R.C.E. 49302 P.L.S. 6368

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STORMWATER MITIGATION REPORT

Haystack Pacifica Mixed Use Project
215 Weller Street
Petaluma, California
APN 007-143-003, -004, -007, -008, -014 and -015

Job No.: 121559

January 2016

Prepared by: ADF

TABLE OF CONTENTS

General Statements

This project falls under the California State Water Recourses Control Board's National Pollutant Discharge Elimination System (NPDES) Permit for small MS4's, Provision E.12. The Bay Area Stormwater Management Agencies Association (BASMAA) Post-Construction Manual was used in the development of the Projects stormwater controls.

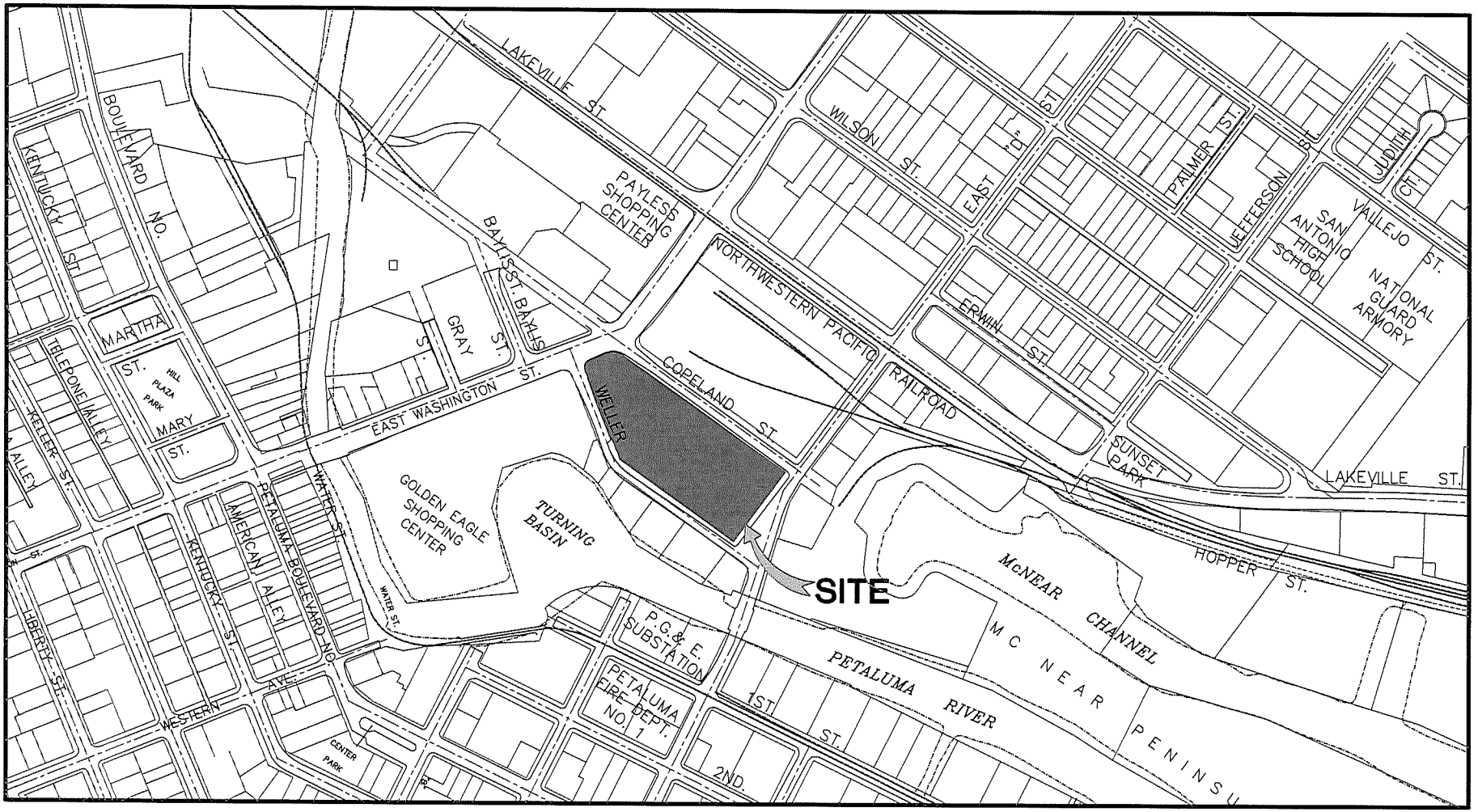
Post-Construction LID Measures

This project will incorporate several post-development measures to reduce chemical and other pollutant run-off prior to reaching the Petaluma River as well as reduce the stormwater run-off associated with the project:

1. Tree Plantings
   Based on the Master Landscape Plan an estimated 6 8 street trees will be planted and approximately 44 landscape trees will be planted within the project parking area and throughout the Project Site.

2. Road Side Bioretention
   Treatment and retention of the storm water run-off in the new public street is handled by the infiltration of the 85th percentile storm event through permeable gutter pans into a structural soil layer that is situated between the sidewalk and the lip of the gutter (see Bio-Retention Details on sheet LID-1). Calculations contained in this report are for the retention and treatment of the largest drainage area and will be adjusted to actual drainage basin areas at the time of compliance engineering.

