DESIGN REPORT

FOR

INCLINE VILLAGE GREEN STREETS PROJECT

INCLINE VILLAGE, NEVADA

July 2014

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1. INTRODUCTION

The Incline Village Green Streets Project is a Low Impact Development (LID) retrofit for an existing stormwater treatment system within the Tahoe Basin, specifically Incline Village, Washoe County, Nevada. The proposed project will install up to six and a minimum of five LID stormwater treatment areas within Nevada Department of Transportation (NDOT) right-of-way (ROW) along Tahoe Blvd/State Route 28. If a site must be omitted from construction based on available construction budget and Contractor bid results, site STA 207 will be omitted.

BACKGROUND

The Lake Tahoe TMDL shifts pollutant control strategies from treatment of the runoff ***volume*** from the 20 year, 1 hour storm event to treatment of the sub 16 µm sediment, nitrogen and phosphorus ***load***. Traditionally, design engineers working in space constrained areas of residential and commercial development relied on in-line treatment trains of structural BMPs for treatment of the runoff volume. However, peer reviewed studies (Roseen, et al., 2006) and leading experts on BMP treatment vault effectiveness (John Sansalone, pers. comm.) indicate that structural, flow-through BMPs are ineffective at retaining sub 16 µm sediment, nitrogen and phosphorus. A USGS report showed the infiltration BMP most efficient at removing suspended solids, lead, and total phosphorus (Zarrielo, et al., 2002). Although the report did not look at sub 16 µm sediment, the fact that phosphorus and lead sorb to the finest particle sizes, implies similar performance for fine sediment. This indicates a need to shift from structural BMPs to infiltration BMPs in the TMDL era from a performance standpoint.

Available budgets also suggest a need to shift toward LID BMPs. As available grant funds for EIP implementation and TMDL compliance continue to dwindle, jurisdictions must become more efficient with use of funds. Not only should the upfront capital costs of the treatment system construction be taken into account, future maintenance requirements in order to achieve satisfactory continued operation (credits) should be weighed. LID BMPs cost significantly less than comparable structural BMPs to construct and maintain. LID BMPs take advantage of natural processes to maintain function thus require less maintenance over time than similar structural BMP performance. Infiltration performance of BMPs is highly related to the soil structure. In general, the more porosity a soil has, the higher the infiltration rate. LID BMPs rely on vegetation (annual root growth and senescence) and soil organisms (burrowing, humus aggregates) to naturally improve and maintain soil structure. LID BMPs are being widely implemented in many areas of the country to effectively treat stormwater runoff. Portland, Oregon has rain gardens that are over 15 years old and still functioning satisfactorily with routine maintenance of sediment trap cleaning (Maria Cahill, pers. comm.).

LID BMPs in Tahoe

In 2010, the Nevada Tahoe Conservation District (NTCD) partnered with Washoe County, Tahoe Regional Planning Agency (TRPA), Nevada Division of Environmental Protection (NDEP), Nevada Division of State Lands (NDSL) and the United States Forest Service (USFS) to design and implement the Hybrid BMP Project. The project was a pilot project to demonstrate the effectiveness of LID BMPs in the Tahoe Basin. The project resulted in the November 2011 completion of 5 rain gardens, a bio-swale and 2

subsurface infiltration systems along Village Boulevard in the Washoe County right-of-way (ROW) of Incline Village, NV. The rain gardens are the first installed in the Tahoe Basin. Two years monitoring results indicate a 68% runoff volume reduction in the catchment as a result of an artificial washoff test which applied 12,000 gallons of water to the catchment before and after the project installation (Figure 1). This volume reduction is greater than the design team expected.

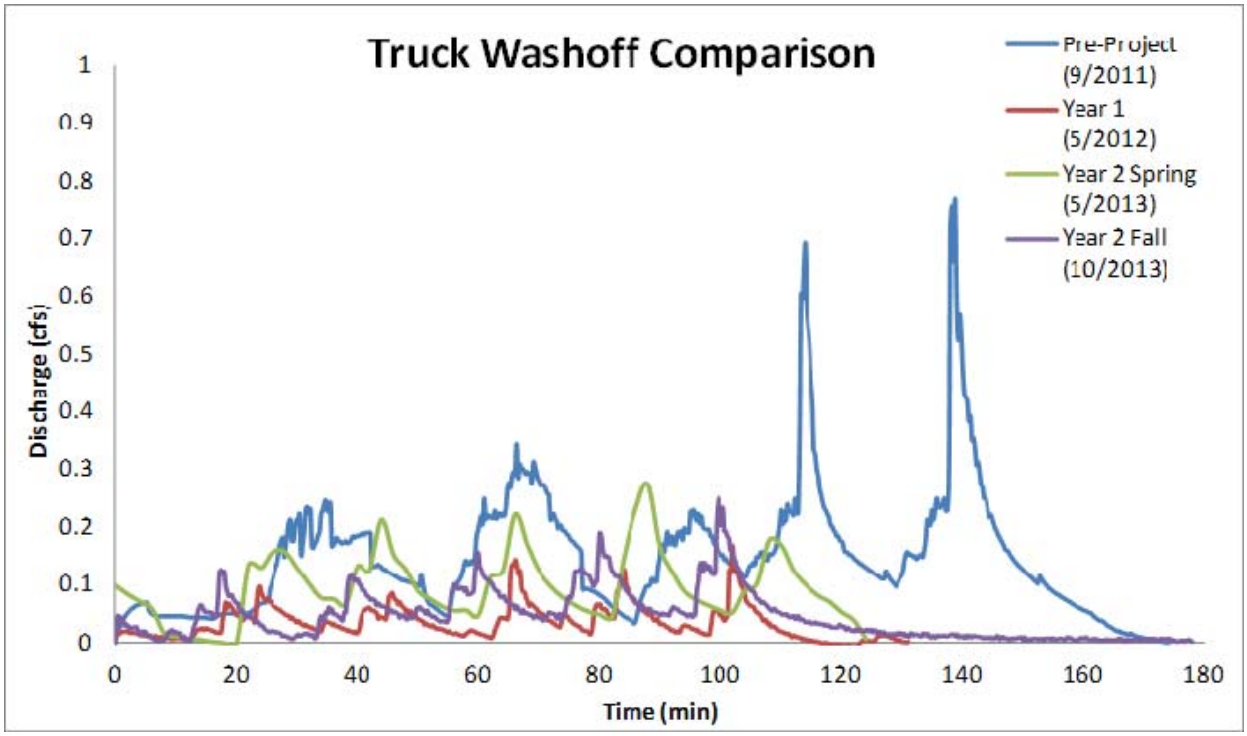

Figure 1. Runoff volume from the artificial water pours collected at the Harold Dr. monitoring station. The project resulted in a 68% runoff volume reduction.

The BMPs have also performed well in regards to vegetation establishment, infiltration rate, and maintenance requirements. The LID BMPs are different from traditional stormwater basins and swales in that they employ vegetation and microorganisms to maintain a loose soil structure conducive to high infiltration. Together, the monitoring results suggest that LID BMPs are a cost-effective option of effectively treating stormwater runoff in the often space-limited area of the ROW. The Hybrid BMP Project was awarded the 2012 TRPA Best in Basin award for erosion control project at the TRPA Board Meeting on March 27, 2013.

PROJECT LOCATION

The Incline Village Green Streets Project is located in Washoe County, in Incline Village, NV, along an approximately 3.4 mile length of Tahoe Blvd/State Route 28. The project area is the NDOT ROW in up to six different gardens in four general locations along the highway (Figure 2). The project sites are located in the Burnt Cedar Creek watershed, Third Creek watershed, and Mill Creek watershed as determined by TRPA.

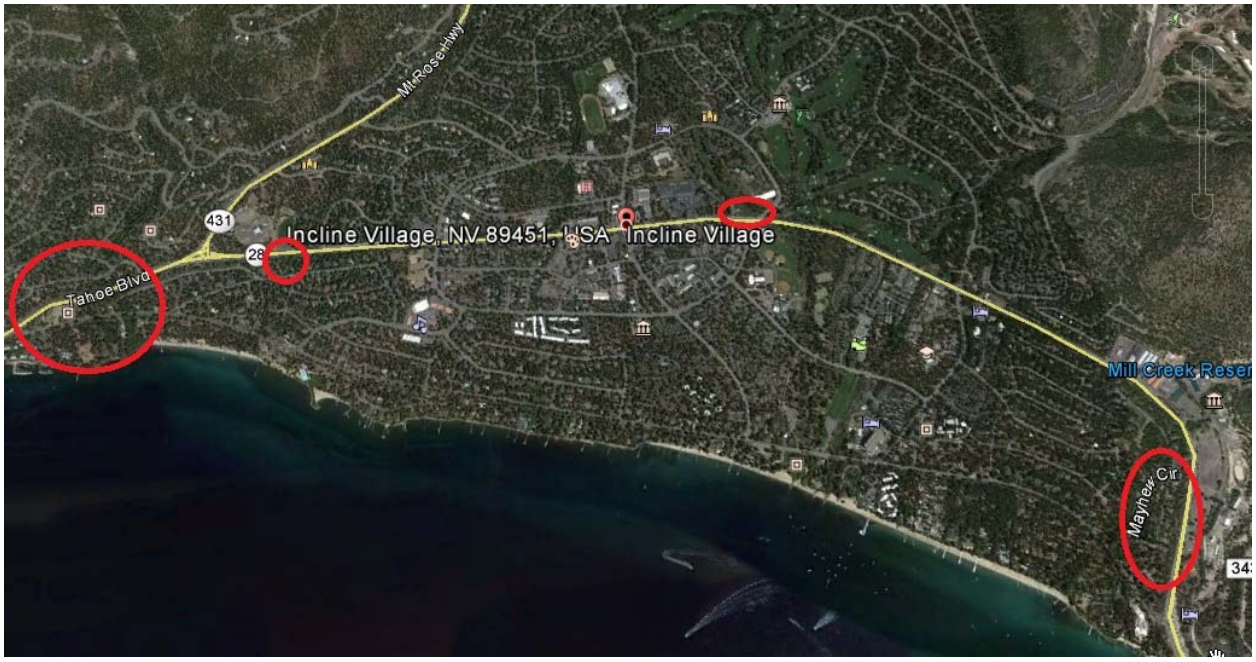

Figure 2. General Location of Proposed Incline Village Green Streets Project.

DESCRIPTION

The Incline Village Green Streets Project will install up to six infiltration BMPs based on LID concepts in the NDOT ROW along Tahoe Blvd/SR 28. Four of the six BMPs will not have an outlet except via infiltration or emergency overflow and most will be designed to become hydraulically isolated from additional inflow when full of water. After the runoff event, stormwater in the BMP will infiltrate and the sequestered fine sediment and other pollutants will not be flushed out by a subsequent large flow event, unlike most stormwater treatment BMPs in the Tahoe Basin. In the event stormwater bypasses the Incline Village Green Streets BMPs, excess stormwater will be travel to discharge points by the existing conveyance stormwater system. BMPs were selected based on topography, existing utilities locations, runoff volume, engineering, and hydro-geologic considerations which will be discussed in more detail later in this report.

GOALS AND OBJECTIVES

The goal of the project is to reduce stormwater pollutant loading to Lake Tahoe and garner Lake Clarity Credits for NDOT by installing distributed LID BMPs in the ROW of State Route 28. The project will also demonstrate that rain gardens are a cost-effective tool for treating stormwater and can add to the aesthetics of a community.

There are three objectives:

1. Through the Pollutant Load Reduction Model and catchment registration, garner Lake Clarity credits for NDOT.

2. Demonstrate ease of routine maintenance through achievement of satisfactory BMP RAM scores.
3. Show that these systems will be accepted by the public by partnering with the Rotary Club of Incline Village for installation, irrigation and maintenance assistance.

The rain gardens were designed to accommodate stormwater runoff equivalent from at least a 0.86 inch, one hour storm (i.e., a 10 year event (Table 1)). The BMPs will bypass stormwater runoff that exceeds the basin treatment capacity. 4 BMPs are designed off-line, while 2 are designed as flow through. The bypassed stormwater will flow through the existing (unaltered) conveyance and treatment system. The hydrologic source control realized by collecting and infiltrating the volume from the vast majority of runoff events will result in equally significant reductions in fine sediment load from the contributing areas of Tahoe Blvd/SR 28.

PROJECT FUNDING

The Project is funded by the Nevada Department of Transportation with matching grants from the Nevada Division of State Lands and the Nevada Division of Environmental Protection. See Table 1 for detail on the sources and the amounts.

Table 1. Funding sources and amounts for the Incline Village Green Streets Project

Agency	**Total Funding Amount**
NDSL, Lake Tahoe License Plate (LTLP) grant	$50,000
NDEP 319(h) grant	$53,000
Nevada Department of Transportation (NDOT)	$80,000
TOTAL	**$183,000**

PROJECT PARTNERS

Nevada Tahoe Conservation District is the project sponsor and lead agency responsible for planning, designing, implementing and monitoring the Incline Village Green Streets Project. NTCD is working closely with NDOT to design the project to their standards. A number of other important partners will continue to participate in the process to ensure successful project delivery and attainment of LID principles. Project partners and their roles are shown in Table 2.

Table 2. Funding sources and amounts for the Incline Village Green Streets Project

Partner	Responsibility
Nevada Tahoe Conservation District (NTCD)	Project Proponent
Nevada Division of State Lands (NDSL)	Funder, Review
Nevada Division of Environmental Protection (NDEP)	Funder, Review, Regulatory
Rotary Club of Incline Village	Assistance with Revegetation and Maintenance

Tahoe Regional Planning Agency (TRPA)	Review, Permitting, Regulatory
Nevada Division of Forestry (NDF)	Providing bioinfiltration soil amendments including aged wood chips and biochar.
Incline Village General Improvement District (IVGID)	Manager of property at Station 207 site. Review and Approval.
Nearby homeowners	Providing irrigation for select sites

2. DRAINAGE AND HYDROLOGY

EXISTING CONDITIONS

The existing sites are located in the NDOT ROW along Tahoe Blvd/SR 28. Tahoe Blvd. is approximately 40 feet wide in most areas and is paved with curb and gutter on both sides. The street is crowned with a 2 percent cross-slope in most locations. The longitudinal slope varies near each site location. The existing topography is well within design guideline criteria published in various rain garden design manuals (i.e., Low Impact Development: Technical Guidance Manual For Puget Sound, Rain Gardens: A How-to Manual for Homeowners). Most manuals identify slopes over 12 percent as being the point at which slopes become too steep for the practical installation of rain gardens (Virginia Department of Forestry, 2010., Hinman, 2005., Bannermen and Considine 2003).

The slope of the ROW generally matches the slope of the street and the ground cover in the areas of proposed disturbance is mostly scattered with pine trees and scant pine needle mulch and native vegetation. Existing drainage consists of drainage inlets, conveyance pipes, and ditches and was installed during previous projects or development. Drainage figures for each site are provided in Appendix B.

No areas within the project area are identified as special hazard areas in the most current FEMA 2009 Flood Insurance Rate Map (FIRM) map numbers 32031C3325G and 3231C3425G.

LAND CAPABILITY

The U.S. Forest Service and TRPA developed the Bailey land capability system in the early 1970s based primarily on the official USDA soils maps for the Tahoe Region. Each soil type was assigned to a land capability class ranging from 1 to 7, with capability 1 being the most environmentally fragile and sensitive to development and 7 being the least fragile. Wherever land was found to be influenced by a stream or high groundwater, it was assigned to capability 1b, also known as "Stream Environment Zone" or SEZ. The Incline Village Green Streets project sites are located within various Bailey Land Capability Classifications as shown in Table 3. These classifications are usually verified in the field by TRPA prior to a project, but since these projects improve the ability of the area to act as a natural treatment area, the verification requirement has been waived. Instead, care will be taken during construction to not impact any nearby sensitive areas and work will be stopped and the rain garden re-designed if groundwater is encountered during excavation.

Table 3. Mapped Land Capabillity Classifications for each site. Land Capability is unverified.

Site	Land Capability
STA 34	6
STA 38	6
STA 108	1B (adjacent to Rosewood Creek)
STA 138	6
STA 200	4
STA 207	4

EXISTING SOILS

NRCS soil survey indicates that all of the rain gardens (except at the site at STA 200) are within soil map unit 7141 Inville gravelly coarse sandy loam, 2 to 9 percent slopes, stony (Figure 5). The site at STA 200 is within soil map unit 7142 Inville gravelly coarse sandy loam, 9 to 15 percent slopes, stony. Both map unit descriptions indicate the area is well drained with more than 80" to the water table. Mapped infiltration rate for these units is listed at 4 inches per hour saturated conductivity (K_{sat}). Appendix A contains the map unit descriptions from the USDA Soil Survey for the Tahoe Basin Area, California and Nevada (USDA, NRCS 2007).

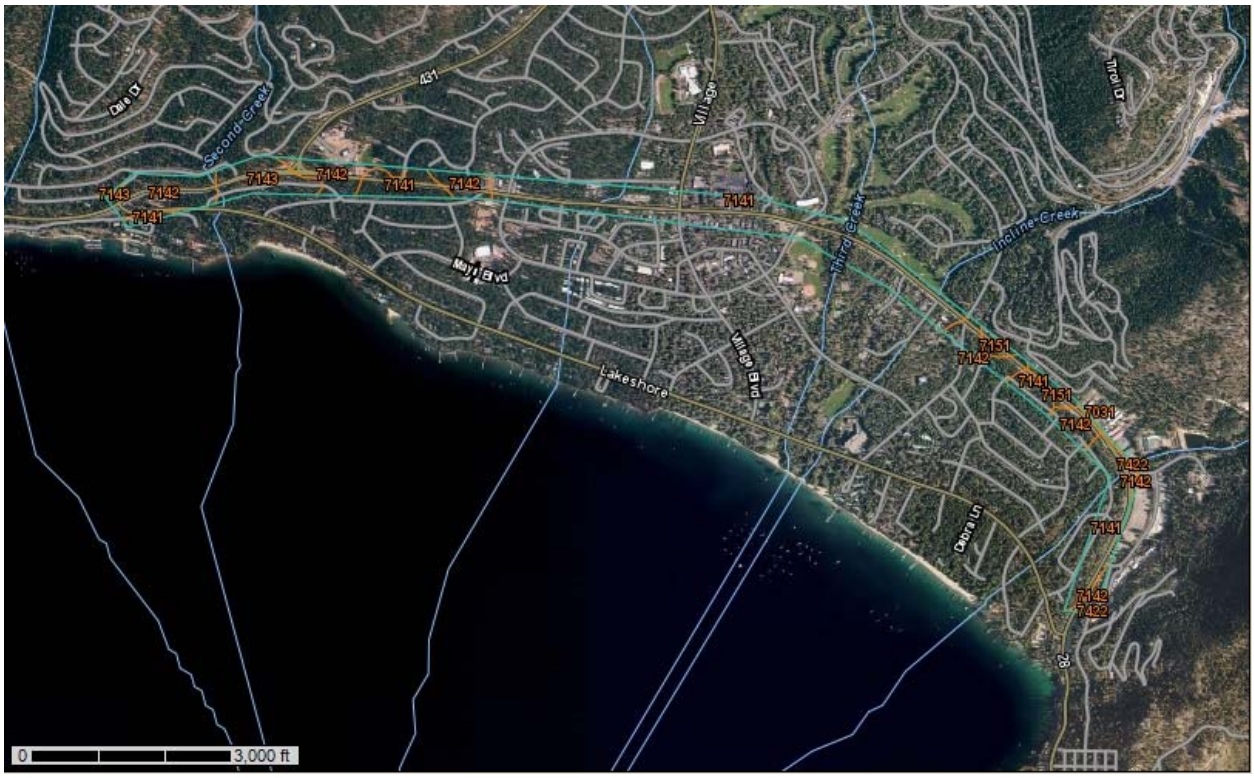

Figure 3. Project area NRCS soil map units. The project area is outlined in red.

On April 21, 2014 NTCD conducted Constant Head Permeability (CHP) tests at each of the basin locations to determine the saturated conductivity rates at each basin. The results are found in Table 4.

Table 4: CHP test results at each proposed location

Site STA	CHP #1 (in/hr)	CHP#2 (in/hr)	CHP#3 (in/hr)	CHP#4 (in/hr)	CHP#5 (in/hr)	CHP#6 (in/hr)	Average (in/hr)
34	1.0	1.2	1.3	1.5	1.5	4.8	1.88
38	1.0	0.8	3.1	6.7	5.3	4.0	3.48
108	1.3	1.2	1.5	15.75	1.3	2.2	3.88
168	6.1	4.8	0.8	22.5	2.9	7.9	7.5
200	0.8	2.2	2.5				1.83
207	1.0	0.5	0.125				0.54

To be conservative, an infiltration rate of 2"/hr was used to determine the rain garden capacities and the Average Return Interval (ARI) that could be treated by the proposed basins. It is assumed that the majority of the fine sediment particles and the nitrogen and phosphorous will be in the first flush that will be intercepted by the rain gardens.

CATCHMENTS

Catchments were delineated using the hydro-reinforced 1 foot contours available from the Tahoe Basin LiDAR performed in 2010 and released in 2011. The water drop and catchment surface tools were used in AutoCAD Civil 3D to delineate the catchments along with the Washoe County Stormwater Asset Inventory. Elements like curb and gutter and unique flow paths were field verified. The drainage figures in Appendix B show the catchment for each station.

