PRELIMINARY SWLIDS REPORT

ELNOKA CCRC

251 ELNOKA LANE

SANTA ROSA, CA 95409

APN'S 031-050-014, 031-050-018, 031-050-019, 031-061-003, 031-050-060 THOUGH 031-050-072

OAKMONT SENIOR LIVING LLC

B&R JOB # 2854.04

MAY 2017

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Attachments

1. LID proposed Condition Exhibits

PROJECT DESCRIPTION

The Elnoka CCRC project is the site of the previously approved and partially implemented Three Bridges Lifecare Community. The project is located on State Highway 12, east of Melita Road in the City of Santa Rosa. The project site totals 68.73± acres on 17 parcels. The site is bounded my state Highway 12 to the north, Oakmont HOA to the east, Channel drive and residences to the North, and Melita Road and residences to the west.

The site's topography has moderate slopes averaging 19%. The site has a high point that runs east west, and divides the site approximately in half, north and south. Oakmont Creek flows east to west through the southerly portion of the site. The South Fork of Melita Creek runs east to west through the northerly portion of the site. The South Form of Melita Creek intersect with the main fork of Melita Creek on the western portion of the site. The northern portion of the site was previously graded by the Three Bridges Lifecare Community project in 1996/1997, an arch span culvert was built over the South Form of Melita Creek in conjunction with creek capacity/widening improvements that were constructed within the South Fork of Melita Creek. The site is primarily covered by annual grasses numerous trees mostly concentrated around each of the creeks that run through the project site. The site currently drains overland from the central high point running through the site, towards the existing creeks in their respective portions of the site. A storm drainage system was installed as part of the previously planned development, with outlets at both Melita South Fork and Melita creeks. The existing storm drainage system is intended to collect the increased stormwater flows from the developed site.

The Soil Map on the following page was generated using the USDA Natural Resource Conservation Service Web Soil Survey. The soil classification for the project area is a mixture of Tuscan cobbly Clay loam (TuE), Riverwash (RnA), Pleasanton loam (PnB), Pleasanton clay loam (PhB) and Manzanita gravelly silt loam (MbC). These soil types are classified as hydrologic soil group C except for Tuscan clay loam which is classified as D soil, and Riverwash. Riverwash has no hydrologic soil group, but given its listed properties as "well drained", a hydraulic soil Group of B has been assigned for the calculations in this report.

The project site will be developed to accommodate 14 senior living apartment buildings, a recreation center, 2 employee housing buildings, 74 cottages, and a care center facility. The exterior improvements will include a pool and patio area, as well as associated roadways, driveways, sidewalks, parking areas, landscaping, storm drainage, water (potable, fire protection, and irrigation) and sanitary sewer. The project is classified as a residential development and triggers these storm water requirements by creating over 10,000 ft^2 of new impervious surface.

Pollution Prevention Measures

The project design has incorporated pollution source controls intended to prevent pollutants from entering downstream drainage systems. These source controls include:

- Drainage inlets and structural BMP's will be fitted with gross pollutant (trash) racks and interceptor trays. Racks and trays will be regularly inspected and any captured debris removed and properly disposed of.

- The site landscape and hardscape will be professionally maintained, swept clean and with landscape leaves and debris removed on a regular schedule over the course of the year.

- Trash will be stored in a covered exterior trash enclosure. Local drainage will be routed away from the trash enclosure location.

- Vehicles will not be allowed to be washed or mechanically maintained on the site. All such activities will be required to occur off-site with encouragement of the use of commercial car-washes and car maintenance and repair shops.

- Landscape irrigation heads will be sized and tuned to avoid overspray and overwatering along with the selected use of drip irrigation.

- Capture and retention of at least the runoff from the 85th percentile storm event to the maximum extent practicable (MEP) of the entire site

- Routing excess intercepted runoff to sheet drain downslope through adjacent existing vegetation.

Types of BMP's

The MS4 Permit's goal is to treat, capture and infiltrate 100% of the runoff generated by the one inch deep 85th percentile 24-hour storm (design storm). The LID strategies and BMPs proposed for use on this project includes new tree planting, preservation of existing trees, bioretention planters, treepod bioretention structures and underground stormwater retention/infiltration basins. See text below for more details on proposed LID strategies and BMPs.

Interceptor Trees -New Tree Planting

Tree planting has been shown to reduce the amount of runoff that comes off a developed project Tree canopies intercept storm water before it contacts the ground and retain a significant volume of captured water on their leaves and branches allowing for evapotranspiration and providing runoff reduction benefits. While the most effective interceptor trees are large canopied evergreen trees, deciduous trees can also provide a measurable benefit. The proposed project includes the planting of many trees within the proposed Improvements.

Interceptor tree credits are calculated into the site design by reducing the amount of tributary area that must be used to calculate treatment and volume capture. New deciduous trees provide a credit of 100 square feet, new evergreen trees provide 200 square feet. All interceptor tree credits calculations are completed with the Credit Calculator of the Storm Water Calculator.

Interceptor Trees -Preservation of Existing Trees

Preserving existing established tree canopies has been shown to reduce the amount of runoff that comes off a developed project. Existing tree canopies intercept storm water before it contacts the ground and retain a significant volume of captured water on their leaves and branches allowing for evapotranspiration and providing runoff reduction benefits. The proposed project will preserve many of the large oak trees that exist on the existing project site.

Interceptor tree credits are calculated into the site design by reducing the amount of tributary area that must be used to calculate treatment and volume capture. All interceptor tree credits calculations are completed with the Credit Calculator of the Storm Water Calculator.

Bioretention Planters

Bioretention planters will consist of excavated areas backfilled with permeable granular material, sandy loam and top soil. Planters will be landscaped with native vegetation that will maximize evapotranspiration. Bioretention areas are to be designed in general accordance with the City of Santa Rosa and County of Sonoma "Storm Water Low Impact Development Technical Design Manual". The proposed bioretention areas will be designed with 18" of a sandy loam mix over of class 2 permeable material. A perforated sub drain will be located near the top of the permeable material for priority 2 bioretention adjacent to paving areas. The permeable material will maximize storm water runoff retention and storm water infiltration.

Pervious Concrete Gutter/ Valley Gutter Bioretention Areas.

Proposed Pervious Concrete Gutter/Valley Gutter bioretention areas are designed in accordance with the City of Santa Rosa and County of Sonoma "Storm Water Low Impact Development Technical Design Manual". Proposed Pervious Concrete Gutter/Valley Gutter will be installed with a minimum of 18" of CU structural treatment soil over a perforated subdrain which will be install on top of another layer of class 2 permeable material. The upper layer of material will provide stormwater treatment and the lower layer of class 2 permeable material below the sub drain will provide storm water retention. The perforated sub drain will be installed to drain the upper layer of class 2 permeable material to prevent stormwater from entering the roadway subgrade and road section. The class 2 permeable material will maximize storm water runoff retention and storm water infiltration. Within each storm drain inlet that collects storm water from pervious concrete gutter/ valley gutter bioinfilltration areas there will be a trash collection bucket and Flogard catch basin insert filter that will collect trash and sediment before storm water is discharged the storm drain system.

Kristar Cudo Retention/Infiltration Basins

Kristar Cudo retention/infiltration basins systems will be connected to onsite treepod bioretention structures to provide a storm water treatment and storm water retention. The Kristar Cudo retention/infiltration basin is a modular system of stackable 2'x2'x2' cubes that creates an underground retention storage area that contains 95% void space. The top sides and bottom of the modular cubes are not enclosed and have a grated cover that allows storm water to infiltrate into the surrounding soils all sides. The Kristar Cudo modular cubes will be wrapped with a filter fabric and backfilled with a 1' thick section of drain rock on the top, bottom and all four sides to prevent the surround sediment from entering the modular storm water retention area. Each Kristar Cudo retention/infiltration basin will have at least one manhole opening to allow inspection, access and cleaning the voids contained within the modular Cudo retention and infiltration basin. The Kristar Cudo retention/infiltration basins functions similar to the retention portion of a standard bio-retention planter but contain a greater quantity of voids. The Kristar Cudo basins will promote storm water infiltration and additional storm water treatment. The Kristar Cudo underground retention/infiltration basins that will be sized to capture the 100% Volume capture requirement of each area. At each storm drain outfall into the Kristar Cudo basins there will be a trash collection bucket and Flogard catch basin insert filter that will collect trash and sediment before storm water is discharged to the storm drain system.

