

City of Dublin
Green Stormwater Infrastructure

**BIORETENTION FEASIBILITY, SITING, SIZING,
AND DESIGN CHECKLIST**



Line	Project Data	
1	Project Name	
2	Project Address (include cross street(s))	
3	APN or Parcel/Tract Number	
4	Total Area of Site [acres]	

Complete Section A to confirm initial planning steps are taken prior to Green Stormwater Infrastructure (GSI) conceptual development.

Line	Section A: Preliminary Planning	Yes	No	Comments
5	Stormwater Requirements Checklist (SWRC) completed and provided to Environmental Services	<input type="checkbox"/>	<input type="checkbox"/>	
6	Project is a C.3 Regulated Project per the SWRC	<input type="checkbox"/>	<input type="checkbox"/>	
7	Municipal Regional Permit (MRP) compliance verified with Environmental Services	<input type="checkbox"/>	<input type="checkbox"/>	
8	GSI project budget (estimated; include hardscape/landscape upgrades as necessary ¹)			

Complete Section B to confirm GSI implementation is feasible and to site and size your facility.

Line	Section B: GSI Feasibility, Siting, and Sizing	Yes	No	Comments
9	Project separated into Drainage Management Areas (DMAs) per ACCWP C.3 Manual Guidance. If more than one DMA, complete all following criteria for each DMA at which GSI is proposed ² .	<input type="checkbox"/>	<input type="checkbox"/>	
10	DMA is delineated based on criteria below:	<input type="checkbox"/>	<input type="checkbox"/>	
10a	Natural/Hydrologic features (e.g., creeks, wetlands, watercourses, seeps, springs, ponds, lakes, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
10b	Site Topography (e.g., slopes, depressions, outcrops, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
10c	Drainage Features (e.g., storm drains, catch basins, roadway gutters, etc.)	<input type="checkbox"/>	<input type="checkbox"/>	
11	DMA total impervious surface area [sq-ft]			
12	DMA total pervious surface area [sq-ft]			
13	<i>Lines 9 – 12 completed</i>	<input type="checkbox"/>	<input type="checkbox"/>	

¹ Hardscape/Landscape upgrades include, but are not limited to, ADA curb ramp upgrades, replacing sidewalk, surrounding vegetation, etc.

² Only one stormwater treatment measure (e.g., bioretention or pervious pavement) may be used per DMA.

Line	Section B-1: GSI Sizing - Desktop Analysis	Yes	No	Comments
	<i>Questions in this section provide guidance for conceptual sizing of the GSI practice. Input values should be updated as the design progresses.</i>			
	Section B-1A: 4 Percent Sizing Method³			
14	Reduced pervious surface area [sq-ft] (Line 12 x 0.1)			
15	Effective impervious area [sq-ft] (Line 11 + Line 14)			
16	Required bioretention surface area [sq-ft] (Line 15 x 0.04)			
	Section B-1B: Constrained Sites: Combination Flow- and Volume-Based Sizing Method (Link to Spreadsheet) <i>The combination flow- and volume-based sizing method utilizes the C.3 spreadsheet calculator available from the Clean Water Program website.</i>			
17	Ponding depth ⁴ [in] (from Spreadsheet Line 6-3)			
18	Required bioretention surface area [sq-ft] (Line 8-1)			
19	Use a storage volume safety factor of 1.5 for bioretention areas proposed in roadway medians. (Write N/A as needed)	<input type="checkbox"/>	<input type="checkbox"/>	
20	Lines 14 – 19 completed	<input type="checkbox"/>	<input type="checkbox"/>	
Line	Section B-2: GSI Feasibility and Siting - Desktop Feasibility Analysis	Yes	No	Comments
	<i>Questions in this section identify potential location(s) within or just downstream of DMA, where all, or most of the DMA could drain.</i>			
21	Location publicly owned or in public right-of-way	<input type="checkbox"/>	<input type="checkbox"/>	
22	Location accessible for maintenance ⁵ (i.e., siting does not prevent staff from readily performing maintenance actions)	<input type="checkbox"/>	<input type="checkbox"/>	
23	Location provides limited or no impacts to transit stops and parking (i.e., reductions to parking spaces or transit stops are minimized and authorized by Transportation Division)	<input type="checkbox"/>	<input type="checkbox"/>	
24	Location provides limited or no impacts to utilities, including but not limited to:			
24a	Potable Water	<input type="checkbox"/>	<input type="checkbox"/>	
24b	Recycled Water	<input type="checkbox"/>	<input type="checkbox"/>	
24c	Storm Drain Lines	<input type="checkbox"/>	<input type="checkbox"/>	
24d	Sanitary Sewer	<input type="checkbox"/>	<input type="checkbox"/>	
24e	Laterals	<input type="checkbox"/>	<input type="checkbox"/>	
24f	Natural Gas	<input type="checkbox"/>	<input type="checkbox"/>	
24g	Electricity	<input type="checkbox"/>	<input type="checkbox"/>	
24h	Telecommunications	<input type="checkbox"/>	<input type="checkbox"/>	
24i	Traffic Loop Detectors	<input type="checkbox"/>	<input type="checkbox"/>	
24k	Streetlight/Utility Poles (and foundations)	<input type="checkbox"/>	<input type="checkbox"/>	
24l	Other: _____	<input type="checkbox"/>	<input type="checkbox"/>	
25	Location does not impact use of or access to emergency resources, including but not limited to:			
25a	Fire Lanes (and turning radius)	<input type="checkbox"/>	<input type="checkbox"/>	
25b	Fire Hydrants	<input type="checkbox"/>	<input type="checkbox"/>	