3. Business Center and Central Square Commercial Center
   These residential spaces have very little pervious surface area in relationship to the roof, parking and sidewalk area. Therefore underground storage and dissipation is used to retain the 85th percentile stormwater runoff and allow it to dissipate back into the groundwater table in an area away from building foundations. Volumetric calculations utilize the City of Santa Rosa and Sonoma County Water Agencies Stormwater Calculator. Advanced Drainage Systems (ADS) manufactures a polyethylene pipe that has perforations throughout the full circumference of the pipe. We have used ADS' sizing calculator to determine the size and length of the bioretention bed required. Storm flows above the 85th percentile storm will present a hydraulic grade line above the top of the retention pipes and will allow excess flow to spill over a weir structure on the outlet side of the pipe network.



VICINITY MAP

N.T.S.

STORM WATER CALCULATOR*

*Go to www.srcity.org/stormwaterlid for the latest version of the calculator

Project:	Haystack North
Address/Location:	215 Weller Street
Designer:	ADF
Date:	January 20, 2016
Inlet Number/Tributary Area/BMP:	Half Site

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

Physical Tributary Area that drains to Inlet/BMP = **65,785** 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)

(65,785 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)

(65,785 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= 13 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 2600 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 13 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 1,300 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 = 3,900 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 =	65,785	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	3,900.00	ft²
Reduced Tributary Area to be used for Calculations =	61,885	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) = 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 (ft³)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft²)

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

A_r =	61,885	ft²
K [7] =	0.83	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{POST} =	98
OR: Composite post development CN [9] =	

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}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

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

Q_{POST}= 0.04724 ft

$$Q_{POST} = \frac{[(0.92 * 0.83)-(0.2 * 0.20)]^2}{[(0.92 * 0.83)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$$

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

V_{GOAL}= 2923.45 ft³

$V_{GOAL} = (0.04724)(61,885)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft³)

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 =	61,885 ft^2	=	1.42 Acres
C_{POST} [10] =	0.90		
K [7] =	0.8		

Solution:

$Q_{TREATMENT}$= 0.21225 cfs

$Q_{TREATMENT}$= (0.2)(1.42)(0.90)(0.83)

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 =	61,885	ft^2
K [7] =	0.8	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Streets and roads - Gravel (including right-of-way)
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{PRE} =	91
CN_{POST} =	98
OR Composite Predevelopment CN [9] =	
Composite Post development CN [9] =	

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 0.98901 in

$$S_{PRE} = \frac{1000}{91} - 10$$

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

Q_{PRE}= 0.01714 ft

$$Q_{PRE} = \frac{[(0.92*0.83)-(0.2*0.99)]^2}{[(0.92*0.83)+(0.8*0.99)]} \times \frac{1ft}{12in}$$

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

V_{PRE}= 1060.71 ft^3

V_{PRE}= (0.01714)(61,885)

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

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

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

Q_{POST}= 0.04724 ft

$$Q_{POST} = \frac{[(0.92*0.83)-(0.2*0.20)]^2}{[(0.92*0.83)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

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

V_{POST}= 2923.45 ft^3

V_{POST}= (0.04724)(61,885)

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= (2,923.45) - (1,060.71)

V_{DELTA}= 1862.74 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.

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%.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **9744.82** ft³

$A_{LID\ GOAL}=(W)(L)$ = **0.00** ft²

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} = **2,923** ft³

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 =	0.3		as a decimal
D =	0.0	ft	Below perforated pipe if present
W =	0.0	ft	
L =	0.0	ft	

Solution:

Percent of Goal Achieved = **0.00** **%** = [(0.0 x 0) / 9,745] x 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.

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%.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **1862.74** ft³

$A_{LID\ DELTA}=(W)(L)$ = **0.00** ft²

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}= **1862.74** ft³

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 =	1.0		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 = **0.00** **%** = [(0.0 x 0) / 1,863] x 100

THE MOST ADVANCED NAME IN DRAINAGE SYSTEMS
Version 7.8

STORMWATER RETENTION / DETENTION PIPE SYSTEM SIZING WORKSHEET

Enter or Select values in the Yellow fields ONLY

Project Name:	Haystack Buildings North
Location (City, State):	Petaluma
Prepared For:	Pacifica Companies
Date Prepared:	1/20/2016
Engineer:	ADF
Contractor:	
Regional Engineer:	
Area Sales Representative:	
Surface Application:	Parking Lot

UNITS	
Unit of Measure	(•) Imperial (ft, in) ( ) Metric (mm, m)

SYSTEM		
Joint Type	Plain End ST	
Design Storage Volume	1862	CF
Average Cover Height[4]	1.00	FT

HEADER	
Header Diameter	18
Number of Headers	2
Perforate Headers?	Yes
Include Header(s) in Storage Volume?	Yes

LATERALS

	Lateral Diameter (in)	Lateral Length (ft)	Number of Laterals	# of Sticks / Lateral	Approx. Length of End Stick
Group 1	18	117	2	6	19.3-ft
Group 2	18	117	2	6	19.3-ft
Group 3	60			0	0-ft

Perforate Laterals? Yes

BACKFILL

Stone Porosity? 30 %
*Enter "0" to not include the backfill in the storage volume

Additional Stone Layer Allowing Storage (ASV)? 12 in.

