7-LOT SUBDIVISION AT 9440 Sagert Street

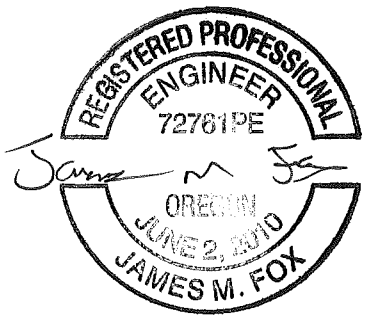
Tualatin, OR

BETTER WORLD HOMES, INC

J.O. SGL 16-072

October 25, 2016
REVISED FEBRUARY 14, 2017

PRELIMINARY STORM DRAINAGE REPORT



EXPIRES: 12/31/2017

SISUL ENGINEERING
A Division of Sisul Enterprises, Inc.
375 Portland Avenue
Gladstone, OR 97027
phone: (503) 657-0188
fax: (503) 657-5779

Narrative:

The project site is located at 9440 SW Sagert Street in Tualatin. The site is a corner lot at the intersection of SW 95th Avenue and Sagert Street with an existing house, paved driveway, and RV parking. The existing site is around 1.53 acres in size and slopes from the southern property line toward Sagert Street (northern property line) at an approximate grade of 4 percent.

The improvements include removing the RV parking and replacing it with a 50-foot wide public street dedication that widens for a cul-de-sac. Six additional lots will be created by this subdivision. Public utilities including sewer, water, and storm will be constructed in the proposed dedication.

Per Clean Water Services drainage reports must including an upstream and downstream analysis. The downstream analysis shall meet the requirements of R&O 07-20, section 2.04.2m is required. If the downstream conveyance does not have the capacity to convey the volume during a 25-year, 24-hour storm event, and the applicant is responsible for mitigating the flow as provided. The upstream analysis must meet the requirements of Section 2.04.2m. The downstream analysis will be performed after the sites water quality and conveyance calculations.

Upstream Analysis:

This project site has three public storm lines in the vicinity. On the sites western boundary is 95th Ave. It has a public storm line that caries flow north. Our storm runoff will connect to this storm line after the extended dry basin we are draining too.

The second storm line heads east in Sagert Street and starts on the north side of the street in front of the neighboring property located at 9440 (Tax Lot 4400) Sagert Street. Our development will not be modifying or adding impervious area to this storm system.

The third public storm line begins on our property but the first pipe segment will be abandoned. A new ditch inlet will be installed in the dry basin after the proposed water quality swale. The ditch inlet will be connected to the two-existing public flow through catch basins in Sagert street. This storm line will be analyzed in the water quality swale and the downstream conveyance calculations.

Directly south of the project site on the uphill side is an existing subdivision. Stormwater runoff from this subdivision is assumed to drain into the existing storm systems constructed at the time of that development.

On the eastern property line is a developable parcel. Metro Contours maps indicate flow will head towards Sagert Street or SW 93rd Avenue. The parcel to the east is assumed not to add any additional stormwater runoff to our site.

The site presents no issues with upstream stormwater drainage. All neighboring parcel are already developed or will flow to alternative drainage basins.

Water Quality Calculations

Water quality is required per Table 4-1 of CWS R&O 07-20. The table is based on the existing impervious area being disturbed by redevelopment.

Existing Impervious Area = 8,195 sf = 0.19 Acres
Ex. Impervious Area Disturbed = 2,315 sf = 0.05 Acres (new impervious area)

The existing impervious area is between 5,280 sf and 0.5 acres and the disturbed area is greater than 1,000 sf, according to CWS table 4-1 100% of the existing impervious area is required to be treated.

A water quality swale is proposed for all impervious area except the existing house. The water quality facility will be designed per Chapter 4 of CWS R&O 07-20.

Area:

Existing Impervious Area:

Existing driveway & RV parking	=	5,394 sf
Existing House	=	2,640 sf
Total existing area		8,034 sf

*Note actual impervious area of the existing house is 2,801 sf, for the calculations we are using 2,640 sf per dwelling unit CWS section 4.05.5.a. The noted impervious area for the existing house is why our area table above have slight variances.

Developed Impervious Area:

Remaining Existing driveway	=	2,395 sf
Lots 2-7	=	15,840 sf (0.36 acres)
Road Improvements	=	13,479 sf
Total new impervious area		31,714 sf

*Note new lots assumed to generate 2,640 sf per dwelling unit per CWS section 4.05.5.a

The existing house is assumed to be connected to an existing public storm line. That runs north in SW 95th Ave to an extended dry basin. It is assumed that the existing house is getting water quality treatment in the extended dry basin and is not included in our developed impervious area.

Water Quality Volume (WQV):

Per CWS, the water quality storm event is 0.36 inches in 4 hours.

$$WQV = \frac{0.36\ (in.) \times Area\ (s.f.)}{12\ (in/ft)} = \frac{0.36\ (in.) \times 31{,}714\ (s.f.)}{12\ (in/ft)} = 951.4\ cu.\ ft.$$

Water Quality Flow (WQF):

$$WQF = \frac{WQV\ (cu.\ ft)}{4\ (hours)} = \frac{951.4\ (cu.\ ft.)}{14{,}400\ (s)} = 0.066\ cfs$$

We are proposing to use a vegetated swale to provide water quality treatment. The flow master program will be used to model the vegetated swale. The swale will be 12' wide with a 2' bottom width. Side slope for the treatment area will 4:1. Side slopes on the freeboard area will vary from 4:1 to 2.5:1 to allow the swale a flatter slope than the proposed road.

Trapezoidal - 9400 Sagert Street

Comment: Water Quality Swale

Solve For.....Depth

Bottom Width...	2.00 ft	Velocity.....	**0.19 fps**
Lt Side Slope..	4.00:1 (H:V)	Flow Area.....	0.37 sf
Rt Side Slope..	4.00:1 (H:V)	Flow Top Width..	3.16 ft
Manning's n....	0.240	Wetted Perimeter	3.19 ft
Channel Slope..	0.0160 ft/ft	Critical Depth..	0.03 ft
Depth.....	**0.14 ft**	Critical Slope..	2.6873 ft/ft
Discharge.....	0.07 cfs	Froude Number...	0.10

Residence time = $\frac{\text{Swale Length}}{\text{Velocity}} = \frac{103\ \text{feet} * 1\ \text{min}}{0.19\ \text{fps} \quad 60\ \text{sec}}$ = **9.04 min**

The following list shows that the vegetated swale requirements in section 4.06.2 a & b, R&O 07-20 have been met.

CWS Requirements	Actual Swale Values	
Minimum residence time = 9 min.	Actual res. time = 9.04 min	.O.K.
Maximum design depth = 0.5'	Actual water depth = 0.14'	.O.K
Minimum length = 100'	Actual length = 100'	.O.K
Minimum slope = 0.5%	Actual slope = 1.60%	.O.K
Minimum bottom width = 2'	Actual bottom width = 2'	.O.K
Maximum treatment depth = 0.5'	Actual treat. depth = 0.14'	.O.K
Maximum 4:1 side slopes	Actual side slopes = 4:1	.O.K
Minimum Freeboard = 1.0'	Actual Freeboard = 1.36'	.O.K

Vegetated WQ Swale Summary:

The water depth during the water quality storm is 0.14', which is less than the 0.5' required. The residence time is 9.04 minutes, which is greater than the 9 minutes required. All other requirements can be met as shown above

Swale and Storm Drain Line Conveyance Calculations

The following calculations will show that the water quality swale and downstream storm drain line have the capacity to convey the 25-year storm event. The Santa Barbara Urban Hydrograph method will be used to calculate the runoff from the impervious area for the 25-year storm event.

