APPENDIX A

Term	Definition
Approving Jurisdiction	The county or municipality having jurisdiction and authority to govern.
Channel Crossing	A structure that allows stormwater to be conveyed below the ground surface to allow continuous flow through an open channel, such as a culvert.
Collection Practices	Stormwater infrastructure which captures stormwater runoff from the surface and routes it to another component of the storm drainage system
Common Plan of Development	A contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under one common plan. The "common plan" of development or sale is broadly defined as any announcement or piece of documentation (including a sign, public notice or hearing, sales pitch, advertisement, drawing, permit application, zoning request, computer design, etc.) or physical demarcation (including boundary signs, lot stakes, surveyor markings, etc.) indicating construction activities may occur on a specific plot (USEPA). The common plan of development must have previously provided stormwater management for the fully developed conditions without substantial changes to the improvements plan.
Conveyance Practice	Part of the stormwater drainage system that routes water from a collection practice or point to the next downstream receiving system. Conveyance practices can include enclosed pipe systems as well as open channel systems (overland drainage path, natural streams, and engineered channels), and curb and gutter streets.
Critical Root Zone (CRZ)	The distance from the trunk that equals one foot for every inch of the tree's diameter. For example: if the tree has a trunk 12 inches in diameter, the CRZ is a 12 foot radius around the tree
Curve Number (CN)	A runoff coefficient developed in the U.S. Natural Resource Conservation Service (NRCS) family of hydrologic models by combining land use and one of four hydrologic soil types on a parcel of land.
Curve Number, Retention-Adjusted (CNR)	Curve number adjusted to account for retention provided in upstream tributary areas when designing detention practices. Retention adjusted curve numbers are calculated for each design event.
Design Event	The combination of rainfall depth, duration, and distribution of a hypothetical rainfall event with a given likelihood of occurring in any year. Deisgn storm can be discussed in terms of annual exceedance probability (AEP) using a defined proabililty that such an event will be equaled or exceeded in a given year (i.e. 50%, 20%, 10%, 4%, 2%, and 1%), or, average recurrance interval (ARP) which represents the average period between years in which a given even magnitude is exeeded at least once (2-, 5-, 10-, 25-, 50-, and 100-year). For the purpose of this manual, design storms are generally discussed in ARP terms.
Design Professional	A licensed or certified professional who is registered with and authorized to practice technical design within the state of registration.
Designated Overflow Route	A dedicated path preserved for routing of stormwater flows in excess of the engineered conveyeance system design capacity.

Term	Definition
Detention	Temporary storage of stormwater runoff volume that is then released at a controlled rate to more closely mimic natural runoff conditions
Detention Volume	Volume of stormwater temporarily held in a stormwater detention basin
Diameter Breast Height (DBH)	The diameter of the tree trunk measured as the width of a standing tree at 4.5 feet above the ground on the uphill side.
Discharge Point	Location(s) where stormwater leaves a project area based on the post-project topographic and storm drainage system conditions.
Disturbed Area	Temporary and/or permanent earth-disturbing activities, such as clearing, excavation or filling, and other construction-related activities that alter the surface of the land.
Downspout Disconnection	The process directing stormwater runoff from roof drainage system to a pervious area rather than to an impervious surface or enclosed conveyance system.
Drainage Area	All land draining to the point of consideration, regardless of ownership.
Driver Decision Point	Locations in which drivers will likely encounter a hazard or signal and must recognize it or its potential threat, select an appropriate speed and path, and perform a required action safely and efficiently.
Easement	Authorization by a property owner for the use by another for a specified purpose, of any designated part of the property.
Engineered Channel	An open channel that has been explicitly designed to convey stormwater runoff in which a natural channel design approach was not utilized.
Floodplain	A relatively level surface that is submerged during times of flooding. Located at either side of a watercourse, it is composed of stratified alluvial soils built up by silt and sand carried out of the main channel. Activities within floodplains are often regulated by Federal Emergency Management Agency (FEMA) or other regulatory agency.
Freeboard	The difference in elevation between the control elevation of a structure (i.e. building opening, storm strucutre opening, primary or secondary outlet structure, or overflow spillway) and the maximum design water surface elevation to provide protection against overtopping of surface water.
Green Stormwater Infrastructure (GSI)	Stormwater management facilities that mitigate the effects of urbanization using natural processes such as vegetation and soils at or near where rain falls to mimic natural water cycle. GSI capture and store runoff. The captured water is allowed to infiltrate, filter, evapotranspire, evaporate, reused, or very slowly released so that less surface runoff is created. GSI may also be referred to by the following terms: ▪Post-construction stormwater best management practices (BMP) ▪Stormwater control measures (SCM) ▪Nature-based solutions ▪Stormwater treatment facility (STF) ▪Blue-Green Infrastructure (BGI)
Gutter Spread	The width of flow measured laterally from the face of the curb.

Term	Definition
Hydrologic Soil Group (HSG)	NRCS soil grouping according to minimum infiltration rate, or the capacity of soil (absent vegetation) to permit infiltration. Soils are grouped from HSG A (greatest infiltration and least runoff) to D (least infiltration and greatest runoff).
Hyetograph	Graph of rainfall volume or intensity verses time.
Impervious Area	Any surface that prevents the infiltration of water into the soil including but not limited to pavement, sidewalks, paved parking areas, driveways, packed gravel, rooftops, or solar panels.
Impervious Coverage	Percentage of Impervious Area divided by the total lot or parcel area.
Infiltration	Percolation of water into the ground.
Initial Abstraction	The portion of rainfall that does not immediately contribute to surface runoff due to factors such as surface depression storage, infiltration, evaporation, and interception by vegetation.
Level Spreader	A stormwater energy dissipation component that redistributes concentrated flows to sheet flow over a wide area to minimize erosive velocities, and to increase infiltration and treatment potential.
Method	The specific equation or set of equations used in a model.
Model	Any calculation or set of calculations, including software packages, hand calculations, and spreadsheet tools, which are used for hydrologic analysis.
Model Calibration	The process of adjusting model input variables within an acceptable range to match observed results under similar conditions.
Model Validation	The process of comparing model results to observed results under similar conditions to demonstrate the model results accurately predict real-world conditions.
National Pollutant Discharge Elimination System (NPDES)	Defined in Section 402 of the Clean Water Act, this provides for the permit system that is key for enforcing the effluent limitations and water quality standards of the Act. The Phase II Final Rule—published in the Federal Register on December 8, 1999—requires NPDES permit coverage for stormwater discharges from certain regulated, small, municipal, separate storm sewer systems (MS4s) and from land areas greater than 1 acre disturbed by construction.
Natural Area	Areas of preservation or restoration within a project site that are protected into perpetuity by a legally binding mechanism such as dedicated tract of land and/or covenant that restricts it from future development.
Natural Channel	Any waterway with the ability to self-form by virtue of having at least one unfixed boundary. This includes drainage ways that may have been previously disturbed but through inactivity over time have begun to reform one or more characteristics of undisturbed streams.

Term	Definition
Nested Rainfall Distributions	A rainfall distribution derived from observed rainfall depth and duration data that creates a single synthetic storm profile that embeds shorter-duration, high-intensity events within a longer design storm, capturing peak rainfall intensities at multiple intervals (e.g., 5-minute, 10-minute, 15-minute, 30-minute). This approach simplifies the design process by applying one event across multiple durations, with common examples including the NRCS "Type" distributions or custom distributions developed using NOAA Atlas 14 rainfall depths. These distributions are often used in scenarios requiring consideration of multiple storm durations within a single event, such as flood control systems or large stormwater infrastructure.
New Construction	Roadway project that requires expansion of the roadway with the addition of new lanes, or a new roadway built in greenfield conditions. For the purpose of this criteria, roadway improvements completed as part of a larger common plan of development shall be considered a site development project type.
New Development	Construction of residential, commercial, or industrial development on previously unimproved land OR construction of residential, commercial, or industrial development on land that has no grading, no clearing, no impervious surfaces, or other infrastructure improvements over the last 20 years per available photography.
Overflow Spillway	A device or devices for discharging water when inflow exceeds designed outflow from a detention facility. The overflow spillway can prevent damage to the detention facility from sudden release of impounded water.
Owner	The owner of record of real property.
Pervious Area	Any surface that allows for the infiltration of water into the soil including. For the purpose of this manual Natural Areas are defined separately and excluded from Pervious Areas calculations.
Preservation	The act of protecting the natural environment from disturbance or construction to maintain valuable soil profiles and vegetation that have adapted to the climate, hydrology, and ecology of the area to minimize the impacts of development. For the purpose of this design criteria, preservation areas must meet the requirements of 5604.
Primary Control Structure	Lowest point of release from a detention outlet structure that is designed to meet the required release rate for detention during the smaller, more frequent design events.
Project	Designed improvements that meet the requirements of this manual as defined in Section 5602.
Project Manual	The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes. (EJCDC, 2025)
Project Type Percentage (PT%)	Percentage of the required retention volume that must be controlled on the site based on the specific project type.

Term	Definition
Public Roadway Improvements	Project type representing public right-of-way improvements to the street or associated public infrastructure including but not limited to curb and gutter, ditches, curb ramps, sidewalks, and bike lanes. If any modifications to the stormwater infrastructure are required for the improvements, this criteria shall apply. For the purpose of this criteria, public roadway improvement projects do not include resurfacing within an existing pavement section, roadways developed as part of a larger common plan of development (site development), linear trail improvements, or emergency repairs.
Rain on Mesh	Also known as rain-on-grid, is a hydrologic modeling approach that applies rainfall directly to a 2D mesh or grid representing the ground surface.
Rainfall Distribution	Time series of precipitation, typically used to size and evaluate the level of service of stormwater infrastructure
Rainfall Volume	The total depth of rainfall associated with a single storm event
Roadway Reconstruction	Roadway project that involves modernization with regard to the roadway structure including, but not limited to, shoulder widening or lane reconfiguration. For the purpose of this criteria, roadway improvement projects do not include resurfacing within an existing pavement section.
Redevelopment	Construction on a site that was previously constructed on including grading, construction of habital builidngs, foundations, parking surfaces, driveways, or other infrastructure that added impervious area or were previously on the site as recorded on development plans or as visiable on an aerial photograph.
Release Rate	Controlled discharge from a detention practice through the primary and secondary control structure(s) designed to limit the rate of peak outflow from a site.
Required Retention Volume (RRV)	Volume of stormwater runoff required to be controlled within the disturbed area of the project.
Restoration	The act of improving the natural environment to achieve higher ecological value. For the purpose of this design criteria, restoration areas must meet the requirements of Section 5604.
Restored Natural Channel	An open channel which has been restored to a healthy natural state using a natural channel design approach
Runoff Reduction	Method of crediting the total performance of stormwater management practices in removing pollutants and reducing runoff volumes.
Secondary Control Structure	Secondary point of release from a detention outlet structure that is designed to meet the required release rate for detention during the larger, less frequent design events.
Sheetflow to Natural Areas	Non-concentrated flow discharging to a preserved or restored natural area, or concentrated flow that is discharged through a level spreader meeting design criteria per Section 5608.
Sheetflow to Pervious Area	Non-concentrated flow discharging to pervious area, or concentrated flow that is discharged through a level spreader meeting design criteria per Section 5602.
Site Conditions Map	Existing and proposed conditions maps identifying key site conditions and drainge features required as part of the Storwmater Concept Anlaysis.

Term	Definition
Site Development	Project type representing improvements done to a parcel or parcels of land including both public and private development projects such as residential, subdivisions, commercial, industrial, multi-use, solar farms, and non-linear municipal or utility facilities. For the purpose of this criteria, site development includes the roadways completed as part of the larger common plan of development.
Standard Roadway GSI Practice	Standard GSI practices with defined footprint, section, and soil and/or aggregate media depths that may be used at a specified spacing interval for roadway redevelopment-type project to meet the required retention volume (RRV)
Storm Drainage System	All of the natural and engineered facilities and components that manage stormwater runoff including but not limited to all stormwater collection, conveyance, retention, detention, preservation, and restoration practices.
Stormwater Concept Analysis	Site analysis required during early stages of the project to identify existing and potential drainage issues and delineate required stormwater infrastructure early in the development process so that stormwater management is proactively planned for with improvements. The Stormwater Concept Analysis includes submittal of the Stormwater Management Calculator Forms, Watershed Location Map, and Existing and Proposed Site Conditions Maps.
Stormwater Drainage Report	Narrative report required to document the stormwater analysis completed and justification for projects pursing variances or exceptions to the stormwater management criteria. The Stormwater Drainage Report should expand on the Stormwater Concept Anaysis Submittal.
Stormwater Management Criteria Calculator	Excel tool with built-in calculations to assist users in determining their retention and detention requirements based on user-input site parameters.
Stream Setback	Land use designation for the area adjacent to stream which restricts development for the protection of riparian corridors and floodplains per Section 5604.
Survey Verification Points	Spot elevations identified on construction drawings to provide critical elevation points for contractor verification during construction.
Temporal Rainfall Distributions	A rainfall distribution derived from observed rainfall depth, duration, and distribution data, reflecting the time-varying intensity of real storms. Examples include NOAA Atlas 14 temporal distributions and Huff distributions, which are developed from regional rainfall data to simulate realistic storm patterns. Temporal distributions are used to model how different rainfall intensities affect stormwater systems over time, providing a natural progression of rainfall intensity. A critical storm duration analysis is typically recommended to determine the most controlling storm event for a watershed. However, in the Midwest, storms within the 1st quartile are recommended for design due to their frequent occurrence (about 50% of all storms occur within the first quartile per NOAA Atlas 14 Volume 8). For drainage design, the 10 percent decile is recommended as it typically produces higher peak flows, while the 50 percent decile is preferred for detention design as it represents an average of all quartile 1 storms.

Term	Definition
Uncontrollled Drainage Area	The portion of a project's disturbed area that is not controlled by stormwater management requirements due to impracticality of capture and conveyance of stormwater. The maximum amount of uncontrolled drainage area cannot exceed the Project Type Percentage (PT%).
Utility Improvements	Project type representing linear utility construction including but not limited to electric, gas, communications, water, sanitary, or storm sewer improvements. Non-linear utility improvements are considered Site Development.
Water Quality	The chemical, physical, and biological characteristics of water. This term also can refer to regulatory concerns about water's suitability for swimming, fishing, drinking, agriculture, industrial activity, and healthy aquatic ecosystems. Water quality standards are federally regulated to maintain the desired condition of water bodies and to define the means by which that condition will be protected or achieved (US EPA).
Water Quality Storm	The storm event that produces less than or equal to 90 percent stormwater runoff volume of all 24-hour storms on an annual basis. In the Kansas City metropolitan area this is the 1.37" storm.
Watershed	All the land area that drains to a given point (also described as a basin, catchment, and drainage area).
Watershed Location Map	A map required as part of the Stormwater Concept Analysis identifying the project's location within the greater watershed

APPENDIX B

Appendix B: Guidelines for Adoption

The following guidelines for adoption are provided to highlight where existing ordinances and policies adopted by local governments may be in conflict with this version of APWA 5600. Upon review of selected ordinances, the following potential conflicts were identified in the ordinance of multiple communities. This list is not exhaustive, and each community is encouraged to complete a review of its ordinances to identify and mitigate conflicts with the updated criteria in this manual.

Definitions and Stormwater Criteria within Ordinances

Definitions of stormwater elements and practices in ordinances may not be identical to the definitions used in this manual. In addition, some governments have added portions of stormwater design criteria within their codes and ordinances. Municipalities are recommended to check that differences in definitions do not cause confusion or misapplication of these standards, and to the extent possible, remove stormwater design criteria from ordinances to avoid the potential for conflicting design standards.

Stormwater Management

Multiple governments in the Kansas City area have stormwater management ordinances which specify acceptable stormwater management practices, which could limit the use of practices within this manual.

Communities with these ordinances are recommended to verify that lists of approved stormwater practices allow for stormwater practices in this manual.

Stormwater Submittal Requirements (Development Review)

Each local government has required development submittals for stormwater design which are then reviewed for compliance with standards. This manual has updated criteria for required submittals, along with new reporting tools (i.e., new forms) to assist in submittal requirements. Communities should verify that the requirements of ordinances for submittals do not conflict with the requirements and reporting tools of this manual.

Streams and Stream Setbacks

This manual sets new required criteria for the dedication of riparian areas for natural streams with drainage areas 20 acres and larger. To avoid conflicting site development criteria, communities with existing stream setback ordinances adopting this manual are recommended to modify to match the requirements of this manual. Communities which adopt this manual without an existing stream setback ordinance may need to highlight to developers the requirements to dedicate riparian areas, as this would represent a new practice required by the manual.

The application of stream buffers shall not operate to deprive any landowner of substantially all the market value of their property or otherwise constitute an unconstitutional taking without compensation. If the application of the stream buffer would create a taking, then the City/County may allow a variance, but only to the extent necessary to avoid a taking, provided that the project has also received appropriate state and federal requirements.

Landscaping and Screening

Landscaping ordinances are used by municipalities to provide visual screening, ensure site beautification, and mitigate urban heat island impacts. Some of these ordinances are prescriptive, providing a list of approved species for plants as well as spacing and placement limitations. These ordinances are recommended to be checked against the requirements of Section 5606.7 to identify conflicts and provide for the requirements of this section to be met.

Detention

This version of APWA 5600 requires stormwater detention facilities for both new and redevelopment sites. Some local development ordinances contain a provision allowing a site undergoing development to be exempt from the requirement to detain stormwater when it can be shown that the development does not cause downstream impacts. These exemptions take a narrow view of stormwater impacts to only refer to flood impacts, however, there has been sufficient research to demonstrate that the impact of impervious area on stream geomorphology inevitably leads to degradation of streams and to aquatic habitat. This revised version of APWA 5600 requires detention facilities for all development which provide extended release of outflows, mitigating the duration of peak erosive flows.

Upon adopting this revised version of APWA 5600, communities with this exemption are recommended to remove it.

MS4 Permit

Many communities within the MARC region have an NPDES MS4 permit regulating their stormwater conveyance system. These permits are renewed on a periodic basis, with new requirements typically added upon each renewal.

The guidance provided in this manual is intended to facilitate compliance with MS4 permits. However, MS4 communities are recommended to monitor changes in their MS4 permit and check them against the requirements of this manual. Where MS4 permit requirements conflict with this manual, the MS4 permit requirements shall prevail, and communities are recommended to adopt a policy codifying specific variances from this manual required to meet MS4 permit requirements.

Maintenance

The requirements of this manual, consistent with previous versions of APWA 5600, require the construction of engineered stormwater systems and maintenance of existing native and natural stormwater systems. These systems require periodic maintenance to continue to provide their intended function, and the responsibility to maintain them falls upon their owner, whether this be a private or public entity. Regardless of ownership, these facilities require resources from the local government: private facilities require inspection and enforcement activities, and public facilities require regular maintenance activities.

While there were no gaps found in ordinances relative to these requirements, it is recommended for governments to adopt policies to periodically review and adjust as necessary available funding and staff for the inspection and maintenance of engineered and natural stormwater systems.

Failure to conduct such reviews leaves communities at risk: risk of stormwater asset failure, which can result in unanticipated flooding, stream erosion, and risk to human life; risk of regulatory action, as the proper functioning of water quality facilities is a standard requirement of MS4 permits; and risk of

degradation of natural systems, as properly designed and constructed engineered stormwater controls protect and preserve streams and native habitat.

For communities which own extensive stormwater infrastructure, this may require implementation of an asset management program to prioritize funding such that it addresses the highest risk portions of the system first. Communities unfamiliar with stormwater asset management programs can refer to the paper' Asset Management Programs for Stormwater and Wastewater Systems: Overcoming Barriers to Development and Implementation' (US EPA, March 2017).

APPENDIX C

APPENDIX C: RAINFALL TABLES

Table C-1: Rainfall Depths – NOAA Atlas-14, Volume 8, 6-Hour Regional Average Rainfall Depths for MARC Counties

Time Interval	Rainfall Depth (inches)						
	1-year	2-year	5-year	10-year	25-year	50-year	100-year
10 minute	0.59	0.69	0.86	1.01	1.22	1.38	1.54
15 minute	0.72	0.84	1.05	1.23	1.48	1.68	1.88
30 minute	1.01	1.19	1.50	1.76	2.12	2.41	2.70
60 minute	1.33	1.58	1.99	2.35	2.85	3.24	3.65
2 hour	1.65	1.96	2.48	2.93	3.57	4.08	4.60
3 hour	1.86	2.21	2.82	3.34	4.08	4.67	5.28
6 hour	2.23	2.66	3.40	4.04	4.96	5.70	6.47

Table C-2: Nested Distribution Hyetograph – NOAA Atlas-14, 6-hour, 50% Nested for MARC Counties

Time (min)	Cumulative Fraction Rainfall	Time (min)	Cumulative Fraction Rainfall
0	0.0000000	250	0.8833698
10	0.0078871	260	0.8995202
20	0.0161230	270	0.9143865
30	0.0247469	280	0.9263133
40	0.0338054	290	0.9374251
50	0.0433544	300	0.9478430
60	0.0534624	310	0.9576621
70	0.0642139	320	0.9669581
80	0.0757161	330	0.9757930
90	0.0881069	340	0.9842176
100	0.1035825	350	0.9922746
110	0.1204854	360	1.0000000
120	0.1391913		
130	0.1606160		
140	0.1853402		
150	0.2150006		
160	0.2628292		
170	0.3430892		
180	0.5932533		
190	0.6976689		
200	0.7531121		
210	0.7956344		
220	0.8225493		
230	0.8454777		
240	0.8656216		

Table C-3: Temporal Distribution Hyetograph – NOAA Atlas-14, Volume 8, Area 3, 50% First Quartile 6-Hour Cumulative Percent of Total Precipitation

Time (min)	Cumulative Percentage of Total Precipitation (%)
0	0
30	19.52
60	38.51
90	57.82
120	74.88
150	84.23
180	88.12
210	91.8
240	95.37
270	97.28
300	98.96
330	99.82
360	100

APPENDIX D

KC Compliance Calculator Instructions

General Instructions

1. **Light blue cells are to be filled in by the designer.**
2. **Gray cells are automatically calculated based on the designer inputs. These cells are locked and should not be changed.**
3. **The blue "View Instructions" button on each tab will bring this sheet up in a separate window as the current tab you are working on.**
4. **The orange buttons execute functions that are dependent on previous steps being completed by the designer.**

Cover Sheet

1. **General Requirements**: Complete these in tandem with the Site Summary section of the Site Inputs sheet.
2. **Designer Verification**: After finishing the design sheets, return to the Cover Sheet to complete the Designer Verification of Compliance with Design Criteria section.
3. **Required Maps**: Ensure the Required Maps section is marked as provided with the submittal when completing the Designer
4. **Saving the Workbook**: Once the Criteria Calculator is completed, click the "Save as PDF" button at the top. Select a location to save the workbook for submittal. A default name, based on the Project Name and the date, will be provided.

Site Inputs

Site Summary

1. **Project and Development Type**: Select the Project and Development Type using the dropdown list options.
2. **System Type**: Select the System Type in which the project is located using the dropdown list options (Combined Sewer System or Separate Storm Sewer System).
3. **Proposed Land Use**: Select the Proposed Land Use of the project using the dropdown list options.
4. **Input Value Basis**: Choose the basis for the post-development input values using the dropdown list options.
   - *If "Estimated Values" is selected, an assumed percent impervious coverage will be generated based on the selected land use. This will be used by the designer to complete the drainage areas worksheet.*
5. **Total Disturbed Area**: Enter the total disturbed area in square feet. A message will appear saying the total of the subdivided drainage areas in the Drainage Areas Worksheet does not match the total disturbed area. After completing the Drainage Areas Worksheet, ensure that the totals match and the message is not displayed.

Treatment Summary Table: This table is auto-calculated based on the remaining inputs of the sheet and is used to determine values in the design sheets and the Verification tab. As the detailed drainage area tables are completed, a message will appear if the volume of the uncontrolled area is too high.

Stormwater Management Criteria Calculator Instructions

Drainage Areas Worksheet

1. **Number of Drainage Areas:** Enter the number of drainage areas that intersect the disturbed area of the site in cell E24. These include both controlled and uncontrolled drainage areas.
   - *The Drainage Area Summary Table will automatically adjust based on the value entered in cell E24. The Unique Drainage Area ID will initially fill with numbers 1, 2, 3, etc.*
2. Complete the **Drainage Area Summary Table**:
   a. **Unique Drainage Area Identifier (ID):** Adjust the Drainage Area IDs if desired.
   b. **Feasibility of Control:** Indicate if each drainage area can be feasibly controlled.
   c. **Disturbed Drainage Area:** Enter the amount of the drainage area within the disturbed area in square feet.
   d. **Total Drainage Area:** Enter the total drainage area in square feet, which may include areas outside the project's disturbed area.
   - *Note: If the total number of drainage areas is changed in cell E24 after values have been entered, the worksheet will prompt you to confirm deletion of any drainage area. If "Yes" is selected, the row and its information will be deleted. If "No" is selected, the row will remain, and the total number of drainage areas in cell E24 must be revised to match the table.*
3. **Generate Detailed Drainage Area Tables:** Click the "Generate Detailed Drainage Area Tables" button. This will create two tables for each drainage area in the Drainage Area Summary Table; a Summary Table, which auto-calculates values needed for the design sheets, and a Cover Type Area Table, for the designer to complete.
   a. If the total number of drainage areas is increased, click the button again to generate additional tables. If decreased, manually delete any unneeded tables.
   - *Note: The Drainage Area ID, control designation (Yes/No), and disturbed drainage area in each detailed table are linked to the corresponding row in the Drainage Area Summary Table. Any revisions must be made in the Drainage Area Summary Table.*
4. **Select Cover Types:** Choose the cover types present in the post-development condition.
   a. **Filter Cover Types:** Use the "Filter Cover Types" button to filter the tables based on selected choices, if desired.
5. **Enter Cover Type Areas:** For each detailed drainage area, enter the area values for applicable cover types within the disturbed area footprint.
   a. Impervious Cover: If unknown, calculate using the assumed percent impervious coverage in cell E9.
   - *Auto-Calculations: Required retention volume, pervious area weighted Rv, impervious area weighted Rv, and post-development condition weighted CN in the detailed summary table will auto-calculate as cover type areas are entered.*
   - *Note: The total cover area must equal the disturbed drainage area in the Drainage Area Summary Table. A message will display until totals match.*
   - *Note: If there are drainage areas that are not controlled, the RRV for the controlled drainage areas will be adjusted to account for the additional volume needing to be controlled.*
6. **Generate Design Sheets:** Once detailed drainage area tables are completed, click the "Generate Design Sheets" button. This will create a tab titled "DA X" for each controlled drainage area, where "DA" stands for "Drainage Area" and "X" corresponds to the Unique Drainage Area ID.
   a. If the total number of drainage areas is increased or a previously uncontrolled area is now controlled, click the button again to generate additional design sheets. If decreased or a controlled area is changed to uncontrolled, manually delete any
   - *Linking: Each design sheet links to the corresponding detailed summary table. Revisions must be made in the Drainage Area Summary Table or the appropriate Cover Type Area Table.*

Stormwater Management Criteria Calculator Instructions

Design Sheets

Linking Values: The values at the top of each design sheet link to the corresponding detailed summary table in the Site Inputs tab. Any revisions must be made in the Drainage Area Summary Table or the appropriate Cover Type Area Table.

Required Retention Volume Reductions

1. **Natural Area Preservation/Restoration and Downspout Disconnections:** Enter the area values of the natural or pervious area receiving the sheetflow/disconnection and the corresponding drainage area (pervious and/or impervious), if any. A credit will be auto-calculated and deducted from the total retention volume required for the drainage area.
2. **Tree Preservation/Planting:** Enter the number of trees either being preserved or planted, if any. A credit will be auto-calculated and deducted from the total retention volume required for the drainage area.

Retention Practices

1. **Material Types and Storage Layers:** Select the material types and/or storage layers to be used for all retention practices in the drainage area. Corresponding columns will appear in the design table below as selections are made.
2. **Retention Facility ID:** Create an ID for each unique retention facility.
3. **Practice:** Select a type of retention practice to design.
4. **In-Series Retention Facilities:** Enter the downstream retention facility ID for routing when retention facilities are applied in-
5. **Tributary Drainage Area:** Enter the pervious and impervious tributary drainage area to each facility.
   - *An approximate target retention volume for each GSI facility is auto-calculated based on the pervious weighted Rv, impervious weighted Rv, the PT%, the tributary drainage area to the GSI, and any bypass volume from upstream facilities. This value is approximate in nature and intended to assist the designer in right-sizing each facility. The approximate target retention volume does does* ***NOT*** *include the* $RRV_{reductions}$ *. and therefore does* ***NOT*** *represent the exact RRV. It is intended to set a target for the designer while giving flexibility in where the* $RRV_{reductions}$ *are applied within each drainage area, so long as the total RRV for the drainage area is met.*
6. **Design Parameters:** Enter the design parameters for each storage and/or material layer of the facility to achieve the required retention volume. Porosity values (n) and volumes are auto-calculated.
   - *The Retention Volume Provided (*V_R*) is auto-calculated based on the GSI total storage volume (*$GSI_{storage}$*) and the GSI runoff reduction factor (*RRF_{GSI}*) based on the GSI Practice type and precense of an underdrain. Note that the* V_R *cannot exceed the maximum retention credit allowed based on maximum WQv tributary to each GSI. Oversizing a facility without the tributary drainage area to support it will not*
   - *A message will appear if the facility is oversized by more than 10%, warning that credit cannot be taken for volume over the maximum retention credit allowed and to consider reducing the facility size.*
   - *The bypass volume is calculated as the difference between the approximate target retention volume and the* V_R *. The bypass volume is automatically routed to the designated downstream retention facility identified. Note that bypass is permitted provided that the bypass at the downstream most facility(ies) do not exceed the* $RRV_{reductions}$ *for the drainage area.*
   - *Underneath the design table, the required retention volume after reductions and the retention volume achieved with retention practices are shown. A message will indicate whether the required retention volume was achieved or if additional volume is needed.*
7. **Hide/Show Blank Rows:** After completing the design table, click the "Hide Blank Rows" button. If necessary, blank rows can be added back by clicking the "Show Blank Rows" button.

Stormwater Management Criteria Calculator Instructions

Detention Calculations	
1.	**Rainfall Depth:** Input the rainfall depth for each design storm based on the project's location.
2.	**Retention Design Completion:** After completing the retention design, cells in row 86 will auto-calculate an adjusted CN, and row 87 will indicate if detention is required for each storm event. Use this information to meet detention release rate
3.	**Peak Outflow Rates:** Input the modeled peak outflow rates for each design storm. A message will appear if the release rate requirements have been met or if the outlet control needs resizing to meet the required release rate.

Verification

Purpose: The verification tab is a tool for both designers and reviewers to ensure that the design for individual drainage areas meets the total site requirements.

Drainage Area Summary: For each drainage area, the tab summarizes the following:

- RRV Prior to Reductions
- RRV Reductions
- RRV After Reductions
- Retention Volume Achieved

Total Site Summary: The Total Site Summary table auto-sums each of these values and checks that the required Percent WQv Control is achieved. A message will appear if the required Percent WQv Control is not achieved, in which case, the design needs revised for one or more drainage areas.

General Requirements

Project Information

Project Name:	
Date:	
Address:	
Nearest Intersection:	
Project Type:	
System Type:	
Proposed Land Use:	
Input Value Basis:	

Site Parameters

Total Disturbed Area of Site		acres
Total Proposed Impervious Area		square feet
Effective FEMA floodplain?		*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?		*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☐ No ☐ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☐ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☐ No ☐ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☐ No ☐ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☐ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☐ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☐ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☐ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 0 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☐ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☐ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	0	0
	RRV (with RRV Reductions)	0	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☐ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☐ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?		
☐ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?		
☐ Yes ☐ No ☐ N/A	100-year peak outflow control achieved?		

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☐ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☐ Yes ☐ No ☐ N/A	Easement(s) provided?
☐ Yes ☐ No ☐ N/A	Enclosed pipe systems per requirements of 5608.2?
☐ Yes ☐ No ☐ N/A	Minor drainage systems per requirements of 5608.3 A?
☐ Yes ☐ No ☐ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☐ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☐ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Maintenance Requirements & Responsibility

Storm Drainage System Components

Select all applicable components of the storm drainage system design

- ☐ Preserved Natural Areas
- ☐ Restored Natural Areas
- ☐ Retention & Detention Practices
- ☐ Collection Practices
- ☐ Conveyance Practices

During Construction

Anticipated Construction Start — Month _____ Year _____

Anticipated Construction Completion — Month _____ Year _____

Responsible Party

Name	Address	Phone

Warranty and/or Vegetation Establishment Period

Anticipated Vegetation Install Start — (month) _____ (year) _____

Anticipated Vegetation Install Completion — (month) _____ (year) _____

Responsible Party

Name	Address	Phone

Long-Term Owner (Post-Warranty Period)

Describe source of funding and the mechansim for maintenance of stormwater drainage system:

Responsible Party

Name	Address	Phone

Certification

I hereby certify as the Owner of this property that the maintenance responsibility information specified herein is accurate, and that responsible parties are aware of the maintenance activities required for all components of the stormwater drainage system.

Site Summary

Project and Development Type:	
System Type:	
Proposed Land Use:	
Input Value Basis:	
Assumed Percent Impervious Coverage:	*Select an Input Value Basis above.*
Total Disturbed Area (sf):	

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	0%
Total Controlled Disturbed Area (sf)	0
Controlled Area Rv ($Rv_{controlled}$)	0.00
Total Uncontrolled Disturbed Area (sf)	0
Total Required Retention Volume (cf) (RRV)	0
Uncontrolled Retention Volume (cf)	0
Adjusted PT% within Controlled Drainage Areas	NA

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 2

Drainage Area Summary Table		
Unique Drainage Area Identifier (ID)	**Can this drainage area be feasibly controlled?**	**Disturbed Drainage Area (sf)**
1	Yes	
2	Yes	

Select post-development cover types within the disturbed area:	
Natural Area	☐
Pervious Area	☐
Impervious Area	☐
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Site Summary

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	0
RRV Prior to Reductions (cf)	**0**
Pervious Area Weighted Rv	-
Impervious Area Weighted Rv	-
Post-Development Condition Weighted CN	-

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70		77	**0**	0%	0.00
Pervious Area		39		61		74		80	**0**	0%	0.25
Impervious Area		98		98		98		98	**0**	0%	0.95
Solar Farm - Native		62		76		84		88	**0**	0%	0.40
Solar Farm - Gravel		75		84		89		92	**0**	0%	0.60
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations		75		84		89		92	**0**	0%	0.60
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts		88		92		94		96	**0**	0%	0.80
Gravel - Public Road with Compacted Subgrade Material		98		99		98		98	**0**	0%	0.95
Artificial Turf - No Underdrain System		66		78		85		89	**0**	0%	0.45
Artificial Turf - Underdrain System		88		92		94		96	**0**	0%	0.80
Water Surfaces		100		100		100		99	**0**	0%	1.00
Total	**0**		**0**		**0**		**0**		**0**	**0%**	

Summary Table for Drainage Area ID:	2
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	0
RRV Prior to Reductions (cf)	**0**
Pervious Area Weighted Rv	-
Impervious Area Weighted Rv	-
Post-Development Condition Weighted CN	-

Cover Type Area Table for Drainage Area 2	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70		77	**0**	0%	0.00
Pervious Area		39		61		74		80	**0**	0%	0.25
Impervious Area		98		98		98		98	**0**	0%	0.95
Solar Farm - Native		62		76		84		88	**0**	0%	0.40
Solar Farm - Gravel		75		84		89		92	**0**	0%	0.60
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations		75		84		89		92	**0**	0%	0.60
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts		88		92		94		96	**0**	0%	0.80
Gravel - Public Road with Compacted Subgrade Material		98		99		98		98	**0**	0%	0.95
Artificial Turf - No Underdrain System		66		78		85		89	**0**	0%	0.45
Artificial Turf - Underdrain System		88		92		94		96	**0**	0%	0.80
Water Surfaces		100		100		100		99	**0**	0%	1.00
Total	**0**		**0**		**0**		**0**		**0**	**0%**	

Design for Drainage Area

Drainage Area ID	
Is this drainage area controlled?	
Disturbed drainage area (sf)	
RRV Prior to Reductions (cf)	
Pervious Area Weighted Rv	
Impervious Area Weighted Rv	
Post-Development Condition Weighted CN	

View Instructions

Required Retention Volume Reductions ($RRV_{Reductions}$)

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees		10	0

Total $RRV_{reductions}$ (cf)	**0**
RRV After Reductions (cf)	**0**
% Reduction in RRV	**0.0%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☑
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows

Show Blank Rows

PT% 0.00%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area (sf)	Impervious Drainage Area (sf)	Approx. Target Retention Volume (cf)	Retention Volume Provided (cf) (V_R)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Choker Course				Total Storage Volume (cf) ($GSI_{storage}$)	Runoff Reduction Factor (%) (GSI_{RRF})	Maximum Retention Credit Allowed (cf)
								Area (sf) A_p	Height (ft) h_p	Volume (cf) V_P	Area (sf) A_m	n	Height (ft) h_m	Volume (cf) V_m	Area (sf) A_m	n	Height (ft) h_m	Volume (cf) V_m	Area (sf) A_m	n	Height (ft) h_m	Volume (cf) V_m			
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0
					0	**0**				0		0.3		0		0.4		0		0.3		0	0		0

Required Retention Volume (cf)	0
Retention Volume Achieved (cf)	0

Design for Drainage Area

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Post-Development Conditions

Weighted CN	0.00
S	1000.00
Ia	50.00

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	0.00	0.00	0.00	0.00	0.00
Post-Development Runoff Volume (in) with Retention	0.00	0.00	0.00	0.00	0.00
Retention Adjusted CN	0.0	0.0	0.0	0.0	0.0
Additional Detention Required?	**No**	**No**	**No**	**No**	**No**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)
2-Year, NOAA Atlas14 Median, First Quartile	0.20	0.00			0.00
10-Year, NOAA Atlas14 Median, First Quartile	0.60	0.00			0.00
100-Year, NOAA Atlas14 Median, First Quartile	3.00	0.00			0.00

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	0
	Total Site Rv:	0.00
	Total RRV Prior to Reductions (cf)	
	Total RRV Reductions (cf)	
	Total RRV After Reductions (cf)	
	Total Retention Volume Achieved (cf)	
	Percent WQv Control Achieved	0.0%

☑ ***Required percent site control achieved!***

APPENDIX E

Dry Detention Basin - Recommended Species

Basin Bottom: Periodic inundation with temporary ponding (up to 72 hours).

Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Aronia melanocarpa	Black Chokeberry	Yes	2 to 3	4 to 5	FACW	Med	Med	Low	Full Sun to Part Shade	Yes
Ceanothus americanus	New Jersey Tea	Yes	3 to 4	3 to 5	n/a	Dry to Med	Med	High	Full Sun to Part Shade	No
Cephalanthus occidentalis	Button Bush	Yes	5 to 12	4 to 8	OBL	Med to Wet	High	Med	Full Sun to Part Shade	No
Hibiscus moscheutos	Rose Mallow	Yes	3 to 8	3 to 8	OBL	Med to Wet	High	Low	Full Sun to Part Shade	Yes
Hydrangea arborescens	Smooth Hydrangea	Yes	3 to 5	3 to 5	FACU	Med	Med	Low	Part Shade	No
Itea virginica	Sweetspire	Yes	3 to 5	3 to 5	OBL	Med to Wet	High	Med	Part Shade to Shade	Yes
Physocarpus opulifolius	Ninebark	Yes	5 to 8	4 to 6	FACW	Dry to Med	Med	Med	Full Sun to Part Shade	No
Prunus virginiana	Choke Cherry	Yes	20 to 30	15 to 20	FACU	Dry to Med	Med	Med	Full Sun to Part Shade	No
Rhus aromatica	Fragrant Sumac	Yes	2 to 6	6 to 10	UPL	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Salix humilis	Prairie Willow	Yes	2 to 10	2 to 10	FACU	Dry	Low	High	Full Sun to Part Shade	Yes
Sambucus canadensis	Elderberry	Yes	5 to 12	5 to 12	n/a	Med to Wet	High	Low	Full Sun to Part Shade	No
Viburnum dentatum	Arrowwood Viburnum	Yes	6 to 10	6 to 10	FAC	Med	Med	High	Full Sun to Part Shade	Yes
Viburnum prunifolium	Blackhaw Viburnum	Yes	12 to 15	6 to 12	FACU	Dry to Med	Low	High	Full Sun to Part Shade	No
Allium cernuum	Nodding Onion	Yes	1 to 1.5	0.25 to 0.5	FACU	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Amsonia hubrichtii	Bluestar	No	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun to Part Shade	Yes
Amsonia illustris	Shining Bluestar	Yes	2 to 3	1.5	n/a	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
Amsonia taebermontnaa	Bluestar	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun to Part Shade	No
Anemone canadensis	Windflower	Yes	1 to 2	2.5	FACW	Med to Wet	High	Med	Full Sun to Part Shade	No
Asclepias incarnata	Swamp Milkweed	Yes	2 to 5	2 to 3	OBL	Med to Wet	High	Med	Full Sun	No
Asclepias tuberosa	Butterfly Milkweed	Yes	1 to 2.5	1.5	n/a	Dry to Med	Med	Med to High	Full Sun	No
Baptisia australis	Blue Wild Indigo	Yes	3 to 4	3 to 4	FACU	Dry to Med	Med	Med to High	Full Sun to Part Shade	No
Callirhoe involucrata	Purple Poppy Mallow	Yes	.5 to 1	.5 to 3	n/a	Dry to Med	Med	Med to High	Full Sun	No
Conoclinium coelestinum	Blue Mist Flower	Yes	1.5 to 3	1.5 to 3	FACW	Med	Med	Med	Full Sun to Part Shade	No
Coreopsos lanceolata	Lanceleaf Coreopsis	Yes	1 to 2	1 to 1.5	FACU	Dry to Med	Low	High	Full Sun	Yes
Echinacea paradoxa	Yellow Coneflower	Yes	2 to 3	1 to 1.5	n/a	Dry to Med	Med	High	Full Sun	No
Echinacea purpurea	Purple Coneflower	Yes	3 to 5	1 to 2	n/a	Dry to Med	Low	High	Full Sun to Part Shade	No
Eryngium yuccifolium	Rattlesnake Master	Yes	4 to 5	2 to 3	FAC	Dry to Med	Low	High	Full Sun	Yes
Iris virginica	Blue Flag Iris	Yes	1 to 3	1 to 3	OBL	Med to Wet	High	Med	Full Sun	Yes
Liatrus pycnostachya	Prairie Blazing Star	Yes	2 to 5	1 to 2	FAC	Dry to Med	Med	Med to High	Full Sun	No
Liatrus spicata	Marsh Blazing Star	Yes	2 to 4	1 to 2	FAC	Med	Med	High	Full Sun	Yes
Monarda bradburiana	Eastern Beebalm	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	Med	Full Sun to Part Shade	No
Monarda fistulosa	Wild Bergamot	Yes	2 to 4	2 to 3	FACU	Dry to Med	Low	Med	Full Sun to Part Shade	Yes
Physostegia virginiana	Obedient Plant	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun	No
Pycnanthemum tenuifolium	Slender Mountain Mint	Yes	2 to 3	2 to 3	FAC	Dry to Med	Med	Med	Full Sun to Part Shade	Yes
Rudbeckia fulgida	Orange Coneflower	Yes	2 to 3	1 to 2	OBL	Dry to Med	Med	Med	Full Sun	No
Solidago rugosa	Rough Goldenrod	Yes	3 to 5	1.5 to 2.5	FAC	Med to Wet	Med	Med	Full Sun	No
Solidago speciosa	Showy Goldenrod	Yes	2 to 3	2 to 3	n/a	Dry to Med	Med	Med to High	Full Sun	No
Symphyotrichum oblongifolium	Aromatic Aster	Yes	1 to 3	1 to 3	n/a	Dry to Med	Low	High	Full Sun	No
Tradescantia ohiensis	Ohio Spiderwort	Yes	1.5 to 3	2 to 3	FACU	Med to Wet	Med	Med	Part Shade to Shade	No

Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Andropogon gerardii	Big Bluestem	Yes	4 to 6	2 to 3	FAC	Dry to Med	Med	High	Full Sun	Yes
Bouteloua curtipendula	Sideoats Grama	Yes	1 to 1.5	1 to 1.5	n/a	Dry	Med	High	Full Sun	Yes
Bouteloua gracilis	Blue Grama	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	High	Full Sun	No
Calamagrostis x acutiflora	Feather Reed Grass	No	3 to 5	1.5 to 2.5	n/a	Med to Wet	Med	Low	Full Sun	No
Calamagrostis brachytricha	Korean Feather Reed Grass	No	3 to 4	2 to 3	n/a	Med to Wet	Med	Low	Full Sun to Part Shade	Yes
Chasmanthium latifolium	Northern Sea Oats	Yes	2 to 5	1 to 2.5	FACW	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
Deschampsia cespitosa	Tufted Hairgrass	Yes	2 to 3	1 to 2	FACW	Med	Med	Med	Part Shade to Shade	Yes
Elymus hystrix	Bottlebrush Grass	Yes	2.5-3	1-1.5	FACU	Dry-Med	Med	High	Full Sun to Part Shade	Yes
Elymus virginicus	Virginia Wildrye	Yes	2 to 4	1 to 2	FACW	Med	Med	Med to High	Full Sun to Part Shade	No
Eragrostis spectabilis	Purple Love Grass	Yes	1 to 2	1 to 2	UPL	Dry to Med	Med	High	Full Sun	No
Panicum virgatum	Switch Grass	Yes	3 to 6	2 to 3	FAC	Med to Wet	High	Med to High	Full Sun to Part Shade	Yes
Schizachyrium scoparium	Little Bluestem	Yes	2 to 4	1.5 to 2	FACU	Dry	High	Med	Full Sun	Yes
Sorghastrum nutans	Indian Grass	Yes	3 to 5	2-Jan	FACU	Dry-Med	Med	High	Full Sun	Yes
Sporobolus heterolepsis	Prairie Dropseed	Yes	2 to 3	2 to 3	FACU	Dry to Med	Low	High	Full Sun	Yes
Carex albicans	White-tinged Sedge	Yes	1 to 1.5	1 to 1.5	UPL	Dry to Med	Low	High	Part Shade to Shade	No
Carex amphibola	Creek Sedge	Yes	1	1	FAC	Med to Wet	High	Low	Full Sun to Part Shade	No
Carex bicknellii	Prairie Sedge	Yes	1 to 1.5	1 to 1.5	FACU	Dry to Wet	Med	High	Full Sun to Part Shade	No
Carex grayi	Gray's Sedge	Yes	2 to 3	2 to 3	FACW	Med to Wet	High	Low	Full Sun to Full Shade	Yes
Carex radiata	Star Sedge	Yes	1 to 1.5	1 to 1.5	FAC	Med to Wet	High	Med	Part Shade to Full Shade	No
Carex shortiana	Short's Sedge	Yes	1.5 to 2	1.5 to 2	FACW	Wet	High	Low	Full Sun to Part Shade	No
Carex vulpinoidea	Fox Sedge	Yes	1 to 3	.5 to 2	FACW	Wet	High	Low	Full Sun to Part Shade	Yes
Juncus effusus	Common Rush	Yes	1.5 to 3	1.5 to 3	OBL	Wet	High	Low	Full Sun to Part Shade	Yes
Juncus tenuis	Path Rush	Yes	.5 to 1.5	.5 to 1.5	FAC	Med to Wet	Med	Med	Full Sun to Part Shade	Yes

Obligate Wetland (OBL) - Almost always occurs in wetlands under natural conditions.
Facultative Wetland (FACW) - Usually occurs in wetlands, but occasionally found in non-wetlands.
Facultative (FAC) - Equally like to occur in wetlands and non-wetlands.
Facultative Upland (FACU) - Usually occurs in non-wetlands, but occasionally found in wetlands.
Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Shrub
Perennial
Grass
Sedge/Rush

Lower Side Slopes - Recommended Species

Lower Side Slopes: From Basin Bottom up to ponding elevation.

Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Aesculus parvifolia	Bottlebrush Buckeye	Yes	8 to 12	8 to 15	n/a	Med	Low	Low	Full Sun to Part Shade	No
Amorpha canescens	Leadplant	Yes	2 to 3	2.5	n/a	Dry to Med	Low	High	Full Sun	No
Aronia melanocarpa	Black Chokeberry	Yes	2 to 3	4 to 5	FACW	Med	Med	Low	Full Sun to Part Shade	Yes
Caryopteris x clandonensis	Blue Mist Shrub	Yes	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun	No
Ceanothus americanus	New Jersey Tea	Yes	3 to 4	3 to 5	n/a	Dry to Med	Med	High	Full Sun to Part Shade	No
Cephalanthus occidentalis	Button Bush	Yes	5 to 12	4 to 8	OBL	Med to Wet	High	Med	Full Sun to Part Shade	No
Clethra alnifolia	Summersweet	Yes	3 to 8	4 to 6	FACW	Med to Wet	High	Low to Med	Full Sun to Part Shade	Yes
Corylus americana	American Hazlenut	Yes	10 to 16	8 to 13	FACU	Med	Med	Med	Full Sun to Part Shade	No
Hamamelis virginiana	Witchhazel	Yes	15 to 20	15 to 20	FACU	Med	Med	Med	Full Sun to Part Shade	No
Hibiscus moscheutos	Rose Mallow	Yes	3 to 8	3 to 8	OBL	Med to Wet	High	Low	Full Sun to Part Shade	Yes
Hydrangea arborescens	Smooth Hydrangea	Yes	3 to 5	3 to 5	FACU	Med	Med	Low	Part Shade	No
Ilex verticillata	Winterberry	No	6 to 12	6 to 12	FACW	Med to Wet	High	Low	Full Sun to Part Shade	No
Itea virginica	Sweetspire	Yes	3 to 5	3 to 5	OBL	Med to Wet	High	Med	Part Shade to Shade	Yes
Physocarpus opulifolius	Ninebark	Yes	5 to 8	4 to 6	FACW	Dry to Med	Med	Med	Full Sun to Part Shade	No
Prunus virginiana	Choke Cherry	Yes	20 to 30	15 to 20	FACU	Dry to Med	Med	Med	Full Sun to Part Shade	No
Rhus aromatica	Fragrant Sumac	Yes	2 to 6	6 to 10	UPL	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Rhus typhina	Staghorn Sumac	Yes	15-25	20 to 30	n/a	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Salix humilis	Prairie Willow	Yes	2 to 10	2 to 10	FACU	Dry	Low	High	Full Sun to Part Shade	Yes
Sambucus canadensis	Elderberry	Yes	5 to 12	5 to 12	n/a	Med to Wet	High	Low	Full Sun to Part Shade	No
Viburnum dentatum	Arrowwood Viburnum	Yes	6 to 10	6 to 10	FAC	Med	Med	High	Full Sun to Part Shade	Yes
Viburnum prunifolium	Blackhaw Viburnum	Yes	12 to 15	6 to 12	FACU	Dry to Med	Low	High	Full Sun to Part Shade	No
Allium cernuum	Nodding Onion	Yes	1 to 1.5	0.25 to 0.5	FACU	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Amsonia hubrichtii	Bluestar	No	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun to Part Shade	Yes
Amsonia illustris	Shining Bluestar	Yes	2 to 3	1.5	n/a	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
Amsonia taebermontnaa	Bluestar	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun to Part Shade	No
Anemone canadensis	Windflower	Yes	1 to 2	2.5	FACW	Med to Wet	High	Med	Full Sun to Part Shade	No
Asclepias incarnata	Swamp Milkweed	Yes	2 to 5	2 to 3	OBL	Med to Wet	High	Med	Full Sun	No
Asclepias tuberosa	Butterfly Milkweed	Yes	1 to 2.5	1.5	n/a	Dry to Med	Med	Med to High	Full Sun	No
Conoclinium coelestinum	Blue Mist Flower	Yes	1.5 to 3	1.5 to 3	FACW	Med	Med	Med	Full Sun to Part Shade	No
Coreopsos lanceolata	Lanceleaf Coreopsis	Yes	1 to 2	1 to 1.5	FACU	Dry to Med	Low	High	Full Sun	Yes
Echinacea paradoxa	Yellow Coneflower	Yes	2 to 3	1 to 1.5	n/a	Dry to Med	Med	High	Full Sun	No
Echinacea purpurea	Purple Coneflower	Yes	3 to 5	1 to 2	n/a	Dry to Med	Low	High	Full Sun to Part Shade	No
Eryngium yuccifolium	Rattlesnake Master	Yes	4 to 5	2 to 3	FAC	Dry to Med	Low	High	Full Sun	Yes
Eupatorium perfoliatum	American Boneset	Yes	4 to 6	3 to 4	OBL	Med to Wet	Med	Low	Full Sun to Part Shade	Yes
Eutrochium fistulosum	Joe Pye Weed	Yes	4 to 7	2 to 4	OBL	Med to Wet	Med	Low	Full Sun to Part Shade	No
Iris fulva	Copper Iris	Yes	2 to 3	1 to 2	OBL	Med to Wet	High	Med	Full Sun to Part Shade	No
Iris virginica	Blue Flag Iris	Yes	1 to 3	1 to 3	OBL	Med to Wet	High	Med	Full Sun	Yes
Liatrus pycnostachya	Prairie Blazing Star	Yes	2 to 5	1 to 2	FAC	Dry to Med	Med	Med to High	Full Sun	No

	Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
	Liatrus spicata	Marsh Blazing Star	Yes	2 to 4	1 to 2	FAC	Med	Med	High	Full Sun	Yes
	Monarda bradburiana	Eastern Beebalm	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	Med	Full Sun to Part Shade	No
	Monarda fistulosa	Wild Bergamot	Yes	2 to 4	2 to 3	FACU	Dry to Med	Low	Med	Full Sun to Part Shade	Yes
	Physostegia virginiana	Obedient Plant	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun	No
	Pycnanthemum tenuifolium	Slender Mountain Mint	Yes	2 to 3	2 to 3	FAC	Dry to Med	Med	Med	Full Sun to Part Shade	Yes
	Rudbeckia fulgida	Orange Coneflower	Yes	2 to 3	1 to 2	OBL	Dry to Med	Med	Med	Full Sun	No
	Solidago rugosa	Rough Goldenrod	Yes	3 to 5	1.5 to 2.5	FAC	Med to Wet	Med	Med	Full Sun	No
	Solidago speciosa	Showy Goldenrod	Yes	2 to 3	2 to 3	n/a	Dry to Med	Med	Med to High	Full Sun	No
	Symphyotrichum oblongifolium	Aromatic Aster	Yes	1 to 3	1 to 3	n/a	Dry to Med	Low	High	Full Sun	No
	Tradescantia ohiensis	Ohio Spiderwort	Yes	1.5 to 3	2 to 3	FACU	Med to Wet	Med	Med	Part Shade to Shade	No
	Verbena hastata	American Blue Vervain	Yes	2 to 6	1 to 2.5	FACW	Med to Wet	Med	Low	Full Sun	No
	Andropogon gerardii	Big Bluestem	Yes	4 to 6	2 to 3	FAC	Dry to Med	Med	High	Full Sun	Yes
	Bouteloua curtipendula	Sideoats Grama	Yes	1 to 1.5	1 to 1.5	n/a	Dry	Med	High	Full Sun	Yes
	Bouteloua gracilis	Blue Grama	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	High	Full Sun	No
	Calamagrostis x acutiflora	Feather Reed Grass	No	3 to 5	1.5 to 2.5	n/a	Med to Wet	Med	Low	Full Sun	No
	Calamagrostis brachytricha	Korean Feather Reed Grass	No	3 to 4	2 to 3	n/a	Med to Wet	Med	Low	Full Sun to Part Shade	Yes
	Chasmanthium latifolium	Northern Sea Oats	Yes	2 to 5	1 to 2.5	FACW	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
	Deschampsia cespitosa	Tufted Hairgrass	Yes	2 to 3	1 to 2	FACW	Med	Med	Med	Part Shade to Shade	Yes
	Elymus hystrix	Bottlebrush Grass	Yes	2.5-3	1-1.5	FACU	Dry-Med	Med	High	Full Sun to Part Shade	Yes
	Elymus virginicus	Virginia Wildrye	Yes	2 to 4	1 to 2	FACW	Med	Med	Med to High	Full Sun to Part Shade	No
	Eragrostis spectabilis	Purple Love Grass	Yes	1 to 2	1 to 2	UPL	Dry to Med	Med	High	Full Sun	No
	Panicum virgatum	Switch Grass	Yes	3 to 6	2 to 3	FAC	Med to Wet	High	Med to High	Full Sun to Part Shade	Yes
	Schizachyrium scoparium	Little Bluestem	Yes	2 to 4	1.5 to 2	FACU	Dry	High	Med	Full Sun	Yes
	Sesleria autumnalis	Autumn Moor Grass	No	1	1 to 1.5	n/a	Dry to Med	Low	High	Full Sun to Part Shade	Yes
	Sorghastrum nutans	Indian Grass	Yes	3 to 5	2-Jan	FACU	Dry-Med	Med	High	Full Sun	Yes
	Sporobolus heterolepsis	Prairie Dropseed	Yes	2 to 3	2 to 3	FACU	Dry to Med	Low	High	Full Sun	Yes
	Carex albicans	White-tinged Sedge	Yes	1 to 1.5	1 to 1.5	UPL	Dry to Med	Low	High	Part Shade to Shade	No
	Carex amphibola	Creek Sedge	Yes	1	1	FAC	Med to Wet	High	Low	Full Sun to Part Shade	No
	Carex bicknellii	Prairie Sedge	Yes	1 to 1.5	1 to 1.5	FACU	Dry to Wet	Med	High	Full Sun to Part Shade	No
	Carex grayi	Gray's Sedge	Yes	2 to 3	2 to 3	FACW	Med to Wet	High	Low	Full Sun to Full Shade	Yes
	Carex radiata	Star Sedge	Yes	1 to 1.5	1 to 1.5	FAC	Med to Wet	High	Med	Part Shade to Full Shade	No
	Carex shortiana	Short's Sedge	Yes	1.5 to 2	1.5 to 2	FACW	Wet	High	Low	Full Sun to Part Shade	No
	Carex stricta	Tussock Sedge	Yes	1 to 3	1 to 2	OBL	Med to Wet	High	Low	Full Sun to Part Shade	No
	Juncus effusus	Common Rush	Yes	1.5 to 3	1.5 to 3	OBL	Wet	High	Low	Full Sun to Part Shade	Yes
	Juncus tenuis	Path Rush	Yes	.5 to 1.5	.5 to 1.5	FAC	Med to Wet	Med	Med	Full Sun to Part Shade	Yes

Obligate Wetland (OBL) - Almost always occurs in wetlands under natural conditions.
Facultative Wetland (FACW) - Usually occurs in wetlands, but occasionally found in non-wetlands.
Facultative (FAC) - Equally like to occur in wetlands and non-wetlands.
Facultative Upland (FACU) - Usually occurs in non-wetlands, but occasionally found in wetlands.
Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Shrub
Perennial
Grass
Sedge/Rush

Upper Side Slopes - Recommended Species

Upper Side Slopes: Above ponding elevation up to top of GSI facility.

Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Aesculus parvifolia	Bottlebrush Buckeye	Yes	8 to 12	8 to 15	n/a	Med	Low	Low	Full Sun to Part Shade	No
Amorpha canescens	Leadplant	Yes	2 to 3	2.5	n/a	Dry to Med	Low	High	Full Sun	No
Caryopteris x clandonensis	Blue Mist Shrub	Yes	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun	No
Ceanothus americanus	New Jersey Tea	Yes	3 to 4	3 to 5	n/a	Dry to Med	Med	High	Full Sun to Part Shade	No
Corylus americana	American Hazlenut	Yes	10 to 16	8 to 13	FACU	Med	Med	Med	Full Sun to Part Shade	No
Hamamelis virginiana	Witchhazel	Yes	15 to 20	15 to 20	FACU	Med	Med	Med	Full Sun to Part Shade	No
Hydrangea arborescens	Smooth Hydrangea	Yes	3 to 5	3 to 5	FACU	Med	Med	Low	Part Shade	No
Physocarpus opulifolius	Ninebark	Yes	5 to 8	4 to 6	FACW	Dry to Med	Med	Med	Full Sun to Part Shade	No
Prunus virginiana	Choke Cherry	Yes	20 to 30	15 to 20	FACU	Dry to Med	Med	Med	Full Sun to Part Shade	No
Rhus aromatica	Fragrant Sumac	Yes	2 to 6	6 to 10	UPL	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Rhus typhina	Staghorn Sumac	Yes	15-25	20 to 30	n/a	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Salix humilis	Prairie Willow	Yes	2 to 10	2 to 10	FACU	Dry	Low	High	Full Sun to Part Shade	Yes
Sambucus canadensis	Elderberry	Yes	5 to 12	5 to 12	n/a	Med to Wet	High	Low	Full Sun to Part Shade	No
Viburnum dentatum	Arrowwood Viburnum	Yes	6 to 10	6 to 10	FAC	Med	Med	High	Full Sun to Part Shade	Yes
Viburnum prunifolium	Blackhaw Viburnum	Yes	12 to 15	6 to 12	FACU	Dry to Med	Low	High	Full Sun to Part Shade	No
Allium cernuum	Nodding Onion	Yes	1 to 1.5	0.25 to 0.5	FACU	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Amsonia hubrichtii	Bluestar	No	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun to Part Shade	Yes
Amsonia illustris	Shining Bluestar	Yes	2 to 3	1.5	n/a	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
Amsonia taebermontnaa	Bluestar	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun to Part Shade	No
Asclepias tuberosa	Butterfly Milkweed	Yes	1 to 2.5	1.5	n/a	Dry to Med	Med	Med to High	Full Sun	No
Baptisia australis	Blue Wild Indigo	Yes	3 to 4	3 to 4	FACU	Dry to Med	Med	Med to High	Full Sun to Part Shade	No
Callirhoe involucrata	Purple Poppy Mallow	Yes	.5 to 1	.5 to 3	n/a	Dry to Med	Med	Med to High	Full Sun	No
Coreopsos lanceolata	Lanceleaf Coreopsis	Yes	1 to 2	1 to 1.5	FACU	Dry to Med	Low	High	Full Sun	Yes
Echinacea paradoxa	Yellow Coneflower	Yes	2 to 3	1 to 1.5	n/a	Dry to Med	Med	High	Full Sun	No
Echinacea purpurea	Purple Coneflower	Yes	3 to 5	1 to 2	n/a	Dry to Med	Low	High	Full Sun to Part Shade	No
Eryngium yuccifolium	Rattlesnake Master	Yes	4 to 5	2 to 3	FAC	Dry to Med	Low	High	Full Sun	Yes
Glandularia canadensis	Rose Verbena	Yes	.5 to 1.5	1 to 2	n/a	Dry to Med	Low	Med to High	Full Sun	No
Liatrus pycnostachya	Prairie Blazing Star	Yes	2 to 5	1 to 2	FAC	Dry to Med	Med	Med to High	Full Sun	No
Liatrus spicata	Marsh Blazing Star	Yes	2 to 4	1 to 2	FAC	Med	Med	High	Full Sun	Yes
Monarda bradburiana	Eastern Beebalm	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	Med	Full Sun to Part Shade	No
Monarda fistulosa	Wild Bergamot	Yes	2 to 4	2 to 3	FACU	Dry to Med	Low	Med	Full Sun to Part Shade	Yes
Oenothera macrocarpa	Missouri Evening Primrose	Yes	1	1 to 1.5	n/a	Dry to Med	Low	High	Full Sun	Yes
Physostegia virginiana	Obedient Plant	Yes	2 to 3	2 to 3	FACW	Med	Med	Med	Full Sun	No
Pycnanthemum tenuifolium	Slender Mountain Mint	Yes	2 to 3	2 to 3	FAC	Dry to Med	Med	Med	Full Sun to Part Shade	Yes
Solidago rugosa	Rough Goldenrod	Yes	3 to 5	1.5 to 2.5	FAC	Med to Wet	Med	Med	Full Sun	No
Solidago speciosa	Showy Goldenrod	Yes	2 to 3	2 to 3	n/a	Dry to Med	Med	Med to High	Full Sun	No
Symphyotrichum oblongifolium	Aromatic Aster	Yes	1 to 3	1 to 3	n/a	Dry to Med	Low	High	Full Sun	No

	Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
	Bouteloua curtipendula	Sideoats Grama	Yes	1 to 1.5	1 to 1.5	n/a	Dry	Med	High	Full Sun	Yes
	Bouteloua gracilis	Blue Grama	Yes	1 to 2	1 to 2	n/a	Dry to Med	Low	High	Full Sun	No
	Elymus hystrix	Bottlebrush Grass	Yes	2.5-3	1-1.5	FACU	Dry-Med	Med	High	Full Sun to Part Shade	Yes
	Eragrostis spectabilis	Purple Love Grass	Yes	1 to 2	1 to 2	UPL	Dry to Med	Med	High	Full Sun	No
	Panicum virgatum	Switch Grass	Yes	3 to 6	2 to 3	FAC	Med to Wet	High	Med to High	Full Sun to Part Shade	Yes
	Schizachyrium scoparium	Little Bluestem	Yes	2 to 4	1.5 to 2	FACU	Dry	High	Med	Full Sun	Yes
	Sesleria autumnalis	Autumn Moor Grass	No	1	1 to 1.5	n/a	Dry to Med	Low	High	Full Sun to Part Shade	Yes
	Sorghastrum nutans	Indian Grass	Yes	3 to 5	2-Jan	FACU	Dry-Med	Med	High	Full Sun	Yes
	Sporobolus heterolepsis	Prairie Dropseed	Yes	2 to 3	2 to 3	FACU	Dry to Med	Low	High	Full Sun	Yes
	Carex albicans	White-tinged Sedge	Yes	1 to 1.5	1 to 1.5	UPL	Dry to Med	Low	High	Part Shade to Shade	No
	Carex amphibola	Creek Sedge	Yes	1	1	FAC	Med to Wet	High	Low	Full Sun to Part Shade	No
	Carex bicknellii	Prairie Sedge	Yes	1 to 1.5	1 to 1.5	FACU	Dry to Wet	Med	High	Full Sun to Part Shade	No
	Carex radiata	Star Sedge	Yes	1 to 1.5	1 to 1.5	FAC	Med to Wet	High	Med	Part Shade to Full Shade	No
	Juncus tenuis	Path Rush	Yes	.5 to 1.5	.5 to 1.5	FAC	Med to Wet	Med	Med	Full Sun to Part Shade	Yes

Obligate Wetland (OBL) - Almost always occurs in wetlands under natural conditions.
Facultative Wetland (FACW) - Usually occurs in wetlands, but occasionally found in non-wetlands.
Facultative (FAC) - Equally like to occur in wetlands and non-wetlands.
Facultative Upland (FACU) - Usually occurs in non-wetlands, but occasionally found in wetlands.
Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Shrub
Perennial
Grass
Sedge/Rush

Overall Aquatic Plant List

Type	Botanical Name	Common Name	Native	Height	Spread	Habit	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Aquatiic	*Justicia americana*	Water Willow	Yes	1 to 3	1 to 3	Spreading	OBL	High	Low	Full Sun to Part Shade	Moderate
Aquatiic	*Peltandra virginica*	Arrow Arum	Yes	1.5 to 2	1.5 to 2	Clumping	OBL	High	Low	Full Sun to Part Shade	Yes
Aquatiic	*Pontedaria cordata*	Pickerelweed	Yes	2 to 4	1.5 to 2	Spreading	OBL	High	Low	Full Sun	Yes
Aquatiic	*Sagittaria latifolia*	Arrowhead	Yes	1 to 4	1 to 3	Spreading	OBL	High	Low	Full Sun	Yes
Aquatiic	*Saururus cernuus*	Lizard's Tail	Yes	1 to 2	1 to 2	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes
Aquatiic	*Schoenoplectus tabernaemontani*	Softstem Bulrush	Yes	4 to 8	3 to 6	Spreading	OBL	High	Low	Full Sun	Yes
Aquatiic	*Scirpus atrovirens*	Common Bulrush	Yes	4 to 5	3 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes
Aquatiic	*Scirpus cyperinus*	Wool Gras	Yes	3 to 5	2 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Moderate
Aquatiic	*Sparganium eurycarpum*	Broadfruited Bur Reed	Yes	3 to 6	2 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes

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Facultative (FAC) - Equally like to occur in wetlands and non-wetlands.
Facultative Upland (FACU) - Usually occurs in non-wetlands, but occasionally found in wetlands.
Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Overall Grass List

Type	Botanical Name	Common Name	Native	Height	Spread	Habit	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant	Layer Type
Grass	*Andropogon gerardii*	Big Bluestem	Yes	4 to 6	2 to 3	Clumping	FAC	Med	High	Full Sun	Yes	Structural
Grass	*Bouteloua curtipendula*	Sideoats Grama	Yes	1 to 1.5	1 to 1.5	Clumping	n/a	Med	High	Full Sun	Yes	Groundcover
Grass	*Bouteloua gracilis*	Blue Grama	Yes	1 to 2	1 to 2	Clumping	n/a	Low	High	Full Sun	No	Groundcover
Grass	*Calamagrostis x acutiflora*	Feather Reed Grass	No	3 to 5	1.5 to 2.5	Clumping	n/a	Med	Low	Full Sun	No	Structural
Grass	*Calamagrostis brachytricha*	Korean Feather Reed Grass	No	3 to 4	2 to 3	Clumping	n/a	Med	Low	Full Sun to Part Shade	Yes	Structural
Grass	*Chasmanthium latifolium*	Northern Sea Oats	Yes	2 to 5	1 to 2.5	Clumping	FACW	Med	Med	Full Sun to Part Shade	Yes	Seasonal
Grass	*Deschampsia cespitosa*	Tufted Hairgrass	Yes	2 to 3	1 to 2	Clumping	FACW	Med	Med	Part Shade to Shade	Yes	Groundcover
Grass	*Elymus hystrix*	Bottlebrush Grass	Yes	2.5-3	1-1.5	Clumping	FACU	Med	High	Full Sun to Part Shade	Yes	Seasonal
Grass	*Elymus virginicus*	Virginia Wildrye	Yes	2 to 4	1 to 2	Clumping	FACW	Med	Med to High	Full Sun to Part Shade	No	Groundcover
Grass	*Eragrostis spectabilis*	Purple Love Grass	Yes	1 to 2	1 to 2	Clumping	UPL	Med	High	Full Sun	No	Groundcover
Grass	*Panicum virgatum*	Switch Grass	Yes	3 to 6	2 to 3	Clumping	FAC	High	Med to High	Full Sun to Part Shade	Yes	Structural
Grass	*Schizachyrium scoparium*	Little Bluestem	Yes	2 to 4	1.5 to 2	Clumping	FACU	High	Med	Full Sun	Yes	Seasonal
Grass	*Seslaria autumnalis*	Autumn Moor Grass	No	1	1 to 1.5	Clumping	n/a	Low	High	Full Sun to Part Shade	Yes	Groundcover
Grass	*Sorghastrum nutans*	Indian Grass	Yes	3 to 5	2-Jan	Clumping	FACU	Med	High	Full Sun	Yes	Structural
Grass	*Sprobolus heterolepsis*	Prairie Dropseed	Yes	2 to 3	2 to 3	Clumping	FACU	Low	High	Full Sun	Yes	Groundcover

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Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Overall Perennial List

Type	Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant	Layer Type
Perennial	*Allium cernuum*	Nodding Onion	Yes	1 to 1.5	0.25 to 0.5	FACU	Low	High	Full Sun to Part Shade	Yes	Seasonal
Perennial	*Amsonia hubrichtii*	Bluestar	No	2 to 3	2 to 3	n/a	Med	Med	Full Sun to Part Shade	Yes	Structural
Perennial	*Amsonia illustris*	Shining Bluestar	Yes	2 to 3	1.5	n/a	Med	Med	Full Sun to Part Shade	Yes	Seasonal
Perennial	*Amsonia taebermontnaa*	Bluestar	Yes	2 to 3	2 to 3	FACW	Med	Med	Full Sun to Part Shade	No	Seasonal
Perennial	*Anemone canadensis*	Windflower	Yes	1 to 2	2.5	FACW	High	Med	Full Sun to Part Shade	No	Groundcover
Perennial	*Asclepias incarnata*	Swamp Milkweed	Yes	2 to 5	2 to 3	OBL	High	Med	Full Sun	No	Structural
Perennial	*Asclepias tuberosa*	Butterfly Milkweed	Yes	1 to 2.5	1.5	n/a	Med	Med to High	Full Sun	No	Seasonal
Perennial	*Baptisia australis*	Blue Wild Indigo	Yes	3 to 4	3 to 4	FACU	Med	Med to High	Full Sun to Part Shade	No	Structural
Perennial	*Callirhoe involucrata*	Purple Poppy Mallow	Yes	.5 to 1	.5 to 3	n/a	Med	Med to High	Full Sun	No	Groundcover
Perennial	*Conoclinium coelestinum*	Blue Mist Flower	Yes	1.5 to 3	1.5 to 3	FACW	Med	Med	Full Sun to Part Shade	No	Seasonal
Perennial	*Coreopsos lanceolata*	Lanceleaf Coreopsis	Yes	1 to 2	1 to 1.5	FACU	Low	High	Full Sun	Yes	Seasonal
Perennial	*Echinacea paradoxa*	Yellow Coneflower	Yes	2 to 3	1 to 1.5	n/a	Med	High	Full Sun	No	Seasonal
Perennial	*Echinacea purpurea*	Purple Coneflower	Yes	3 to 5	1 to 2	n/a	Low	Med	Full Sun to Part Shade	No	Seasonal
Perennial	*Eryngium yuccifolium*	Rattlesnake Master	Yes	4 to 5	2 to 3	FAC	Low	High	Full Sun	Yes	Structural
Perennial	*Eupatorium perfoliatum*	American Boneset	Yes	4 to 6	3 to 4	OBL	Med	Low	Full Sun to Part Shade	Yes	Structural
Perennial	*Eutrochium fistulosum*	Joe Pye Weed	Yes	4 to 7	2 to 4	OBL	Med	Low	Full Sun to Part Shade	No	Structural
Perennial	*Glandularia canadensis*	Rose Verbena	Yes	.5 to 1.5	1 to 2	n/a	Low	Med to High	Full Sun	No	Groundcover
Perennial	*Iris fulva*	Copper Iris	Yes	2 to 3	1 to 2	OBL	High	Med	Full Sun to Part Shade	No	Seasonal
Perennial	*Iris virginica*	Blue Flag Iris	Yes	1 to 3	1 to 3	OBL	High	Med	Full Sun	Yes	Structural
Perennial	*Liatrus pycnostachya*	Prairie Blazing Star	Yes	2 to 5	1 to 2	FAC	Med	Med to High	Full Sun	No	Seasonal
Perennial	*Liatrus spicata*	Marsh Blazing Star	Yes	2 to 4	1 to 2	FAC	Med	High	Full Sun	Yes	Seasonal
Perennial	*Monarda bradburiana*	Eastern Beebalm	Yes	1 to 2	1 to 2	n/a	Low	Med	Full Sun to Part Shade	No	Seasonal
Perennial	*Monarda fistulosa*	Wild Bergamot	Yes	2 to 4	2 to 3	FACU	Low	Med	Full Sun to Part Shade	Yes	Seasonal
Perennial	*Oenothera macrocarpa*	Missouri Evening Primrose	Yes	1	1 to 1.5	n/a	Low	High	Full Sun	Yes	Groundcover
Perennial	*Physostegia virginiana*	Obedient Plant	Yes	2 to 3	2 to 3	FACW	Med	Med	Full Sun	No	Seasonal
Perennial	*Pycnanthemum tenuifolium*	Slender Mountain Mint	Yes	2 to 3	2 to 3	FAC	Med	Med	Full Sun to Part Shade	Yes	Seasonal
Perennial	*Rudbeckia fulgida*	Black-eyed Susan	Yes	2 to 3	1 to 2	OBL	Low	Med	Full Sun	No	Seasonal
Perennial	*Solidago rugosa*	Rough Goldenrod	Yes	3 to 5	1.5 to 2.5	FAC	Med	Med	Full Sun	No	Seasonal
Perennial	*Solidago speciosa*	Showy Goldenrod	Yes	2 to 3	2 to 3	n/a	Med	Med to High	Full Sun	No	Seasonal
Perennial	*Symphyotrichum oblongifolium*	Aromatic Aster	Yes	1 to 3	1 to 3	n/a	Low	High	Full Sun	No	Seasonal
Perennial	*Tradescantia ohiensis*	Ohio Spiderwort	Yes	1.5 to 3	2 to 3	FACU	Med	Med	Part Shade to Shade	No	Seasonal
Perennial	*Verbena hastata*	American Blue Vervain	Yes	2 to 6	1 to 2.5	FACW	Med	Low	Full Sun	No	Seasonal

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Overall Sedge & Rush List

Type	Botanical Name	Common Name	Native	Height	Spread	Tree Shape	Habit	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant	Layer Type
Sedge/Rush	*Carex albicans*	White-tinged Sedge	Yes	1 to 1.5	1 to 1.5		Clumping	UPL	Low	High	Part Shade to Shade	No	Groundcover
Sedge/Rush	*Carex amphibola*	Creek Sedge	Yes	1	1		Clumping	FAC	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex bicknellii*	Prairie Sedge	Yes	1 to 1.5	1 to 1.5		Clumping	FACU	Med	High	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex crinita*	Fringed Sedge	Yes	1 to 3	1 to 1.5		Clumping	OBL	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex emoryi*	Emory's Sedge	Yes	1 to 2	1 to 1.5		Spreading	OBL	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex frankii*	Frank's Sedge	Yes	1 to 2	1 to 2		Clumping	OBL	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex grayi*	Gray's Sedge	Yes	2 to 3	2 to 3		Clumping	FACW	High	Low	Full Sun to Full Shade	Yes	Seasonal
Sedge/Rush	*Carex lurida*	Sallow Sedge	Yes	1.5-3	2-Jan		Clumping	OBL	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex muskingumensis*	Palm Sedge	Yes	2 to 3	2 to 3		Spreading	OBL	High	High	Full Sun to Full Shade	Yes	Groundcover
Sedge/Rush	*Carex radiata*	Star Sedge	Yes	1 to 1.5	1 to 1.5		Clumping	FAC	High	Med	Part Shade to Full Shade	No	Groundcover
Sedge/Rush	*Carex shortiana*	Short's Sedge	Yes	1.5 to 2	1.5 to 2		Clumping	FACW	High	Low	Full Sun to Part Shade	No	Seasonal
Sedge/Rush	*Carex stricta*	Tussock Sedge	Yes	1 to 3	1 to 2		Clumping	OBL	High	Low	Full Sun to Part Shade	No	Groundcover
Sedge/Rush	*Carex vulpinoidea*	Fox Sedge	Yes	1 to 3	.5 to 2		Clumping	FACW	High	Low	Full Sun to Part Shade	Yes	Structural
Sedge/Rush	*Juncus effusus*	Common Rush	Yes	1.5 to 3	1.5 to 3		Clumping	OBL	High	Low	Full Sun to Part Shade	Yes	Structural
Sedge/Rush	*Juncus tenuis*	Path Rush	Yes	.5 to 1.5	.5 to 1.5		Spreading	FAC	High	High	Full Sun to Part Shade	Yes	Groundcover

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Facultative Upland (FACU) - Usually occurs in non-wetlands, but occasionally found in wetlands.
Obligate Upland (UPL) - Almost always occurs in non-wetlands under natural conditions.

Overall Shrub List

Type	Botanical Name	Common Name	Native	Height	Spread	Wetland Indicator Status	Water	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Shrub	*Aesculus parvifolia*	Bottlebrush Buckeye	Yes	8 to 12	8 to 15	n/a	Med	Med	Low	Full Sun to Part Shade	No
Shrub	*Amorpha canescens*	Leadplant	Yes	2 to 3	2.5	n/a	Dry to Med	Low	High	Full Sun	No
Shrub	*Aronia melanocarpa*	Black Chokeberry	Yes	2 to 3	4 to 5	FACW	Med	Med	Low	Full Sun to Part Shade	Yes
Shrub	*Caryopteris x clandonensis*	Blue Mist Shrub	Yes	2 to 3	2 to 3	n/a	Med	Med	Med	Full Sun	No
Shrub	*Ceanothus americanus*	New Jersey Tea	Yes	3 to 4	3 to 5	n/a	Dry to Med	Med	High	Full Sun to Part Shade	No
Shrub	*Cephalanthus occidentalis*	Button Bush	Yes	5 to 12	4 to 8	OBL	Med to Wet	High	Med	Full Sun to Part Shade	No
Shrub	*Clethra alnifolia*	Summersweet	Yes	3 to 8	4 to 6	FACW	Med to Wet	High	Low	Full Sun to Part Shade	Yes
Shrub	*Corylus americana*	American Hazlenut	Yes	10 to 16	8 to 13	FACU	Med	Med	Med	Full Sun to Part Shade	No
Shrub	*Hamamelis virginiana*	Witchhazel	Yes	15 to 20	15 to 20	FACU	Med	Med	Med	Full Sun to Part Shade	No
Shrub	*Hibiscus moscheutos*	Rose Mallow	Yes	3 to 8	3 to 8	OBL	Med to Wet	High	Low	Full Sun to Part Shade	Yes
Shrub	*Hydrangea arborescens*	Smooth Hydrangea	Yes	3 to 5	3 to 5	FACU	Med	Med	Low	Part Shade to Shade	No
Shrub	*Ilex verticillata*	Winterberry	Yes	6 to 12	6 to 12	FACW	Med to Wet	High	Low	Full Sun to Part Shade	Yes
Shrub	*Itea virginica*	Sweetspire	Yes	3 to 5	3 to 5	OBL	Med to Wet	High	Med	Part Shade to Shade	Yes
Shrub	*Physocarpus opulifolius*	Ninebark	Yes	5 to 8	4 to 6	FACW	Dry to Med	Med	Med	Full Sun to Part Shade	No
Shrub	*Prunus virginiana*	Choke Cherry	Yes	20 to 30	15 to 20	FACU	Dry to Med	Med	Med	Full Sun to Part Shade	No
Shrub	*Rhus aromatica*	Fragrant Sumac	Yes	2 to 6	6 to 10	UPL	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Shrub	*Rhus typhina*	Staghorn Sumac	Yes	15-25	20 to 30	n/a	Dry to Med	Low	High	Full Sun to Part Shade	Yes
Shrub	*Salix humilis*	Prairie Willow	Yes	2 to 10	2 to 10	FACU	Dry	Low	High	Full Sun to Part Shade	Yes
Shrub	*Sambucus canadensis*	Elderberry	Yes	5 to 12	5 to 12	n/a	Med to Wet	High	Low	Full Sun to Part Shade	No
Shrub	*Viburnum dentatum*	Arrowwood Viburnum	Yes	6 to 10	6 to 10	FAC	Med	Med	High	Full Sun to Part Shade	Yes
Shrub	*Viburnum prunifolium*	Blackhaw Viburnum	Yes	12 to 15	6 to 12	FACU	Dry to Med	Low	High	Full Sun to Part Shade	No

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Overall Tree List

Type	Botanical Name	Common Name	Native	Height	Spread	Tree Shape	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Tree	*Aesculus x carnea*	Horse Chestnut	Yes	30 to 40	25 to 35	Rounded	N/A		Low	Full Sun to Part Shade	Yes
Tree	*Acer campestre*	Hedge Maple	No	25 to 35	25 to 35	Rounded	N/A		Med	Full Sun to Part Shade	Yes
Tree	*Acer griseum*	Paperbark Maple	No	20 to 30	15-25	Rounded	FAC		Low	Full Sun to Part Shade	No
Tree	*Acer rubrum*	Red Maple	Yes	40 to 70	30 to 50	Oval	FACU	High	Low	Full Sun to Part Shade	No
Tree	*Acer saccharum*	Sugar Maple	Yes	40 to 80	30 to 60	Rounded	n/a	Med	Med	Full Sun to Part Shade	No
Tree	*Aesculus glabra*	Ohio Buckeye	Yes	20 to 40	20 to 40	Oval	FAC	Med	Med	Full Sun to Part Shade	No
Tree	*Betula nigra*	River Birch	Yes	40 to 70	20 to 30	Oval	FACW	High	Med	Full Sun to Part Shade	Yes
Tree	*Carya illinoinensis*	Pecan	Yes	75 to 100	40 to 70	Pyramid	FACW	Med	Med	Full Sun	No
Tree	*Catalpa speciosa*	Northern Catalpa	Yes	40 to 70	20 to 40	Rounded	FACU	Low	Med	Full Sun to Part Shade	No
Tree	*Celtis occidentalis*	Hackberry	Yes	40 to 60	40 to 60	Rounded	FAC	High	High	Full Sun to Part Shade	Yes
Tree	*Cercis canadensis*	Eastern Redbud	Yes	20 to 30	25 to 35	Flat Oval	FACU	Med	Med	Full Sun to Part Shade	No
Tree	*Cladrastis kentukea*	American Yellowwood	Yes	30 to 50	40 to 55	Vase	n/a	Med	Med	Full Sun to Part Shade	No
Tree	*Gleditsia triacanthos v. inermis*	Thornless Honeylocust	Yes	30 to 70	25 to 40	Spreading	FACU		High	Full Sun	Yes
Tree	*Gymnocladus dioica*	Kentucky Coffeetree	Yes	60 to 80	40 to 55	Oval	n/a	Med	High	Full Sun	No
Tree	*Juniperus virginiana*	Eastern Red Cedar	Yes	30 to 65	8 to 25	Conical	FACU	Low	High	Full Sun	No
Tree	*Maclura pomifera*	Osage Orange	Yes	35 to 60	35 to 60	Rounded	FACU	Med	Med	Full Sun to Part Shade	No
Tree	*Magnolia soulengeana*	Saucer Magnolia	No	20 to 25	20 to 25	Rounded	n/a	Low	Low	Full Sun to Part Shade	No
Tree	*Nyssa sylvatica*	Blackgum	Yes	30 to 50	20 to 30	Pyramidal	FAC	High	Med	Full Sun to Part Shade	Yes
Tree	*Quercus bicolor*	Swamp White Oak	Yes	50 to 60	50 to 60	Rounded	FACW	Med	High	Full Sun	No
Tree	*Quercus muehlenbergii*	Chinkapin Oak	Yes	40 to 60	50 to 70	Rounded	FACU	Low	High	Full Sun	No
Tree	*Taxodium ascendens*	Pond Cypress	Yes	30 to 70	15 to 20	Pyramidal	OBL	High	Med	Full Sun	Yes
Tree	*Taxodium disticum*	Bald Cypress	Yes	40 to 50	20 to 30	Columnar	OBL	High	Med	Full Sun	Yes
Tree	*Tillia americana*	American Linden	Yes	50 to 80	30 to 50	Oval	FACU	Med	Med	Full Sun to Part Shade	No
Tree	*Ulmus americana*	American Elm	Yes	60 to 80	40 to 70	Vase	FACW	Med	Med	Full Sun to Part Shade	Yes

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Overall Wetland Plant List

Type	Botanical Name	Common Name	Native	Height	Spread	Habit	Wetland Indicator Status	Inundation Tolerance	Drought Tolerance	Light	Salt Tolerant
Wetland	*Justicia americana*	Water Willow	Yes	1 to 3	1 to 3	Spreading	OBL	High	Low	Full Sun to Part Shade	Moderate
Wetland	*Peltandra virginica*	Arrow Arum	Yes	1.5 to 2	1.5 to 2	Clumping	OBL	High	Low	Full Sun to Part Shade	Yes
Wetland	*Pontedaria cordata*	Pickerelweed	Yes	2 to 4	1.5 to 2	Spreading	OBL	High	Low	Full Sun	Yes
Wetland	*Sagittaria latifolia*	Arrowhead	Yes	1 to 4	1 to 3	Spreading	OBL	High	Low	Full Sun	Yes
Wetland	*Saururus cernuus*	Lizard's Tail	Yes	1 to 2	1 to 2	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes
Wetland	*Schoenoplectus tabernaemontani*	Softstem Bulrush	Yes	4 to 8	3 to 6	Spreading	OBL	High	Low	Full Sun	Yes
Wetland	*Scirpus atrovirens*	Common Bulrush	Yes	4 to 5	3 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes
Wetland	*Scirpus cyperinus*	Wool Gras	Yes	3 to 5	2 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Moderate
Wetland	*Sparganium eurycarpum*	Broadfruited Bur Reed	Yes	3 to 6	2 to 4	Spreading	OBL	High	Low	Full Sun to Part Shade	Yes

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Wet Detention - Recommended Species

Above Littoral Zone: These plants tolerant both inundation (standing water up to 72 hours) and temporary periods of drought.

Botanical Name	Common Name	Comments
Amsonia hubrichtii	Bluestar	
Amsonia illustris	Shining Bluestar	
Asclepias incarnata	Swamp Milkweed	
Eupatorium perfoliatum	American Boneset	
Eutrochium fistulosum	Joe Pye Weed	
Iris fulva	Copper Iris	
Iris virginica	Blue Flag Iris	
Liatrus pycnostachya	Prairie Blazing Star	
Liatrus spicata	Marsh Blazing Star	
Andropogon gerardii	Big Bluestem	
Calamagrostis x acutiflora	Feather Reed Grass	
Calamagrostis brachytricha	Korean Feather Reed Grass	
Chasmanthium latifolium	Northern Sea Oats	
Panicum virgatum	Switch Grass	
Sorghastrum nutans	Indian Grass	
Carex amphibola	Creek Sedge	
Carex bicknellii	Prairie Sedge	
Carex crinita	Fringed Sedge	
Carex emoryi	Emory's Sedge	
Carex frankii	Frank's Sedge	
Carex grayi	Gray's Sedge	
Carex lurida	Sallow Sedge	
Carex muskingumensis	Palm Sedge	
Carex radiata	Star Sedge	
Carex shortiana	Short's Sedge	
Carex stricta	Tussock Sedge	
Carex vulpinoidea	Fox Sedge	
Juncus effusus	Common Rush	
Juncus tenuis	Path Rush	

Perennial
Grass
Sedge/Rush

Wet Detention - Recommended Species

Littoral Zone: These plants tolerant standing water depths up to 12 inches.

	Botanical Name	Common Name	Water Depth	Comments
	Asclepias incarnata	Swamp Milkweed		
	Eupatorium perfoliatum	American Boneset		
	Eutrochium fistulosum	Joe Pye Weed		
	Iris fulva	Copper Iris		
	Iris virginica	Blue Flag Iris		
	Carex amphibola	Creek Sedge		
	Carex crinita	Fringed Sedge		
	Carex emoryi	Emory's Sedge		
	Carex frankii	Frank's Sedge		
	Carex grayi	Gray's Sedge		
	Carex lurida	Sallow Sedge		
	Carex muskingumensis	Palm Sedge		
	Carex shortiana	Short's Sedge		
	Carex stricta	Tussock Sedge		
	Carex vulpinoidea	Fox Sedge		
	Juncus effusus	Common Rush		
	Juncus tenuis	Path Rush		
	Justicia americana	Water Willow		
	Peltandra virginica	Arrow Arum		
	Pontedaria cordata	Pickerelweed		
	Sagittaria latifolia	Arrowhead		
	Saururus cernuus	Lizard's Tail		
	Schoenoplectus tabernaemontani	Softstem Bulrush		
	Scirpus atrovirens	Common Bulrush		
	Scirpus cyperinus	Wool Gras		
	Sparganium eurycarpum	Broadfruited Bur Reed		

Perennial
Grass
Sedge/Rush
Aquatic

Wetland & Wet Detention Ponds - Recommended Shrubs

The shrubs listed below tolerant a range of soil conditions, from standing water to drier soils.

Botanical Name	Common Name	Comments
Aronia melanocarpa	Black Chokeberry	
Cephalanthus occidentalis	Button Bush	
Clethra alnifolia	Summersweet	
Hibiscus moscheutos	Rose Mallow	
Ilex verticillata	Winterberry	
Itea virginica	Sweetspire	
Physocarpus opulifolius	Ninebark	
Viburnum dentatum	Arrowwood Viburnum	
Viburnum prunifolium	Blackhaw Viburnum	

Wetland & Wet Detention Ponds - Recommended Trees

The trees listed below tolerant a range of soil conditions, from standing water to drier soils.

Botanical Name	Common Name	Comments
Acer rubrum	Red Maple	Tolerant of a wide range of soils, but prefers moist conditions.**
Betula nigra	River Birch	Prefers moist fertile soil including semi-aquatic conditions, but also tolerates drier soils.*
Carya illinoinensis	Pecan	Grows in deep, moist, well-drained soil in full sun.*
Nyssa sylvatica	Blackgum	Prefers mesic soil, but adaptable to dry sites and a wide range of soil types. Once established, resistant to drought and some degree of flooding.*
Quercus bicolor	Swamp White Oak	One of the most flood tolerant oaks. Native in low, almost swampy areas, but grows well in well-drained soils also. Very adaptable tree.*
Quercus lyrata	Overcup Oak	Very tolerant of flooding, great for low areas Adaptable to many soils.*
Platanus occidentalis	Sycamore	Plant in moist soil. Fouind naturally along streams and rivers.*
Taxodium ascendens	Pond Cypress	Prefers moist soils, but tolerates a wide range of soil conditions ranging from average moisture soils to wet soils in some standing water.**
Taxodium disticum	Bald Cypress	Tolerates a wide range of conditions ranging from relatively dry soil to wet soil and standing water.*

*From Grow Native (www.grownative.org)

**From Missouri Botanical Garden (www.mobot.org)

Wetland - Recommended Species

High Marsh Zone: These plants tolerant standing water depths up to 6 inches.