	STORAGE VOLUME COMPONENT				APPROXIMATE SYSTEM SIZE		EXCAVATION						
	Product Volume (CF)	Stone (CF)	ASV (CF)	Total System (CF)	Width (FT)	Length (FT)	Pipe Diameter (IN)	Width (FT)	Length (FT)	Disturbed Surface Area (SYD)	Excav-ation[2] (CYD)	Estimated Backfill[3] (CYD)	ASV (CYD)
Group 1	430	267	249	946	5	122	18	7	124	92	95	80	31
Group 2	430	267	249	946	5	122	18	7	124	92	95	80	31
Group 3	0	0	0	0	0	0	60	0	0	0	0	0	0
TOTALS	**860**	**534**	**499**	1,892.71						185	191	159	62

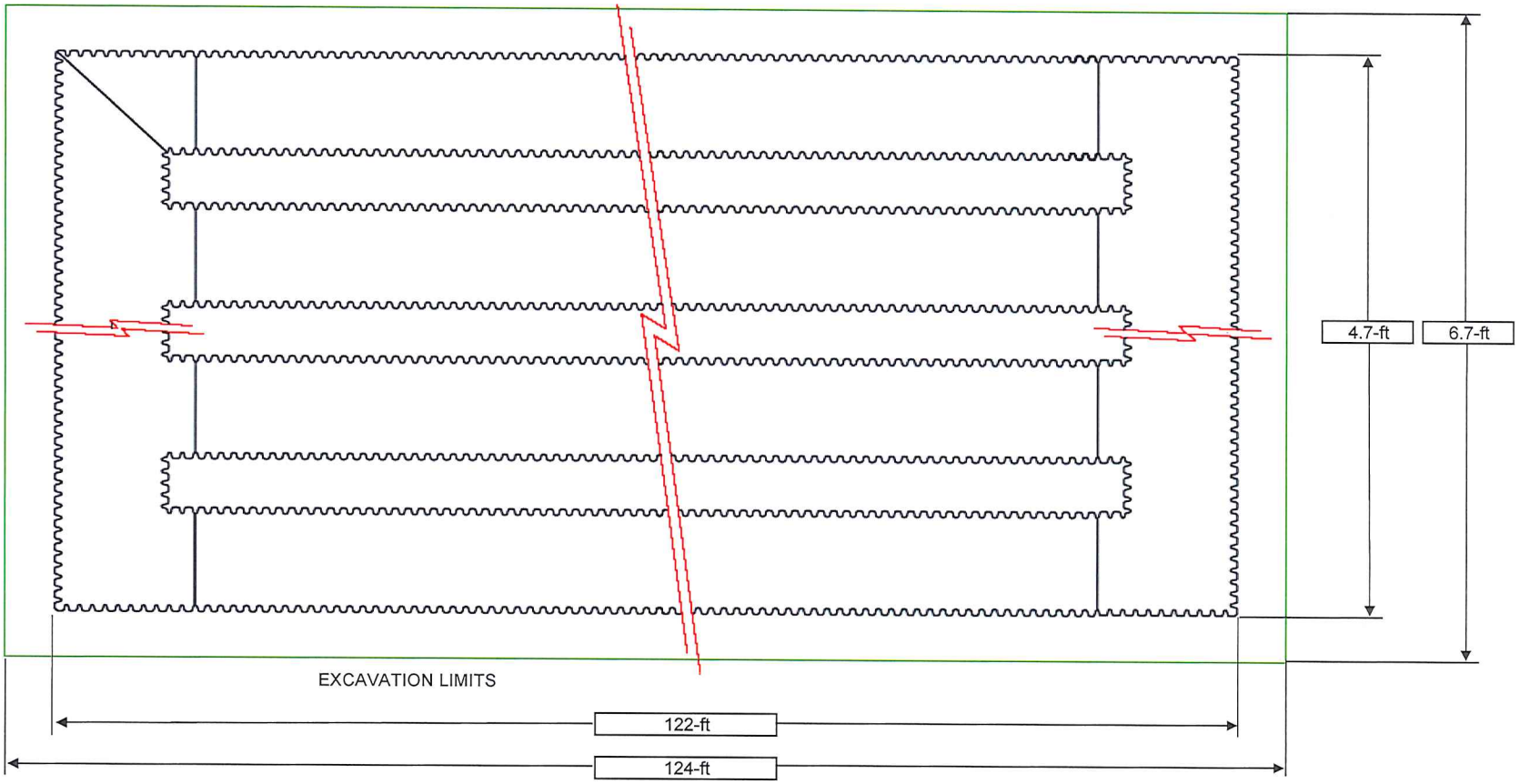
101.6% of the required storage

NOTES

1 - Full Stick: Assumed a standard lay length of 19'-8".
2 - Excavation: Based on manufacturer's recommended trench width and bedding depth. Estimated volumes assume a flat system based on the user-entered Average Cover Height.
3 - Backfill: Does not account for pipe corrugations - calculated for conservative quanitites. Not for use with take-offs or ordering purposes.
4 - Cover Height: For traffic installations, 1-ft of minimum cover is required for diameters 12-36", 2-ft for 42-60". Maximum cover shall not exceed 8-ft without consulting Applications Engineering.
5 - Bill of Materials: Does not differentiate between ST and WT fittings or between A and H profile connections. Determined on a project-specific basis.
6 - Quantities: Assumes all Groups are same diameter. Run separate calculations to determine quantities and costs for different Group diameters.