PEAK AND DESIGN FLOW

Because of the relatively small size of the contributing drainage areas (under 3 acres in most cases), the rational method was used to evaluate the 5 year and 100 year flows being received by each BMP. The rational method calculates flow as ***Q = CiA*** where Q is flow in cubic feet, C is the unitless runoff coefficient based on the type of development, i is the precipitation intensity in inches per hour, and A is the contributing area in acres. All engineering calculations discussed below are available in Appendix C. The coefficient, C, was determined using methods available in the Truckee Meadows Regional Drainage Manual. The precipitation intensity, i, was determined using Figure 4 which was found using NOAA's Precipitation Frequency Data Server. Figure 5 shows the location of the NOAA precipitation data query. The results of the design and peak flow calculations are displayed in Table 2.

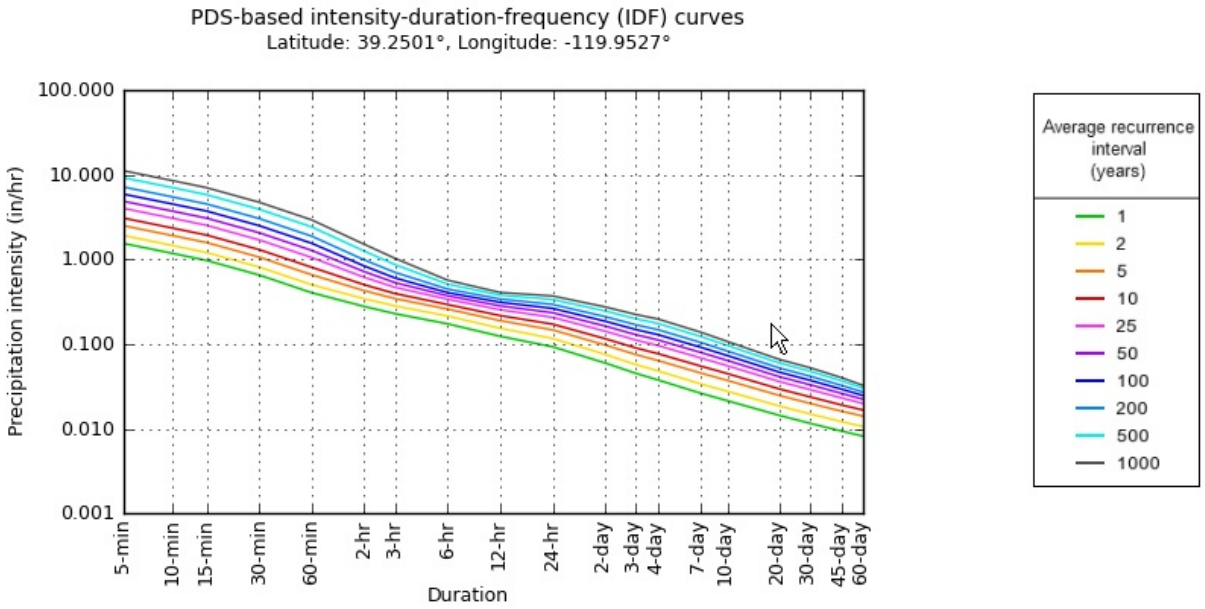

Figure 4. Precipitation intensity curves within project area. The 25-year and 100-year curves used to determine design and peak flows.

One item to note is the short time of concentration (t_c) for all sites. Because each site receives predominately street runoff, travel time over a small paved area is short. Velocity estimates used to calculate t_c are from NRCS TR-55 (1986) or the equation: $V = 20.3282(S^{0.5})$. This equation overestimates the velocity for lengths under 200 feet (Lindberg, 2008), but is the best available method. The Truckee Meadows Regional Drainage Manual recommends a minimum t_c of 5 minutes, however, the more conservative approach of using the calculated t_c was utilized since slopes are steep in the area and sizing inlets to maximize interception is critical to the success of the LID features.

Figure 5. Location of precipitation data from NOAA.

Table 5. Results of Rational Method Calculations for each BMP (see Appendix C for detailed calculations).

STA	Paved A (sf)	Unpaved A (sf)	Street Slope (S) (%)	Avg V (ft/s)*	Paved L (ft)	Travel time tt (min)	C25 (paved)	C100 (paved)	C25 (unpaved)	C100 (unpaved)	tc check (min)	Final tc25 (min)	i(25) (in/hr)	i(100) (in/hr)	Q25 (cfs)	Q100 (cfs)
34	16690	6704	2.4	3.15	900	4.76	0.95	0.99	0.05	0.20	15.0	4.8	4.89	6.24	1.82	2.51
38	76038	7230	2	2.87	370	2.15	0.95	0.99	0.05	0.20	12.1	2.1	4.89	6.24	8.15	10.85
108	54418	77965	3.9	4.01	1200	4.98	0.95	0.99	0.05	0.20	16.7	5.0	4.89	6.24	6.24	9.50
168	44366	23830	4	4.07	855	3.50	0.95	0.99	0.05	0.20	14.8	3.5	4.89	6.24	4.87	6.68
200	6591	25355	4	4.07	700	2.87	0.80	0.90	0.05	0.20	13.9	2.9	4.89	6.24	0.73	1.18
207	10866	25175	5.2	4.64	350	1.26	0.95	0.99	0.05	0.20	11.9	1.3	4.89	6.24	1.30	1.69

3. DESIGN

GUIDING PRINCIPLES

LID design principles, low maintenance needs, and a focus on capturing sub-16 micron sediment were used to guide the design of the project. The project gave preference to products and designs with low maintenance requirements, which are expected to integrate into NDOT's current maintenance schedule. Economical and easily maintained BMPs were chosen over more highly engineered solutions requiring frequent maintenance at a higher cost. Rain gardens were designed to be self-maintaining by utilizing native plants to maintain infiltration rate through biological activity and annual growth and senescence of plant roots. Dense vegetation and direct-fall of pine needle will eliminate the need for mulch replenishment.

SITE SELECTION

Nineteen potential sites were originally identified using a combination of LiDAR topography, Dr. Schladow's microbasin study, local knowledge, and field walks. Nine sites were eliminated based on the presence of stormwater treatment downstream, property ownership, estimated contributing area, estimated lake clarity credit potential, and construction feasibility. Sizes of sites were further evaluated based on mapped utility locations. Next, NTCD, along with Matthew Nussbaumer, Rupali Mohansingh, and Kelly Rini from NDOT, walked the site along Tahoe Blvd/SR 28 and identified potential sites based on visual appearance of space and utility locations. Due to budget constraints, estimated load reductions and utility conflicts four more sites were eliminated. The six remaining sites will have the highest lake clarity credit potential and construction and maintenance feasibility, are estimated to be within the construction budget, and have the fewest known utility conflicts of the 19 original potential sites.

PLRM

The project utilized PLRM information generated as part of the Sediment Load Reduction Plan (SLRP) but did not perform PLRM for the project. Instead, because the contributing area was mainly NDOT catchments with a consistent loading rate and uniform land use, analysis and estimation of pollutant load reduction as a result of each planned rain garden was performed in an Excel spreadsheet. PLRM was performed on one site to verify the formula used to determine the estimated pollutant load reduction for the sites and a difference in the results were negligible. The results and site selection process report is included in Appendix E.

RAIN GARDEN TYPES

While the goal of this project was to construct mainly off-line rain gardens, the characteristics of some sites made them better candidates for flow-through once a certain storm intensity was reached. The sites at stations 108 and 200 were designed as flow through basins due to the expensive and unnecessary need to change their existing inlets. These sites are basically improvements to existing conveyance ditches. Table 6 contains summarizes each site based on its size, capacity, and inlet type. Inlets are discussed in more detail later in this report.

TREATMENT CAPACITY

The rain gardens in this project were designed to treat the largest storm possible given site constraints. Once the contributing areas and locations of the rain gardens were determined, the rain garden was sized within the allowable area. Factors such as property lines, slopes, trees, existing fences, and existing utilities often placed limitations on the extents of the rain garden. An Excel-based calculator based on the Type 2 hydrograph (Figure 6), Darcy's Law, and the Rational Method was used to determine the BMP's treatment capacity. For Darcy's Law, a conservative soil infiltration rate of 2"/hr was used even though engineering the soil will produce higher infiltration rates on the majority of the sites. Bioinfiltration soils are expected to have an infiltration rate between 4"/hr and 12"/hr. The 2"/hr figure was estimated from site-specific Constant Head Permeameter (CHP) measurements in the area that averaged 3.8"/hr for the 6 sites as well as NRCS soil surveys for the area that predict rates of 4"/hr. Methods for establishing the properties of the existing soils are discussed in further detail earlier in this report under EXISTING SOILS.

Table 7 lists the Precipitation Depth (inches) for the designated storm frequency (Average Recurrence Interval). Treatment capacity for each rain garden can be found in Table 6.

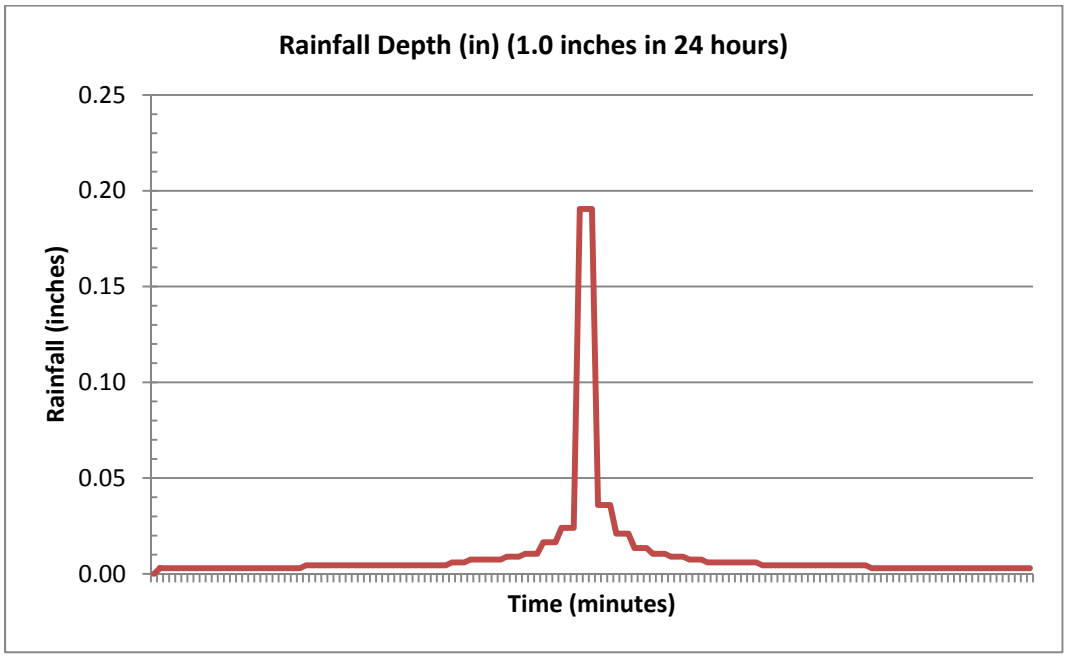

Figure 6. SCS Type II Unit Hydrograph used to calculate rain garden capacity.

Table 6. Capacity estimates for 1 hour storm based on calculated capture efficiency of inlet. (See Appendix C for all calculations)

Site	1 hr storm depth (In)	ARI (Yrs)	Ponding Depth (In)	Bottom Area (Sq Ft)	Ponding Area (Sq Ft)	Contributing Area (Sq Ft)	Inlet Type
STA 34	0.97	20	18.01	193.56	637.52	23394	Existng Sediment Can to 8" HDPE Pipe
STA 38	0.71	7	18.01	1003.74	2127.85	83268	New Type 4R Catch Basin to 12" Pipe
STA 108	0.57	3	18.05	289.81	1053.58	132383	Existing 8" Pipe from Treatment Vault
STA 168	0.67	5	18.00	563.5	1193.42	68196	Existng Sediment Can to 12" HDPE Pipe
STA 200	0.81	11	12.06	62.62	264.71	31946	Existing 12" HDPE from Drainage Inlet
STA 207	0.81	10	12.01	229.53	477	36041	New Sediment Can and 8" HDPE Pipe

Table 7. Precipitation depth from NOAA Atlas 14 for 1 hour and 24 hour storms based on average recurrence interval.

Average Recurrence Interval	1 hr Storm Depth (in)	24 hr Storm Depth (in)
1	0.404	2.23
2	0.502	2.80
5	0.658	3.53
10	0.807	4.13
25	1.05	4.96
50	1.28	5.63
100	1.55	6.33
200	1.88	7.06
500	2.42	8.07
1000	2.93	8.88

RAIN GARDEN DESIGN

The final six sites are ideal locations for rain gardens since the areas are relatively flat and wide with few trees and existing utility conflicts. The general design criterion for the rain garden berm height was 6 inches of freeboard from the maximum ponding height. The recommended ponding depth is between 6 and 24 inches (Oregon State, 2010). The ponding depths vary from 12 to 18 inches depending on needed capacity and overall size (Table 6).

Berms are specified to have a 12 inch minimum top width and 3:1 cut/fill slopes. The top width of 12 inches is wide enough to resist breaching, but narrow enough to discourage foot traffic. The native soils are currently compacted road shoulders and are ideal for achieving 90 percent compaction for the rain garden berms.

The bottoms of all rain gardens are flat. Bottom elevations were chosen to balance cut and fill as much as possible and work hydraulically with the existing inlet elevation. For the flow through rain gardens, overflows were added. Overflows were designed to match existing assets and consist of a standpipe and outlet pipe for Station 108 and a rock channel for Station 200. Both outlets return the overflow to the original flow path. See Appendix C for pipe and rock sizing for both inlets and outlets.

INLET DESIGN

Sites at Stations 34, 38, 138, and 207 are rain gardens that hydraulically isolate themselves once the maximum ponding depth of 12 or 18 inches is reached. When the rain gardens are at their maximum ponding depths and the sediment traps are full, water can no longer enter and will bypass to the existing drainage configuration which is typically a rock lined channel overflow or another drainage inlet.

Sites at Stations 34 and 138 receive flow after it enters existing NDOT sediment cans. Flow from the inlet pipe enters the basin after flowing across a rock dissipater to slow velocity. The invert elevation of the pipe is raised off the bottom of the basin to reduce clogging and the associated maintenance.

The site at Station 38 receives flow from a new type 4 curb inlet with a sediment trap via a 12 inch HDPE pipe. Runoff exits the HDPE pipe across a rock dissipater to slow velocity. The invert elevation of the pipe is kept off the bottom of the BMP to reduce clogging and the associated maintenance.

The site at Station 108 receives flow from an existing drainage inlet after flowing through an existing treatment vault. Like the other sites, a rock dissipater will be installed at the end of the existing 8” pipe to minimize erosion. Since this basin will remain online and receive flow above the design storm, stormwater will exit through a 24" diameter standpipe with trash rack and 8" pipe to a rock dissipater installed in the existing ditch.

The site at Station 200 receives flow from an existing curb inlet and the existing roadside ditch. Topography on the north side of the proposed basin will require a short rock retaining wall be constructed. Since this basin will remain online and receive flow above the design storm, stormwater will exit through a rock lined trapezoidal channel and discharge into the existing ditch.

The site at Station 207 is located in the grass area north of the west end of the Lakeside Drive walking trail head. A sediment trap will be installed in the existing rock lined channel to direct the design storm into the proposed basin and allow flows greater than the design storm to bypass the system. Since this rain garden is in a park setting, landscape plants will be used instead of the native plant and grass seed mix of the other rain gardens. The secondary goal of this basin besides providing stormwater treatment is to be a low-maintenance, aesthetically-pleasing addition to the park.

Table 8. Inlet and Outlet Calculations for Rain Gardens.

Site STA	Inlet or Outlet	Swale/Pipe Material (n)	Flow (cfs)		Velocity (ft/s)	Rock Size	
			25 year	100 year	25 year Velocity (ft/s)	D50 - 100 Year Size (ft)	Class
34	Inlet	8" HDPE Pipe (0.01)	1.82	2.51	8.94	0.29	150
38	Inlet	12" HDPE Pipe (0.01)	8.15	10.85	13.19	0.63	150
108	Outlet	8" HDPE Pipe (0.01)	6.24	9.50	9.00	0.58	150
168	Inlet	12" HDPE Pipe (0.01)	4.87	6.68	10.71	0.41	150
200	Outlet	Rock Channel (0.035)	1.30	1.69	6.59	0.00	150
207	Inlet	8" HDPE Pipe (0.01)	1.30	1.69	7.39	0.90	150

Because Tahoe Blvd/SR 28 receives a substantial amount of traction control in the winter months, a Type 4R Catch Basin was specified for the proposed inlet at station 38. HEC-22 outlines the numerous advantages to curb-opening inlets, many of which would apply at Tahoe Blvd/SR 28, including more efficiency with large amounts of floating debris. One way to increase the efficiency of a curb opening inlet is to add a depression or sump within the gutter. Adding a 2 inch depression to a curb inlet increases the flow interception efficiency to above many types of grate inlets (HEC-22) (see Figure 7).

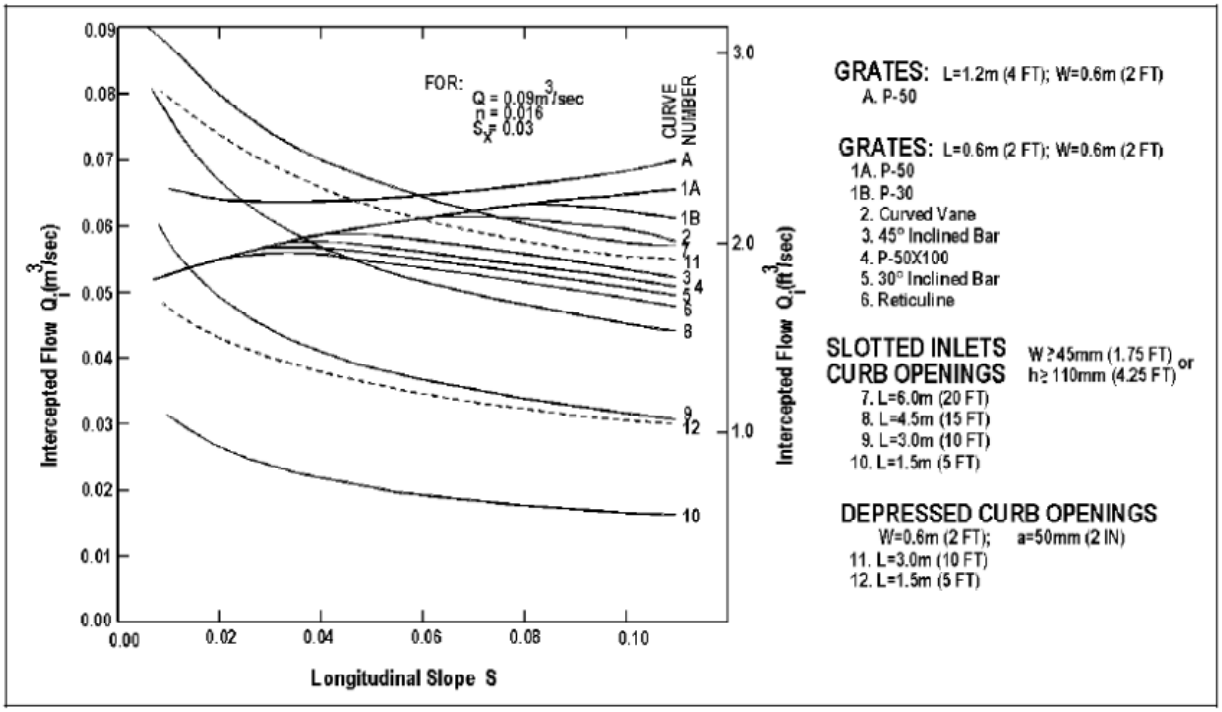

Figure 7. Comparison of inlet interception capacity on variable street grades (HEC-22 Figure 4-11).

BIOINFILTRATION SOILS

Rain garden design manuals recommend a bioinfiltration soil mix typically consisting of topsoil, sand and compost (Hinman, 2005., Prince George's, 2007.). The objective of a bioinfiltration soil mix is to balance the infiltration rate between adequate drawdown and pollutant removal while providing a healthy growing medium for long-term plant and soil health. Common guidelines for bioinfiltration soil mix are as follows:

1. Between 2 and 5 percent fine particles passing the #200 sieve.
2. Minimum organic matter content of 10 percent by dry weight.
3. Minimum 1 inch per hour K_{sat} and maximum of 12 inches per hour K_{sat}.
4. 24 inches minimum depth for nitrogen and phosphorus removal.

The average K_{sat} of existing soils exceeds 1 inch per hour. Because native plants do not require a rich soil, acceptable organic matter content could be achieved through the addition of aged wood chips, which are readily available, maintain soil structure, act as a moisture source during summer droughts and degrade slowly. The existing soils in the project area do not currently support a population of invasive weeds, thus using the existing soils as a component of the bioinfiltration soil mix should pose no danger of future invasive weed infestation.

The existing in-situ soils will be amended to obtain a suitable bioinfiltration soil mix. Bioinfiltration soil mix will be created outside the rain garden using native soils from the excavated rain garden and soil amendments. Two different bioinfiltration soil mixes shall be utilized. Bioinfiltration soil mix #1 shall be used at all sites except where bioinfiltration soil mix #2 is used. Bioinfiltration soil mix #2 shall be used for half of the bioinfiltration soils at site STA 38.