³ A footprint smaller than 4% of the effective impervious surface area may be used for non-Regulated Projects. The 4 Percent Method is generally more conservative than the Combination Flow- and Volume-Based Method.

⁴ Ponding depth should be no less than 6 inches (preferred depth) and no more than 12 inches.

⁵ The party responsible for maintenance should be identified during this step (e.g., City, HOA, private entity, etc.).

Line	Section B-2: GSI Feasibility and Siting - Desktop Feasibility Analysis (continued)	Yes	No	Comments
26	Location minimizes site disturbance and protects sensitive areas when in close proximity to:			
26a	Creeks and riparian habitats	<input type="checkbox"/>	<input type="checkbox"/>	
26b	Wetlands	<input type="checkbox"/>	<input type="checkbox"/>	
27	Location minimizes impacts to existing trees	<input type="checkbox"/>	<input type="checkbox"/>	
28	If answer to Line 27 is no:			
28a	Describe condition of tree(s) (e.g., mature, young, needs replacement).			
28b	GSI can be installed without damaging existing tree(s).	<input type="checkbox"/>	<input type="checkbox"/>	
29	Slope of DMA upstream of potential location is generally $\leq 10\%$ (refer to Steep Slope Areas GIS layer (<i>link pending</i>)).	<input type="checkbox"/>	<input type="checkbox"/>	
31	Location does not promote infiltration to areas of subsurface contamination (i.e., soils or groundwater). Underlying contamination is not present at location according to data available on Geotracker and Envirostor.	<input type="checkbox"/>	<input type="checkbox"/>	
32	Depth to seasonal high groundwater from bottom of proposed facility ≥ 5 ft (refer to Depth to Seasonal High Groundwater GIS layer (<i>link pending</i>)) (<i>an impermeable liner and consultation with a geotechnical engineer should be performed where this is not feasible</i>).	<input type="checkbox"/>	<input type="checkbox"/>	
33	Location is outside of a landslide hazard area (refer to Landslide Hazard Areas GIS layer) (<i>consultation with a geotechnical engineer otherwise required</i>).	<input type="checkbox"/>	<input type="checkbox"/>	
34	Location set back > 50 feet from nearby septic system leach fields (if applicable)	<input type="checkbox"/>	<input type="checkbox"/>	
35	Location is not within 100 feet of water supply well. Verify with Zone 7.	<input type="checkbox"/>	<input type="checkbox"/>	
36	<i>Lines 21 – 35 completed</i>	<input type="checkbox"/>	<input type="checkbox"/>	
Line	Section B-3: GSI Siting - Field Investigation			
	<i>Field investigations should verify assumptions from the desktop analysis, provide feedback on site constraints, and provide additional parameters used for design.</i>			
37	Verify surface features and existing infrastructure determined from desktop analysis. Identify surface features, subsurface features, and infrastructure that were not included in the desktop analysis.	<input type="checkbox"/>	<input type="checkbox"/>	
38	Use pot-holing or similar approved methods to identify and verify locations of subsurface features.	<input type="checkbox"/>	<input type="checkbox"/>	
39	Verify siting location selected is preferable for facility given field conditions. If yes, conduct infiltration testing.	<input type="checkbox"/>	<input type="checkbox"/>	
40	Conduct infiltration testing of native soil using double-ring infiltrometer (or similar approved method)	<input type="checkbox"/>	<input type="checkbox"/>	
41	Infiltration rate of native soil ⁶ (Ksat) [in/hr]			
42	<i>Lines 37 – 40 completed</i>	<input type="checkbox"/>	<input type="checkbox"/>	