APPROXIMATE SYSTEM LAYOUT - GROUP 1

18-in Perforated system with 2 laterals, 117-ft long



Schmatic is for system dimension information only. Laterals (4) are depicted for illustration only - actual number of laterals is indicated above. Clean-outs, risers, and other add-ons maybe recommended but are not shown in this schematic
For perforated retention systems, a geotextile wrap may be recommended

STORM WATER CALCULATOR*

*Go to www.srcity.org/stormwaterlid for the latest version of the calculator

Project:	Haystack South
Address/Location:	215 Weller Street
Designer:	ADF
Date:	January 20, 2016
Inlet Number/Tributary Area/BMP:	Half Site

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

Physical Tributary Area that drains to Inlet/BMP = **67,110** 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)

(67,110 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)

(67,110 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.*

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[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= 13 **New Evergreen Trees**

Area Reduction due to new Evergreen Trees= 2600 ft^2 (200 ft^2/tree)

Number of new ***Deciduous Trees*** that qualify as interceptor trees= 13 **New Deciduous Trees**

Area Reduction due to new Deciduous Trees= 1,300 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 = 3,900 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 =	67,110	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	3,900.00	ft²
Reduced Tributary Area to be used for Calculations =	63,210	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) = 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 (ft³)
A_r= Reduced Tributary Area including credit for Pollution Prevention Measures (ft²)

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

A_r =	63,210	ft²
K [7] =	0.83	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{POST} =	98
OR: Composite post development CN [9] =	

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}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

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

Q_{POST}= 0.04724 ft

$$Q_{POST} = \frac{[(0.92 * 0.83)-(0.2 * 0.20)]^2}{[(0.92 * 0.83)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$$

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

V_{GOAL}= 2986.04 ft³

$V_{GOAL} = (0.04724)(63,210)$

V_{GOAL}= Post Development Volume of Storm Water to be Retained (ft³)

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 =	63,210 ft^2 =	1.45	Acres
C_{POST} [10] =	0.90		
K [7] =	0.8		

Solution:

$Q_{TREATMENT}$= 0.21679 cfs

$Q_{TREATMENT}$= (0.2)(1.45)(0.90)(0.83)

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 =	63,210	ft^2
K [7] =	0.8	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Streets and roads - Gravel (including right-of-way)
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{PRE} =	91
CN_{POST} =	98
OR Composite Predevelopment CN [9] =	
Composite Post development CN [9] =	

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 0.98901 in

$$S_{PRE} = \frac{1000}{91} - 10$$

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

Q_{PRE}= 0.01714 ft

$$Q_{PRE} = \frac{[(0.92*0.83)-(0.2*0.99)]^2}{[(0.92*0.83)+(0.8*0.99)]} \times \frac{1ft}{12in}$$

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

V_{PRE}= 1083.42 ft^3

V_{PRE}= (0.01714)(63,210)

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

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$$S_{POST} = \frac{1000}{98} - 10$$

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

Q_{POST}= 0.04724 ft

$$Q_{POST} = \frac{[(0.92*0.83)-(0.2*0.20)]^2}{[(0.92*0.83)+(0.8*0.20)]} \times \frac{1ft}{12in}$$

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

V_{POST}= 2986.04 ft^3

V_{POST}= (0.04724)(63,210)

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= (2,986.04) - (1,083.42)

V_{DELTA}= 1902.62 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).

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.

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%.

Formulas:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **9953.47** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **0.00** 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} = **2,986** 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 =	0.3	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Goal Achieved = **0.00** **%** = [(0.0 x 0) / 9,953] x 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.

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%.

Formulas:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **1902.62** 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}= **1902.62** 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 =	1.0	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 = **0.00** **%** = [(0.0 x 0) / 1,903] x 100

THE MOST ADVANCED NAME IN DRAINAGE SYSTEMS
Version 7.8

STORMWATER RETENTION / DETENTION PIPE SYSTEM SIZING WORKSHEET

Enter or Select values in the Yellow fields ONLY

UNITS	
Unit of Measure	(•) Imperial (ft, in) ( ) Metric (mm, m)

SYSTEM		
Joint Type	Plain End ST	
Design Storage Volume	1902	CF
Average Cover Height[4]	1.00	FT

Project Name:	Haystack Buildings South
Location (City, State):	Petaluma
Prepared For:	Pacifica Companies
Date Prepared:	1/20/2016
Engineer:	ADF
Contractor:	
Regional Engineer:	
Area Sales Representative:	
Surface Application:	Parking Lot

HEADER

Header Diameter	18
Number of Headers	2
Perforate Headers?	Yes
Include Header(s) in Storage Volume?	Yes

LATERALS

	Lateral Diameter (in)	Lateral Length (ft)	Number of Laterals	# of Sticks / Lateral	Approx. Length of End Stick
Group 1	18	120	2	7	2.6-ft
Group 2	18	120	2	7	2.6-ft
Group 3	60			0	0-ft

Perforate Laterals? Yes

BACKFILL

Stone Porosity? 30 %
*Enter "0" to not include the backfill in the storage volume

Additional Stone Layer Allowing Storage (ASV)? 12 in.