	Botanical Name	Common Name	Comments
	Asclepias incarnata	Swamp Milkweed	Tolerant of a wide variety of soils from well drained to mucky, and even heavy clay. It will withstand dry spells once established and with some protection from afternoon sun.^
	Eupatorium perfoliatum	American Boneset	It prefers soil rich in organic matter that remains consistently moist and adapts well to average garden conditions.^
	Eutrochium fistulosum	Hollow Joe Pye Weed	Thrives in plenty of sun in soil that remains consistently moist. It will even withstand occasional flooding. It will grow in a range of soil types and adapts to average garden conditions but needs consistent moisture.
	Iris fulva	Copper Iris	Found in swampy woods and is perfectly adapted for pond edges and around water features.It can withstand extended periods submerged in up to 6" of water.^
	Iris virginica	Blue Flag Iris	Grows best in wet , sandy, acidic soil and will even tolerate having its roots under water for protracted periods of time.^
	Carex amphibola	Creek Sedge	Prefers moist to wet soils, but is adaptable to drier conditions.
	Carex crinita	Fringed Sedge	It is adapted to a variety of soil types with high levels of moisture, and can withstand seasonal or periodic inundation.^
	Carex emoryi	Emory's Sedge	
	Carex frankii	Frank's Sedge	It can withstand regular inundation, occasional periods of standing water, and is one of the most ornamental sedges for use in rain gardens.^
	Carex grayi	Gray's Sedge	Tolerant of occasional and seasonal flooding.^
	Carex lurida	Sallow Sedge	It can withstand regular inundation, occasional periods of standing water, and is one of the most ornamental sedges for use in rain gardens.^
	Carex muskingumensis	Palm Sedge	A versatile, easy to grow wetland species that can tolerate periods inundation.^
	Carex shortiana	Short's Sedge	
	Carex stricta	Tussock Sedge	Thrives in sandy or mucky soil and is tolerant of intermittent flooding.^
	Carex vulpinoidea	Fox Sedge	It is well adapted to seasonal, or regular inundation in up to 6" of water.^
	Juncus effusus	Common Rush	Adaptable to fluctuating conditions and tolerant of more typical moist garden conditions.^
	Juncus tenuis	Path Rush	Tolerates mesic to dry conditions, as well as wet, mucky and saturated ones.^

*Information from Grow Native (www.grownative.org)

^Information from Izel Native Plants (www.izelplants.com)

	Perennial
	Sedge/Rush

Wetland - Recommended Species

Temporary Inundation Zone: These plants tolerant both inundation (standing water up to 72 hours) and temporary periods of drought.

	Botanical Name	Common Name	Comments
	Amsonia hubrichtii	Bluestar	
	Amsonia illustris	Shining Bluestar	
	Asclepias incarnata	Swamp Milkweed	Grows naturally in swamps and wet meadows but also grows well in the garden.*
	Eupatorium perfoliatum	American Boneset	Grows in full sun in moderate to wet soil.* Plants may flop in shade locations.
	Eutrochium fistulosum	Joe Pye Weed	Prefers moist soils which do not dry out.**
	Iris fulva	Copper Iris	Grows in full sun with moderate to moist soil.*
	Iris virginica	Blue Flag Iris	
	Liatrus pycnostachya	Prairie Blazing Star	
	Liatrus spicata	Marsh Blazing Star	
	Andropogon gerardii	Big Bluestem	
	Calamagrostis x acutiflora	Feather Reed Grass	
	Calamagrostis brachytricha	Korean Feather Reed Grass	
	Chasmanthium latifolium	Northern Sea Oats	
	Panicum virgatum	Switch Grass	
	Sorghastrum nutans	Indian Grass	
	Carex amphibola	Creek Sedge	
	Carex bicknellii	Prairie Sedge	
	Carex crinita	Fringed Sedge	
	Carex emoryi	Emory's Sedge	
	Carex frankii	Frank's Sedge	
	Carex grayi	Gray's Sedge	
	Carex lurida	Sallow Sedge	
	Carex muskingumensis	Palm Sedge	
	Carex radiata	Star Sedge	
	Carex shortiana	Short's Sedge	
	Carex stricta	Tussock Sedge	Clumping in wet conditions, spreading in drier conditions.
	Carex vulpinoidea	Fox Sedge	Forms colonies by rhizomes, competitve.
	Juncus effusus	Common Rush	
	Juncus tenuis	Path Rush	

Perennial
Grass
Sedge/Rush

*Information from Grow Native (www.grownative.org)

**Information from Missouri Botanical Garden (www.mobot.org)

Wetland - Recommended Species

Low Marsh Zone: These plants tolerant standing water depths greater than 6 inches and colonize wetlands.

Botanical Name	Common Name	Water Depth	Comments
Justicia americana	Water Willow	Up to 12"	It is ideal for areas where the water levels fluctuate and can establish in saturated soil as well shallow water up to 12" deep.^
Peltandra virginica	Arrow Arum	Up to 18"	Requires a consistently wet environment to thrive. It can withstand permanent submersion in up to 18" of water, and is tolerant of low levels of salt and slightly brackish waters.
Pontedaria cordata	Pickerelweed	Up to 12"	Grown in full sun or shade in shallow water.* The root mass of pickerel weed must remain submerged under water year round. The ideal depth is anywhere between 3 to 12". It can withstand periodic flooding up to 20".^
Sagittaria latifolia	Arrowhead	Up to 18"	Prefers standing water, but also handles wet soil for extended periods.*
Saururus cernuus	Lizard's Tail	Up to 4"	Grows in shallow water to moist or wet soil. Thick mat of roots help stabilize pond banks.*
Schoenoplectus tabernaemontani	Softstem Bulrush	Up to 12"	Requires wet soil at all times.^
Scirpus atrovirens	Dark Green Bulrush	Up to 12"	An attractive plant that can be used in low areas that are consistently moist, stream margins, or submerged at the edge of a pond.^
Scirpus cyperinus	Wool Grass	Up to 12"	Aquatic species that can withstand periods of inundation in up to 12" of water. It is however quite adaptable to average, moist conditions and will even tolerate an occasional dry spell.^
Sparganium eurycarpum	Broadfruited Bur Reed	Up to 12"	Grows along wet margins and low marshes and shallow water.^

*Information from Grow Native (www.grownative.org)

^Information from Izel Native Plants (www.izelplants.com)

Aquatic

APPENDIX F

APPENDIX F SCENARIO EXAMPLES (UNDER DEVELOPMENT)

General Requirements

Project Information

Project Name:	Urban Redevelopment
Date:	2/4/2025
Address:	
Nearest Intersection:	
Project Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Estimated values based on development type

Site Parameters

Total Disturbed Area of Site	6.31	acres
Total Proposed Impervious Area	247,378	square feet
Total Tributary Drainage Area to Site	6.31	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☑ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☐ No ☑ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☐ No ☑ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 510 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	11,046	10,899
	RRV (with RRV Reductions)	10,536	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☑ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?	1.262001837	1.14
☑ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?	3.78600551	3.74
☐ Yes ☐ No ☑ N/A	100-year peak outflow control achieved?	18.93002755	0

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Easement(s) provided?
☐ Yes ☐ No ☑ N/A	Enclosed pipe systems per requirements of 5608.2?
☐ Yes ☐ No ☑ N/A	Minor drainage systems per requirements of 5608.3 A?
☐ Yes ☐ No ☑ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Estimated values based on development type
Assumed Percent Impervious Coverage:	90%
Total Disturbed Area (sf):	274,864

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	40%
Total Controlled Disturbed Area (sf)	274,864
Controlled Area Rv ($Rv_{controlled}$)	0.88
Total Uncontrolled Disturbed Area (sf)	0
Total Required Retention Volume (cf) (RRV)	11,046
Uncontrolled Retention Volume (cf)	0
Adjusted PT% within Controlled Drainage Areas	NA

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 1

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	Can this drainage area be feasibly controlled?	Disturbed Drainage Area (sf)	Column1
1	Yes	274,864	

Select post-development cover types within the disturbed area:	
Natural Area	☐
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	274,864
RRV Prior to Reductions (cf)	**11,046**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	96.20

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Pervious Area		39		61		74	27,486	80	**27,486**	0%	0.25
Impervious Area		98		98		98	247,378	98	**247,378**	0%	0.95
Total	**0**		**0**		**0**		**274,864**		**274,864**	**0%**	**0.88**

Design for Drainage Area 1

Drainage Area ID	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	274,864
RRV Prior to Reductions (cf)	**11,046**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	96.20

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees	51	10	510

Total $RRV_{reductions}$ (cf)	**510**
RRV After Reductions (cf)	**10,536**
% Reduction in RRV	**4.6%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☑
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☑

Hide Blank Rows | Show Blank Rows

PT% 40.00%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Choker Course				Storage Chamber	Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit
P-1	Permeable Pavement, Controlled Release	SS-1	4,810	42,838	**1,913**	**2,238**		4,305	0.0	0		0.3		0	4,305	0.4	2.0	3443.70362	4,305	0.3		0		3,444	65%	2,238	4,783
BIO1	Bioretention, Controlled Release	SS-1	3,989	35,900	**1,603**	**1,749**		1,295	0.8	971	899	0.3	2.5	675	899	0.4	1.5	539.653096	899	0.3		0		2,186	80%	1,749	4,007
BIO2	Bioretention, Controlled Release	SS-1	2,688	24,188	**1,080**	**808**	**273**	609	0.8	507	324	0.3	2.5	243	324	0.4	2.0	259.242827	324	0.3		0		1,009	80%	808	2,700
P-1.1	Permeable Pavement, Controlled Release	SS-1	8,835	79,517	**3,551**	**1,803**	**1,748**	2,774	0.0	0		0.3		0	2,774	0.4	2.5	2773.96664	2,774	0.3		0		2,774	65%	1,803	8,876
T1	Bioretention, Controlled Release	SS-1	1,353	12,181	**544**	**836**		380	0.8	304	380	0.3	2.5	285	380	0.4	3.0	456	380	0.3		0		1,045	80%	836	1,360
SS-1	Subsurface Storage, Infiltration Only	NA	5,857	52,709	**4,374**	**3,465**	**909**	6,248		0		0.3		0		0.4		0		0.3		0	3,465	3,465	100%	3,465	7,904
Required Retention Volume (cf)		10,536																									
Retention Volume Achieved (cf)		10,899	☑ *You met the Required Retention Volume.*																								

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	96.20
S	0.40
Ia	0.02

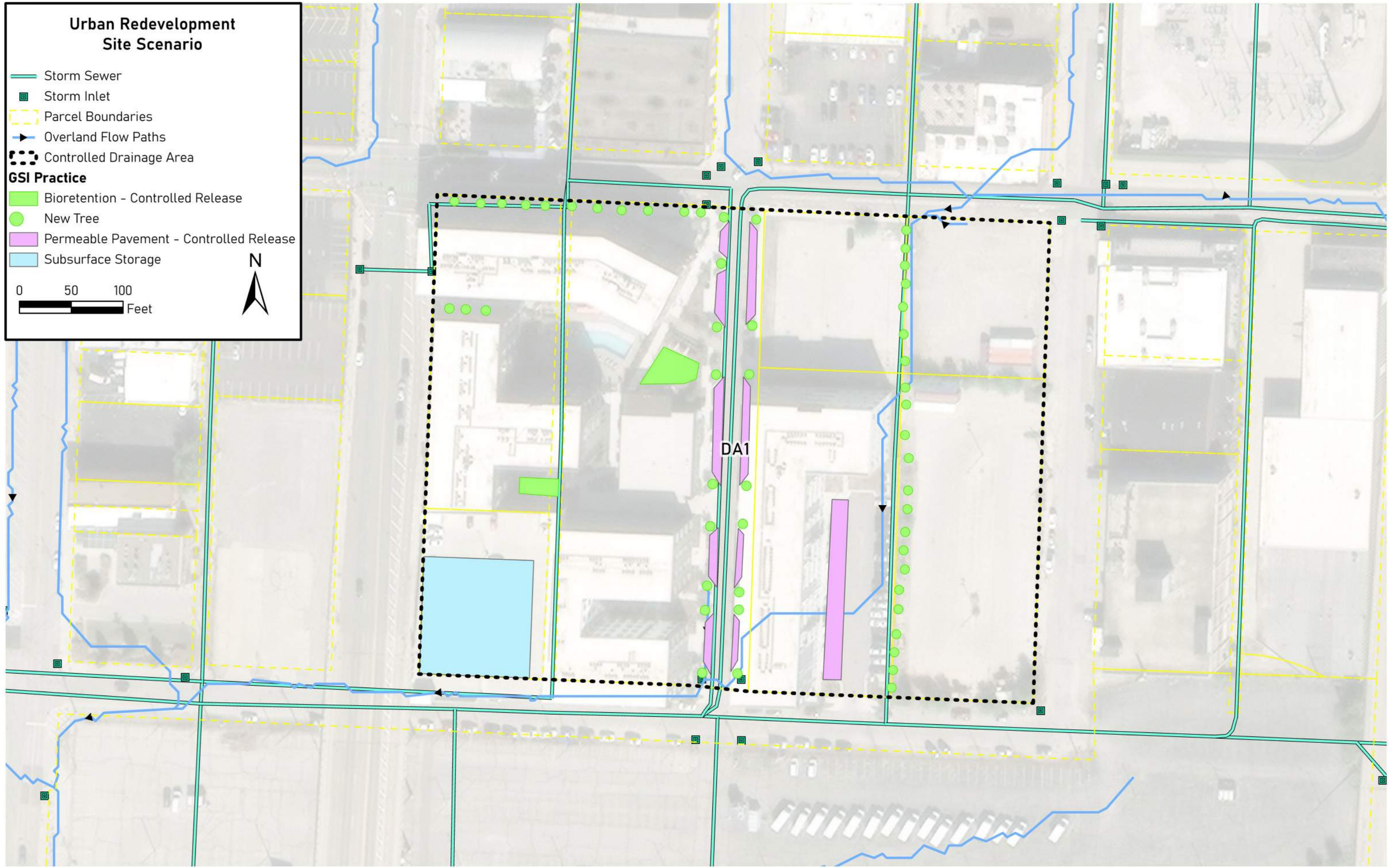
	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	2.30	3.66	4.57	5.31	6.08
Post-Development Runoff Volume (in) with Retention	1.69	3.05	3.97	4.70	5.47
Retention Adjusted CN	90.1	90.9	91.2	91.3	91.4
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	1.26	1.14	2.581	0.18	*Required release rate met.*
10-Year, NOAA Atlas14 Median, First Quartile	0.60	3.79	3.74	4.484	0.59	*Required release rate met.*
100-Year, NOAA Atlas14 Median, First Quartile	3.00	18.93			0.00	

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	274,864	
	Total Site Rv:	0.88	
	Total RRV Prior to Reductions (cf)	11,046	
	Total RRV Reductions (cf)	510	
	Total RRV After Reductions (cf)	10,536	
	Total Retention Volume Achieved (cf)	10,899	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	41.3%	☑ *Required percent site control achieved!*

Drainage Area 1	**Disturbed Drainage Area (sf)**	274,864
	RRV Prior to Reductions (cf)	11,046
	$RRV_{reductions}$ (cf)	510
	RRV After Reductions (cf)	10,536
	Retention Volume Achieved (cf)	10,899


Urban Redevelopment
Site Scenario
Storm Sewer
Storm Inlet
Parcel Boundaries
Overland Flow Paths
Controlled Drainage Area
GSI Practice
Bioretention - Controlled Release
New Tree
Permeable Pavement - Controlled Release
Subsurface Storage
N
0
50
100
Feet
DA1

General Requirements

Project Information

Project Name:	Example Industrial Development
Date:	1/31/2025
Address:	123 Industrial Avenue
Nearest Intersection:	Industrial Avenue and State Street
Project Type:	Site Development - New Development
System Type:	Separate Storm Sewer System
Proposed Land Use:	Industrial
Input Value Basis:	Actual measured values based on improvement plans

Site Parameters

Total Disturbed Area of Site	12.02	acres
Total Proposed Impervious Area	350,602	square feet
Total Tributary Drainage Area to Site	12.51	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☑ Yes ☐ No ☐ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☑ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☐ No ☑ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☐ No ☑ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 830 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	36,518	35,739
	RRV (with RRV Reductions)	35,688	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☑ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?	2.403810836	2.2
☑ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?	7.211432507	6.58
☑ Yes ☐ No ☐ N/A	100-year peak outflow control achieved?	36.05716253	29.64

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☑ Yes ☐ No ☐ N/A	Easement(s) provided?
☑ Yes ☐ No ☐ N/A	Enclosed pipe systems per requirements of 5608.2?
☑ Yes ☐ No ☐ N/A	Minor drainage systems per requirements of 5608.3 A?
☑ Yes ☐ No ☐ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - New Development
System Type:	Separate Storm Sewer System
Proposed Land Use:	Industrial
Input Value Basis:	Actual measured values based on improvement plans
Assumed Percent Impervious Coverage:	NA
Total Disturbed Area (sf):	523,550

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	85%
Total Controlled Disturbed Area (sf)	497,352
Controlled Area Rv ($Rv_{controlled}$)	0.74
Total Uncontrolled Disturbed Area (sf)	26,198
Total Required Retention Volume (cf) (RRV)	36,518
Uncontrolled Retention Volume (cf)	640
Adjusted PT% within Controlled Drainage Areas	86.52%

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 3

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	Can this drainage area be feasibly controlled?	Disturbed Drainage Area (sf)	Column1
1	No	26,198	
2	Yes	17,250	
3	Yes	480,102	

Select post-development cover types within the disturbed area:	
Natural Area	☐
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	No
Disturbed drainage area (sf)	26,198
Uncontrolled Retention Volume (cf)	**640**
Pervious Area Weighted Rv	NA
Impervious Area Weighted Rv	NA
Post-Development Condition Weighted CN	74.07

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Pervious Area		39		61	26,126	74		80	**26,126**	0%	0.25
Impervious Area		98		98	72	98		98	**72**	0%	0.95
Total	**0**		**0**		**26,198**		**0**		**26,198**	**0%**	**0.25**

Summary Table for Drainage Area ID:	2
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	17,250
Adjusted RRV Prior to Reductions (cf)	**436**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	74.21

Cover Type Area Table for Drainage Area 2	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Pervious Area		39		61	17,102	74		80	**17,102**	0%	0.25
Impervious Area		98		98	148	98		98	**148**	0%	0.95
Total	**0**		**0**		**17,250**		**0**		**17,250**	**0%**	**0.26**

Summary Table for Drainage Area ID:	3
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	480,102
Adjusted RRV Prior to Reductions (cf)	**36,081**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	91.52

Cover Type Area Table for Drainage Area 3	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Pervious Area		39		61	129,720	74		80	**129,720**	0%	0.25
Impervious Area		98		98	350,382	98		98	**350,382**	0%	0.95
Total	**0**		**0**		**480,102**		**0**		**480,102**	**0%**	**0.76**

Design for Drainage Area 2

Drainage Area ID	2
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	17,250
Adjusted RRV Prior to Reductions (cf)	**436**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	74.21

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)	24	20	480
New Trees		10	0

Total $RRV_{reductions}$ (cf)	**480**
RRV After Reductions (cf)	**-44**
% Reduction in RRV	**110.0%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☐
Bioretention Soil	☐
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☐
Choker Course	☐
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows

Show Blank Rows

Adjusted PT% 86.52%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit

Required Retention Volume (cf)	-44
Retention Volume Achieved (cf)	0

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	74.21
S	3.48
Ia	0.17

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.04	2.04	2.77	3.39	4.06
Post-Development Runoff Volume (in) with Retention	1.04	2.04	2.77	3.39	4.06
Retention Adjusted CN	80.6	79.5	79.0	78.7	78.5
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)
2-Year, NOAA Atlas14 Median, First Quartile	0.20	0.08			0.00
10-Year, NOAA Atlas14 Median, First Quartile	0.60	0.24			0.00
100-Year, NOAA Atlas14 Median, First Quartile	3.00	1.19			0.00

Design for Drainage Area 3

Drainage Area ID	3
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	480,102
Adjusted RRV Prior to Reductions (cf)	**36,081**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	91.52

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees	35	10	350

Total $RRV_{reductions}$ (cf)	**350**
RRV After Reductions (cf)	**35,731**
% Reduction in RRV	**1.0%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☑
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows | Show Blank Rows

Adjusted PT% 86.52%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Choker Course				Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit	
Bio-1	Bioretention, Controlled Release	Det-3	50,371	109,420	**11,511**	**11,772**		7,780	1.0	7,780	7,076	0.3	2.0	4,246	7,076	0.4	0.8	2264.32	7,076	0.3	0.2	424.56	14,714	80%	11,772	13,305	☑ *This facility meets the Required Retention Volume.*
Bio-2	Bioretention, Controlled Release	Det-3	69,074	177,993	**18,408**	**18,233**	**175**	10,029	1.1	11,032	9,187	0.3	3.0	8,268	9,187	0.4	0.8	2939.84	9,187	0.3	0.2	551.22	22,791	80%	18,233	21,276	☑ *This facility meets the Required Retention Volume.*
Det-3	Dry Detention Basin, Controlled Release		10,275	62,969	**6,337**	**5,735**	**603**	7,352	1.3	9,558		0.3		0		0.4		0		0.3		0	9,558	60%	5,735	7,297	☑ *This facility meets the Required Retention Volume.*

Required Retention Volume (cf)	35,731
Retention Volume Achieved (cf)	35,739

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	91.52
S	0.93
Ia	0.05

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.93	3.24	4.13	4.86	5.61
Post-Development Runoff Volume (in) with Retention	0.75	2.06	2.96	3.68	4.44
Retention Adjusted CN	75.1	79.8	81.0	81.6	82.1
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	2.20	2.2	1.3	0.20	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	6.61	6.58	3.7	0.60	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	33.06	29.64	5.6	2.69	***Required release rate met.***

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	523,550	
	Total Site Rv:	0.72	
	Total RRV Prior to Reductions (cf)	36,518	
	Total RRV Reductions (cf)	830	
	Total RRV After Reductions (cf)	35,688	
	Total Retention Volume Achieved (cf)	35,739	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	85.1%	☑ *Required percent site control achieved!*

Drainage Area 3	**Disturbed Drainage Area (sf)**	480,102
	RRV Prior to Reductions (cf)	36,081
	$RRV_{reductions}$ (cf)	350
	RRV After Reductions (cf)	35,731
	Retention Volume Achieved (cf)	35,739

Drainage Area 2	**Disturbed Drainage Area (sf)**	17,250
	RRV Prior to Reductions (cf)	436
	$RRV_{reductions}$ (cf)	480
	RRV After Reductions (cf)	-44
	Retention Volume Achieved (cf)	0

Industrial New Development Site Scenario

- Storm Sewer
- Storm Inlet
- Impervious Area
- Parcel Boundaries
- Overland Flow Paths

GSI Practice

- Bioretention - Controlled Release
- Dry Detention Basin
- New Tree

Drainage Areas

- Uncontrolled Drainage Area
- Controlled Drainage Area

0 50 100 Feet

N

DA1

General Requirements

Project Information

Project Name:	Multi-Family Redevelopment
Date:	1/31/2025
Address:	
Nearest Intersection:	
Project Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Multifamily Residential
Input Value Basis:	Actual measured values based on improvement plans

Site Parameters

Total Disturbed Area of Site	4.16	acres
Total Proposed Impervious Area	154,996	square feet
Single-family/duplex dwelling part of a larger common plan of development?	No	*(Select Yes/No)*
Lot Size		acres
Percent Impervious Coverage		%
Total Tributary Drainage Area to Site	4.16	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	No	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☑ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☐ No ☑ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☐ No ☑ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 120 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	7,026	6,925
	RRV (with RRV Reductions)	6,906	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☑ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?	0.832984389	0.83
☑ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?	2.498953168	2.49
☐ Yes ☐ No ☑ N/A	100-year peak outflow control achieved?	12.49476584	11.89

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☑ Yes ☐ No ☐ N/A	Easement(s) provided?
☑ Yes ☐ No ☐ N/A	Enclosed pipe systems per requirements of 5608.2?
☑ Yes ☐ No ☐ N/A	Minor drainage systems per requirements of 5608.3 A?
☑ Yes ☐ No ☐ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Multifamily Residential
Input Value Basis:	Actual measured values based on improvement plans
Assumed Percent Impervious Coverage:	NA
Total Disturbed Area (sf):	181,424

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	40%
Total Controlled Disturbed Area (sf)	181,424
Controlled Area Rv ($Rv_{controlled}$)	0.85
Total Uncontrolled Disturbed Area (sf)	0
Total Required Retention Volume (cf) (RRV)	7,026
Uncontrolled Retention Volume (cf)	0
Adjusted PT% within Controlled Drainage Areas	NA

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 1

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	**Can this drainage area be feasibly controlled?**	**Disturbed Drainage Area (sf)**	**Column1**
1	Yes	181,424	

Select post-development cover types within the disturbed area:	
Natural Area	☐
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	181,424
RRV Prior to Reductions (cf)	**7,026**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	94.50

Cover Type Area Table for Drainage Area 1	**Area (sf)**										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Pervious Area		39		61	26,428	74		80	**26,428**	0%	0.25
Impervious Area		98		98	154,996	98		98	**154,996**	0%	0.95
Total	**0**		**0**		**181,424**		**0**		**181,424**	**0%**	**0.85**

Design for Drainage Area 1

Drainage Area ID	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	181,424
RRV Prior to Reductions (cf)	**7,026**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	94.50

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees	12	10	120

Total $RRV_{reductions}$ (cf)	**120**
RRV After Reductions (cf)	**6,906**
% Reduction in RRV	**1.7%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☐
Bioretention Soil	☐
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☐
Choker Course	☐
Green Roof Drainage Layer	☑
Green Roof Growing Media	☑
Storage Chamber(s)	☐

Hide Blank Rows Show Blank Rows

PT% 40.00%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Green Roof Drainage Layer				Green Roof Growing Media				Total Storage Volume (cf) ($GSI_{storage}$)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit Allowed	
GR-1	Green Roof			15,855	**688**	**1,720**		10,572	0.5	0.1	528.6	9,832	0.4	0.33	1297.824	1,826	100%	1,826	1,720	*Facility size is larger than needed to meet the Required Retention Volume. Consider adjusting the design parameters*
GR-2	Green Roof			14,973	**650**	**1,624**		9,982	0.5	0.1	499.1	9,982	0.4	0.33	1317.624	1,817	100%	1,817	1,624	*Facility size is larger than needed to meet the Required Retention Volume. Consider adjusting the design parameters*
GR-3	Green Roof			33,026	**1,433**	**3,582**		22,017	0.5	0.1	1100.85	21,340	0.4	0.33	2816.88	3,918	100%	3,918	3,582	*Facility size is larger than needed to meet the Required Retention Volume. Consider adjusting the design parameters*

Required Retention Volume (cf)	6,906
Retention Volume Achieved (cf)	6,925

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	94.50
S	0.58
Ia	0.03

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	2.15	3.50	4.41	5.14	5.91
Post-Development Runoff Volume (in) with Retention	1.65	3.00	3.91	4.64	5.41
Retention Adjusted CN	89.7	90.4	90.6	90.8	90.9
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	0.83	0.83	0.9	0.20	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	2.50	2.49	3.1	0.60	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	12.49	11.89	4.8	2.85	***Required release rate met.***

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	181,424	
	Total Site Rv:	0.85	
	Total RRV Prior to Reductions (cf)	7,026	
	Total RRV Reductions (cf)	120	
	Total RRV After Reductions (cf)	6,906	
	Total Retention Volume Achieved (cf)	6,925	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	40.1%	☑ *Required percent site control achieved!*

Drainage Area 1	**Disturbed Drainage Area (sf)**	181,424
	RRV Prior to Reductions (cf)	7,026
	$RRV_{reductions}$ (cf)	120
	RRV After Reductions (cf)	6,906
	Retention Volume Achieved (cf)	6,925

Multifamily Redevelopment Site Scenario

- Storm Inlet
- Impervious Area
- Parcel Boundaries
- Overland Flow Paths
- Controlled Drainage Area

GSI Practice

- New Tree
- Green Roof
- Subsurface Storage

0 20 40 Feet

N

DA1

bing

General Requirements

Project Information

Project Name:	Single Family New Development
Date:	2/4/2025
Address:	
Nearest Intersection:	
Project Type:	Site Development - New Development
System Type:	Separate Storm Sewer System
Proposed Land Use:	Single Family Residential
Input Value Basis:	Actual measured values based on improvement plans

Site Parameters

Total Disturbed Area of Site	80.29	acres
Total Proposed Impervious Area	1,078,211	square feet
Single-family/duplex dwelling part of a larger common plan of development?	Yes	*(Select Yes/No)*
Total Tributary Drainage Area to Site	80.29	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☑ No ☑ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No	Project incorporates preservation or restoration of Natural Areas?
☑ Yes ☐ No ☐ N/A	Natural Area meets requirements of Section 5604?
☑ Yes ☐ No ☐ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☑ Yes ☐ No ☐ N/A	Sheetflow to Natural Areas
☑ Yes ☐ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 29,361 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	155,947	131,102
	RRV (with RRV Reductions)	126,585	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☑ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?	16.05762296	10.96
☑ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?	48.17286889	40.75
☑ Yes ☐ No ☐ N/A	100-year peak outflow control achieved?	240.8643445	147.46

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Easement(s) provided?
☐ Yes ☐ No ☑ N/A	Enclosed pipe systems per requirements of 5608.2?
☐ Yes ☐ No ☑ N/A	Minor drainage systems per requirements of 5608.3 A?
☐ Yes ☐ No ☑ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - New Development
System Type:	Separate Storm Sewer System
Proposed Land Use:	Single Family Residential
Input Value Basis:	Actual measured values based on improvement plans
Assumed Percent Impervious Coverage:	NA
Total Disturbed Area (sf):	3,497,350

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	85%
Total Controlled Disturbed Area (sf)	3,160,790
Controlled Area Rv ($Rv_{controlled}$)	0.45
Total Uncontrolled Disturbed Area (sf)	336,560
Total Required Retention Volume (cf) (RRV)	155,947
Uncontrolled Retention Volume (cf)	17,310
Adjusted PT% within Controlled Drainage Areas	95.61%

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 4

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	Can this drainage area be feasibly controlled?	Disturbed Drainage Area (sf)	Column1
1	Yes	902,785	
2	Yes	346,454	
3	Yes	1,911,552	
4	No	336,560	

Select post-development cover types within the disturbed area:	
Natural Area	☑
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	902,785
Adjusted RRV Prior to Reductions (cf)	**43,220**
Pervious Area Weighted Rv	0.19
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	85.44

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70	155,726	77	**155,726**	0%	0.00
Pervious Area		39		61		74	448,235	80	**448,235**	0%	0.25
Impervious Area		98		98		98	298,823	98	**298,823**	0%	0.95
Total	**0**		**0**		**0**		**902,785**		**902,785**	**0%**	**0.44**

Summary Table for Drainage Area ID:	2
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	346,454
Adjusted RRV Prior to Reductions (cf)	**20,044**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	87.20

Cover Type Area Table for Drainage Area 2	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70		77	**0**	0%	0.00
Pervious Area		39		61		74	207,872	80	**207,872**	0%	0.25
Impervious Area		98		98		98	138,581	98	**138,581**	0%	0.95
Total	**0**		**0**		**0**		**346,454**		**346,454**	**0%**	**0.53**

Summary Table for Drainage Area ID:	3
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	1,911,552
Adjusted RRV Prior to Reductions (cf)	**92,683**
Pervious Area Weighted Rv	0.19
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	85.55

Cover Type Area Table for Drainage Area 3	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70	309,536	77	**309,536**	0%	0.00
Pervious Area		39		61		74	961,210	80	**961,210**	0%	0.25
Impervious Area		98		98		98	640,806	98	**640,806**	0%	0.95
Total	**0**		**0**		**0**		**1,911,552**		1,911,552	**0%**	**0.44**

Summary Table for Drainage Area ID:	4
Is this drainage area controlled?	No
Disturbed drainage area (sf)	336,560
Uncontrolled Retention Volume (cf)	**17,310**
Pervious Area Weighted Rv	NA
Impervious Area Weighted Rv	NA
Post-Development Condition Weighted CN	87.20

Cover Type Area Table for Drainage Area 4	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70		77	**0**	0%	0.00
Pervious Area		39		61		74	201,936	80	**201,936**	0%	0.25
Impervious Area		98		98		98	134,624	98	**134,624**	0%	0.95
Total	**0**		**0**		**0**		**336,560**		336,560	**0%**	**0.53**

Design for Drainage Area 1

Drainage Area ID	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	902,785
Adjusted RRV Prior to Reductions (cf)	**43,220**
Pervious Area Weighted Rv	0.19
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	85.44

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area	155,726	103,286	68,858	100%	4,634
Sheetflow to Pervious Area	181,161		72,464	50%	2,438
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)	62	20	1,240
New Trees	127	10	1,270

Total $RRV_{reductions}$ (cf)	**9,582**
RRV After Reductions (cf)	**33,639**
% Reduction in RRV	**22.2%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☑
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows Show Blank Rows

Adjusted PT% 95.61%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Choker Course				Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit
BIO1-1	Bioretention, Controlled Release	BIO1-2	21,825	14,550	**1,951**	**1,975**		1,725	0.5	862	1,409	0.3	2.5	1,057	1,409	0.4	0.6	338.094504	1,409	0.3	0.5	211.309065	2,468	80%	1,975	2,040
BIO1-2	Bioretention, Controlled Release	DET1	122,002	81,334	**10,905**	**11,406**		6,341	0.8	5,073	5,422	0.3	2.5	4,066	5,422	0.4	2.0	4337.44307	5,422	0.3	0.5	813.270576	14,290	80%	11,432	11,406
DET1	Dry Detention Basin, Infiltration Only	NA	304,409	202,939	**27,210**	**21,405**	**5,805**	21,000	0.8	16,800	19,186	0.3	0.8	4,605		0.4		0		0.3		0	21,405	100%	21,405	28,459

Required Retention Volume (cf)	33,639
Retention Volume Achieved (cf)	34,785

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	85.44
S	1.70
Ia	0.09

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.55	2.76	3.61	4.31	5.04
Post-Development Runoff Volume (in) with Retention	1.04	2.26	3.10	3.80	4.53
Retention Adjusted CN	80.7	82.2	82.6	82.8	83.0
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	4.15	2.09	3.687	0.10	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	12.44	12.36	5.734	0.60	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	62.18	43.6	6.167	2.10	***Required release rate met.***

Design for Drainage Area 2

Drainage Area ID	2
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	346,454
Adjusted RRV Prior to Reductions (cf)	**20,044**
Pervious Area Weighted Rv	0.25
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	87.20

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	**Natural or Pervious Area Footprint (sf)**	**Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)**	**Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)**	**Runoff Reduction Credit**	**Retention Volume Credited (cf) $RRV_{reduction}$**
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area	67,981		45,320	50%	1,525
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	**Number of Trees (Each)**	**Runoff Reduction Credit (cf/tree)**	**Retention Volume Credited (cf) $RRV_{reduction}$**
Existing Trees (Preserved)	38	20	760
New Trees	57	10	570

Total $RRV_{reductions}$ (cf)	**2,855**
RRV After Reductions (cf)	**17,189**
% Reduction in RRV	**14.2%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☐
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☐
Choker Course	☐
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows

Show Blank Rows

Adjusted PT% 95.61%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit
DET2-1	Dry Detention Basin, Infiltration Only	NA	207,872	138,581	**20,044**	**18,000**	**2,044**	20,000	0.9	18,000	18,000	100%	18,000	20,963

Required Retention Volume (cf)	17,189
Retention Volume Achieved (cf)	18,000

☑ ***You met the Required Retention Volume.***

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	87.20
S	1.47
Ia	0.07

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.65	2.90	3.76	4.46	5.20
Post-Development Runoff Volume (in) with Retention	1.03	2.27	3.13	3.84	4.58
Retention Adjusted CN	80.4	82.4	82.9	83.2	83.4
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	1.59	1.38	1.066	0.17	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	4.77	3.92	1.848	0.49	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	23.86	12.49	2.954	1.57	***Required release rate met.***

Design for Drainage Area 3

Drainage Area ID	3
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	1,911,552
Adjusted RRV Prior to Reductions (cf)	**92,683**
Pervious Area Weighted Rv	0.19
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	85.55

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area	256,232	153,739	102,493	100%	6,897
Sheetflow to Pervious Area	226,835		151,223	50%	5,088
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)	94	20	1,880
New Trees	306	10	3,060

Total $RRV_{reductions}$ (cf)	**16,925**
RRV After Reductions (cf)	**75,758**
% Reduction in RRV	**18.3%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☑
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows Show Blank Rows

Adjusted PT% 95.61%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Choker Course				Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit
BIO3-1	Bioretention, Controlled Release	DET	331,113	220,742	**29,726**	**30,528**		17,555	0.8	14,044	15,900	0.3	2.5	11,925	15,900	0.4	1.2	7420.13008	15,900	0.3	1.0	4770.08362	38,160	80%	30,528	31,090
BIO3-2	Dry Detention Basin, Infiltration Only	DET3	341,941	227,961	**30,698**	**24,503**	**6,195**	23,856	0.8	17,892	22,038	0.3	1.0	6,611		0.4		0		0.3		0	24,503	100%	24,503	32,107
DET3	Dry Detention Basin, Infiltration Only	NA	288,155	192,104	**32,064**	**23,286**	**8,778**	22,827	0.8	18,262	20,934	0.3	0.8	5,024		0.4		0		0.3		0	23,286	100%	23,286	33,251

Required Retention Volume (cf)	75,758
Retention Volume Achieved (cf)	78,317

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	85.55
S	1.69
Ia	0.08

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.56	2.77	3.62	4.32	5.05
Post-Development Runoff Volume (in) with Retention	1.02	2.23	3.08	3.78	4.51
Retention Adjusted CN	80.2	81.9	82.4	82.6	82.8
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	8.78	7.49	2.424	0.17	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	26.33	24.47	4.56	0.56	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	131.65	91.37	5.207	2.08	***Required release rate met.***

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	3,497,350	
	Total Site Rv:	0.46	
	Total RRV Prior to Reductions (cf)	155,947	
	Total RRV Reductions (cf)	29,361	
	Total RRV After Reductions (cf)	126,585	
	Total Retention Volume Achieved (cf)	131,102	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	87.5%	☑ *Required percent site control achieved!*

Drainage Area 1	**Disturbed Drainage Area (sf)**	902,785
	RRV Prior to Reductions (cf)	43,220
	$RRV_{reductions}$ (cf)	9,582
	RRV After Reductions (cf)	33,639
	Retention Volume Achieved (cf)	34,785

Drainage Area 2	**Disturbed Drainage Area (sf)**	346,454
	RRV Prior to Reductions (cf)	20,044
	$RRV_{reductions}$ (cf)	2,855
	RRV After Reductions (cf)	17,189
	Retention Volume Achieved (cf)	18,000

Drainage Area 3	**Disturbed Drainage Area (sf)**	1,911,552
	RRV Prior to Reductions (cf)	92,683
	$RRV_{reductions}$ (cf)	16,925
	RRV After Reductions (cf)	75,758
	Retention Volume Achieved (cf)	78,317

Residential New Development Site Scenario

- Storm Sewer
- Storm Inlet
- Impervious Area
- Parcel Boundaries
- Overland Flow Paths

GSI Practice

- Bioretention - Controlled Release
- Dry Detention Basin
- Preserved Tree

RRV Reduction

- Sheetflow to Pervious Area
- Preserved/Restored
- Sheetflow to Natural Area

Drainage Areas

- Uncontrolled Drainage Area
- Controlled Drainage Area

0 150 300 Feet

N

DA1

DA2

DA3

General Requirements

Project Information

Project Name:	Small Commercial Scenario
Date:	1/30/2025
Address:	
Nearest Intersection:	
Project Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Actual measured values based on improvement plans

Site Parameters

Total Disturbed Area of Site	3.33	acres
Total Proposed Impervious Area	80,872	square feet
Total Tributary Drainage Area to Site	3.33	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☑ No ☐ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☑ No ☐ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☑ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 200 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☑ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	4,103	4,240
	RRV (with RRV Reductions)	3,903	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☑ Yes ☐ No ☐ N/A	2-year peak outflow control achieved?	0.665050505	0.14
☑ Yes ☐ No ☐ N/A	10-year peak outflow control achieved?	1.662626263	1.13
☑ Yes ☐ No ☐ N/A	100-year peak outflow control achieved?	9.975757576	8

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Easement(s) provided?
☐ Yes ☐ No ☑ N/A	Enclosed pipe systems per requirements of 5608.2?
☐ Yes ☐ No ☑ N/A	Minor drainage systems per requirements of 5608.3 A?
☐ Yes ☐ No ☑ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Actual measured values based on improvement plans
Assumed Percent Impervious Coverage:	NA
Total Disturbed Area (sf):	144,848

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	40%
Total Controlled Disturbed Area (sf)	144,848
Controlled Area Rv ($Rv_{controlled}$)	0.62
Total Uncontrolled Disturbed Area (sf)	0
Total Required Retention Volume (cf) (RRV)	4,103
Uncontrolled Retention Volume (cf)	0
Adjusted PT% within Controlled Drainage Areas	NA

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 1

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	Can this drainage area be feasibly controlled?	Disturbed Drainage Area (sf)	Column1
1	Yes	144,848	

Select post-development cover types within the disturbed area:	
Natural Area	☑
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	144,848
RRV Prior to Reductions (cf)	**4,103**
Pervious Area Weighted Rv	0.20
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	89.80

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70	11,900	77	**11,900**	0%	0.00
Pervious Area		39		61		74	52,076	80	**52,076**	0%	0.25
Impervious Area		98		98		98	80,872	98	**80,872**	0%	0.95
Total	**0**		**0**		**0**		**144,848**		**144,848**	**0%**	**0.62**

Design for Drainage Area 1

Drainage Area ID	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	144,848
RRV Prior to Reductions (cf)	**4,103**
Pervious Area Weighted Rv	0.20
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	89.80

View Instructions

Required Retention Volume Reductions ($RRV_{Reductions}$)

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees	20	10	200

Total $RRV_{reductions}$ (cf)	**200**
RRV After Reductions (cf)	**3,903**
% Reduction in RRV	**4.9%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☐
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☐
Choker Course	☐
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows | Show Blank Rows

PT% 40.00%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit	
DET1	Dry Detention Basin, Infiltration Only		52,076	80,872	**3,992**	**4,240**		5,300	0.8	4,240	4,240	100%	4,240	9,981	☑ *This facility meets the Required Retention Volume.*

Required Retention Volume (cf)	3,903
Retention Volume Achieved (cf)	4,240

☑ *You met the Required Retention Volume.*

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	89.80
S	1.14
Ia	0.06

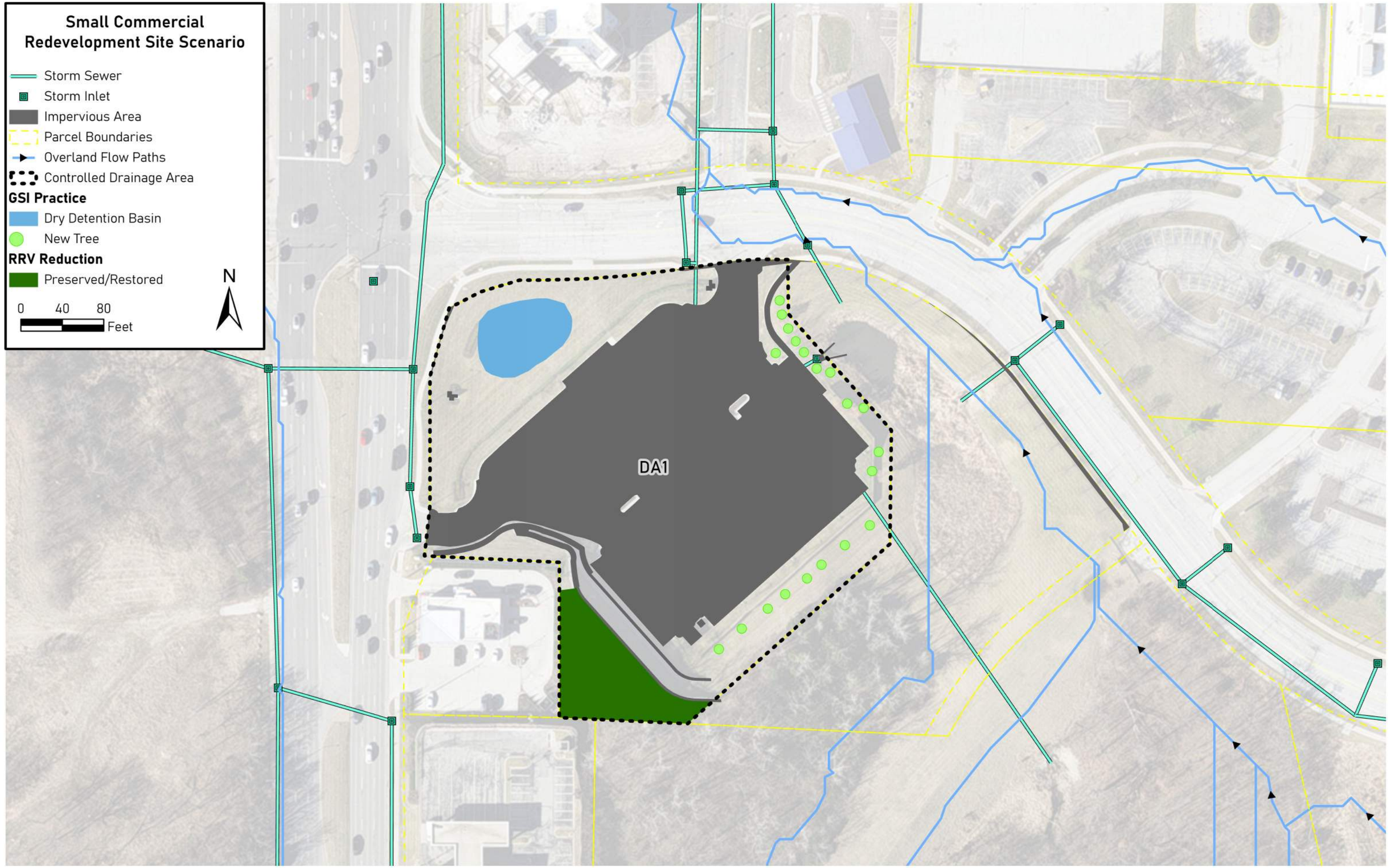
	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	1.81	3.10	3.98	4.70	5.45
Post-Development Runoff Volume (in) with Retention	1.46	2.75	3.63	4.35	5.10
Retention Adjusted CN	87.2	87.8	87.9	88.0	88.1
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	0.67	0.14	2.43	0.04	***Required release rate met.***
10-Year, NOAA Atlas14 Median, First Quartile	0.60	2.00	1.13	3.32	0.34	***Required release rate met.***
100-Year, NOAA Atlas14 Median, First Quartile	3.00	9.98	8	4.25	2.41	***Required release rate met.***

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	144,848	
	Total Site Rv:	0.62	
	Total RRV Prior to Reductions (cf)	4,103	
	Total RRV Reductions (cf)	200	
	Total RRV After Reductions (cf)	3,903	
	Total Retention Volume Achieved (cf)	4,240	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	43.3%	☑ *Required percent site control achieved!*

Drainage Area 1	**Disturbed Drainage Area (sf)**	144,848
	RRV Prior to Reductions (cf)	4,103
	$RRV_{reductions}$ (cf)	200
	RRV After Reductions (cf)	3,903
	Retention Volume Achieved (cf)	4,240


Small Commercial
Redevelopment Site Scenario
Storm Sewer
Storm Inlet
Impervious Area
Parcel Boundaries
Overland Flow Paths
Controlled Drainage Area
GSI Practice
Dry Detention Basin
New Tree
RRV Reduction
Preserved/Restored
0
40
80
Feet
N
DA1

General Requirements

Project Information

Project Name:	Small Commercial - Redevelopment Site
Date:	1/30/2025
Address:	
Nearest Intersection:	
Project Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Estimated values based on development type

Site Parameters

Total Disturbed Area of Site	1.25	acres
Total Proposed Impervious Area	46,304	square feet
Total Tributary Drainage Area to Site	1.25	acres
Effective FEMA floodplain?	No	*(Select Yes/No)*

Describe Known Stormwater Issues (if any):

Stormwater Management Requirements/Variance

Project required to meet stormwater management criteria?	Yes	
Request for Variance?	No	*(Select Yes/No)*

Why? Explain:

Landscape Professional Verification of Compliance with Design Criteria

Preservation/Restoration

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Stream setbacks meet requirements of Section 5604 and placed within a separate dedicated tract of land restricted from future development?
☐ Yes ☑ No	Project incorporates preservation or restoration of Natural Areas?
☐ Yes ☐ No ☑ N/A	Natural Area meets requirements of Section 5604?
☐ Yes ☐ No ☑ N/A	Natural Area placed within a separate dedicated tract of land restricted from future development?
☑ Yes ☐ No ☐ N/A	Project incorporates the following Sustainable Stormwater Management Practices and RRV reductions meeting requirements of Section 5602 and 5604 (select all that apply):
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Sheetflow to Natural Areas
☐ Yes ☑ No ☐ N/A	Downspout Disconnection (not applicable for residential developments)
☑ Yes ☐ No ☐ N/A	Preservation of Existing Trees or Planting New Trees?