Impervious Area Disconnection

Impervious area disconnection allow storm water from impervious areas, such as rooftops and pavement, to be directed to pervious natural or landscaped areas and infiltrate into the soil. All landscape areas where impervious area disconnections are proposed will be amended with compost (mixed into the soil with a rototiller) to a depth of 8 inches to allow for storm water treatment and infiltration before reaching a storm drain inlet. This BMP also slows the speed and amount of runoff from a site over conventional direct storm drain connections. All rooftop drainage for this project shall be disconnected from direct connection to the storm drain system and will be directed to storm drain treatment areas utilizing splash blocks or curb drains to paved areas that allow sheet flow to bio-retention areas.

Level of Treatment and Volume Capture

The design goal of 100% capture for the overall site will be achieved by routing 100% of event runoff (or as near to 100% as possible) through the various BMP's associated with each of the DMA's around the project. In addition, BMP's will be designed to retain at minimum the volume of runoff generated by the 1 inch deep 85th percentile event directed into each BMP before bypassing any excess runoff. A 100 square foot type B bioretention planter is proposed in the rear yard of almost all of the proposed cottages on the Elnoka project site (these areas are defined as DMA #60 (typ)). The type B bioretention planters were sized using the largest cottage footprint and applying that size bioretention planter to all of the cottages. The type B bioretention planters at each cottage will treat and retain the one inch 85% percentile storm event runoff from the cottage roof, patio and sidewalks. Each of the cottage driveways will

drain to the proposed site roads and the stormwater will be treated and retained by the proposed roadway BMP's

Maintenance Funding

BMPs shall be inspected and maintained as described in "Planter Strip Bioretention Inspection and Maintenance Checklist", "Porous Pavement Inspection and Maintenance Checklist" and "Interception Trench Inspection and Maintenance Checklist provided in the **LID** Manual Reference Documents Section. Structural BMP's such as the "Cudo" unit arrays shall be inspected and maintained in accordance with the operations and maintenance (O&M) manual published by the manufacturer. All associated costs for inspection or maintenance of the onsite best management practices (BMPs) shall be budgeted for this purpose and carried out by Oakmont Senior Living LLC., or its assigned successor(s).

FOR OFFICE USE ONLY:
Does this project require permanent storm water BMP's?

☐ Y ☐ N

Date Submitted: _____

Print Form

File No:	Quadrant
Related Files:	
Set:	
Department Use Only	

2017 Storm Water LID Determination Worksheet

PURPOSE AND APPLICABILITY: Use this form to determine whether or not this project will need to incorporate permanent Storm Water Best Management Practices (BMP's) and submit a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System Municipal Separate Storm Sewer Systems (NPDES MS4) only. Your project may still need to incorporate permanent storm water BMP's as required by other regulatory authority, such as, but not limited to CALGREEN or North Coast Reqional Water Quality Control Board (NCRWQCB).

Part 1: Project Information

Elnoka CCRC	OSL Santa Rosa Projects LLC
Project Name	Applicant (owner or developer) Name
251 Elnoka Ave.	9240 Old Redwood Hyw, Suite 200
Project Site Address	Applicant Mailing Address
Santa Rosa/ Ca/ 95409	Windsor, Ca 95492
Project City/State/Zip	Applicant City/State/Zip
N/A	707-535-3500
Permit Number(s) - (if applicable)	Applicant Phone/Email/Fax
Brelje & Race Consulting Engineers	475 Aviation Blvd, Suite 120
Designer Name	Designer Mailing Address
Santa Rosa, Ca, 95403	707-576-1322/ Gleason@brce.com
Designer City/State/Zip	Designer Phone/Email

Type of Application/Project:

☐ Subdivision ☐ Grading Permit ☐ Building Permit ☑ Hillside Development

☑ Design Review ☑ Use Permit ☐ Encroachment ☐ Time Extensions ☐ Other :_____

PART 2: Project Exemptions

1. Is this a project that creates or replaces *less than* 10,000 square feet of impervious surface[1], including all project phases and off-site improvements?

   ☑ Yes ☐ No

1 Impervious surface replacement, such as the reconstruction of parking lots or excavation to roadway subgrades, is not a routine maintenance activity. Reconstruction is defined as work that replaces surfaces down to the subgrade. Overlays, resurfacing, trenching and patching are defined as maintenance activities per section ??????

2. Is this project a routine maintenance activity[2] that is being conducted to maintain original line and grade, hydraulic capacity, and original purpose of facility such as resurfacing existing roads and parking lots?Is
3. this project a stand alone pedestrian pathway, trail or off-street bike lane?

☐ Yes ☑ No

4. **Did you answer "YES" to any of the questions in Part 2?**

☑ **YES:** This project does *not* need to inclrporate permanent Storm Water BMP's as required by the NPDES MS4 Permit. **Please complete Section 4 and "Exemption Signature Section" on Page 4.**

☐ **NO:** Proceed with worksheet.

Part 3: Project Triggers

Projects that Trigger Requirements:
Please answer the following questions to determine whether this project requires permanent Storm Water BMP's and the submittal of a SW LIDs as required by the NPDES MS4 Permit order # ???????

1. Does this project create or replace a combined total of 10,000 square feet or more of impervious surface[1] including all project phases and off-site improvements?

☑ Yes ☐ No

2. Does this project create or replace a combined total or 10,000 square feet or more of impervious streets, roads, highways, or freeway construction or reconstruction[3]? ☑ Yes ☐ No

3. Does this project create or replace a combined total of 1.0 acre or more of impervious surface[1] including all project phases and off-site improvements? ☑ Yes ☐ No

4. **Did you answer "YES" to any of the above questions in Part 3?**

☑ **YES:** This project does *not* need to incorporate permanent Storm Water BMP's as required by the NPDES MS4 Permit. **Please complete Section 4 and "Exemption Signature Section" on Page 4**

☐ **NO:** This project will *not* need to incorporate permanent Storm Water BMP's as required by the NPDES MS4 permit. **Please complete the"Exemption Signature Section" on Page 4**.

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1 Imprevious surface replacement, such as the reconstruction of parking lots or excavation to roadway subgrades, is not a routine maintence activity. Reconstruction is defined as work that replaces surfaces down to the subgrade. Overlays, resurfacint, trenching and patching are defined as maintenance activities.

2 "Rountine Maintenance Activity" includes activities such as overlays and/or resurfacing of existing roads or parking lots as well as trenching and patching activities and reroofing activities.

3 "Reconstruction" is defined as work that extends into the subgrade of a pavement section.

Part 4: Project Description

1. Total Project area: 68.73 ○ square feet ◉ acres

2. Existing land use(s): (check all that apply)

☐ Commercial ☐ Industrial ☑ Residential ☐ Public ☐ Other

Description of buildings, significant site features (creeks, wetlands, heritage trees), etc.:

There are 3 existing single family homes on the project with associated paved driveways. Oakmont Creek South flows through the northerly portion of the site. Melita Creek South Fork runs through the northerly portion of the site. Melita Creek runs through the Westerly portion of the site. There are numerous Oak trees on the project site.

3. Existing impervious surface area: 1.90 ○ square feet ◉ acres

4. Proposed Land Use(s): (check all that apply)

☐ Commercial ☐ Industrial ☑ Residential ☐ Public ☐ Other

Description of buildings, significant site features (creeks, wetlands, heritage trees), etc.:

The project proposes to construct a senior housing community consisting of 74 cottages, 13 apartment buildings with 528 units, a care center consisting of 62 units, a recreation center, a maintenance building and a 12 unit employee housing building. The project will also build a a private road network, private sewer system, private storm drain system and public water system.

5. Proposed impervious surface area: 28.50 ○ square feet ◉ acres

Project Name

2017 Storm Water LID Determination Worksheet | Elnoka CCRC

Acknowledgment Signature Section:

As the property owner or developer, I understand that this project is required to implement permanent Storm Water Best Management Practices and provide a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) Permit.* Any unknown responses must be resolved to determine if the project is subject to these requirements.

_____ _____

Applicant Signature Date

Exemption Signature Section:

As the property owner or developer, I understand that this project as currently designed does not require permanent Storm Water BMP's nor the submittal of a Storm Water Low Impact Development Submittal (SW LIDS) as required by the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) Permit*. I understand that redesign may require submittal of a new Determination Worksheet and may require permanent Storm Water BMP's.

_____ _____

Applicant Signature Date

* **Your project may still need to incorporate permanent storm water BMP's as required by other regulatory authority, such as but not limited to CALGREEN or North Coast Reqional Water Quality Control Board (NCRWQCB).**

Implementation Requirements: *All calculations shall be completed using the "Storm Water Calculator" available at: www.srcity.org/stormwaterLID*

Hydromodification Control/100% Volume Capture: Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by a 1.0" 24-hour storm event, as calculated using the "Urban Hydrology for Small Watersheds" TR-55 Manual method. 100% volume capture is the ideal condition and if achieved satisfies all requirements so that no additonal treatment is required. This is a retention requirement.

***Treatment Requirement*:** Treatment of 100% of the flow calculated using the modified Rational Method and a known intensity of 0.20 inches per hour.