Bioinfiltration soil mix #1 shall consist of (by volume):

- 50% native soil
- 30% aged wood chips
- 20% compost

Bioinfiltration soil mix #2 shall consist of (by volume):

- 50% native soils
- 20% aged wood chips
- 10% biochar
- 20% compost

Existing in-situ soils will be salvaged to be used for bioinfiltration soil mix and/or grading as specified in the plans and specifications and indicated in the field by the Engineer. The rain gardens will be excavated to allow for the placement of 30" of bioinfiltration soil mix as shown in the plans and as specified by the Engineer. Side walls will be close to vertical to maximize the volume of infiltration media backfill and to simplify the calculations of needed materials. Sub-soils in the rain garden will be thoroughly scarified to a depth of twelve (12) inches with a toothed backhoe to create a transition between existing soils and the bioinfiltration mix.

PLANT SELECTION

Vegetation helps to maintain the infiltration capacity of rain gardens thereby easing the expected maintenance (Clar *et al*., 2004). Maria Cahill (Green Girl Land Development Solutions, Portland, OR; www.greengirlpdx.com) suggested that at least one shrub, grass and groundcover species be planted in each rain garden. Native vegetation was given a preference over adapted vegetation due to easier maintenance of native vegetation concerning snow loading and anticipated summer drought. Herbaceous vegetation will be established in the project area from seed, while woody vegetation will be established from transplanted containerized plants.

The plants will likely see high snow loads from plowing the roads as well as high concentrations of stormwater pollutants. The selected plants must also be tolerant of periodic inundation of up to a foot of water for two days. Plants must also be drought tolerant to handle the long dry summers.

NTCD staff put together an initial list of candidate plants based off of the plant lists in the *Home Landscaping Guide for Lake Tahoe and Vicinity, Sierra Nevada Lawn and Garden* and *Native Plants for High-Elevation Western Gardens.* This initial list has been added to and refined as a result of conversations with Ed Kleiner Jr. of Comstock Seed.

A seed mix of several native species was chosen due to cost constraints and a lack of data on which plant species would thrive in Tahoe rain gardens. Also, establishing a dense vegetative cover will obviate the need for future mulch replenishment, thereby lowering maintenance requirements. Appendix D contains the full plant list.

4. PROJECT PERMITTING

The Incline Village Green Streets Project is approaching the permit process as if it were an EIP project spearheaded by NTCD.

TRPA EIP PROJECT PERMIT

The TRPA EIP Project Review Application and Initial Environmental Checklist for the Incline Village Green Streets project will be submitted to TRPA once the TAC reviews 100 percent plans.

NDOT ENCROACHMENT PERMIT

The application for the NDOT Encroachment Permit for the Incline Village Green Streets project will be submitted to NDOT once the TAC reviews 100 percent plans.

NDSL RIGHT OF ENTRY

An NDSL Right of Entry Permit is needed since we are placing temporary erosion control measures on the NDSL parcel adjacent to the site at station 38. The permit application will be submitted during the TAC's review of the 100 percent plans.

STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

The area of disturbance associated with the implementation of the project is expected to be less than an acre in size, therefore, does not trigger a Stormwater Pollution Prevention Plan.

WASHOE COUNTY DUST CONTROL PERMIT

The area of disturbance associated with the implementation of the project is expected to be less than an acre, therefore, does not trigger a Dust Control Permit.

5. PROJECT MAINTENANCE

NTCD staff produced a 'Rain Garden Maintenance Plan' (Appendix E) to outline anticipated inspection and maintenance activities of the rain gardens for NDOT. The plan was produced from a review of the literature, experience regarding vegetation and infiltration basin maintenance in Tahoe and from conversations with Maria Cahill and Mike Isensee—two prominent experts in the field of rain garden design. As there are currently no rain gardens within the Tahoe Basin, exact maintenance is unknown. This maintenance plan will be refined and updated as actual rain garden inspection and maintenance are performed.

IRRIGATION

Temporary irrigation will be provided to establish the vegetation in the project area by establishing an agreement with adjacent property owners to access their water system. NTCD is in the process of establishing right-of-entry agreements with adjacent homeowners. If agreements cannot be established by May 2015, a passive, gravity-fed irrigation system will be installed in the right-of-way and refilled as necessary. NTCD will maintain the irrigation for one to two growing seasons depending on plant establishment success and then remove temporary irrigation after plant establishment. Maintenance will include periodic checks to ensure proper functioning, coverage and water delivery of the irrigation system.

PRETREATMENT ASSETS

Each rain garden will include sediment traps at each inlet (existing or proposed) to capture coarse sediment before it enters the BMP. The traps are designed to be cleaned with a Vactor truck. The traps will be located either in or just behind the curb so that regular street sweeping removes accumulated pine needles from their inlet grates and pans. Installation of the LID features is not expected to increase street sweeping or Vactoring frequency as the overall sediment load will be the same but more distributed with the additional assets**.** Sediment traps will reduce the amount of coarse sediment that enters each LID feature and therefore increase their lifespan by limiting surficial sediment accumulation.

VEGETATION

The rain gardens will be planted with low-maintenance, native vegetation approved by NDOT for sight safety concerns. Regular irrigation is required for the first growing season and occasional irrigation the second year (performed by NTCD). Once vegetation is established, maintenance of the rain gardens consists of periodic trash and debris removal. The rain gardens may also require removal of invasive

weeds similar to other stormwater facilities and NDOT right-of-ways. Thick vegetation in the rain gardens and a natural pine needle mulch supply from surrounding trees will obviate the need for mulch replenishment. BMP RAM protocols to determine vegetative cover should be followed annually as the LID features will be classified as 'infiltration features' according to BMP RAM. Desired percentage of vegetation differs from BMP RAM default values in that ideal vegetation percent cover in the LID features should be between 50 and 80 percent.

Rotary Club of Incline Village will assist NTCD in the maintainance of all revegetation areas following completion of work for 2 years, so that there is no evidence of erosion, such as rills or gullies. During the maintenance period, NTCD and Rotary Club of Incline Village will identify and remove any noxious and invasive weeds (listed as Class One and Two weeds by the Lake Tahoe Basin Weed Coordinating Group) from the revegetation treatment areas.

After the 2 year maintenance period, NDOT will assume maintenance responsibilities for the vegetation and rain gardens in accordance with their standard procedures. Properly designed and installed rain gardens require little maintenance once established. NTCD expects maintenance needs at the end of the 2 year vegetation establishment period to be trash and tree seedling removal.

INFILTRATION PERFORMANCE

Soils will be amended to increase infiltration and create a healthy growing medium. The City of Portland has experienced acceptable infiltration rates over the life of their rain gardens, some of which are 10 to 15 years old (Maria Cahill, Portland, OR, pers comm.). It is expected that once vegetation is established, the biological activity will maintain or even increase the infiltration rates of the soil. Other municipalities have experienced an *increase* in infiltration rates five years following construction, likely due to soil biological activity and the annual cycle of plant root growth and senescence (Mike Isensee, Burnsville, MN, pers. comm.). Thus, it is not expected that maintenance will include replacing the engineered soils of the rain gardens. However, since rain gardens have not been installed in the Tahoe basin, it's unknown whether soil infiltration will be self-maintaining as in other regions.

The maintenance trigger for infiltration performance is ponding water for longer than 3 days or unsatisfactory infiltration performance using BMP RAM protocols for infiltration features. Loosening of the soil profile with a broadfork is the first step of soil reconditioning. If desired infiltration performance is not achieved, removal of the top inch of soil in late summer or aerating or tilling the top few inches of soil may restore desired infiltration. Revegetation is not necessary if care is taken not to destroy vegetation or remove the seed bank. If major soil reconditioning (soil replacement) is needed after years of proper function, then vegetation would have to be reestablished.

INSPECTION AND MAINTENANCE SCHEDULE

Maintenance of the rain gardens is required when inspections reveal the following:

- Trash, debris or sediment accumulation (determined visually, inspect annually)
    - Remove trash, debris and dispose of properly

    - Remove accumulated sediment and dispose of properly (ensure design depth of rain gardens is maintained)
- Weeds (use the same protocol and frequency for right of ways)
    - Remove invasive weeds and any tree seedlings to prevent their establishment
- Full sediment traps (inspect and maintain at the same frequency as existing catch basins along Tahoe Blvd. using BMP RAM protocols)
    - Empty sediment traps and dispose of properly
- Pine needle obstruction of inlets
    - Remove pine needles from entry via regular street sweeping
- Ponding water for longer than 3 days or poor infiltration (using BMP RAM protocols for infiltration basins)
    - Loosen soil profile with broadfork or remove top inch of soil in gardens or aerate/till the top few inches of soil in late summer.

Refer to Table 9 Anticipated Rain Garden Inspection and Maintenance for a more detailed schedule.

Table 9. Anticipated Rain Garden Inspection and Maintenance Schedule.

Anticipated Rain Garden Inspection and Maintenance		
Task	Schedule	Responsibility
Irrigation	1" of water per week during the first growing season to establish vegetation. Possibly additional irrigation the second year.	NTCD and Rotary (first 2 years)
Weeding	The rain gardens will be planted with native vegetation. Invasive weeds and tree seedlings are not desired. Invasive weeds must be managed as in any stormwater treatment facility or NDOT Right-of-Way.	NTCD and Rotary (first 2 years) NDOT thereafter
Street Sweeping	Four times a year and before and after major storm events. Removing pine needles from the drainage inlets is key for stormwater entry to the gardens.	NDOT
Empty Sediment Traps	Follow the current schedule of twice a year. (Spring and Fall)	NDOT
Remove Trash/Debris	Annually (same schedule as any other stormwater basin).	NTCD and Rotary (first 2 years) NDOT thereafter
BMP RAM	Use BMP RAM Field Observation Protocols for Infiltration Features. Percent cover vegetation should be between 50 and 80 percent. Conduct annually, or as often as condition scores are desired	NTCD (first 2 years) NDOT thereafter
Soil Reconditioning	Not Anticipated[1]. The experience of other municipalities is that reconditioning of bioretention basins is a very rare maintenance requirement. The vegetation is expected to maintain porosity and infiltration. Rain gardens often have a higher infiltration rate five years after construction, likely due to soil biological activity and the annual cycle of root growth and senescence[2]. In the unlikely event that desired infiltration is not maintained, loosening of the soil profile with a broad fork is recommended. Removal of the top inch of soil or aerating or tilling the top few inches of soil may in late summer also be performed to restore function.	NDOT

[1] 7/20/10 Conversation with Maria Cahill of Green Girl Land Development Solutions.
[2] 7/22/10 Conversation with Mike Isensee of Dakota County Soil and Water Conservation District.

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APPENDIX A
Soil Descriptions

7141 - Inville gravelly coarse sandy loam, 2 to 9 percent slopes, stony

Composition

- Inville and similar soils: 80 percent of the unit
- Christopher, Loamy coarse sand and similar soils: 10 percent of the unit
- Cassenai, gravelly loamy coarse sand and similar soils: 4 percent of the unit
- Jorge, very gravelly sandy loam and similar soils: 3 percent of the unit
- Kingsbeach and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit

Setting

Landform(s) mountains, hillslopes on outwash terraces
Slope 2 to 9 percent
Elevatio 6234 to 6955 feet
Air temperature: 41 to 46 ºF
Precipitatio 19 to 33 inches
Frost-free 45 to 110 days

Characteristics of Inville and similar soils

Average total avail. water in top five feet 3.6
Soil loss tolerance (T 5
Available water capacity Low
Wind erodibility group 7
Parent outwash derived from mixed
Wind erodibility index 38
Restrictive none
Land capability class, irrigated:
Depth to Water none within the soil profile
Land capability class, non- 4e
Drainage well drained
Hydric soil: no
Flooding none
Hydrologic B
Ponding none
Runoff class: low
Potential frost moderate

Saturated hydraulic conductivity High

Representative soil profile:

Horizon --	Depth (inches)	Texture	Ksat	pH	Salinity (mmhos/cm)	SAR
Oi --	0 to 2	Slightly decomposed plant	56.7		0 - 0	0 - 0
A --	2 to 12	Gravelly coarse sandy loam	4.0	5.6 to 6.5	0 - 0	0 - 0
Bt --	12 to 37	Extremely cobbly sandy loam	4.0	5.6 to 6.5	0 - 0	0 - 0
C --	37 to 56	Extremely gravelly loamy coarse sand	21.3	5.6 to 6.5	0 - 0	0 - 0

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi-Abies concolor/Ceanothus cordulatus-Ceanothus prostratus/Pedicularis semibarbata-Kelloggia

Tabular Data Version: 3
Tabular Data Version Date: 01/13/2007

Brief Soil Descriptions (Tahoe)

Tahoe Basin Area, California and Nevada

[7142 - Inville gravelly coarse sandy loam, 9 to 15 percent slopes, stony]

7142 - Inville gravelly coarse sandy loam, 9 to 15 percent slopes, stony

Composition

- Inville and similar soils: 80 percent of the unit
- Cassenai, gravelly loamy coarse sand and similar soils: 10 percent of the unit
- Christopher, Gravelly Loamy Coarse Sand and similar soils: 4 percent of the unit
- Jorge, very gravelly sandy loam and similar soils: 3 percent of the unit
- Meeks, extremely bouldery and similar soils: 2 percent of the unit
- Aquic Xerorthents and similar soils: 1 percent of the unit

Setting

Landform(s) mountains, hillslopes on outwash terraces
Slope 9 to 15 percent
Elevatio 6234 to 7251 feet
Air temperature: 41 to 46 ºF
Precipitatio 21 to 37 inches
Frost-free 45 to 110 days

Characteristics of Inville and similar soils

Average total avail. water in top five feet 3.6
Soil loss tolerance (T 5
Available water capacity Low
Wind erodibility group 7
Parent outwash derived from mixed
Wind erodibility index 38
Restrictive none
Land capability class, irrigated:
Depth to Water none within the soil profile
Land capability class, non- 4e
Drainage well drained
Hydric soil: no
Flooding none
Hydrologic B
Ponding none
Runoff class: low
Potential frost moderate

Saturated hydraulic conductivity High

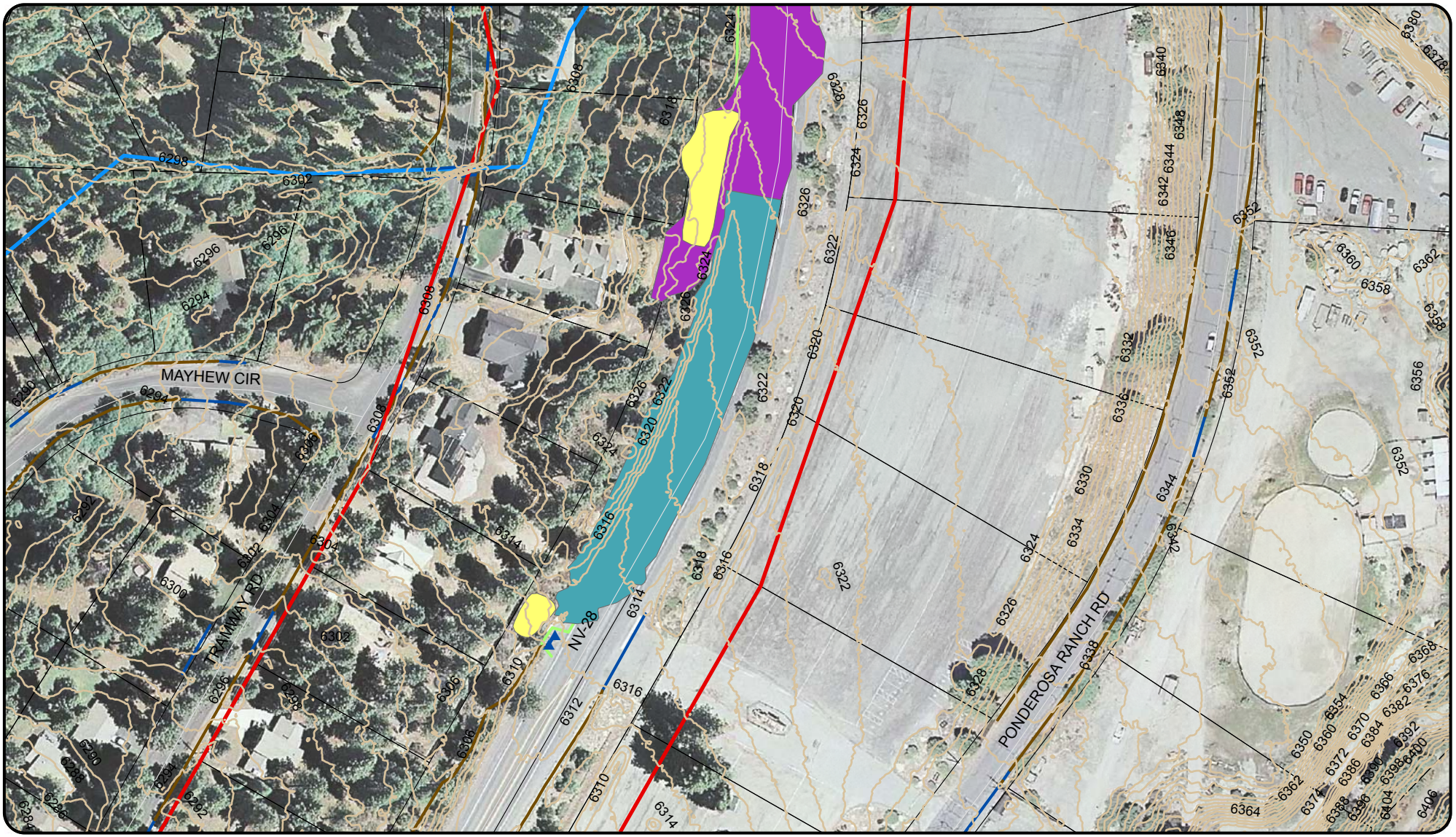
Representative soil profile:

Horizon --	Depth (inches)	Texture	Ksat	pH	Salinity (mmhos/cm)	SAR
Oi --	0 to 2	Slightly decomposed plant	56.7		0 - 0	0 - 0
A --	2 to 12	Gravelly coarse sandy loam	4.0	5.6 to 6.5	0 - 0	0 - 0
Bt --	12 to 37	Extremely cobbly sandy loam	4.0	5.6 to 6.5	0 - 0	0 - 0
C --	37 to 56	Extremely gravelly loamy coarse sand	21.3	5.6 to 6.5	0 - 0	0 - 0

Ecological class(es): NRCS Forestland Site - Pinus jeffreyi-Abies concolor/Ceanothus cordulatus-Ceanothus prostratus/Pedicularis semibarbata-Kelloggia

APPENDIX B
Drainage Figures

1. STA 34
2. STA 38
3. STA 108
4. STA 138
5. STA 200
6. STA 207



STA 34 Basin

Catchment: Station (acres)

34 (0.54)

Nevada Tahoe Conservation District

Sediment Trap

Drainage Inlet

Conveyance Ditch

Conveyance Pipe

Curb Gutter

Flow Path

Treatment Vault

Project Area

Parcels

6308 2 ft Contours

Streams

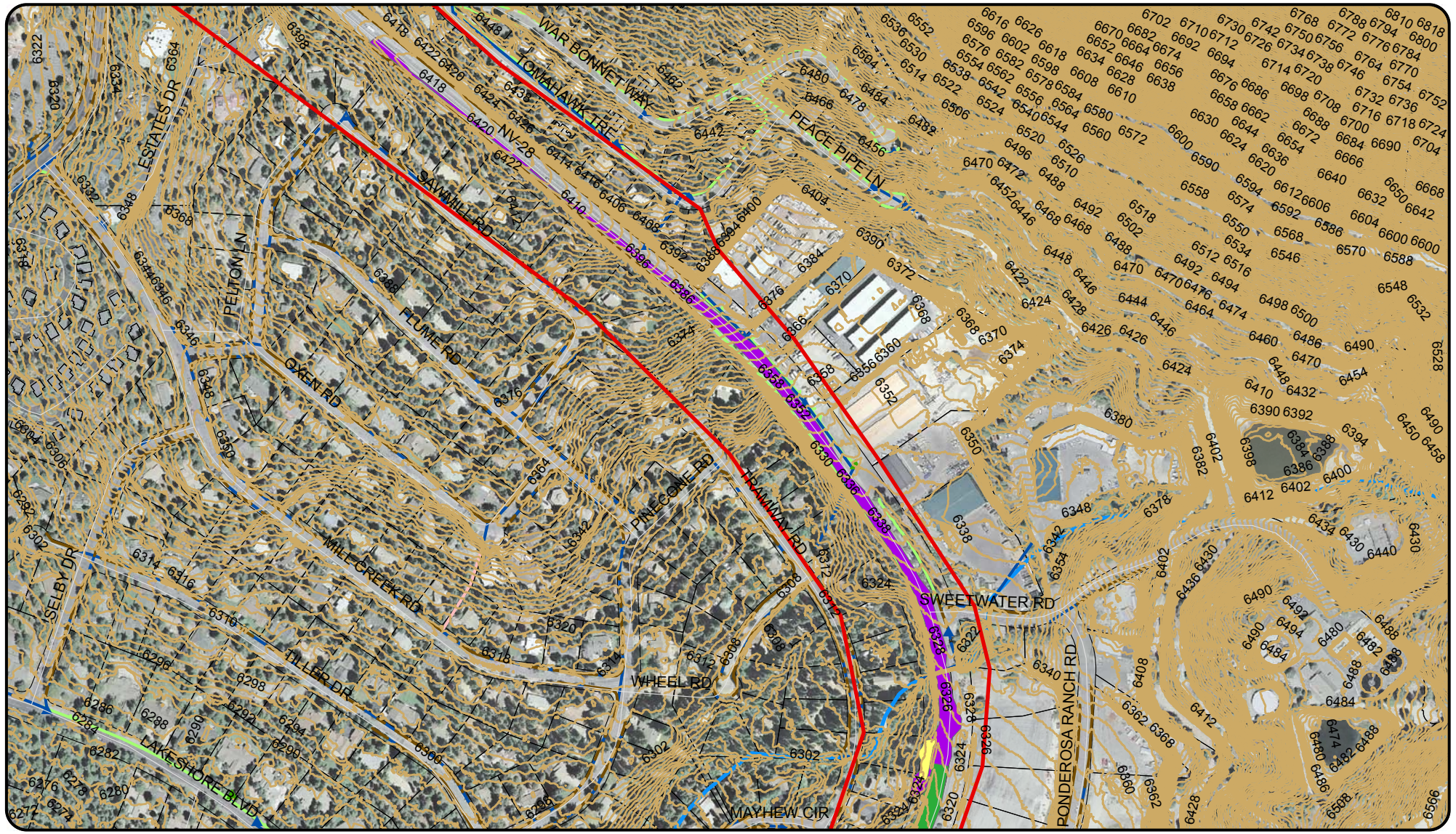
Incline Village Green Streets

Catchment: Station 34

Scale - 1:1,500

0 25 50 100 150 200 250 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014



Estimated Basin Size

Catchment: Station (acres)