⁶ The C.3 manual states that a bioretention area may be designed without an underdrain where underlying soil has a Ksat > 1.6 in/hr. However, it is best practice to include an underdrain for flow rates in excess of infiltration rate.

Use Section C: Bioretention Area Design to check that design details recommended in the GSI Typical Design Details and ACCWP C.3 Manual are met.

Line	Section C: Bioretention Area Design	Yes	No	N/A	Comments
	Section C-1: Bioretention Area Design <i>Refer to the appropriate GSI Typical Detail for all relevant sections.</i>				
	<u>General</u>				
43	Required bioretention surface area is provided ⁷	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
44	Flows greater than the design flow rate/storage volume are diverted upstream of the facility. Green street installations are designed per GSI Typical Details.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
45	Parcel-based and regional facilities utilize flow splitters/diversions sized using adequate engineering measures.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
46	Slope of the bioretention facility, measured from the inlet to surface grade at outlet, is < 4%. If slope cannot be met, complete Line 46a.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
46a	If surface slope cannot be achieved, check dams may be used. The elevation changes between each upstream and downstream segment is ≤ 6 inches. Check dams or similar separation measure is used to separate cells.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
47	<u>Where hydromodification standards are required:</u> Bioretention areas are analyzed using the Bay Area Hydromodification Model (BAHM) and outlet controls (e.g., orifices, weirs, etc.) are designed to meet flow rate requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
48	Provide signage indicating the area is a GSI facility.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Sloped Side Design</u>				
49	Bottom width is ≥ 2 feet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
50	Side slopes are ≤ 3H:1V and stabilization measures have been specified (see GSI Typical Detail GI-3A).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
51	Edge treatments are provided to stabilize adjacent pavement (if necessary).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Line	Section C: Bioretention Area Design	Yes	No	N/A	Comments
	<u>Vertical Side Wall Design (if space limits sloped sides)</u>				
52	Bottom width is ≥ 3 feet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
53	Concrete curb extends ≥ 6 inches above ponding surface.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

⁷ Bioretention surface area is defined as the area under which the minimum required bioretention soil and ponding depth are provided. A relationship between annual precipitation capture and size of the bioretention area with respect to the upstream tributary was assessed in Bay Area Stormwater Management Agencies Association's (BASMAA's) "Green Infrastructure Facility Sizing for Non-Regulated Street Projects" by Dubin Environmental dated December 13, 2017.

54	Edge treatments are provided to stabilize adjacent pavement (if necessary).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
55	Drainage notches are provided for external areas sloping toward walls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
56	Use of concrete backfill specified where vertical side walls extend into existing storm drainpipe trench backfill (<i>Skip if not applicable</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Liner</u>				
57	Impermeable liner is provided beneath aggregate layer where 'Yes' is answered for any of the following:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
57a	Vertical separation from seasonal high groundwater level to facility base is < 5 feet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
57b	Location set back < 10 feet from nearby structures.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Underdrain</u>				
58	No impermeable liner: place underdrain ≥ 6 inches above the bottom of the aggregate layer. With impermeable liner: place underdrain directly on top of the liner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
59	Underdrain diameter is ≥ 4 inches ⁸ .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
60	Underdrain specified as perforated with perforations facing downward.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
61	Underdrain cleanout located at upstream end of pipe and at underdrain pipe angles exceeding 45 degrees ⁹ (e.g., junctions).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
62	Underdrain longitudinal slope is $\geq 0.5\%$.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
63	Underdrain connection to storm drain provides positive drainage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Inlets (GSI Typical Details GI-6A, GI-6B, GI-6C)</u>				
64	Concrete splash apron(s) are provided at each curb cut/opening inlet location.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
65	If runoff enters facility via curb cut, width of curb cut is ≥ 18 inches (<i>Skip if not applicable</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
66	For facilities adjacent to pavement sections or other structures, a cutoff wall is included as part of the design. (<i>Skip if not applicable</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
67	If cobbles are provided for additional energy dissipation, they are specified to be grouted in place (<i>Skip if not applicable</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
68	If bioretention area is proposed adjacent to street parking, a courtesy strip pedestrian landing area is provided per GSI Typical Detail GI-2A (<i>Skip if N/A</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Outlets</u>				
69	Top of outlet riser is at design ponding depth.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