Delta Volume Capture Requirement: Capture (infiltration and/or reuse) of the increase in volume of storm water due to development generated by a 1.0" 24-hour storm event, as calculated using the "Urban Hydrology for Small Watersheds" TR-55 Manual method. This is a retention requirement.

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in priority selected?	Yes	No	Explanation of selection	Other notes:
Universal LID Features- to be considered on all projects.	Living Roof	N/A	N/A		x	x	x		x	x				X	
	Rainwater Harvesting	N/A	N/A		x	x	x			x				X	
	Interceptor Trees	N/A	N/A		x	x	x				x			X	
	Vegetated Buffer Strip	UN-01	Vegetated Buffer Strip								x			X	
	Bovine Terrace	UN-02	Bovine Terrace		x						x			X	
	Impervious Area Disconnection	N/A	N/A		x	x	x				x			X	

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 1 and 1A BMPs- to be installed with no underdrains or liners. Must drain all stading water within 72 hours.	Rain Garden	P1-01	Rain Garden						x	x				X		
	Roadside Bioretention	P1-02	Roadside Bioretention - no C & G						x	x				X		
	Vegetated Swale-with Bioretention	P1-06	Swale with Bioretention						x	x				X		
	Constructed Wetlands	N/A	N/A						x	x				X		
	Infiltration Trench	P1-07	Infiltration Trench						x	x			X			

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 2 BMPs- with subsurface drains installed above the capture volume.	Rain Garden	P2-01	Rain Garden						x	x				X		
	Roadside Bioretention	P2-02	Roadside Bioretinton - Flush Design Roadside						x	x			X			
		P2-03	Roadside Bioretenion- Contiguous SW						x	x			X			
		P2-04	Roadside Bioretenion- Curb Opening						x	x				X		
		P2-05	Roadside Bioretenion- No C & G						x	x				X		
	Pervious Pavement	P2-06	Vegetated Buffer Strip						x	x				X		
	Constructed Wetlands	N/A	N/A						x	x				X		

BMP Selection Table

	Best Management Practice (BMP)	Detail Sheet	Detail Title	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 3 BMPs- installed with subdrains and/or impermeable liner. Does not achieve volume capture and must be used as part of a treatment train.	Rain Garden	P3-01	Rain Garden		x	x	x		x					X		
	Bioretention	P3-02	Roadside Bioretinton - Flush Design Roadside		x	x	x		x					X		
		P3-03	Roadside Bioretenion- Contiguous SW		x	x	x		x					X		
		P3-04	Roadside Bioretenion- Curb Opening		x	x	x		x					X		
		P3-05	Roadside Bioretenion- No C & G		x	x	x		x	x				X		
	Flow Through Planters													X		
	Pervious Pavement	P1-04	Vegetated Buffer Strip		x	x	x		x	x				X		
	Vegetated Swale	P3-07	Vegetated Swale		x	x	x		x	x				X		

BMP Selection Table

	Best Management Practice (BMP)	Can be used with...	High Ground Water	Contamination	Slope Constraints	Achieves...	Treatment	Volume Capture	Pollution Prevention Credit	BMP in this priority selected?	Yes	No	Explanation of selection	Other notes:
Priority 4 BMPs- does not achieve volume capture and must be used as part of a treatment train.	Tree Filter Unit		x	x	x		x					X		
	Modular Bioretention		x	x	x		x					X		
Priority 5 BMPs- does not achieve volume capture and must be used as part of a treatment train.	Chambered Separator Units		x	x	x		x					X		
	Centrifugal Separator Units		x	x	x		x					X		
	Trash Excluders		x	x	x		x					X		
	Filter Inserts		x	x	x		x					X		
Priority 6 BMPs-	Offset Program						N/A	N/A	N/A					
Other	Detention		x											

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #1

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **20,850** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(20,850 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(20,850 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	20,850	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	20,850	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,850	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.61571 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05473 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.62)]^2}{[(1.00 * 1.17)+(0.8 * 0.62)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1141.12 ft^3

V_{GOAL}= (0.05473)(20,850)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	20,850	ft^2 =	0.47865 Acres
C_{POST} [10] =	0.60		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.06720 cfs

$Q_{TREATMENT}$= (0.2)(0.4787)(0.60)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,850	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 62.76 ft^3

V_{PRE}= (0.00301)(20,850)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.61571 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04807 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.62)]^2}{[(0.92*1.17)+(0.8*0.62)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1002.26 ft^3

V_{POST}= (0.04807)(20,850)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,002.26) - (62.76)

V_{DELTA}= 939.50 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:

If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #2

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,049** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,049 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,049 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,049	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,049	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,049	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.67236 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05243 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.67)]^2}{[(1.00 * 1.17)+(0.8 * 0.67)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1260.89 ft^3

V_{GOAL}= (0.05243)(24,049)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	24,049	ft^2 =	0.55209 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.07622 cfs**

$Q_{TREATMENT}$= (0.2)(0.5521)(0.59)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,049	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 72.39 ft^3

V_{PRE}= (0.00301)(24,049)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.67236 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04590 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.67)]^2}{[(0.92*1.17)+(0.8*0.67)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1103.85 ft^3

V_{POST}= (0.04590)(24,049)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,103.85) - (72.39)

V_{DELTA}= 1031.46 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **2865.66** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **900.00** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,261** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.2 ft	Below perforated pipe if present
W =	30.0 ft	
L =	30.0 ft	

Solution:

Percent of Goal Achieved = **100.50** % = [(3.2 x 900) / 2,866] x 100

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = **1031.46** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #3

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **48,548** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(48,548 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(48,548 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	48,548	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	48,548	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	48,548	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	94

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05198 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 2523.53 ft^3

V_{GOAL}= (0.05198)(48,548)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	48,548	ft^2 =	1.11 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.15387 cfs

$Q_{TREATMENT}$= (0.2)(1.11)(0.59)(1.17)

C value note:
The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.
The table of values can be found here
This smaller value should not be used to size the overflow bypass.

NOTE:
The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	48,548	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$S_{PRE} = \frac{1000}{74} - 10$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 146.13 ft^3

$V_{PRE} = (0.00301)(48,548)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$S_{POST} = \frac{1000}{94} - 10$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 2207.96 ft^3

$V_{POST} = (0.04548)(48,548)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (2,207.96) - (146.13)

V_{DELTA}= 2061.83 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 5735.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1554.72 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 2,524 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.7 ft	Below perforated pipe if present
W =	39.4 ft	
L =	39.4 ft	

Solution:

Percent of Goal Achieved = 100.30 % = [(3.7 x 1,555) / 5,735] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 2061.83 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

34

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #4

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **12,728** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(12,728 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(12,728 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**12,728** ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00** ft²
Reduced Tributary Area to be used for Calculations =	**12,728** ft²

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**12,728** ft²
K [7] =	**1.17**

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**
OR: Composite post development CN [9] =	**96**

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.38422** in	S_{POST}=	$\frac{1000}{96} - 10$
Q_{POST}=	**0.06766** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.38)]^2}{[(1.00 * 1.17)+(0.8 * 0.38)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**861.18** ft^3	V_{GOAL}=	(0.06766)(12,728)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	12,728	ft^2 =	0.29219 Acres
C_{POST} [10] =	0.66		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.04513 cfs**

$Q_{TREATMENT}$= (0.2)(0.2922)(0.66)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92
K= Seasonal Precipitation Factor [7]

0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,728	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 38.31 ft^3

$V_{PRE} = (0.00301)(12{,}728)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.38422 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.06042 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.38)]^2}{[(0.92*1.17)+(0.8*0.38)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 769.03 ft^3

$V_{POST} = (0.06042)(12{,}728)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (769.03) - (38.31)

V_{DELTA}= 730.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1957.22 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 484.88 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 861 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	22.0 ft	
L =	22.0 ft	

Solution:

Percent of Goal Achieved = 100.09 % = [(4.0 x 485) / 1,957] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 730.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

40

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #5

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **22,393** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(22,393 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(22,393 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	22,393	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft²
Reduced Tributary Area to be used for Calculations =	22,393	ft²

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,393	ft²
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	85

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.75 in

$$S_{POST} = \frac{1000}{85} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02180 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.75)]^2}{[(1.00 * 1.17)+(0.8 * 1.75)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 488.17 ft³

$$V_{GOAL} = (0.02180)(22,393)$$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	22,393	ft^2 =	0.51407 Acres
C_{POST} [10] =	0.38		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04571 cfs

$Q_{TREATMENT}$= (0.2)(0.5141)(0.38)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,393	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	85

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 67.40 ft^3

V_{PRE}= (0.00301)(22,393)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.75 in

$$S_{POST} = \frac{1000}{85} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.01776 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.75)]^2}{[(0.92*1.17)+(0.8*1.75)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 397.70 ft^3

