Stormwater Design Handbook
for Homes and Small Projects

CITY OF Salem
AT YOUR SERVICE

Clean Streams
CLEAR CHOICES





Revised May 2014

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STORMWATER DESIGN HANDBOOK

for Homes and Small Projects

Rain Dog Designs Seattle, WA

List of Acronyms

BMP	Best Management Practice
CN	Curve Number
EPSC	Erosion Prevention and Sediment Control
GSI	Green Stormwater Infrastructure
hr	hour
MEF	Maximum Extent Feasible
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PWDS	Public Works Design Standards
SAR	Salem Administrative Rules
SBUH	Santa Barbara Urban Hydrograph
SCS	Soil Conservation Service
sf	square feet
SFR	single-family residential
SRC	Salem Revised Code
TIA	Total Impervious Area

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1. Introduction

This handbook is provided as a guide for residents, home builders, and small project developers in designing green stormwater infrastructure (GSI) consistent with the City of Salem Public Works Design Standards (PWDS) contained in Administrative Rule 109-004.

Integrating GSI into a site plan improves the ability of developed areas to absorb rainfall and reduce runoff, which improves water quality, reduces peak flooding events, and reduces erosion in streams.

This manual explains the steps involved in planning, designing, sizing, constructing, permitting, and maintaining a GSI facility for single-family developments and other small projects.

C. Stoughton, EMSWCD

Rain Dog Designs Seattle, WA

Ryan Makie

Threshold for Single-Family Residential Projects

A single-family residential project is one single-family dwelling or two attached single-family dwellings on a single existing unit of land that is zoned Single Family Residential where the total new and replaced impervious surface is **1,300 to 10,000 square feet.** Residences larger than 10,000 square feet of impervious area are considered large projects and have additional requirements.

Salem Revised Code (SRC) 71 - Stormwater requires single-family residential properties mitigate runoff using GSI to the maximum extent feasible. Lots that are part of a subdivision where stormwater facilities are already constructed are exempt from this requirement.

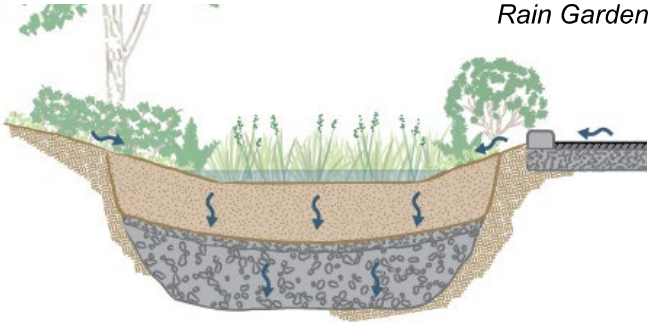
What is Green Stormwater Infrastructure?

The City defines GSI as a stormwater facility that mimics natural hydrology through infiltration and/or evapotranspiration, or that involves stormwater reuse. Detailed typical plans have been developed for each approved GSI facility and are available on the City's website. Below are illustrations of several GSI facilities.

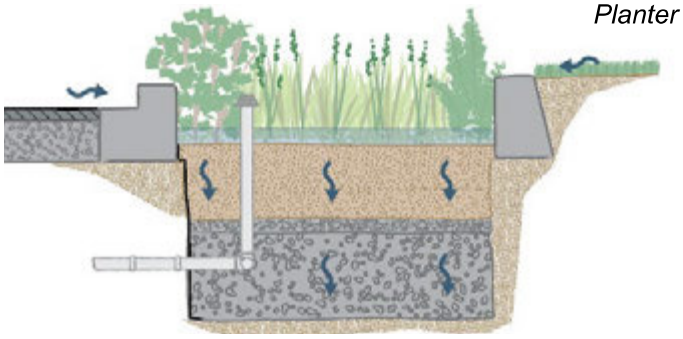
Infiltration is the best approach to mimicking natural hydrology on developed sites. For this reason, Salem has prioritized using infiltration facilities wherever soil infiltration rates exceed 0.5″ per hour. The City recommends partial infiltration facilities where infiltration rates are less than 0.5″ per hour. Filtration facilities that incorporate vegetation should be used when infiltration is not feasible due to site constraints such as high groundwater, steep slopes, contaminated soils, or if setback requirements cannot be achieved.