⁸ An underdrain diameter of 4 inches or greater is typical to prevent clogging. A diameter less than 4 inches should not be used. Outlet controls (e.g., orifices, weirs, etc.) may be incorporated to meet hydromodification management requirements.

⁹ Minimum of one underdrain cleanout per bioretention area.

70	Outlet riser is sized to convey the 10-year, 24-hour event and riser footprint area is considered additional to total required bioretention footprint surface area when sizing/designing. (GSI Typical Detail GI-4).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
71	If outlet riser is deeper than 5 feet and interior length and width are ≥ 30 inches, include a permanent ladder for maintenance access (<i>Skip if N/A</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
72	Outlet riser proposed ten feet away from inlets and adjacent to pedestrian edge for ease of maintenance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
73	A removable, grated top is proposed for the top of the outlet riser.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
74	Riser outlet pipe invert elevation is above the storm drain hydraulic grade line.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Layer Stratification</u>				
75	Freeboard is ≥ 2 inches from top of ponding.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
76	Ponding depth ¹⁰ is 6-12 inches based on calculated design criteria.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
77	Mulch thickness is ≥ 3 inches (refer to specifications).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
78	Bioretention soil mix meets BASMAA specification and depth is ≥ 18 inches (refer to specifications).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
79	Caltrans Standard Section 68-1.025 permeable material Class 2 subdrain layer is ≥ 12 inches.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Vegetation</u>				
80	Vegetation proposed does not create traffic and safety concerns.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
81	Vegetation is specified in accordance with City of Dublin Guidance for Plant Selection, Spacing, and Irrigation in Stormwater Treatment Facilities and/or Appendix B of the ACCWP C.3 Manual. Vegetation should be installed in hydrozones based on water and light needs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
82	Landscape Design Plan completed in accordance with Dublin Municipal Code 8.88.070.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
83	If trees are proposed, all the following criteria are met: (<i>Skip if not applicable</i>).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
83a	Trees are offset from underdrains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
83b	Trees proposed on side slopes are specified as planted in native soil.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
83c	Trees proposed in bioretention area footprint are designed with a pedestal of native soil. (ACCWP C.3 Manual Figure 6.1-8).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
84	Irrigation Design Plan completed in accordance with Dublin Municipal Code 8.88.080.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
85	Irrigation to bioretention areas controlled by a separate irrigation line and controller.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

¹⁰ Surface ponding depth neglects the mulch layer. Dimension should be taken from the top of bioretention soil.

86	Irrigation emitters specified to exclude subsurface applications or overspray to areas outside of bioretention area ¹¹ .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Maintenance</u>				
87	Layout allows for ample safe working area for maintenance crews (e.g., separation from traffic is provided).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
88	Layout provides access for maintenance equipment to facility (i.e., adjacent areas provide ample space to for equipment access).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<u>Engineering Drawings</u> – confirm all are provided. Detailed requirements provided on GSI Typical Details.				
89	Bioretention area width and length.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
90	Depth of ponding, freeboard, and layer depths.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
91	Underdrain specifications and location.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
92	Bioretention surface elevation at upslope and downslope ends of facility.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
93	Dimensions and distance to every inlet, outlet, check dam, sidewalk, notch, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
94	Elevations of every inlet, overflow riser, structure rim and invert check dam, bioretention area wall corner, and sidewalk notch.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
95	Type and design of bioretention area components (e.g., edge treatments, inlets/gutter modifications, liner, and planting details).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
96	Depth and type of mulch.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
97	Existing utilities and potential utility crossings or conflicts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
98	Minimum utility setbacks and protection measures specified to conform to local jurisdiction standards.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
99	Lines 42 – 98 completed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

¹¹ Subsurface emitters should be omitted due to the relatively high infiltration rate of the bioretention soil.