V_{POST}= (0.01776)(22,393)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (397.70) - (67.40)

V_{DELTA}= 330.30 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1109.47 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 595.36 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 488 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.9 ft	Below perforated pipe if present
W =	24.4 ft	
L =	24.4 ft	

Solution:

Percent of Goal Achieved = 101.96 % = [(1.9 x 595) / 1,109] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 330.30 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #6

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,625** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,625 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,625 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,625**	**ft²**
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	**ft²**
Reduced Tributary Area to be used for Calculations =	**25,625**	**ft²**

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,625**	**ft²**
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] = **C: 0.05 - 0.15 in/hr infiltration (transmission) rate**

Select post development ground cover description [5] = **Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**90**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= **1.06** in

$$S_{POST} = \frac{1000}{90} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= **0.03790** ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.06)]^2}{[(1.00 * 1.17)+(0.8 * 1.06)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= **971.19** ft^3

$V_{GOAL} = (0.03790)(25,625)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	25,625	ft^2 =	0.58827 Acres
C_{POST} [10] =	0.51		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07020 cfs

$Q_{TREATMENT}$= (0.2)(0.5883)(0.51)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,625	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	90

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 77.13 ft^3

$V_{PRE} = (0.00301)(25,625)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.06 in

$$S_{POST} = \frac{1000}{90} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03236 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.06)]^2}{[(0.92*1.17)+(0.8*1.06)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 829.23 ft^3

$V_{POST} = (0.03236)(25,625)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (829.23) - (77.13)

V_{DELTA}= 752.09 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2207.24 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 882.09 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 971 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.5 ft	Below perforated pipe if present
W =	29.7 ft	
L =	29.7 ft	

Solution:

Percent of Goal Achieved = 100.31 % = [(2.5 x 882) / 2,207] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 752.09 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #7

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,490** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,490 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,490 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,490**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**25,490**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,490**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**93**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.74114** in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	**0.04940** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.74)]^2}{[(1.00 * 1.17)+(0.8 * 0.74)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**1259.21** ft^3	V_{GOAL}=	(0.04940)(25,490)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	25,490	ft^2 =	0.58517 Acres
C_{POST} [10] =	0.58		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.07942 cfs**

$Q_{TREATMENT}$= (0.2)(0.5852)(0.58)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,490	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 76.72 ft^3

V_{PRE}= (0.00301)(25,490)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.74114 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04305 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.74)]^2}{[(0.92*1.17)+(0.8*0.74)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1097.34 ft^3

V_{POST}= (0.04305)(25,490)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,097.34) - (76.72)

V_{DELTA}= 1020.62 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2861.83 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,259 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.4 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 100.88 % = [(4.4 x 650) / 2,862] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1020.62 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #8

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **21,834** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(21,834 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(21,834 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	21,834	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	21,834	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,834	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	89

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.27 in	S_{POST}=	$\frac{1000}{89} - 10$
Q_{POST}=	0.03199 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.27)]^2}{[(1.00 * 1.17)+(0.8 * 1.27)]} \times \frac{1ft}{12in}$
V_{GOAL}=	698.47 ft^3	V_{GOAL}=	(0.03199)(21,834)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	21,834	ft^2 =	0.50124 Acres
C_{POST} [10] =	0.47		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05513 cfs

$Q_{TREATMENT}$= (0.2)(0.5012)(0.47)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	21,834	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	89

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 65.72 ft^3

V_{PRE}= (0.00301)(21,834)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.27 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02694 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.27)]^2}{[(0.92*1.17)+(0.8*1.27)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 588.21 ft^3

V_{POST}= (0.02694)(21,834)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (588.21) - (65.72)

V_{DELTA}= 522.49 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1587.43 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 324.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 698 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	5.0 ft	Below perforated pipe if present
W =	18.0 ft	
L =	18.0 ft	

Solution:

Percent of Goal Achieved = 102.05 % = [(5.0 x 324) / 1,587] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 522.49 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

64

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #9

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **8,414** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(8,414 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(8,414 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	8,414	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	8,414	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,414	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.85776 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04467 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.86)]^2}{[(1.00 * 1.17)+(0.8 * 0.86)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 375.85 ft^3

$V_{GOAL} = (0.04467)(8,414)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	8,414	ft^2 =	0.19316 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02260 cfs

$Q_{TREATMENT}$= (0.2)(0.1932)(0.50)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,414	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 25.33 ft^3

$V_{PRE} = (0.00301)(8,414)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.85776 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03863 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.86)]^2}{[(0.92*1.17)+(0.8*0.86)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 325.03 ft^3

$V_{POST} = (0.03863)(8,414)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (325.03) - (25.33)

V_{DELTA}= 299.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 854.21 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 204.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 376 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.2 ft	Below perforated pipe if present
W =	14.3 ft	
L =	14.3 ft	

Solution:

Percent of Goal Achieved = 100.54 % = [(4.2 x 204) / 854] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 299.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

70

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #10

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **39,220** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(39,220 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(39,220 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	39,220	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	39,220	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,220	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways

CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04216 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.93)]^2}{[(1.00 * 1.17)+(0.8 * 0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1653.52 ft^3

$V_{GOAL} = (0.04216)(39,220)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	39,220	ft^2 =	0.90037 Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.11377 cfs

$Q_{TREATMENT}$= (0.2)(0.9004)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,220	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 118.05 ft^3

V_{PRE}= (0.00301)(39,220)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03629 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.93)]^2}{[(0.92*1.17)+(0.8*0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1423.29 ft^3

V_{POST}= (0.03629)(39,220)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,423.29) - (118.05)

V_{DELTA}= 1305.24 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3757.99 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1914.06 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,654 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.0 ft	Below perforated pipe if present
W =	43.8 ft	
L =	43.8 ft	

Solution:

Percent of Goal Achieved = 101.87 % = [(2.0 x 1,914) / 3,758] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1305.24 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #11

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **14,350** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(14,350 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(14,350 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	14,350	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	14,350	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,350	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03948 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 566.54 ft^3

$V_{GOAL} = (0.03948)(14,350)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	14,350	ft^2 =	0.32943 Acres
C_{POST} [10] =	0.52		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04009 cfs

$Q_{TREATMENT}$= (0.2)(0.3294)(0.52)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

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Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,350	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 43.19 ft^3

V_{PRE}= (0.00301)(14,350)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 485.17 ft^3

V_{POST}= (0.03381)(14,350)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (485.17) - (43.19)

V_{DELTA}= 441.98 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1287.59 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 338.56 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 567 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.8 ft	Below perforated pipe if present
W =	18.4 ft	
L =	18.4 ft	

Solution:

Percent of Goal Achieved = 100.97 % = [(3.8 x 339) / 1,288] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 441.98 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

City of Santa Rosa

APPENDIX C
STORM WATER CALCULATOR

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #12

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **26,208** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(26,208 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(26,208 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

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[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	26,208	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	26,208	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	26,208	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.88139 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04394 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.88)]^2}{[(1.00 * 1.17)+(0.8 * 0.88)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1151.58 ft^3

V_{GOAL}= (0.04394)(26,208)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	26,208 ft^2 =	0.60165	Acres
C_{POST} [10] =	0.55		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07743 cfs

$Q_{TREATMENT}$= (0.2)(0.6017)(0.55)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	26,208	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 78.89 ft^3

V_{PRE}= (0.00301)(26,208)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.88139 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03795 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.88)]^2}{[(0.92*1.17)+(0.8*0.88)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 994.59 ft^3

V_{POST}= (0.03795)(26,208)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (994.59) - (78.89)

V_{DELTA}= 915.71 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1645.11 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 320.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,152 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.7	as a decimal
D =	5.5 ft	Below perforated pipe if present
W =	8.0 ft	
L =	40.0 ft	

Solution:

Percent of Goal Achieved = 106.98 % = [(5.5 x 320) / 1,645] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 915.71 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #13

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **19,862** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(19,862 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(19,862 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	19,862	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	19,862	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,862	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04216 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.93)]^2}{[(1.00 * 1.17)+(0.8 * 0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 837.38 ft^3

V_{GOAL}= (0.04216)(19,862)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	19,862	ft^2 =	0.45597 Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.05762 cfs

$Q_{TREATMENT}$= (0.2)(0.4560)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	19,862	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 59.78 ft^3

V_{PRE}= (0.00301)(19,862)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.92896 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03629 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.93)]^2}{[(0.92*1.17)+(0.8*0.93)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 720.79 ft^3

V_{POST}= (0.03629)(19,862)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (720.79) - (59.78)

V_{DELTA}= 661.01 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1903.14 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 449.44 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 837 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.2 ft	Below perforated pipe if present
W =	21.2 ft	
L =	21.2 ft	