Examples of Green Stormwater Infrastructure Facilities

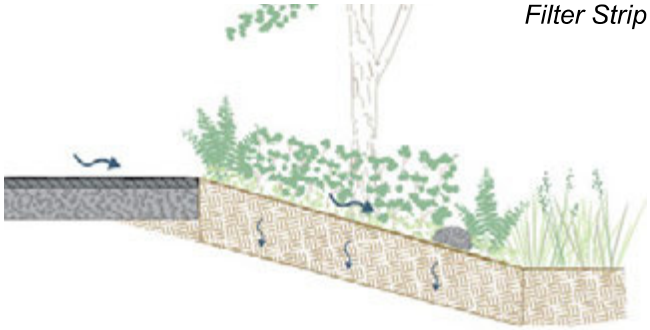
Rain Garden



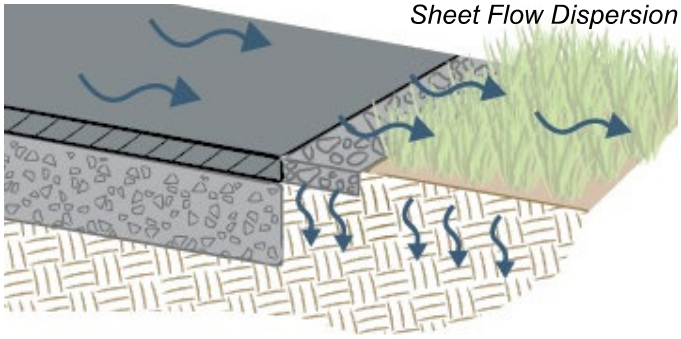
Planter



Filter Strip



Sheet Flow Dispersion

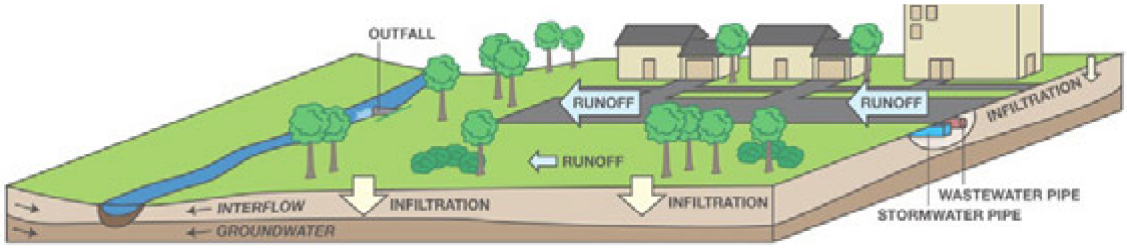


Why Use Green Stormwater Infrastructure?

As new homes, buildings, parking lots, and streets are constructed, impervious surfaces replace areas that previously infiltrated stormwater. Impervious surfaces prevent infiltration and force stormwater to runoff. The runoff is collected in stormwater pipes and conveyed to detention facilities or discharged directly to a stream. Unless it is properly managed, stormwater runoff contributes to high flow rates in streams during storms. High flow rates in streams cause flooding and destabilize stream banks, which can threaten homes, roads, utilities, and other important infrastructure.

Additionally, stormwater runoff can pick up pollutants from impervious surfaces and carry them directly to the stream.

The Salem stormwater management program was originally developed to minimize flooding by constructing stormwater detention facilities. However, as development continues to increase, detention facilities are proving inadequate at removing pollutants and reducing peak flow rates in streams. As a result the City is requiring GSI as a way to better manage pollutants and reduce runoff to streams.



GSI facilities mimic natural systems like native forests because they incorporate vegetation and allow stormwater to infiltrate. Infiltration reduces the runoff volume reaching streams and helps to recharge groundwater aquifers. The vegetation intercepts rainfall, filters runoff, and promotes evapotranspiration.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Seattle, WA

Planning and Developing Green Stormwater Infrastructure

To install a GSI facility on your property, there are several steps that will help to complete your project successfully:

1. **Assess your site**—Draw a map of the existing and future features of your site. *(Section 2, pages 3-5)*
2. **Test infiltration rate**—The infiltration rate will determine what type of GSI facility is appropriate and provide information for the sizing calculations. *(Section 3, pages 6-8)*
3. **Asses the location and area of the impervious surfaces**—Stormwater facilities should be located down slope of impervious surfaces. The amount of impervious area will dictate the size of your facility. *(Section 4, page 10)*
4. **Select the type of GSI facility**—Use the fact sheets to choose the GSI facility that works best for your site. *(Section 4, pages 10 and 11)*
5. **Size the facility**—Use the provided form to calculate the facility size to address the impervious area to be mitigated. *(Section 4, pages 11-13)*
6. **Complete the permit process.** *(Section 5, page 14)*
7. **Construct the GSI facility.** *(Section 6, pages 15 and 16)*
8. **Maintain the GSI facility**—Proper maintenance of your facility will make sure it operates properly and does not become a source of invasive weeds. *(Section 7, page 17)*

2. Site Planning Assessment

Site planning is an integral part of of implementing GSI. To identify opportunities to integrate GSI, it is important to assess the site for both natural characteristics and built infrastructure. Preserving matures trees will reduce the impacts of impervious areas because the trees will intercept rainfall, reduce the volume of runoff through uptake, and their roots will improve infiltration by breaking up tight soils.

It is also important to evaluate flow patterns to and from the site. In some cases, off-site areas will contribute stormwater to proposed facilities.

The next page shows several of the most common site characteristic reviews that you should complete when planning your GSI facility.


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Natural Site Characteristics

Identify Slopes	▶ Identify if your slope is steeper than 5% using slope calculation method shown on the next page. If the slope is greater than 5%, a filtration facility may be required. ▶ Identify and map erosion prone areas such as eroding banks or slopes.
Characterize Soils	▶ Test the soil infiltration rate at potential GSI site locations. Whenever possible, locate GSI facilities where the infiltration rates are highest. ▶ Identify locations where soils may be contaminated by past activities such as underground oil drums. Areas with contaminated soils are not suitable for infiltration GSI (filtration GSI is allowed). ▶ Identify locations with high groundwater on the site map. High groundwater restricts infiltration capacity and these areas are likely not good locations for infiltration facilities. The persistent ground surface saturation/ponding or standing water in the infiltration pit just after digging can be indications of high groundwater.
Locate Existing Vegetation/Trees	▶ Locate mature trees on the site, especially those within 10 feet of impervious areas, and add them to the site map. In addition to the trunk location, draw the extent of the tree's drip line. The drip line can be a good approximation of the extent of the tree's root system. ▶ Preserve existing mature trees whenever possible. "Heritage trees," "significant trees" and trees in a riparian corridor, and trees on lots greater than 20,000 square feet are subject to SRC 808 - Preservation of Trees and Vegetation. Consult an arborist if the GSI facility will be located within the drip line of an existing tree to determine if the facility will destabilize or otherwise adversely affect the health of the tree
Describe Water Resources	▶ Construction near streams and wetlands may require additional considerations and permits. Consult a natural resource scientist if you think you will need to do work within a sensitive natural area. ▶ Avoid areas where ponding occurs. This indicates low infiltration potential and possibly high groundwater.