Area:

Total new Impervious Area = 31,714 sf = 0.73 Acres

Runoff Curve Numbers:

Impervious Surfaces Hydrologic Group 'D' => 98

Rainfall Distribution: (See attached CWS Drawing No. 1280)

25 yr, 24-hour storm event Total depth = 3.9 inches

Time of Concentration – Post Developed:

Since small impervious, the minimum time of concentration of 5 minutes will be used.

Tc = 5 minutes

Post Development Hydrograph:

The post development hydrograph will be generated using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.21B)

25-year Runoff Rate – Post Development

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0,0,0.73,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN      A     CN
       0.7        .0    .0     .7   98.0         5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      0.75           7.67           9712

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672d25.dev
```

Water Quality Manhole Sizing Calculations:

Per CWS Standard Drawing No. 240, the sump volume requirements are:

20 cf / 1.0 cfs of inflow

Per the calculations above the runoff for the 25-year storm event is 0.75 cfs. The sump volume requirements are calculated below:

0.75 cfs* (20 cf /1.0 cfs) = 15 cubic feet

The required sump volume for the water quality manhole is 15 cubic feet.

Per CWS Standard Drawing No. 240, the minimum sump volume is 58.9 cubic feet. Therefore, the minimum sump volume of 58.9 cubic feet will be used.

The sump depth will be 3.0' below the water quality structure, which is 4.5' below the invert elevation of the outlet pipe in the manhole.

Swale Rock Protection at Pipe Outfall Design to Swale:

For preliminary calculations we will assume outfall line from the sedimentation manhole to the water quality swale will be a 12" in size at a slope of 0.5%.

Circular Channel: Manning's Equation - 9400 Sagert Street

Comment: 10" Storm from SD5 to SD4

Solve For.....Actual Depth

Diameter.....	1.00 ft	Velocity.....	2.80 fps
Slope.....	0.0050 ft/ft	Flow Area.....	0.27 sf
Manning's n....	0.013	Critical Slope	0.0057 ft/ft
Discharge.....	0.75 cfs	Critical Depth	0.36 ft
Depth.....	**0.37 ft**	Percent Full..	37.40 %
		Froude Number.	0.94
		Full Capacity.	2.52 cfs
		QMAX @.94D....	2.71 cfs

The rip rap pad at the outfall of the 12" storm drain line will be designed per section 5.07.7, R&O 07-20. Table 5-5 will be used to size the rip rap pad. The velocity in the 12" pipe is 2.80 fps.

Per Table 5-5, with a velocity between 0 and 5 fps the requirements are:

Rip Rap	Class 50
Thickness	1.5'
Width	Diameter + 6 ft
Length	8 ft
Crown	1 ft over

The rip rap pad at the outfall of the 12' storm line is designed to meet the requirements above.

Vegetated Swale Conveyance Calculations:
Per section 4.06.2.a.6 R&O 07-20, the water quality swale must be able to convey the 25-year storm at a maximum velocity of 2.0 feet per second. The depth of flow will also be calculated to show that swale has adequate capacity to convey the 25-year storm event.

The 25 year post developed runoff from the impervious surfaces is 0.75 cfs. The flowmaster program will be used to model the swale.

Trapezoidal - 9400 Sagert Street

Comment: WQ Swale - 25 year storm event

Solve For.....Depth

Bottom Width...	2.00 ft	Velocity.....	0.37 fps
Lt Side Slope..	4.00:1 (H:V)	Flow Area.....	2.01 sf
Rt Side Slope..	4.00:1 (H:V)	Flow Top Width..	6.02 ft
Manning's n....	0.240	Wetted Perimeter	6.14 ft
Channel Slope..	0.0160 ft/ft	Critical Depth..	0.15 ft
Depth.....	**0.50 ft**	Critical Slope..	1.7287 ft/ft
Discharge.....	0.75 cfs	Froude Number...	0.11

The calculations above demonstrate a 25-year storm event has a velocity of 0.37 feet per second and a max depth of 0.50' in the water quality swale. The velocity is less than 2.0 feet per second, so it meets Cleanwater Services requirements. The swale will be a minimum of 1.50' deep and provides a foot of freeboard. Therefore, the swale has adequate capacity to convey the 25-year storm event.

Detention Calculations:

The proposed storm drain system for 9440 Sagert Street subdivision will outfall into a proposed water quality swale. The water quality swale will discharge into a dry basin designed to reduce a post developed 25-year stormwater event the existing 25-year storm event. Stormwater from the drybasin will be discharged into the existing public storm system in Sagert Street.

We will begin by determining the sites pre and post developed flow rate for a 25-year storm event.

Area:

Existing Area Breakdown:

Pervious area	= 59,012 sf - 1.35 acres
Impervious area	= 8,034 sf – 0.18 acres
Total area	= 67,027 sf - 1.54 acres

Post Developed Area Breakdown:

Pervious area	= 35,313 sf - 0.81 acres
Impervious area	= 31,714 sf - 0.73 acres
Total area	= 67,027 sf - 1.54 acres

Runoff Curve Numbers:

Impervious Surfaces	Hydrologic Group 'D' => 98
Pervious Surface grass	Hydrologic Group 'D' => 84

Rainfall Distribution: (See attached CWS Drawing No. 1280)

25 yr, 24-hour storm event Total depth = 3.9 inches

Pre-developed Time of Concentration:

Sheet Flow1: $T_1 = \frac{0.42\,(n_s L)^{0.8}}{(P_2)^{0.5} * (s_o)^{0.4}}$

$L = 50$ ft.

$P_2 = 2.5$ in.

$S_o = 0.064$ ft./ft.

$n_s = 0.15$ short grass

$T_1 = 3.99$ min.

Sheet flow limited to 50 feet per CWS subsection 5.05.2.f

Shallow Concentrated Flow: $T_2 = \frac{L}{60*(k_s * (S_o)^{0.5}} =$

$L = 284$ ft.

$S_o = 0.030$ (194.8-186.25) / 284

$K_s = 11$ (Short grass)

$T_2 = 2.48$ min.

$T_c = T_1 + T_2 = 3.99 + 2.48 =$ **6.48 min**

The existing T_c Covers the longest drainage path leading to the existing private catchbasin.

Post-developed Time of Concentration:

$T_c =$ **5.0 min**

Hydrographs:

The predeveloped and post development hydrograph will be generated using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.21B)

25-year Runoff Rate – Pre-Development

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
1.35,84,0.18,98,6.48

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN     A     CN
       1.5       1.4    84.0  .2    98.0        6.5

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      0.97           7.83           13582

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672e25.dev
```

25-year Runoff Rate – Post Development

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.81,84,0.73,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN     A     CN
       1.5       .8     84.0   0.7   98.0        5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      1.24           7.67           16426