Solution:

Percent of Goal Achieved = 100.13 % = [(4.2 x 449) / 1,903] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 661.01 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #14

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **8,121** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(8,121 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(8,121 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	8,121	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	8,121	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,121	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.44 in	S_{POST}=	$\frac{1000}{87} - 10$
Q_{POST}=	0.02792 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.44)]^2}{[(1.00 * 1.17)+(0.8 * 1.44)]} \times \frac{1ft}{12in}$
V_{GOAL}=	226.74 ft^3	V_{GOAL}=	(0.02792)(8,121)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

Input:

A_r =	8,121	ft^2 =	0.18643 Acres
C_{POST} [10] =	0.43		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.01876 cfs

$Q_{TREATMENT}$= (0.2)(0.1864)(0.43)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	8,121	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 24.44 ft^3

V_{PRE}= (0.00301)(8,121)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.44 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02324 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.44)]^2}{[(0.92*1.17)+(0.8*1.44)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 188.73 ft^3

V_{POST}= (0.02324)(8,121)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (188.73) - (24.44)

V_{DELTA}= 164.29 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 515.31 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 368.64 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 227 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.4 ft	Below perforated pipe if present
W =	19.2 ft	
L =	19.2 ft	

Solution:

Percent of Goal Achieved = 100.15 % = [(1.4 x 369) / 515] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 164.29 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

100

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #15

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,620** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,620 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,620 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,620	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft²
Reduced Tributary Area to be used for Calculations =	24,620	ft²

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,620	ft²
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways

CN_{POST} =	98	
OR: Composite post development CN [9] =	94	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.68376 in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	0.05198 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1279.75 ft³	V_{GOAL}=	(0.05198)(24,620)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	24,620	ft^2 =	0.56520 Acres
C_{POST} [10] =	0.59		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.07803 cfs**

$Q_{TREATMENT}$= (0.2)(0.5652)(0.59)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,620	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 74.11 ft^3

V_{PRE}= (0.00301)(24,620)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1119.72 ft^3

V_{POST}= (0.04548)(24,620)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,119.72) - (74.11)

V_{DELTA}= 1045.61 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2908.52 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 948.64 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,280 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.1 ft	Below perforated pipe if present
W =	30.8 ft	
L =	30.8 ft	

Solution:

Percent of Goal Achieved = 101.11 % = [(3.1 x 949) / 2,909] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 1045.61 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #16

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **24,684** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(24,684 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(24,684 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	24,684	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	24,684	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,684	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.77586 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04776 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.78)]^2}{[(1.00 * 1.17)+(0.8 * 0.78)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1178.91 ft^3	V_{GOAL}=	(0.04776)(24,684)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	24,684	ft^2 =	0.56667 Acres
C_{POST} [10] =	0.53		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07028 cfs

$Q_{TREATMENT}$= (0.2)(0.5667)(0.53)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	24,684	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 74.30 ft^3

V_{PRE}= (0.00301)(24,684)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.77586 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04152 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.78)]^2}{[(0.92*1.17)+(0.8*0.78)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1024.88 ft^3

V_{POST}= (0.04152)(24,684)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,024.88) - (74.30)

V_{DELTA}= 950.58 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **2679.34** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **745.29** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,179** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.6 ft	Below perforated pipe if present
W =	27.3 ft	
L =	27.3 ft	

Solution:

Percent of Goal Achieved = **100.14** % = [(3.6 x 745) / 2,679] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= **950.58** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #17

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **13,521** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**

Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²

Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(13,521 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre

Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(13,521 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] *From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).*

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	13,521	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	13,521	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	13,521	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	88

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.31 in

$$S_{POST} = \frac{1000}{88} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03098 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.31)]^2}{[(1.00 * 1.17)+(0.8 * 1.31)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 418.88 ft^3

V_{GOAL}= (0.03098)(13,521)

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	13,521	ft^2 =	0.31040 Acres
C_{POST} [10] =	0.38		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.02760 cfs

$Q_{TREATMENT}$= (0.2)(0.3104)(0.38)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	13,521	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	88

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 40.70 ft^3

V_{PRE}= (0.00301)(13,521)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.31 in

$$S_{POST} = \frac{1000}{88} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02602 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.31)]^2}{[(0.92*1.17)+(0.8*1.31)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 351.82 ft^3

V_{POST}= (0.02602)(13,521)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (351.82) - (40.70)

V_{DELTA}= 311.12 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 952.00 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 620.01 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 419 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.5 ft	Below perforated pipe if present
W =	24.9 ft	
L =	24.9 ft	

Solution:

Percent of Goal Achieved = 100.30 % = [(1.5 x 620) / 952] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 311.12 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #18

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **12,302** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(12,302 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(12,302 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	12,302	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	12,302	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,302	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.01 in	S_{POST}=	$\frac{1000}{91} - 10$
Q_{POST}=	0.03948 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$
V_{GOAL}=	485.68 ft^3	V_{GOAL}=	(0.03948)(12,302)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	12,302	ft^2 =	0.28242 Acres
C_{POST} [10] =	0.46		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03040 cfs

$Q_{TREATMENT}$= (0.2)(0.2824)(0.46)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	12,302	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 37.03 ft^3

V_{PRE}= (0.00301)(12,302)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 415.93 ft^3

V_{POST}= (0.03381)(12,302)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (415.93) - (37.03)

V_{DELTA}= 378.90 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1103.82 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 420.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 486 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.6 ft	Below perforated pipe if present
W =	20.5 ft	
L =	20.5 ft	

Solution:

Percent of Goal Achieved = 100.51 % = [(2.6 x 420) / 1,104] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 378.90 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #19

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **20,821** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(20,821 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(20,821 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	20,821	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	20,821	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,821	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	88

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.39 in	S_{POST}=	$\frac{1000}{88} - 10$
Q_{POST}=	0.02906 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.39)]^2}{[(1.00 * 1.17)+(0.8 * 1.39)]} \times \frac{1ft}{12in}$
V_{GOAL}=	605.06 ft^3	V_{GOAL}=	(0.02906)(20,821)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	20,821	ft^2 =	0.47798 Acres
C_{POST} [10] =	0.36		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04027 cfs

$Q_{TREATMENT}$= (0.2)(0.4780)(0.36)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	20,821	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	88

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$$S_{PRE} = \frac{1000}{74} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 62.67 ft^3

V_{PRE}= (0.00301)(20,821)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.39 in

$$S_{POST} = \frac{1000}{88} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02427 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.39)]^2}{[(0.92*1.17)+(0.8*1.39)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 505.33 ft^3

V_{POST}= (0.02427)(20,821)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (505.33) - (62.67)

V_{DELTA}= 442.65 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1375.13 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 605 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.1 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 101.19 % = [(2.1 x 650) / 1,375] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 442.65 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #20

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **15,006** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(15,006 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(15,006 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): Not Directly-connected Paved Area
Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	15,006	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	15,006	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	15,006	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.01 in	S_{POST}=	$\frac{1000}{91} - 10$
Q_{POST}=	0.03948 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.01)]^2}{[(1.00 * 1.17)+(0.8 * 1.01)]} \times \frac{1ft}{12in}$
V_{GOAL}=	592.44 ft^3	V_{GOAL}=	(0.03948)(15,006)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	15,006	ft^2 =	0.34449 Acres
C_{POST} [10] =	0.46		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.03708 cfs

$Q_{TREATMENT}$= (0.2)(0.3445)(0.46)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \le C_{PRE}$ or $CN_{POST} \le CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	15,006	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	74
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 3.51 in

$S_{PRE} = \frac{1000}{74} - 10$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00301 ft

$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*3.51)]^2}{[(0.92*1.17)+(0.8*3.51)]} \times \frac{1ft}{12in}$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 45.17 ft^3

$V_{PRE} = (0.00301)(15{,}006)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.01 in

$S_{POST} = \frac{1000}{91} - 10$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03381 ft

$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.01)]^2}{[(0.92*1.17)+(0.8*1.01)]} \times \frac{1ft}{12in}$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 507.35 ft^3

$V_{POST} = (0.03381)(15{,}006)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

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Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (507.35) - (45.17)

V_{DELTA}= 462.18 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 1346.45 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 750.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 592 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	1.8 ft	Below perforated pipe if present
W =	27.4 ft	
L =	27.4 ft	

Solution:

7

Percent of Goal Achieved = 100.37 % = [(1.8 x 751) / 1,346] x 100

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 462.18 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

136

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #22

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **43,427** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(43,427 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(43,427 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	43,427	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	43,427	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.45 in	S_{POST}=	$\frac{1000}{87} - 10$
Q_{POST}=	0.02770 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.45)]^2}{[(1.00 * 1.17)+(0.8 * 1.45)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1202.93 ft^3	V_{GOAL}=	(0.02770)(43,427)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	43,427	ft^2 =	0.99695 Acres
C_{POST} [10] =	0.34		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= **0.07932 cfs**