Total RRV Reductions: 220 (cf)

I hereby certify, as a Landscape Professional, that the information in the Preservation/Restoration section of this form was assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Professional Engineer Verification of Compliance with Design Criteria

Retention

Requirements Met?	Design Criteria	Retention Volume (cf)	
☑ Yes ☐ No ☐ N/A	Required Retention Volume met per Section 5602?		
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Required***	***Designed***
	RRV (prior to RRV Reductions)	2,068	1,936
	RRV (with RRV Reductions)	1,848	

Detention

Requirements Met?	Design Criteria	Release Rates (cfs)	
☑ Yes ☐ No ☐ N/A	Easement(s) provided?	***Maximum Allowable***	***Designed***
☐ Yes ☐ No ☑ N/A	2-year peak outflow control achieved?	0.249343434	0
☐ Yes ☐ No ☑ N/A	10-year peak outflow control achieved?	0.623358586	0
☑ Yes ☐ No ☐ N/A	100-year peak outflow control achieved?	3.740151515	2.81

Collection

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Inlet placement and gutter spread per requirements of Section 5607?

Conveyance

Requirements Met?	Design Criteria
☐ Yes ☐ No ☑ N/A	Easement(s) provided?
☐ Yes ☐ No ☑ N/A	Enclosed pipe systems per requirements of 5608.2?
☐ Yes ☐ No ☑ N/A	Minor drainage systems per requirements of 5608.3 A?
☐ Yes ☐ No ☑ N/A	Designated overflow routes for 100-year design storm per requirements of Section 5608.3 B?
☐ Yes ☐ No ☑ N/A	Channel stabilization per requirements of 5608.4?
☐ Yes ☐ No ☑ N/A	Road crossings per requirements of 5608.5?

I hereby certify, as a Professional Engineer, that the information in the Retention, Detention, Collection, and Conveyance sections of this form were assembled under my direct personal charge and is in compliance with the Stormwater Management Criteria.

Professional Name	License Number	State

Required Maps

☐ **Watershed Location Map.** Describes the project's location within the greater watershed depicting:

1. Watershed boundary and area (acres)
2. Delineated drainage area tributary to the project site (acres)
3. Natural overland drainage paths to, through and downstream of the project site to the downstream destination of runoff (whether open channel or enclosed system)
4. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
5. Existing stormwater retention/detention facility location(s) in upstream or downstream watershed affecting stormwater management at project site (if applicable)

☐ **Existing Site Conditions Map.** Demonstrates existing conditions of the site depicting:

1. Existing contours
2. Aerial imagery
3. Water bodies & regulatory floodplain (lakes, rivers, streams, creeks, wetlands, etc.)
4. Natural overland drainage paths and discharge points from the site
5. Existing utilities, including existing stormwater infrastructure
6. Parcel boundaries
7. Existing impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
8. Key statistics including total disturbed area, total impervious area, and lot size (if applicable)

☐ **Proposed Site Conditions Map.** Demonstrates proposed conditions of the site depicting:

1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
2. Existing and proposed utilities, including existing stormwater infrastructure overland drainage paths
3. Designated overflow routes and discharge points from the site
4. Proposed drainage areas labeled with IDs and acreages correlating to the stormwater management calculator inputs, including uncontrolled drainage area
5. Parcel boundaries depicting required utility easements, stream setbacks identifying key features and statistics (top of bank or bank-full extents, centerline, Zone 1, and Zone 2, and dimensional offset), and Natural Areas with key statistics (total footprint, minimum length and width).
6. Impervious surfaces and types (i.e. building, parking lot, gravel, etc.)
7. Stormwater improvements including Natural Areas of preservation or restoration, preserved trees, new trees, retention practices, detention practices, collection and conveyance practices with labels correlating to the stormwater management calculator inputs

Site Summary

Project and Development Type:	Site Development - Redevelopment
System Type:	Separate Storm Sewer System
Proposed Land Use:	Commercial
Input Value Basis:	Estimated values based on development type
Assumed Percent Impervious Coverage:	90%
Total Disturbed Area (sf):	54,307

Treatment Summary Table

Water Quality Storm Event (in) (P_{WQ})	1.37
Percent of Water Quality Storm to be Retained (PT%)	40%
Total Controlled Disturbed Area (sf)	54,307
Controlled Area Rv ($Rv_{controlled}$)	0.83
Total Uncontrolled Disturbed Area (sf)	0
Total Required Retention Volume (cf) (RRV)	2,068
Uncontrolled Retention Volume (cf)	0
Adjusted PT% within Controlled Drainage Areas	NA

☑ ***Uncontrolled area is within the limit to achieve the total site retention requirements.***

Drainage Areas Worksheet

View Instructions

How many total drainage areas are included on the site? 1

Drainage Area Summary Table			
Unique Drainage Area Identifier (ID)	Can this drainage area be feasibly controlled?	Disturbed Drainage Area (sf)	Column1
1	Yes	54,307	

Select post-development cover types within the disturbed area:	
Natural Area	☑
Pervious Area	☑
Impervious Area	☑
Solar Farm - Native	☐
Solar Farm - Gravel	☐
Gravel - Overflow Parking Lots, Trails/Maintenance Paths, Substations	☐
Gravel - Primary Parking Lots, Access Driveways, Railroad Ballasts	☐
Gravel - Public Road with Compacted Subgrade Material	☐
Artificial Turf - No Underdrain System	☐
Artificial Turf - Underdrain System	☐
Water Surfaces	☐

Generate Detailed Drainage Area Tables

Filter Cover Types

Generate Design Sheets

Summary Table for Drainage Area ID:	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	54,307
RRV Prior to Reductions (cf)	**2,068**
Pervious Area Weighted Rv	0.16
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	95.19

Cover Type Area Table for Drainage Area 1	Area (sf)										
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN	Soil Type D	CN	**Total**	**% Cover**	Rv
Natural Area		30		55		70	2,858	77	**2,858**	0%	0.00
Pervious Area		39		61		74	5,145	80	**5,145**	0%	0.25
Impervious Area		98		98		98	46,304	98	**46,304**	0%	0.95
Total	**0**		**0**		**0**		**54,307**		**54,307**	**0%**	**0.83**

Design for Drainage Area 1

Drainage Area ID	1
Is this drainage area controlled?	Yes
Disturbed drainage area (sf)	54,307
RRV Prior to Reductions (cf)	**2,068**
Pervious Area Weighted Rv	0.16
Impervious Area Weighted Rv	0.95
Post-Development Condition Weighted CN	95.19

Required Retention Volume Reductions ($RRV_{Reductions}$)

View Instructions

Preservation/Restoration, & Disconnection $RRV_{reductions}$	Natural or Pervious Area Footprint (sf)	Pervious Tributary Area (sf) ($P_{Tributary\ Area}$)	Impervious Tributary Area (sf) ($I_{Tributary\ Area}$)	Runoff Reduction Credit	Retention Volume Credited (cf) $RRV_{reduction}$
Sheetflow to Natural Area				100%	0
Sheetflow to Pervious Area				50%	0
Downspout Disconnection				25%	0

Tree $RRV_{reductions}$	Number of Trees (Each)	Runoff Reduction Credit (cf/tree)	Retention Volume Credited (cf) $RRV_{reduction}$
Existing Trees (Preserved)		20	0
New Trees	22	10	220

Total $RRV_{reductions}$ (cf)	**220**
RRV After Reductions (cf)	**1,848**
% Reduction in RRV	**10.6%**

Retention Practices

Select material types and storage layers used for this design:	
Open Storage (Ponding Area)	☑
Bioretention Soil	☑
Structural Soil	☐
Sand	☐
Storage Aggregate Media	☑
Choker Course	☐
Green Roof Drainage Layer	☐
Green Roof Growing Media	☐
Storage Chamber(s)	☐

Hide Blank Rows Show Blank Rows

PT% 40.00%

Retention Facility ID	Practice	Downstream Retention Facility ID	Pervious Drainage Area	Impervious Drainage Area	Target Retention Volume	Credited Storage Volume (cf)	Bypass RRV (cf)	Open Storage (Ponding)			Bioretention Soil				Storage Aggregate Media				Total Storage Volume (cf)	Runoff Reduction Factor (%)	Retention Volume Provided (cf)	Maximum Retention Credit	
BIO1	Bioretention, Controlled Release	INF1	937	8,430	**373**	**406**		350	0.5	175	350	0.3	2.5	263	350	0.4	0.5	70	508	80%	406	932	☑ *This facility meets the Required Retention Volume.*
BIO2	Bioretention, Controlled Release	INF1	763	6,871	**304**	**275**	**28**	219	0.5	110	219	0.3	2.5	164	219	0.4	0.8	70.155393	344	80%	275	759	☑ *This facility meets the Required Retention Volume.*
BIO3	Bioretention, Controlled Release	INF1	1,189	10,702	**473**	**285**	**188**	216	0.5	108	216	0.3	2.5	162	216	0.4	1.0	86.2308172	356	80%	285	1,183	☑ *This facility meets the Required Retention Volume.*
INF1	Infiltration Trench, Infiltration Only	NA	2,256	20,301	**1,114**	**970**	**144**	693	0.8	554		0.3		0	693	0.4	1.5	415.690384	970	100%	970	2,460	☑ *This facility meets the Required Retention Volume.*
Required Retention Volume (cf)		1,848																					
Retention Volume Achieved (cf)		1,936	☑ *You met the Required Retention Volume.*																				

Detention Calculations

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Required Rainfall Event (in) - 6 hour Events	2.66	4.04	4.96	5.70	6.47

Pre-Development Conditions

Weighted CN	69.00
S	4.49
Ia	1.80

Post-Development Conditions

Weighted CN	95.19
S	0.51
Ia	0.03

	2-year storm	10-year storm	25-year storm	50-year storm	100-year storm
Pre-Development Runoff Volume (in)	0.14	0.75	1.31	1.81	2.38
Post Development Runoff Volume (in) with no Retention	2.21	3.57	4.48	5.21	5.98
Post-Development Runoff Volume (in) with Retention	1.73	3.08	4.00	4.73	5.50
Retention Adjusted CN	90.6	91.2	91.4	91.5	91.6
Additional Detention Required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Design Storm	Required Release Rate (cfs/acre)	Allowable Site Release (cfs)	Peak Outflow (cfs)	Max Ponding Depth (ft)	Achieved Release Rate (cfs/acre)	
2-Year, NOAA Atlas14 Median, First Quartile	0.20	0.25			0.00	
10-Year, NOAA Atlas14 Median, First Quartile	0.60	0.75			0.00	
100-Year, NOAA Atlas14 Median, First Quartile	3.00	3.74	2.81		2.25	***Required release rate met.***

Verification of Required Retention Volume (RRV)

Total Site Summary	**Total Disturbed Area (sf):**	54,307	
	Total Site Rv:	0.83	
	Total RRV Prior to Reductions (cf)	2,068	
	Total RRV Reductions (cf)	220	
	Total RRV After Reductions (cf)	1,848	
	Total Retention Volume Achieved (cf)	1,936	☑ *Total Required Retention Volume achieved!*
	Percent WQv Control Achieved	41.7%	☑ *Required percent site control achieved!*

Drainage Area 1	**Disturbed Drainage Area (sf)**	54,307
	RRV Prior to Reductions (cf)	2,068
	$RRV_{reductions}$ (cf)	220
	RRV After Reductions (cf)	1,848
	Retention Volume Achieved (cf)	1,936

Small Commercial Redevelopment Site Scenario

GSI Practice

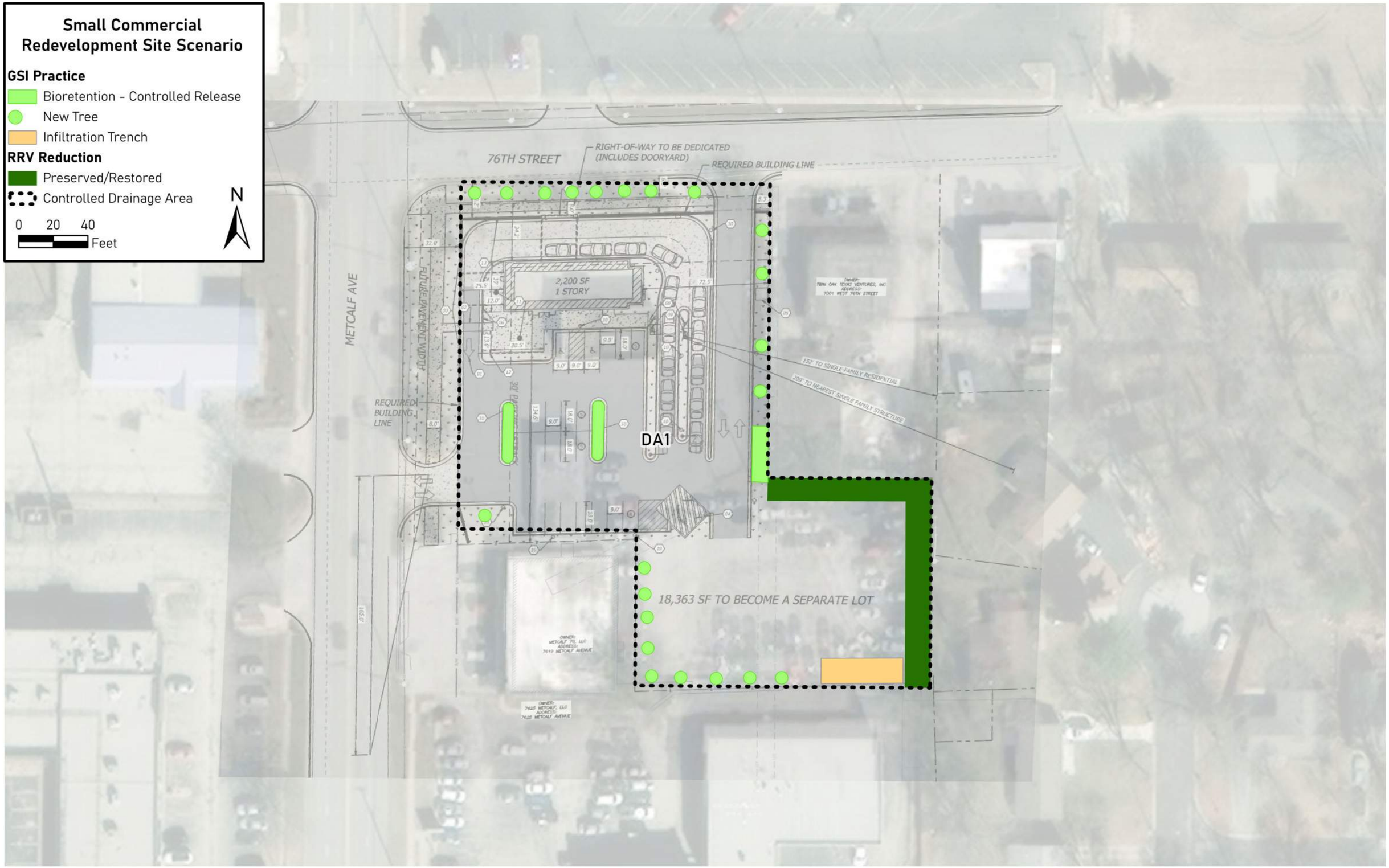
- Bioretention - Controlled Release
- New Tree
- Infiltration Trench

RRV Reduction

- Preserved/Restored
- Controlled Drainage Area

0 20 40 Feet

N

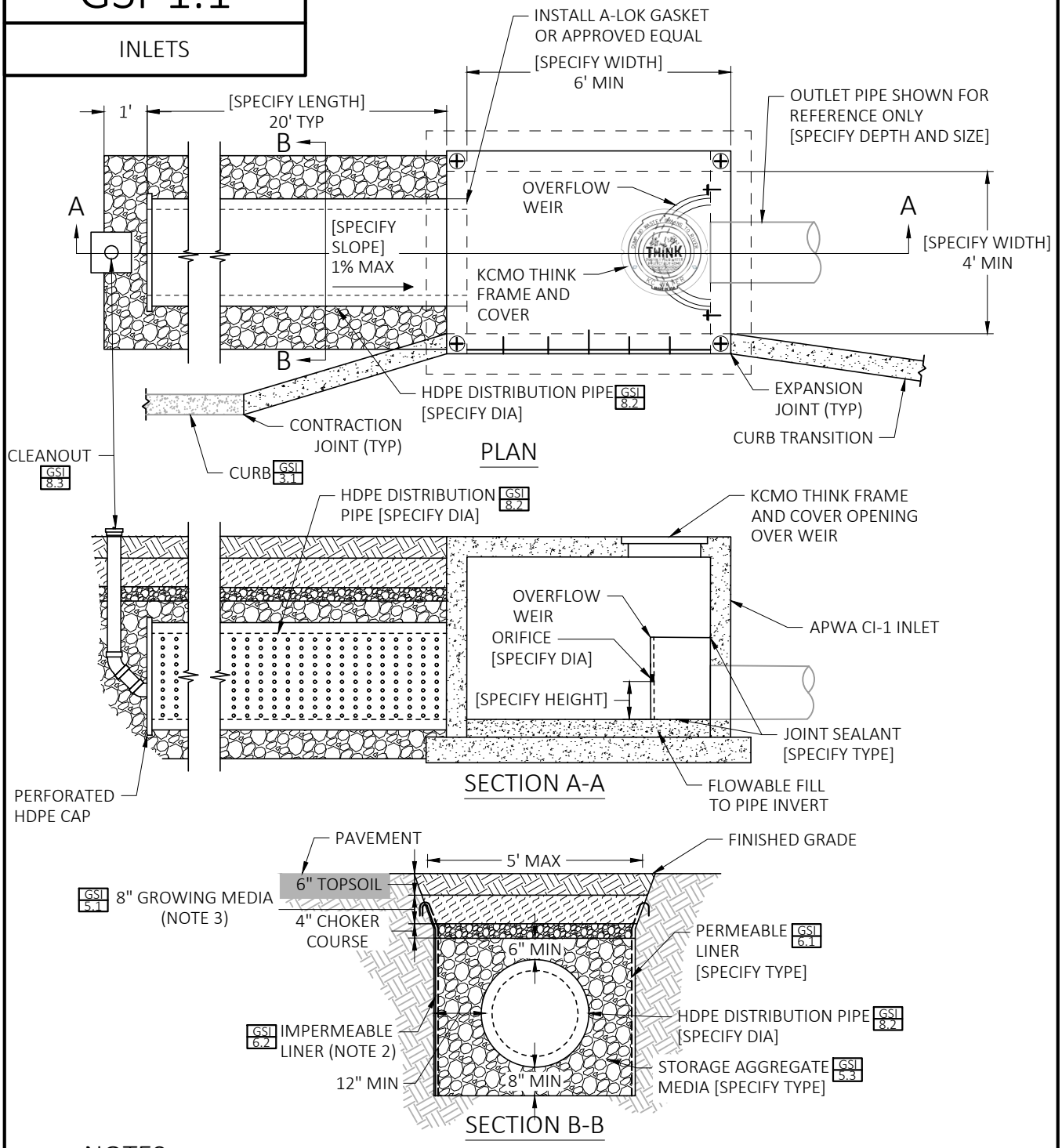


APPENDIX G

APPENDIX G GSI Component Details Under Development

GSI-1.1

INLETS



NOTES:

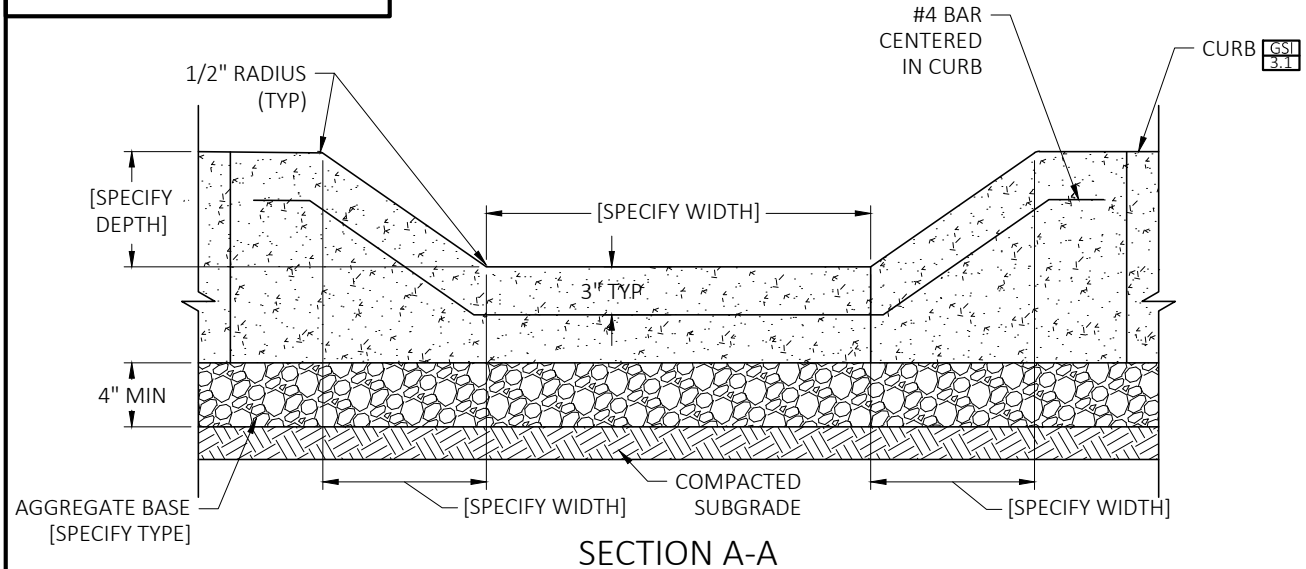
1. INFILTRATION INLET SHALL BE PER 02940.
2. IF INFILTRATION INLET IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

INFILTRATION INLET

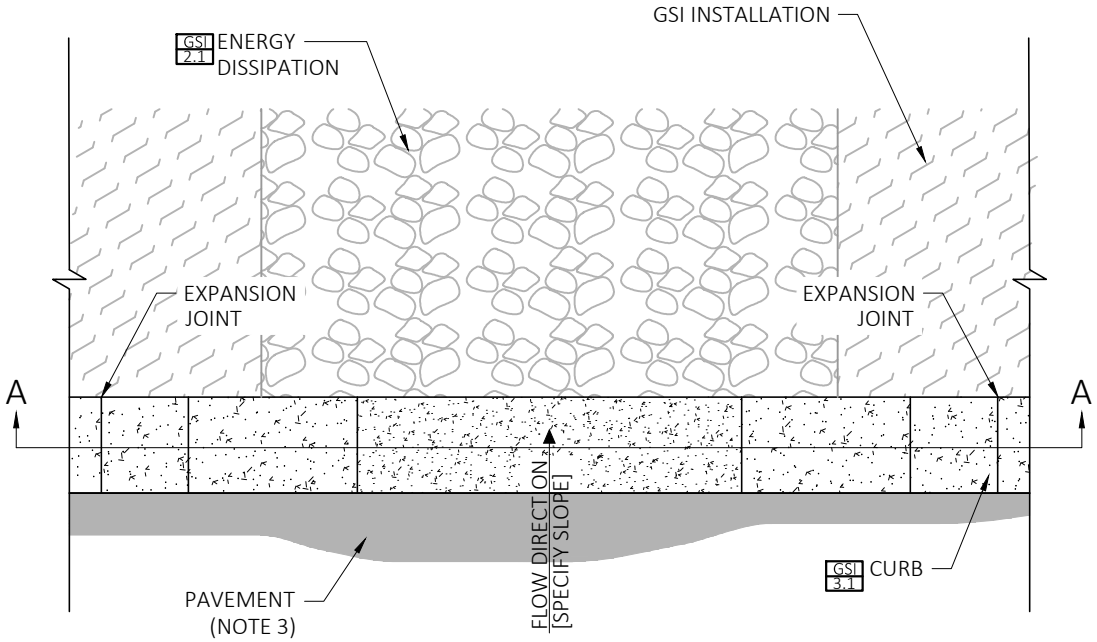
OCTOBER 2022

GSI-1.2

INLETS



SECTION A-A



PLAN

NOTES:

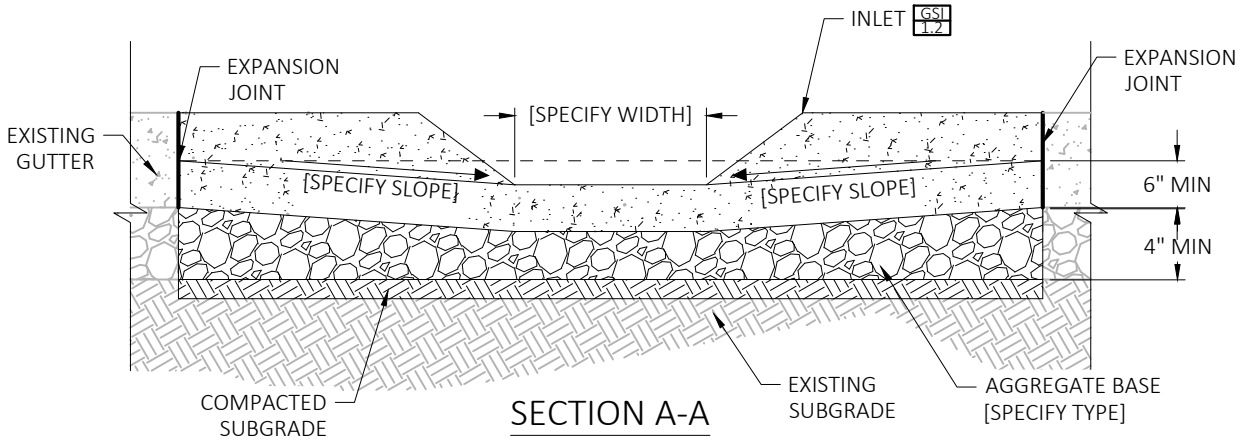
1. CURB CUT SHALL BE PER 02940.
2. TRANSITION TO TYPICAL CURB SECTION PER GSI-3.1.
3. ADJACENT GRADE MUST HAVE POSITIVE SLOPE TOWARDS THE GSI INLET.

CURB CUT

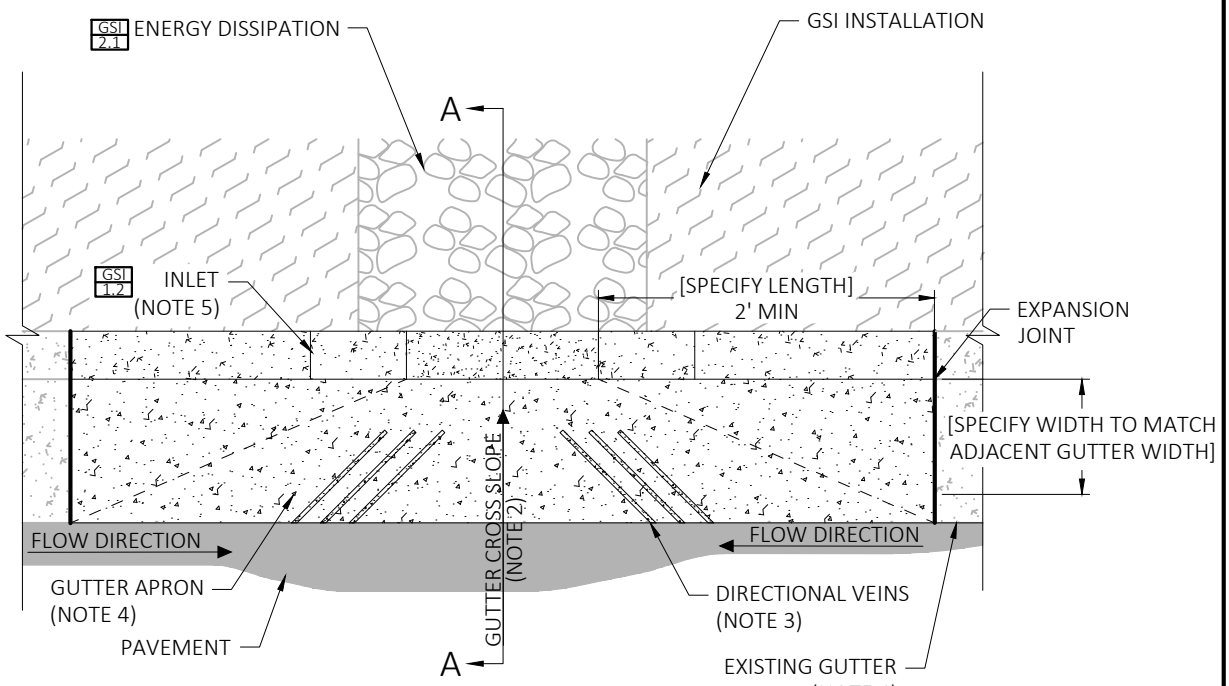
OCTOBER 2022

GSI-1.3

INLETS



SECTION A-A



PLAN

NOTES:

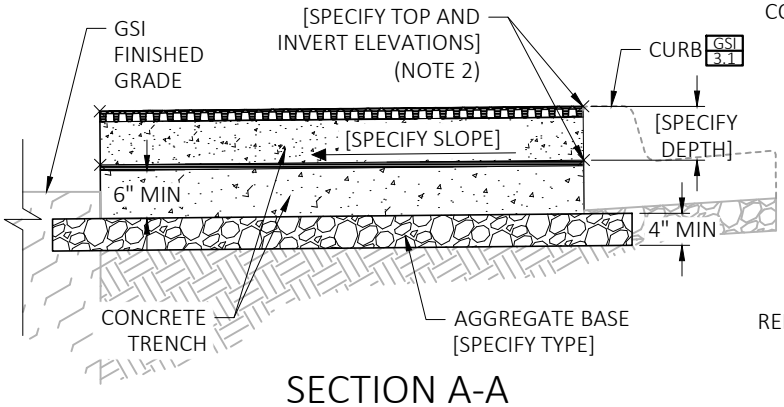
1. GUTTER APRON SHALL BE PER 02940.
2. CROSS SLOPE SHALL BE SPECIFIED BY DESIGN PROFESSIONAL TO MEET REQUIRED INLET CAPACITY.
3. DIRECTIONIAL VEINS SHALL BE ANGLED SUCH THAT UPSTREAM END INTERCEPTS FLOW FROM STREET AND DIRECTS TOWARDS INLET (GSI-1).
4. REINFORCEMENT IN GUTTER APRON SHALL MATCH THAT OF THE ADJACENT GUTTER. TRANSITION TO TYPICAL CURB AND GUTTER SECTION PER GSI 3.1.
5. INLET CURB AND GUTTER APRON SHALL BE CAST MONOLITHICALLY.

GUTTER APRON

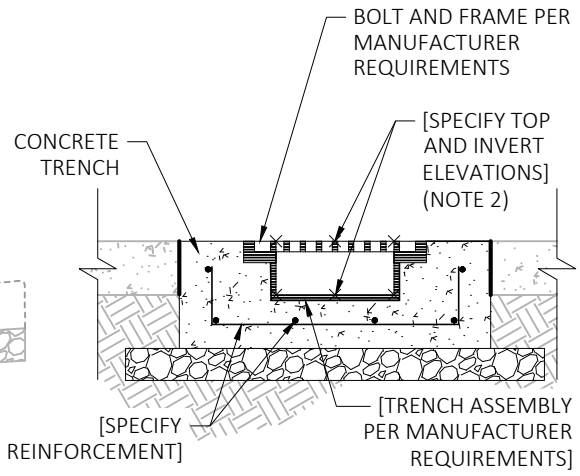
OCTOBER 2022

GSI-1.4

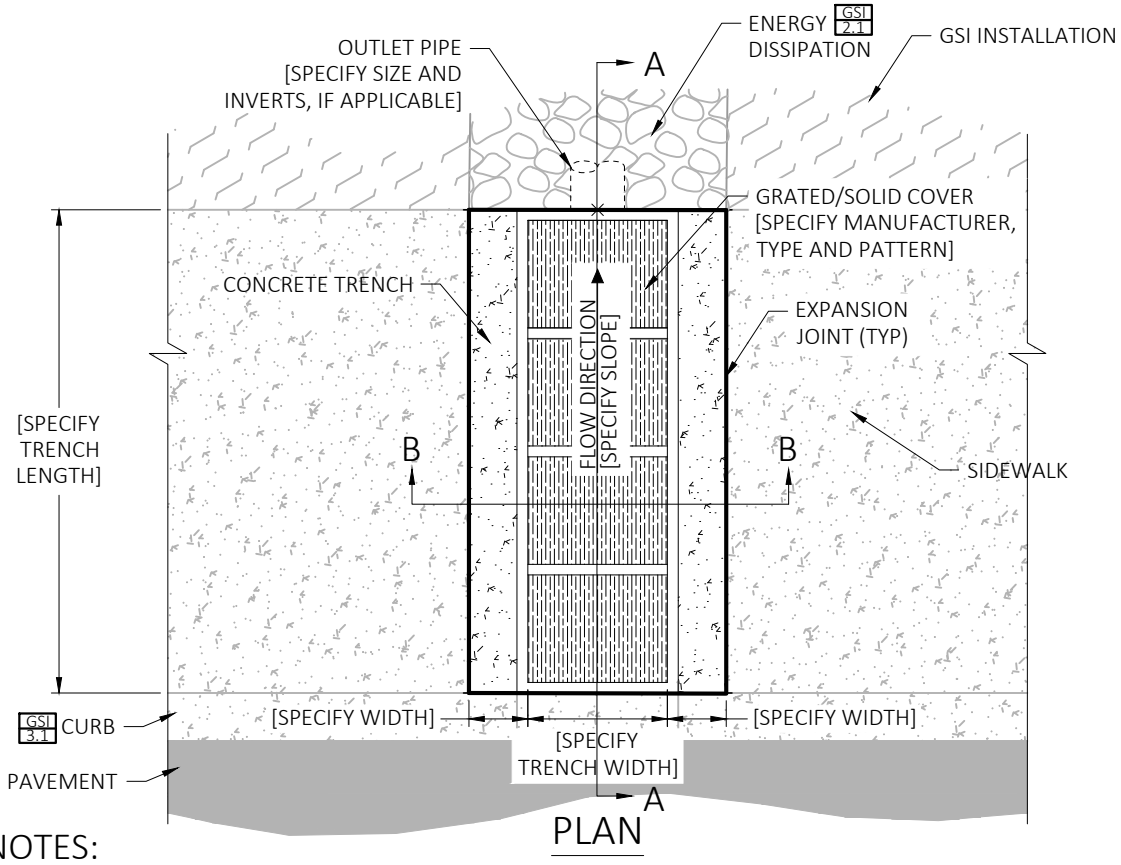
INLETS



SECTION A-A



SECTION B-B



PLAN

NOTES:

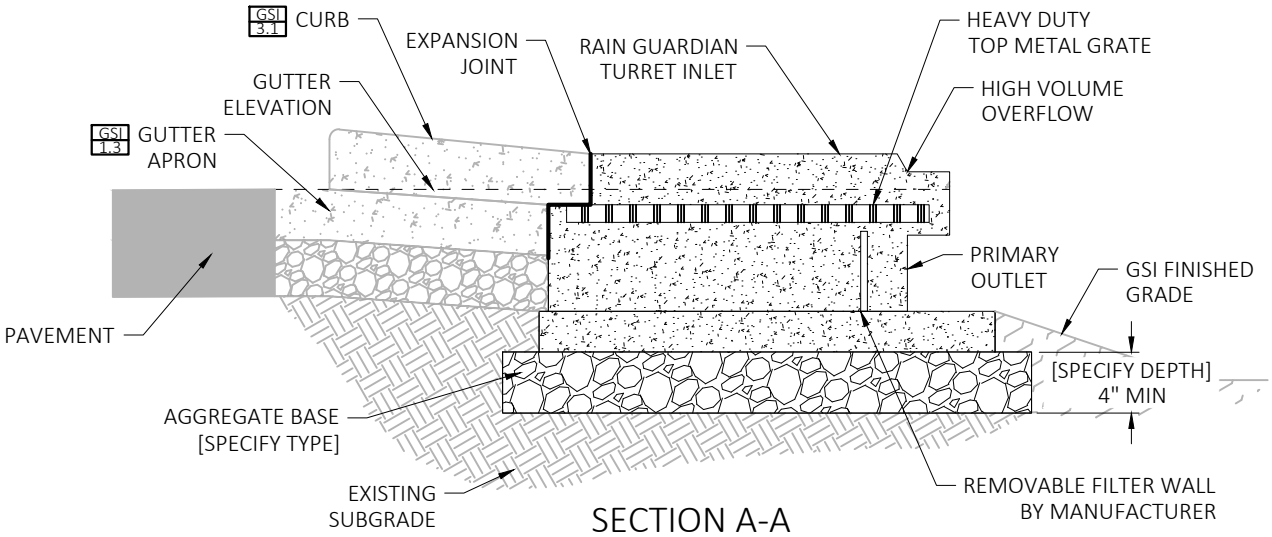
1. TRENCH DRAIN SHALL BE PER 02940.
2. PROVIDE INVERT ELEVATIONS, TOP ELEVATIONS, CROSS SLOPE AND LONGITUDINAL SLOPE OF TRENCH CHANNEL.
3. GRATES LOCATED IN PEDESTRIAN WALKWAYS SHALL HAVE A MAXIMUM GRATE OPENING OF 1/2" IN ONE DIRECTION PER SECTION 302 OF THE 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN.
4. BOLT DOWN GRATE AND FRAME IS REQUIRED. ALL BOLTS SHALL BE FLUSH WITH EXISTING GRADE OF THE SIDEWALK.
5. TRENCH DRAIN AND GRATE/COVER SHALL BE AASHTO H-20 LOAD RATED.

TRENCH DRAIN

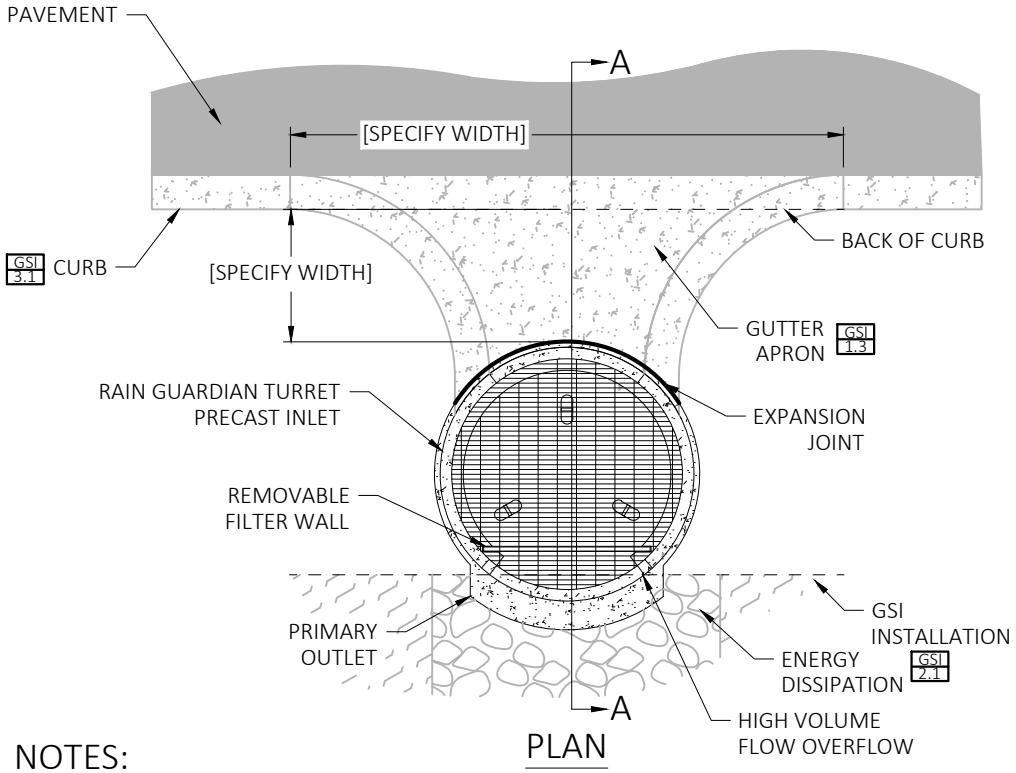
OCTOBER 2022

GSI-1.5

INLETS



SECTION A-A



PLAN

NOTES:

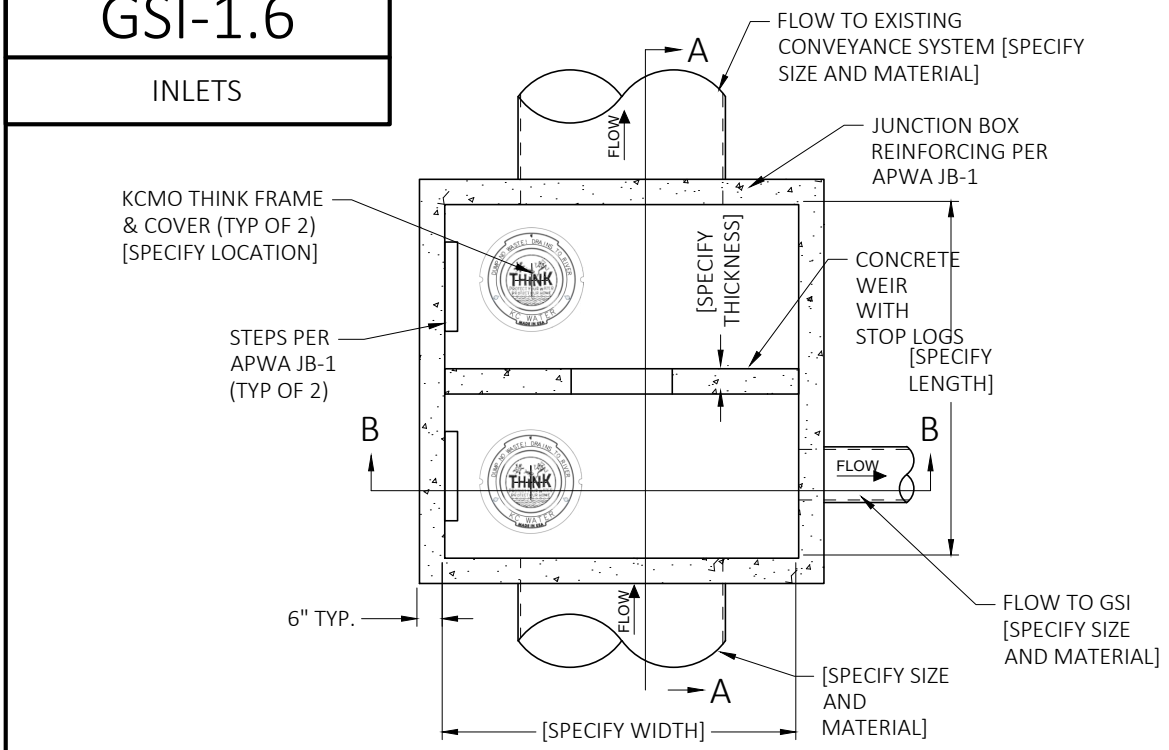
1. MANUFACTURED INLET SHALL BE PER 02940.
2. POSITION MANUFACTURED INLET SO PRIMARY OUTLET ALIGNS WITH TOE OF GSI SIDE SLOPE TO AVOID SOIL INTERFERENCE WITH FILTER.

MANUFACTURED INLET
(RAIN GUARDIAN TURRET EXAMPLE)

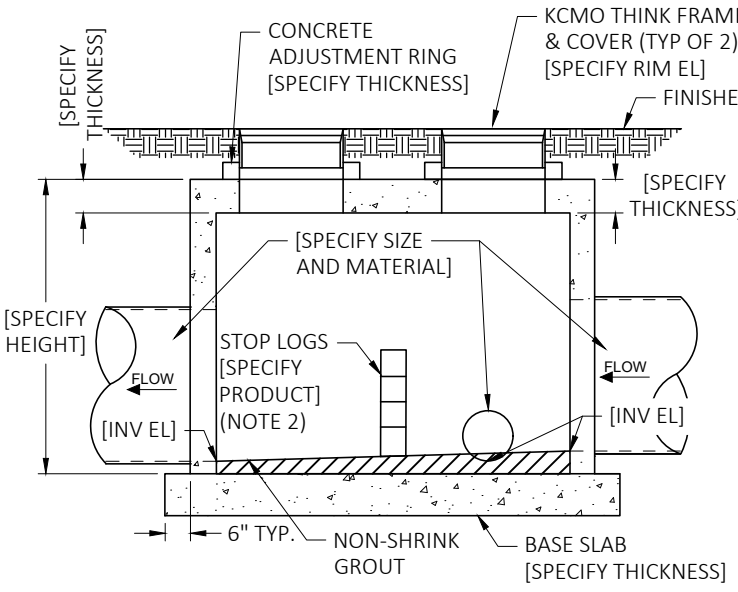
OCTOBER 2022

GSI-1.6

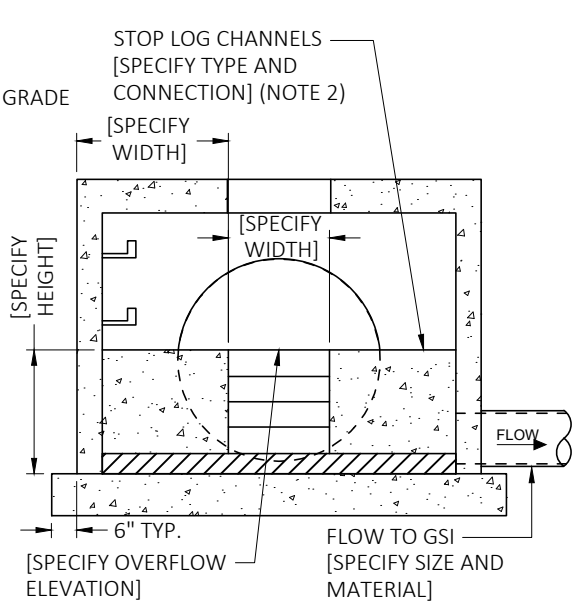
INLETS



PLAN



SECTION A-A



SECTION B-B

NOTES:

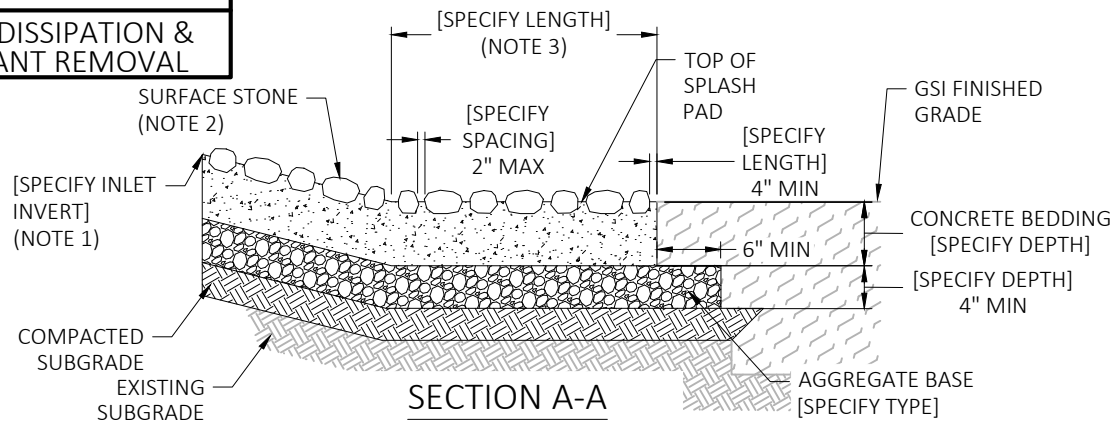
1. FLOW CONTROL STRUCTURE SHALL BE PER [DESIGNER TO INPUT SPECIFICATION SECTION REFERENCE].
2. STOP LOG CHANNEL CONNECTIONS SHALL BE SUFFICIENT TO WITHSTAND [DESIGNER TO SPECIFY MAXIMUM FORCE FROM STORMWATER INFLOW].
3. [DESIGNER TO SPECIFY PRODUCT AND MANUFACTURER FOR WEIR STOP LOGS].