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672p25.dev
```

The additional flow added by this development is the difference between post developed condition and pre-developed conditions.

Additional Flow = 1.24 cfs – 0.97 cfs = **0.27 cfs**

Detention Routing

For detention routing the post developed runoff rate from a SCS 1A 25-year storm event will be reduced 0.27 cfs to match existing. The routing data will be based upon the 25-year storm event calculated in the water quality section. Below is the post developed 25-year runoff rate previously calculated.

Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.21B) will be used for detention routing.

25-year Runoff Rate – Post Development

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0,0,0.73,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN      A     CN
       0.7        .0    .0     .7   98.0         5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      0.75           7.67           9712

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672d25.dev
```

```
RESERVOIR ROUTING INFLOW/OUTFLOW ROUTINE

SPECIFY [d:][path]filename[.ext] OF ROUTING DATA
1672det.det

DISPLAY ROUTING DATA (Y or N)? y

ROUTING DATA:

STAGE(FT)    DISCHARGE(CFS)    STORAGE(CU-FT)    PERM-AREA(SQ-FT)
    .40             .00               .0                .0
    .50             .05              12.1               .0
   1.00             .29              96.4               .0
   1.50             .39             226.6               .0
   2.00             .47             411.4               .0
   2.50             .54             660.1               .0

AVERAGE PERM-RATE:     .0 MINUTES/INCH

ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
1672d25
```

```
INFLOW/OUTFLOW ANALYSIS:

  PEAK-INFLOW(CFS)    PEAK-OUTFLOW(CFS)    OUTFLOW-VOL(CU-FT)
         .75                  .48                  9762

  INITIAL-STAGE(FT)   TIME-OF-PEAK(HRS)    PEAK-STAGE-ELEV(FT)
         .00                 8.00                 2.13

  PEAK STORAGE:       470 CU-FT

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
Money
```

For the proposed dry basin, a permeant pool 0.4 feet deep was used along with bottom base 4.5 feet by 14 feet. Side slopes were all design at 3:1 with the assumption landscape walls will be used above the detention zone. Please see the attached pond routing data.

The post developed flow rate was reduced **0.27 cfs** from 0.75 CFS to 0.48 cfs. Allowing us to match existing conditions.

Downstream Conveyance Calculations:

Per section 2.04.2.m.3.A of CWS R&0 07-20 each development constructing new impervious surface of greater than 5,280 square feet, or collecting and discharging greater than 5,280 square feet of impervious area, except for the construction of a detached single family dwelling the design engineer shall perform a capacity and condition analysis of the existing downstream storm facilities and conveyance elements receiving flow from the proposed development

CWS subsection 2.04.2.m.3 notes the downstream analysis shall extend downstream to a point in the drainage system where the additional flow from proposed development site constitutes 10 percent or less of the total tributary. Once we are less than 10 percent of the total tributary we must carry the downstream analysis ¼ mile or until the flow constitutes less than 5 percent of the total tributary drainage flow. We will start the downstream analysis by evaluating existing and proposed conditions to determine the additional flow added by our development.

The additional flow added by this development is the difference between post developed conditions and pre-developed conditions.

Additional Flow = Post developed -Predeveloped – Detention reduction
Additional Flow = 1.24 cfs – 0.97 cfs – 0.27 cfs = **0.0 cfs**

Downstream conveyance explanation:

The proposed storm drain system for 9440 Sagert Street subdivision will outfall into a proposed water quality swale that flows into a stormwater culvert. The culvert pass through a 15-foot public stormwater easement before discharged into a detention pond. From the detention pond stormwater is discharge into the existing public storm system. Stormwater will start by being directed through two existing flow through catchbains located in Sagert street that discharge into an existing public water quality and detention facility.

Discharge from the water quality and detention facility is released into the existing public storm system in SW 95th Avenue. Stormwater will travel north through a series of pipes in SW 95th Avenue until its released into a 2nd stormwater facility.

Catchbasin notations shown are based upon topographic survey provided by Northwest Surveying. Invert elevation are based upon data provided by surveyor in topographic survey. Pipe lengths are based on distance measured in AutoCAD drawings. Manholes were assigned a number to provide clarity to our current downstream location.

12" Storm Line from Pond DI To Catchbasin SD4:

The proposed 12" PVC storm drain line from the detention pond's proposed ditch inlet will flow to public catchbasin (SD4). Based upon detention routing data the ditch inlet rim elevation will be around 183.5 and SD4 invert elevation in is 182.6. The distance between the catchbasin measures 12 feet.

$$\text{10" pipe slope} = \frac{\text{Elevation Difference} = (183.5-182.6)}{\text{Pipe Length}} = \frac{}{12} = 0.075 \text{ ft/ft}$$

The slope of the pipe is 7.50%. The calculations on the next page show that the pipe has adequate capacity to convey the 25-year storm event.

Per the detention calculations, the 25-year runoff rate is 0.48 cfs. The flowmaster program will be used to model this pipe segment.

Circular Channel: Manning's Equation - 9400 Sagert Street

Comment: 12" Storm from SD5 to SD4

Solve For.....Actual Depth

Diameter.....	1.00 ft	Velocity.....	6.44 fps
Slope.....	0.075 ft/ft	Flow Area.....	0.07 sf
Manning's n....	0.013	Critical Slope	0.0056 ft/ft
Discharge.....	0.48 cfs	Critical Depth	0.29 ft
Depth.....	**0.15 ft**	Percent Full..	15.09 %
		Froude Number.	3.52
		Full Capacity.	9.76 cfs
		QMAX @.94D....	10.50 cfs

The depth of flow during the 25-year storm event is 0.15 feet, therefore the pipe has adequate capacity.

12" Storm Line from Catchbasin SD4 to Catchbasin SD3:

Catchbasin SD4 collects stormwater runoff from half the right of way of Sagert street (390 feet in length) and about 50 feet worth of right of way 95th Ave. It is assumed that Tax Lot 4,400 flows flow into Sagert Southern Basin and has 2,630 sf of impervious area. The calculations below determine the existing flow rate entering catchbasin SD4.

Areas: The calculations will be performed based upon existing conditions.

Sagert Southern Basin Drainage Area:

Sagert Impervious area	=	1,103 sf - 0.025 acres
Sagert Pervious area	=	11,197 sf - 0.257 acres
Total basin area	=	12,300 sf - 0.282 acres

TL 4440 & TL 12300 Basin Area:

Impervious area	=	2,630 sf - 0.060 acres
Pervious area	=	9,673 sf - 0.222 acres
Total basin area		12,313 sf – 0.282 acres

Combined Drainage Basin Area:

Impervious area	=	3,733 sf - 0.086 acres
Pervious area	=	20,870 sf - 0.479 acres
Total basin area		24,613 sf - 0.745 acres

Rainfall: (See attached CWS Drawing No. 1280)

25-year, 24 Hour Rainfall Depth = 3.90 inches

Time of Concentration:

Sheet Flow1: $T_1 = \frac{0.42\,(n_s L)^{0.8}}{(P_2)^{0.5} * (s_o)^{0.4}}$

$L = 258$ ft.
$P_2 = 2.5$ in.
$S_o = 0.009$ ft./ft.
$n_s = 0.012$ gutter

$T_1 = 4.03$ min => use 5 min.

Soil Type and Hydrologic Group:

Per the Soil Survey for Washington County, there are two soil types at the site (see attached soil survey sheets).