	STORAGE VOLUME COMPONENT				APPROXIMATE SYSTEM SIZE		EXCAVATION					
	Product Volume (CF)	Stone (CF)	ASV (CF)	Total System (CF)	Width (FT)	Length (FT)	Pipe Diameter (IN)	Width (FT)	Length (FT)	Disturbed Surface Area (SYD)	Excavation[2] (CYD)	Estimated Backfill[3] (CYD)	ASV (CYD)
Group 1	441	274	255	970	5	125	18	7	127	95	98	81	32
Group 2	441	274	255	970	5	125	18	7	127	95	98	81	32
Group 3	0	0	0	0	0	0	60	0	0	0	0	0	0
TOTALS	881	547	511	1,939.40						189	196	163	63

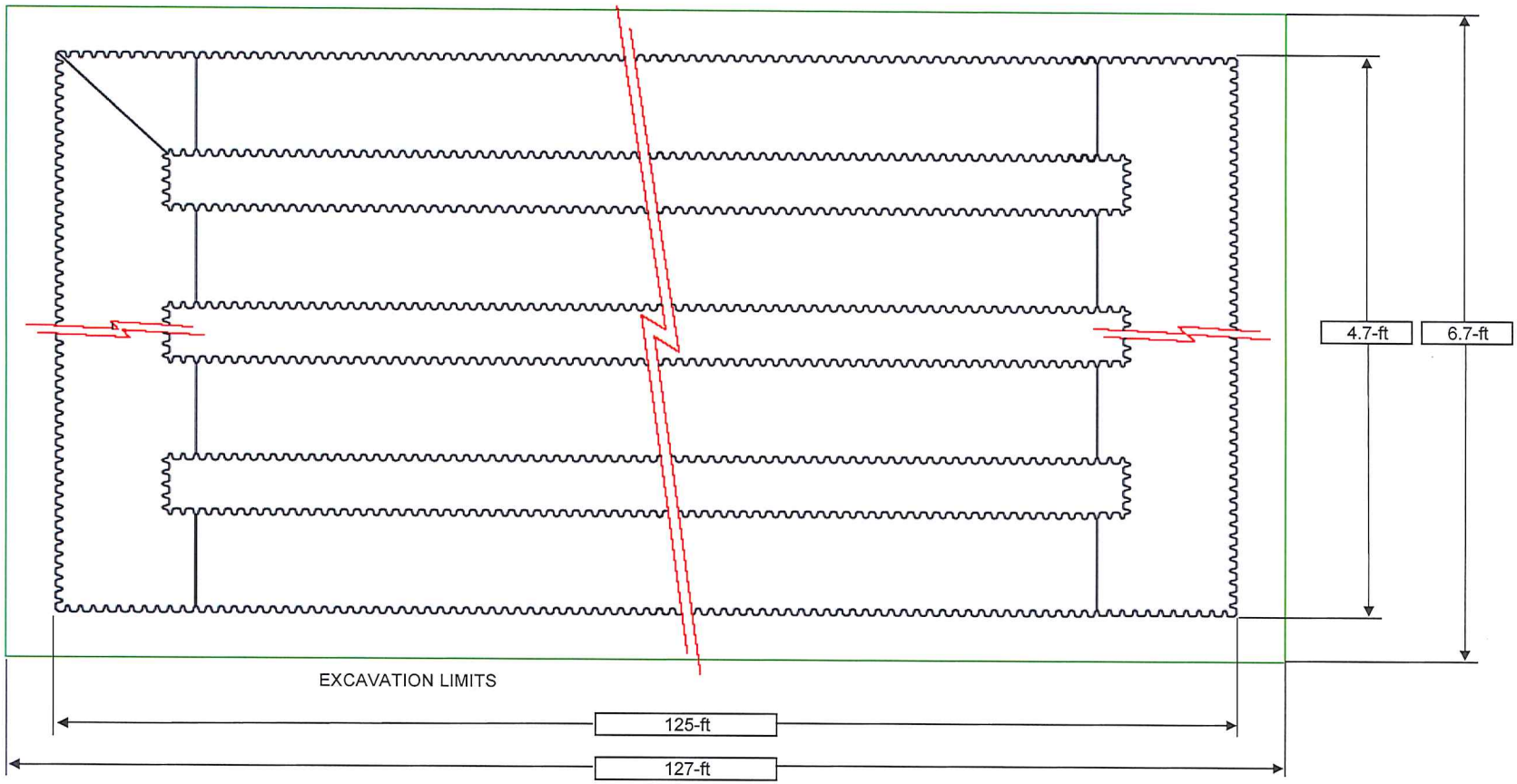
102% of the required storage

NOTES

1 - Full Stick: Assumed a standard lay length of 19'-8".
2 - Excavation: Based on manufacturer's recommended trench width and bedding depth. Estimated volumes assume a flat system based on the user-entered Average Cover Height.
3 - Backfill: Does not account for pipe corrugations - calculated for conservative quanitites. Not for use with take-offs or ordering purposes.
4 - Cover Height: For traffic installations, 1-ft of minimum cover is required for diameters 12-36", 2-ft for 42-60". Maximum cover shall not exceed 8-ft without consulting Applications Engineering.
5 - Bill of Materials: Does not differentiate between ST and WT fittings or between A and H profile connections. Determined on a project-specific basis.
6 - Quantities: Assumes all Groups are same diameter. Run separate calculations to determine quantities and costs for different Group diameters.