FLOW CONTROL STRUCTURE

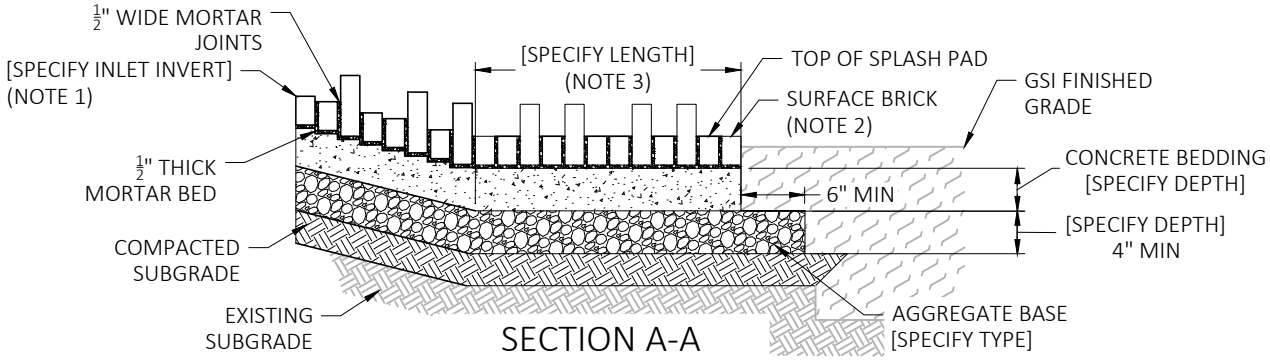
OCTOBER 2022

GSI-2.1.1

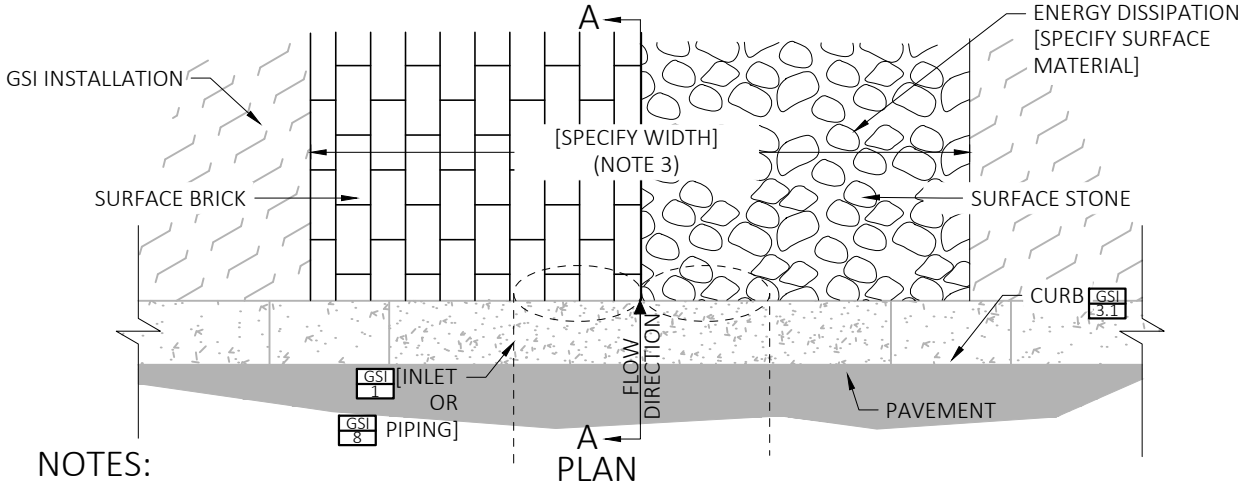
ENERGY DISSIPATION & POLLUTANT REMOVAL



SECTION A-A
(STONE SPLASH PAD)



SECTION A-A
(BRICK SPLASH PAD)



PLAN

NOTES:

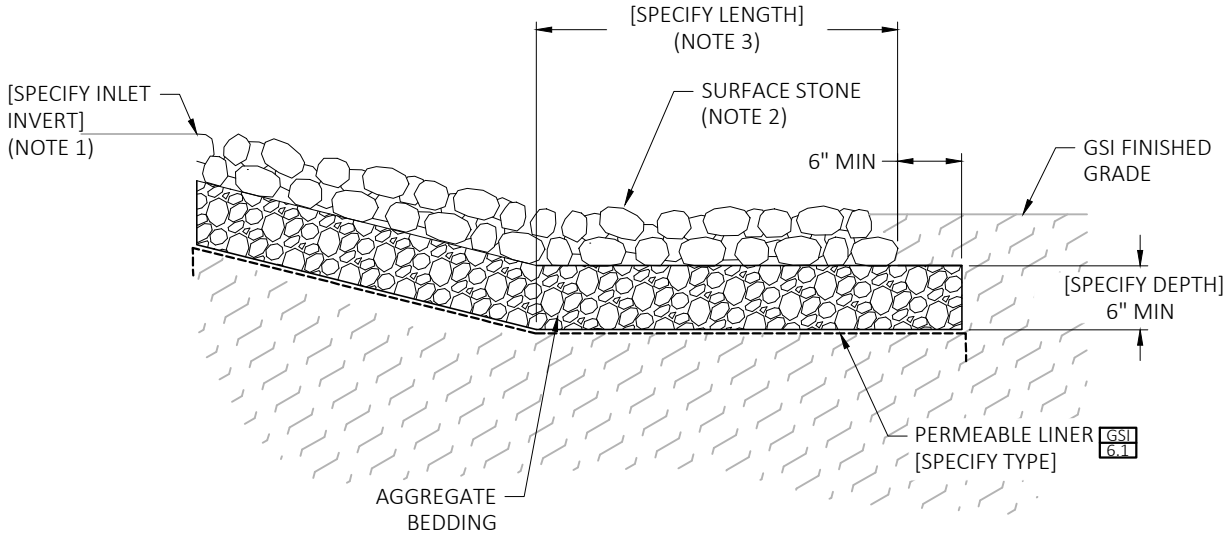
1. CONCRETE EMBEDDED SPLASH PAD SHALL BE PER 02941.
2. TOP OF SPLASH PAD ELEVATION SHALL NOT EXCEED THE HEIGHT OF THE INLET INVERT. [DESIGNER TO SPECIFY TOP OF STONE OR BRICK ELEVATION, AND MINIMUM AND MAXIMUM HEIGHT VARIATION BETWEEN SURFACE MATERIAL AND DEPTH OF EMBEDMENT IN CONCRETE BEDDING.] SURFACE MATERIAL SHOULD BE EMBEDDED A MINIMUM OF $\frac{1}{3}$ TO $\frac{1}{2}$ OF THE HEIGHT OF THE STONE/BRICK. [DESIGNER TO SPECIFY SURFACE MATERIAL TYPE, SIZE AND PATTERN OF SURFACE MATERIAL.]
3. SPLASH PAD WIDTH SHALL BE MINIMUM TWICE INLET OPENING WIDTH OR PIPE DIAMETER. SPLASH PAD LENGTH SHALL BE A MINIMUM OF 3 TIMES THE THICKNESS OF THE SURFACE STONE AND CONCRETE BEDDING.

CONCRETE EMBEDDED SPLASH PAD

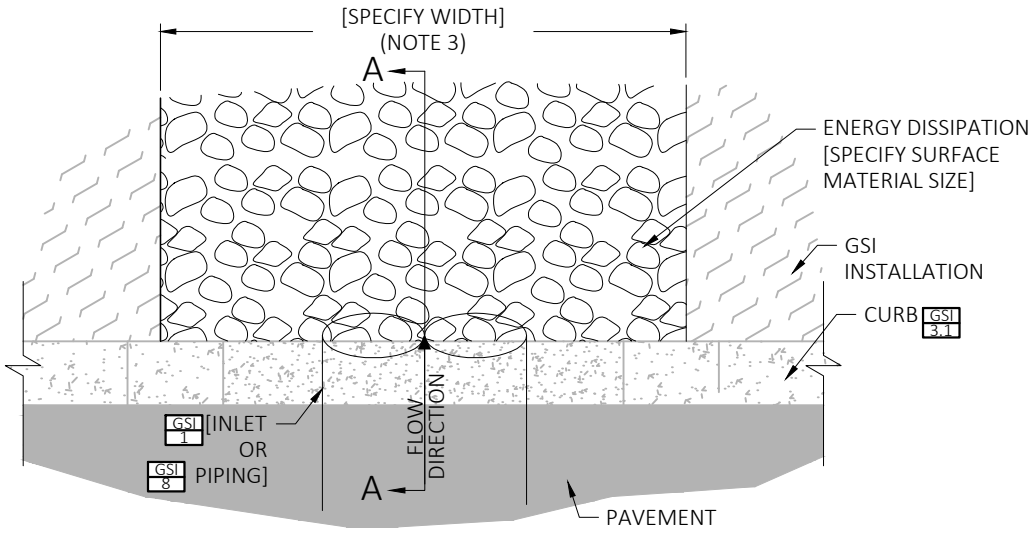
OCTOBER 2022

GSI-2.1.2

ENERGY DISSIPATION & POLLUTANT REMOVAL



SECTION A-A



PLAN

NOTES:

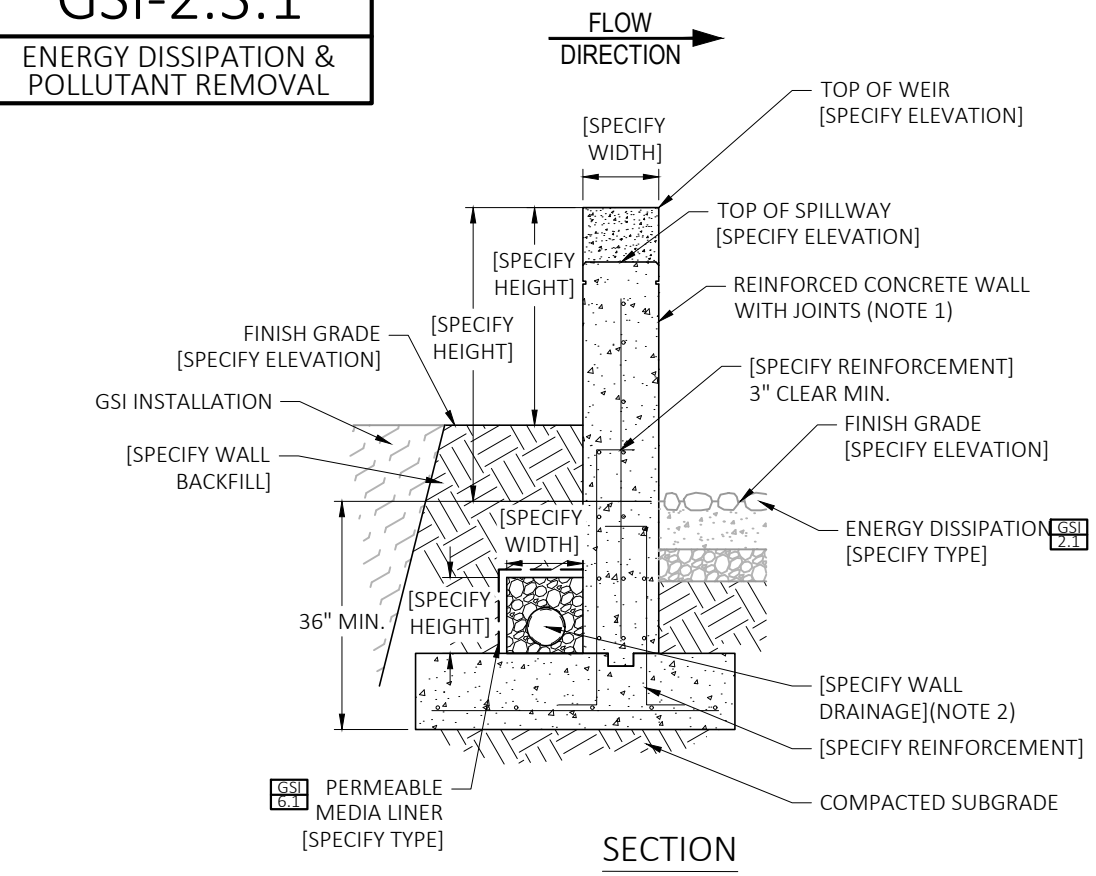
1. SURFACE STONE SPLASH PAD SHALL BE PER 02941.
2. TOP OF SPLASH PAD ELEVATION SHALL NOT EXCEED THE HEIGHT OF THE INLET INVERT. [DESIGNER TO SPECIFY SIZE OF SURFACE STONE AND SPLASH PAD ELEVATION.]
3. SPLASH PAD WIDTH SHALL BE MINIMUM TWICE INLET OPENING WIDTH OR PIPE DIAMETER. SPLASH PAD LENGTH SHALL BE A MINIMUM OF 3 TIMES THE THICKNESS OF SURFACE STONE AND AGGREGATE BEDDING.

SURFACE STONE SPLASH PAD

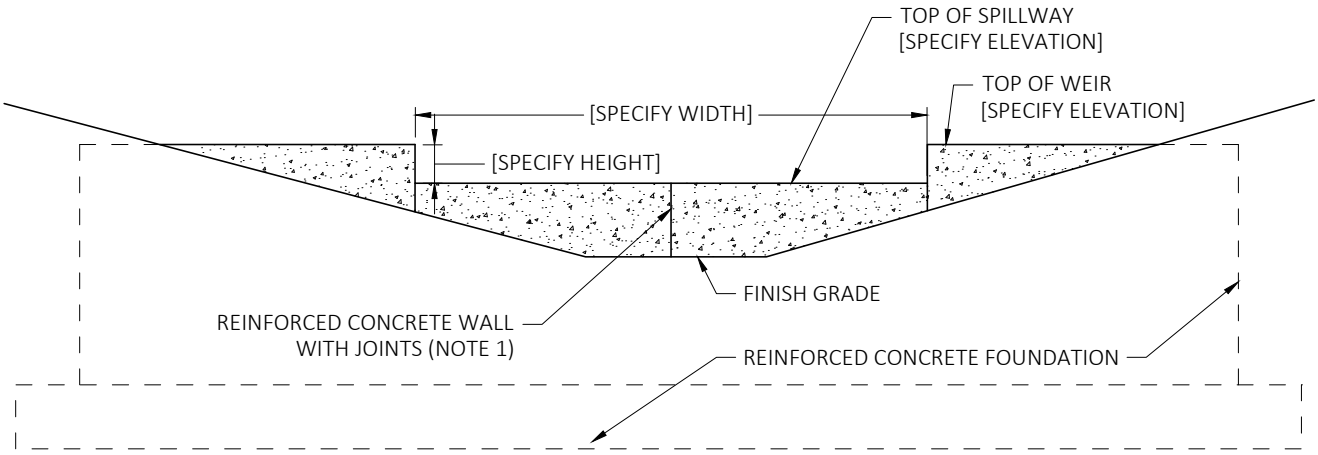
OCTOBER 2022

GSI-2.3.1

ENERGY DISSIPATION & POLLUTANT REMOVAL



SECTION



ELEVATION

NOTES:

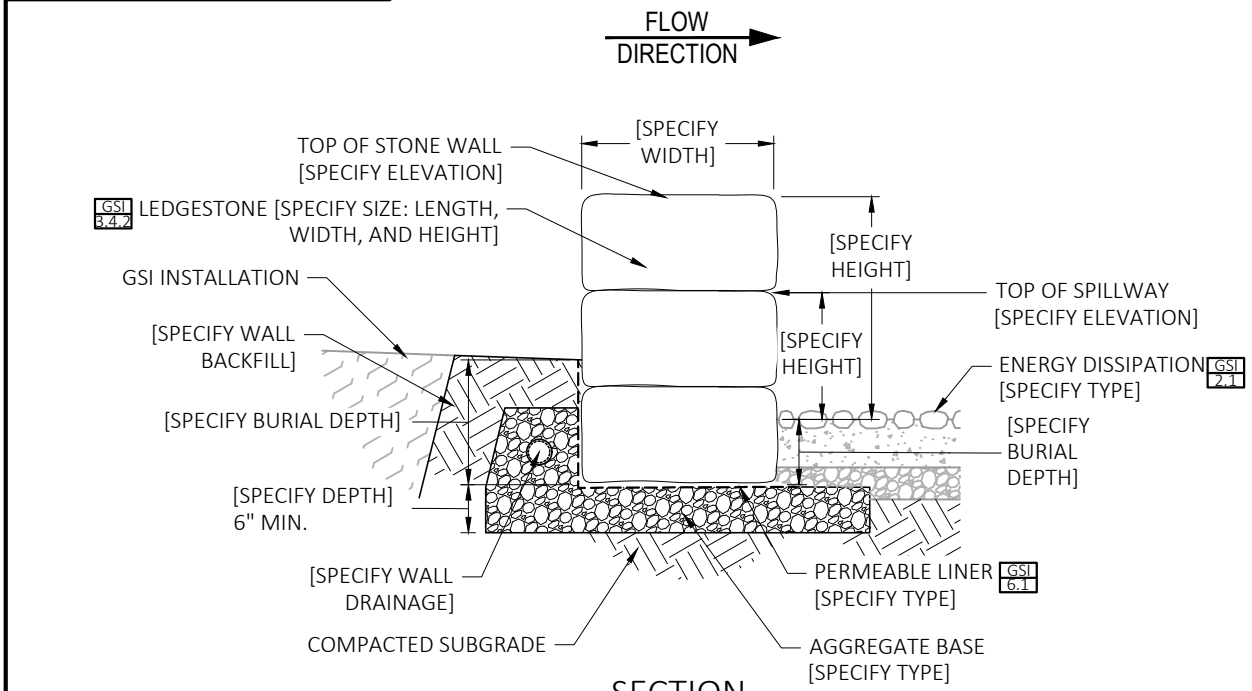
1. PROVIDE VERTICAL EXPANSION JOINTS AT [DESIGNER TO SPECIFY SPACING].
2. WALL DRAINAGE SHALL HAVE A MINIMUM SLOPE OF 0.5% ALONG THE WEIR AND DAYLIGHT AT THE END OF THE WEIR OR TO WEEP HOLES.

CONCRETE SURFACE WEIR

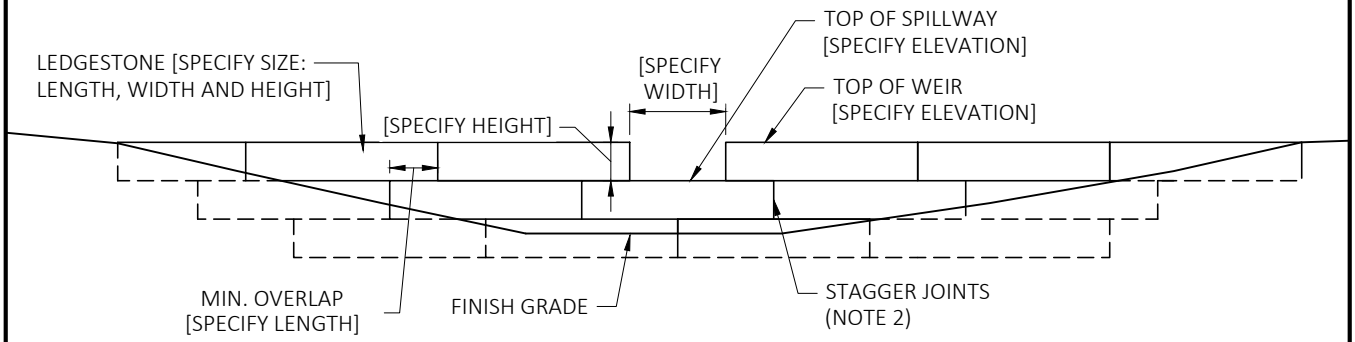
OCTOBER 2022

GSI-2.3.2

ENERGY DISSIPATION & POLLUTANT REMOVAL



SECTION



ELEVATION

NOTES:

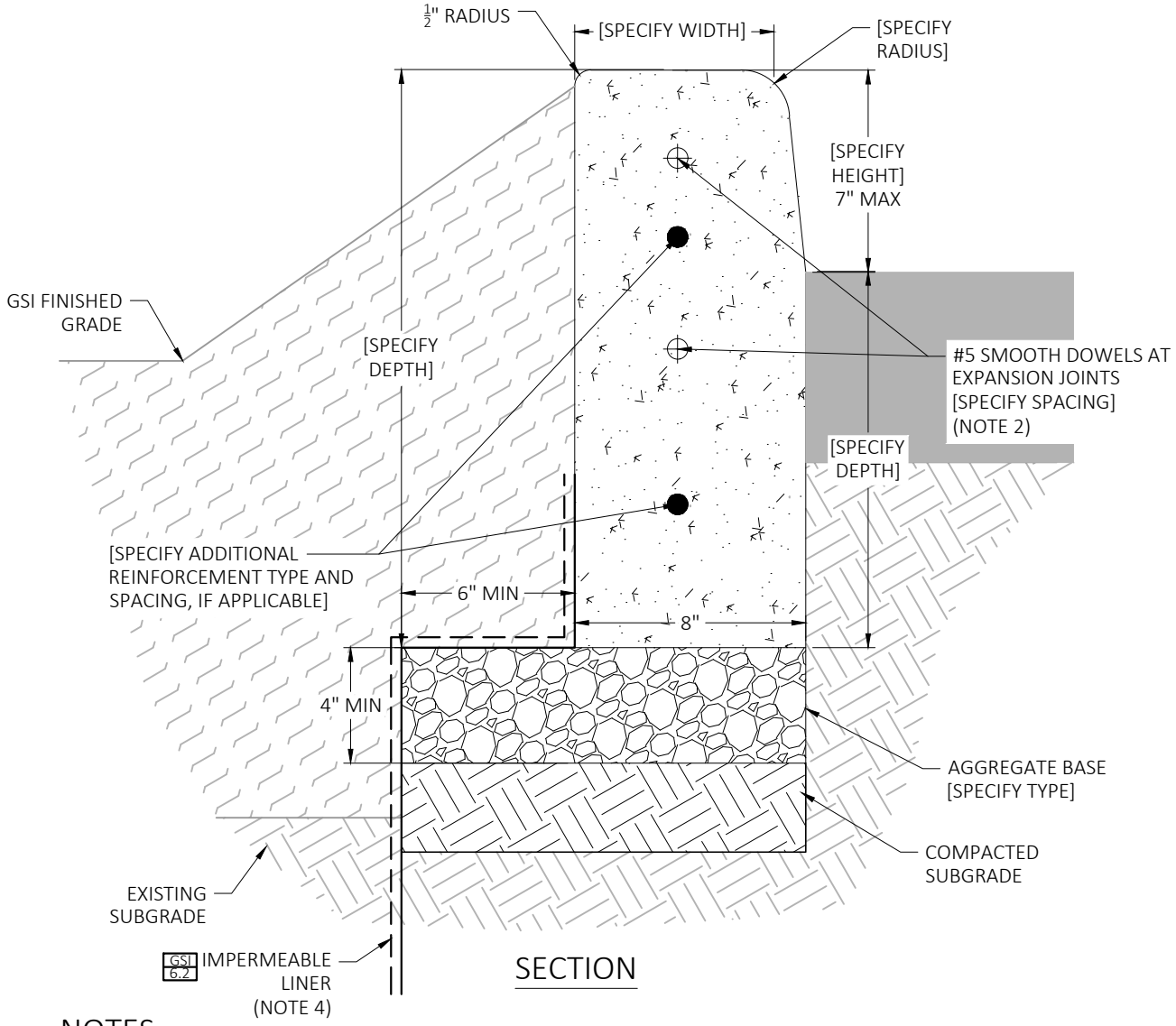
1. LEDGESTONE SHALL BE PER SPEC 02942.
2. STAGGER JOINTS SO THAT THERE IS A MINIMUM [SPECIFY LENGTH] OVERLAP BETWEEN LAYERS OF LEDGESTONE. ABUT END OF LEDGESTONE SO THAT JOINT SPACING DOES NOT EXCEED [SPECIFY WIDTH].

STACKED STONE SURFACE WEIR

OCTOBER 2022

GSI-3.1.1

ABOVE GRADE BARRIERS



SECTION

NOTES:

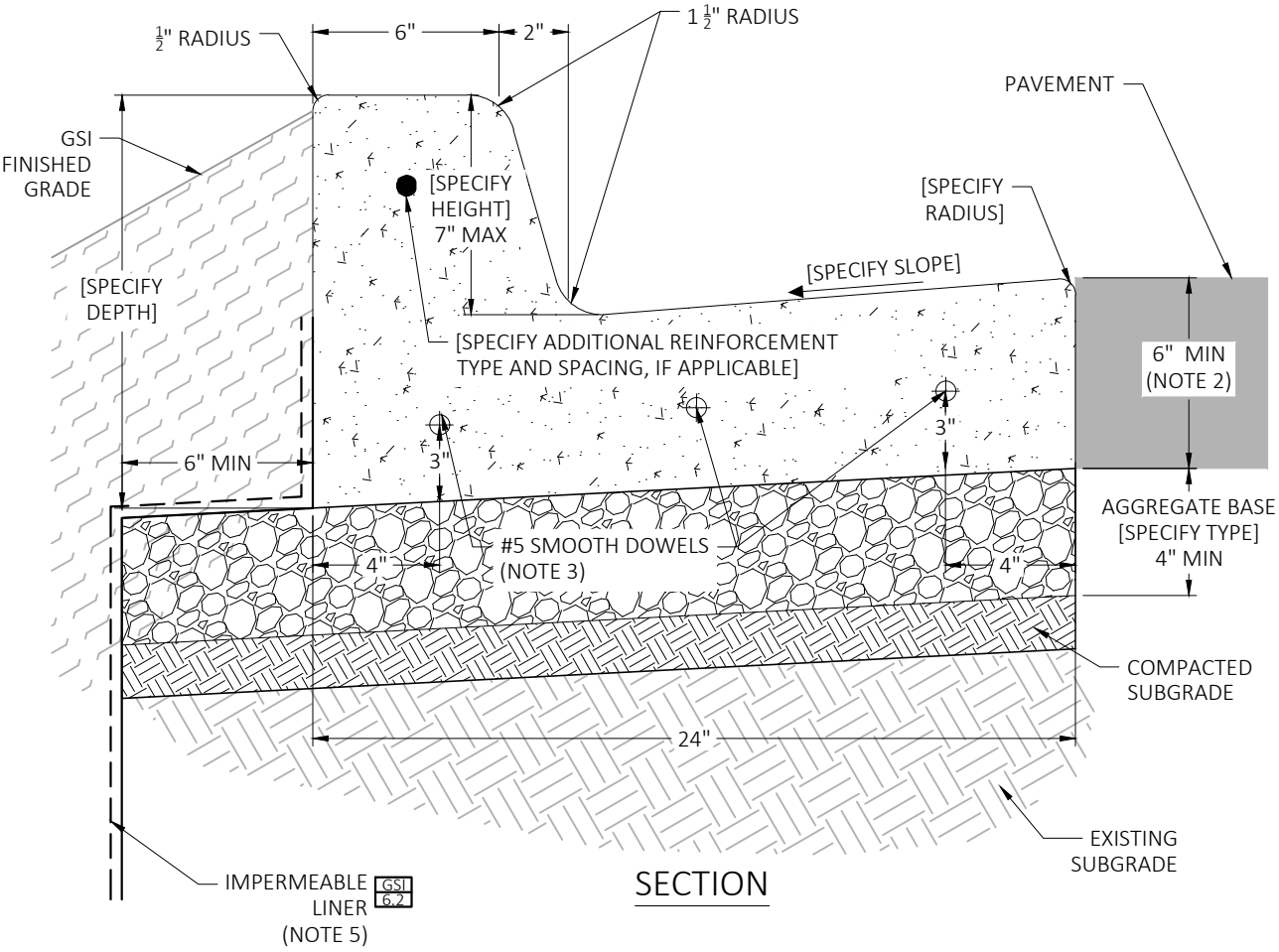
1. CURBING SHALL BE PER 02942.
2. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
3. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

STRAIGHT CURB

OCTOBER 2022

GSI-3.1.2

ABOVE GRADE BARRIERS



SECTION

NOTES:

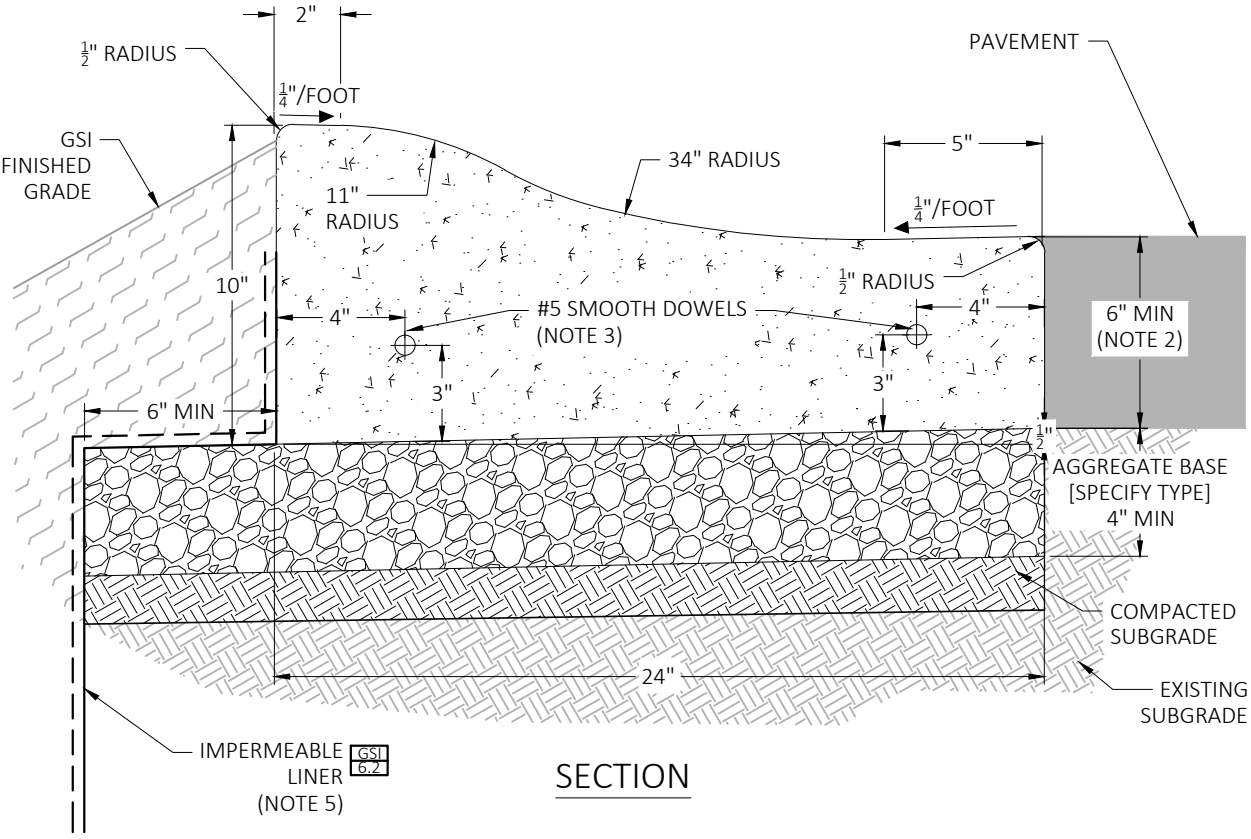
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

STRAIGHT BACK CURB & GUTTER

OCTOBER 2022

GSI-3.1.3

ABOVE GRADE BARRIERS



SECTION

NOTES:

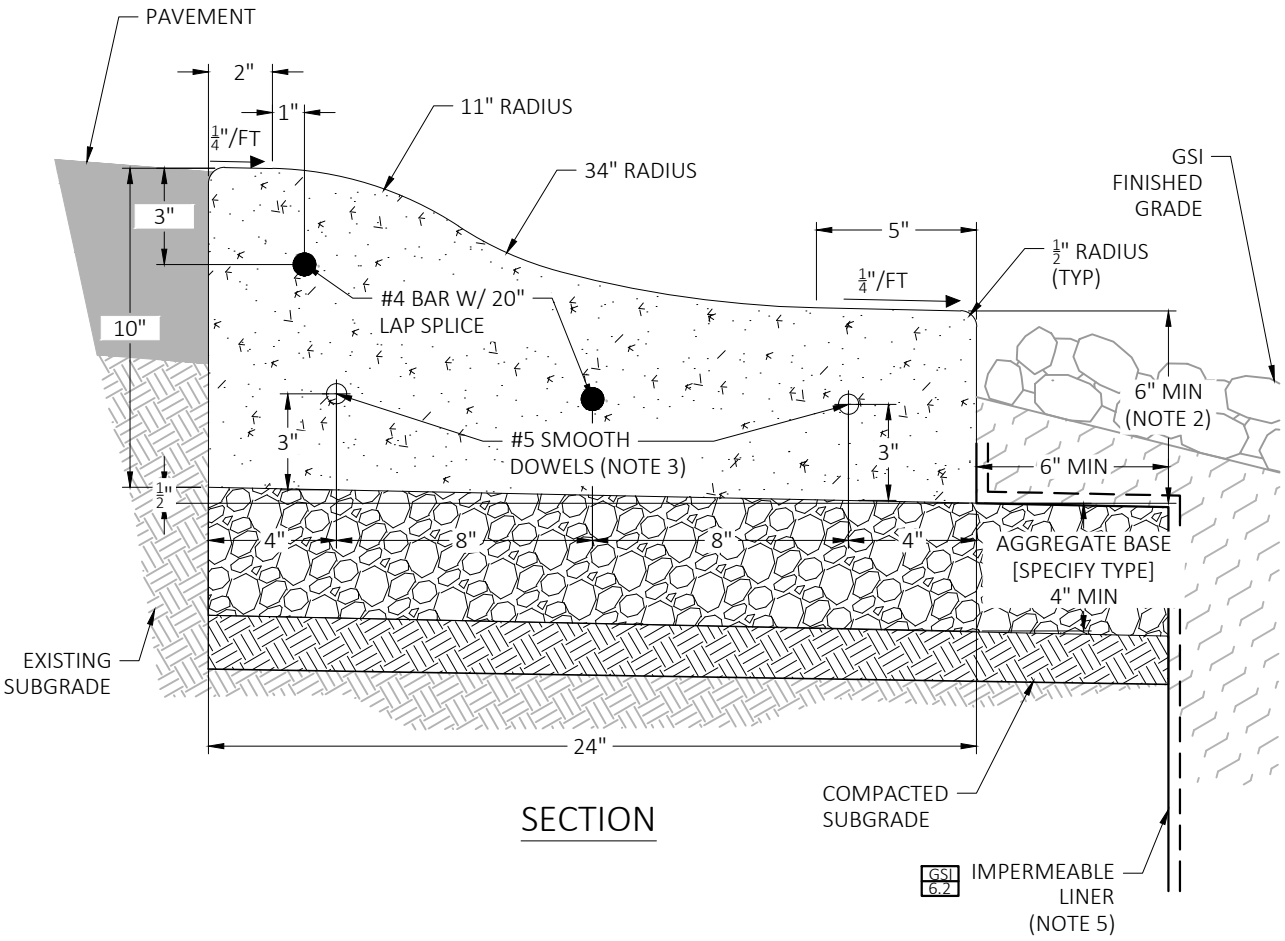
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

ROLL BACK CURB & GUTTER

OCTOBER 2022

GSI-3.1.4

ABOVE GRADE BARRIERS



SECTION

NOTES:

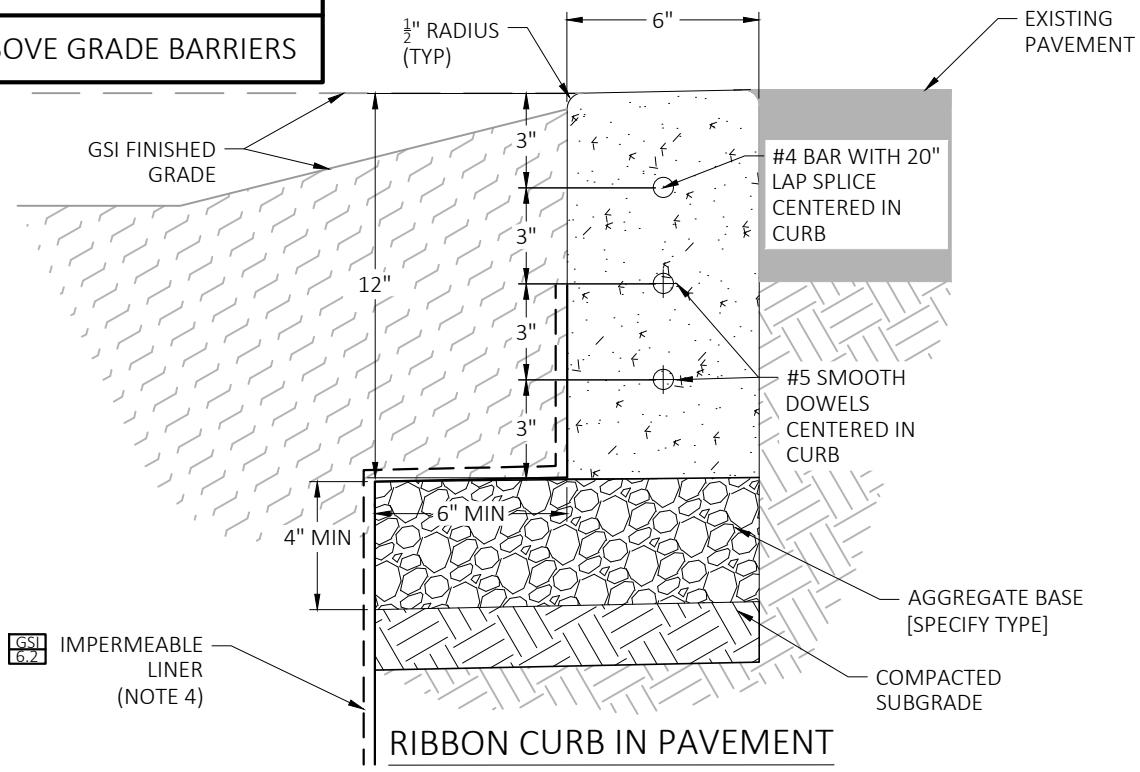
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

REVERSE ROLL BACK CURB & GUTTER

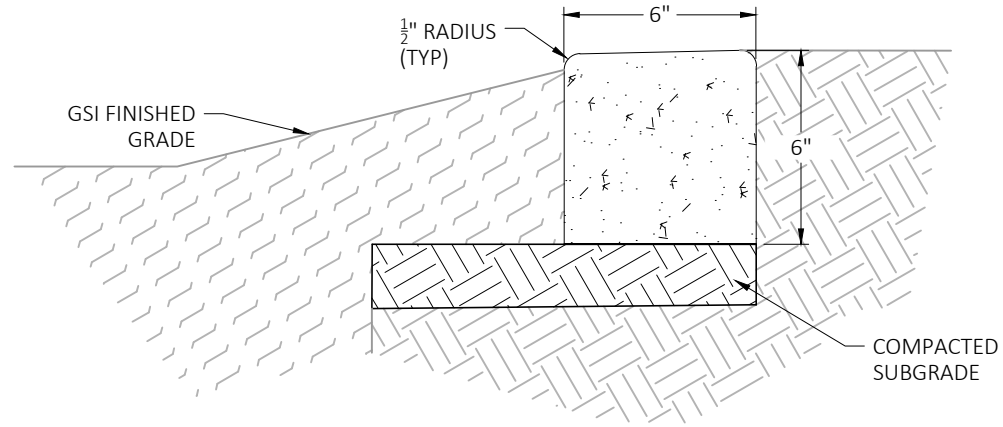
OCTOBER 2022

GSI-3.1.5

ABOVE GRADE BARRIERS



RIBBON CURB IN PAVEMENT



RIBBON CURB IN SOIL

NOTES:

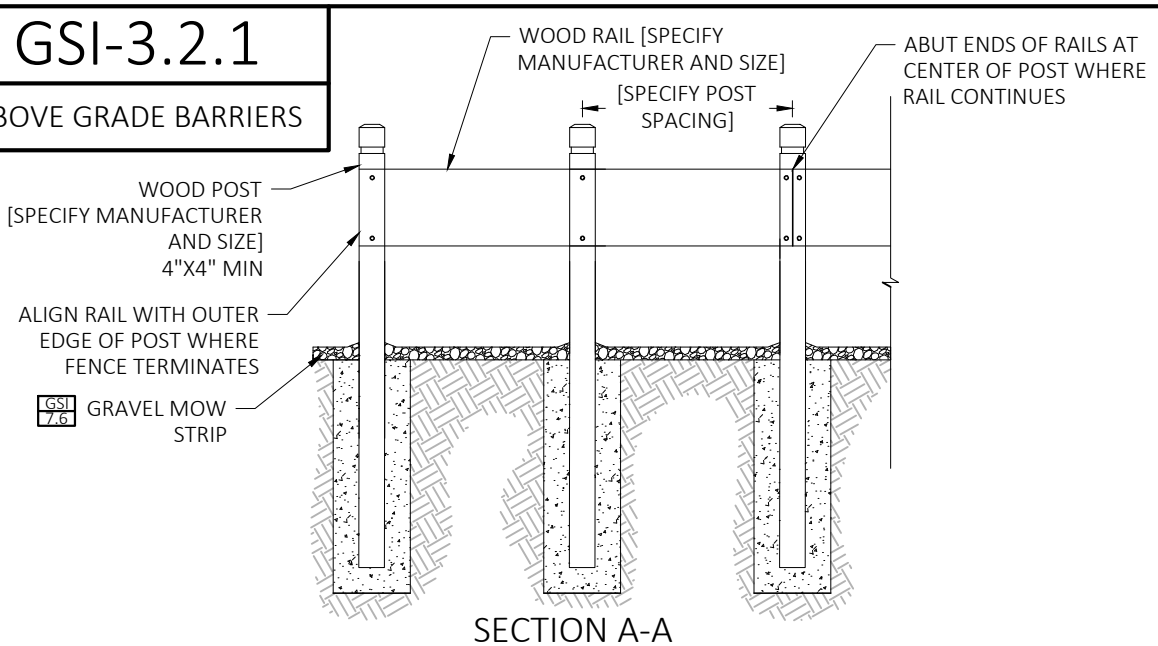
1. CURBING SHALL BE PER 02942.
2. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
3. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

RIBBON CURB

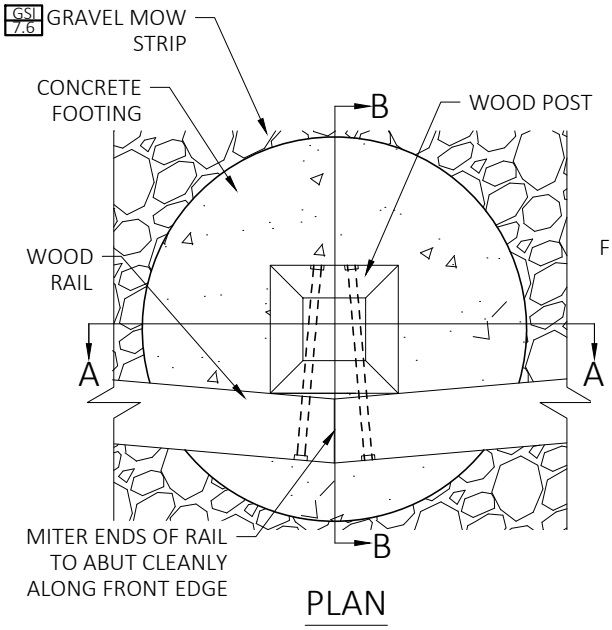
OCTOBER 2022

GSI-3.2.1

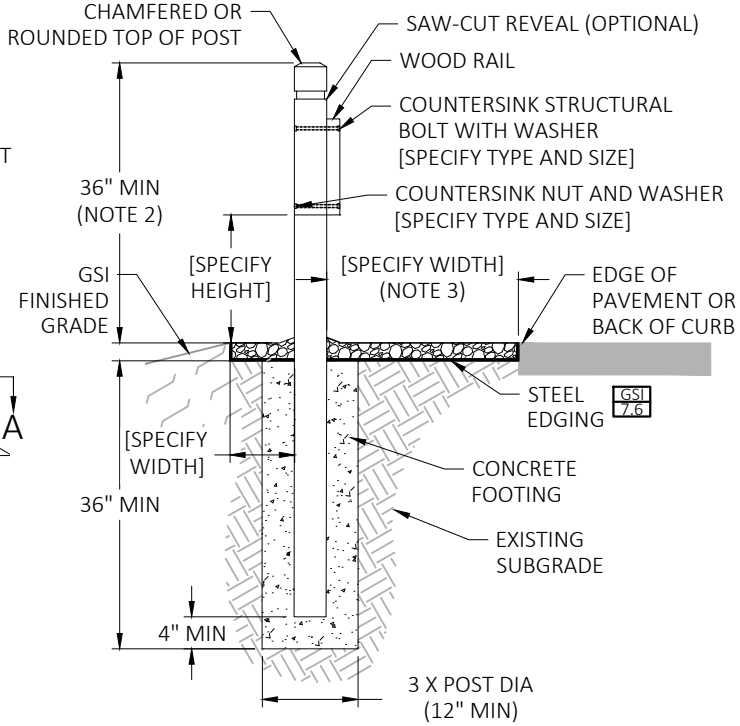
ABOVE GRADE BARRIERS



SECTION A-A



PLAN



SECTION B-B

NOTES:

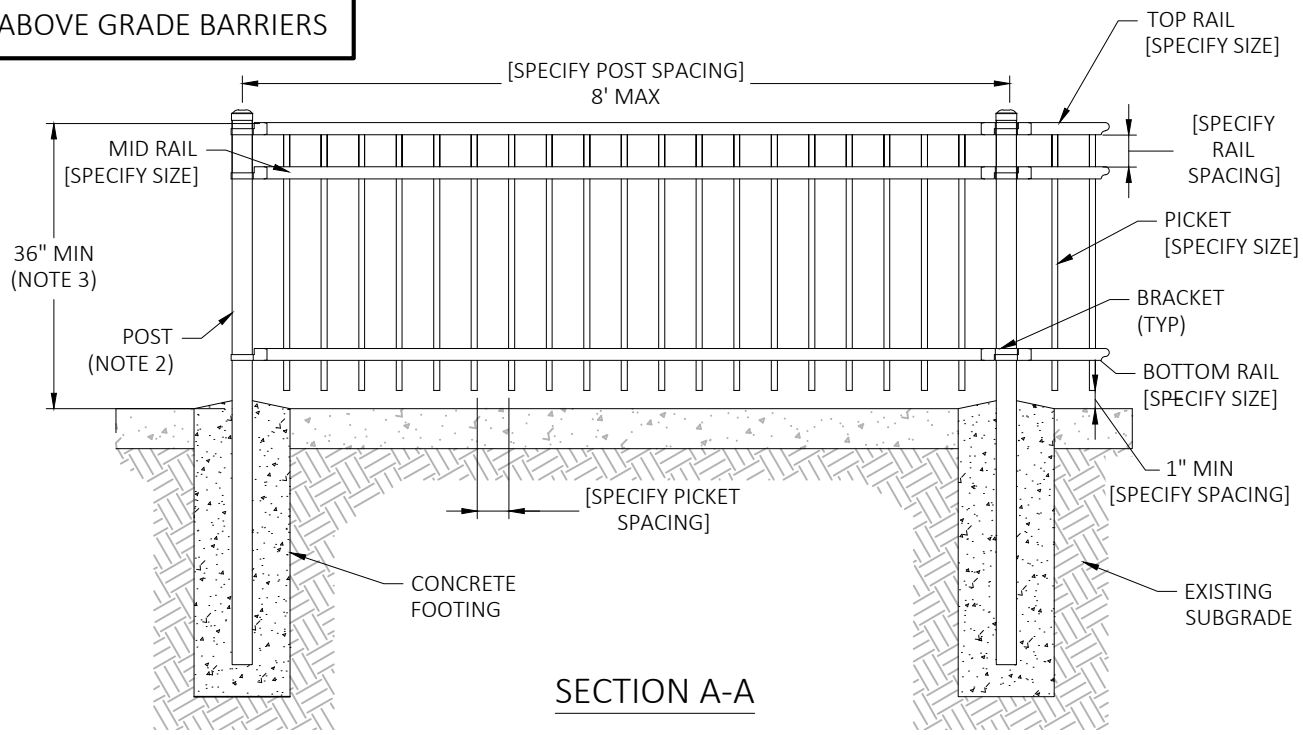
1. WOOD FENCING SHALL BE PER 02942.
2. WHEN VERTICAL DROP BETWEEN PEDESTRIAN AREA AND GSI EXCEEDS 30 INCHES, MINIMUM FENCE HEIGHT OF 42 INCHES IS REQUIRED. [DESIGNER TO SPECIFY FENCE HEIGHT.]
3. WHEN FENCING IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.

