)

All the proposed driveways have been designed to utilize a porous pavement section in order to provide treatment, infiltration and runoff reduction. Each porous pavement driveway will only collect the rainfall directly falling on the surface and not receive runoff from any upstream areas. The residential community will primarily utilize two driveway configurations; therefore the surface area for the two (2) typical driveways will be 460 sf and 1,600 sf.

The porous pavement sections have been designed in accordance with the NYSDEC SMDM as well as the University of New Hampshire Stormwater Center (UNHSC) Design Specifications for Porous Asphalt Pavement and Infiltration Beds. The porous pavement design will incorporate 4 inches minimum of porous asphalt, a 6" choker course and an 18" thick stone recharge bed. Due to the small drainage area and presence of soils with high hydraulic conductivity rates (>>5 inches per hour), an underdrain will not be installed. The use of an 18" thick recharge bed provides excess runoff storage for large storm events. Assuming a very conservative infiltration rate of 1 inch per hour, hydraulic modelling indicates the recharge bed has sufficient storage for all storm events up to and including the 100-year storm. Infiltration testing will be completed to confirm the high infiltration capacity of the soil.

5.3 NYS Unified Stormwater Sizing Criteria

The proposed post development site conditions were analyzed using Applied Microcomputer System' "HydroCAD" computer modeling program, the results have been included with this report. A technical description of the HydroCAD stormwater modeling program was provided in a previous section.

The area to be disturbed as a result of the proposed construction activities was modeled under post-development conditions using 15 subcatchment areas, excluding the porous pavement driveways (Figure 3). The subcatchment areas were routed into the storm sewer conveyance structures and stormwater management areas. The contributing area of each stormwater management area is identified in Table 2. The post development stormwater management system has been designed based on the Unified Stormwater Sizing Criteria as described in the following sections of this narrative.

5.3.1 Water Quality (WQ_v)

In general, small storm events and the initial runoff from larger storm events are an environmental concern as this stormwater runoff typical contains roadway pollutants and thermal energy stored by the asphalt. In accordance with the NYS SMDM, this initial runoff is designated as the Water Quality Volume (WQv) and special attention is given to this volume of runoff to meet water quality objectives.

The NYS SMDM identifies several standard practices that area acceptable for water quality treatment. These acceptable Stormwater Management Practices (SMPs) area designed to capture and treat the full water quality volume (WQv), provide up to 80% TSS removal and 40% TP removal, have acceptable longevity in the field, and have pretreatment characteristics. The porous pavement sections have been designed to fully attenuate and infiltrate the respective contributing WQv.

The water quality storage volume, WQ_v, is calculated as follows:

$$WQ_v = \frac{P \cdot R_v \cdot A}{12}$$

where:

WQ_v = water quality volume (acre-feet)
P = 90% rainfall event number
R_v = 0.05+0.009(I), where I is percent impervious cover
A = site area (acres), impervious area used with I = 100%

Table 2: Required Water Quality Volume

I.D.	P	R_v	A (acres)	Required WQ_v (cf)	Provided RRv (cf)	Provided WQ_v (cf)
SMA#1	1.1	0.54	0.11	238	238	1,116
SMA#2	1.1	0.61	0.12	293	293	1,116
SMA#3	1.1	0.56	0.10	225	225	1,116
SMA#4	1.1	0.55	0.09	198	198	1,116
SMA#5	1.1	0.57	0.10	217	217	1,116
SMA#6	1.1	0.52	0.10	199	199	1,116
SMA#7	1.1	0.60	0.14	333	333	1,116
SMA#8	1.1	0.50	0.10	200	200	535
SMA#9	1.1	0.55	0.10	218	218	616
SMA#10	1.1	0.65	0.09	234	234	519
SMA#11	1.1	0.61	0.12	293	293	535
SMA#12	1.1	0.54	0.11	238	238	535
SMA#13	1.1	0.72	0.14	386	386	1,058
Driveways	1.1	0.95	0.35	1,328	1,328	9,072
			Totals	**4,598**	**4,598**	**20,682**

The overall site WQv was computed using a site area of 6.695 acres and an impervious coverage of 1.88 acres. **The total WQv was determined to be 8,100 cf** (3,502 cf from disconnection of rooftop runoff)

5.3.1.1 ***Pretreatment Practices***

As per the NYSDEC Design Manual, F-5 Bioretention Areas require a pretreatment measure such as a sedimentation basin or gravel diaphragm sized to a minimum of 25% of the contributing Water Quality volume. The thirteen (13) proposed Bioretention areas will each utilize a gravel diaphragm for pretreatment.

The Bioretention areas have each been designed with a 2 ft wide gravel diaphragm to provide pretreatment of the contributing runoff. The gravel diaphragms have been designed in accordance with the Design Manual requirements. The gravel diaphragms have been designed as rectangular prisms providing storage of 25% of the contributing WQv. The smaller diaphragm has dimensions of 5'x10'x3' and the larger diaphragm has dimensions of 8'x10'x3', each with 40% voids space.