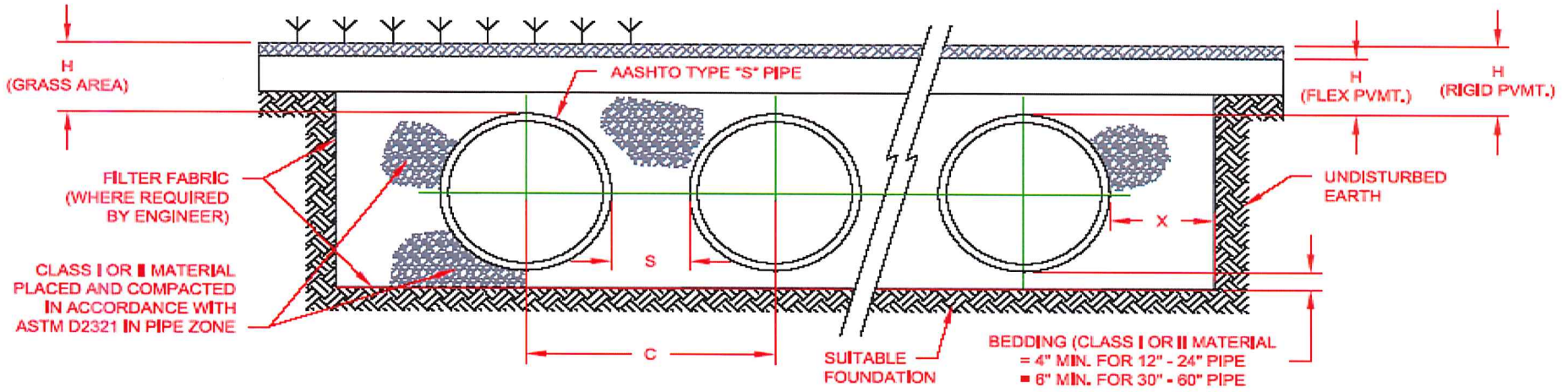
APPROXIMATE SYSTEM LAYOUT - GROUP 1

18-in Perforated system with 2 laterals, 120-ft long



Schmatic is for system dimension information only. Laterals (4) are depicted for illustration only - actual number of laterals is indicated above. Clean-outs, risers, and other add-ons maybe recommended but are not shown in this schematic

For perforated retention systems, a geotextile wrap may be recommended



NOTES:

1. ALL REFERENCES TO CLASS I OR II MATERIAL ARE PER ASTM D2321 "STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY FLOW APPLICATIONS", LATEST EDITION.

2. ALL RETENTION AND DETENTION SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH ASTM D2321, LATEST EDITION AND THE MANUFACTURER'S PUBLISHED INSTALLATION GUIDELINES.

3. MEASURES SHOULD BE TAKEN TO PREVENT THE MIGRATION OF NATIVE FINES INTO THE BACKFILL MATERIAL, WHEN REQUIRED. SEE ASTM D2321.

4. FILTER FABRIC: A GEOTEXTILE FABRIC MAY BE USED AS SPECIFIED BY THE ENGINEER TO PREVENT THE MIGRATION OF FINES FROM THE NATIVE SOIL INTO THE SELECT BACKFILL MATERIAL.

5. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE AND AT THE DISCRETION OF THE DESIGN ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.

6. BEDDING: SUITABLE MATERIAL SHALL BE CLASS I OR II. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER, MINIMUM BEDDING THICKNESS SHALL BE 4" (100mm) FOR 4"-24" (100mm-600mm); 6" (150mm) FOR 30"-60" (750mm-900mm).

7. INITIAL BACKFILL: SUITABLE MATERIAL SHALL BE CLASS I OR II IN THE PIPE ZONE EXTENDING NOT LESS THAN 6" ABOVE CROWN OF PIPE. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. MATERIAL SHALL BE INSTALLED AS REQUIRED IN ASTM D2321, LATEST EDITION.

8. MINIMUM COVER: MINIMUM COVER OVER ALL RETENTION/DETENTION SYSTEMS IN NON-TRAFFIC APPLICATIONS (GRASS OR LANDSCAPE AREAS) IS 12" FROM TOP OF PIPE TO GROUND SURFACE. ADDITIONAL COVER MAY BE REQUIRED TO PREVENT FLOATATION. FOR TRAFFIC APPLICATIONS, MINIMUM COVER IS 12" UPTO 36" DIAMETER PIPE AND 24" OF COVER FOR 42" - 60" DIAMETER PIPE, MEASURED FROM TOP OF PIPE TO BOTTOM OF FLEXIBLE PAVEMENT OR TO TOP OF RIGID PAVEMENT.