$Q_{TREATMENT}$= (0.2)(0.9969)(0.34)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 390.84 ft^3

V_{PRE}= (0.00900)(43,427)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02304 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.45)]^2}{[(0.92*1.17)+(0.8*1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1000.56 ft^3

V_{POST}= (0.02304)(43,427)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,000.56) - (390.84)

V_{DELTA}= 609.72 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2733.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1274.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,203 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.2 ft	Below perforated pipe if present
W =	35.7 ft	
L =	35.7 ft	

Solution:

Percent of Goal Achieved = 102.56 % = [(2.2 x 1,274) / 2,734] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 609.72 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #22

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **43,427** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(43,427 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(43,427 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	43,427	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	43,427	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	87

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.45 in	S_{POST}=	$\frac{1000}{87} - 10$
Q_{POST}=	0.02770 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.45)]^2}{[(1.00 * 1.17)+(0.8 * 1.45)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1202.93 ft^3	V_{GOAL}=	(0.02770)(43,427)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

Input:

A_r =	43,427	ft^2 =	0.99695 Acres
C_{POST} [10] =	0.34		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07932 cfs

$Q_{TREATMENT}$= (0.2)(0.9969)(0.34)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	43,427	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	87

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 390.84 ft^3

V_{PRE}= (0.00900)(43,427)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.45 in

$$S_{POST} = \frac{1000}{87} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02304 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.45)]^2}{[(0.92*1.17)+(0.8*1.45)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1000.56 ft^3

V_{POST}= (0.02304)(43,427)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,000.56) - (390.84)

V_{DELTA}= 609.72 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2733.93 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1274.49 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,203 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.2 ft	Below perforated pipe if present
W =	35.7 ft	
L =	35.7 ft	

Solution:

Percent of Goal Achieved = 102.56 % = [(2.2 x 1,274) / 2,734] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 609.72 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #23

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **23,920** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(23,920 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(23,920 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**23,920**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**23,920**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**23,920**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	**C: 0.05 - 0.15 in/hr infiltration (transmission) rate**
Select post development ground cover description [5] =	**Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**
OR: Composite post development CN [9] =	**96**

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.46025** in	S_{POST}=	$\frac{1000}{96} - 10$
Q_{POST}=	**0.06297** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.46)]^2}{[(1.00 * 1.17)+(0.8 * 0.46)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**1506.24** ft^3	V_{GOAL}=	(0.06297)(23,920)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	23,920	ft^2 =	0.54913 Acres
C_{POST} [10] =	0.62		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07967 cfs

$Q_{TREATMENT}$= (0.2)(0.5491)(0.62)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	23,920	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 215.28 ft^3

V_{PRE}= (0.00900)(23,920)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.46025 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05591 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.46)]^2}{[(0.92*1.17)+(0.8*0.46)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1337.37 ft^3

V_{POST}= (0.05591)(23,920)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,337.37) - (215.28)

V_{DELTA}= 1122.09 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3423.28 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1128.96 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,506 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.1 ft	Below perforated pipe if present
W =	33.6 ft	
L =	33.6 ft	

Solution:

Percent of Goal Achieved = 102.23 % = [(3.1 x 1,129) / 3,423] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1122.09 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #24

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **34,991** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(34,991 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(34,991 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	34,991	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	34,991	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	34,991	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.76426 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04857 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.76)]^2}{[(1.00 * 1.17)+(0.8 * 0.76)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1699.51 ft^3	V_{GOAL}=	(0.04857)(34,991)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	34,991	ft^2 =	0.80328 Acres
C_{POST} [10] =	0.53		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.09962 cfs

$Q_{TREATMENT}$= (0.2)(0.8033)(0.53)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	34,991	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 314.92 ft^3

V_{PRE}= (0.00900)(34,991)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.76426 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04228 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.76)]^2}{[(0.92*1.17)+(0.8*0.76)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1479.42 ft^3

V_{POST}= (0.04228)(34,991)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,479.42) - (314.92)

V_{DELTA}= 1164.50 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3862.53 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 1369.00 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,700 ft^3

Percent of Goal Achieved = $\frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	2.8 ft	Below perforated pipe if present
W =	37.0 ft	
L =	37.0 ft	

Solution:

Percent of Goal Achieved = 100.66 % = [(2.8 x 1,369) / 3,863] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1164.50 ft^3

Percent of Requirement Achieved = $\frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #25

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **33,215** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(33,215 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(33,215 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	33,215	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	33,215	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,215	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 1.04 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03852 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 1.04)]^2}{[(1.00 * 1.17)+(0.8 * 1.04)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1279.44 ft^3

$V_{GOAL} = (0.03852)(33,215)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	33,215	ft^2 =	0.76251 Acres
C_{POST} [10] =	0.45		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.08029 cfs

$Q_{TREATMENT}$= (0.2)(0.7625)(0.45)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,215	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 298.94 ft^3

V_{PRE}= (0.00900)(33,215)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.04 in

$$S_{POST} = \frac{1000}{91} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03293 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.04)]^2}{[(0.92*1.17)+(0.8*1.04)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1093.77 ft^3

V_{POST}= (0.03293)(33,215)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,093.77) - (298.94)

V_{DELTA}= 794.83 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **2907.82** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **702.25** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,279** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.1 ft	Below perforated pipe if present
W =	26.5 ft	
L =	26.5 ft	

Solution:

Percent of Goal Achieved = **99.98** % = [(4.1 x 702) / 2,908] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= **794.83** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #26

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **51,446** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(51,446 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(51,446 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	51,446	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	51,446	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	51,446	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	92

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.86957 in	S_{POST}=	$\frac{1000}{92} - 10$
Q_{POST}=	0.04430 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.87)]^2}{[(1.00 * 1.17)+(0.8 * 0.87)]} \times \frac{1ft}{12in}$
V_{GOAL}=	2279.06 ft^3	V_{GOAL}=	(0.04430)(51,446)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	51,446	ft^2 =	1.18 Acres
C_{POST} [10] =	0.50		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.13818 cfs

$Q_{TREATMENT}$= (0.2)(1.18)(0.50)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	51,446	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	92

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 463.01 ft^3

V_{PRE}= (0.00900)(51,446)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.86957 in

$$S_{POST} = \frac{1000}{92} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03829 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.87)]^2}{[(0.92*1.17)+(0.8*0.87)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1969.87 ft^3

V_{POST}= (0.03829)(51,446)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,969.87) - (463.01)

V_{DELTA}= 1506.85 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **5179.68** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **1036.84** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **2,279** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	5.0 ft	Below perforated pipe if present
W =	32.2 ft	
L =	32.2 ft	

Solution:

Percent of Goal Achieved = **100.09** % = [(5.0 x 1,037) / 5,180] x 100

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INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= **1506.85** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #27

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **39,558** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(39,558 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(39,558 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] *Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.*

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	39,558	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	39,558	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,558	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	91

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.05 in	S_{POST}=	$\frac{1000}{91} - 10$
Q_{POST}=	0.03821 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.05)]^2}{[(1.00 * 1.17)+(0.8 * 1.05)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1511.51 ft^3	V_{GOAL}=	(0.03821)(39,558)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	39,558	ft^2 =	0.90813 Acres
C_{POST} [10] =	0.45		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.09563 cfs

$Q_{TREATMENT}$= (0.2)(0.9081)(0.45)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.
($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	39,558	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	91

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$S_{PRE} = \frac{1000}{80} - 10$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 356.02 ft^3

V_{PRE}= (0.00900)(39,558)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.05 in

$S_{POST} = \frac{1000}{91} - 10$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.03264 ft

$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.05)]^2}{[(0.92*1.17)+(0.8*1.05)]} \times \frac{1ft}{12in}$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1291.17 ft^3

V_{POST}= (0.03264)(39,558)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,291.17) - (356.02)

V_{DELTA}= 935.15 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **3435.25** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **973.44** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,512** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	3.5 ft	Below perforated pipe if present
W =	31.2 ft	
L =	31.2 ft	

Solution:

Percent of Goal Achieved = **100.31** % = [(3.5 x 973) / 3,435] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= **935.15** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #28

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **33,681** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(33,681 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(33,681 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	33,681	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	33,681	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,681	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	89

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	1.20 in	S_{POST}=	$\frac{1000}{89} - 10$
Q_{POST}=	0.03384 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 1.20)]^2}{[(1.00 * 1.17)+(0.8 * 1.20)]} \times \frac{1ft}{12in}$
V_{GOAL}=	1139.77 ft^3	V_{GOAL}=	(0.03384)(33,681)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)
C_{POST} = Rational method runoff coefficient for the developed condition[10]
A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)
K = Seasonal Precipitation Factor[7]