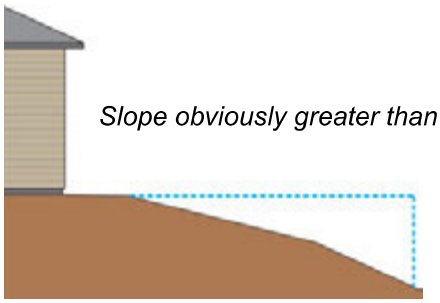
Infrastructure Characteristics

Identify Stormwater Flow Patterns and Impervious Areas	▶ Draw a diagram of flow directions. There is an example diagram on the next page. ▶ Calculate how much impervious area will be draining into each GSI facility.
Map Setbacks	▶ Identify the areas available for infiltration GSI facilities – at least 10 feet from structures and 5 feet from property lines where the adjacent property is down slope.
Locate Utilities	▶ Locate existing utilities such as electric, water, sewer, and gas lines that run underground. Call 811 to have utilities located with spray paint on your site.

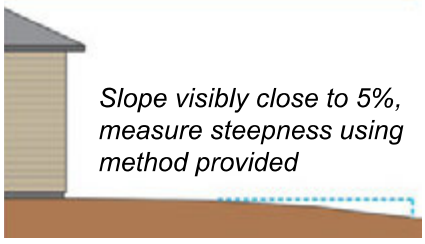
Measuring Steepness of the Slope

Most GSI facilities can be installed in areas with slopes less than or equal to 5%. Usually it is obvious if a slope is greater than 5%. When the slope is visibly close to 5% you can measure the steepness by using the method presented here.

Slope obviously less than 5%



Slope obviously greater than 5%



Slope visibly close to 5%, measure steepness using method provided

Note: Use the same units for measurements (for example, feet) to avoid the need for conversions.

To determine the slope of the site:

1. Place stakes in the ground at the top and bottom of the slope to be calculated.
2. Attach a heavy-duty string to the two stakes. Have the line touch the ground on the uphill stake. Use the level to make sure the line is level.
3. Measure the horizontal distance (along the line) between the two stakes.
4. Measure the rise (vertical distance) from the ground up to the line on the downhill stake.
5. Calculate the slope by plugging your numbers into the following equation:

$$slope = \frac{RISE}{HORIZONTAL\ DISTANCE} X\ 100\%$$

SLOPE CALCULATION EXAMPLE

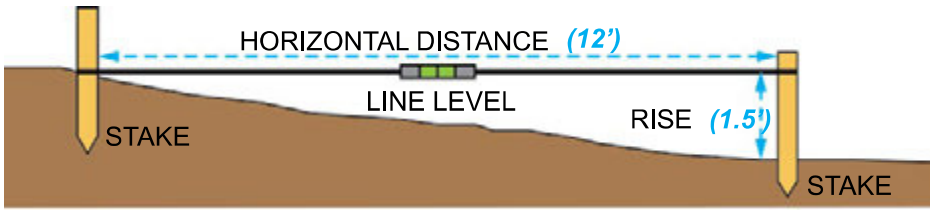
RISE = 1.5 feet
HORIZONTAL DISTANCE = 12 feet

$$slope = \frac{1.5\ feet}{12\ feet} X\ 100\% = 12.5\%$$

Conclusion: Too steep for most GSI facilities.

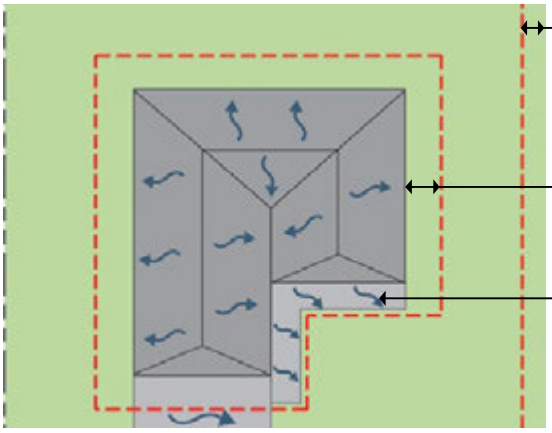
Tools needed:

- Two Stakes
- Level
- String
- Measuring tape



*This example altered and reproduced from OSU Rain Garden Guide.

Runoff Flow Direction and Property Setbacks



Property line setback

5-ft from property lines where the adjacent property is down slope

Structure setback

10-ft from structures

Runoff flow direction

Place GSI facilities down slope and adjacent to impervious surfaces to collect runoff

811
Know what's below.
Call before you dig.

3. Infiltration Testing

Soil infiltration rate must be determined at the location of the proposed GSI facility. For small projects, the Basic Method (Open Pit Infiltration Test) can be used. A licensed professional is not required for the Basic Method, but results of the test must be documented on the Basic Method Report Form (on the next page).

Testing with the Basic Method —Open Pit Infiltration Test:

1. Dig a test hole to the depth where the bottom of the stormwater treatment facility will be located. If the depth to the bottom of the facility is unknown dig down to four feet (48 inches). This can be done by hand using a shovel, auger, or post-hole digger. Ideally, this should be done when soils are not frozen and when groundwater levels are generally high (such as spring). If a layer hard enough to prevent further excavation or if standing water is encountered, stop and measure this depth from the surface and record it on the Basic Method Form. Proceed with the test at this depth.
2. Fill the hole with water to a height of about six inches from the bottom of the hole or to one-half the maximum depth of the proposed facility (whichever is greater), and record the exact time. Check the water level at regular intervals for a minimum of four elevation readings before all the water has infiltrated. More elevation readings will provide more accurate results. On the form, record the distance the water has dropped from the top edge of the hole for each time interval.
3. Calculate time interval, drop in water level, and infiltration rate for each interval. The infiltration rate for the hole is the average of all individual infiltration rates.

$$\text{Percolation rate} = \frac{\text{(Drop in water level)}}{\text{Time interval}} \times \text{conversion}$$

For example:

$$\frac{0.6 \text{ inches}}{20 \text{ minutes}} \times (60 \text{ minutes/hour}) = 1.8 \text{ inches per hour}$$

4. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to assess the soil's ability to infiltrate while saturated.
5. As part of the permit application (see Section 5), submit the results for all three test runs at each test pit on the property.