38 (1.91)

Nevada Tahoe Conservation District

- Sediment Trap
- Drainage Inlet
- Conveyance Ditch
- Conveyance Pipe
- Curb Gutter
- Flow Path
- Treatment Vault
- Project Area
- Parcels
- 6308 2 ft Contours
- Streams

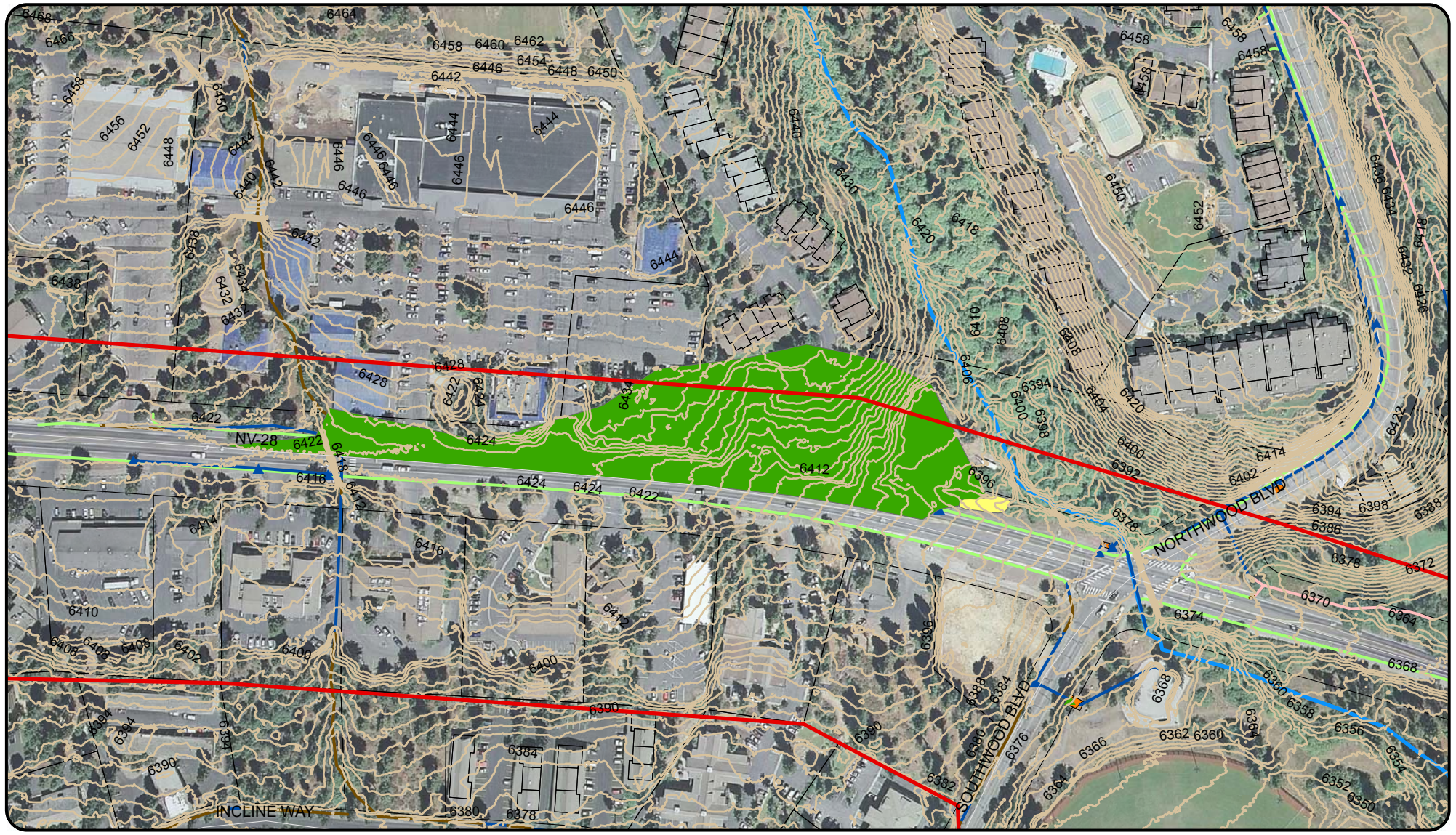
Incline Village Green Streets

Catchment: Station 38

Scale - 1:5,000

0 100 200 400 600 800 1,000 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014



Estimated Basin Size

Catchment: Station (acres)

108 (3.04)

Sediment Trap

Drainage Inlet

Conveyance Ditch

Conveyance Pipe

Curb Gutter

Flow Path

Treatment Vault

Project Area

Parcels

6308 2 ft Contours

Streams

Nevada Tahoe Conservation District

Incline Village Green Streets

Catchment: Station 108

Scale - 1:2,500

0 50 100 200 300 400 500 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014

Estimated Basin Size

Catchment: Station (acres)

168 (1.57)

Sediment Trap

Drainage Inlet

Conveyance Ditch

Conveyance Pipe

Curb Gutter

Flow Path

Treatment Vault

Project Area

Parcels

6308 2 ft Contours

Streams

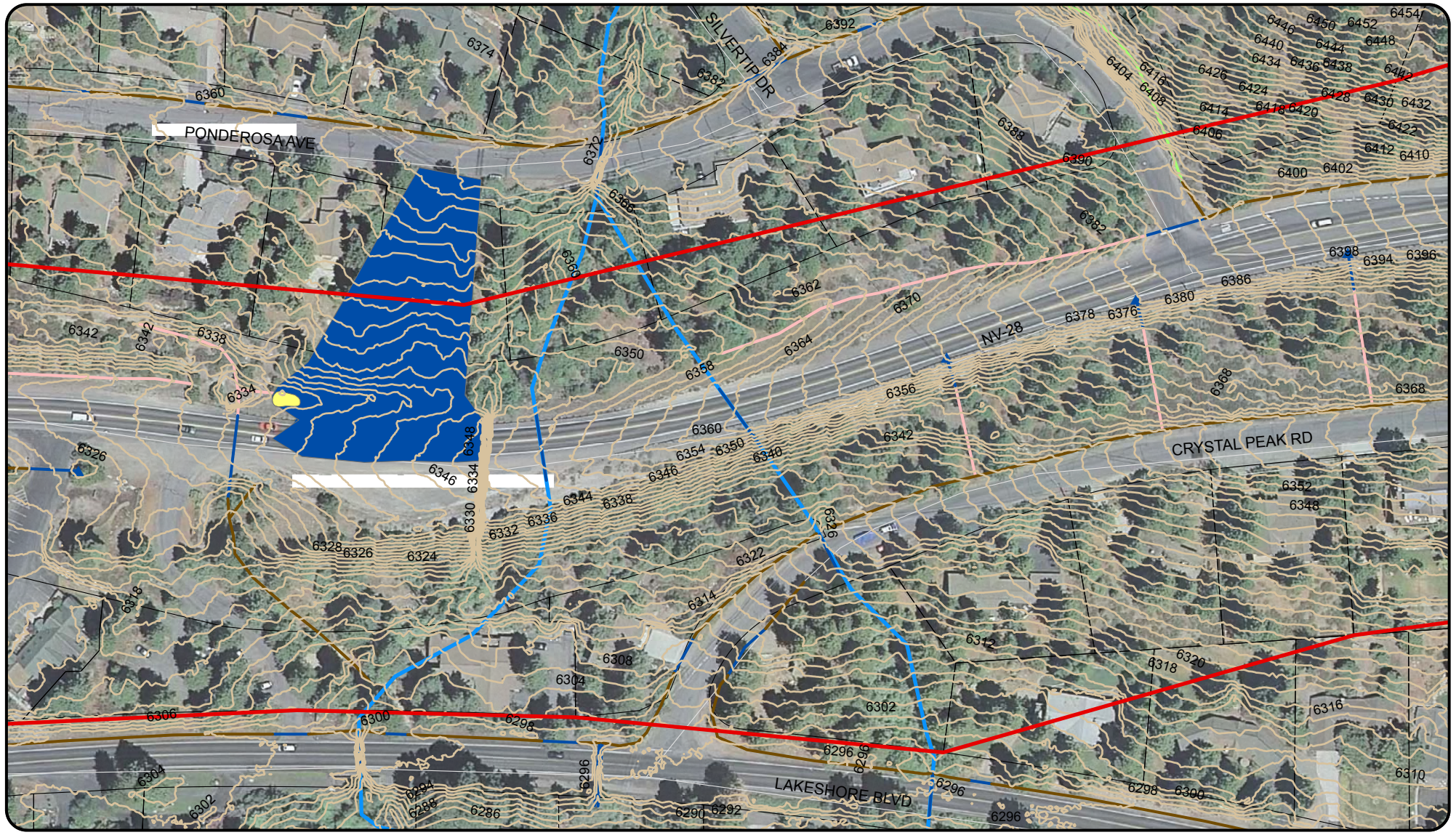
Nevada Tahoe Conservation District

Incline Village Green Streets
Catchment: Station 168

Scale - 1:3,000

0 50 100 200 300 400 500 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014



Estimated Basin Size

Catchment: Station (acres)

200 (0.73)

Nevada Tahoe Conservation District

Sediment Trap

Drainage Inlet

Conveyance Ditch

Conveyance Pipe

Curb Gutter

Flow Path

Treatment Vault

Project Area

Parcels

6308 2 ft Contours

Streams

Incline Village Green Streets

Catchment: Station 200

Scale - 1:1,500

0 25 50 100 150 200 250 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014

Estimated Basin Size

Catchment: Station (acres)

207 (0.83)

Sediment Trap

Drainage Inlet

Conveyance Ditch

Conveyance Pipe

Curb Gutter

Flow Path

Treatment Vault

Project Area

Parcels

6308 2 ft Contours

Streams

Nevada Tahoe Conservation District

Incline Village Green Streets
Catchment: Station 207

Scale - 1:1,500

0 25 50 100 150 200 250 Feet

NV West State Plane	NAD 83	horiz. units: feet
Prepared by NTCD		June 2014

APPENDIX C
Engineering Calculations

1. Rational Method
2. Inlet/Outlet Sizing
3. Rain Garden Capacity
    1. Summary
    2. STA 34
    3. STA 38
    4. STA 108
    5. STA 168
    6. STA 200
    7. STA 307

Rational Method Calculations

$$ti5 = \frac{1.8(1.1 - C5)\sqrt{L}}{S^{1/3}}$$

$$ti100 = \frac{1.8(1.1 - C100)\sqrt{L}}{S^{1/3}}$$

$$V = 20.3282\sqrt{S}$$

$$Q = CiA$$

STA	Paved A (sf)	Unpaved A (sf)	Total A (sf)	Gutter Slope (S) (%)	Avg V (ft/s)*	Paved L (ft)	Travel time tt (min)	C25 (paved)	C100 (paved)	tc25 (min)	C25 (unpaved)	C100 (unpaved)	tc100 (min)	Total L (ft)	tc check (min)	Final tc25 (min)	i(25) (in/hr)	Final tc100 (min)	i(100) (in/hr)	Q25 (cfs)	Q100 (cfs)
	CAD	CAD	Sum	TIN Surface		CAD	tt = L/V			=ti+tt			=ti+tt	Paved L + Land L	L/180 +10	Min of tc check and tc5	from NOAA	Min of tc check and tc100	from NOAA		
34	16690	6704	23394	2.4	3.15	900	4.76	0.95	0.99	4.76	0.05	0.20	4.76	900	15.0	4.8	4.89	4.76	6.24	1.82	2.51
38	76038	7230	83268	2	2.87	370	2.15	0.95	0.99	2.15	0.05	0.20	2.15	370	12.1	2.1	4.89	2.15	6.24	8.15	10.85
108	54418	77965	132383	3.9	4.01	1200	4.98	0.95	0.99	4.98	0.05	0.20	4.98	1200	16.7	5.0	4.89	4.98	6.24	6.24	9.50
168	44366	23830	68196	4	4.07	855	3.50	0.95	0.99	3.50	0.05	0.20	3.50	855	14.8	3.5	4.89	3.50	6.24	4.87	6.68
200	6591	25355	31946	4	4.07	700	2.87	0.80	0.90	2.87	0.05	0.20	2.87	700	13.9	2.9	4.89	2.87	6.24	0.73	1.18
207	10866	25175	36041	5.2	4.64	350	1.26	0.95	0.99	1.26	0.05	0.20	1.26	350	11.9	1.3	4.89	1.26	6.24	1.30	1.69

* C (unpaved) assumes impacted open space since pavement is accounted for

Variable	Description
A	Area
V	Velocity
S	Slope
L	Length
tt	travel time in gutter
tic	initial flow time
tc	time of concentration
C	runoff coefficient (based on land use and %)
tc check	this is a way to check tc calcs, use the minimum of the 2.

Input to Raingarden Calculator

STA	Total A (SF)	C (25)
34	23394	0.69
38	83268	0.87
108	132383	0.42
168	68196	0.64
200	31946	0.20
207	36041	0.32

Inlet/Outlet Sizing

FROM RATIONAL METHOD

STA	Q25 (cfs)	Q100 (cfs)	Overflow
34	1.82	2.51	
38	8.15	10.85	
108	6.24	9.50	3.26
168	4.87	6.68	
200	0.73	1.18	0.45
207	1.30	1.69	0.39

MANNINGS ROUGHNESS ASSUMPTIONS

n assumptions

Rock	0.035
HDPE	0.01

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

LEGEND

	calculated
	input

STA 34 (less than half full)

input	value	units
depth of water (y)	0.333	ft
DIA	0.667	ft
R	0.3335	
theta	3.14459116	
cross sectional area (A_c)	0.174374	ft2
wetted perimeter (P)	1.04672115	ft
channel slope (S)	0.0395	ft/ft
hydraulic radius (R)	0.16659069	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	8.94165373	ft/s
pipe flow (Q)	1.55919194	CFS

STA 34 (more than half

input	value	units
depth of water (	0.37	ft
DIA	0.667	ft
R	0.3335	
theta	2.922263	
cross sectional ai	0.199004	ft2
wetted perimete	1.120868	ft
channel slope (S)	0.0395	ft/ft
hydraulic radius	0.177545	ft
conversion (C_1)	1.486	
Mannings roughi	0.01	
mean velocity (v	9.329452	ft/s
pipe flow (Q)	1.856601	CFS
D50	0.289401	ft

need 8" pipe to pass 25 yr storm
=0.2D*(Q/(sqrt(g)*D^.25)^4/3*(D/0.4D
)
Class 150 RipRap (FHWA 2011)

STA 38 (less than half full)

input	value	units
depth of water (y)	0.5	ft
DIA	1	ft
R	0.5	
theta	3.14159265	
cross sectional area (A_c)	0.39269908	ft2
wetted perimeter (P)	1.57079633	ft
PIPE slope (S)	0.05	ft/ft
hydraulic radius (R)	0.25	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	13.1865287	ft/s
pipe flow (Q)	5.17833771	CFS

STA 38 (more than half

input	value	units
depth of water (	0.59	ft
DIA	1	ft
R	0.5	
theta	2.77962	
cross sectional ai	0.482211	ft2
wetted perimete	1.751783	ft
PIPE slope (S)	0.05	ft/ft
hydraulic radius	0.275269	ft
conversion (C_1)	1.486	
Mannings roughi	0.01	
mean velocity (v	14.06074	ft/s
pipe flow (Q)	6.78024	CFS
D50	0.632647	ft

need 8" pipe to pass 25 yr storm
Class 150 RipRap

STA 108 (less than half full)

input	value	units
depth of water (y)	0.333	ft
DIA	0.667	ft
R	0.3335	
theta	3.14459116	
cross sectional area (A_c)	0.174374	ft2
wetted perimeter (P)	1.04672115	ft
channel slope (S)	0.04	ft/ft
hydraulic radius (R)	0.16659069	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	8.99806851	ft/s
pipe flow (Q)	1.56902921	CFS

STA 108 (more than half

input	value	units
depth of water (	0.667	ft
DIA	0.667	ft
R	0.3335	
theta	0	
cross sectional ai	0.349415	ft2
wetted perimete	2.095442	ft
channel slope (S)	0.04	ft/ft
hydraulic radius	0.16675	ft
conversion (C_1)	1.486	
Mannings roughi	0.01	
mean velocity (v	9.003804	ft/s
pipe flow (Q)	3.146064	CFS
D50	0.584653	ft

match inlet pipe
Class 150 Rip Rap

STA 168 (less than half full)

input	value	units
depth of water (y)	0.5	ft
DIA	1	ft
R	0.5	
theta	3.14159265	
cross sectional area (A_c)	0.39269908	ft2
wetted perimeter (P)	1.57079633	ft
channel slope (S)	0.033	ft/ft
hydraulic radius (R)	0.25	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	10.7127866	ft/s
pipe flow (Q)	4.20690144	CFS

STA 168 (more than half

input	value	units	
depth of water (	0.55	ft	
DIA	1	ft	
R	0.5		
theta	2.941258		
cross sectional a	0.442616	ft2	
wetted perimete	1.670964	ft	
channel slope (S)	0.033	ft/ft	
hydraulic radius	0.264886	ft	
conversion (C_1)	1.486		
Mannings roughı	0.01		
mean velocity (v	11.13394	ft/s	
pipe flow (Q)	4.928056	CFS	need 8" pipe to pass 25 yr storm
D50	0.413431	ft	Class 150 Rip Rap

STA 200 (less than half full)

input	value	units
depth of water (y)	0.2	ft
DIA	1	ft
R	0.5	
theta	4.42859487	
cross sectional area (A_c)	0.1118238	ft2
wetted perimeter (P)	0.92729522	ft
channel slope (S)	0.033	ft/ft
hydraulic radius (R)	0.12059137	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	6.58900659	ft/s
pipe flow (Q)	0.73680778	CFS

STA 200 (overflow)

input	value	units	
depth of water (y)	0.2	ft	
Width	2	ft	
Side Slopes	2	2:01	
cross sectional area (A_c)	0.28	ft2	
wetted perimeter (P)	2.89442719	ft	
channel slope (S)	0.033	ft/ft	
hydraulic radius (R)	0.09673762	ft	
conversion (C_1)	1.486		
Mannings roughness (n)	0.035		
mean velocity (v)	1.62531672	ft/s	
channel flow (Q)	0.45508868	CFS	
D50	0.0034242	ft	Class 150 RipRap

STA 207 (less than half full)

input	value	units
depth of water (y)	0.333	ft
DIA	0.667	ft
R	0.3335	
theta	3.14459116	
cross sectional area (A_c)	0.174374	ft2
wetted perimeter (P)	1.04672115	ft
channel slope (S)	0.027	ft/ft
hydraulic radius (R)	0.16659069	ft
conversion (C_1)	1.486	
Mannings roughness (n)	0.01	
mean velocity (v)	7.39266764	ft/s
pipe flow (Q)	1.28908904	CFS

STA 207 (more than half

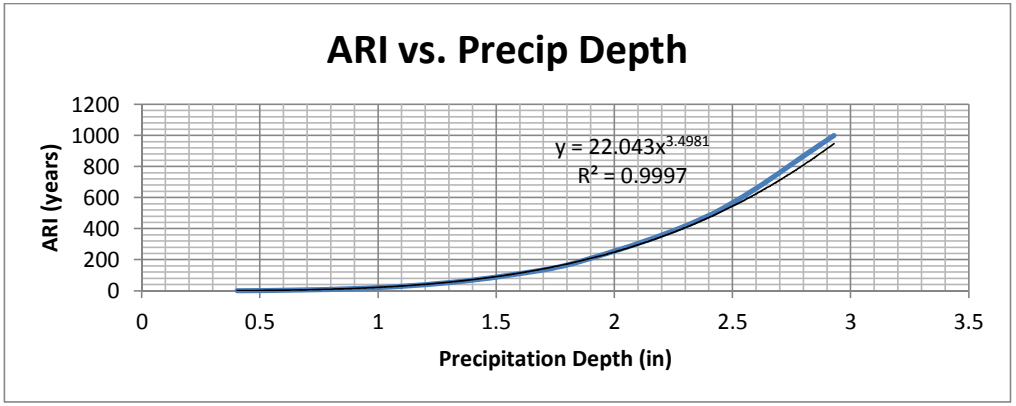
input	value	units	
depth of water (	0.334	ft	
DIA	0.667	ft	
R	0.3335		
theta	3.138594		
cross sectional a	0.175041	ft2	
wetted perimete	1.048721	ft	
channel slope (S)	0.027	ft/ft	
hydraulic radius	0.166909	ft	
conversion (C_1)	1.486		
Mannings roughı	0.01		
mean velocity (v	7.402082	ft/s	
pipe flow (Q)	1.295668	CFS	
D50	0.899673	ft	Class 150 Rip Rap