WOOD FENCING

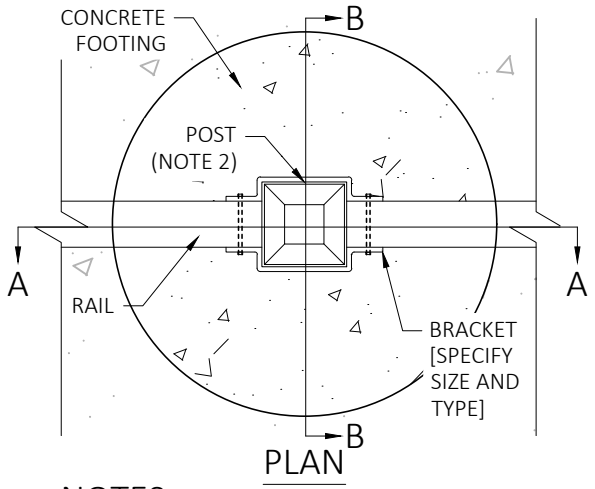
OCTOBER 2022

GSI-3.2.2

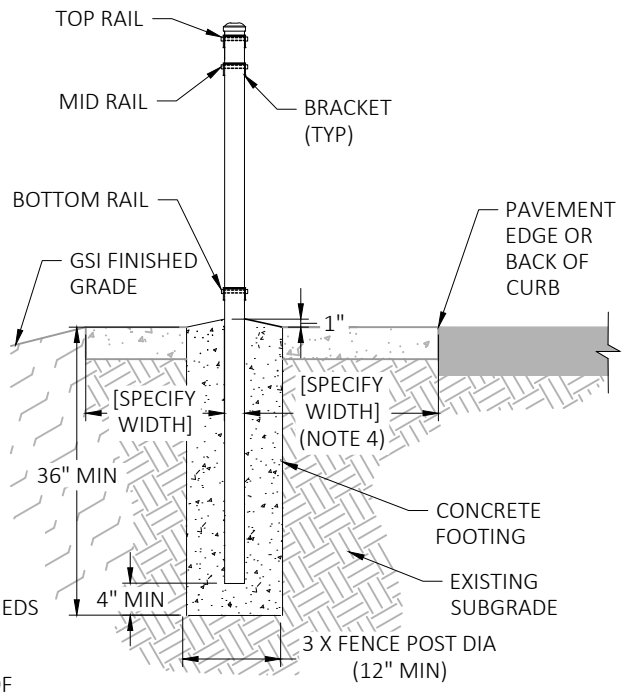
ABOVE GRADE BARRIERS



SECTION A-A



PLAN



SECTION B-B

NOTES:

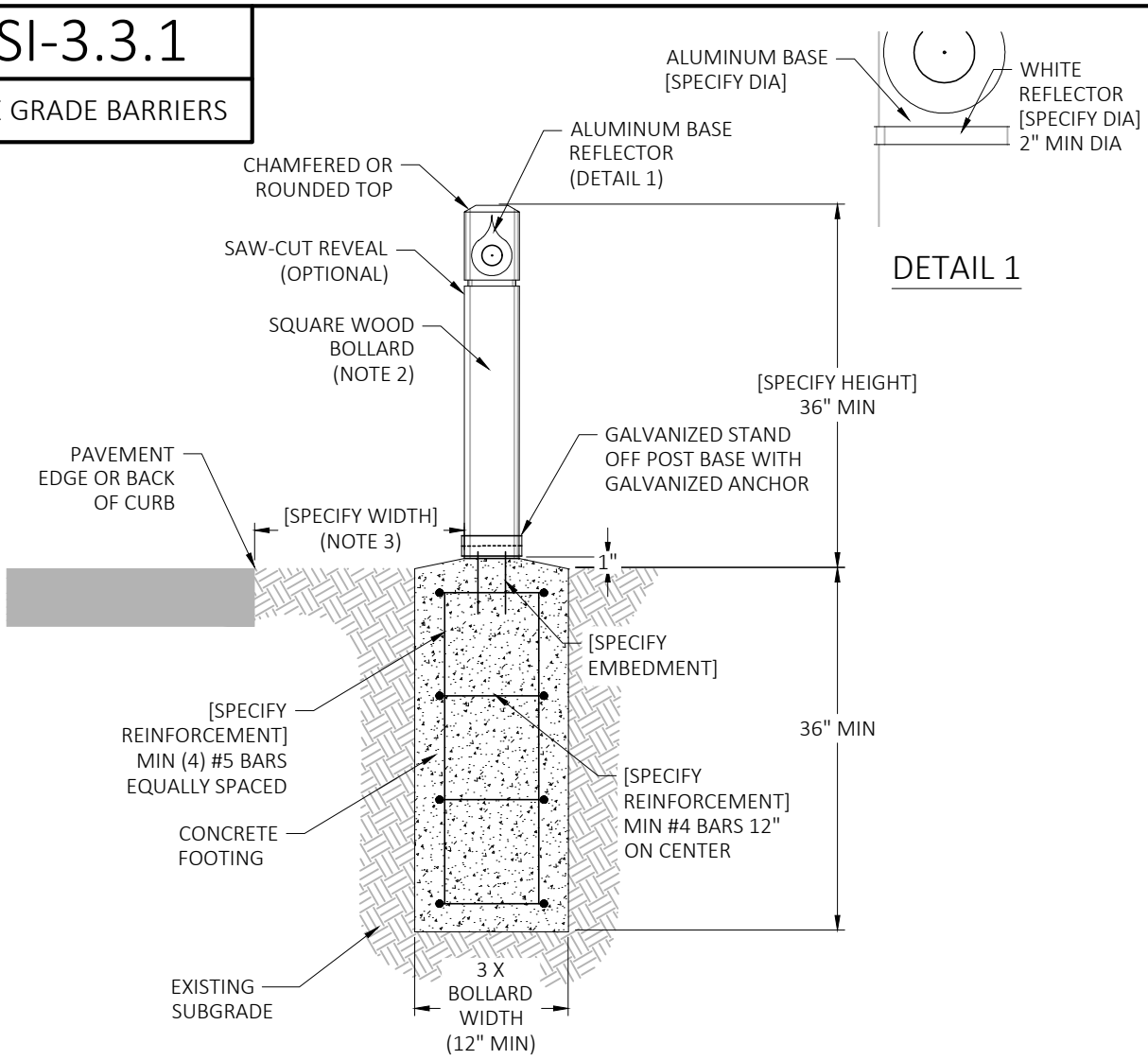
1. METAL FENCING SHALL BE PER 02942.
2. POST SIZE DEPENDS ON FENCE HEIGHT, EXPECTED LOADING, AND WIND FORCE. [DESIGNER TO SPECIFY POST SIZE AND HEIGHT.]
3. WHEN VERTICAL DROP BETWEEN PEDESTRIAN AREA AND GSI EXCEEDS 30 INCHES, MINIMUM FENCE HEIGHT OF 42 INCHES IS REQUIRED.
4. WHEN FENCING IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.
5. DIMENSIONS SHOULD BE STANDARD PER MANUFACTURER REQUIREMENTS.

METAL FENCING

OCTOBER 2022

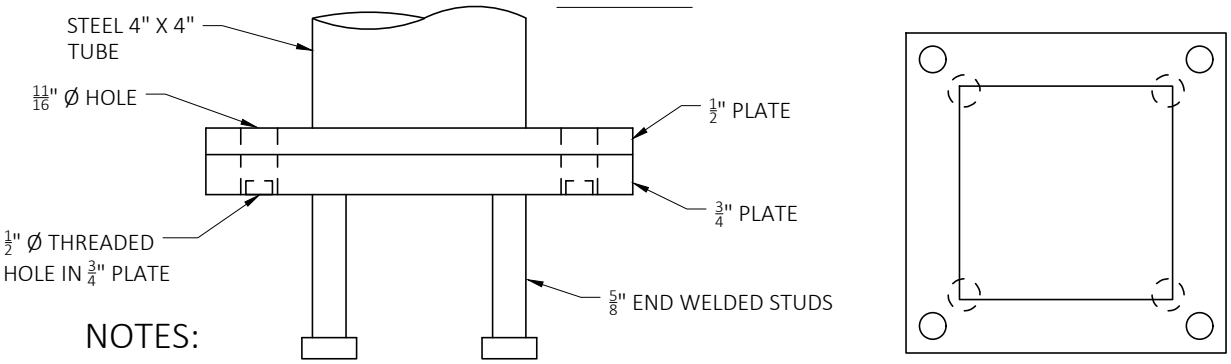
GSI-3.3.1

ABOVE GRADE BARRIERS



DETAIL 1

SECTION



BREAKWAWAY FOOTING (NTS)

NOTES:

1. WOOD BOLLARD SHALL BE PER 02942.
2. [DESIGNER TO SPECIFY SIZE AND FINISH.]
3. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.

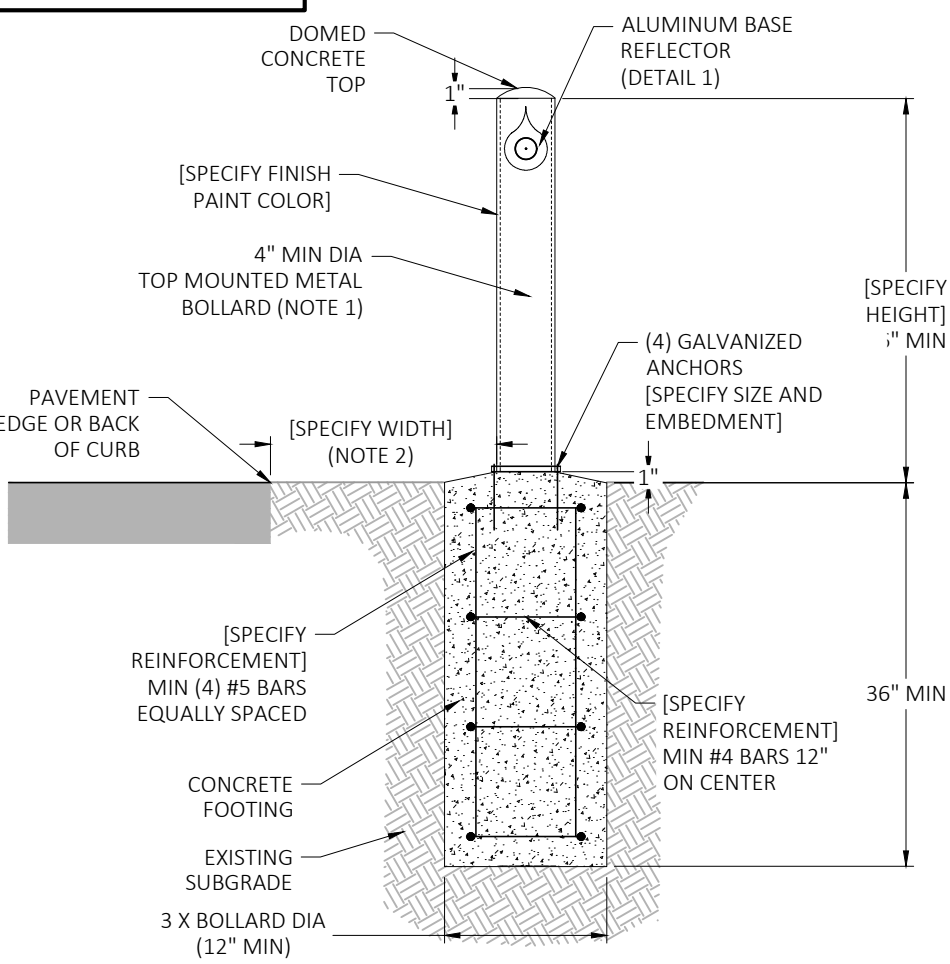
WOOD BOLLARD

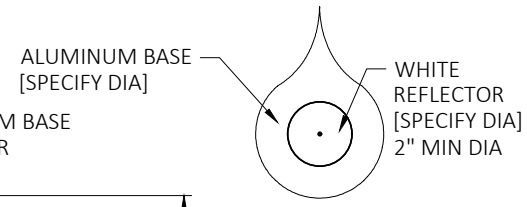
OCTOBER 2022

GSI-3.3.2

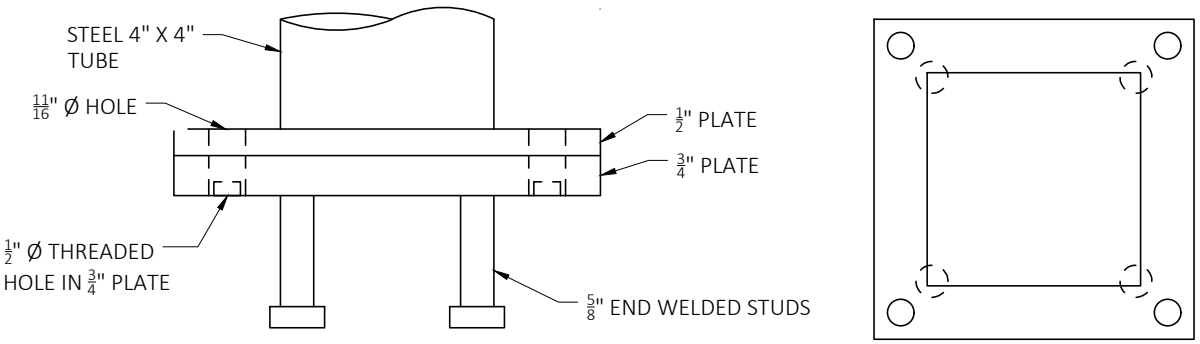
ABOVE GRADE BARRIERS

SECTION





DETAIL 1



BREAKWAWAY FOOTING (NTS)

NOTES:

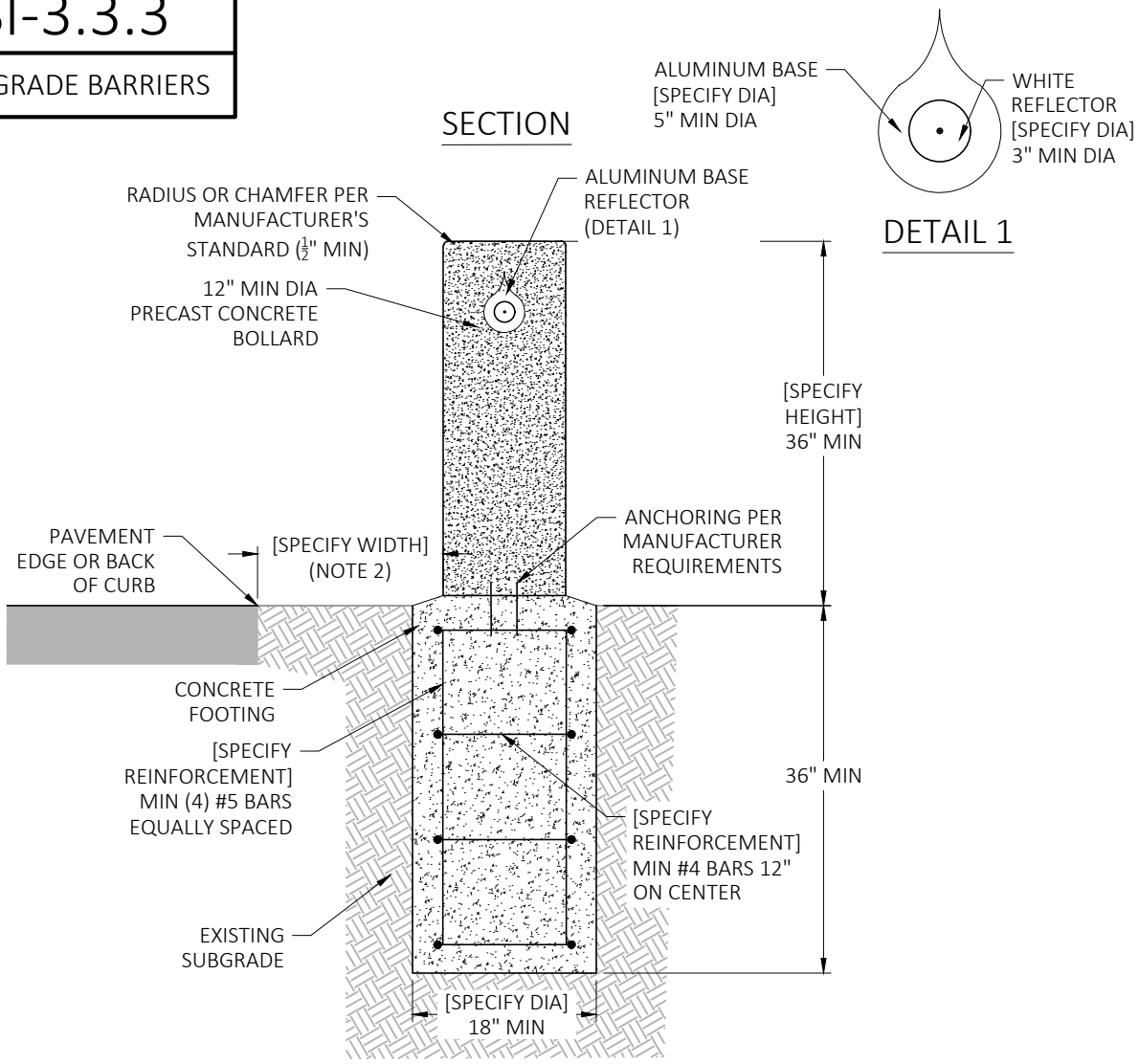
1. METAL BOLLARD SHALL BE MINIMUM SCHEDULE 40 STEEL AND CONCRETE FILLED PER 02942.
2. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

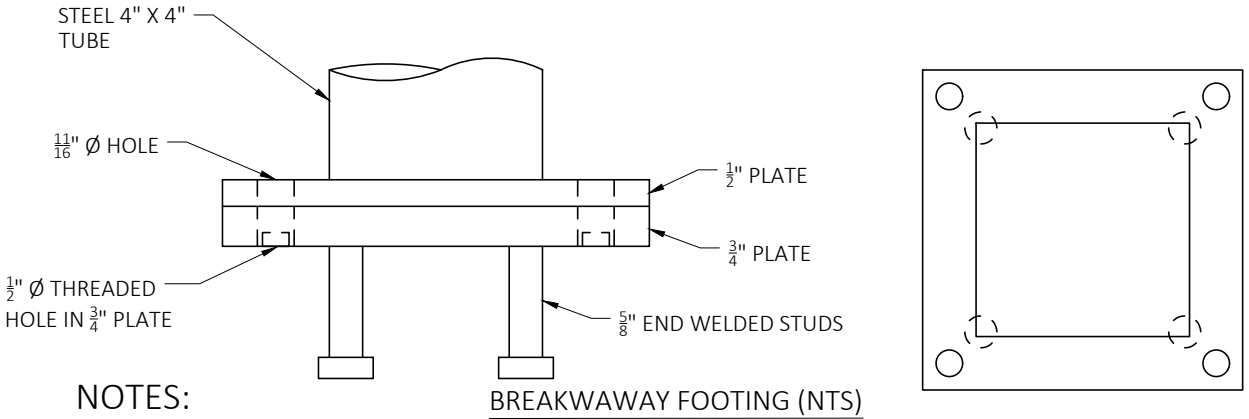
METAL BOLLARD

OCTOBER 2022

GSI-3.3.3

ABOVE GRADE BARRIERS





BREAKWAWAY FOOTING (NTS)

NOTES:

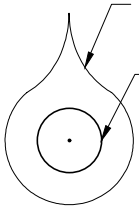
1. PRECAST CONCRETE BOLLARD SHALL BE PER 02942.
2. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

PRECAST CONCRETE BOLLARD

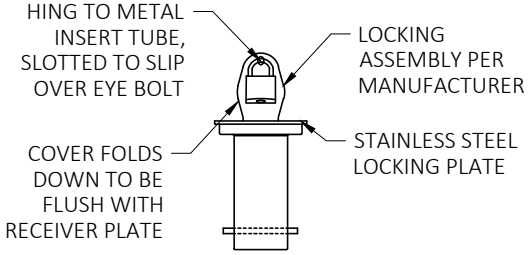
OCTOBER 2022

GSI-3.3.4

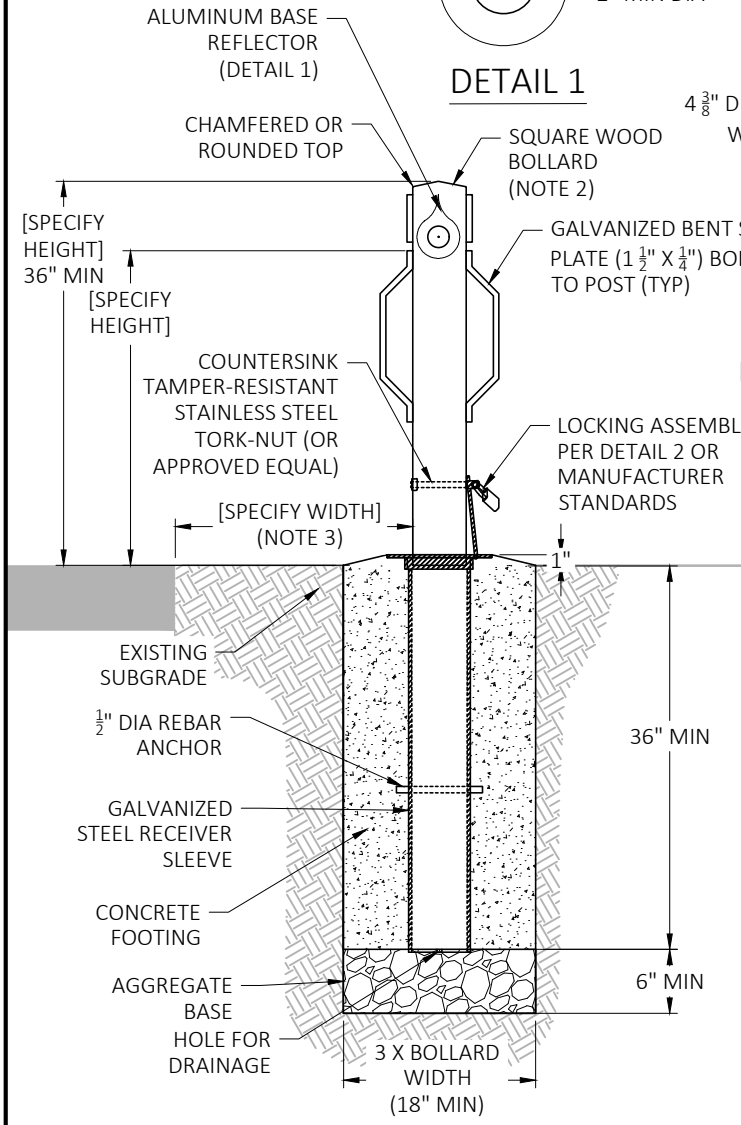
ABOVE GRADE BARRIERS



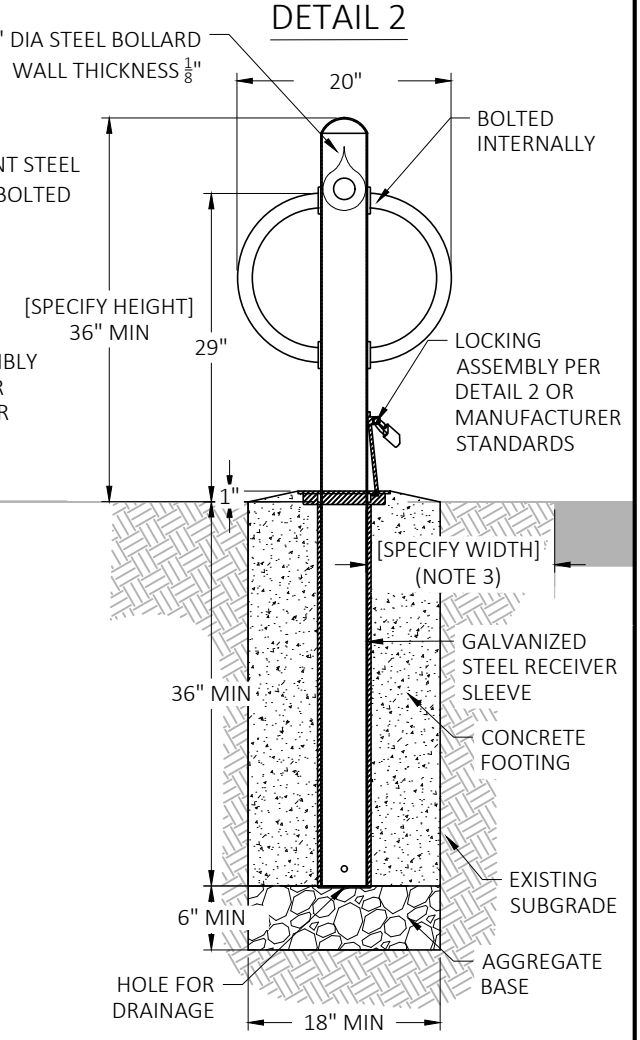
DETAIL 1



DETAIL 2



WOOD REMOVABLE BOLLARD SECTION



METAL REMOVABLE BOLLARD SECTION

NOTES:

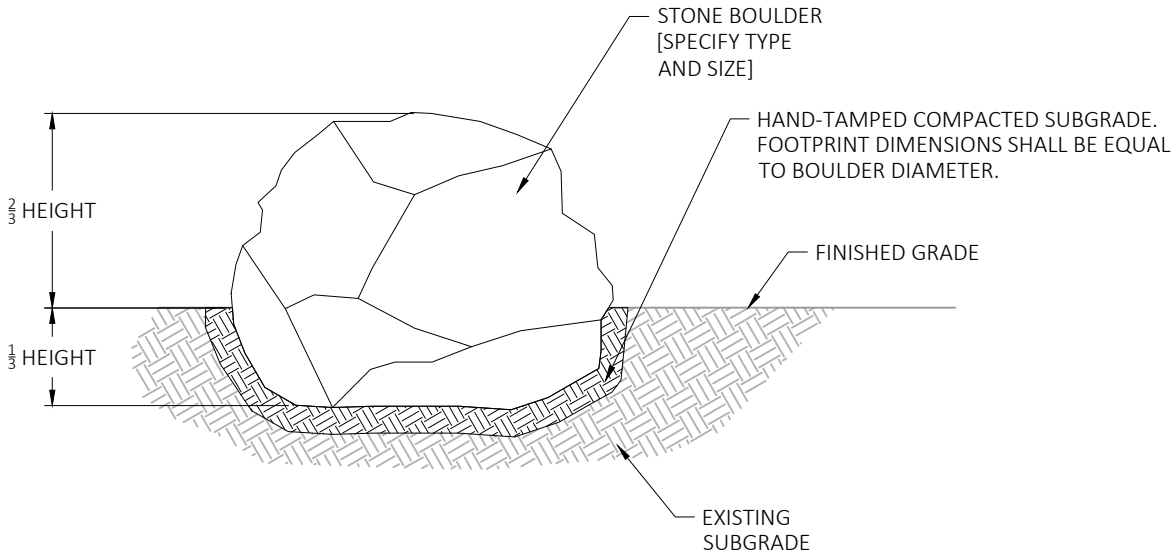
1. REMOVABLE BOLLARD SHALL BE PER 02942.
2. [DESIGNER TO SPECIFY SIZE AND FINISH.]
3. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

REMOVABLE BOLLARD

OCTOBER 2022

GSI-3.4.1

ABOVE GRADE BARRIERS



SECTION

NOTES:

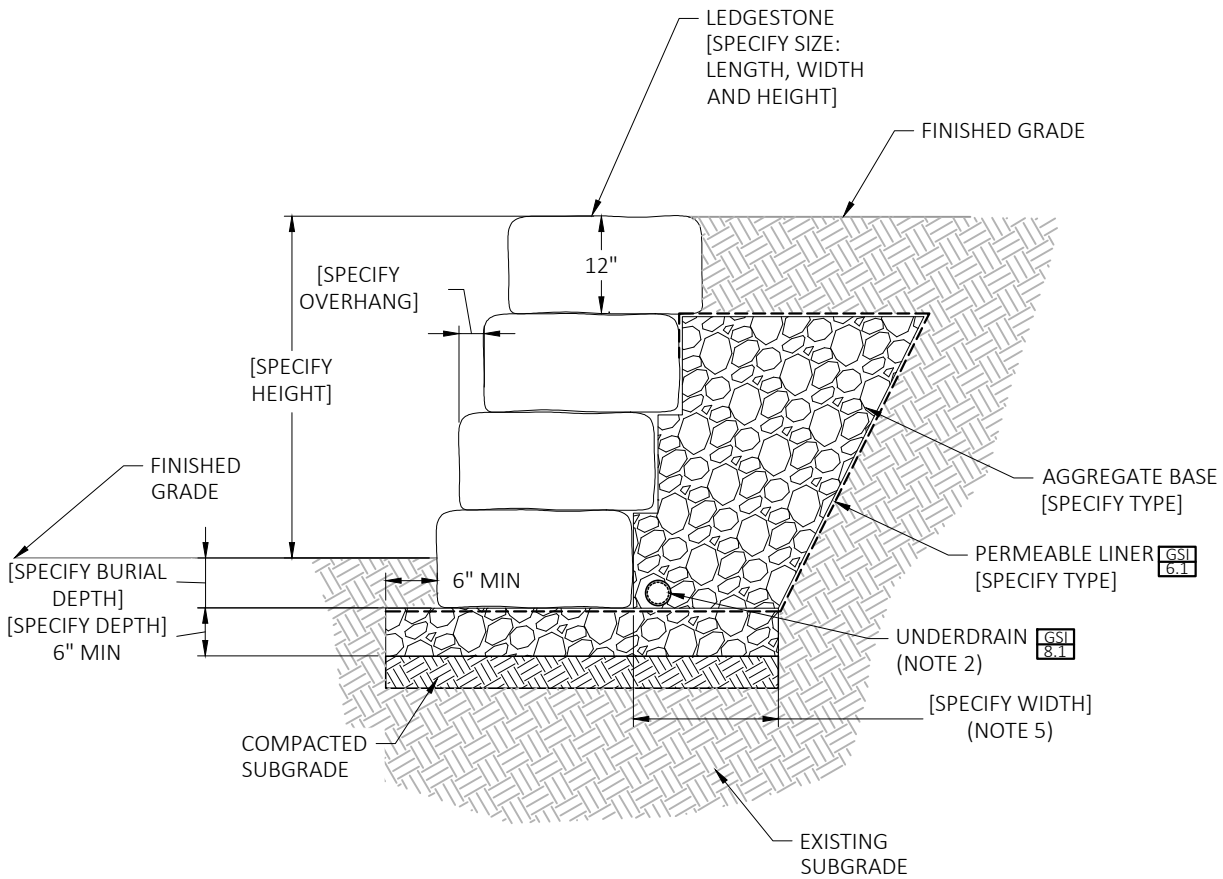
1. STONE BOULDER SHALL BE PER 02942.
2. SIZE OF BOULDER SHALL BE DETERMINED BY MEASURING HORIZONTALLY AT WIDEST SECTION OF STONE AT 1/3 HEIGHT

STONE BOULDER

OCTOBER 2022

GSI-3.4.2

ABOVE GRADE BARRIERS



SECTION

NOTES:

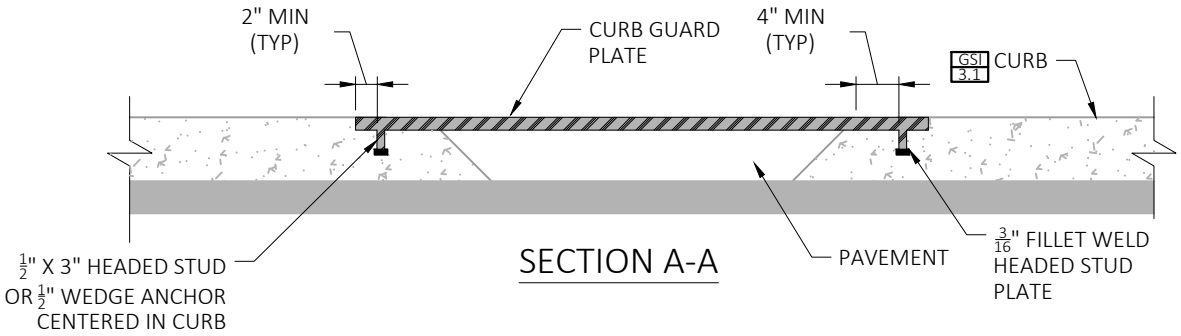
1. LEDGESTONE SHALL BE PER 02942.
2. UNDERDRAIN SHALL HAVE A MINIMUM SLOPE OF 0.5% ALONG THE WALL AND DAYLIGHT AT THE END OF THE WALL, OR TO WEEP HOLES AT THE BOTTOM OF THE WALL.
3. STONES SHALL BE STACKED IN A RUNNING BOND PATTERN.
4. STACKED STONE WALLS SHALL BE DESIGNED TO WITHSTAND THE ANTICIPATED SOIL PRESSURE AND PROVIDE SUFFICIENT REINFORCEMENT FOR ADJACENT SLOPE.
5. WIDTH OF AGGREGATE BASE FROM BACK OF BOTTOM STONE SHALL BE EQUAL TO THE TOTAL HEIGHT OF THE WALL.

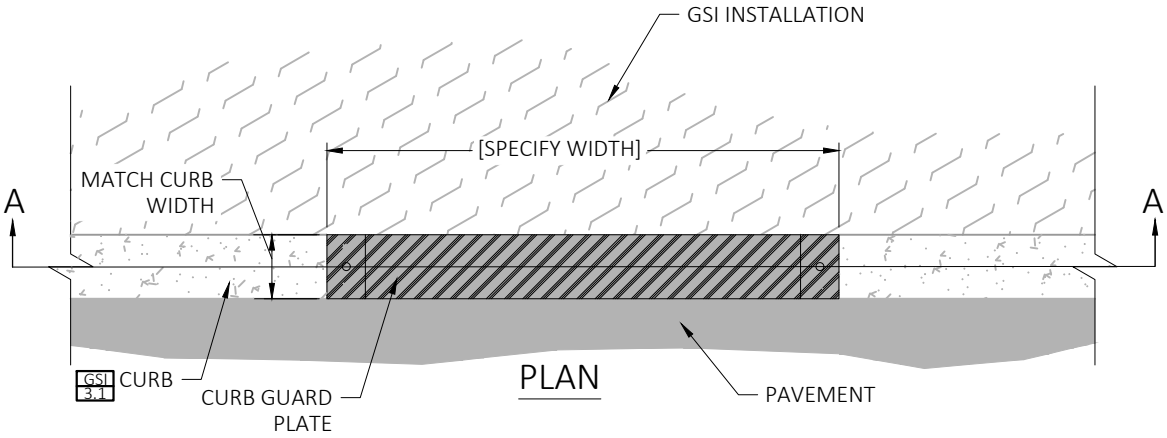
LEDGESTONE

OCTOBER 2022

GSI-3.5

ABOVE GRADE BARRIERS





NOTES:

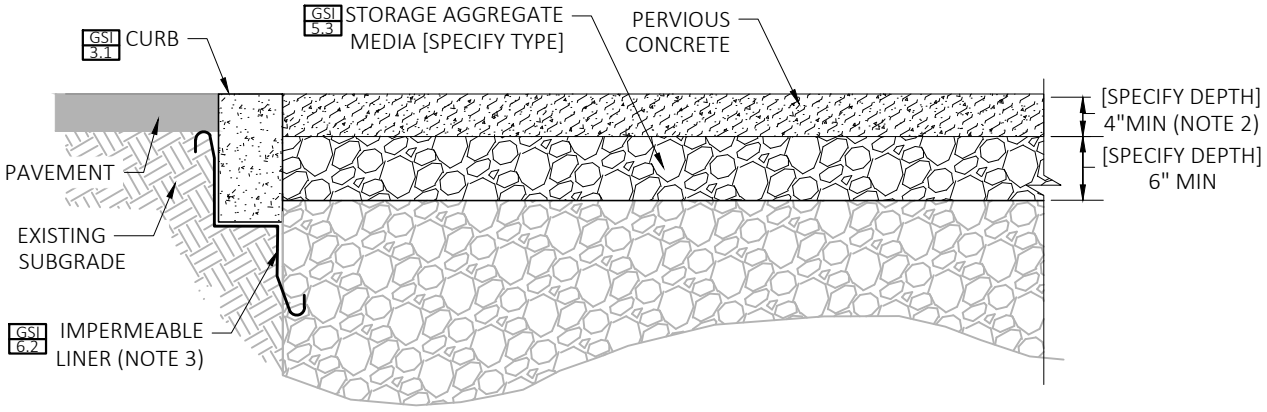
1. CURB GUARD SHALL BE PER 02942.

CURB GUARD

OCTOBER 2022

GSI-4.1

PERMEABLE PAVEMENT



SECTION

NOTES:

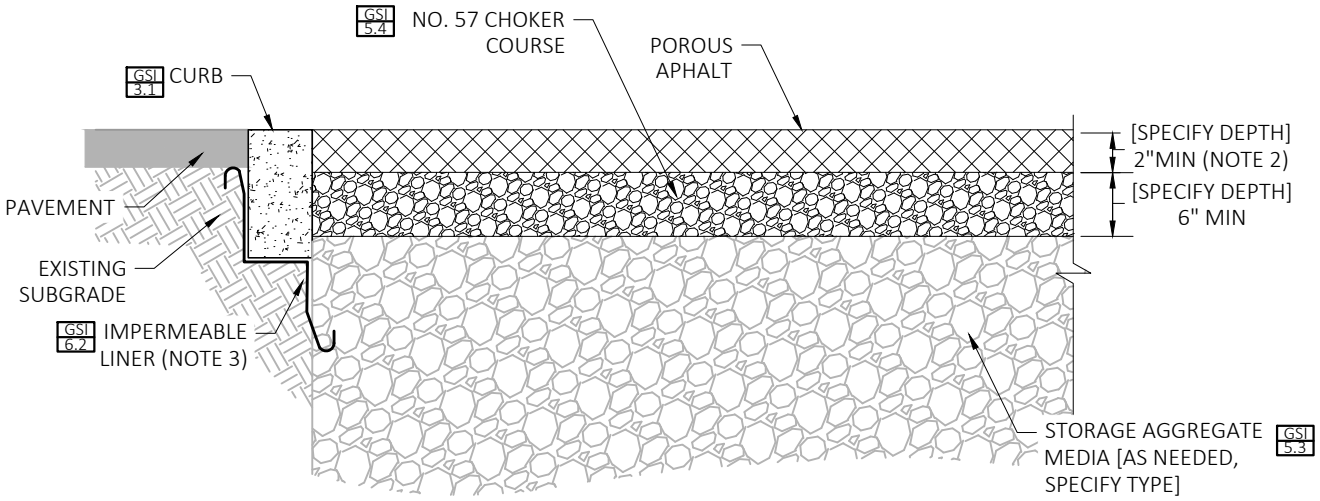
1. PERVIOUS CONCRETE SHALL BE PER 02943.
2. [DESIGNER TO SPECIFY DEPTH OF PERVIOUS CONCRETE.] DEPTH SHALL BE DESIGNED TO WITHSTAND ANTICIPATED STRUCTURAL LOADING.
3. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

PERVIOUS CONCRETE

OCTOBER 2022

GSI-4.2

PERMEABLE PAVEMENT



SECTION

NOTES:

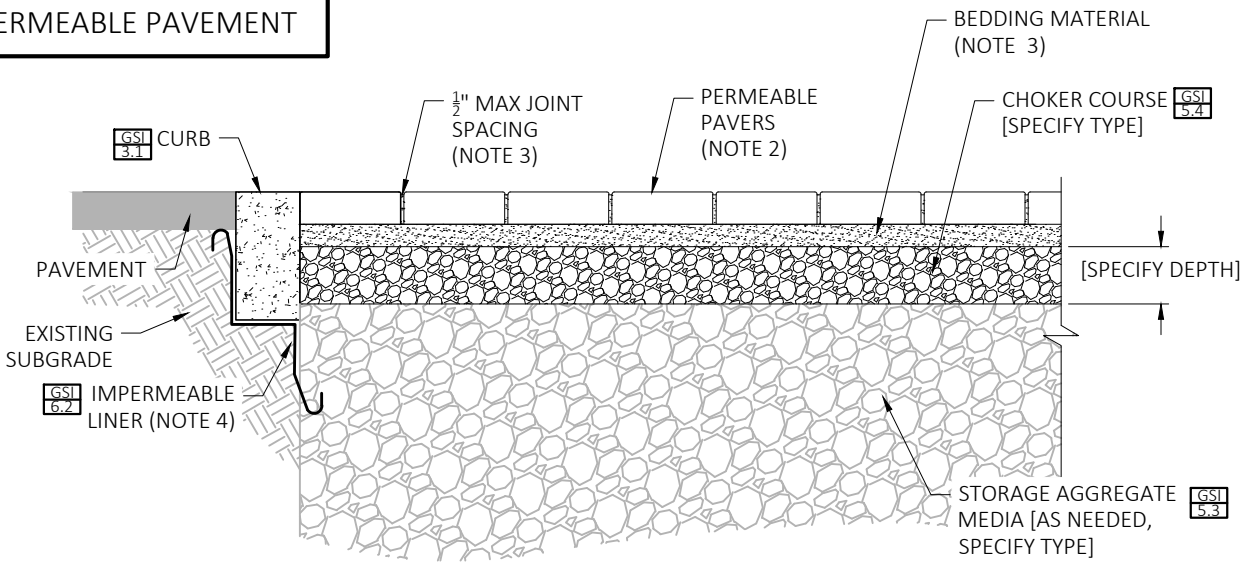
1. POROUS ASPHALT SHALL BE PER 02944.
2. [DESIGNER TO SPECIFY DEPTH OF POROUS ASPHALT.] DEPTH SHALL BE DESIGNED TO WITHSTAND ANTICIPATED STRUCTURAL LOADING.
3. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

POROUS ASPHALT

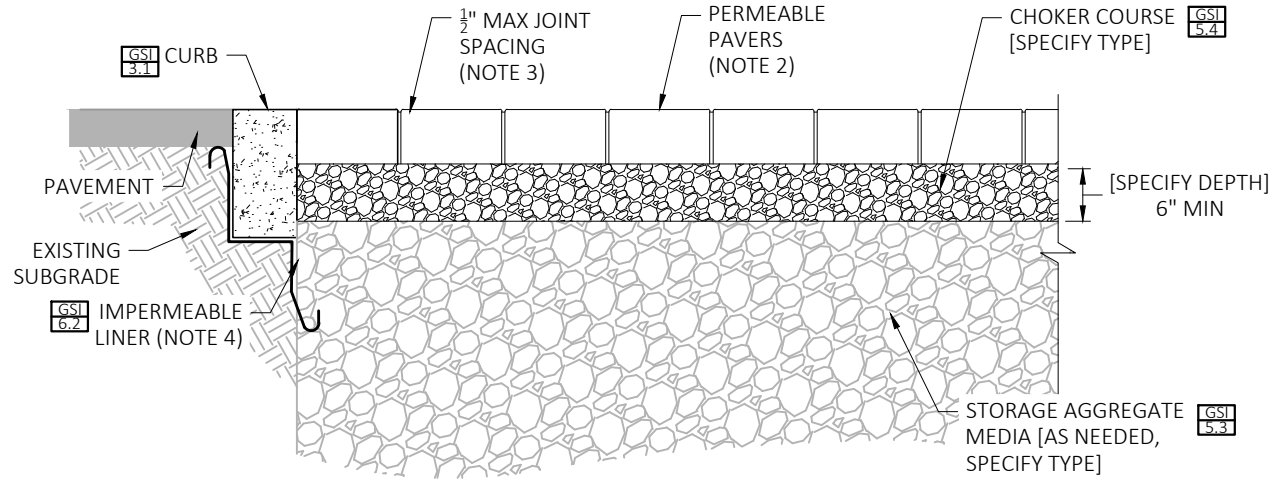
OCTOBER 2022

GSI-4.3

PERMEABLE PAVEMENT



PERMEABLE PAVERS WITH JOINTING MATERIAL



PERMEABLE PAVERS WITHOUT JOINTING MATERIAL

NOTES:

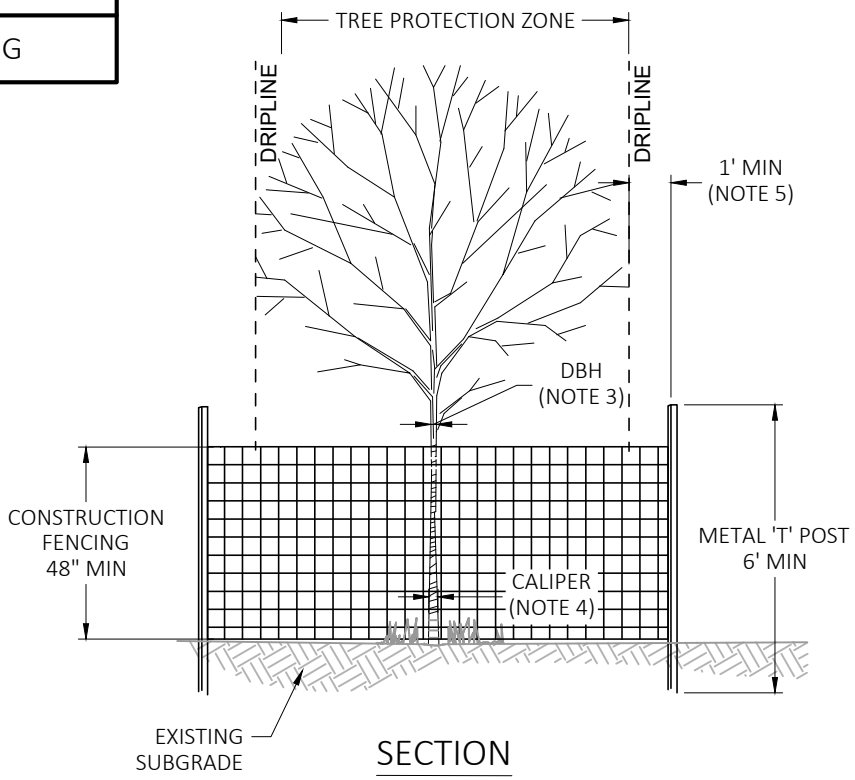
1. PERMEABLE PAVERS SHALL BE PER 02945.
2. [DESIGNER TO SPECIFY MANUFACTURER AND TYPE OF PERMEABLE PAVERS.] THICKNESS OF PERMEABLE PAVERS PER MANUFACTURER REQUIREMENTS DEPENDENT ON APPLICATION. PERMEABLE PAVERS SHALL HAVE CHAMFERED EDGES.
3. PERMEABLE PAVER JOINTS SHALL BE SPACED AND FILLED PER MANUFACTURER RECOMMENDATIONS. [DESIGNER TO SPECIFY JOINTING AND BEDDING MATERIAL TYPE, DEPTH, AND REQUIRED SPACING.]
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION.