Robert Emanuel

Basic Method—Open Pit Infiltration Test Form

Location:	Tester's Name:	Date:
Depth to bottom of hole:	Diameter of hole:	Test Number:

n	A	B	C	D	E	F
	Time	Time interval, minutes $(A_n - A_{n-1})$	Measurement, inches	Drop in water level, inches $(C_n - C_{n-1})$	Infiltration rate, inches per hour (D/B) * 60 min/hr	Comments
0						
1						
2						
3						
4						
5						
6						
7						
8						
				Average Infiltration Rate		

Ryan Makie

EXAMPLE: Basic Method Form

Location: XX Market St.	Tester's Name: J. Smith	Date: March 10, 2014
Depth to bottom of hole: 36 inches	Diameter of hole: 12 inches	Test Number: 1

n	A	B	C	D	E	F
	Time	Time interval, minutes ($A_n - A_{n-1}$)	Measurement, inches	Drop in water level, inches ($C_n - C_{n-1}$)	Infiltration rate, inches per hour (D/B) * 60 min/hr	Comments
0	1:50 PM	0	30	--	n/a	Filled with 6" water
1	2:10	20	30 1/4 = 30.25	0.25	0.75	
2	2:30	20	30 9/16 = 30.5625	0.3125	0.9375	A couple of small rocks
3	2:50	20	30 3/4 = 30.75	0.1875	0.5625	
4	3:10	20	30 7/8 = 30.875	0.125	0.375	
5	3:30	20	31	0.125	0.375	
6						
7						
8					4.5/5 = 0.9	
				Average Infiltration Rate	0.9	

1/16 = 0.0625
1/8 = 0.125
1/4 = 0.25
1/2 = 0.5

The Effect of Infiltration on GSI Facilities

The infiltration rate will affect the required size of the GSI facility. Generally:

- Low infiltration results in relatively large facilities
- High infiltration results in relatively small facilities

Runoff must be stored during rain events when the infiltration rate is less than the rate of runoff. Runoff is stored underground in the rock reservoir and ponding area above plants.

GSI facilities can be designed as infiltration, partial infiltration, or filtration. The City requires infiltration facilities whenever possible. If infiltration is particularly low or prohibited, partial infiltration or filtration facilities are allowable. The following outlines requirements for the use of infiltration, partial infiltration, or filtration facilities. More information is available in the PWDS.

- If infiltration is ***greater than or equal to 0.5 inches per hour,*** use infiltration facilities.
- If infiltration is ***less than 0.5 inches per hour,*** partial infiltration facilities are allowed.
- When infiltration is prohibited by contamination or high groundwater, filtration facilities can be used.

4. GSI Facility Design

A number of factors are involved in the selection of appropriate stormwater facilities; cost and aesthetics are important, but facilities should also be selected to work with the natural and infrastructure characteristics of the site identified during site planning and assessment.

The following sub-sections highlight the key elements of GSI facility design. The designer should identify the specific features, targets, and requirements that apply to the site and determine if the total impervious area can be reduced. Then choose a location for the facility that can easily collect runoff.

Design Methods

There are two design methods approved by the City for the design of GSI facilities: The simplified method and the engineered method.

The simplified method allows you to multiply a sizing factor, based on the infiltration rate, to the total impervious area to easily calculate the GSI facility size. This method is approved for small projects (less than 10,000 total square feet of new and replaced impervious surface). The Simplified Approach for Stormwater Management, included on the next page, is a tool that walks the project owner through the simplified design method.

The engineered method uses typical hydraulic and hydrologic engineering calculations to determine the facility size required. This method is required on large projects (10,000 total square feet or more of new and replaced impervious surface) and for GSI or other stormwater facilities that are too complicated to be accurately sized using the simplified method.

More information on the two design methods is available in the PWDS.

Facility Types

The following is a list of GSI stormwater facilities organized by the allowable design method.

Simplified Method

- Infiltration and Filtration rain gardens
- Infiltration and Filtration stormwater planters
- Vegetated filter strips
- Partial infiltration rain gardens
- Partial infiltration stormwater planters

Engineered Method

- Pervious pavement
- Green roof
- Drywell
- Infiltration vault
- Vegetated Swale/Combination Swale

Fact Sheets

Fact sheets are available for each facility both here in this handbook and on the City of Salem website. If you would like more information on design and construction, see the PWDS.

For small projects, the best GSI options are infiltration rain gardens and planters. These facilities can be designed using the simplified method, are straight forward to construct, and typically fit in well with other landscaping.

Vegetated filter strips can also be designed using the simplified method and work best when they collect unconcentrated stormwater over a linearly shaped area such as pathways or parking strips. When located adjacent to sensitive areas, vegetated filter strips provide a valuable buffer around wetlands and streams.

Other GSI facilities listed above require the engineered design method. These are less common for small projects but are allowable. More information is available in the fact sheets and the PWDS.

Simplified Method Form

The City has produced this form to provide a quick and simple approach to managing stormwater on-site. Facilities sized with this form are presumed to comply with basic treatment and flow control requirements.