1 Aloha Silt loam - Hydrologic Group C/D
15 Dayton silt loam - Hydrologic Group D

25-year Runoff Rate – Post Development

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.479,84,0.086,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN     A     CN
       0.6        .5   84.0    .1    98.0         5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      0.20           7.67           6907

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672d252.dev
```

The onsite conveyance calculations determined the 25-year peak runoff rate released from the detention pond is 0.48 cfs. The detention pond doesn't collect the sites entire post developed runoff. Under the conveyance section it was determined the post developed 25-year runoff rate was 1.24 cfs. The detention pond reduced the runoff rate from the impervious area by 0.27 cfs, from 0.75 cfs to 0.48 cfs, to match existing flow rates. However, this still leaves the runoff from the previous area unaccounted for. The pervious areas flow rate of 0.49 cfs will be introduced at existing catchbasin SD4.

Pervious Area Peak = Post developed total – impervious = 1.24 cfs – 0.75 cfs = 0.49 cfs

The total 25-year peak flow rate passing through catchbasin SD4 is the combination of the pervious area peak, detention pond peak, and Sagert Southern basin. This gives a total flow rate of 0.96 cfs

Total Peak Flow Rate = 0.49 cfs + 0.48 cfs + 0.2 cfs = **0.96 cfs**

The 12" PVC storm drain line from the catchbasin (SD4) flows to the catchbasin SD3. SD4 invert elevation is 182.3 and SD3 invert elevation is 182.2. The distance between catchbasins is 42.9 feet.

$$12\text{" pipe slope} = \frac{\text{Elevation Difference} = (182.3-182.2)}{\text{Pipe Length}} = \frac{}{42} = 0.0024 \text{ ft/ft}$$

The slope of the pipe is 0.23%. The calculations show that the pipe has adequate capacity to convey the 25-year storm event.

The flow master program will be used to model the pipe

Circular Channel: Manning's Equation - 9400 Sagert Street

Comment: 12" Storm from SD4 to SD3

Solve For.....Actual Depth

Diameter.....	1.00 ft	Velocity.....	2.24 fps
Slope.....	0.0023 ft/ft	Flow Area.....	0.43 sf
Manning's n....	0.013	Critical Slope	0.0058 ft/ft
Discharge.....	0.96 cfs	Critical Depth	0.41 ft
Depth.....	**0.54 ft**	Percent Full..	53.61 %
		Froude Number.	0.60
		Full Capacity.	1.71 cfs
		QMAX @.94D....	1.84 cfs

The depth of flow during the 25-year storm event is 0.54 feet, therefore the pipe has adequate capacity.

15" Storm Line from Catchbasin SD3 to Extended dry pond:

The drainage basin area entering the conveyance system will increase at existing catchbasin SD3. Catchbasin SD3 collects stormwater runoff from the northern half the right of way of Sagert street (390 feet in length). Below are the calculations determining the existing flow rate entering the conveyance system at catchbasin SD3.

Areas: The calculations will be performed based upon existing conditions.

Sagert Half Street Drainage Area:

Impervious area	=	1,418 sf - 0.033 acres
Pervious area	=	9,482 sf - 0.217 acres
Total basin area		10,900 sf - 0.250 acres

Time of Concentration:

The basin is assumed to have the same time of concentration as calculated for the drainage basin to catchbasin SD4

Tc = 5 minutes

25-year Runoff Rate – Post Development

The site analysis will be performed using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.21B)

```
------------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.033,84,0.217,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN     A     CN
       0.3        .0   84.0    .2    98.0         5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      0.24           7.67           3160

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
1672d253.dev
```

The previous calculated flow was 0.96 cfs. We are adding an additional 0.24 cfs to peak flow at catchbasin SD3. This provides a total flow rate of 1.20 cfs

Total flow = 0.96 cfs + 0.24 cfs = 1.20 cfs

The 15" storm drain line from the catchbasin (SD3) flows to the extended dry pond. The provided topographic survey does not provide the outfall location or invert elevation. For safety minimum allowed pipe slope of 0.15% was assumed

The flowmaster program will be used to model the pipe

```
Circular Channel: Manning's Equation - 9400 Sagert Street

Comment: 15" Storm from SD3 to Pond Outfall

 Solve For......Actual Depth

 Diameter.......    1.25 ft          Velocity......    2.02 fps
 Slope..........    0.0015 ft/ft     Flow Area.....    0.59 sf
 Manning's n....    0.013            Critical Slope    0.0052 ft/ft
 Discharge......    1.20 cfs         Critical Depth    0.43 ft
 Depth..........    0.61 ft          Percent Full..    48.48 %
                                     Froude Number.    0.52
                                     Full Capacity.    2.50 cfs
                                     QMAX @.94D....    2.69 cfs
```

The depth of flow during the 25-year storm event is 0.61 feet, therefore the pipe has adequate capacity based assumptions made.

The record drawings have a discrepancy with the surveyed datum over the pipe size existing SD3. The record drawings indicate the line from SD3 to the pond is only 12" in size. It also notes a slope of 0.83%. To verify there is no flow issues we will demonstrate that the 12" pipe noted in records drawing has adequate capacity.

The flowmaster program will be used to model the pipe

Circular Channel: Manning's Equation - 9400 Sagert Street

Comment: 12" Storm from SD3 to Pond Outfall -record drawings

Solve For.....Actual Depth

Diameter.....	1.00 ft	Velocity.....	3.82 fps
Slope.....	0.0083 ft/ft	Flow Area.....	0.31 sf
Manning's n....	0.013	Critical Slope	0.0060 ft/ft
Discharge.....	1.20 cfs	Critical Depth	0.46 ft
Depth.....	**0.42 ft**	Percent Full..	42.09 %
		Froude Number.	1.19
		Full Capacity.	3.25 cfs
		QMAX @.94D....	3.49 cfs

Dry Pond Outfall lines to SW 95th Ave:

Stormwater runoff exiting the existing water quality and detention facility will travel into one of the two connected ditch inlets. From the 2nd ditch inlets designed for a 25-year storm event water will flow through a 12" storm pipe to a detention manhole.

Per record drawings the outfall line from the ditch inlet to the detention manhole is a 12" pvc pipe with a slope of 2.9%. The pipe is 10 feet long.

Inside the detention manhole is an 18" orifice control system that discharges to an existing 12" public storm line. The 12" storm line drains into an existing manhole located in SW 95th Ave. We will refer to this manhole as SDMH D-1

Per record drawing the second pipe line is a 12" PVC pipe with a slope of 7.68%. The pipe is noted at 34 feet long.

Both pipes have adequate capacity based upon the record drawing flow calculations from SD3 to Pond. The two pipe segments leaving the detention pond are both 12", carrying the same flow, and have steeper slopes than the pipe analyzed in SD3 to pond.

SW 95th Ave:

Storm Manhole D-1 was constructed over an existing 12" storm line that conveys stormwater runoff from SW 95th Ave drainage basin. This SW 95th Ave drainage basin appears to starts at the intersection of SW Avery Street and drain north collecting stormwater runoff from 1310 feet improved right of way. In addition to the right of way it appears that SW 95th drainage basin is collecting stormwater from the school ground on the east (Tax Lot 102).

For the school ground, the area breakdown appears to be around 40% is impervious and 60% pervious. However, the provided record drawing for the school site indicate a detention pipe was installed. For these calculations, its assumed post developed flows were detained to predeveloped conditions.

The properties on the east side of SW 95th Ave between Avery and Sagert street are all developed and appear to drain to SW 93rd Ave. On the west side of SW 95th Ave, north of the schools is Tax Lot 100. Tax lot 100 is a grass field with a depression in the middle. For these calculations, its assumed Tax Lot 100 is infiltrating onsite.

SW 95th Ave Drainage Basin:

Impervious area	=	52,387 sf - 1.21 acres
Pervious area	=	36,671 sf - 0.84 acres
Total basin area		89,058 sf - 2.04 acres

Tax Lot 102 Area:

Pervious area	=	8.70 acres
Total basin area		8.70 acres

Combined Drainage area:

Impervious area	=	1.21 acres
Pervious area	=	9.53 acres
Total basin area		10.74 acres

Time of Concentration:

The major flow path would be through the school grounds. The school grounds impervious area is composed of buildings and parking lots, which convey stormwater runoff through a piped system to 95th Ave. A minimum time of concentration was assumed.

Tc = 5 minutes

25-year Runoff Rate – Post Development

The site analysis will be performed using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.21B)