PERMEABLE PAVERS

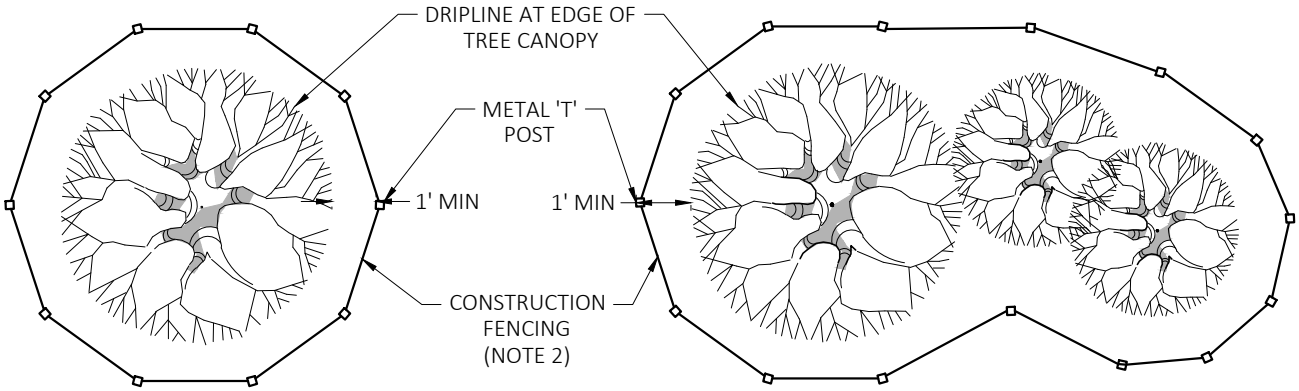
OCTOBER 2022

GSI-7.1

LANDSCAPING



SECTION



PLAN
(SINGLE TREE)

PLAN
(TREE GROUP)

NOTES:

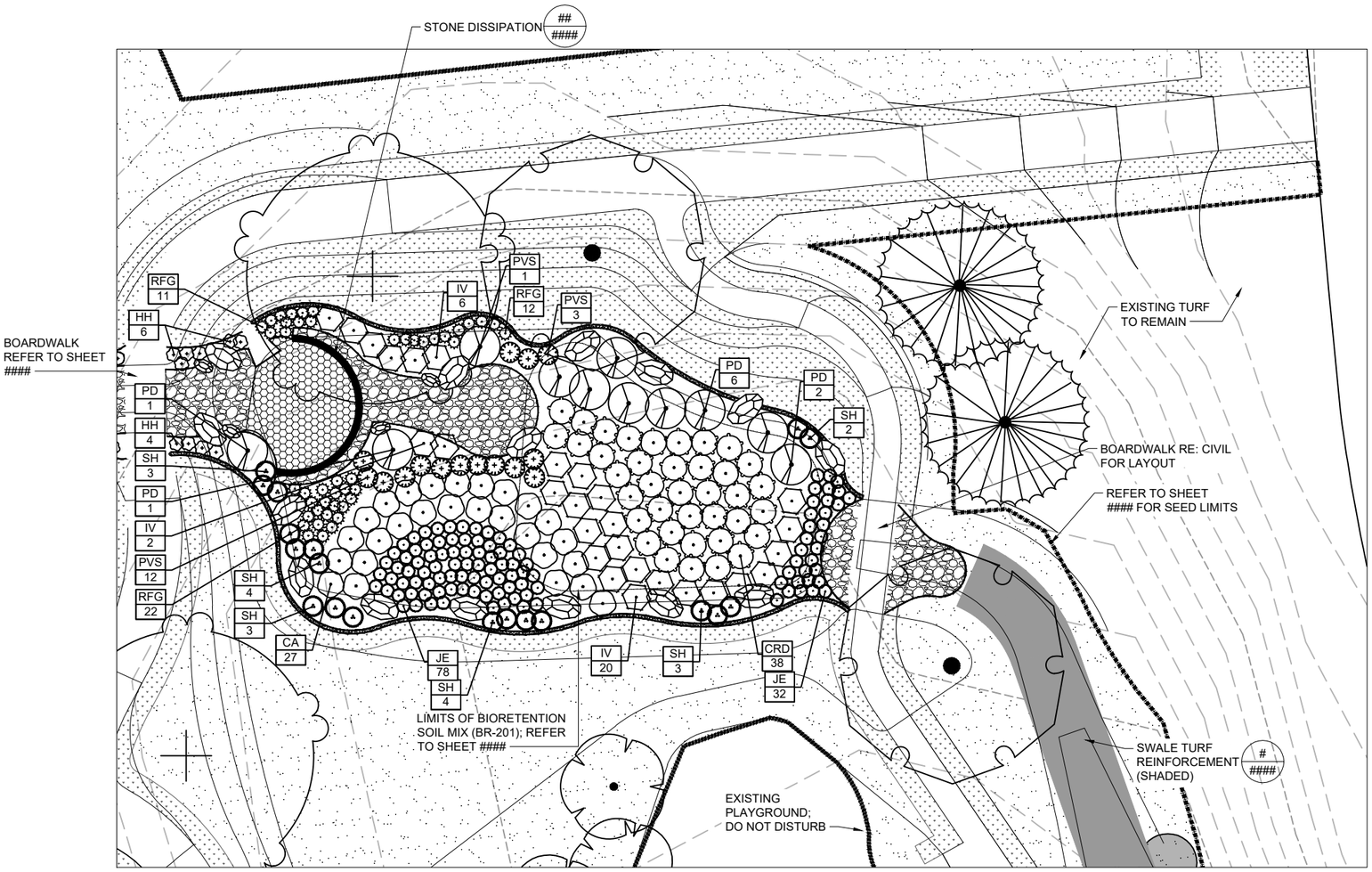
1. TREE PROTECTION SHALL BE PER 02949.
2. CONSTRUCTION FENCE SHALL BE INSTALLED PRIOR TO CONSTRUCTION OPERATIONS
3. DIAMETER BREAST HEIGHT (DBH) SHALL BE MEASURED AS THE OUTSIDE BARK DIAMETER 4'-6" ABOVE THE GROUND ON THE UPHILL SIDE OF THE TREE.
4. FOR TREES UP TO 4.5" IN DIAMETER, CALIPER SHALL BE MEASURED 6" ABOVE GROUND LEVEL. IF CALIPER MEASURED AT 6" ABOVE GROUND LEVEL EXCEEDS 4.5", THE CALIPER SHALL BE MEASURED AT 12" ABOVE GROUND LEVEL.
5. LOCATE TREE PROTECTION FENCE 1' OUTSIDE DRIPLINE.

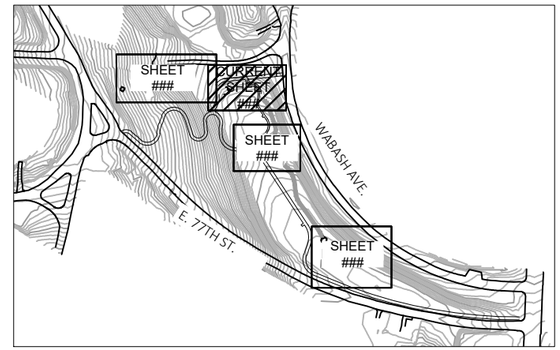
EXISTING TREE PROTECTION

OCTOBER 2022

GSI-7.2

LANDSCAPING





KEY PLAN - SCALE: 1"=400'

PLANT SCHEDULE

GRASSES	QTY	BOTANICAL NAME	COMMON NAME	CONT	SPACING
JE	110	Juncus effusus	Soft Rush	1 gal	2` O.C.
PVS	15	Panicum virgatum `Shenandoah`	Burgundy Switch Grass	1 gal	2` O.C.
SH	19	Sporobolus heterolepis	Prairie Dropseed	1 gal	3` O.C.
PERENNIALS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**CONT**	**SPACING**
HH	10	Hemerocallis x `Happy Returns`	Happy Returns Daylily	1 gal	18" O.C.
RFG	45	Rudbeckia fulgida `Goldsturm`	Goldsturm Black-eyed Susan	1 gal	2` O.C.
SHRUBS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**CONT**	**SPACING**
CA	27	Clethra alnifolia `Hummingbird`	Summersweet	3 gal	4` O.C.
CRD	38	Cornus alba `Regnzam`	Red Twig Dogwood	3 gal	4` O.C.
IV	28	Itea virginica `Sprich`	Virginia Sweetspire	3 gal	4` O.C.
PD	11	Physocarpus opulifolius `Diablo`	Diablo Ninebark	3 gal	6` O.C.

LEGEND:

- LARGE BOULDER: 5' NOM. DIA. RE: SPECIFICATIONS (# / ####)
- SMALL BOULDER: 3' NOM. DIA. RE: SPECIFICATIONS (# / ####)
- RIBBON CURB (# / ####)
- STEEL EDGING (# / ####)
- TYPE 1 TYPE 2 DECORATIVE GRAVEL (# / ####)
- FESCUE SEED MIX PER SPECIFICATION 02951
- FESCUE SOD PER SPECIFICATION 02951
- LIMITS OF SEED
- RFG 22 PLANT CODE AND QUANTITY

NOTES:

1. PLANTING SHALL BE PER 02949, 02950 AND 02951.
2. REFER TO SHEET #### FOR LANDSCAPE SETOUT PLAN AND GSI LIMITS OF SOIL AREA.
3. ALL EXISTING TREES SHOWN ON THIS PLAN SHALL REMAIN AS SHOWN AND SHALL BE PROTECTED DURING CONSTRUCTION, UNLESS OTHERWISE NOTED IN PLAN. REFER TO CIVIL PLANS, FOR TREE REMOVAL.
4. THIS PROJECT IS NOT REQUIRED TO MEET CITY ORDINANCE SECTION 88-425 LANDSCAPING AND SCREENING.

NORTH

0 5' 10' 20'

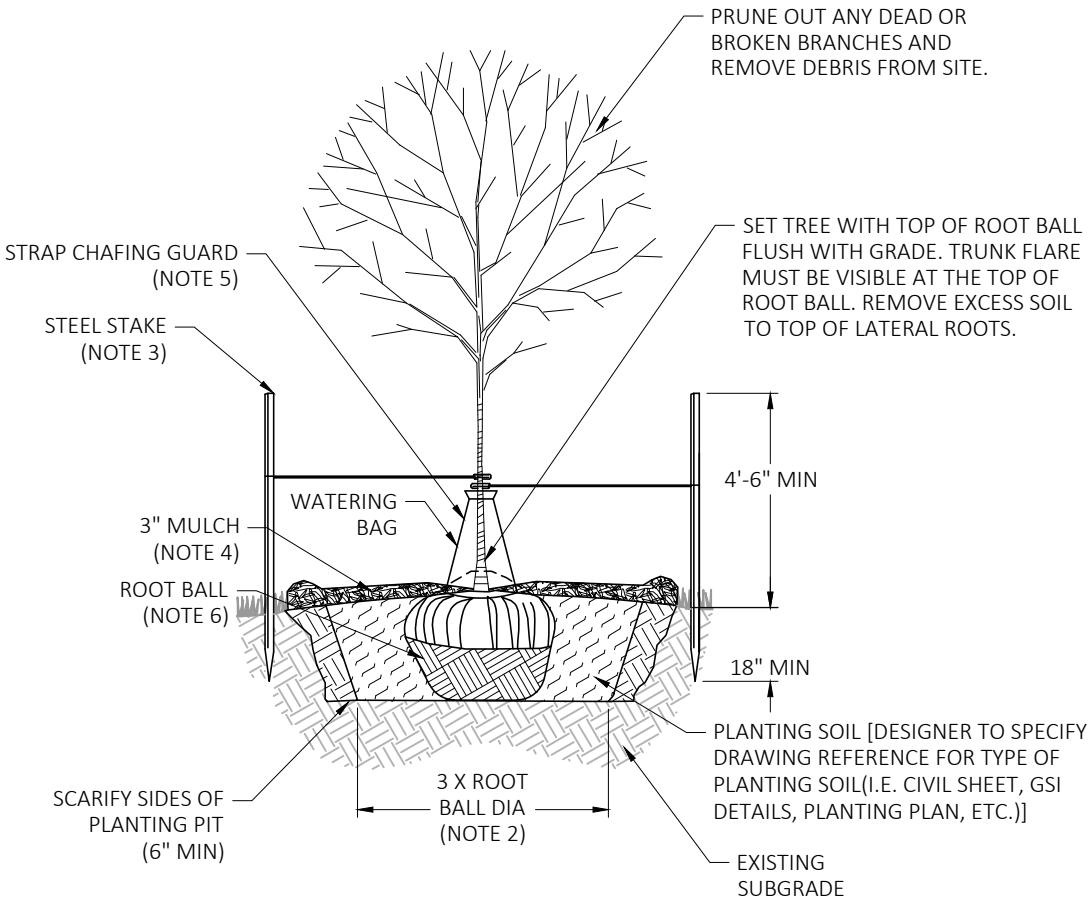
HORIZONTAL SCALE IN FEET

EXAMPLE PLANTING PLAN

OCTOBER 2022

GSI-7.3.1

LANDSCAPING



SECTION

NOTES:

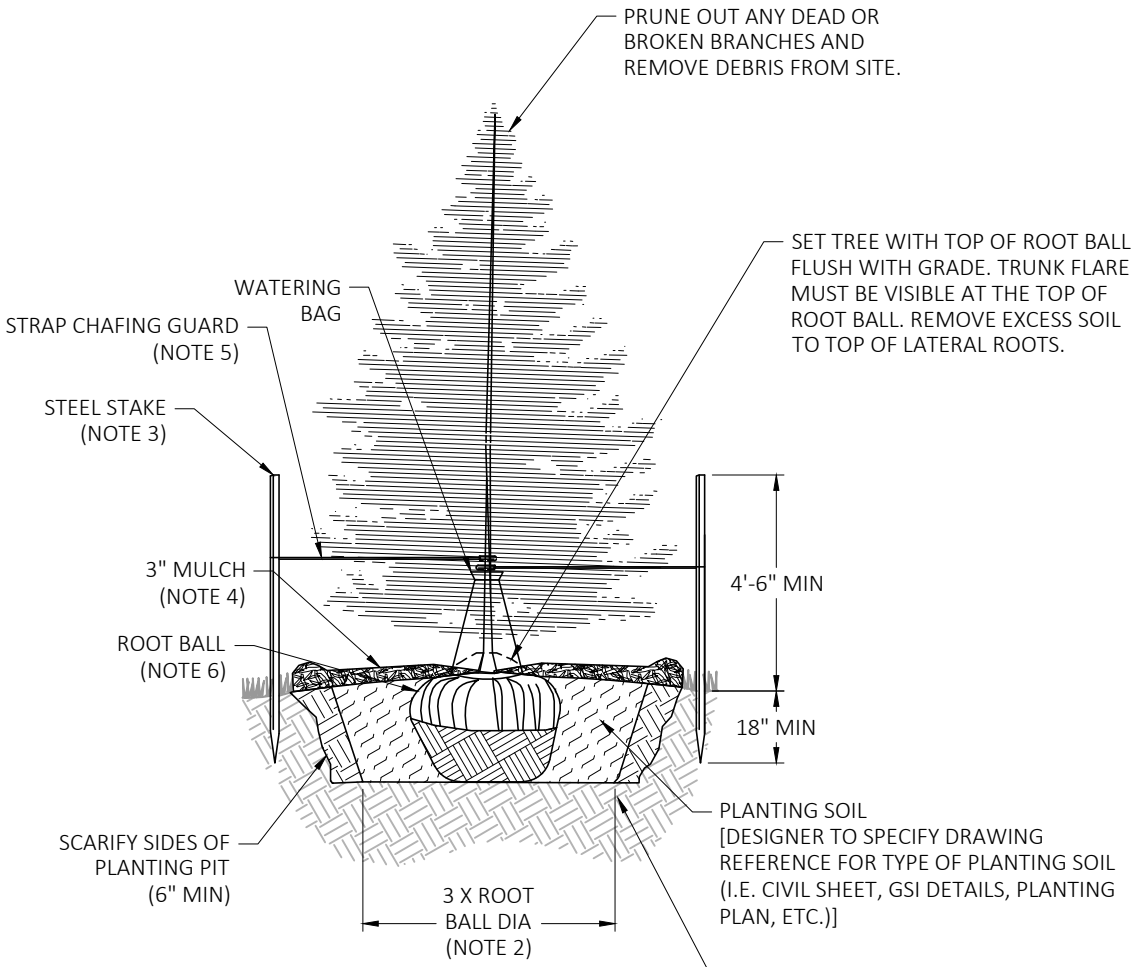
1. TREE PLANTING SHALL BE PER 02951.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES NORTH AND SOUTH OF TREE. ALTERNATIVE STAKING MAY BE APPROVED.
4. [DESIGNER TO SPECIFY TYPE OF MULCH.] DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE.
7. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2) WILL BE REJECTED.

DECIDUOUS TREE PLANTING

OCTOBER 2022

GSI-7.3.2

LANDSCAPING



SECTION

NOTES:

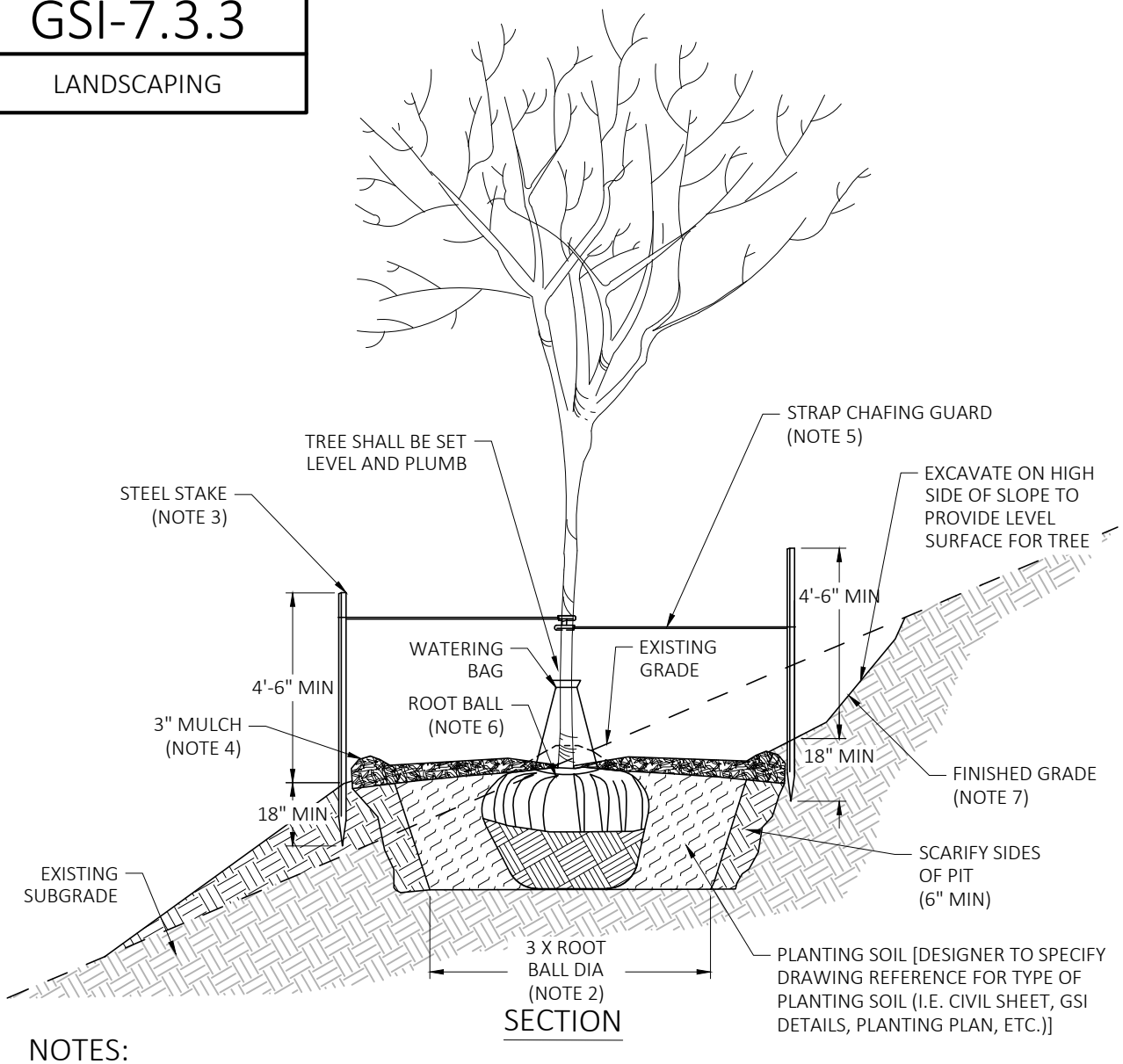
1. TREE PLANTING SHALL BE PER 02951.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES NORTH AND SOUTH OF TREE. ALTERNATIVE STAKING MAY BE APPROVED.
4. [DESIGNER TO SPECIFY TYPE OF MULCH.] DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE.
7. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2)WILL BE REJECTED.
8. USE OF EVERGREEN TREES SHALL BE RESERVED FOR AREAS OUTSIDE THE GSI PONDING AREAS.

EVERGREEN TREE PLANTING

OCTOBER 2022

GSI-7.3.3

LANDSCAPING



SECTION

NOTES:

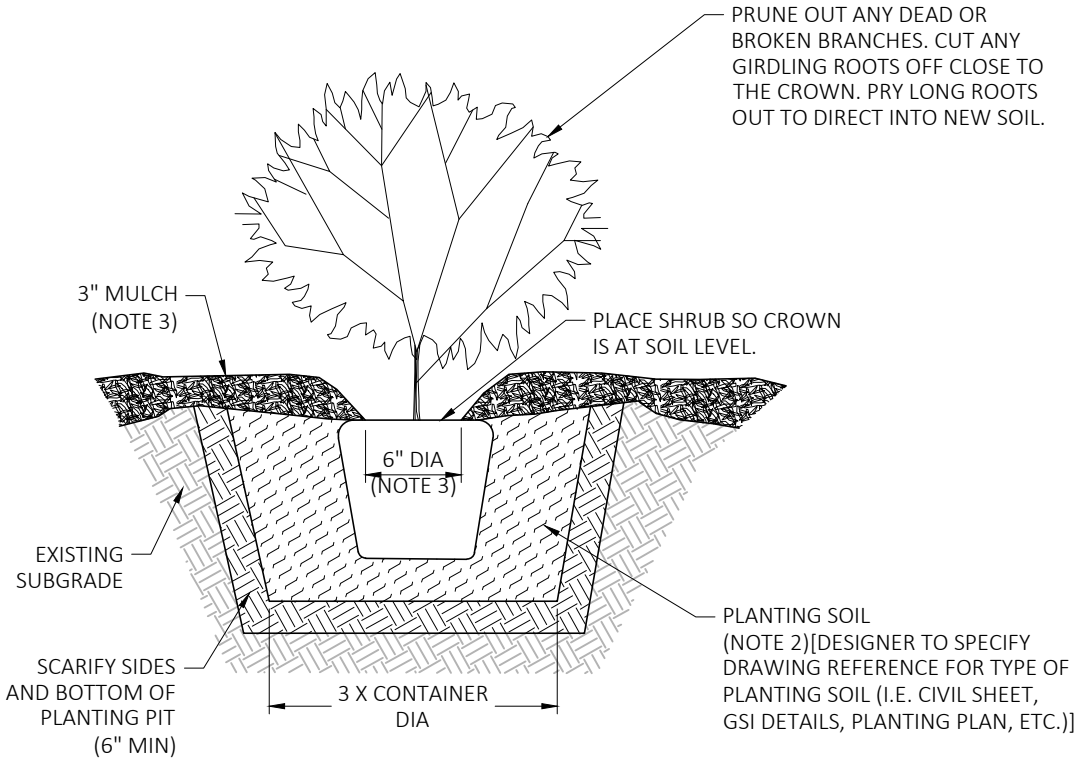
1. TREE PLANTING SHALL BE PER 02951.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES ON OPPOSITE SIDES OF TRUNK WITH DOWNHILL STAKE SET IN EXISTING GRADE. ALTERNATIVE STAKING MAY BE APPROVED.
4. [DESIGNER TO SPECIFY TYPE OF MULCH.] DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE. ROOT BALL SHALL BE SET LEVEL; PLACE TOP OF ROOT BALL AT EXISTING GRADE
7. [DESIGNER TO SPECIFY MAXIMUM SLOPE FOR FINISHED GRADE.] PROVIDE NECESSARY EROSION CONTROL MEASURES TO ENSURE SOIL STABILITY ON FINISHED GRADE.
8. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2) WILL BE REJECTED.

TREE PLANTING ON SLOPE

OCTOBER 2022

GSI-7.4

LANDSCAPING



SECTION

NOTES:

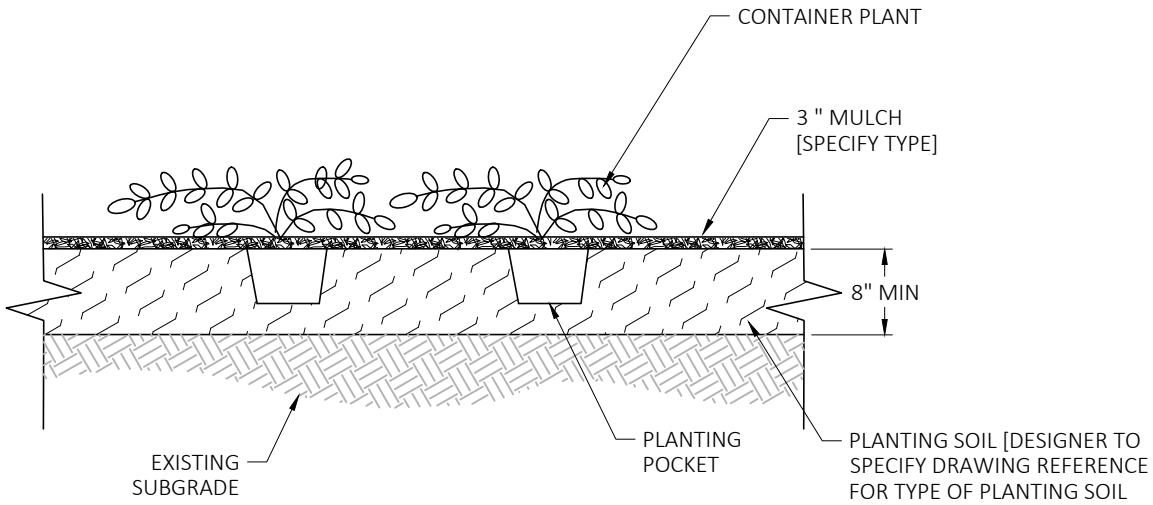
1. SHRUB PLANTING SHALL BE PER 02951.
2. FILL PLANTING PIT WITH PLANTING SOIL. CONSTRUCT RING AROUND PLANTED SHRUB TO FORM SAUCER.
3. INSTALL 3" MULCH THROUGHOUT PLANTING BED. LEAVE A 6" BARE CIRCLE AT BASE OF PLANT. [DESIGNER TO SPECIFY TYPE OF MULCH.]
4. CONTRACTOR TO WATER THOROUGHLY AFTER PLANTING.

SHRUB PLANTING

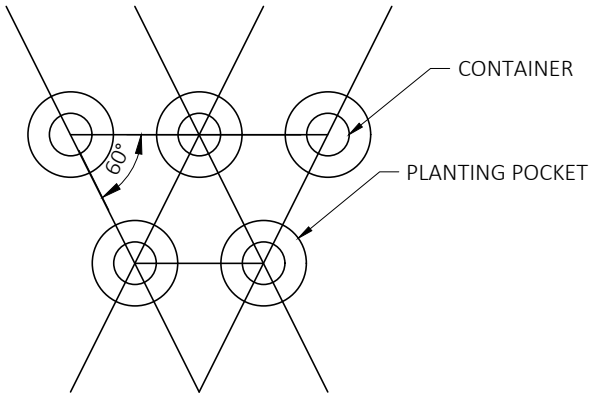
OCTOBER 2022

GSI-7.5

LANDSCAPING



SECTION



PLAN

NOTES:

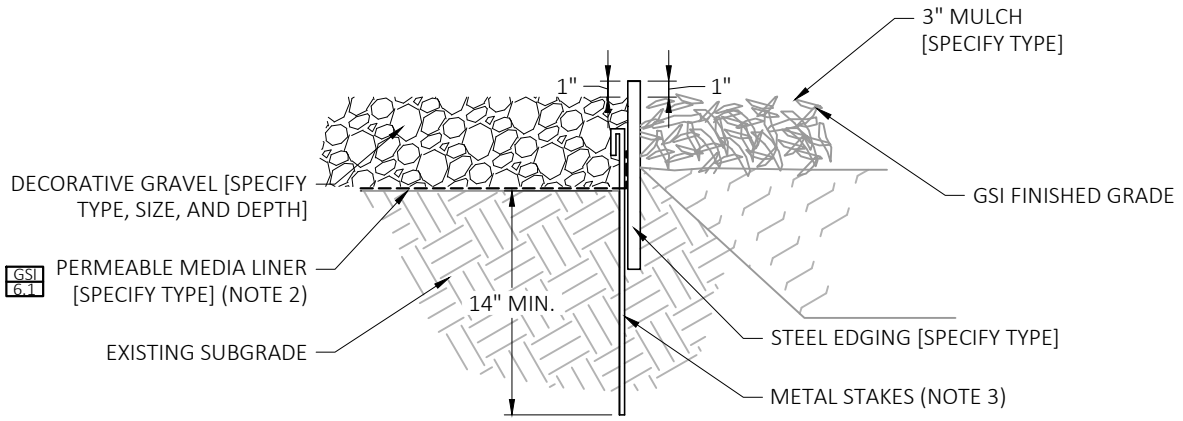
1. CONTAINER PLANT SHALL BE PER 02951.
2. CONTRACTOR TO WATER THOROUGHLY AFTER PLANTING.

CONTAINER PLANTING
(GRASSES, PERENNIALS, & GROUNDCOVERS)

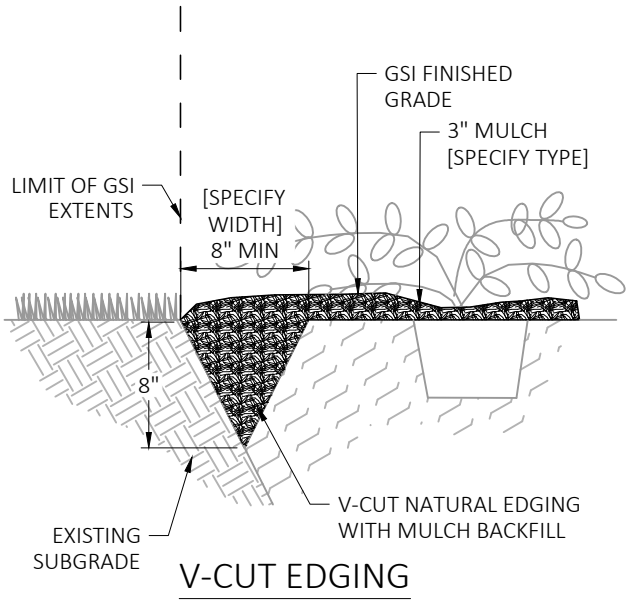
OCTOBER 2022

GSI-7.6

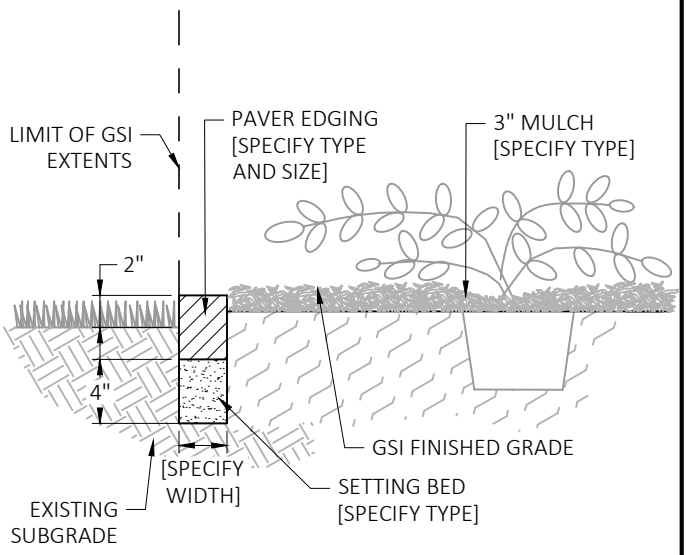
LANDSCAPING



STEEL EDGING AND DECORATIVE GRAVEL MOW STRIP



V-CUT EDGING



PAVER EDGING

NOTES:

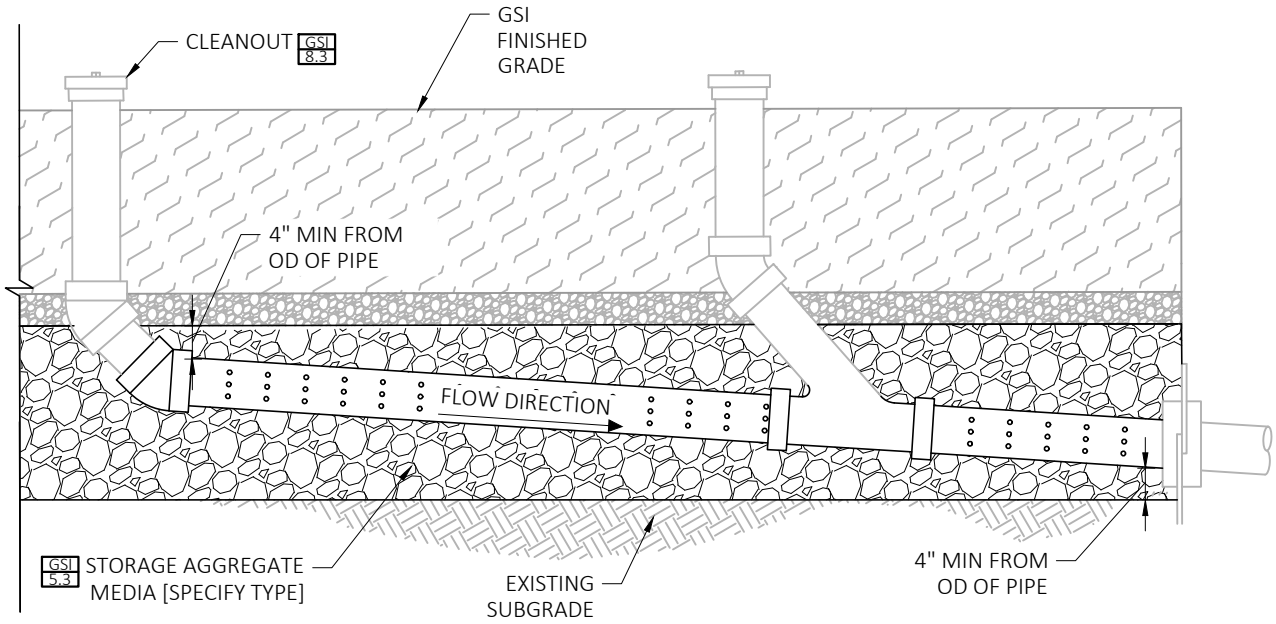
1. LANDSCAPE EDGING SHALL BE PER 02951.
2. PERMEABLE LINER SHALL NOT BE VISIBLE AT THE COMPLETION OF DECORATIVE GRAVEL INSTALLATION.
3. STAKE EDGING WITH METAL STAKES PER MANUFACTURER REQUIREMENTS.

LANDSCAPE EDGING

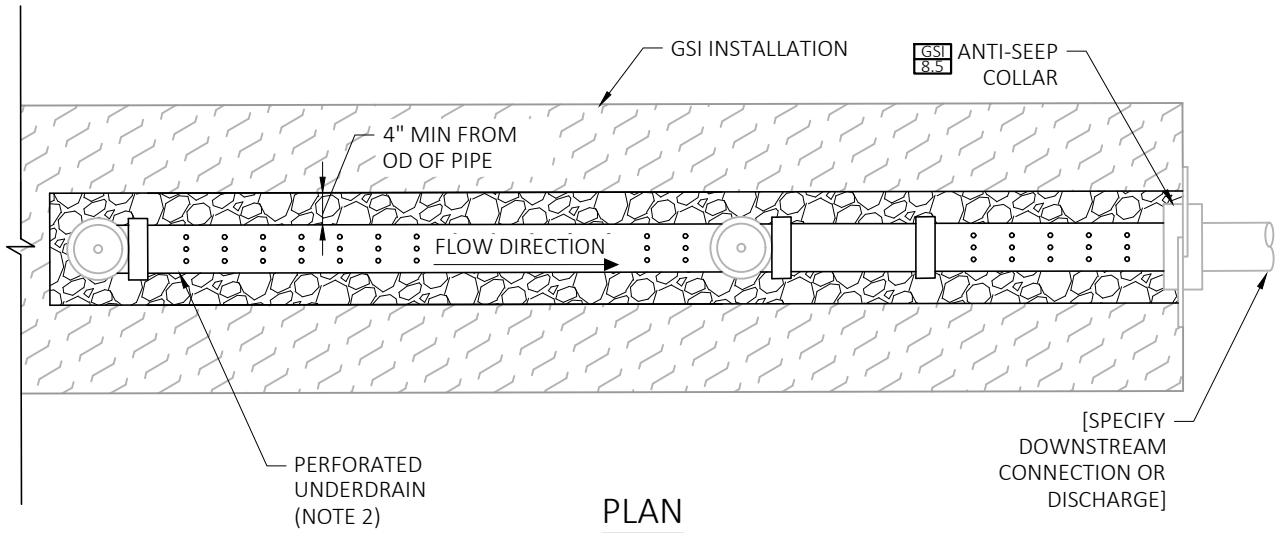
OCTOBER 2022

GSI-8.1

PIPING



PROFILE



PLAN

NOTES:

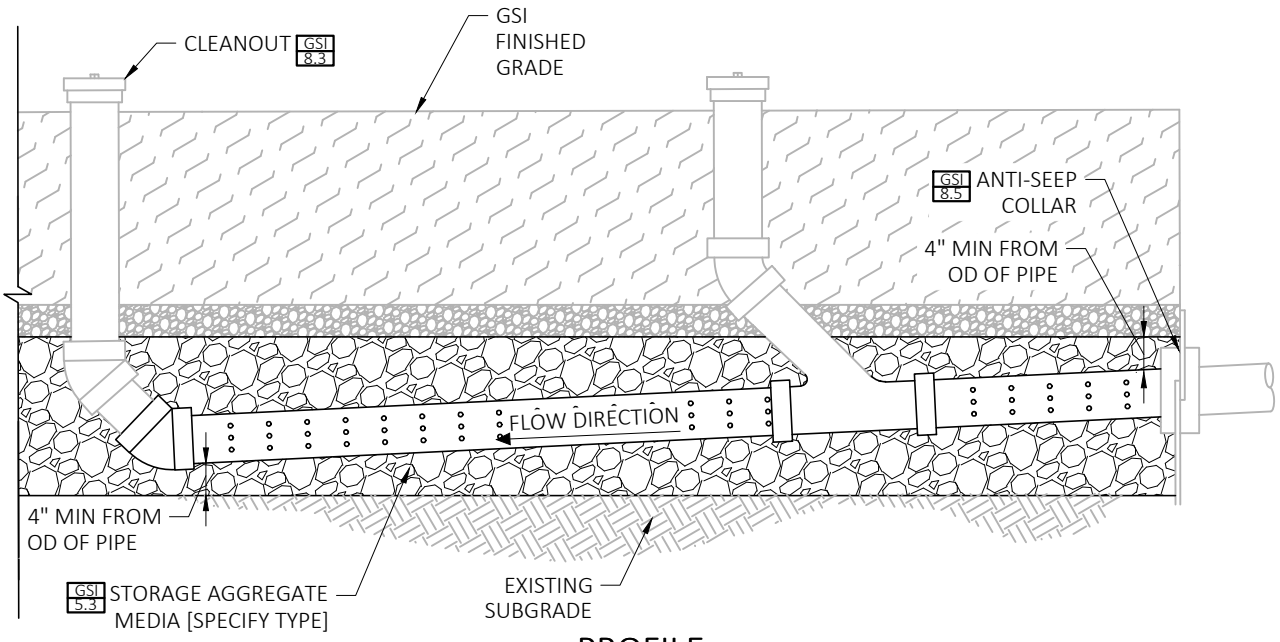
1. UNDERDRAIN SHALL BE PER 02954.
2. [DESIGNER TO SPECIFY TYPE AND DIAMETER OF UNDERDRAIN.] UNDERDRAINS SHALL BE A MINIMUM OF 6" DIAMETER.

UNDERDRAIN

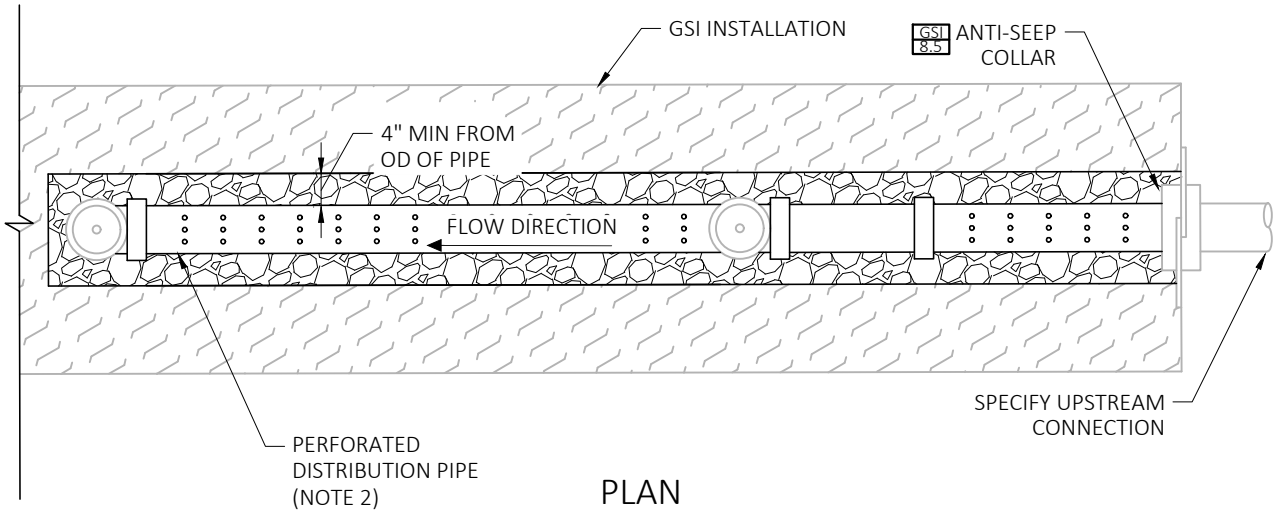
OCTOBER 2022

GSI-8.2

PIPING



PROFILE



PLAN

NOTES:

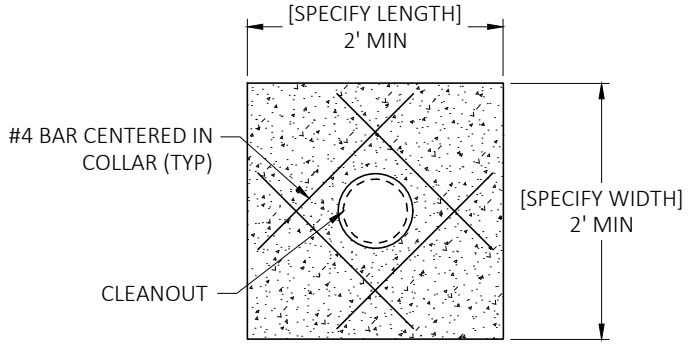
1. DISTRIBUTION PIPE SHALL BE PER 02954.
2. [DESIGNER TO SPECIFY TYPE AND DIAMETER OF DISTRIBUTION PIPING.] DISTRIBUTION PIPE SHALL BE A MINIMUM OF 6" DIAMETER.