INSTRUCTIONS	SITE INFORMATION
1. Enter Square footage of new and/or replaced impervious site area.	(1) Total Impervious Area ____ sf
2. Enter amount of area reduction. This includes trees, pervious pavement, green roofs, and areas with rainwater harvesting.	(2) Total Impervious Area Reduction ____ sf
3. Subtract (2) from (1) to calculate total impervious area requiring stormwater facilities (3) = (1) – (2)	(3) Required Mitigation Area ____ sf
4. Select desired stormwater facilities from rows (b) through (f) in Column 1, below. Enter the square footage of impervious area that will flow into each facility type in Column 2.	
5. Multiply each impervious area from Column 2 by the corresponding sizing factor in Column 3, and enter the result in Column 4. This is the facility surface area required.	
6. Total Column 2 (Rows b - f) and enter the resulting "Impervious Area Managed" on line (6).	(6) Total Impervious Area Managed ____ sf
7. Subtract (6) from (3) and enter the result on line (7). This must be zero or less. Submit this form with the application for permit. (7) = (3) - (6)	(7) Remaining Area ____ sf

Column 1	Column 2	Column 3		Column 4
Stormwater Management Facility	Impervious Area Managed	Infiltration Rate	Sizing Factor	Facility Surface Area
b. Infiltration Planter (Standard Plan STD215)	____ sf	0.5-0.75	0.11	= ____ sf
		0.75-1.25	0.09	= ____ sf
		1.25-1.75	0.07	= ____ sf
		>1.75	0.06	= ____ sf
c. Filtration Planter (Standard Plan STD216)	____ sf		0.06	= ____ sf
d. Infiltration Rain Garden (Standard Plan STD217)	____ sf	0.5-0.75	0.11	= ____ sf
		0.75-1.25	0.09	= ____ sf
		1.25-1.75	0.07	= ____ sf
		>1.75	0.06	= ____ sf
e. Filtration Rain Garden (Standard Plan STD217)	____ sf		0.06	= ____ sf
f. Vegetated Filter Strip (Standard Plan STD218)	____ sf		0.20	= ____ sf

Design Considerations

When thinking about how to incorporate GSI into your plans, consider the following:

- Incorporate stormwater facilities into other landscaping features.
- Use pervious pavement where practicable to minimize impervious area and surface runoff.
- Amend soils in disturbed areas to improve infiltration.
- Choose plants that reduce irrigation and fertilizer needs.

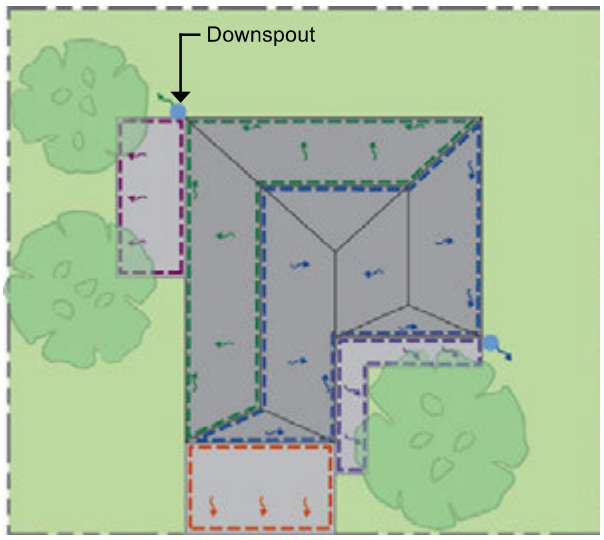
Total Impervious Area

Total impervious area is the new plus replaced impervious surface that will drain to a particular GSI facility. The delineation should be done using the proposed site configuration including grading and any existing or proposed stormwater facilities. The total area calculation should include roofs, sidewalks, paths, patios, and driveways. If the driveway drains to a road with existing stormwater treatment facilities, do not include it in the total. Also, do not include pervious pavement or green roofs.

Impervious Area Reduction

The options for reducing total impervious area (TIA) are listed in the table below.

The PWDS has detailed information on impervious area reduction. The table below summarizes the calculations for the reductions applicable to the simplified method and also serves as a worksheet to help you calculate the total reduction on the Simplified Approach Form.



Impervious Area Drainage Plan

Required Mitigation Area

The required mitigation area is the difference between the total impervious area and the impervious area reduction. The result is what must be managed to meet the PWDS requirements.

Total Impervious Area Managed

The total impervious area managed is the total area managed by each facility. This number must match the required mitigation area calculated previously to meet PWDS requirements.

Simplified Method Impervious Area Reduction

Method	Reduction Allowances	Calculation	Total
Preservation of Existing Trees	50 sf for each existing tree preserved within 10 feet of impervious area*	# of Trees x 50 sf =	
New Trees Planted	20 sf for each new tree planted within 10 feet of impervious area*	# of Trees x 20 sf =	
Pervious pavement	100% of paved area	Area in sq ft x 1 =	
Green Roof Area	50% of green roof area for water quantity control	Area in sq ft x 0.5 =	
Rainwater Harvesting Area	100% of the area for which the runoff will be fully utilized as shown in a water use budget submitted to the City	Area in sq ft x 1 =	
		Total Impervious Area Reduction (sq ft): (Transfer total to Simplified Approach Form line 2)	

*New and preserved deciduous trees must be at least 2 caliper inches. New and preserved evergreen trees must be at least 8 feet tall. Trees can only reduce the amount of impervious area by a maximum of 10%. Trees planted to meet stormwater facility planting requirements cannot also be used toward impervious area reduction.