```
------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
9.53,84,1.21,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS    TC(MINUTES)
                  A     CN      A     CN
       10.7       9.5   84.0    1.2   98.0        5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      7.09           7.67          95084

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
Sw 95th.dev
```

The previous calculated peak flow rate from the existing detention pond is 1.20 cfs. The existing 95th Ave drainage basin conveys an additional peak flow rate of 7.09 cfs to existing manhole D-1. The total peak flow rate leaving manhole D-1 is 8.29 cfs

Total 25-year Peak Flow Rate = 7.09 cfs + 1.20 cfs = 8.29 cfs

All pipes between where our calculations end and the next detention facility located at the rail road crossing of 95th Ave appear to be undersized. Please see attached capacity calculations.

Downstream Conveyance Summary:

Our calculations demonstrate that the conveyance system has enough capacity to carry the peak flow rate for 25-year storm event from our development to the nearest downstream extended dry basin. Stormwater will be detained in the existing dry basin and released to the existing storm system in SW 95th Avenue.

The stormwater drainage basin in 95th Avenue appears to be undersized. Our calculations indicate a larger pipe size is required. However, our project site does not contribute any additional flow to the existing drainage basin and should not be held responsible for correcting an existing issue.

Additional datum is required to perform a full analysis of the existing extended dry basin capacity and downstream conveyance.

SUPPLEMENTAL DATUM

Pond ROUTING DATA Sagert:

SGL 16-072

Given:

Pipe Diameter:	12.0	inches
Pipe Inv. Elev:	0.40	ft
Orifice #1 Diameter:	3 11/16	inches
Orifice #1 Elevation:	0.40	inches
Orifice #2 Diameter:		inches
Orifice #2 Elevation:		inches

	B	C	D	E		F	G	H	J
	Stage	Elevation (ft)	Surface Area (sq.ft)	Storage Volume (cu.ft.)		Pipe Capacity (cfs)	Orifice #1 Discharge (cfs)	Orifice #2 Discharge (cfs)	Actual Discharge (cfs)
Perm. Pool ->		0.00	63.00	0.00		-	-	-	-
		0.40	113.63	35.33		-	-	-	-
Detention -	1	0.40	113.63	0.00	0.00	0.000	0.000	0.000	0.000
Storage	2	0.50	127.50	12.06	1.29	0.045	0.117	0.000	0.045
Pond	3	1.00	210.00	96.43	6.28	2.134	0.286	0.000	0.286
	4	1.50	310.50	226.56		-	0.387	0.000	0.387
	5	2.00	429.00	411.43		-	0.467	0.000	0.467
	6	2.50	565.5	660.06		-	0.535	0.000	0.535

B Stage Number

C Water Surface Elevation.

D Water Surface Area @ given Elevation

E Storage Volume = [(Average Area) x (d Elevation)] + Previous Volume

ORIFCE $Q = 0.62 \times (\text{area}) \times (2 \times g \times h)^{1/2}$

F Capacity of Discharge Pipe

G Q = Orifice Eq.

H Q = Orifice Eq.

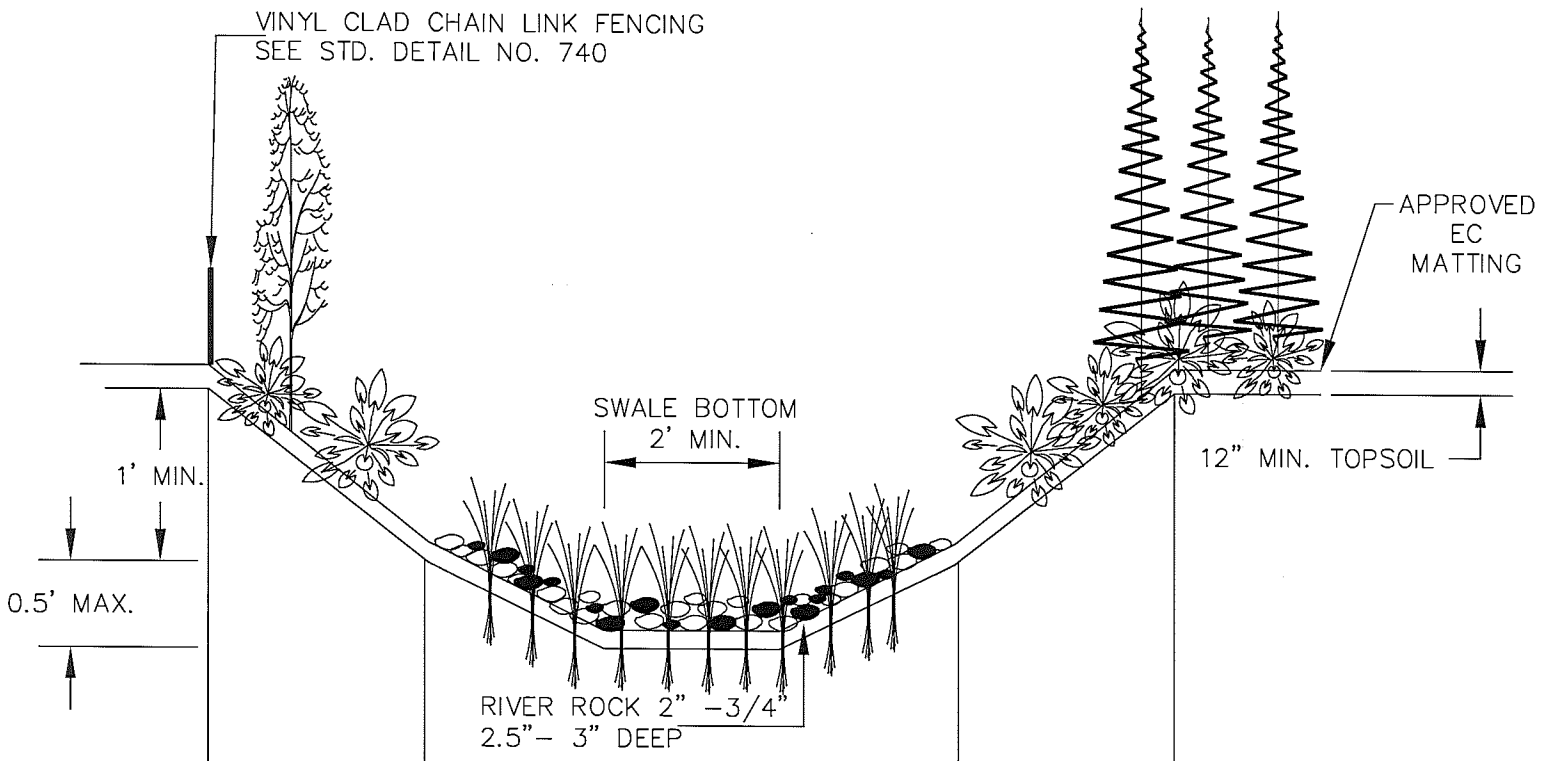
J Less of => columns F or columns G + H

Project:	7-Lot Subdivision at 9440 Sagert Street											% Pipe Capacity Used		
Project:	Stormwater Conveyance Calculation Check											0-82		Acceptable
Date:	2/14/2016											83 +		Upsize if City's
Calc'd By:	JMF											83 +		Awareness for Private
							Pipe Information and Calculations							
Design Section	Q (Calc'd) "Q"	Pipe Dia. (inch) "D"	Pipe Dia. (ft) "D"	Manning's number "n"	Slope "S" %	Slope "S"	Area Full (Calc'd) "Af"	Wetted Perimeter (Calc'd) "WPf"	Hydraulic Radius (Calc'd) "Rf"	Velocity Full (Calc'd) "Vf"	Flow Rate Full (Calc'd) "Qf"	% Pipe Capacity Used (Calc'd) "Q/Qf"	Velocity @ Q/Qf (Calc'd) "V"	Acceptable or Redesign Necessary
Downstream														
Ditch Inlet to SD4	0.48	10	0.83	0.013	1.38	0.0848	0.545	2.618	0.208	11.730	6.397	7.5%	0.88	Acceptable
Exist. SD4 to SD3	0.96	12	1.00	0.013	0.24	0.0024	0.785	3.142	0.250	2.219	1.743	55.1%	1.22	Acceptable
Exist SD3 to Pond	1.2	15	1.25	0.013	0.15	0.0015	1.227	3.927	0.313	2.044	2.509	47.8%	0.98	Acceptable
AB SD3 to Pond	1.2	12	1.00	0.013	0.83	0.0083	0.785	3.142	0.250	4.144	3.255	36.9%	1.53	Acceptable
Pond														
Outfall	1.2	12	1.00	0.013	2.9	0.0290	0.785	3.142	0.250	7.746	6.084	19.7%	1.53	Acceptable
Det MH to SDMH-D1	1.2	12	1	0.013	7.68	0.0768	0.785	3.142	0.250	12.605	9.900	12.1%	1.53	Acceptable