Input:

A_r =	33,681	ft^2 =	0.77321 Acres
C_{POST} [10] =	0.41		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07418 cfs

$Q_{TREATMENT}$= (0.2)(0.7732)(0.41)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92
K= Seasonal Precipitation Factor [7]

0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	33,681	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	89

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 303.13 ft^3

$V_{PRE} = (0.00900)(33,681)$

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 1.20 in

$$S_{POST} = \frac{1000}{89} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.02863 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*1.20)]^2}{[(0.92*1.17)+(0.8*1.20)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 964.29 ft^3

$V_{POST} = (0.02863)(33,681)$

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (964.29) - (303.13)

V_{DELTA}= 661.16 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 2590.38 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 650.25 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,140 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	25.5 ft	
L =	25.5 ft	

Solution:

Percent of Goal Achieved = 100.41 % = [(4.0 x 650) / 2,590] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = 661.16 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #29

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **22,085** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(22,085 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(22,085 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	22,085	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	22,085	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$V = (Q)(A_r)$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,085	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	96

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}= 0.41667 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.06526 ft

$$Q_{POST} = \frac{[(1.00 * 1.17)-(0.2 * 0.42)]^2}{[(1.00 * 1.17)+(0.8 * 0.42)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{GOAL}= 1441.27 ft^3

$V_{GOAL} = (0.06526)(22,085)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Input:

A_r =	22,085	ft^2 =	0.50700 Acres
C_{POST} [10] =	0.63		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07474 cfs

$Q_{TREATMENT}$= (0.2)(0.5070)(0.63)(1.17)

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	22,085	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	96

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 198.77 ft^3

V_{PRE}= (0.00900)(22,085)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.41667 in

$$S_{POST} = \frac{1000}{96} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.05811 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.42)]^2}{[(0.92*1.17)+(0.8*0.42)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1283.36 ft^3

V_{POST}= (0.05811)(22,085)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,283.36) - (198.77)

V_{DELTA}= 1084.59 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

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LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = 3275.61 ft^3

$A_{LID\ GOAL}=(W)(L)$ = 750.76 ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = 1,441 ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.4 ft	Below perforated pipe if present
W =	27.4 ft	
L =	27.4 ft	

Solution:

Percent of Goal Achieved = 100.85 % = [(4.4 x 751) / 3,276] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = #DIV/0! ft^3

$A_{LID\ DELTA}=(W)(L)$ = 0.00 ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA}= 1084.59 ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = #DIV/0! % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #30

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **25,456** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: **Based on the total rooftop drainage area** - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(25,456 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: **Based on density (units per acre)** - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(25,456 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	**25,456**	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	**0.00**	ft^2
Reduced Tributary Area to be used for Calculations =	**25,456**	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	**25,456**	ft^2
K [7] =	**1.17**	

Drop down Lists

Select post development hydrologic soil type within tributary area[8] = **C: 0.05 - 0.15 in/hr infiltration (transmission) rate**

Select post development ground cover description [5] = **Impervious - Paved Parking, Rooftop, Driveways**

CN_{POST} =	**98**	
OR: Composite post development CN [9] =	**94**	

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	**0.68376** in	S_{POST}=	$\frac{1000}{94} - 10$
Q_{POST}=	**0.05198** ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.68)]^2}{[(1.00 * 1.17)+(0.8 * 0.68)]} \times \frac{1ft}{12in}$
V_{GOAL}=	**1323.20** ft^3	V_{GOAL}=	(0.05198)(25,456)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	25,456	ft^2 =	0.58439 Acres
C_{POST} [10] =	0.55		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.07521 cfs

$Q_{TREATMENT}$= (0.2)(0.5844)(0.55)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	25,456	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	94

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 229.10 ft^3

V_{PRE}= (0.00900)(25,456)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.68376 in

$$S_{POST} = \frac{1000}{94} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04548 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.68)]^2}{[(0.92*1.17)+(0.8*0.68)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 1157.74 ft^3

V_{POST}= (0.04548)(25,456)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (1,157.74) - (229.10)

V_{DELTA}= 928.63 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).

LID BMP Sizing Tool: 100% Volume Capture Goal; V_{GOAL}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **3007.28** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **761.76** ft^2

Where:
$V_{LID\ GOAL}$ = Required volume of soil in LID BMP.
$A_{LID\ GOAL}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{GOAL} = **1,323** ft^3

$$\text{Percent of Goal Achieved} = \frac{(D)(A_{LID\ GOAL})}{V_{LID\ GOAL}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.4	as a decimal
D =	4.0 ft	Below perforated pipe if present
W =	27.6 ft	
L =	27.6 ft	

Solution:

Percent of Goal Achieved = **101.32** % = [(4.0 x 762) / 3,007] x 100

7

INSTRUCTIONS:
The 100% volume capture sizing tool helps the designer appropriately size a LID BMP to achieve the design goal of 100% volume capture of the post development condition. Enter the percent porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Goal" equals 100%.

LID BMP Sizing Tool Delta Volume Capture Requirement: V_{DELTA}

NOTE:
LID Sizing Tool only applicable for volume based BMPs. Not required if site requires treatment only.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **#DIV/0!** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft^2

Where:
$V_{LID\ DELTA}$ = Required volume of soil in LID BMP
$A_{LID\ DELTA}$ = Footprint of LID BMP area for a given depth (below perforated pipe if present).

V_{DELTA} = **928.63** ft^3

$$\text{Percent of Requirement Achieved} = \frac{(D)(A_{LID\ DELTA})}{V_{LID\ DELTA}} \times 100$$

Where:
P= Porosity (enter as a decimal)
D= Depth below perforated pipe if present (in decimal feet)
W= Width (in decimal feet)
L= Length (in decimal feet)

Input:

P =	0.0	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Requirement Achieved = **#DIV/0!** % = #DIV/0!

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INSTRUCTIONS:
The Delta Volume Capture sizing tool helps the designer appropriately size a LID BMP to achieve the design requirement of the delta volume capture. Enter the percent of porosity of the specified soil and depth below perforated pipe (if present). The width and length entries will need to be interactively adjusted until "Percent of Requirement achieved" reaches 100%.

STORM WATER CALCULATOR*

***For example only, go to www.srcity.org/stormwaterlid for the latest version of the calculator**

Project:	2854.04
Address/Location:	Elnoka CCRC
Designer:	Brelje & Race Consulting Engineers
Date:	May 19, 2017
Inlet Number/Tributary Area/BMP:	DMA #31

NOTE: In order for this calculator to function properly **macros must be enabled**.

Physical Tributary Area that drains to Inlet/BMP = **14,563** ft²

This portion of the Storm water Calculator is designed to account for pollution prevention measures implemented on site. Additional information and description of these measures can be found in the Fact Sheets in Appendix F and in Chapter 4 of the narrative.

Disconnected Roof Drains [1]

Input:

Select disconnection condition: **Runoff is directed across landscape; Width of area: 5' to 9'**
Condition Factor = **0.25**

Method 1: Based on the total rooftop drainage area - to be used if rooftop information is known.

Input:

Enter amount of rooftop area that drain to disconnected downspouts = **0** ft²
Rooftop Area Factor = **0.00** Rooftop Area Factor= (Total Rooftop Disconnected Area/Tributary Area)

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Rooftop Area Factor)

(14,563 x 0.25 x 0.00) = **0.00** ft² **Rooftop Drainage Area Reduction**

Method 2: Based on density (units per acre) - to be used if rooftop information is unknown.

Input:

Enter percent of rooftop area to be disconnected from downspouts: **0** %

Select Density: **3-4** Units per Acre
Density Reduction Factor= **0.19**

NOTE:
Either Method 1 (rooftop area) or Method 2 (density) can be used. Providing input for both methods will cause an error. If rooftop area information is available, Method 1 should be used.

Solution:

Area reduction = (Physical Tributary Area x Conditional Factor x Percent Disconnected x Density Factor)

(14,563 x 0.25 x 0.00 x 0.19) = **0.00** ft² **Density Reduction**

[1] *See "Impervious Area Disconnection" Fact Sheet in Appendix E for further details.*

[2] See "Interceptor Trees" Fact Sheet in Appendix E for further details and see "Plant and Tree List" in Appendix G for approved trees.

[3] See "Vegetated Buffer Strip" and "Bovine Terrace" Fact Sheets in Appendix E for further details.