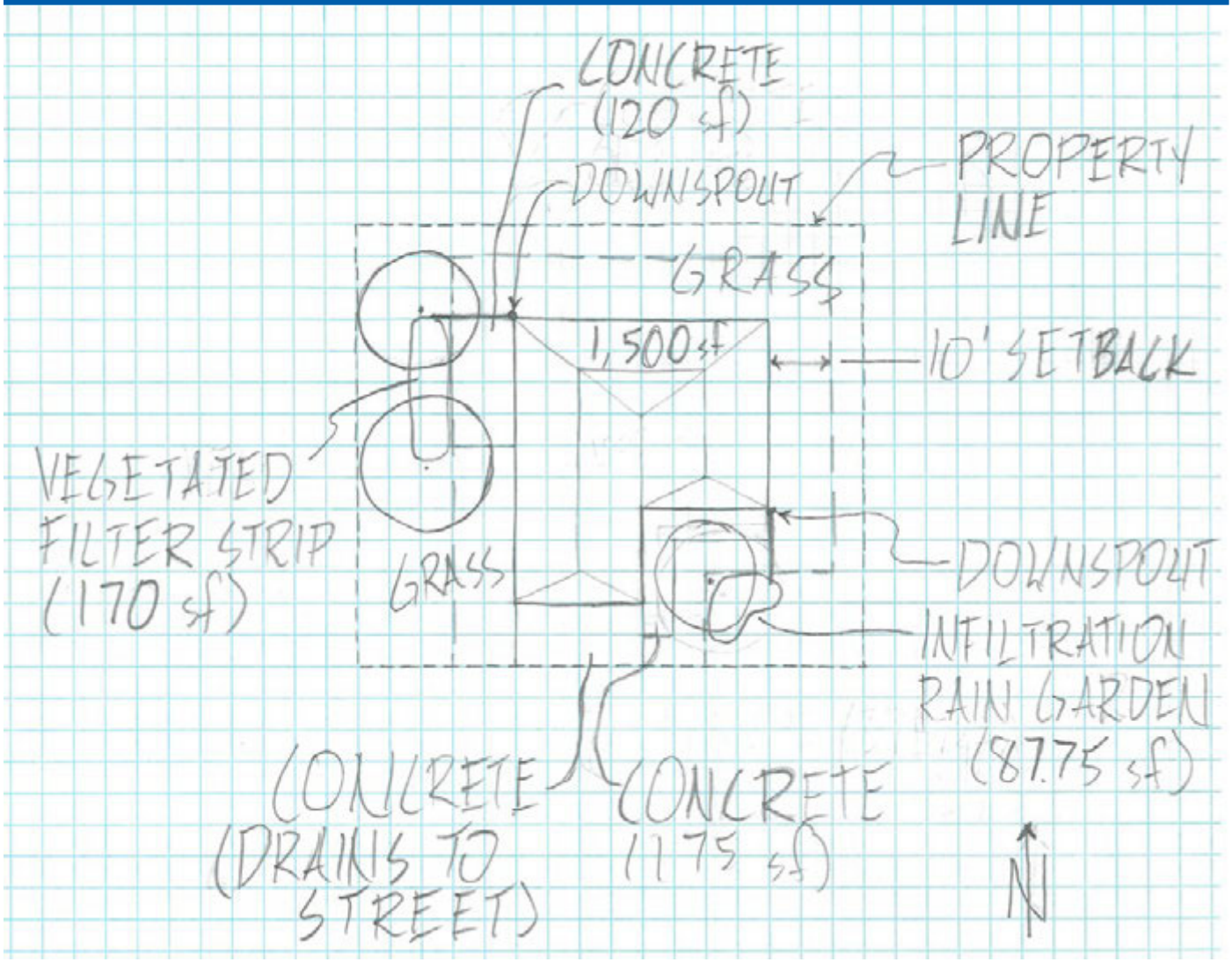
EXAMPLE: Using the Simplified Method Form to Size GSI Facilities

The City has produced this form to provide a quick and simple approach to managing stormwater on-site. Facilities sized with this form are presumed to comply with basic treatment and flow control requirements.

INSTRUCTIONS	SITE INFORMATION	
1. Enter Square footage of new and/or replaced impervious site area.	(1) Total Impervious Area	1,795 sf
2. Enter amount of area reduction. This includes trees, pervious pavement, green roofs, and areas with rainwater harvesting.	(2) Total Impervious Area Reduction	150 sf
3. Subtract (2) from (1) to calculate total impervious area requiring stormwater facilities (3) = (1) – (2)	(3) Required Mitigation Area	1,645 sf
4. Select desired stormwater facilities from rows (b) through (f) in Column 1, below. Enter the square footage of impervious area that will flow into each facility type in Column 2.		
5. Multiply each impervious area from Column 2 by the corresponding sizing factor in Column 3, and enter the result in Column 4. This is the facility surface area required.		
6. Total Column 2 (Rows b - f) and enter the resulting "Impervious Area Managed" on line (6).	(6) Total Impervious Area Managed	1,825 sf
7. Subtract (6) from (3) and enter the result on line (7). This must be zero or less. Submit this form with the application for permit. (7) = (3) - (6)	(7) Remaining Area	-150 sf

Column 1	Column 2	Column 3		Column 4
Stormwater Management Facility	Impervious Area Managed	Infiltration Rate	Sizing Factor	Facility Surface Area
b. Infiltration Planter (Standard Plan STD215)	sf	0.5-0.75 0.75-1.25 1.25-1.75 >1.75	0.11 0.09 0.07 0.06	= sf = sf = sf = sf
c. Filtration Planter (Standard Plan STD216)	sf		0.06	= sf
d. Infiltration Rain Garden (Standard Plan STD217)	975 sf	0.5-0.75 0.75-1.25 1.25-1.75 >1.75	0.11 0.09 0.07 0.06	= sf = 87.75 sf = sf = sf
e. Filtration Rain Garden (Standard Plan STD217)	sf		0.06	= sf
f. Vegetated Filter Strip (Standard Plan STD218)	850 sf		0.20	= 170 sf

EXAMPLE: Using the Simplified Method Form to Size GSI Facilities Site Plan



Mauria Pappagallo

5. Plan Submittal

The construction of a GSI stormwater management facility requires the project owner to acquire a Development Permit from the City of Salem. If your project was completed using the Simplified Method Form, use the checklist provided here to keep track of the forms required as part of the submittal package.