NOMINAL DIAMETER	NOMINAL O.D.	TYPICAL SPACING "S"	TYPICAL SPACING "C"	TYPICAL SIDE WALL "X"	H (NON-TRAFFIC)	H (TRAFFIC)
12" (300 MM)	14.5" (368 MM)	11" (279 MM)	25.4" (645 MM)	8" (203 MM)	12" (292 MM)	12" (292 MM)
15" (375 MM)	18" (457 MM)	12" (292 MM)	28.9" (734 MM)	8" (203 MM)	12" (292 MM)	12" (292 MM)
18" (450 MM)	21" (533 MM)	13" (330 MM)	33.9" (862 MM)	9" (229 MM)	12" (292 MM)	12" (292 MM)
24" (600 MM)	28" (711 MM)	13" (330 MM)	40.7" (1034 MM)	10" (254 MM)	12" (292 MM)	12" (292 MM)
30" (750 MM)	36" (914 MM)	18" (457 MM)	53.1" (1347 MM)	18" (457 MM)	12" (292 MM)	12" (292 MM)
36" (900 MM)	42" 1067 MM)	22" (559 MM)	63" (1600 MM)	18" (457 MM)	12" (292 MM)	12" (292 MM)
42" (1050 MM)	48" (1219 MM)	24" (610 MM)	71.9" (1826 MM)	18" (457 MM)	12" (292 MM)	24" (610 MM)
48" (1200 MM)	54" (1372 MM)	25" (635 MM)	78.5" (1994 MM)	18" (457 MM)	12" (292 MM)	24" (610 MM)
60" (1500 MM)	67" (1702 MM)	24" (610 MM)	90" (2286 MM)	18" (457 MM)	12" (292 MM)	24" (610 MM)