5.3.2 Runoff Reduction Volume (RRv)

The NYS Stormwater Design Manual specifies that the runoff shall be reduced by 100% of the site WQv using green infrastructure techniques and standard SMPs with RRv capacity. The purpose of these standards is to minimize the impacts to the existing hydrology of the site. The overall WQv calculated for this site is 8,100 cubic feet.

5.3.2.1 ***Green Infrastructure***

The green infrastructure practices, as defined in Chapter 5 of the design manual, provided on this site includes disconnection of rooftop runoff and porous pavement.

The proposed residential community has been designed to utilize disconnection of rooftop runoff for the rear portion of the units. The site has been graded to provide adequate drainage for downspouts to discharge to the pervious greenspace areas where filtration and infiltration will occur. The impervious roof areas are adequately disconnected and can therefore be treated as pervious area for computing the Water Quality volume. The disconnection of rooftop area and receiving pervious areas account for 4.94 acres and 0.7 acres of impervious; therefore a reduction in WQv of 3,502 cf.

Porous pavement is proposed for the single and shared driveways for all the proposed units. The porous pavement will provide treatment, attenuation and infiltration of the rainfall landing on the driveways. The contributing WQv will be captured and stored in the recharge layer where it will fully infiltrate. Porous pavement is effective at pollutant removal and provides infiltration at the source which will allow for the post-development hydrology to more closely match the predevelopment. The porous pavement sections proposed must be designed by and constructed to the specification of a licensed Geotechnical Engineer with a minimum stone depth of 18" and stone porosity of 0.40. In the case of clogging due to lack of maintenance, the parking areas have been graded to properly convey runoff into the downstream drainage system. The RRv provided from the implementation of the porous pavement is summarized in Table 3.

Table 3: Porous Pavement WQv and Sizing Calculations

I.D.	Count	Contributing WQv (ac)	% I	Rv	WQv (cf)	Surface Area (sf)	Porosity	Recharge Layer depth (ft)	Provided WQv (cf)
Single Driveway	12	0.011	100	0.95	39.8	460	0.4	1.5	276
Shared Driveway	6	0.037	100	0.95	140.4	1600	0.4	1.5	960
Total WQv for all Driveway Area					**1,328**	**Total Storage Provided**			**9,072**

5.3.2.2 ***Stormwater Management Practices (SMPs)***

Thirteen (13) Bioretention areas are proposed to provide treatment, attenuation and infiltration of stormwater runoff from the private road. The bioretention areas have been designed with overflow standpipes to convey excess runoff from large storm events to downstream drywells and infiltration chambers. The elevation of the standpipe was set to allow for 6 inches of ponding prior to overflow. The drywells and chambers provide additional storage and infiltration capacity for the runoff. A summary of the RRv provided by the Bioretention areas is provided in Table 4.

Table 4: Runoff Reduction Volume Summary

Runoff Reduction Technique	RRv (cf)
Bioretention Areas	3,270
Porous Pavment	1,328
Disconnection of Rooftop Runoff	3,502
Total Provided Site Reduction	**8,100**
Required Site RRv	**8,100**
% of project WQv reduced	**100%**

5.3.3 Channel Protection (Cp_v)

In accordance with the NYS SMDM, stream channel protection, designed to protect stream channels from erosion, is accomplished by providing 24-hour extended detention of the one year, 24 hour storm event. The Cp_v requirement is typically satisfied by providing additional storage above the water quality (WQ_v) volume.

The one-year storm event was analyzed using the HydroCAD stormwater modeling program (TR-20) under the post development drainage conditions shown on Figure 3. Using a one-year, 24-hour design storm of 2.15 inches the required Cp_v was calculated as depicted in Table 5. The total Cpv required for the site was computed to be 5,183 cf and the provided Cpv was designed to be 20,682 cf.

Table 5: Channel Protection Volume Summary

	1-Year Design Storm (in)	Weighted CN	Cp_v (cf)	Cp_v (provided) (cf)
SMA#1	2.15		131	1,116
SMA#2			131	1,116
SMA#3			261	1,116

SMA#4			174	1,116
SMA#5	2.15		131	1,116
SMA#6			131	1,116
SMA#7			261	1,116
SMA#8			174	535
SMA#9			218	616
SMA#10			261	519
SMA#11			174	535
SMA#12			174	535
SMA#13			348	1,058
Driveways			2,614	9,072
		Total	**5,183**	**20,682**

5.3.4 Overbank Flood (Q_p)

Overbank Flood Control Criteria has been established to limit the frequency and magnitude of out-of-bank flooding generated through changes in runoff characteristics as a result of increased impervious surface area. As per the NYS Stormwater Design Manual, providing sufficient storage volume to attenuate the post development 10-year, 24-hour peak discharge rate to the equivalent predevelopment discharge rate control overbank flooding.