Submittal Package Checklist

The following items must be included:

- ☐ Site Plans
- ☐ Cross Section and Details of the Proposed Facilities (See Salem Standard Plans)
- ☐ Infiltration Test Results
- ☐ Landscaping Plans
- ☐ Irrigation Plans
- ☐ Simplified Method Form
- ☐ Private Stormwater Facilities Agreement
- ☐ Operation and Maintenance Plan

Site Plans

Provide a map of the proposed site based on a scale of 1″ = 10′. Information on the site plan must include:

- North arrow
- Elevations and topography
- Property lines
- Lot area and setbacks
- Footprints of structures
- Easements and driveways
- Wells and/or on-site septic systems
- All existing and proposed utility services (buried and overhead)
- Width of right-of-way and curb height
- Impervious areas
- Type, location, and size of stormwater facility
- Existing and proposed surface drainage (including the overflow path when GSI facility is over-topped in a large storm event)
- Sidewalks
- Surface materials (Concrete, asphalt, grass, bark mulch, etc.)
- Appropriate Dimensions
- Proposed stormwater discharge pointCross Section and Details of the Proposed Facilities

Develop a cross-section of the proposed stormwater facility. The cross-section must show the elevations of inlets, outlets, and discharge points on the cross-section(s) with arrows showing the direction of flow. Standard details of the facilities are included in the Salem Standard Plans.

Infiltration Test Results

Results of test and Basic Method Report Form as described in Section 3.

Landscaping Plans

Provide map and cross-section of the proposed planting plan for the stormwater facility. Information on the landscape plan should include:

- North Arrow
- Property lines
- Lot area and setbacks
- Footprints of structures
- Easements and driveways
- All existing and proposed utility services (buried and overhead
- Planting zones, plant layout, and distribution
- Plant legend with the following information for each plant:
  - Botanical name
  - Common name
  - Quantity
  - Condition
  - Size
  - Spacing
  - Appropriate planting zone
- Soil preparation and planting details and notes
- Mulch, compost, soil amendment, and topsoil specifications and quantities
- Seed mixes, method, rates, and areas of application, if used

Irrigation Plan

Map of irrigation layout, material legend, details, and notes, if used.

Simplified Method Form

(Included in this handbook)

Private Stormwater Facilities Agreement

If on private property and privately maintained, this form needs to be included. (Administrative Rule 109-011)

Operations and Maintenance Forms

If on private property and privately maintained, this form needs to be included. (Administrative Rule 109-011)

6. Construction Guide and Planting

Constructing a stormwater facility consists of the following activities: excavating, constructing structures (inlets, outlets, planter walls, overflows, etc.), constructing growing medium, placing erosion protection, and planting. Directions specific to individual facility type are given on the respective fact sheets and in the PWDS. Provided below are some additional considerations that apply to most stormwater facilities.

Siting

It is helpful to layout your facility before you begin excavating. Use string lines or spray paint to mark the footprint on the ground. If you haven't already done so as part of the Site Assessment, measure elevations of the edge of impervious area or the collection pipe, the ground surface where the facility will be located, and the approved point of discharge, if applicable. Refer to Section 2 for a simple topography measuring method.

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Growing Medium

Growing medium consists of topsoil amended with compost. For projects that will install a GSI facility on an existing landscaped area, you can scrape off the top 8″ of the ground (the topsoil) and set it aside. Then buy compost and mix it with the topsoil. The PWDS contains additional detail on the specific material requirements for growing medium. If you need to purchase growing medium, follow specifications of 1/3 sand, 1/3 compost, and 1/3 clay. After excavation is complete place the growing medium and till the soil. A layer of mulch can help prevent erosion and rilling of the soil as the plants mature.

Soil Compaction

Soil compaction reduces soil infiltration capacity. If additional construction is occurring on the property, plan the construction activities to minimize grading and compaction of GSI facility location and areas to remain natural or landscaped.

Erosion Protection

Erosion Prevention and Sediment Control (EPSC) permits are required for all projects disturbing over 1,000 square feet of earth. The EPSC permit is obtained from the City and requires submitting an EPSC plan showing how you will reduce or prevent sediment from leaving a site during construction. Detailed description of design, analysis, and implementation of EPSC Best Management Practices are provided in Chapter 109-007 of the PWDS.

For projects with less than 1,000 square feet of disturbance, an EPSC permit is not required. However, there are a number of erosion protection measures that should be considered:

- If stormwater is entering your facility from a pipe, erosion control measures should be taken to protect the area around the pipe outlet.
- Fine sediment in construction runoff can clog soils and significantly reduce the infiltration potential; therefore, turbid runoff from adjacent construction should be directed away from the proposed GSI facility location.
- Areas where native/existing vegetation will be used for dispersion should be delineated and protected from construction activities.

Planting

The City has provided specific guidance on planting stormwater facilities, including native plant species appropriate for a given facility and locations for planting within the facility. The City encourages the use of native plants, since they are best suited to long-term survival in the local climate. Plant species included on the City's Non-Native, Nuisance, and Noxious Weed lists are prohibited.

Flowering Plants

Homeowners are encouraged to incorporate perennials and flowering plants in their planting designs.

Each GSI facility has planting zones that correspond to the amount of saturation each area receives:

- Zone 1: bottom of the facility; moist to wet soils requiring moisture tolerant plants
- Zone 2: side slopes of the facility; dry to moist soils requiring drought tolerant plants
- Zone 3: upper edge of the facility; dry soils requiring drought tolerant plants

Minimum plant quantities are specified in the PWDS. Plants should be evenly spaced according to the guidelines for the species. As with any garden, planting more mature plants will make a newly planted area look full and will help to prevent erosion or soil rilling.

Below are some transplanting tips that will help to increase the survivability of your new plants.

Transplanting Tips

- Plant in the dormant season to encourage strong root growth.
- Choose plant species according to sun exposure.
- Choose plants according to the saturation of the planting zone where the plant will be placed.
- Supplemental watering should be provided for the first few growing seasons until the plants are established. Supplemental watering should also be provided during extended periods of dry weather.
- Select plants that require minimal need for fertilizers, pesticides, and maintenance.