References

FHWA, 2011. Hydraulic Design of Energy Dissapators for Culverts and Channels, HEC 14, 3rd Edition.
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/06086/hec14ch10.cfm

From NOAA

ARI* (years)	60 min	24 hr
1	0.404	0.093
2	0.502	0.117
5	0.658	0.147
10	0.807	0.172
25	1.05	0.207
50	1.28	0.234
100	1.55	0.264
200	1.88	0.294
500	2.42	0.336
1000	2.93	0.37

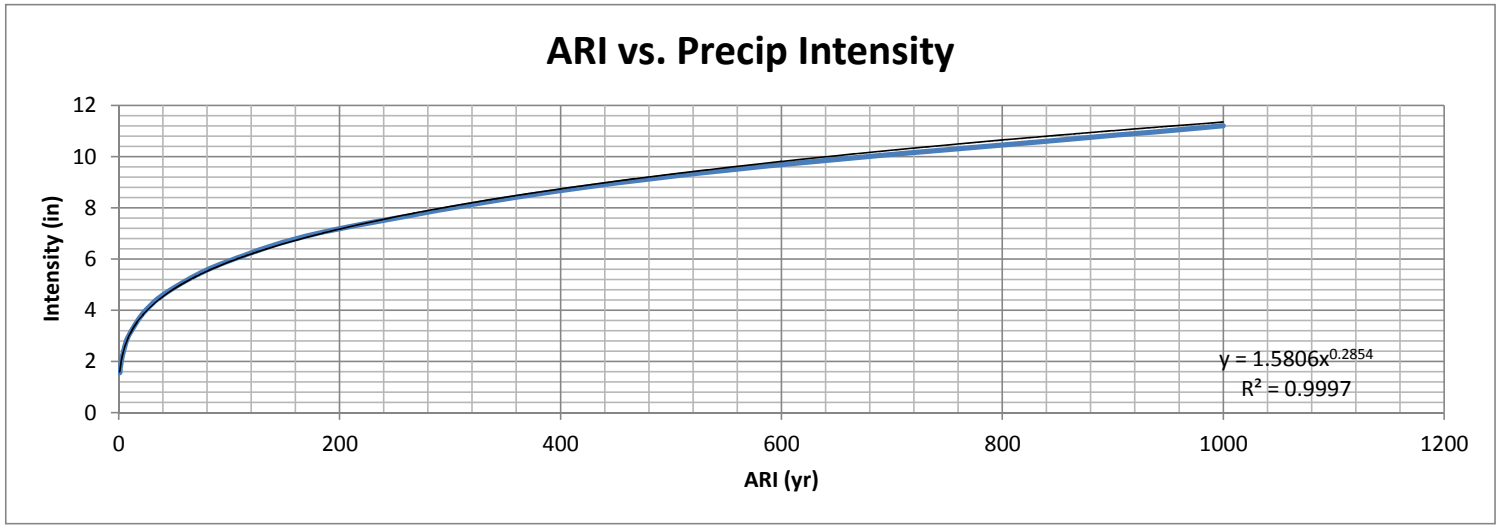


Proposed Raingarden Capacities

Site	1 hr storm depth (In)	Average Return Interval ARI (Yrs)	Soil Infiltration Rate (In/hr)	Biofiltration Soil Depth (In)	Ponding Depth (In)	Bottom Area (Sq Ft)	Ponding Area (Sq Ft)	Contributing Area (Sq Ft)
STA 34	0.97	20	2	30	18.01	193.56	637.52	23394
STA 38	0.71	7	2	30	18.01	1003.74	2127.85	83268
STA 108	0.57	3	2	30	18.05	289.81	1053.58	132383
STA 168	0.67	5	2	30	18.00	563.5	1193.42	68196
STA 200	0.81	11	2	30	12.06	62.62	264.71	31946
STA 207	0.81	10	2	30	12.01	229.53	477	36041

Intensity from NOAA

ARI** (years)	5 min
1	1.55
2	1.92
5	2.51
10	3.08
25	4.02
50	4.87
100	5.92
200	7.18
500	9.23
1000	11.2



Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 34

1 Hour Rainfall Depth =	0.968	in	Enter
Peak Rainfall Intensity =	2.00	in/hr	Calculated from distribution
Contributing Area (SF) =	23394		Enter
Runoff Coefficient =	0.69		calculation from land use
Rain Garden Square-Footage =	637.52		
Ratio of Rain Garden to Impervious Surface =	0.027		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	18.01	in	weighted avg = (1.5" x 497+ 6" x 67)/564
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	398.45	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0295148	-0.02951	-0.7379	0.00	0.00	0.00
0.4167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1.87	0.14	0.00
0.8333	0.0010	0.14	0.05	1.30211	0.00067	0.0295148	0.02257	0.5642	2.43	0.18	0.00
1.25	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	4.30	0.32	0.00
1.6667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	6.16	0.46	0.00
2.0833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	8.03	0.60	0.00
2.5	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	9.90	0.75	0.00
2.9167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	11.76	0.89	0.00
3.3333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	13.63	1.03	0.00
3.75	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	15.50	1.17	0.00
4.1667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	17.36	1.31	0.00
4.5833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	19.23	1.45	0.00
5	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	21.09	1.59	0.00
5.4167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	22.96	1.73	0.00
5.8333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	24.83	1.87	0.00
6.25	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	26.69	2.01	0.00
6.6667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	28.56	2.15	0.00
7.0833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	30.43	2.29	0.00
7.5	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	32.29	2.43	0.00
7.9167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	34.16	2.57	0.00
8.3333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	36.02	2.71	0.00
8.75	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	37.89	2.85	0.00
9.1667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	39.76	2.99	0.00
9.5833	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	42.93	3.23	0.00
10	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	44.79	3.37	0.00
10.417	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	47.96	3.61	0.00
10.833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	49.83	3.75	0.00
11.25	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	53.00	3.99	0.00
11.667	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	56.16	4.23	0.00
12.083	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	58.03	4.37	0.00
12.5	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	61.20	4.61	0.00
12.917	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	64.37	4.85	0.00
13.333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	66.23	4.99	0.00
13.75	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	69.40	5.23	0.00
14.167	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	72.57	5.46	0.00
14.583	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	74.44	5.60	0.00
15	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	77.61	5.84	0.00
15.417	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	80.77	6.08	0.00
15.833	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	85.24	6.42	0.00
16.25	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	88.41	6.66	0.00
16.667	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	91.58	6.90	0.00
17.083	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	96.05	7.23	0.00
17.5	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	99.22	7.47	0.00
17.917	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	102.39	7.71	0.00

18.333	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	106.86	8.05	0.00
18.75	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	110.03	8.28	0.00
19.167	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	113.20	8.52	0.00
19.583	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	117.67	8.86	0.00
20	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	120.84	9.10	0.00
20.417	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	125.31	9.43	0.00
20.833	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	131.08	9.87	0.00
21.25	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	135.55	10.21	0.00
21.667	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	141.32	10.64	0.00
22.083	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	145.79	10.98	0.00
22.5	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	151.57	11.41	0.00
22.917	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	157.34	11.85	0.00
23.333	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	164.41	12.38	0.00
23.75	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	170.19	12.81	0.00
24.167	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	177.26	13.35	0.00
24.583	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	184.33	13.88	0.00
25	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	191.41	14.41	0.00
25.417	0.0068	0.98	0.36	9.11477	0.00468	0.0295148	0.33508	8.3769	199.79	15.04	0.00
25.833	0.0077	1.12	0.42	10.4169	0.00534	0.0295148	0.38716	9.6790	209.47	15.77	0.00
26.25	0.0068	0.98	0.36	9.11477	0.00468	0.0295148	0.33508	8.3769	217.84	16.40	0.00
26.667	0.0106	1.53	0.57	14.3232	0.00735	0.0295148	0.54341	13.5853	231.43	17.42	0.00
27.083	0.0106	1.53	0.57	14.3232	0.00735	0.0295148	0.54341	13.5853	245.01	18.45	0.00
27.5	0.0106	1.53	0.57	14.3232	0.00735	0.0295148	0.54341	13.5853	258.60	19.47	0.00
27.917	0.0155	2.23	0.83	20.8338	0.01069	0.0295148	0.80384	20.0959	278.69	20.98	0.00
28.333	0.0145	2.09	0.78	19.5317	0.01002	0.0295148	0.75175	18.7938	297.49	22.40	0.00
28.75	0.0155	2.23	0.83	20.8338	0.01069	0.0295148	0.80384	20.0959	317.58	23.91	0.00
29.167	0.1229	17.70	6.61	165.368	0.08483	0.0295148	6.58520	164.6301	482.21	30.00	1.89
29.583	0.1220	17.56	6.56	164.066	0.08416	0.0295148	6.53312	163.3280	645.54	30.00	5.58
30	0.1229	17.70	6.61	165.368	0.08483	0.0295148	6.58520	164.6301	810.17	30.00	9.30
30.417	0.0232	3.35	1.25	31.2506	0.01603	0.0295148	1.22051	30.5128	840.69	30.00	9.99
30.833	0.0232	3.35	1.25	31.2506	0.01603	0.0295148	1.22051	30.5128	871.20	30.00	10.68
31.25	0.0232	3.35	1.25	31.2506	0.01603	0.0295148	1.22051	30.5128	901.71	30.00	11.37
31.667	0.0136	1.95	0.73	18.2295	0.00935	0.0295148	0.69967	17.4917	919.20	30.00	11.76
32.083	0.0126	1.81	0.68	16.9274	0.00868	0.0295148	0.64758	16.1896	935.39	30.00	12.13
32.5	0.0136	1.95	0.73	18.2295	0.00935	0.0295148	0.69967	17.4917	952.88	30.00	12.52
32.917	0.0087	1.25	0.47	11.719	0.00601	0.0295148	0.43924	10.9811	963.86	30.00	12.77
33.333	0.0097	1.39	0.52	13.0211	0.00668	0.0295148	0.49133	12.2832	976.15	30.00	13.05
33.75	0.0087	1.25	0.47	11.719	0.00601	0.0295148	0.43924	10.9811	987.13	30.00	13.30
34.167	0.0068	0.98	0.36	9.11477	0.00468	0.0295148	0.33508	8.3769	995.51	30.00	13.49
34.583	0.0068	0.98	0.36	9.11477	0.00468	0.0295148	0.33508	8.3769	1003.88	30.00	13.68
35	0.0068	0.98	0.36	9.11477	0.00468	0.0295148	0.33508	8.3769	1012.26	30.00	13.86
35.417	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	1019.33	30.00	14.02
35.833	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	1025.11	30.00	14.15
36.25	0.0058	0.84	0.31	7.81266	0.00401	0.0295148	0.28299	7.0748	1032.18	30.00	14.31
36.667	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	1037.95	30.00	14.44
37.083	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1042.43	30.00	14.55
37.5	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	1048.20	30.00	14.68
37.917	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1052.67	30.00	14.78
38.333	0.0048	0.70	0.26	6.51055	0.00334	0.0295148	0.23091	5.7727	1058.44	30.00	14.91
38.75	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1062.91	30.00	15.01
39.167	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1067.38	30.00	15.11
39.583	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1071.85	30.00	15.21
40	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1076.32	30.00	15.31
40.417	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1080.79	30.00	15.41
40.833	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1085.26	30.00	15.51
41.25	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1089.74	30.00	15.61
41.667	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1092.90	30.00	15.69
42.083	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1097.37	30.00	15.79
42.5	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1100.54	30.00	15.86
42.917	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1103.71	30.00	15.93
43.333	0.0039	0.56	0.21	5.20844	0.00267	0.0295148	0.17882	4.4706	1108.18	30.00	16.03
43.75	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1111.35	30.00	16.10
44.167	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1114.52	30.00	16.17
44.583	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1117.69	30.00	16.25

45	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1120.86	30.00	16.32
45.417	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1124.02	30.00	16.39
45.833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1125.89	30.00	16.43
46.25	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1129.06	30.00	16.50
46.667	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1132.23	30.00	16.57
47.083	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1134.09	30.00	16.62
47.5	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1137.26	30.00	16.69
47.917	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1140.43	30.00	16.76
48.333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1142.30	30.00	16.80
48.75	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1145.47	30.00	16.87
49.167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1147.33	30.00	16.92
49.583	0.0029	0.42	0.16	3.90633	0.002	0.0295148	0.12674	3.1685	1150.50	30.00	16.99
50	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1152.37	30.00	17.03
50.417	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1154.23	30.00	17.07
50.833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1156.10	30.00	17.11
51.25	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1157.97	30.00	17.16
51.667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1159.83	30.00	17.20
52.083	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1161.70	30.00	17.24
52.5	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1163.56	30.00	17.28
52.917	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1165.43	30.00	17.32
53.333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1167.30	30.00	17.37
53.75	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1169.16	30.00	17.41
54.167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1171.03	30.00	17.45
54.583	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1172.90	30.00	17.49
55	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1174.76	30.00	17.53
55.417	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1176.63	30.00	17.58
55.833	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1178.50	30.00	17.62
56.25	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1180.36	30.00	17.66
56.667	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1182.23	30.00	17.70
57.083	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1184.09	30.00	17.75
57.5	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1185.96	30.00	17.79
57.917	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1187.83	30.00	17.83
58.333	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1189.69	30.00	17.87
58.75	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1191.56	30.00	17.91
59.167	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1193.43	30.00	17.96
59.583	0.0010	0.14	0.05	1.30211	0.00067	0.0295148	0.02257	0.5642	1193.99	30.00	17.97
60	0.0019	0.28	0.10	2.60422	0.00134	0.0295148	0.07465	1.8663	1195.86	30.00	18.01
60.417	0.0000	0.00	0.00	0	0	0.0295148	-0.02951	-0.7379	1195.12	30.00	17.99
60.833	0.0000	0.00	0.00	0	0	0.0295148	-0.02951	-0.7379	1194.38	30.00	17.98
	0.97			0	**0.67**						

Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 38

1 Hour Rainfall Depth =	0.714	in	Enter
Peak Rainfall Intensity =	2.00	in/hr	Calculated from distribution
Contributing Area (SF) =	83268		Enter
Runoff Coefficient =	0.87		calculation from land use
Rain Garden Square-Footage =	2110.39		
Ratio of Rain Garden to Impervious Surface =	0.025		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	18.01	in	Calculated
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	1318.99	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0977032	-0.09770	-2.4426	0.00	0.00	0.00
0.4167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	6.18	0.14	0.00
0.8333	0.0007	0.10	0.17	4.31037	0.00062	0.0977032	0.07471	1.8678	8.05	0.18	0.00
1.25	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	14.22	0.32	0.00
1.6667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	20.40	0.46	0.00
2.0833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	26.58	0.60	0.00
2.5	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	32.76	0.75	0.00
2.9167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	38.94	0.89	0.00
3.3333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	45.11	1.03	0.00
3.75	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	51.29	1.17	0.00
4.1667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	57.47	1.31	0.00
4.5833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	63.65	1.45	0.00
5	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	69.83	1.59	0.00
5.4167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	76.01	1.73	0.00
5.8333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	82.18	1.87	0.00
6.25	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	88.36	2.01	0.00
6.6667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	94.54	2.15	0.00
7.0833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	100.72	2.29	0.00
7.5	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	106.90	2.43	0.00
7.9167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	113.07	2.57	0.00
8.3333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	119.25	2.71	0.00
8.75	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	125.43	2.85	0.00
9.1667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	131.61	2.99	0.00
9.5833	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	142.10	3.23	0.00
10	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	148.28	3.37	0.00
10.417	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	158.76	3.61	0.00
10.833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	164.94	3.75	0.00
11.25	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	175.43	3.99	0.00
11.667	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	185.92	4.23	0.00
12.083	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	192.10	4.37	0.00
12.5	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	202.59	4.61	0.00
12.917	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	213.07	4.85	0.00
13.333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	219.25	4.99	0.00
13.75	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	229.74	5.23	0.00
14.167	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	240.23	5.46	0.00
14.583	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	246.41	5.60	0.00
15	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	256.90	5.84	0.00
15.417	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	267.39	6.08	0.00
15.833	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	282.18	6.42	0.00
16.25	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	292.67	6.66	0.00
16.667	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	303.16	6.90	0.00
17.083	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	317.96	7.23	0.00
17.5	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	328.45	7.47	0.00
17.917	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	338.94	7.71	0.00

18.333	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	353.74	8.05	0.00
18.75	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	364.22	8.28	0.00
19.167	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	374.71	8.52	0.00
19.583	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	389.51	8.86	0.00
20	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	400.00	9.10	0.00
20.417	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	414.80	9.43	0.00
20.833	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	433.91	9.87	0.00
21.25	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	448.71	10.21	0.00
21.667	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	467.82	10.64	0.00
22.083	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	482.62	10.98	0.00
22.5	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	501.72	11.41	0.00
22.917	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	520.83	11.85	0.00
23.333	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	544.25	12.38	0.00
23.75	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	563.36	12.81	0.00
24.167	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	586.78	13.35	0.00
24.583	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	610.20	13.88	0.00
25	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	633.62	14.41	0.00
25.417	0.0050	0.72	1.21	30.1726	0.00435	0.0977032	1.10920	27.7300	661.35	15.04	0.00
25.833	0.0057	0.82	1.38	34.4829	0.00497	0.0977032	1.28161	32.0404	693.39	15.77	0.00
26.25	0.0050	0.72	1.21	30.1726	0.00435	0.0977032	1.10920	27.7300	721.12	16.40	0.00
26.667	0.0079	1.13	1.90	47.414	0.00683	0.0977032	1.79886	44.9715	766.09	17.42	0.00
27.083	0.0079	1.13	1.90	47.414	0.00683	0.0977032	1.79886	44.9715	811.07	18.45	0.00
27.5	0.0079	1.13	1.90	47.414	0.00683	0.0977032	1.79886	44.9715	856.04	19.47	0.00
27.917	0.0114	1.65	2.76	68.9659	0.00994	0.0977032	2.66093	66.5233	922.56	20.98	0.00
28.333	0.0107	1.54	2.59	64.6555	0.00932	0.0977032	2.48852	62.2129	984.77	22.40	0.00
28.75	0.0114	1.65	2.76	68.9659	0.00994	0.0977032	2.66093	66.5233	1051.30	23.91	0.00
29.167	0.0907	13.06	21.90	547.417	0.07889	0.0977032	21.79897	544.9742	1596.27	30.00	1.89
29.583	0.0900	12.95	21.72	543.106	0.07827	0.0977032	21.62655	540.6638	2136.93	30.00	5.58
30	0.0907	13.06	21.90	547.417	0.07889	0.0977032	21.79897	544.9742	2681.91	30.00	9.30
30.417	0.0171	2.47	4.14	103.449	0.01491	0.0977032	4.04025	101.0063	2782.91	30.00	9.99
30.833	0.0171	2.47	4.14	103.449	0.01491	0.0977032	4.04025	101.0063	2883.92	30.00	10.68
31.25	0.0171	2.47	4.14	103.449	0.01491	0.0977032	4.04025	101.0063	2984.93	30.00	11.37
31.667	0.0100	1.44	2.41	60.3452	0.0087	0.0977032	2.31610	57.9026	3042.83	30.00	11.76
32.083	0.0093	1.34	2.24	56.0348	0.00808	0.0977032	2.14369	53.5922	3096.42	30.00	12.13
32.5	0.0100	1.44	2.41	60.3452	0.0087	0.0977032	2.31610	57.9026	3154.32	30.00	12.52
32.917	0.0064	0.93	1.55	38.7933	0.00559	0.0977032	1.45403	36.3507	3190.67	30.00	12.77
33.333	0.0071	1.03	1.72	43.1037	0.00621	0.0977032	1.62644	40.6611	3231.34	30.00	13.05
33.75	0.0064	0.93	1.55	38.7933	0.00559	0.0977032	1.45403	36.3507	3267.69	30.00	13.30
34.167	0.0050	0.72	1.21	30.1726	0.00435	0.0977032	1.10920	27.7300	3295.42	30.00	13.49
34.583	0.0050	0.72	1.21	30.1726	0.00435	0.0977032	1.10920	27.7300	3323.15	30.00	13.68
35	0.0050	0.72	1.21	30.1726	0.00435	0.0977032	1.10920	27.7300	3350.88	30.00	13.86
35.417	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	3374.30	30.00	14.02
35.833	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	3393.41	30.00	14.15
36.25	0.0043	0.62	1.03	25.8622	0.00373	0.0977032	0.93679	23.4196	3416.83	30.00	14.31
36.667	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	3435.93	30.00	14.44
37.083	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3450.73	30.00	14.55
37.5	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	3469.84	30.00	14.68
37.917	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3484.64	30.00	14.78
38.333	0.0036	0.51	0.86	21.5518	0.00311	0.0977032	0.76437	19.1093	3503.75	30.00	14.91
38.75	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3518.55	30.00	15.01
39.167	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3533.35	30.00	15.11
39.583	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3548.15	30.00	15.21
40	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3562.95	30.00	15.31
40.417	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3577.75	30.00	15.41
40.833	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3592.54	30.00	15.51
41.25	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3607.34	30.00	15.61
41.667	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3617.83	30.00	15.69
42.083	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3632.63	30.00	15.79
42.5	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3643.12	30.00	15.86
42.917	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3653.61	30.00	15.93
43.333	0.0029	0.41	0.69	17.2415	0.00248	0.0977032	0.59196	14.7989	3668.41	30.00	16.03
43.75	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3678.89	30.00	16.10
44.167	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3689.38	30.00	16.17
44.583	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3699.87	30.00	16.25