SDMH-D1-D2	8.29	12	1	0.013	2.62	0.0262	0.785	3.142	0.250	7.362	5.782	143.4%	10.56	Check Design
SDMH-D2-D3	8.29	12	1	0.013	2.56	0.0256	0.785	3.142	0.250	7.278	5.716	145.0%	10.56	Check Design
SDMH-D3-D4	8.29	15	1.25	0.013	1.58	0.0158	1.227	3.927	0.313	6.634	8.142	101.8%	6.76	Check Design
D4 - Pond 2	8.29	16	1.33	0.013	1.58	0.0158	1.396	4.189	0.333	6.926	9.671	85.7%	5.94	Check Design

WATER QUALITY SWALE

DRAWING NO. 700

REVISED 12-06



SWALE AREA	FREEBOARD AREA	TREATMENT AREA 6' MINIMUM WIDTH			FREEBOARD AREA	BUFFER/MITIGATION AREA
EC MATTING	ECONOJUTE*	COCONUT FIBER OR GEOJUTE PLUS*			ECONOJUTE*	ECONOJUTE* (S> 20%)
SEED MIX	LOW GROW MIX SEE NOTE #5	NONE			LOW GROW MIX SEE NOTE #5	AS APPROVED BY DISTRICT OR CITY
MAX. SLOPE	2.5:1	4:1	FLAT BOTTOM	4:1	2.5:1	NA

* OR AS APPROVED

NOTES:

1. REFER TO APPENDIX A, CWS DESIGN & CONSTRUCTION STANDARDS, FOR LANDSCAPING REQUIREMENTS INCLUDING TREE PLACEMENT, TOPSOIL AND PLANTING SPECIFICATIONS.
2. PROVIDE IRRIGATION AS APPROVED BY CWS.
3. JUTE MATTING- GEOJUTE PLUS IN TREATMENT AREA, ECONOJUTE FOR ALL OTHER AREAS, OR SIMILIAR FABRICS. COCONUT FIBER IS ALSO ACCEPTABLE.
4. 12-INCHES OF TOPSOIL SHALL BE PLACED THROUGHOUT THE WATER QUALITY TRACT.
5. FREEBOARD AREA SEED MIX, DWARF TALL FESCUE 40%, DWARF PERENIAL RYE 30%, CREEPING RED FESCUE 25%, COLONIAL BENT GRASS 5%. APPLY AT A RATE OF 120# / ACRE.

Clean Water Services
Our commitment is clear.

CONSTRUCTION

1. Water Quality Swale shall be over-excavated and filled to final grade with 12-inch amended topsoil. Topsoil amendments shall be garden compost, not conventional fertilizer amendments.
2. A biodegradable Erosion Control Matting shall be placed over the topsoil throughout the swale cross section, fabric shall be held in place in accordance with the manufacturer's installation requirements. Anchor spacing shall be based on 3 fps flow over the fabric.
    a. Treatment area - high-density jute matting (Geojute Plus or other approved equal)
    b. All other areas - low-density jute matting (Econojute or other approved equal)
3. 2.5-3 inches of 2"-$\frac{3}{4}$" river run rock shall be placed over the matting evenly throughout the length and width of the swale.
4. Plant materials shall be placed in accordance with the plan and plant table as shown on approved plans.
5. The water quality swale treatment area plantings can be deemed "substantially complete" once active green growth has occurred to an average growth of 3" and plant density is an average of approx. 6 plants (minimum 1-inch plugs or equivalent) per square foot.
6. The facility shall be deemed acceptable to begin the maintenance period when plant growth and density matches the engineer's design as shown on the approved plans and all other requirements have been met. The engineer must certify the facility to be functional, in accordance with the approved plan design to begin the two-year maintenance period.

MAINTENANCE

1. The permittee is responsible for the maintenance of this facility for a minimum of two years following construction and acceptance of this facility per Chapter 2.
2. Irrigation is to be provided per separate irrigation plan as approved.
   Note: Irrigation needs are to be met using a temporary irrigation system with a timer during the dry season. Systems should be winterized during the wet season to assure longevity and guard against damage from freezing temperatures. Water source shall be as shown on the approved plans.
3. Engineer or Owners Representative is to visit and evaluate the site a minimum of twice annually (Spring and Fall). The landscaping shall be evaluated and replanted as necessary to ensure a minimum of 80% survival rate of the required vegetation and 90% aerial coverage. Non-native, invasive plant species shall be removed when occupying more than 20% of the site.
4. The facility shall be re-excavated and planted if siltation greater than 3 inches in depth occurs within the two-year maintenance period.

WATER QUALITY SWALE CONSTRUCTION & MAINTENANCE NOTES

DETAIL NO. 710 REVISED 12-06

Clean Water Services
Our commitment is clear.

TABLE 5-5
ROCK PROTECTION AT OUTFALLS

Discharge Velocity at Design Flow (fps)		Minimum Required Protection Dimensions				