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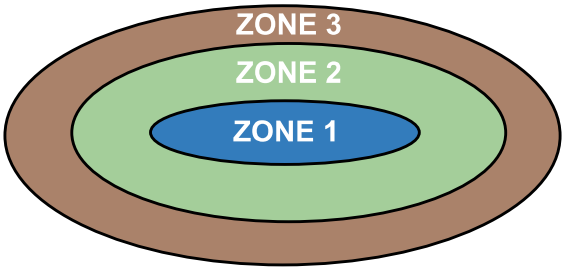
Rain Garden Planting Zones



7. Operations and Maintenance

Regular inspections and routine maintenance are critical to the proper operation of a stormwater facility. Facilities should be observed regularly, particularly during the plant establishment period (first 2 to 3 years). See the Operations and Maintenance forms (Administrative Rule 109-011) for more detailed description of maintenance needs.

Typical Operations and Maintenance Tasks

- Vegetation (including native species) requires supplemental watering for the first 2–3 years while the plants become established.
- Remove sediment buildup and replenish mulch and pea gravel as needed.
- Perform routine garden maintenance including: pruning, removal of unwanted weeds, and replacing of dead plants.
- Avoid applying chemicals such as herbicides and fertilizers, which pollute surface water.

A Private Stormwater Facility Agreement is required for any development that constructs a stormwater facility that will be privately operated and maintained. This form identifies the property owner, financial method to ensure maintenance, and party responsible for inspection and maintenance. The project proponent should submit the agreement during the development permit application process; a notarized copy of the agreement will be kept on file with the City of Salem Public Works Department. A copy of this form can be found in Administrative Rule 109-011.

As part of the Operations and Maintenance Plan, facility specific Facility Maintenance Forms need to be completed regularly. These forms identify specific maintenance tasks that are important to proper long-term function of the facility. Forms can be revised and/or modified by property owner to adjust for maintenance based on site-specific conditions and operations. Copies of this form can be found in Administrative Rule 109-011.

Care must be taken with the use of herbicides, pesticides, and fertilizers. These chemicals are a source of water pollution if used incorrectly and can harm in-stream organisms. The following requirements must be followed when applying herbicides, pesticides, and fertilizers:

- Follow all State and Federal regulations.
- Read and strictly follow application instructions.
- Use the application rate indicated or less and do not over-apply.
- Avoid application when rainfall is expected.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- Avoid application during winds to minimize chemical "drift."

City staff has the authority and responsibility to inspect stormwater facilities on both public and private property to ensure proper maintenance is being performed; however, City inspection will occur based on a prioritized list, and not all facilities will be inspected every year.


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8. Annotated References

Salem Administrative Rules Chapter 109-004 (Stormwater System Design Standards)
Stormwater design standards provide implementation requirements for the design of stormwater facilities. The standards provide criteria on what actions are applicable for managing runoff given the type of development and site conditions. Green infrastructure that provides infiltration and evapotranspiration functions are required to the maximum extent feasible. Standards are provided for approved stormwater facilities, including detailed appendices with planting guidelines and infiltration testing directions.

www.cityofsalem.net/Departments/PublicWorks/PW%20Administrative%20Rules/admin_rule_109-001_109-007.pdf

Chapter 109-007 ErosAvion Prevention Sediment Control Plan (EPSCP)
The EPSCP standards define how the requirements of the SRC are implemented. The standards aid in planning construction activities and implementing actions that prevent erosion and control sediment discharge by using best management practices. The design standards for preparing a EPSCP are provided.

www.cityofsalem.net/Departments/PublicWorks/PW%20Administrative%20Rules/admin_rule_109-001_109-007.pdf

Chapter 109-011 Operations and Maintenance
The rules address operation and maintenance practices for all stormwater facilities. Private Stormwater Facility Agreement and Facility Maintenance forms are included.

www.cityofsalem.net/Departments/PublicWorks/PW%20Administrative%20Rules/admin_rule_109-011.pdf

SRC Chapter 71 (Stormwater Code)

SRC Chapter 71 establishes a consistent set of stormwater regulations for development projects with requirements associated with stormwater flow control and treatment standards, requiring and prioritizing the use of green stormwater infrastructure. The Stormwater Code includes the mandated requirements contained in the NPDES municipal stormwater permit and consolidates existing local requirements, regulations, and practices related to stormwater management.

www.cityofsalem.net/Departments/PublicWorks/Pages/stormwater-code.aspx

SRC Chapter 68 (Preservation of Trees and Vegetation)

SRC Chapter 68 establishes requirements for the preservation of trees, and native vegetation within riparian corridors, throughout the City. The chapter specifically includes requirements for the preservation of heritage trees, significant trees, trees and native vegetation within riparian corridors, and trees on lots and parcels 20,000 square feet or greater. The chapter also includes requirements for tree and vegetation removal permits, tree conservation plans, adjustments to tree conservation plans, and variances.

http://salemcodecleanup.net/?page_id=3189

Non-Native, Noxious Weed and Nuisance Plant Lists

The City of Salem provides three websites describing plants that are discouraged and/or prohibited from use by Oregon State law: Non-Native Plant List, Noxious Weed List, and Nuisance Plant List.

www.cityofsalem.net/Departments/PublicWorks/Administration/WaterResources/SalemNativePlants/Pages/default.aspx

Salem's Stormwater Utility: Information Report

The intent of this document is to explain the stormwater utility fee system. The Base Fee is applied regardless of the amount of impervious surface, whereas the Impervious Surface Charge may be reduced by either a rate adjustment (based on less total impervious area) or rate credit (for non-single-family residents). Reasoning for the fee program and example calculations of fees are provided.

www.cityofsalem.net/Departments/PublicWorks/Pages/sw_utility.aspx

OSU Rain Garden Guide

http://seagrant.oregonstate.edu/node/319

http://seagrant.oregonstate.edu/sgpubs/onlinepubs/h10001.pdf

Western Washington Rain Garden Guide

https://fortress.wa.gov/ecy/publications/publications/1310027.pdf

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