REV.	DESCRIPTION	BY	MM/DD/YY	CHK'D

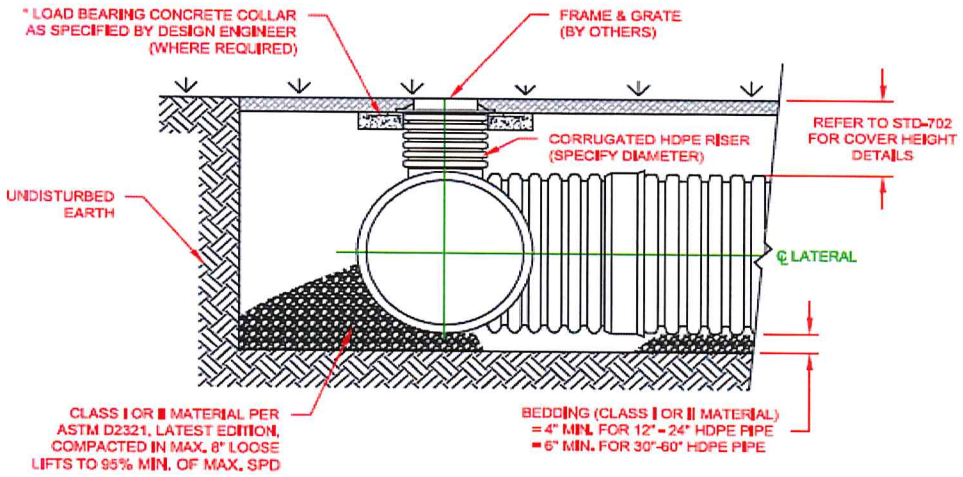
DIA. DET/RET SYSTEM

TYPICAL RET/DET CROSS SECTION DETAIL

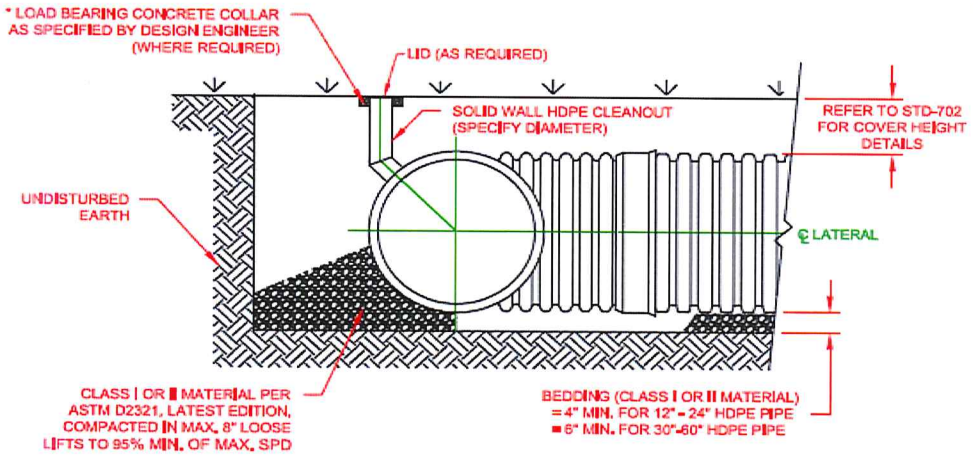
DRAWING NUMBER: STD-702

ADS
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OHIO 43026

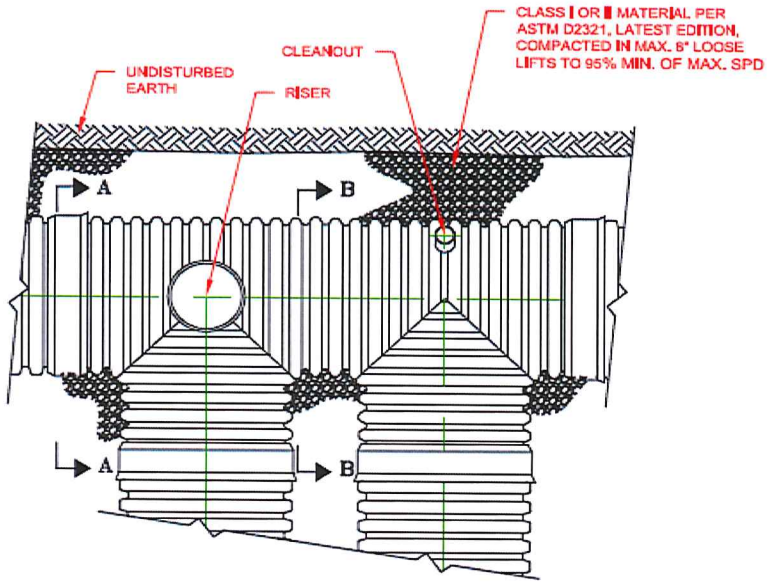
DRAWN BY: AWM
DATE: 07.25.06
SCALE: NTS
SHEET: OF



SECTION A-A



SECTION B-B



* LOAD BEARING CONCRETE COLLAR SHALL BE CONSTRUCTED IN TRAFFIC AREAS SUCH THAT THE LIVE LOAD IS TRANSMITTED TO THE SURROUNDING SOIL AND NOT DIRECTLY TO THE RISER.

REV.	DESCRIPTION	BY	MM/DD/YY	CHK'D
1	UPDATED DRAWING	TJR	03/13/07	CKS

TYPICAL RET/DET RISER/CLEAN-OUT DETAIL

DRAWING NUMBER: STD-703

ADS ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OHIO 43026

DRAWN BY	CRM
DATE	10/23/06
CHK'D BY	
SCALE	NTS
SHEET	OF

STORM WATER CALCULATOR*

*Go to www.srcity.org/stormwaterlid for the latest version of the calculator

Project:	Haystack
Address/Location:	215 Weller Street
Designer:	ADF
Date:	January 20, 2016
Inlet Number/Tributary Area/BMP:	Public Street

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

Physical Tributary Area that drains to Inlet/BMP = **9,311** 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)

(9,311 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)

(9,311 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 =	9,311	ft²
Tributary Area Reduction due to Pollution Prevention Measures [4] =	0.00	ft²
Reduced Tributary Area to be used for Calculations =	9,311	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.

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.

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) = 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 =	9,311	ft²
K [7] =	0.83	

Drop down Lists

Select post development hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{POST} =	98
OR: Composite post development CN [9] =	

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}= 0.20408 in

$S_{POST} = \frac{1000}{98} - 10$

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

Q_{POST}= 0.04724 ft

$Q_{POST} = \frac{[(0.92 * 0.83)-(0.2 * 0.20)]^2}{[(0.92 * 0.83)+(0.8 * 0.20)]} \times \frac{1ft}{12in}$

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

V_{GOAL}= 439.85 ft^3

$V_{GOAL} = (0.04724)(9,311)$

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

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 =	9,311	ft^2 =	0.21375 Acres
C_{POST} [10] =	0.90		
K [7] =	0.8		

Solution:

$Q_{TREATMENT}$= 0.03193 cfs

$Q_{TREATMENT}$= (0.2)(0.2138)(0.90)(0.83)

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 =	9,311	ft^2
K [7] =	0.8	

Drop down Lists

Select hydrologic soil type within tributary area [8] =	D: 0 - 0.05 in/hr infiltration (transmission) rate
Select predevelopment ground cover description [5] =	Streets and roads - Gravel (including right-of-way)
Select post development ground cover description [5] =	Streets and roads - Paved; curbs and gutters (excluding right-of-way)
CN_{PRE} =	91
CN_{POST} =	98
OR Composite Predevelopment CN [9] =	
Composite Post development CN [9] =	

Solution:

Pre Development Storm Water Runoff Volume

S_{PRE}= 0.98901 in

$S_{PRE} = \frac{1000}{91} - 10$

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

Q_{PRE}= 0.01714 ft

$Q_{PRE} = \frac{[(0.92*0.83)-(0.2*0.99)]^2}{[(0.92*0.83)+(0.8*0.99)]} \times \frac{1ft}{12in}$

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

V_{PRE}= 159.59 ft^3

$V_{PRE} = (0.01714)(9,311)$

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

Post Development Storm Water Runoff Volume

S_{POST}= 0.20408 in

$S_{POST} = \frac{1000}{98} - 10$

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

Q_{POST}= 0.04724 ft

$Q_{POST} = \frac{[(0.92*0.83)-(0.2*0.20)]^2}{[(0.92*0.83)+(0.8*0.20)]} \times \frac{1ft}{12in}$

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

V_{POST}= 439.85 ft^3

$V_{POST} = (0.04724)(9,311)$

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= (439.85) - (159.59)

V_{DELTA}= 280.26 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:

$V_{LID\ GOAL}=((V_{GOAL}))/(P)$ = **1466.17** ft^3

$A_{LID\ GOAL}=(W)(L)$ = **0.00** 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} = **440** 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 =	0.3	as a decimal
D =	0.0 ft	Below perforated pipe if present
W =	0.0 ft	
L =	0.0 ft	

Solution:

Percent of Goal Achieved = **0.00** **%** = [(0.0 x 0) / 1,466] 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:

$V_{LID\ DELTA}=((V_{DELTA}))/(P)$ = **934.20** ft^3

$A_{LID\ DELTA}=(W)(L)$ = **325.00** 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}= **280.26** 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 =	0.3	as a decimal
D =	3.0 ft	Below perforated pipe if present
W =	6.5 ft	
L =	50.0 ft	

Solution:

Percent of Requirement Achieved = **104.37** **%** = [(3.0 x 325) / 934] x 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%.