45	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3710.36	30.00	16.32
45.417	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3720.85	30.00	16.39
45.833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3727.03	30.00	16.43
46.25	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3737.52	30.00	16.50
46.667	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3748.00	30.00	16.57
47.083	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3754.18	30.00	16.62
47.5	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3764.67	30.00	16.69
47.917	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3775.16	30.00	16.76
48.333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3781.34	30.00	16.80
48.75	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3791.83	30.00	16.87
49.167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3798.00	30.00	16.92
49.583	0.0021	0.31	0.52	12.9311	0.00186	0.0977032	0.41954	10.4885	3808.49	30.00	16.99
50	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3814.67	30.00	17.03
50.417	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3820.85	30.00	17.07
50.833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3827.03	30.00	17.11
51.25	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3833.21	30.00	17.16
51.667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3839.38	30.00	17.20
52.083	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3845.56	30.00	17.24
52.5	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3851.74	30.00	17.28
52.917	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3857.92	30.00	17.32
53.333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3864.10	30.00	17.37
53.75	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3870.27	30.00	17.41
54.167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3876.45	30.00	17.45
54.583	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3882.63	30.00	17.49
55	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3888.81	30.00	17.53
55.417	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3894.99	30.00	17.58
55.833	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3901.17	30.00	17.62
56.25	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3907.34	30.00	17.66
56.667	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3913.52	30.00	17.70
57.083	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3919.70	30.00	17.75
57.5	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3925.88	30.00	17.79
57.917	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3932.06	30.00	17.83
58.333	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3938.23	30.00	17.87
58.75	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3944.41	30.00	17.91
59.167	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3950.59	30.00	17.96
59.583	0.0007	0.10	0.17	4.31037	0.00062	0.0977032	0.07471	1.8678	3952.46	30.00	17.97
60	0.0014	0.21	0.34	8.62074	0.00124	0.0977032	0.24713	6.1782	3958.64	30.00	18.01
60.417	0.0000	0.00	0.00	0	0	0.0977032	-0.09770	-2.4426	3956.19	30.00	17.99
60.833	0.0000	0.00	0.00	0	0	0.0977032	-0.09770	-2.4426	3953.75	30.00	17.98
	0.71			0	**0.62**						

Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 108

1 Hour Rainfall Depth =	0.465	in	Enter
Peak Rainfall Intensity =	2.00	in/hr	Calculated from distribution
Contributing Area (SF) =	132383		Enter
Runoff Coefficient =	0.42		calculation from land use
Rain Garden Square-Footage =	1053.58		
Vault Volume =	216	CF	**ADD 0.1" to 1 hr Rainfall Depth**
Ratio of Rain Garden to Impervious Surface =	0.008		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	18.05	in	weighted avg = (1.5" x 497+ 6" x 67)/564
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	658.49	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0487769	-0.04878	-1.2194	0.00	0.00	0.00
0.4167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	3.09	0.14	0.00
0.8333	0.0005	0.07	0.09	2.15453	0.0002	0.0487769	0.03740	0.9351	4.02	0.18	0.00
1.25	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	7.11	0.32	0.00
1.6667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	10.20	0.46	0.00
2.0833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	13.29	0.61	0.00
2.5	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	16.38	0.75	0.00
2.9167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	19.47	0.89	0.00
3.3333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	22.56	1.03	0.00
3.75	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	25.65	1.17	0.00
4.1667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	28.74	1.31	0.00
4.5833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	31.83	1.45	0.00
5	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	34.92	1.59	0.00
5.4167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	38.01	1.73	0.00
5.8333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	41.10	1.87	0.00
6.25	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	44.19	2.01	0.00
6.6667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	47.28	2.15	0.00
7.0833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	50.37	2.29	0.00
7.5	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	53.46	2.44	0.00
7.9167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	56.55	2.58	0.00
8.3333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	59.64	2.72	0.00
8.75	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	62.73	2.86	0.00
9.1667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	65.82	3.00	0.00
9.5833	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	71.06	3.24	0.00
10	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	74.15	3.38	0.00
10.417	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	79.40	3.62	0.00
10.833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	82.49	3.76	0.00
11.25	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	87.73	4.00	0.00
11.667	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	92.97	4.24	0.00
12.083	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	96.06	4.38	0.00
12.5	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	101.31	4.62	0.00
12.917	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	106.55	4.85	0.00
13.333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	109.64	5.00	0.00
13.75	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	114.89	5.23	0.00
14.167	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	120.13	5.47	0.00
14.583	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	123.22	5.61	0.00
15	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	128.46	5.85	0.00
15.417	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	133.71	6.09	0.00
15.833	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	141.11	6.43	0.00
16.25	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	146.35	6.67	0.00
16.667	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	151.59	6.91	0.00
17.083	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	158.99	7.24	0.00
17.5	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	164.24	7.48	0.00

17.917	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	169.48	7.72	0.00
18.333	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	176.88	8.06	0.00
18.75	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	182.12	8.30	0.00
19.167	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	187.37	8.54	0.00
19.583	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	194.77	8.87	0.00
20	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	200.01	9.11	0.00
20.417	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	207.41	9.45	0.00
20.833	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	216.96	9.88	0.00
21.25	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	224.36	10.22	0.00
21.667	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	233.92	10.66	0.00
22.083	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	241.31	10.99	0.00
22.5	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	250.87	11.43	0.00
22.917	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	260.42	11.86	0.00
23.333	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	272.13	12.40	0.00
23.75	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	281.68	12.83	0.00
24.167	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	293.39	13.37	0.00
24.583	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	305.10	13.90	0.00
25	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	316.81	14.43	0.00
25.417	0.0033	0.47	0.60	15.0817	0.00137	0.0487769	0.55449	13.8623	330.67	15.06	0.00
25.833	0.0037	0.54	0.69	17.2363	0.00156	0.0487769	0.64067	16.0168	346.68	15.79	0.00
26.25	0.0033	0.47	0.60	15.0817	0.00137	0.0487769	0.55449	13.8623	360.55	16.43	0.00
26.667	0.0051	0.74	0.95	23.6999	0.00215	0.0487769	0.89922	22.4804	383.03	17.45	0.00
27.083	0.0051	0.74	0.95	23.6999	0.00215	0.0487769	0.89922	22.4804	405.51	18.47	0.00
27.5	0.0051	0.74	0.95	23.6999	0.00215	0.0487769	0.89922	22.4804	427.99	19.50	0.00
27.917	0.0074	1.07	1.38	34.4725	0.00312	0.0487769	1.33012	33.2531	461.24	21.01	0.00
28.333	0.0070	1.00	1.29	32.318	0.00293	0.0487769	1.24394	31.0986	492.34	22.43	0.00
28.75	0.0074	1.07	1.38	34.4725	0.00312	0.0487769	1.33012	33.2531	525.59	23.95	0.00
29.167	0.0591	8.50	10.95	273.626	0.0248	0.0487769	10.89625	272.4063	798.00	30.00	1.91
29.583	0.0586	8.44	10.86	271.471	0.02461	0.0487769	10.81007	270.2518	1068.25	30.00	5.60
30	0.0591	8.50	10.95	273.626	0.0248	0.0487769	10.89625	272.4063	1340.66	30.00	9.32
30.417	0.0112	1.61	2.07	51.7088	0.00469	0.0487769	2.01958	50.4894	1391.15	30.00	10.01
30.833	0.0112	1.61	2.07	51.7088	0.00469	0.0487769	2.01958	50.4894	1441.64	30.00	10.70
31.25	0.0112	1.61	2.07	51.7088	0.00469	0.0487769	2.01958	50.4894	1492.13	30.00	11.39
31.667	0.0065	0.94	1.21	30.1635	0.00273	0.0487769	1.15776	28.9440	1521.07	30.00	11.79
32.083	0.0060	0.87	1.12	28.0089	0.00254	0.0487769	1.07158	26.7895	1547.86	30.00	12.16
32.5	0.0065	0.94	1.21	30.1635	0.00273	0.0487769	1.15776	28.9440	1576.80	30.00	12.55
32.917	0.0042	0.60	0.78	19.3908	0.00176	0.0487769	0.72686	18.1714	1594.97	30.00	12.80
33.333	0.0047	0.67	0.86	21.5453	0.00195	0.0487769	0.81304	20.3259	1615.30	30.00	13.08
33.75	0.0042	0.60	0.78	19.3908	0.00176	0.0487769	0.72686	18.1714	1633.47	30.00	13.33
34.167	0.0033	0.47	0.60	15.0817	0.00137	0.0487769	0.55449	13.8623	1647.33	30.00	13.52
34.583	0.0033	0.47	0.60	15.0817	0.00137	0.0487769	0.55449	13.8623	1661.20	30.00	13.70
35	0.0033	0.47	0.60	15.0817	0.00137	0.0487769	0.55449	13.8623	1675.06	30.00	13.89
35.417	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	1686.77	30.00	14.05
35.833	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	1696.32	30.00	14.18
36.25	0.0028	0.40	0.52	12.9272	0.00117	0.0487769	0.46831	11.7078	1708.03	30.00	14.34
36.667	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	1717.58	30.00	14.48
37.083	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1724.98	30.00	14.58
37.5	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	1734.53	30.00	14.71
37.917	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1741.93	30.00	14.81
38.333	0.0023	0.33	0.43	10.7727	0.00098	0.0487769	0.38213	9.5532	1751.48	30.00	14.94
38.75	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1758.88	30.00	15.04
39.167	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1766.28	30.00	15.14
39.583	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1773.68	30.00	15.24
40	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1781.08	30.00	15.34
40.417	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1788.48	30.00	15.44
40.833	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1795.88	30.00	15.55
41.25	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1803.28	30.00	15.65
41.667	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1808.52	30.00	15.72
42.083	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1815.92	30.00	15.82
42.5	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1821.16	30.00	15.89
42.917	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1826.41	30.00	15.96
43.333	0.0019	0.27	0.34	8.61813	0.00078	0.0487769	0.29595	7.3987	1833.81	30.00	16.06
43.75	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1839.05	30.00	16.14
44.167	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1844.29	30.00	16.21

44.583	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1849.54	30.00	16.28
45	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1854.78	30.00	16.35
45.417	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1860.03	30.00	16.42
45.833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1863.12	30.00	16.46
46.25	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1868.36	30.00	16.54
46.667	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1873.60	30.00	16.61
47.083	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1876.69	30.00	16.65
47.5	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1881.94	30.00	16.72
47.917	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1887.18	30.00	16.79
48.333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1890.27	30.00	16.84
48.75	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1895.52	30.00	16.91
49.167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1898.61	30.00	16.95
49.583	0.0014	0.20	0.26	6.4636	0.00059	0.0487769	0.20977	5.2442	1903.85	30.00	17.02
50	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1906.94	30.00	17.06
50.417	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1910.03	30.00	17.11
50.833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1913.12	30.00	17.15
51.25	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1916.21	30.00	17.19
51.667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1919.30	30.00	17.23
52.083	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1922.39	30.00	17.27
52.5	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1925.48	30.00	17.32
52.917	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1928.57	30.00	17.36
53.333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1931.66	30.00	17.40
53.75	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1934.75	30.00	17.44
54.167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1937.84	30.00	17.49
54.583	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1940.93	30.00	17.53
55	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1944.02	30.00	17.57
55.417	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1947.11	30.00	17.61
55.833	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1950.19	30.00	17.65
56.25	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1953.28	30.00	17.70
56.667	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1956.37	30.00	17.74
57.083	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1959.46	30.00	17.78
57.5	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1962.55	30.00	17.82
57.917	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1965.64	30.00	17.87
58.333	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1968.73	30.00	17.91
58.75	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1971.82	30.00	17.95
59.167	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1974.91	30.00	17.99
59.583	0.0005	0.07	0.09	2.15453	0.0002	0.0487769	0.03740	0.9351	1975.85	30.00	18.01
60	0.0009	0.13	0.17	4.30907	0.00039	0.0487769	0.12359	3.0896	1978.94	30.00	18.05
60.417	0.0000	0.00	0.00	0	0	0.0487769	-0.04878	-1.2194	1977.72	30.00	18.03
60.833	0.0000	0.00	0.00	0	0	0.0487769	-0.04878	-1.2194	1976.50	30.00	18.01
	0.46			0	**0.20**						

Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 168

1 Hour Rainfall Depth =	0.67	in	Enter
Peak Rainfall Intensity =	2.00	in/hr	Calculated from distribution
Contributing Area (SF) =	68196	sf	Enter
Runoff Coefficient =	0.64		calculation from land use
Rain Garden Square-Footage =	1193.42		
Ratio of Rain Garden to Impervious Surface =	0.017		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	18.00	in	Calculated
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	745.89	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0552509	-0.05525	-1.3813	0.00	0.00	0.00
0.4167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	3.49	0.14	0.00
0.8333	0.0007	0.10	0.10	2.43687	0.00043	0.0552509	0.04222	1.0556	4.55	0.18	0.00
1.25	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	8.04	0.32	0.00
1.6667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	11.53	0.46	0.00
2.0833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	15.03	0.60	0.00
2.5	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	18.52	0.74	0.00
2.9167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	22.01	0.89	0.00
3.3333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	25.50	1.03	0.00
3.75	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	29.00	1.17	0.00
4.1667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	32.49	1.31	0.00
4.5833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	35.98	1.45	0.00
5	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	39.47	1.59	0.00
5.4167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	42.97	1.73	0.00
5.8333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	46.46	1.87	0.00
6.25	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	49.95	2.01	0.00
6.6667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	53.44	2.15	0.00
7.0833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	56.94	2.29	0.00
7.5	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	60.43	2.43	0.00
7.9167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	63.92	2.57	0.00
8.3333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	67.41	2.71	0.00
8.75	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	70.90	2.85	0.00
9.1667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	74.40	2.99	0.00
9.5833	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	80.33	3.23	0.00
10	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	83.82	3.37	0.00
10.417	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	89.75	3.61	0.00
10.833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	93.24	3.75	0.00
11.25	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	99.17	3.99	0.00
11.667	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	105.10	4.23	0.00
12.083	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	108.59	4.37	0.00
12.5	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	114.52	4.61	0.00
12.917	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	120.45	4.84	0.00
13.333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	123.94	4.99	0.00
13.75	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	129.87	5.22	0.00
14.167	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	135.80	5.46	0.00
14.583	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	139.29	5.60	0.00
15	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	145.22	5.84	0.00
15.417	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	151.15	6.08	0.00
15.833	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	159.52	6.42	0.00
16.25	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	165.45	6.65	0.00
16.667	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	171.38	6.89	0.00
17.083	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	179.74	7.23	0.00
17.5	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	185.67	7.47	0.00
17.917	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	191.60	7.71	0.00
18.333	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	199.97	8.04	0.00
18.75	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	205.90	8.28	0.00

19.167	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	211.83	8.52	0.00
19.583	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	220.19	8.86	0.00
20	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	226.12	9.09	0.00
20.417	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	234.49	9.43	0.00
20.833	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	245.29	9.87	0.00
21.25	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	253.66	10.20	0.00
21.667	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	264.46	10.64	0.00
22.083	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	272.83	10.97	0.00
22.5	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	283.63	11.41	0.00
22.917	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	294.43	11.84	0.00
23.333	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	307.67	12.37	0.00
23.75	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	318.48	12.81	0.00
24.167	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	331.72	13.34	0.00
24.583	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	344.96	13.87	0.00
25	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	358.20	14.41	0.00
25.417	0.0047	0.68	0.68	17.0581	0.003	0.0552509	0.62707	15.6768	373.87	15.04	0.00
25.833	0.0054	0.77	0.78	19.495	0.00343	0.0552509	0.72455	18.1137	391.99	15.77	0.00
26.25	0.0047	0.68	0.68	17.0581	0.003	0.0552509	0.62707	15.6768	407.66	16.40	0.00
26.667	0.0074	1.06	1.07	26.8056	0.00472	0.0552509	1.01697	25.4243	433.09	17.42	0.00
27.083	0.0074	1.06	1.07	26.8056	0.00472	0.0552509	1.01697	25.4243	458.51	18.44	0.00
27.5	0.0074	1.06	1.07	26.8056	0.00472	0.0552509	1.01697	25.4243	483.94	19.46	0.00
27.917	0.0107	1.54	1.56	38.9899	0.00686	0.0552509	1.50435	37.6087	521.55	20.98	0.00
28.333	0.0101	1.45	1.46	36.5531	0.00643	0.0552509	1.40687	35.1718	556.72	22.39	0.00
28.75	0.0107	1.54	1.56	38.9899	0.00686	0.0552509	1.50435	37.6087	594.33	23.90	0.00
29.167	0.0851	12.25	12.38	309.483	0.05446	0.0552509	12.32405	308.1013	902.43	30.00	1.89
29.583	0.0844	12.16	12.28	307.046	0.05403	0.0552509	12.22658	305.6644	1208.09	30.00	5.58
30	0.0851	12.25	12.38	309.483	0.05446	0.0552509	12.32405	308.1013	1516.19	30.00	9.29
30.417	0.0161	2.32	2.34	58.4849	0.01029	0.0552509	2.28414	57.1036	1573.30	30.00	9.98
30.833	0.0161	2.32	2.34	58.4849	0.01029	0.0552509	2.28414	57.1036	1630.40	30.00	10.67
31.25	0.0161	2.32	2.34	58.4849	0.01029	0.0552509	2.28414	57.1036	1687.50	30.00	11.36
31.667	0.0094	1.35	1.36	34.1162	0.006	0.0552509	1.30940	32.7349	1720.24	30.00	11.76
32.083	0.0087	1.25	1.27	31.6793	0.00557	0.0552509	1.21192	30.2980	1750.54	30.00	12.12
32.5	0.0094	1.35	1.36	34.1162	0.006	0.0552509	1.30940	32.7349	1783.27	30.00	12.52
32.917	0.0060	0.87	0.88	21.9318	0.00386	0.0552509	0.82202	20.5506	1803.82	30.00	12.77
33.333	0.0067	0.96	0.97	24.3687	0.00429	0.0552509	0.91950	22.9874	1826.81	30.00	13.04
33.75	0.0060	0.87	0.88	21.9318	0.00386	0.0552509	0.82202	20.5506	1847.36	30.00	13.29
34.167	0.0047	0.68	0.68	17.0581	0.003	0.0552509	0.62707	15.6768	1863.04	30.00	13.48
34.583	0.0047	0.68	0.68	17.0581	0.003	0.0552509	0.62707	15.6768	1878.71	30.00	13.67
35	0.0047	0.68	0.68	17.0581	0.003	0.0552509	0.62707	15.6768	1894.39	30.00	13.86
35.417	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	1907.63	30.00	14.02
35.833	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	1918.43	30.00	14.15
36.25	0.0040	0.58	0.58	14.6212	0.00257	0.0552509	0.52960	13.2399	1931.67	30.00	14.31
36.667	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	1942.48	30.00	14.44
37.083	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	1950.84	30.00	14.54
37.5	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	1961.65	30.00	14.67
37.917	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	1970.01	30.00	14.77
38.333	0.0034	0.48	0.49	12.1844	0.00214	0.0552509	0.43212	10.8031	1980.82	30.00	14.90
38.75	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	1989.18	30.00	15.00
39.167	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	1997.55	30.00	15.10
39.583	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2005.91	30.00	15.20
40	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2014.28	30.00	15.30
40.417	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2022.65	30.00	15.41
40.833	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2031.01	30.00	15.51
41.25	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2039.38	30.00	15.61
41.667	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2045.31	30.00	15.68
42.083	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2053.67	30.00	15.78
42.5	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2059.60	30.00	15.85
42.917	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2065.53	30.00	15.92
43.333	0.0027	0.39	0.39	9.74748	0.00172	0.0552509	0.33465	8.3662	2073.90	30.00	16.02
43.75	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2079.83	30.00	16.10
44.167	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2085.76	30.00	16.17
44.583	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2091.69	30.00	16.24
45	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2097.62	30.00	16.31
45.417	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2103.55	30.00	16.38
45.833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2107.04	30.00	16.42
46.25	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2112.97	30.00	16.50

46.667	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2118.90	30.00	16.57
47.083	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2122.39	30.00	16.61
47.5	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2128.32	30.00	16.68
47.917	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2134.25	30.00	16.75
48.333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2137.74	30.00	16.79
48.75	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2143.67	30.00	16.87
49.167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2147.16	30.00	16.91
49.583	0.0020	0.29	0.29	7.31061	0.00129	0.0552509	0.23717	5.9293	2153.09	30.00	16.98
50	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2156.58	30.00	17.02
50.417	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2160.08	30.00	17.06
50.833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2163.57	30.00	17.11
51.25	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2167.06	30.00	17.15
51.667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2170.55	30.00	17.19
52.083	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2174.05	30.00	17.23
52.5	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2177.54	30.00	17.27
52.917	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2181.03	30.00	17.32
53.333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2184.52	30.00	17.36
53.75	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2188.02	30.00	17.40
54.167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2191.51	30.00	17.44
54.583	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2195.00	30.00	17.49
55	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2198.49	30.00	17.53
55.417	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2201.99	30.00	17.57
55.833	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2205.48	30.00	17.61
56.25	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2208.97	30.00	17.65
56.667	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2212.46	30.00	17.70
57.083	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2215.96	30.00	17.74
57.5	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2219.45	30.00	17.78
57.917	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2222.94	30.00	17.82
58.333	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2226.43	30.00	17.86
58.75	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2229.93	30.00	17.91
59.167	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2233.42	30.00	17.95
59.583	0.0007	0.10	0.10	2.43687	0.00043	0.0552509	0.04222	1.0556	2234.47	30.00	17.96
60	0.0013	0.19	0.19	4.87374	0.00086	0.0552509	0.13970	3.4925	2237.97	30.00	18.00
60.417	0.0000	0.00	0.00	0	0	0.0552509	-0.05525	-1.3813	2236.59	30.00	17.99
60.833	0.0000	0.00	0.00	0	0	0.0552509	-0.05525	-1.3813	2235.20	30.00	17.97
	0.67			0	**0.43**						

Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 200

1 Hour Rainfall Depth =	0.81	in	Enter
Peak Rainfall Intensity =	3.00	in/hr	Calculated from distribution
Contributing Area (SF) =	31946		Enter
Runoff Coefficient =	0.2		calculation from land use
Rain Garden Square-Footage =	264.71		
Ratio of Rain Garden to Impervious Surface =	0.008		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	12.06	in	
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	165.44	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0122551	-0.01226	-0.3064	0.00	0.00	0.00
0.4167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	0.56	0.10	0.00
0.8333	0.0008	0.12	0.02	0.43127	0.00016	0.0122551	0.00500	0.1249	0.68	0.12	0.00
1.25	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	1.24	0.22	0.00
1.6667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	1.79	0.33	0.00
2.0833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	2.35	0.43	0.00
2.5	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	2.91	0.53	0.00
2.9167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	3.46	0.63	0.00
3.3333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	4.02	0.73	0.00
3.75	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	4.57	0.83	0.00
4.1667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	5.13	0.93	0.00
4.5833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	5.69	1.03	0.00
5	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	6.24	1.13	0.00
5.4167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	6.80	1.23	0.00
5.8333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	7.36	1.33	0.00
6.25	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	7.91	1.43	0.00
6.6667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	8.47	1.54	0.00
7.0833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	9.02	1.64	0.00
7.5	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	9.58	1.74	0.00
7.9167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	10.14	1.84	0.00
8.3333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	10.69	1.94	0.00
8.75	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	11.25	2.04	0.00
9.1667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	11.80	2.14	0.00
9.5833	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	12.79	2.32	0.00
10	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	13.35	2.42	0.00
10.417	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	14.34	2.60	0.00
10.833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	14.89	2.70	0.00
11.25	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	15.88	2.88	0.00
11.667	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	16.87	3.06	0.00
12.083	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	17.42	3.16	0.00
12.5	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	18.41	3.34	0.00
12.917	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	19.40	3.52	0.00
13.333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	19.95	3.62	0.00
13.75	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	20.94	3.80	0.00
14.167	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	21.93	3.98	0.00
14.583	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	22.48	4.08	0.00
15	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	23.47	4.26	0.00
15.417	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	24.46	4.44	0.00
15.833	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	25.88	4.69	0.00
16.25	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	26.87	4.87	0.00
16.667	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	27.85	5.05	0.00
17.083	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	29.27	5.31	0.00
17.5	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	30.26	5.49	0.00
17.917	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	31.25	5.67	0.00
18.333	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	32.67	5.92	0.00
18.75	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	33.65	6.10	0.00

19.167	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	34.64	6.28	0.00
19.583	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	36.06	6.54	0.00
20	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	37.05	6.72	0.00
20.417	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	38.47	6.97	0.00
20.833	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	40.32	7.31	0.00
21.25	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	41.73	7.57	0.00
21.667	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	43.58	7.90	0.00
22.083	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	45.00	8.16	0.00
22.5	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	46.85	8.50	0.00
22.917	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	48.70	8.83	0.00
23.333	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	50.98	9.24	0.00
23.75	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	52.83	9.58	0.00
24.167	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	55.11	9.99	0.00
24.583	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	57.40	10.41	0.00
25	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	59.68	10.82	0.00
25.417	0.0057	0.82	0.12	3.0189	0.00113	0.0122551	0.10850	2.7125	62.39	11.31	0.00
25.833	0.0065	0.93	0.14	3.45017	0.0013	0.0122551	0.12575	3.1438	65.53	11.88	0.00
26.25	0.0057	0.82	0.12	3.0189	0.00113	0.0122551	0.10850	2.7125	68.25	12.38	0.00
26.667	0.0089	1.28	0.19	4.74398	0.00178	0.0122551	0.17750	4.4376	72.68	13.18	0.00
27.083	0.0089	1.28	0.19	4.74398	0.00178	0.0122551	0.17750	4.4376	77.12	13.98	0.00
27.5	0.0089	1.28	0.19	4.74398	0.00178	0.0122551	0.17750	4.4376	81.56	14.79	0.00
27.917	0.0130	1.87	0.28	6.90034	0.00259	0.0122551	0.26376	6.5940	88.15	15.98	0.00
28.333	0.0122	1.75	0.26	6.46907	0.00243	0.0122551	0.24651	6.1627	94.32	17.10	0.00
28.75	0.0130	1.87	0.28	6.90034	0.00259	0.0122551	0.26376	6.5940	100.91	18.30	0.00
29.167	0.1029	14.81	2.19	54.7714	0.02057	0.0122551	2.17860	54.4650	155.37	28.17	0.00
29.583	0.1021	14.70	2.17	54.3401	0.02041	0.0122551	2.16135	54.0338	209.41	30.00	2.39
30	0.1029	14.81	2.19	54.7714	0.02057	0.0122551	2.17860	54.4650	263.87	30.00	5.35
30.417	0.0194	2.80	0.41	10.3505	0.00389	0.0122551	0.40177	10.0441	273.92	30.00	5.90
30.833	0.0194	2.80	0.41	10.3505	0.00389	0.0122551	0.40177	10.0441	283.96	30.00	6.45
31.25	0.0194	2.80	0.41	10.3505	0.00389	0.0122551	0.40177	10.0441	294.01	30.00	6.99
31.667	0.0113	1.63	0.24	6.03779	0.00227	0.0122551	0.22926	5.7314	299.74	30.00	7.31
32.083	0.0105	1.52	0.22	5.60652	0.00211	0.0122551	0.21201	5.3001	305.04	30.00	7.59
32.5	0.0113	1.63	0.24	6.03779	0.00227	0.0122551	0.22926	5.7314	310.77	30.00	7.91
32.917	0.0073	1.05	0.16	3.88144	0.00146	0.0122551	0.14300	3.5751	314.34	30.00	8.10
33.333	0.0081	1.17	0.17	4.31271	0.00162	0.0122551	0.16025	4.0063	318.35	30.00	8.32
33.75	0.0073	1.05	0.16	3.88144	0.00146	0.0122551	0.14300	3.5751	321.93	30.00	8.51
34.167	0.0057	0.82	0.12	3.0189	0.00113	0.0122551	0.10850	2.7125	324.64	30.00	8.66
34.583	0.0057	0.82	0.12	3.0189	0.00113	0.0122551	0.10850	2.7125	327.35	30.00	8.81
35	0.0057	0.82	0.12	3.0189	0.00113	0.0122551	0.10850	2.7125	330.06	30.00	8.96
35.417	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	332.34	30.00	9.08
35.833	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	334.19	30.00	9.18
36.25	0.0049	0.70	0.10	2.58763	0.00097	0.0122551	0.09125	2.2812	336.48	30.00	9.30
36.667	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	338.33	30.00	9.40
37.083	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	339.74	30.00	9.48
37.5	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	341.59	30.00	9.58
37.917	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	343.01	30.00	9.66
38.333	0.0041	0.58	0.09	2.15636	0.00081	0.0122551	0.07400	1.8500	344.86	30.00	9.76
38.75	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	346.28	30.00	9.84
39.167	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	347.70	30.00	9.91
39.583	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	349.12	30.00	9.99
40	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	350.54	30.00	10.07
40.417	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	351.96	30.00	10.15
40.833	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	353.37	30.00	10.22
41.25	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	354.79	30.00	10.30
41.667	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	355.78	30.00	10.35
42.083	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	357.20	30.00	10.43
42.5	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	358.19	30.00	10.49
42.917	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	359.17	30.00	10.54
43.333	0.0032	0.47	0.07	1.72508	0.00065	0.0122551	0.05675	1.4187	360.59	30.00	10.62
43.75	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	361.58	30.00	10.67
44.167	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	362.57	30.00	10.72
44.583	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	363.56	30.00	10.78
45	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	364.54	30.00	10.83
45.417	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	365.53	30.00	10.88
45.833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	366.09	30.00	10.91
46.25	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	367.07	30.00	10.97

46.667	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	368.06	30.00	11.02
47.083	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	368.62	30.00	11.05
47.5	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	369.61	30.00	11.11
47.917	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	370.59	30.00	11.16
48.333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	371.15	30.00	11.19
48.75	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	372.14	30.00	11.24
49.167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	372.69	30.00	11.27
49.583	0.0024	0.35	0.05	1.29381	0.00049	0.0122551	0.03950	0.9874	373.68	30.00	11.33
50	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	374.24	30.00	11.36
50.417	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	374.79	30.00	11.39
50.833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	375.35	30.00	11.42
51.25	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	375.90	30.00	11.45
51.667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	376.46	30.00	11.48
52.083	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	377.02	30.00	11.51
52.5	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	377.57	30.00	11.54
52.917	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	378.13	30.00	11.57
53.333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	378.69	30.00	11.60
53.75	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	379.24	30.00	11.63
54.167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	379.80	30.00	11.66
54.583	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	380.35	30.00	11.69
55	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	380.91	30.00	11.72
55.417	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	381.47	30.00	11.75
55.833	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	382.02	30.00	11.78
56.25	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	382.58	30.00	11.81
56.667	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	383.13	30.00	11.84
57.083	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	383.69	30.00	11.87
57.5	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	384.25	30.00	11.90
57.917	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	384.80	30.00	11.93
58.333	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	385.36	30.00	11.96
58.75	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	385.92	30.00	11.99
59.167	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	386.47	30.00	12.02
59.583	0.0008	0.12	0.02	0.43127	0.00016	0.0122551	0.00500	0.1249	386.60	30.00	12.03
60	0.0016	0.23	0.03	0.86254	0.00032	0.0122551	0.02225	0.5562	387.15	30.00	12.06
60.417	0.0000	0.00	0.00	0	0	0.0122551	-0.01226	-0.3064	386.85	30.00	12.04
60.833	0.0000	0.00	0.00	0	0	0.0122551	-0.01226	-0.3064	386.54	30.00	12.03
	0.81			0	**0.16**						

Spreadsheet Illustrating Rain Garden Sizing
24 Hour Storms, NRCS Type 2 Rainfall Distribution

STA 207

1 Hour Rainfall Depth =	0.807	in	Enter
Peak Rainfall Intensity =	2.00	in/hr	Calculated from distribution
Contributing Area (SF) =	36041		Enter
Runoff Coefficient =	0.32		calculation from land use
Rain Garden Square-Footage =	477		
Ratio of Rain Garden to Impervious Surface =	0.013		Calculated
Soil Infiltration Rate =	2	in/hr	Enter
Maximum Ponding Depth in Rain Garden =	12.01	in	weighted avg = (1.5" x 497+ 6" x 67)/564
Depth of bioinfiltration soil below Rain Garden =	30.00	inches	
Void ratio for bioinfiltration soil =	25%	25% for bioinf soil	
Storage capacity of bioinfiltration soil=	298.13	cf	

(1) Time (min)	(2) Rainfall Depth (in)	(3) Rainfall Intensity (in/hr)	(4) Inflow Rate (cfs)	(5) Inflow Volume (cf)	(6) Runoff Depth (in)	(7) Maximum Infiltration Rate (cfs)	(8) Inflow - Infiltration Rate (cfs)	(9) Inflow - Infiltration Volume (cf)	(10) Cumulative Inflow - Outflow (cf)	(11) Rock trench Ponding Depth (in)	(12) Raingarden Ponding Depth (in)
0	0.0000	0.00	0.00	0	0	0.0220833	-0.02208	-0.5521	0.00	0.00	0.00
0.4167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	1.00	0.10	0.00
0.8333	0.0008	0.12	0.03	0.7756	0.00026	0.0220833	0.00894	0.2235	1.22	0.12	0.00
1.25	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	2.22	0.22	0.00
1.6667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	3.22	0.32	0.00
2.0833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	4.22	0.42	0.00
2.5	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	5.22	0.53	0.00
2.9167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	6.22	0.63	0.00
3.3333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	7.22	0.73	0.00
3.75	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	8.22	0.83	0.00
4.1667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	9.22	0.93	0.00
4.5833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	10.21	1.03	0.00
5	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	11.21	1.13	0.00
5.4167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	12.21	1.23	0.00
5.8333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	13.21	1.33	0.00
6.25	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	14.21	1.43	0.00
6.6667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	15.21	1.53	0.00
7.0833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	16.21	1.63	0.00
7.5	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	17.21	1.73	0.00
7.9167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	18.21	1.83	0.00
8.3333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	19.21	1.93	0.00
8.75	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	20.21	2.03	0.00
9.1667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	21.21	2.13	0.00
9.5833	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	22.98	2.31	0.00
10	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	23.98	2.41	0.00
10.417	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	25.75	2.59	0.00
10.833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	26.75	2.69	0.00
11.25	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	28.53	2.87	0.00
11.667	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	30.30	3.05	0.00
12.083	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	31.30	3.15	0.00
12.5	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	33.08	3.33	0.00
12.917	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	34.85	3.51	0.00
13.333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	35.85	3.61	0.00
13.75	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	37.62	3.79	0.00
14.167	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	39.40	3.96	0.00
14.583	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	40.40	4.07	0.00
15	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	42.17	4.24	0.00
15.417	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	43.95	4.42	0.00
15.833	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	46.50	4.68	0.00
16.25	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	48.27	4.86	0.00
16.667	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	50.05	5.04	0.00
17.083	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	52.60	5.29	0.00
17.5	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	54.37	5.47	0.00
17.917	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	56.15	5.65	0.00

18.333	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	58.70	5.91	0.00
18.75	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	60.47	6.09	0.00
19.167	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	62.25	6.26	0.00
19.583	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	64.80	6.52	0.00
20	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	66.57	6.70	0.00
20.417	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	69.12	6.96	0.00
20.833	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	72.45	7.29	0.00
21.25	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	75.00	7.55	0.00
21.667	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	78.32	7.88	0.00
22.083	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	80.88	8.14	0.00
22.5	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	84.20	8.47	0.00
22.917	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	87.53	8.81	0.00
23.333	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	91.63	9.22	0.00
23.75	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	94.95	9.56	0.00
24.167	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	99.06	9.97	0.00
24.583	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	103.16	10.38	0.00
25	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	107.26	10.79	0.00
25.417	0.0056	0.81	0.22	5.42922	0.00181	0.0220833	0.19509	4.8771	112.14	11.28	0.00
25.833	0.0065	0.93	0.25	6.20482	0.00207	0.0220833	0.22611	5.6527	117.79	11.85	0.00
26.25	0.0056	0.81	0.22	5.42922	0.00181	0.0220833	0.19509	4.8771	122.67	12.34	0.00
26.667	0.0089	1.28	0.34	8.53163	0.00284	0.0220833	0.31918	7.9795	130.65	13.15	0.00
27.083	0.0089	1.28	0.34	8.53163	0.00284	0.0220833	0.31918	7.9795	138.63	13.95	0.00
27.5	0.0089	1.28	0.34	8.53163	0.00284	0.0220833	0.31918	7.9795	146.60	14.75	0.00
27.917	0.0129	1.86	0.50	12.4096	0.00413	0.0220833	0.47430	11.8576	158.46	15.95	0.00
28.333	0.0121	1.74	0.47	11.634	0.00387	0.0220833	0.44328	11.0820	169.54	17.06	0.00
28.75	0.0129	1.86	0.50	12.4096	0.00413	0.0220833	0.47430	11.8576	181.40	18.25	0.00
29.167	0.1025	14.76	3.94	98.5015	0.0328	0.0220833	3.91798	97.9494	279.35	28.11	0.00
29.583	0.1017	14.64	3.91	97.7259	0.03254	0.0220833	3.88695	97.1738	376.52	30.00	2.37
30	0.1025	14.76	3.94	98.5015	0.0328	0.0220833	3.91798	97.9494	474.47	30.00	5.32
30.417	0.0194	2.79	0.74	18.6145	0.0062	0.0220833	0.72249	18.0624	492.54	30.00	5.87
30.833	0.0194	2.79	0.74	18.6145	0.0062	0.0220833	0.72249	18.0624	510.60	30.00	6.41
31.25	0.0194	2.79	0.74	18.6145	0.0062	0.0220833	0.72249	18.0624	528.66	30.00	6.96
31.667	0.0113	1.63	0.43	10.8584	0.00362	0.0220833	0.41225	10.3063	538.97	30.00	7.27
32.083	0.0105	1.51	0.40	10.0828	0.00336	0.0220833	0.38123	9.5307	548.50	30.00	7.56
32.5	0.0113	1.63	0.43	10.8584	0.00362	0.0220833	0.41225	10.3063	558.80	30.00	7.87
32.917	0.0073	1.05	0.28	6.98042	0.00232	0.0220833	0.25713	6.4283	565.23	30.00	8.06
33.333	0.0081	1.16	0.31	7.75602	0.00258	0.0220833	0.28816	7.2039	572.44	30.00	8.28
33.75	0.0073	1.05	0.28	6.98042	0.00232	0.0220833	0.25713	6.4283	578.87	30.00	8.48
34.167	0.0056	0.81	0.22	5.42922	0.00181	0.0220833	0.19509	4.8771	583.74	30.00	8.62
34.583	0.0056	0.81	0.22	5.42922	0.00181	0.0220833	0.19509	4.8771	588.62	30.00	8.77
35	0.0056	0.81	0.22	5.42922	0.00181	0.0220833	0.19509	4.8771	593.50	30.00	8.92
35.417	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	597.60	30.00	9.04
35.833	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	600.92	30.00	9.14
36.25	0.0048	0.70	0.19	4.65361	0.00155	0.0220833	0.16406	4.1015	605.03	30.00	9.26
36.667	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	608.35	30.00	9.37
37.083	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	610.90	30.00	9.44
37.5	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	614.23	30.00	9.54
37.917	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	616.78	30.00	9.62
38.333	0.0040	0.58	0.16	3.87801	0.00129	0.0220833	0.13304	3.3259	620.10	30.00	9.72
38.75	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	622.65	30.00	9.80
39.167	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	625.20	30.00	9.87
39.583	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	627.76	30.00	9.95
40	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	630.31	30.00	10.03
40.417	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	632.86	30.00	10.11
40.833	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	635.41	30.00	10.18
41.25	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	637.96	30.00	10.26
41.667	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	639.73	30.00	10.31
42.083	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	642.28	30.00	10.39
42.5	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	644.06	30.00	10.44
42.917	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	645.83	30.00	10.50
43.333	0.0032	0.46	0.12	3.10241	0.00103	0.0220833	0.10201	2.5503	648.38	30.00	10.57
43.75	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	650.16	30.00	10.63
44.167	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	651.93	30.00	10.68
44.583	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	653.71	30.00	10.73

45	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	655.48	30.00	10.79
45.417	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	657.26	30.00	10.84
45.833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	658.25	30.00	10.87
46.25	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	660.03	30.00	10.93
46.667	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	661.80	30.00	10.98
47.083	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	662.80	30.00	11.01
47.5	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	664.58	30.00	11.06
47.917	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	666.35	30.00	11.12
48.333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	667.35	30.00	11.15
48.75	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	669.13	30.00	11.20
49.167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	670.13	30.00	11.23
49.583	0.0024	0.35	0.09	2.32681	0.00077	0.0220833	0.07099	1.7747	671.90	30.00	11.28
50	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	672.90	30.00	11.31
50.417	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	673.90	30.00	11.34
50.833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	674.90	30.00	11.37
51.25	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	675.90	30.00	11.40
51.667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	676.90	30.00	11.43
52.083	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	677.89	30.00	11.46
52.5	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	678.89	30.00	11.49
52.917	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	679.89	30.00	11.53
53.333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	680.89	30.00	11.56
53.75	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	681.89	30.00	11.59
54.167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	682.89	30.00	11.62
54.583	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	683.89	30.00	11.65
55	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	684.89	30.00	11.68
55.417	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	685.89	30.00	11.71
55.833	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	686.89	30.00	11.74
56.25	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	687.89	30.00	11.77
56.667	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	688.88	30.00	11.80
57.083	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	689.88	30.00	11.83
57.5	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	690.88	30.00	11.86
57.917	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	691.88	30.00	11.89
58.333	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	692.88	30.00	11.92
58.75	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	693.88	30.00	11.95
59.167	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	694.88	30.00	11.98
59.583	0.0008	0.12	0.03	0.7756	0.00026	0.0220833	0.00894	0.2235	695.10	30.00	11.98
60	0.0016	0.23	0.06	1.5512	0.00052	0.0220833	0.03996	0.9991	696.10	30.00	12.01
60.417	0.0000	0.00	0.00	0	0	0.0220833	-0.02208	-0.5521	695.55	30.00	12.00
60.833	0.0000	0.00	0.00	0	0	0.0220833	-0.02208	-0.5521	695.00	30.00	11.98
	0.81			0	**0.26**						