Greater than	Less than or Equal	Type	Thickness (ft)	Width	Length (use greater of)	Height Over Crown
0	5	ODOT Class 50 Riprap*	1.5	Diam. + 6 ft	8 ft. or 4 x diam.	1 ft
5	10	ODOT Class 200 Riprap	2.5	Greater of: Diam. + 6 ft	12 ft. or 4 x diam.	1 ft
10		Engineered Energy Dissipater Required				

* - The District or City may require ODOT Class 100 Riprap in areas with a likelihood of vandalism.

5.07.8 Headwalls (Storm only)

Pipe headwalls or other approved end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to stabilize slope. Details of all headwalls and end protection shall be included in the construction drawings.

5.07.9 Trash Racks and Debris Barriers (Storm only)

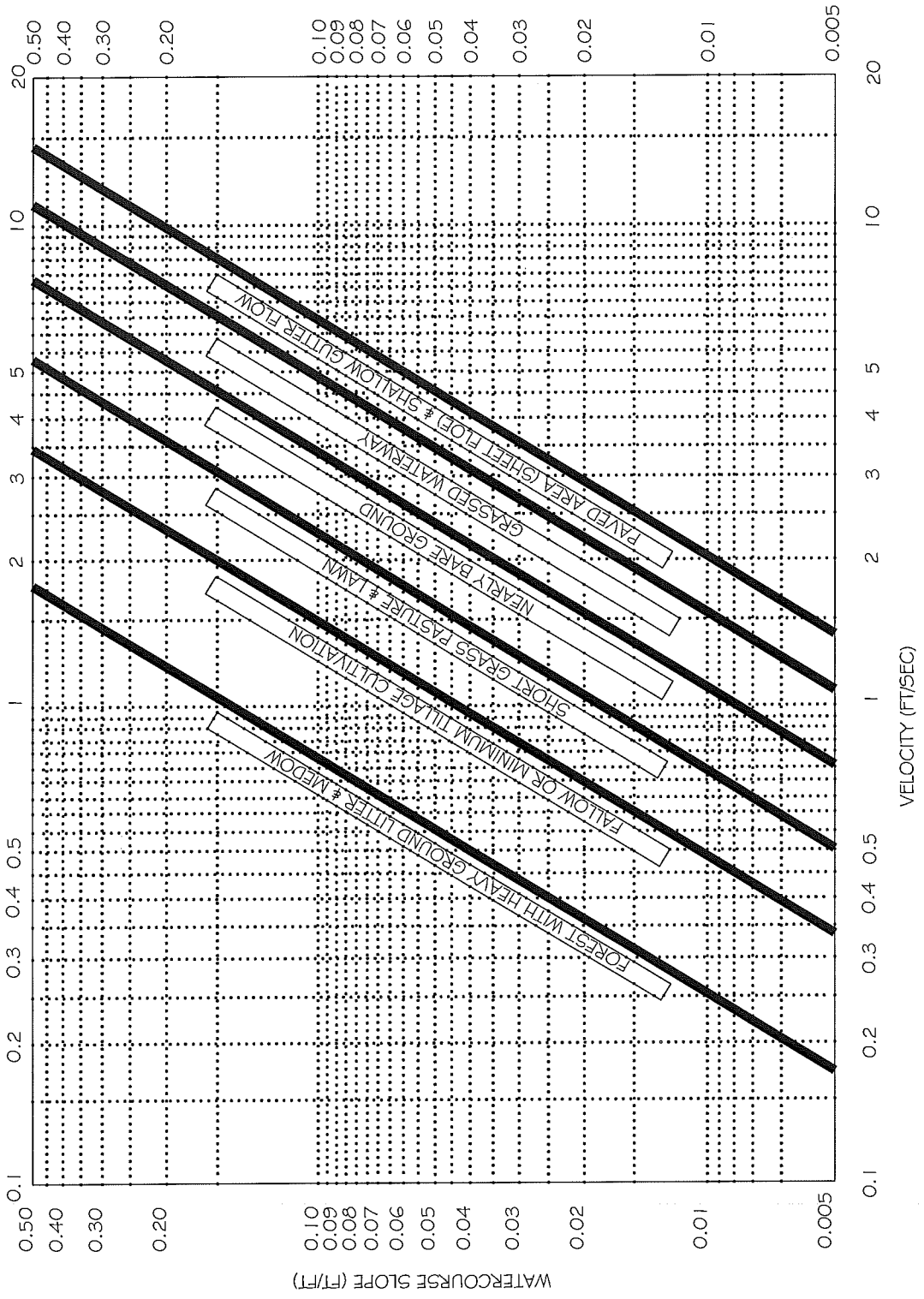
If trash racks or debris barriers are required by the District or City for pipe or culvert systems, the Engineer shall submit the trash-rock-debris barrier system design to the District or City for approval.

5.08 Other Requirements for Public Conveyance Systems

5.08.1 Surveying

The Owner's Engineer or Surveyor shall be responsible for establishing the location of the sanitary and storm sewer system by means of construction stakes offset along the center lines prior to commencement of construction. Moving upstream, there shall be a construction stake placed within 25 feet of each manhole, and at no more than 100-foot intervals along the mainline. Each lateral location shall be staked.

5.08.2 Railroad Crossings



AVERAGE VELOCITIES FOR ESTIMATING TRAVEL TIME FOR OVERLAND FLOWS*

* FOR USE WITH THE RATIONAL METHOD ONLY, FARM SOIL CONSERVATION SERVICE, TECH. RELEASE NO. 55, JANUARY 1975

DRAWING NO. 1250

REVISED 02–03

Clean Water Services

Our commitment is clear.

24-HOUR RAINFALL DEPTHS

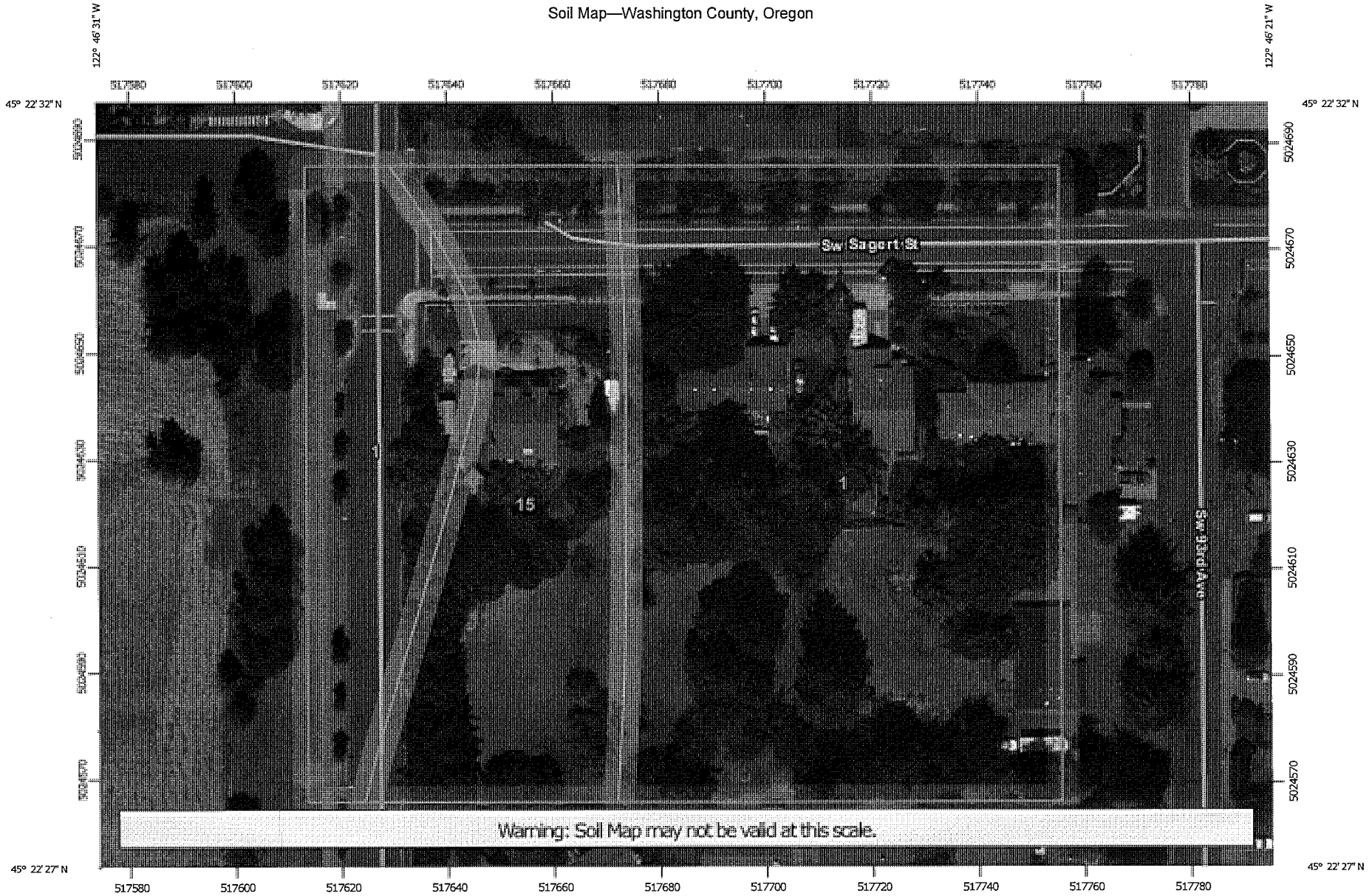
RECURRENCE INTERVAL (YEARS)	TOTAL PRECIPITATION DEPTH (INCHES)
2	2.50
5	3.10
10	3.45
25	3.90
50	4.20
100	4.50

24-HOUR RAINFALL DEPTHS

DRAWING NO. 1280

REVISED 12–06

Clean Water Services
Our commitment is clear.



Map Scale: 1:1,010 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 13, Sep 18, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 3, 2014—Aug 23, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Washington County, Oregon (OR067)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Aloha silt loam	3.1	74.5%
15	Dayton silt loam	1.1	25.5%
Totals for Area of Interest		**4.2**	**100.0%**

Washington County, Oregon

1—Aloha silt loam

Map Unit Setting

National map unit symbol: 21x8
Elevation: 150 to 250 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 160 to 210 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Aloha and similar soils: 90 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aloha

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old loamy alluvium

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 46 inches: silt loam
H3 - 46 to 65 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Other vegetative classification: Somewhat Poorly Drained (G001XY007OR)
Hydric soil rating: No

Minor Components

Huberly

Percent of map unit: 1 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 13, Sep 18, 2015

Washington County, Oregon

15—Dayton silt loam

Map Unit Setting

National map unit symbol: 21xn
Elevation: 150 to 400 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 165 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Dayton and similar soils: 90 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dayton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old alluvium

Typical profile

H1 - 0 to 16 inches: silt loam
H2 - 16 to 39 inches: clay
H3 - 39 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 12 to 24 inches to abrupt textural change
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

Minor Components

Verboort

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 13, Sep 18, 2015

D. Rainfall

The SCS method requires use of the standard SCS Type 1A rainfall distribution (hyetograph) and total storm depth corresponding to the critical storm duration to calculate runoff quantities. The hyetograph distributes the total rainfall volume for select storm frequencies and durations. Select a total rainfall depth from Table 6.10 Total Rainfall Depths for Various Storm Durations Recorded at the Portland International Airport (PIA) and apply the appropriate SCS Type 1A Hyetograph found in Table 6.12.