The 10-year storm event was analyzed using the HydroCAD stormwater modeling program (TR-20) under the post development drainage conditions shown on Figure 3. Using a 10-year, 24 hour design storm of 3.9 inches, the overflow standpipes, drywells and infiltration chambers have been sized to fully attenuate the post development peak discharge rate. The only remaining runoff contributing to the design point is the offsite area from Route 9P, Dyer Switch Road and Regatta View Drive, which is unchanged from pre development. The following table depicts the predevelopment and post development discharge rates for discharge off the site. As indicated, the post development discharge rate is less than or approximately equivalent to the predevelopment rate as required.

Table 6: Overbank Flood, Q_p, (10-Year Storm) Discharge Rates

Design Point	Predevelopment 10-Year Storm (cfs)	Postdevelopment 10-Year Storm (cfs)
A	1.97	1.97

5.3.5 Extreme Storm (Q_f)

In accordance with the NYS Stormwater Design Manual, the stormwater management system must attenuate the post development 100-year, 24-hour peak discharge rate to the predevelopment rate while providing safe passage of this storm event.

The 100-year storm event was analyzed using the HydroCAD stormwater modeling program (TR-20) under the post development drainage conditions shown in Figure 3. Using a 100-year, 24-hour design storm of 6.25 inches, the overflow standpipes, drywells and infiltration chambers have been sized to fully attenuate the post development peak discharge rate. The only remaining runoff contributing to the design point is the offsite area from Route 9P, Dyer Switch Road and Regatta View Drive, which is unchanged from pre development. The following table depicts the predevelopment and post development discharge rates for discharge off the site. As indicated, the post development discharge rate is less than or approximately equivalent to the predevelopment rate as required.

Table 7: Extreme Storm, Q_f, (100-Year Storm) Discharge Rates

Design Point	Predevelopment 100-Year Storm (cfs)	Postdevelopment 100-Year Storm (cfs)
A	4.79	4.79

6.0 SUMMARY

Development of the proposed property will alter the stormwater characteristics of the existing site; impervious area will be constructed and the site will be re-graded to support the proposed site improvements. Changes to the stormwater drainage characteristics of the site have been evaluated in accordance with the NYS Stormwater Management Design Manual. The proposed stormwater management system complies with the recommendations in the design manual related to water quality, runoff reduction, channel protection, overbank flood control, and extreme flood control.

The proposed stormwater management system has been designed to attenuate and treat the stormwater runoff generated from storm events up to and including the 100-year design storm event. The proposed stormwater management design includes the use of thirteen (13) Bioretention areas, porous pavement driveways and drywells and infiltration chambers. Extended detention storage will be provided above the required water quality volume to achieve detention (Q_p) and channel protection (Cp_v) requirements. Stormwater modeling results, based on the proposed site layout, indicate the ability to reduce the overall post development discharge rate from the site as summarized in Table 10.

Table 8: Post Development Stormwater Peak Discharge Rates

Peak Discharge Rates in cfs	10-Year Storm	100-Year Storm
Total Site Discharge		
Predevelopment	1.97	4.79
Post Development	1.97	4.79
Overall Reduction (cfs)	0.00	0.00

Through the implementation of acceptable stormwater management practices, recommended by the NYS Stormwater Management Design Manual, the proposed project will not adversely affect adjacent or downstream properties including any basement areas.

Respectfully Submitted,

Kristopher LaPan, E.I.T.
Environmental Design Partnership

7.0 REFERENCES

HydroCAD version 6.00, Applied Microcomputer Systems, Chocura, New Hampshire.

NYSDEC, 1990. "Technical and Operational Guidance Series (5.1.8) Stormwater Management Guidelines for New Development", New York State Department of Environmental Conservation, Division of Water.

NYSDEC, 1992. "Reducing the Impacts of Stormwater Runoff from New Development", New York State Department of Environmental Conservation, Division of Water.

NYSDEC, 2015. "New York State Stormwater Management Design Manual", Center for Watershed Protection, Ellicott City, MD.

Rawls, W.J., Brakensiek, D.L., and Saxton, K. E., 1982. "Estimation of Soil Properties", Transactions of the American Society of Agricultural Engineers, Vol. 25, No. J, pp. 1316-1320.

S.C.S., 1982. "TR-20 Project Formulation-Hydrology, Technical Release No. 20", U.S. Department of Agriculture, Soil Conservation Service, Hydrology Unit Division of Engineering.

S.C.S., 1988. "Soil Survey of Saratoga County, New York", U.S. Department of Agriculture, Soil Conservation Service.

Appendix A

Runoff Reduction Calculations

Appendix B

Stormwater Modeling Calculations

Pre-development HydroCAD Report

Post-development HydroCAD Report