[4] *Total area reductions due to pollution Prevention Measures cannot exceed 50% of the physical Tributary Area.*

[5] *Per the "Urban Hydrology For Small Watersheds" TR-55 manual.*

[6] *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[7] *From Sonoma County Water Agency Flood Control Design Criteria.*

[8] *Hydrologic soil type based of infiltration rate of native soil as defined by "Urban Hydrology For Small Watersheds" TR-55 Manual.*

[9] Composite CN calculated per "Worksheet 2 Part 1 of the Urban Hydrology For Small Watersheds" TR-55 manual.

[10] From "Using Site Design to Meet Development Standards For Storm water Quality" by the Bay Area Storm water Management Agencies Association (BASMAA).

Paved Area Disconnection [1]

Paved Area Type (select from drop down list): **Not Directly-connected Paved Area**

Multiplier = 1

Enter area of alternatively designed paved area: 0 ft^2

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit for driveways designed to minimize runoff. Enter type and area of alternate design.

Interceptor Trees [2]

Number of new ***Evergreen Trees*** that qualify as interceptor trees= 0 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 0 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 0 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 0 ft^2 (100 ft^2/tree)

Enter square footage of qualifying **existing tree canopy** = 0 **Existing Tree Canopy**

Allowed reduction credit for existing tree canopy= 0 ft^2 Allowed credit for existing tree canopy = 50 % of actual canopy square footage

Area Reduction = 0 ft^2 = Sum of areas managed by evergreen + deciduous + existing canopy

NOTE:
Total Interceptor Area Reduction is limited to 50% of the physical tributary area.

INSTRUCTIONS:
Calculates the area reductions credit due to interceptor trees. Includes both new and existing trees. Enter the number of new deciduous and evergreen trees and the canopy area of existing trees.

Buffer Strips & Bovine Terraces [3]

Enter area draining to a Buffer Strip or Bovine Terrace = 0 ft^2

Buffer Factor = 0.7

Solution:

Area Reduction = (Area draining to Buffer Strip or Bovine Terrace) x (Buffer Factor) =

Area Reduction = 0.00 ft^2

INSTRUCTIONS:
Calculates the area reduction credit due to buffer strips and/or bovine terraces. Runoff Must be direct to these features as sheet flow. Enter the area draining to these features.

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Revised Tributary Area due to Pollution Prevention Measures

Physical Tributary Area =	14,563	ft^2
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft^2
Reduced Tributary Area to be used for Calculations =	14,563	ft^2

This worksheet calculates the quantity of storm water that needs to be addressed (captured and/or treated) to comply with the NPDES Storm Water Permit issued to the City of Santa Rosa and County of Sonoma by the North Coast Regional Water Quality Control Board.

Design Goal: 100% Volume Capture

Capture (infiltration and/or reuse) of 100% of the volume of runoff generated by the 85th percentile 24 hour storm event.

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12"}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = **1.00**
K= Seasonal Precipitation Factor [7]

***1.00 Per 2016 MS4 ***
0.92 inches in the Santa Rosa area, based on local historical data.

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,563	ft^2
K [7] =	1.17	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{POST} =	98
OR: Composite post development CN [9] =	93

NOTE:
Entering a calculated composite CN will override selections made from the pull down menu above. Calculation worksheet should be used for all composite calculations and included with submittal.

Solution:

Volume of storm water - Post Development

S_{POST}=	0.72961 in	S_{POST}=	$\frac{1000}{93} - 10$
Q_{POST}=	0.04982 ft	Q_{POST}=	$\frac{[(1.00 * 1.17)-(0.2 * 0.73)]^2}{[(1.00 * 1.17)+(0.8 * 0.73)]} \times \frac{1ft}{12in}$
V_{GOAL}=	725.53 ft^3	V_{GOAL}=	(0.04982)(14,563)

Where:
S_{POST}= Post development potential maximum retention after runoff (in).
Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*
V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft^3)

INSTRUCTIONS:
This Design Goal of 100% Capture is the ideal condition and if achieved satisfies all requirements so that no additional treatment is required and pages 4 and 5 of this calculator do not need to be completed.

NOTE:
If the Design Goal of 100% Capture is not achieved, 100% Treatment AND Volume Capture must be achieved and both pages 4 and 5 of this calculator need to be completed.

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Requirement 1: 100% Treatment

Treatment of 100% of the flow generated by 85th percentile 24 hour mean annual rain event (0.2 in/hr).

Formula:

$Q_{TREATMENT}$= (0.2 in/hr)(A_r)(C_{POST})(K) cfs

Where:

$Q_{TREATMENT}$= Design flow rate required to be treated (cfs)

C_{POST} = Rational method runoff coefficient for the developed condition[10]

A_r = Reduced Tributary Area including credit for Pollution Prevention Measures (in Acres)

K = Seasonal Precipitation Factor[7]

Input:

A_r =	14,563 ft^2 =	0.33432	Acres
C_{POST} [10] =	0.54		
K [7] =	1.2		

Solution:

$Q_{TREATMENT}$= 0.04224 cfs

$Q_{TREATMENT}$= (0.2)(0.3343)(0.54)(1.17)

C value note:

The C value used for this calculation is smaller than the value used for hydraulic Flood Control design.

The table of values can be found here

This smaller value should not be used to size the overflow bypass.

NOTE:

The Flow Rate calculated here should only be used to size the appropriate BMP. All associated overflow inlets and systems should be sized for the Flood Control event.

INSTRUCTIONS:

If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, this page of the calculator, AND Requirement 2- Volume Capture, page 5 of the calculator, **must** be achieved.

Requirement 2: Delta Volume Capture

No increase in volume of runoff leaving the site due to development for the 85th percentile 24 hour storm event.

INSTRUCTIONS:
If the Design Goal of 100% Capture on page 3 of this calculator is not achieved; then Requirement 1-100% Treatment, page 4 of the calculator, AND Requirement 2- Volume Capture, this page of the calculator, **must** be achieved.

NOTE:
If the amount of volume generated after development is less than or equal to that generated before development, Requirement 2-Volume Capture is not required.

($C_{POST} \leq C_{PRE}$ or $CN_{POST} \leq CN_{PRE}$)

Formulas:

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

Where:
S= Potential maximum retention after runoff (in)[5]
CN= Curve Number [5]

$$Q = \frac{[(P*K)-(0.2*S)]^2}{[(P*K)+(0.8*S)]} \times \frac{1ft}{12in}$$

Where:
Q= Runoff depth (ft) [6]
P= Precipitation (in) = 0.92 *0.92 inches in the Santa Rosa area, based on local historical data.*
K= Seasonal Precipitation Factor [7]

$$V = (Q)(A_r)$$

Where:
V= Volume of Storm Water to be Retained (ft^3)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft^2)

Input: (Pick data from drop down lists or enter calculated values)

A_r =	14,563	ft^2
K [7] =	1.2	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	C: 0.05 - 0.15 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Woods (50%), grass (50%) combination (orchard or tree farm) - Fair
Select post development ground cover description [5] =	Impervious - Paved Parking, Rooftop, Driveways
CN_{PRE} =	76
CN_{POST} =	90.3
OR Composite Predevelopment CN [9] =	80
Composite Post development CN [9] =	93

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 2.50 in

$$S_{PRE} = \frac{1000}{80} - 10$$

Where:
S_{PRE}= Pre development potential maximum retention after runoff (in).

Q_{PRE}= 0.00900 ft

$$Q_{PRE} = \frac{[(0.92*1.17)-(0.2*2.50)]^2}{[(0.92*1.17)+(0.8*2.50)]} \times \frac{1ft}{12in}$$

Q_{PRE}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{PRE}= 131.07 ft^3

V_{PRE}= (0.00900)(14,563)

V_{PRE}= Pre Development Volume of Storm Water Generated (ft^3)

Post Development Storm Water Runoff Volume

S_{POST}= 0.72961 in

$$S_{POST} = \frac{1000}{93} - 10$$

Where:
S_{POST}= Post development potential maximum retention after runoff (in).

Q_{POST}= 0.04345 ft

$$Q_{POST} = \frac{[(0.92*1.17)-(0.2*0.73)]^2}{[(0.92*1.17)+(0.8*0.73)]} \times \frac{1ft}{12in}$$

Q_{POST}= *Q in feet of depth as defined by the "Urban Hydrology For Small Watersheds" TR-55 Manual.*

V_{POST}= 632.76 ft^3

V_{POST}= (0.04345)(14,563)

V_{POST}= Post Development Volume of Storm Water Generated (ft^3)

Solution: Volume Capture Requirement

Increase in volume of storm water that must be retained onsite (may be infiltrated or reused).

Delta Volume Capture= $(V_{POST}-V_{PRE})$

Delta Volume Capture= (632.76) - (131.07)

V_{DELTA}= 501.70 ft^3

Where:
Delta Volume Capture= The increase in volume of storm water generated by the 85th percentile 24 hour storm event due to development that must be retained onsite (may be infiltrated or reused).