Table 6.6 SCS Method Runoff Curve Numbers for Urban Areas (Antecedent Moisture Conditions II)

Cover Type and Hydrologic Conditions	Avg. Percent Impervious [a]	A	B	C	D
Fully Developed urban area with vegetation established					
Open space (lawns, parks, golf courses, cemeteries, etc) [b]:					
Poor condition (grass cover less than 50%)		68	79	86	89
Fair conditions: grass cover < 50 to 75%		49	69	79	84
Good conditions: grass cover > 75%		39	61	74	80
Impervious Area:					
Paved parking lots, roofs, driveways (excluding right-of-way)		98	98	98	98
Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (excluding right-of-way)		83[c]	89	92	93
Gravel: (including right-of-way)		76	85	89	91
Dirt: (including right-of-way)		72	82	87	89
Urban Districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts					
1/8 acres or less (e.g. townhouses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	12	46	65	77	82
Developing Urban Areas					
Newly graded area (pervious area only, no vegetation)		77	86	91	94

Table 6.7 SCS Method Runoff Curve Numbers for Agricultural Areas (Antecedent Moisture Conditions II)

Cover Type and Hydrologic Conditions	A	B	C	D
Agricultural Land				
Pasture grassland or range – continuous forage for grazing:				
Poor: less than 50% ground cover or heavily grazed with no mulch	68	79	86	89
Fair: < 50 to 75% ground cover and not heavily grazed	49	69	79	84
Good:> 75% ground cover or lightly or occasionally grazed	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	30	58	71	78
Brush-brush-weed-grass mixture with brush the major element:				
Poor: < 50% ground cover	48	67	77	83
Fair: < 50 to 75% ground cover	35	56	70	77
Good: > 75% ground cover	30[c]	48	65	73
Woods –grass combination (orchard or tree farm: [d]				
Poor	57	73	82	86
Fair	43	65	76	82
Good	32	58	70	79
Woods:				
Poor: Forest litter, small trees and brush are destroyed by heavy grazing or burning	45	66	77	83
Fair: Woods are grazed but not burned, some fresh litter covers the soil	36	60	73	79
Good: Woods are protected from grazing, litter and brush adequately cover the soil	30	55	70	77

Reference: Urban Hydrology for Small Watersheds, SCS, 1986

[a] The average percent impervious area shown was used to develop composite CNs. Other assumptions are as follows: Impervious areas are directly connected to the drainage system, impervious areas have CN of 98 and pervious areas are considered equivalent to open space in good hydrologic condition.

[b] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

[c] Actual CN is less than 30; Use CN=30 for runoff computations

[d] CNs were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be present.

Example 6.1 Calculating A Weighted Curve Number for a Mixed Use Area

Given: A 100 acre drainage basin containing the following mix of land uses: 80 acres Residential R-5 with HSG soil type – B and 20 acres of Open field in good condition with HSG soil type – C.

Required: Calculate a weighted CN for the area.

Land Use	% of Total Land Area	CN from Table 6.6 & 6.7	Calculated Weighted CN
Residential Lot R-5 Zoning Soil HSG - B	80	85	(80/100) x 85 = 68
Meadow – Good Condition Soil HSG - C	80	71	(80/100) x 71 = 14

Total Weighted Composite CN = 82

Table 6.15, Manning's Surface Roughness "n_s" Coefficient for Sheet Flow Calculation less than 300 feet.

Surface Description	Manning's Surface Roughness, n_s
Concrete or asphalt	0.011
Bare sand	0.010
Graveled surface	0.020
Bare clay- loam (eroded)	0.020
Grass	
Short grass prairie	0.15
Dense grass – lawn	0.24
Bermuda grass	0.41
Woods	
Light underbrush	0.40
Dense underbrush	0.80
Paved Streets and Gutters	
Concrete gutter, trowel finished	0.012
Asphalt pavement	
Smooth texture	0.0.13
Rough texture	0.018
Concrete gutter with asphalt pavement	
Smooth	0.013
Rough	0.015
Concrete Pavement	
Float finish	0.014
Broom finish	0.016
For gutters with small slope where sediment may accumulate increase the n_s value by:	0.002