APPENDIX D

Seed Mixes and Containerized Plants

UPLAND MIX

Location	Common Name	Species	Height	Lbs/Acre
BMP 2, BMP 3, BMP 8, BMP 11, BMP 19	Sheep Fescue 'Covar'	*Festuca trachyphylla 'Covar'*	6"	4.00
	Streambank Wheatgrass 'Sodar'	*Elymus lanceolatus ssp. psammophilus 'Sodar'*	12-18"	6.00
	Showy Penstemon	*Penstemon speciosus*	1-3'	0.50
	Sulfur-flower Buckwheat	*Eriogonum umbellatum*	1'	0.50
	Yarrow	*Achillea millefolium*	1-2'	0.25
	Blue Flax	*Linum perenne*	18-24"	2.00
	California Poppy	*Eschscholzia californica*	16"	3.00
	Slender Wheatgrass	*Elymus trachycaulus 'Revenue'*	2-2.5'	6.00
	California Sierra Brome	*Bromus carinatus*	3'	1.00

GRASS FILTER STRIP

Location	Common Name	Species	Height	Lbs/Acre
BMP 2, BMP 3, BMP 8, BMP 11, BMP 19	Blue Wildrye	*Elymus glaucus*	2-3'	6.00
	Sheep Fescue 'Covar'	*Festuca trachyphylla 'Covar'*	6"	4.00
	Creeping Wildrye	*Elymus triticoides*	3'	2.00
	Streambank Wheatgrass 'Sodar'	*Elymus lanceolatus ssp. psammophilus 'Sodar'*	12-18"	7.00
	Slender Wheatgrass	*Elymus trachycaulus 'Revenue'*	2-2.5'	10.00
	Hard Fescue	*Festuca trachyphylla 'Durar'*	1-2'	4.00
	California Sierra Brome	*Bromus carinatus*	3'	1.00

BASIN MIX

Location	Common Name	Species	Height	Lbs/Acre
BMP 2, BMP 3, BMP 8, BMP 11, BMP 19	Blue Wildrye	*Elymus glaucus*	2-3'	5.00
	Sheep Fescue 'Covar'	*Festuca trachyphylla 'Covar'*	6"	4.00
	Hard Fescue	*Festuca trachyphylla 'Durar'*	1-2'	4.00
	Creeping Wildrye	*Elymus triticoides*	3'	6.00
	Sierra Wildflower Mix	*See Wildfower Mix worksheet*	6"-3'	3.00
	Slender Wheatgrass	*Elymus trachycaulus 'Revenue'*	2-2.5'	1.00
	California Sierra Brome	*Bromus carinatus*	3'	1.00

WETLANDS MIX

Location	Common Name	Species	Height	Lbs/Acre
BMP 11	Meadow Barley	*Hordeum brachyantherum*	1.5-3.5'	0.5
	Tufted Hairgrass	*Deschampsia cespitosa*	2-3'	0.25
	Slender Wheatgrass	*Elymus trachycaulus 'Revenue'*	2-2.5'	1.00
	Baltic Rush	*Juncus balticus*	2-3'	0.20
	Nebraskensis Sedge	*Carex nebrascensis* Dewey	1-3'	0.35
	Praegracilis Sedge	*Carex praegracilis*	6"-1'	0.35
	Bigleaf Lupine	*Lupinus polyphyllus*	2.5-3.5'	0.25

WILDFLOWER MIX SIERRA			
Location	Common Name	Species	Height
Basin Mix BMP 2, BMP 3, BMP 8, BMP 11, BMP 19	Arnica Mollis	*Arnica mollis*	1-2'
	Black-eyed Susan	*Rudbeckia hirta*	1-2'
	Buckwheat Sulphur	*Eriogonum umbellatum*	1'
	Candytuft	*Iberis sempervirens*	6-12"
	Catchfly	*Silene armeria*	1-2'
	Cinquefoil	*Potentilla gracilis*	1-2'
	Columbine, red	*Aquilegia formosa*	18"
	Coreopsis Lanceleaf	*Coreopsis lanceolata*	1-2'
	Coreopsis Plains	*Coreopsis tinctoria*	1-2'
	Flax, blue	*Linum perenne*	18-24"
	Flax, scarlet	*Linum grandiflorum*	12-18"
	Geum	*Geum macrophyllum*	1-2'
	Gilia, golden	*Linanthus aureus*	6"
	Gilia, scarlet	*Ipomopsis aggregata*	3-4'
	Indian Blanketflower	*Gaillardia aristata*	1-3'
	Iris missouriensis	*Iris missouriensis*	1'
	Keckellia	*Keckiella breviflora*	3'
	Lupine, argentus	*Lupinus argenteus*	18"
	Lupine, perennis	*Lupinus perennis*	1-2'
	Monkeyflower, yellow	*Mimulus guttatus*	1-2'
	Monkeyflower, Lewis	*Mimulus lewisii*	18-24"
	Penstemon, rydbergii	*Penstemon rydbergii*	3'
	Penstemon, strictus	*Penstemon strictus*	2-3'
	Poppy, California	*Eschscholzia californica*	12-18"
	Poppy, Flanders	*Papaver rhoeas*	1-3'
	Shasta Daisy	*Leucanthemum x superbum*	2-3'
	Showy Goldeneye	*Viguiera multiflora*	18-24"
	Snow in Summer	*Cerastium tomentosum*	6"
	Wallflower	*Erysimum asperum*	6-12"

CONTAINERIZED PLANTS					
Location	Common Name	Species	Height	Size	Quantity
BMP 12	Arctic Willow	*Salix purpurea 'Nana'*	3'	1 gallon	3
	Alpine Currant	*Ribes alpinum*	3'	1 gallon	2
	Spirea	*Spirea spp.*	3'	1 gallon	3
	Golden Currant	*Ribes aureum aureum*	5-6'	1 gallon	2
	Dogwood	*Cornus sericea*	6'-8	1 gallon	2
	Black Chokeberry	*Aronia melanocarpa var. elata*	3-6	1 gallon	2
	Bearberry	*Arctostaphylos uva-ursi*	6"	1 quart	5
	Salvia	*Salvia nemorosa 'East Friesland'*	2'	1 quart	5
	Catmint	*Nepeta x faassenii 'Walker's Low'*	2'	1 quart	5
	Blue Flax	*Linum perenne* var. lewisii	1'	4"	3
	Columbine	*Aquilegia spp.*	1'	4"	5
	Mountain Pride Penstemon	*Penstemon newberryii*	6"	4"	5

APPENDIX E
Proposed Rain Garden Site Selection Process

NTCD identified 19 potential rain garden sites within NDOT catchments previously modeled as part of *Nevada Tahoe TMDL Implementing Agencies Stormwater Load Reduction Plans Baseline and Existing Conditions Final Technical Documents* (SLRP Existing Conditions Report) using the following criteria:

1. Field identification of sites based on road drainage patterns, existing stormwater infrastructure, elevations and slope, construction feasibility and maintenance access.

2. GIS identification based on aerial photograghs, LiDAR elevations, catchment load rank from the Stormwater Load Reduction Plans existing conditions, property ownership, road shoulder conditions and hydrology.

3. Applicable micro-basin location recommendations from Dr. Schladow's Distributed Stormwater Detention System study database.

The 19 potential sites were ranked (NTCD Rank) based on existing stormwater treatment assets, modeled catchment load rank, contributing area, property ownership, construction and maintenance feasibility, presence of utilities and other site limitations as shown in Table 1. NDOT catchments were delineated and modeled in PLRM as part of SLRP. NDOT Catchment, Load Rank Catchment Total Area and FSP lbs/yr/acre were all populated from information found in SLRP Existing Conditions Report. Maps of the 19 potential sites are included as Attachment A.

Table 1. Potential site catchment information and ranking

Potential Site #	NDOT Catchment	Load Rank	Catchment FSP lbs/yr	Catchment Total Area (acres)	FSP lbs/yr /acre	Existing Treatment Downstream	Utility Conflict	NTCD Rank	Notes
1	2863	3	1117	1.7	657	No	Cable	12	Potential Site (PS)#2 downstream
2	2863	3	1117	1.7	657	No	Cable	4	Hillside location; load reductions assumes absense of PS#1; Existing DI's
3	2861	4	1979	2.4	825	No	No	9	Maintenance access; Historic SEZ nearby
4	2821	2	930	1.8	516	Yes	No	14	Existing Dry Basin WCDB0013 downstream treats 91% per PLRM
5	2821	2	930	1.8	516	Yes	No	19	Site of existing Dry Basin. Retrofit/augemntation not needed as it treats 91% per PLRM
6	2809	1	177	2.6	68	Yes	Yes	16	Sewer and Water mains; small contributing area; treatment downstream Dry Basin WCDB0003 downstream
7	2850A	3	430	0.7	614	No	Maybe	8	Sewer and Water Mains nearby; Small contributing area
8	2850 B	3	926	1.4	661	No	No	1	Large contributing area; NDSL land adjacent
9	2850 B	3	926	1.4	661	No	Yes	5	Large contributing area; bottom of catchment; Sewer main nearby.
10	2816	4	1646	1.8	914	Yes	Yes	3	Large contributing area; Existing Vault WCTV0009 (sand/oil Seperator) downstream; Sewer Mains
11	2816	4	1646	1.8	914	Yes	Yes	18	DI's just upstream; Small contributing area; Treatment vault downstream
12	2821	2	930	1.8	516	No	No	2	Large contributing area; Irrigation connection.
13	2821	2	930	1.8	516	Yes	No	13	Existing Dry Basin WCDB0013 downstream
14	2821	2	930	1.8	516	No	No	15	Small contributing area; top of catchment; PS#12 downstream
15	2861	4	1979	2.4	825	No	No	7	Maintenance access?; PS#3 downstream
16	2861	4	1979	2.4	825	No	No	8	PS#3 and PS#15 downstream
17	2863	3	1117	1.7	657	No	No	17	SEZ; Maintenance access?
18	2815	4	817	0.9	908	No	Yes	10	Water Main
19	2850B	3	926	1.4	661	No	No	11	PS#8 upstream; Existing DI's

The Project Technical Advisory Committee (TAC) met on March 3, 2014 to review the potential sites and eliminate sites based on the presence of stormwater treatment downstream, property ownership, estimated contributing area, estimated lake clarity credit potential and construction feasibility. 9 sites were eliminated at the TAC meeting as indicated by the red shading on Table 1.

With NDOT input regarding highway drainage patterns, NTCD created estimated contributing areas shapefiles in ArcGIS for the remaining sites. Estimated rain garden size shapefiles were also created based on topography, property lines, utilities and other site characteristics. The estimated rain garden size and contributing area was used to calculate the storm event treated using a Rain Garden Calculator Spreadsheet with a NRCS Type 2 Rainfall Distribution. All rain gardens were designed using a 2"/hr infiltration rate, a 12 inch ponding depth, and treated the runoff from at minimum, a 50 year storm event to create a basis for comparison of estimated FSP load reductions as shown in Table 2. The estimated FSP load reduction was

obtained by multiplying the estimated contributing area by the FSP Load Rate (SLRP Existing Conditions). Connectivity (OCRAM Score) has been factored into the FSP load rate as part of SLRP. Estimated load reductions ranged from 100 to 1064 pounds of FSP annually.

It's worth noting that Potential Site #8 has a greater load potential than the baseline load for the catchment due to the fact that the catchment is not delineated correctly. Based on field evaluation with NDOT personnel, we believe that PS#8 has a greater contributing area than the NDOT delineated catmints in SLRP indicate. Runoff from the adjacent catchment (2809) is comingling with runoff from catchment 2850B. The spanning of two NDOT catchments explains the estimated load reduction being greater than baseline. The load rate for 2850B was applied to the runoff from 2809 that comingled with 2850B, as 2809's load rate takes into account a treatment basin downstream, which the comingled runoff does not enter.

Also noteworthy is that potential site #19 required two basins to meet the 50 year design storm due to space limitations in the right-of-way (ROW).

Table 2. Potential sites prioritized according to estimated load reduction and utility conflicts

Potential Site #	FSP lbs/yr /acre	Estimated Contributing Area (acre)	Estimated Load Reduction (lbs FSP/yr)	Utility Conflict	Load Rank	1 hr storm depth (in)	Average Return Interval (yrs)	NTCD Priority	Notes
1	657	0.325895317	214.11	Yes; Gas, Cable	8	2.56	505		Potential Site (PS)#2 downstream; Gas and fiber optic cable through middle.
2	657	0.956795225	628.61	No	2	1.37	55	2	Hillside location; load reductions assumes absense of PS#1; Existing DI's
3	825	0.121923783	100.59	No	10	3	886	5	Maintenance access; Historic SEZ nearby
7	614	0.402203857	246.95	Yes; Sewer	7	2.7	610		Convey vault outlet from Mill Creek to rain garden; Sewer main at edge; Irrigated landscape encroachment in ROW.
8	661	1.610399449	1064.47	No	1	1.45	67	1	Large contributing area; NDSL land adjacent
9	661	0.386294766	255.34	Yes; Sewer	6	1.79	142		Bottom of catchment; Sewer main at edge; substantial regrading require; Irrigated landscape encroachment in ROW.
10	914	0.673347107	615.44	Yes; Gas, Sewer, Cable	3	1.43	64		Large contributing area; Existing Vault WCTV0009 (sand/oil Seperator) downstream; Sewer Mains, Fiber optic cable and gas through middle
11	914	0.608999082	556.63	Yes; Phone	4	1.4	59	3	Convey vault outlet to rain garden near SEZ Rosewood Creek; underground phone line at edge-may be able to avoid.
12	516	0.218709826	112.85	No	9	1.35	52	6	Irrigation connection; IVGID Parks maintained?
19	661	0.446648301	295.23	No	5	1.37	55	4	PS#8 upstream; Existing DI's; 2 basins necessary, 1 basin treats 12 year storm
To estimateload reduction = contributing area x the load rate									

Based on estimated load reductions and utility conflicts, the following sites were eliminated:

Potential Site #1: Utilities consisting of gas and fiber optic cable are present through the proposed location. Additionally, runoff can still be treated with the design and construction of potential site #2 downstream, which does not have the utility conflicts and has existing stormwater infrastructure such as sediment traps in place.

Potential Site #7: NDOT preferred that this site be eliminated due to ROW use limitations with an encroachment permit and expenses associated with the design and construction. Ponderosa Ranch may have an encroachment permit for landscaping and irrigation lines in the NDOT ROW, which the proposed treatment would disturb. Extensive grading and disturbance would be necessary to achieve correct elevations and ponding depths. Additionally, this site also required redirecting runoff to another catchment for treatment. Retrofitting the existing treatment vault in the future to filter FSP may be an easier option for treating this outfall. However, that will likely wait on monitoring results from the NDOT paired vault monitoring project.

Potential Site #9: NDOT preferred that this site be eliminated due to ROW use limitations with an encroachment permit. Ponderosa Ranch may have an encroachment permit for landscaping and irrigation lines in the NDOT ROW, which the proposed treatment would disturb. Extensive grading and disturbance would be necessary to achieve correct elevations and ponding depths.

Potential Site #10: This site has a high estimated pollutant load reduction, but utilities consisting of gas, fiber optic cable and sewer are present through the proposed location, eliminating it from design consideration. Alternative locations to treat the catchment runoff were explored, but no suitable treatment sites in the NDOT ROW were found. A suitable site on IVGID property exists adjacent to the skate park. It is recommended that NDOT pursue discussions with IVGID in the future to develop treatment options; however, facilitating treatment on IVGID property is beyond the scope of this project.

NTCD met with NDOT staff in the field on 4/3/2014 to discuss the selected sites and attain NDOT approval with the ranking. With TAC concurrence to the selection process, the remaining 5-6 sites (based on engineer's construction estimates and available construction budget) will be developed to further design. NTCD proposes to prioritize the sites as denoted in the 'NTCD Priority' column, based on the estimated pollutant load reduction with the exception of prioritizing Potential Site #3 higher than Potential Site #12. Although #3 has a lower estimated pollutant load than Potential Site #12 (100 versus 112), it has existing stormwater infrastructure (sediment trap, conveyance pipe, flared end section, riprap dissipater) and topography to facilitate construction. Potential Site #12 is currently an irrigated turf area being maintained by Washoe County through an encroachment permit and would require Washoe County cooperation, installation of stormwater infrastructure and maintenance of existing rock lined channel and culverts to adequately convey flows to the site.

APPENDIX F
Anticipated Rain Garden Inspection and Maintenance

Rain Garden Maintenance Plan

Properly designed and installed rain gardens require little maintenance once established.

Sediment Traps: Each rain garden will include sediment traps at each inlet to capture coarse sediment before it enters the BMP. The traps are designed to be cleaned with a Vactor truck. The traps will be located either in or just behind the curb so that regular street sweeping removes accumulated pine needles from their inlet grates and pans. Installation of the rain gardens is not expected to increase street sweeping or Vactoring frequency as the overall sediment load will be the same but more distributed with the additional assets**.** Sediment traps will reduce the amount of coarse sediment that enters each rain garden and therefore increase their lifespan by limiting surficial sediment accumulation.

Vegetation: The rain gardens will be planted with low-maintenance, native vegetation approved by NDOT for sight safety concerns. Regular irrigation is required for the first growing season and occasional irrigation the second year (performed by NTCD). Once vegetation is established, maintenance of the rain garden consists of periodic trash and debris removal. The rain gardens may also require removal of invasive weeds similar to other stormwater facilities and NDOT right-of-ways. Thick vegetation in the rain gardens and a natural pine needle mulch supply from surrounding trees will obviate the need for mulch replenishment. BMP RAM protocols should be followed annually as the LID features will be classified as 'infiltration features' according to BMP RAM. Desired percentage of vegetation differs from BMP RAM default values in that ideal vegetation percent cover in the rain gardens should be between 50 and 80 percent.

Infiltration Performance: The City of Portland has experienced acceptable infiltration rates over the life of their rain gardens, some of which are 10 to 15 years old[1]. Once vegetation is established, it is expected that biological activity will maintain or even increase infiltration rates of the soil. Other municipalities have experienced increased infiltration rates five years following construction, likely due to soil biological activity and the annual cycle of plant root growth and senescence[2]. Thus, replacement of the amended soils in the rain gardens is not anticipated.

The maintenance trigger for infiltration performance is ponding water for longer than 3 days or unsatisfactory infiltration performance using Constant Head Permeameter (CHP) measurements. Loosening of the soil profile with a broadfork is the first step of soil reconditioning. If desired infiltration performance is not achieved, removal of the top inch of soil in late summer or aerating or tilling the top few inches of soil may restore desired infiltration. Revegetation is not necessary if care is taken not to destroy vegetation or remove the seed bank. If major soil reconditioning is performed (soil replacement), then vegetation would have to be reestablished.

Inspection and Maintenance: Maintenance of the rain gardens is required when inspections reveal the following:

- Trash, debris or sediment accumulation (determined visually, inspect annually)
    - Remove trash, debris and dispose of properly
    - Remove accumulated sediment and dispose of properly (ensure design depth of rain gardens is maintained)
- Weeds (use the same protocol and frequency for all NDOT right-of-ways)
    - Remove invasive weeds and any tree seedlings to prevent establishment
- Full sediment traps (inspect and maintain at the same frequency as existing catch basins using BMP RAM protocols)
    - Empty sediment traps and dispose of properly
- Pine needle obstruction of inlets
    - Remove pine needles from entry via regular street sweeping
- Ponding water for longer than 3 days or poor infiltration (using CHP measurements)
    - Loosen soil profile with broadfork **or** remove top inch of soil in gardens **or** aerate/till the top few inches of soil in late summer.

Anticipated Rain Garden Inspection and Maintenance		
Task	Schedule	Responsibility
Irrigation	1" of water per week during the first growing season to establish vegetation. Possibly additional irrigation the second year.	NTCD and Rotary Club (first 2 years)
Weeding	The LID features will be planted with native vegetation to improve infiltration and nutrient up take. Invasive weeds and tree seedlings are not desired in the LID features. Invasive weeds must be managed as in any stormwater treatment facility or County Right-of-Way.	NTCD and Rotary Club (first 2 years) NDOT thereafter
Street Sweeping	Four times a year and before and after major storm events. Removing pine needles from the drainage inlets is key for stormwater entry to the gardens.	NDOT
Empty Sediment Traps	Follow the current schedule of twice a year. (Spring and Fall)	NDOT
Remove Trash/Debris	Annually (same schedule as any other stormwater basin).	INTCD and Rotary Club (first 2 years) NDOT thereafter
BMP RAM	Use BMP RAM Field Observation Protocols for Infiltration Features. Percent cover vegetation should be between 50 and 80 percent. Conduct annually, or as often as condition scores are desired	NTCD (first 2 years) NDOT thereafter
Soil Reconditioning	Not Anticipated[3]. The experience of other municipalities is that reconditioning of bioretention basins is a very rare maintenance requirement. The vegetation is expected to maintain porosity and infiltration. Rain gardens often have a higher infiltration rate five years after construction, likely due to soil biological activity and the annual cycle of root growth and senescence[4]. In the unlikely event that desired infiltration is not maintained, loosening of the soil profile with a broad fork is recommended. Removal of the top inch of soil or aerating or tilling the top few inches of soil may in late summer also be performed to restore function.	NDOT

[3] 7/20/10 Conversation with Maria Cahill of Green Girl Land Development Solutions.
[4] 7/22/10 Conversation with Mike Isensee of Dakota County Soil and Water Conservation District.