DISTRIBUTION PIPE

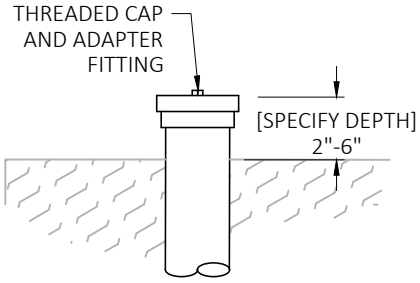
OCTOBER 2022

GSI-8.3

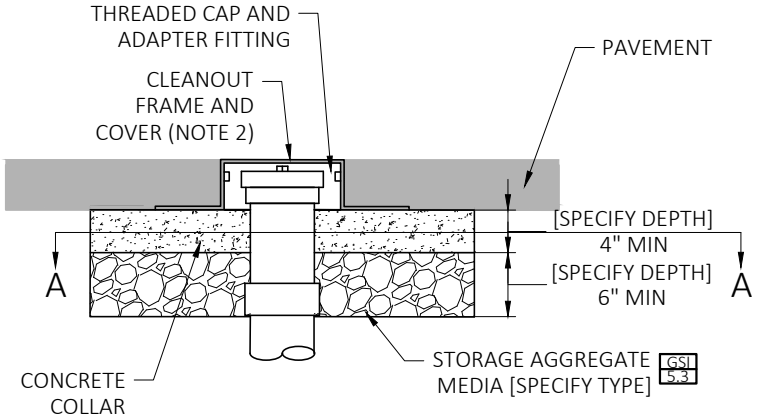
PIPING



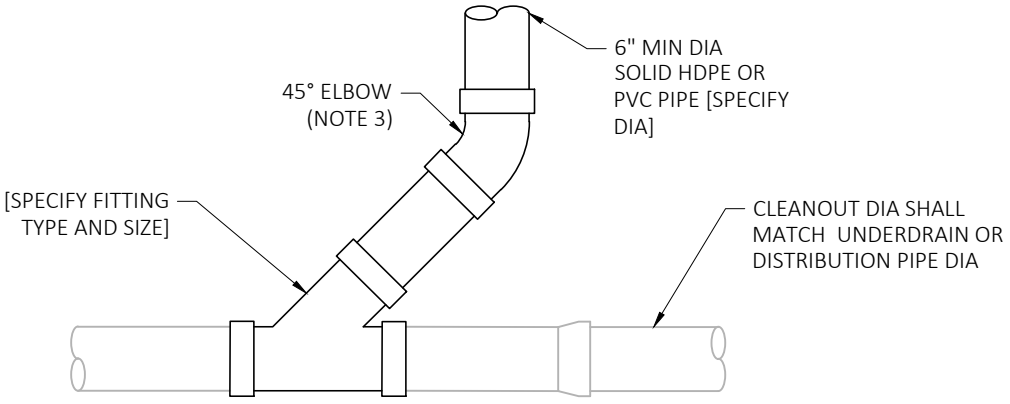
SECTION A-A



CLEANOUT IN SOIL



CLEANOUT IN PAVEMENT



CLEANOUT

NOTES:

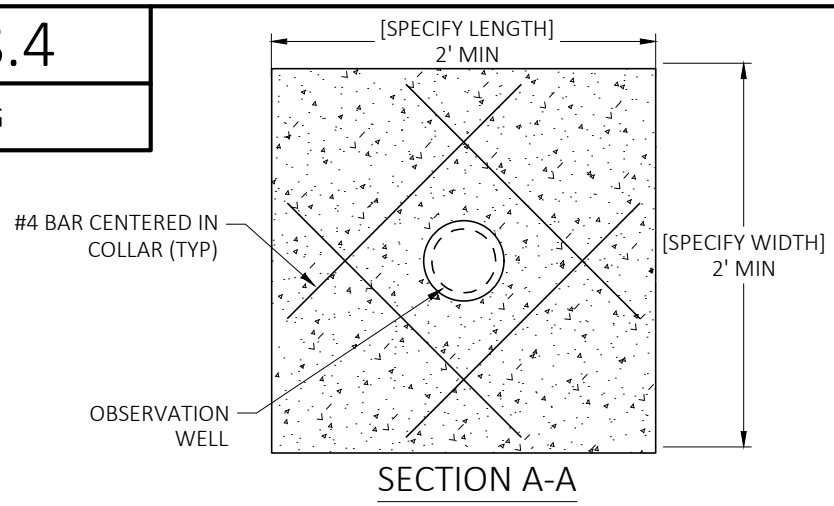
1. CLEANOUT SHALL BE PER 02954.
2. CLEANOUT FRAME AND COVER SHALL BE NEENAH R-1976 OR APPROVED EQUAL FOR PAVEMENT APPLICATIONS. COVER SHALL BE CLEARLY MARKED WITH A UNIQUE IDENTIFIER PROVIDED BY OWNER. FRAME SHALL BE SECURED IN CONCRETE COLLAR IF NOT SECURED IN PAVEMENT SURFACE. COVERS IN PAVEMENT SHALL BE FLUSH WITH FINISHED GRADE.
3. FITTINGS OF 45° ELBOWS CAN BE REPLACED WITH 90° ELBOW OR TEE FITTING WHEN CONSTRAINED BY DEPTH.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

CLEANOUT

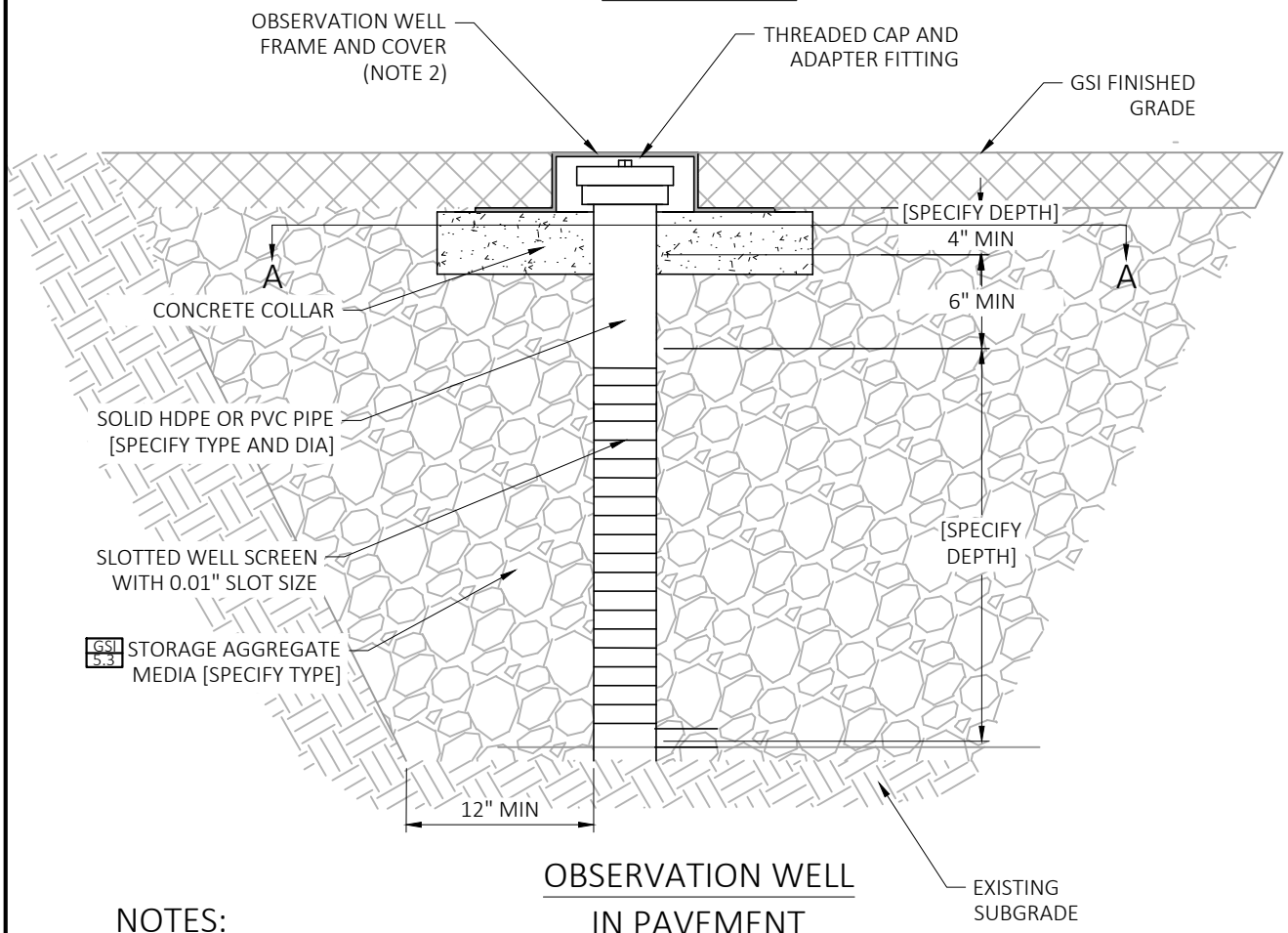
OCTOBER 2022

GSI-8.4

PIPING



SECTION A-A



OBSERVATION WELL IN PAVEMENT

NOTES:

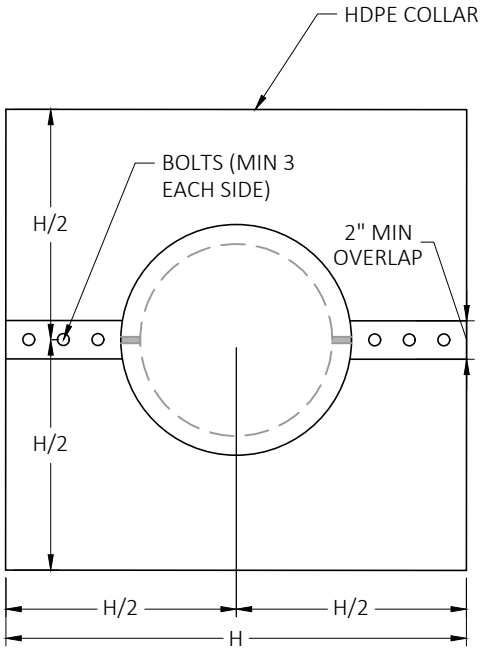
1. OBSERVATION WELL SHALL BE PER 02954.
2. OBSERVATION WELL FRAME AND COVER SHALL BE NEENAH R-1976 FOR PAVEMENT APPLICATIONS. COVER SHALL BE CLEARLY MARKED WITH A UNIQUE IDENTIFIER PROVIDED BY OWNER. FRAME SHALL BE SECURED TO CONCRETE COLLAR IF NOT SECURED IN PAVEMENT SURFACE. COVERS IN PAVEMENT SHALL BE FLUSH WITH FINISHED GRADE.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

OBSERVATION WELL

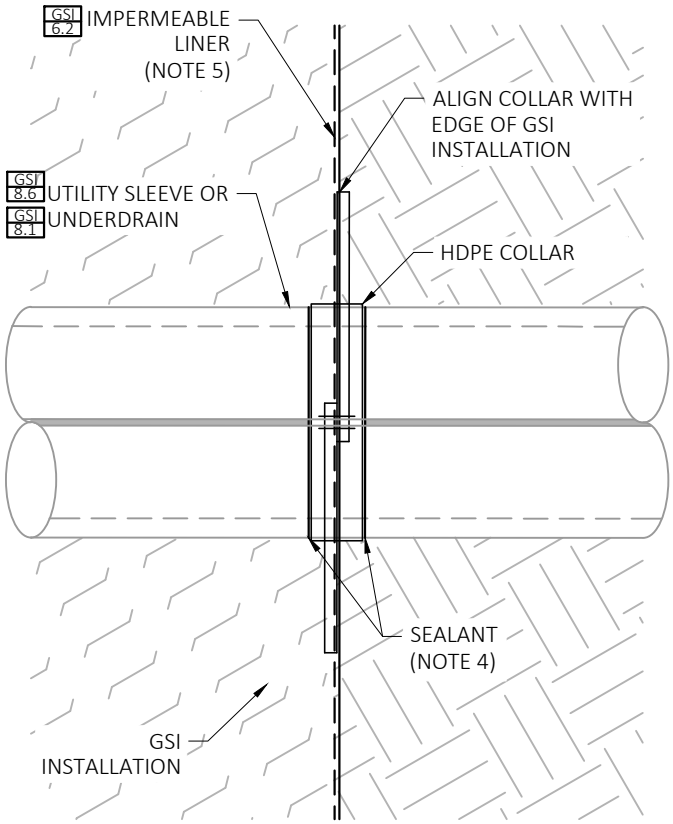
OCTOBER 2022

GSI-8.5.1

PIPING



SECTION



PROFILE

NOTES:

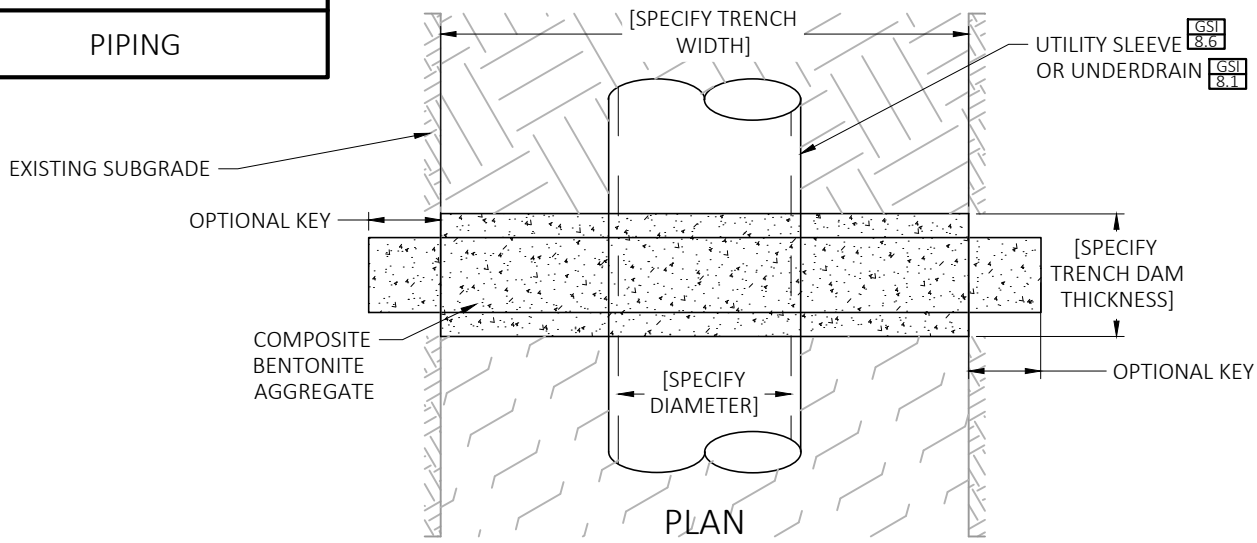
1. ANTI-SEEP COLLAR SHALL BE PER 02954.
2. ANTI-SEEP COLLAR SHALL BE USED IN CONJUNCTION WITH UTILITY SLEEVE OR AS SPECIFIED BY DESIGN PROFESSIONAL [IF APPLICABLE].
3. DIMENSION 'H' SHALL BE A MINIMUM OF 3X THE DIAMETER OF THE UTILITY SERVICE, UTILITY SLEEVE OR PIPE [IF APPLICABLE].
4. SEAL SURFACE OF UTILITY SLEEVE AND ANTI-SEEP COLLAR WITH WATER-TIGHT SEALANT, AS RECOMMENDED BY MANUFACTURER
5. IMPERMEABLE LINER SHALL BE INSTALLED ON INSIDE FACE OF ANTI-SEEP COLLAR UNLESS OTHERWISE NOTED BY THE DESIGN PROFESSIONAL.

HDPE ANTI-SEEP COLLAR

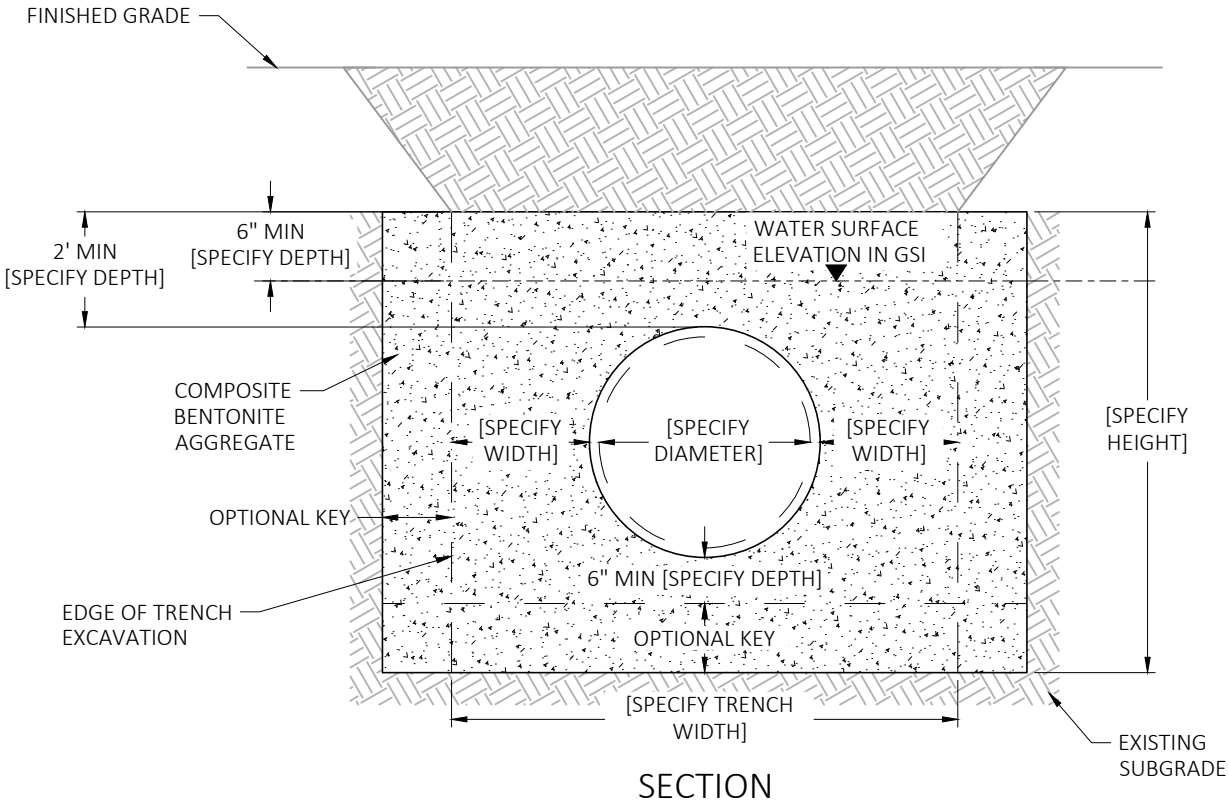
OCTOBER 2022

GSI-8.5.2

PIPING



PLAN



SECTION

NOTES:

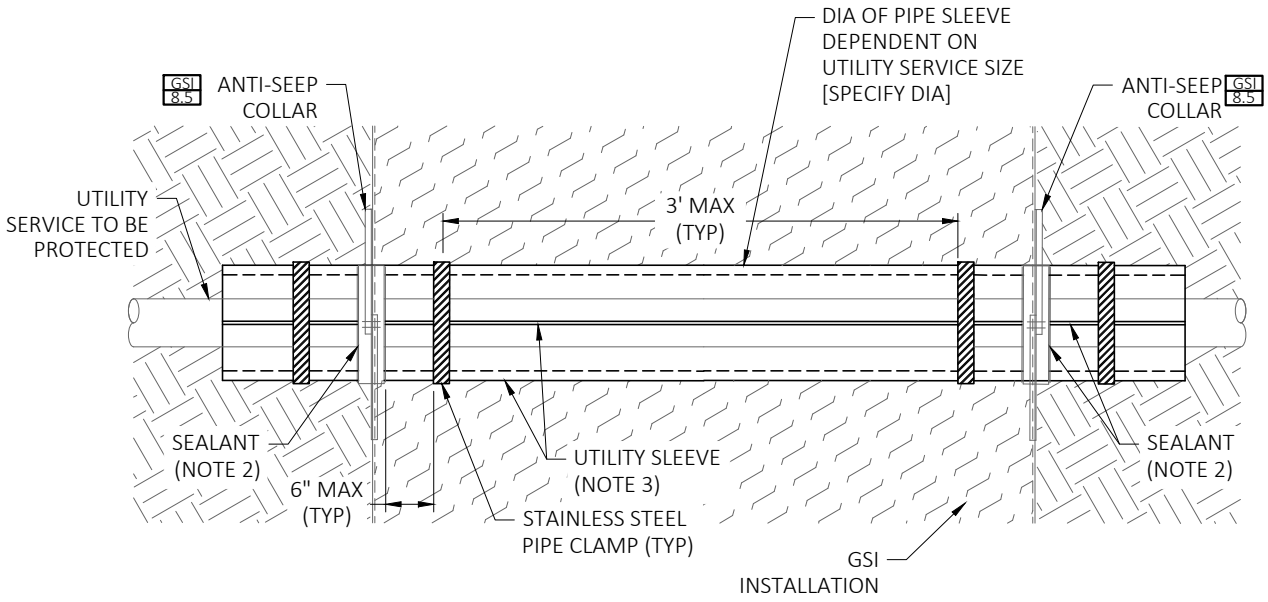
1. ANTI-SEEP COLLAR SHALL BE PER 02954.
2. ANTI-SEEP COLLAR SHALL BE USED IN CONJUNCTION WITH UTILITY SLEEVE OR AS SPECIFIED BY DESIGN PROFESSIONAL [IF APPLICABLE].

COMPOSITE BENTONITE AGGREGATE ANTI-SEEP COLLAR

OCTOBER 2022

GSI-8.6

PIPING



SECTION

NOTES:

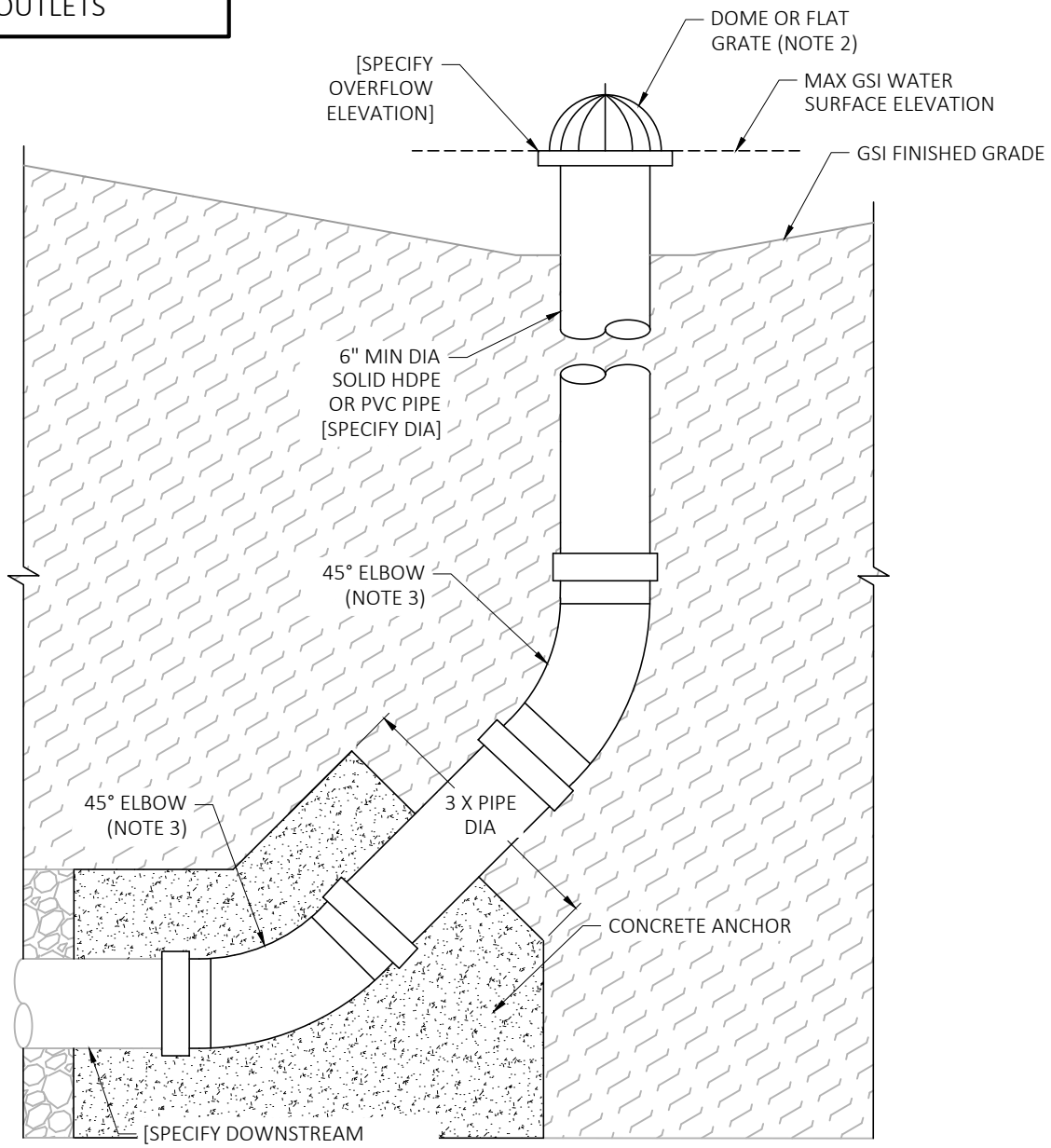
1. UTILITY SLEEVE SHALL BE PER 02954.
2. SEAL SURFACE OF UTILITY SLEEVE AND ANTI-SEEP COLLAR WITH WATER-TIGHT SEALANT, AS RECOMMENDED BY MANUFACTURER
3. APPLY WATERTIGHT SEALANT BETWEEN TWO HALVES OF UTILITY SLEEVE.

UTILITY SLEEVE

OCTOBER 2022

GSI-9.1.1

OUTLETS



SECTION

NOTES:

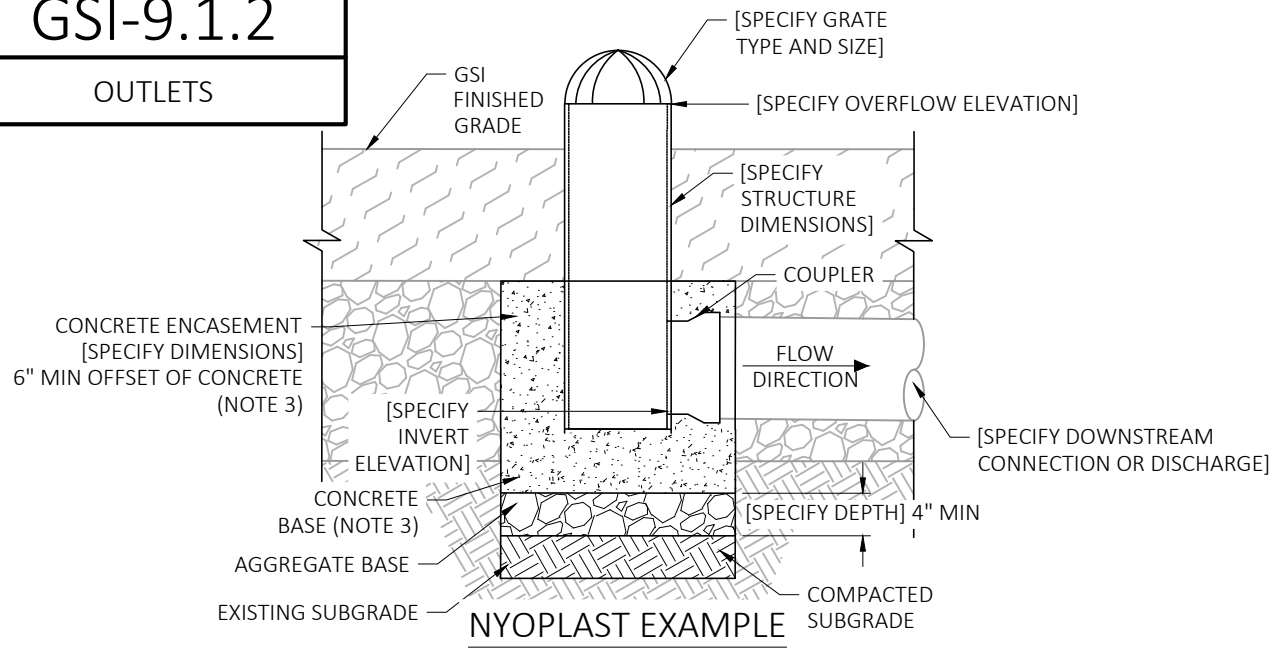
1. OVERFLOW RISER SHALL BE PER 02955.
2. FRAMES, GRATES AND COVERS SHALL BE SPECIFIED BY THE DESIGN PROFESSIONAL. DOMED GRATE SHOWN FOR REFERENCE ONLY.
3. FITTINGS OF 45° ELBOWS CAN BE REPLACED WITH 90° ELBOW OR TEE FITTING WHEN CONSTRAINED BY DEPTH.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

OVERFLOW RISER

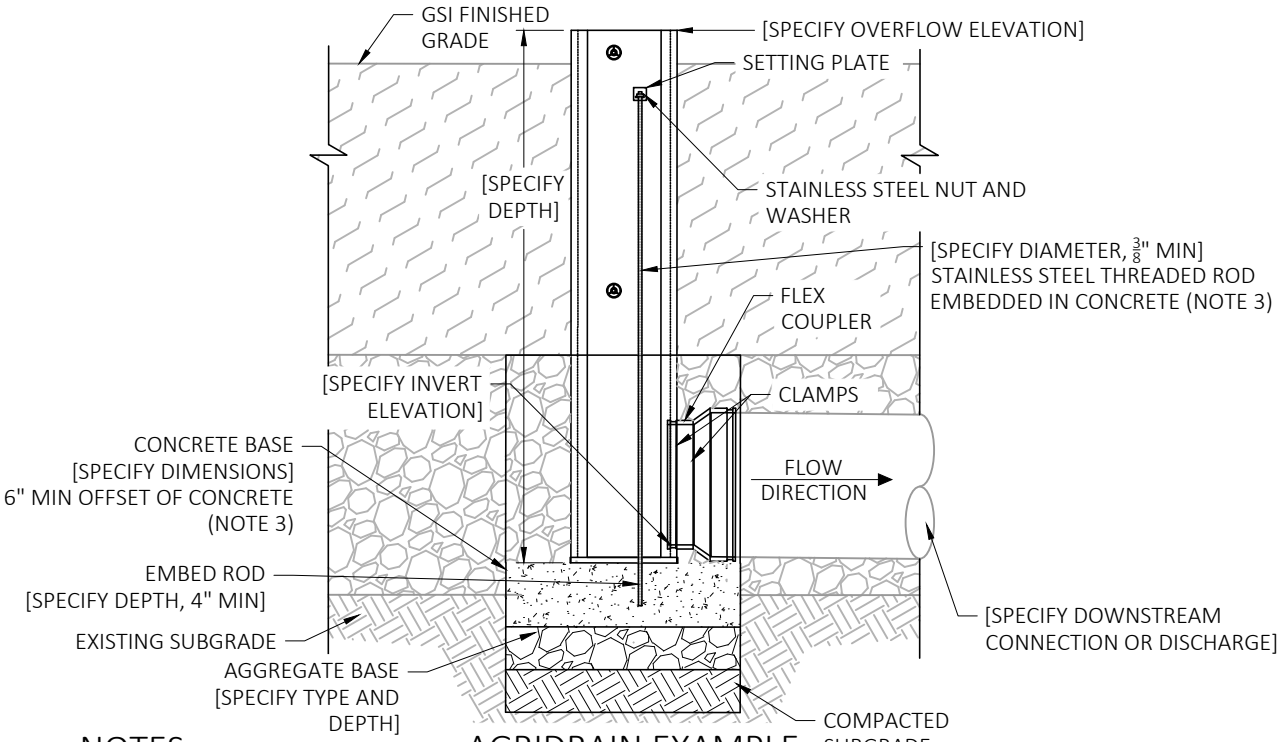
OCTOBER 2022

GSI-9.1.2

OUTLETS



NYOPLAST EXAMPLE



AGRIDRAIN EXAMPLE

NOTES:

1. OUTLET STRUCTURE SHALL BE PER 02955.
2. [DESIGNER TO SPECIFY MANUFACTURER AND PRODUCT.]
3. [OVERFLOW RISER AND ANCHORING SHALL BE DESIGNED TO RESIST BUOYANCY. DESIGNER TO SPECIFY DIMENSIONS AND REINFORCEMENT OF CONCRETE BASE AND ANCHORING (IF APPLICABLE). CONCRETE BASE WITH ANCHORING SHOWN FOR REFERENCE ONLY.] ANY METAL COMPONENTS OF STRUCTURE EMBEDDED IN CONCRETE MUST BE STAINLESS STEEL.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

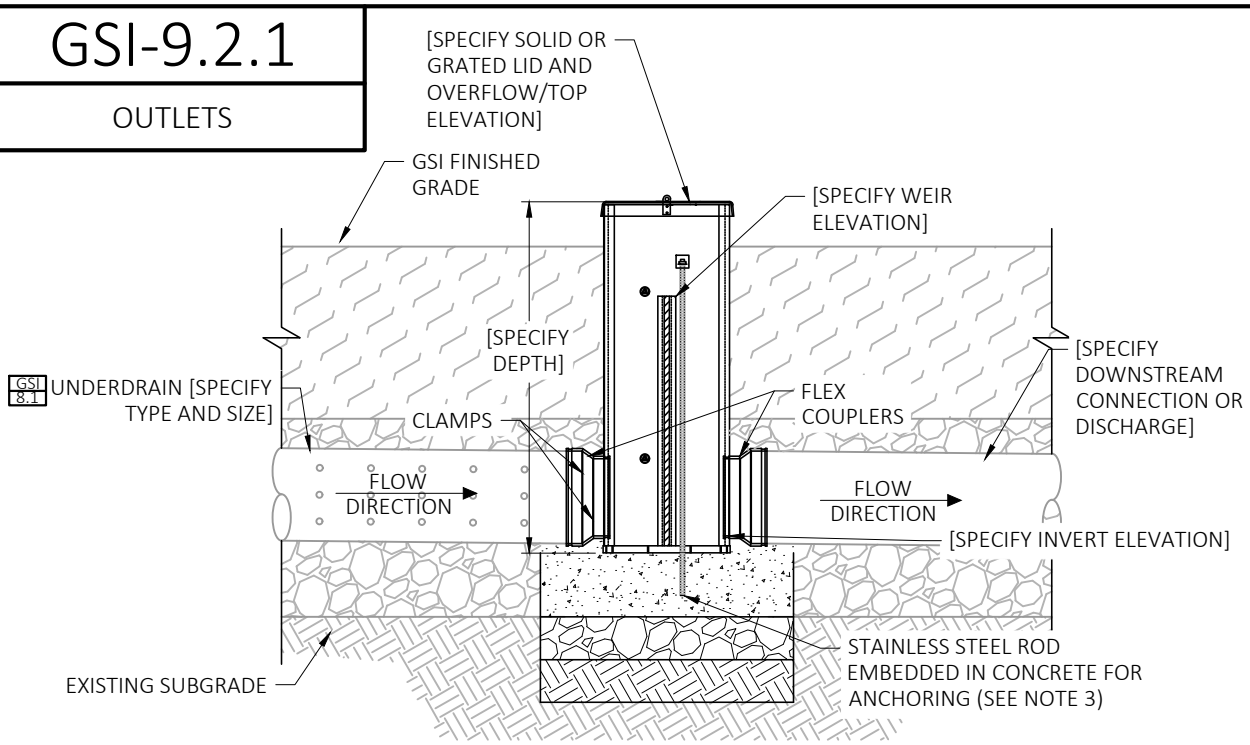
MANUFACTURED OVERFLOW RISER

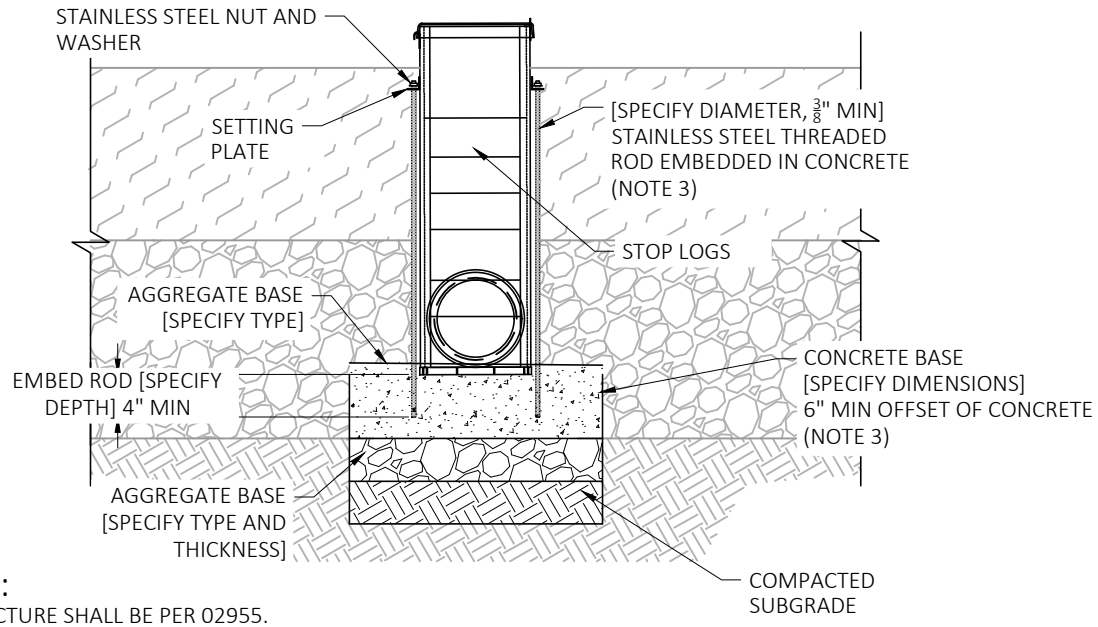
(NYOPLAST & AGRIDRAIN EXAMPLES)

OCTOBER 2022

GSI-9.2.1

OUTLETS





NOTES:

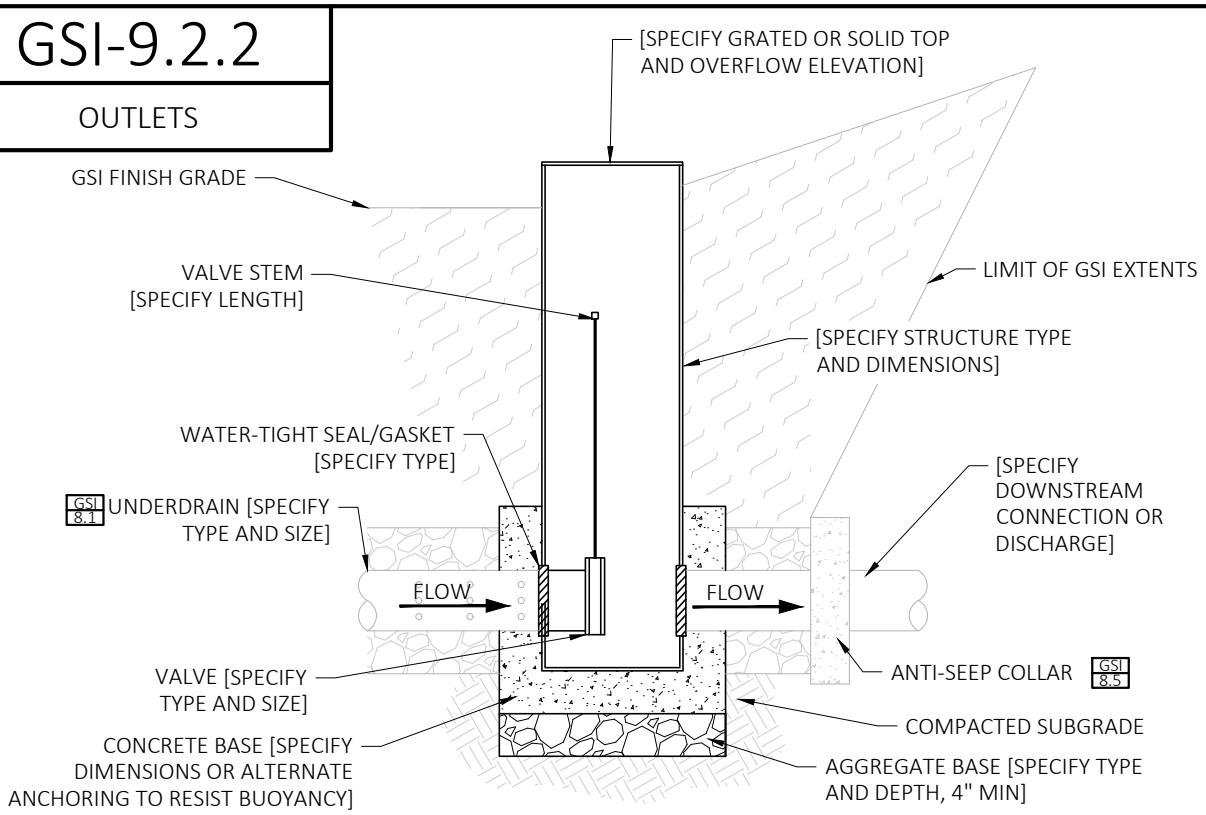
1. OUTLET STRUCTURE SHALL BE PER 02955.
2. [DESIGNER TO SPECIFY MANUFACTURER AND PRODUCT.]
3. [OUTLET CONTROL STRUCTURE AND ANCHORING SHALL BE DESIGNED TO RESIST BUOYANCY. DESIGNER TO SPECIFY DIMENSIONS AND REINFORCEMENT OF CONCRETE BASE AND ANCHORING (IF APPLICABLE). CONCRETE BASE WITH ANCHORING SHOWN FOR REFERENCE ONLY.] ANY METAL COMPONENTS OF STRUCTURE EMBEDDED IN CONCRETE MUST BE STAINLESS STEEL.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

WEIR OUTLET CONTROL STRUCTURE (AGRIDRAIN EXAMPLE)

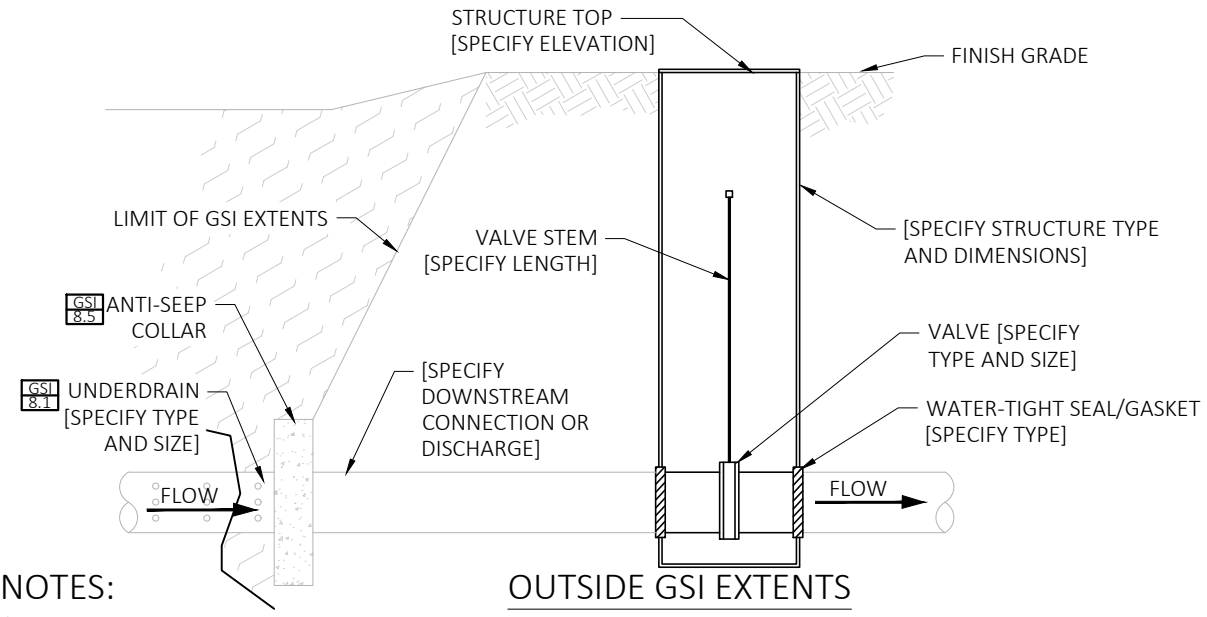
OCTOBER 2022

GSI-9.2.2

OUTLETS



INSIDE GSI EXTENTS



OUTSIDE GSI EXTENTS

NOTES:

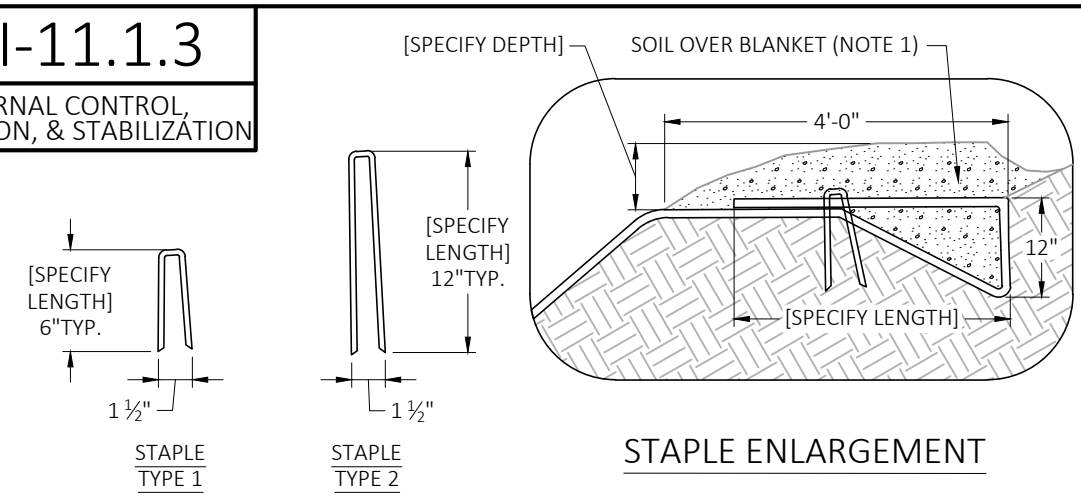
1. INSTALL VALVE PER MANUFACTURER RECOMMENDATIONS.
2. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM 1/3 DRIVEN INTO THE GROUND.
3. [DESIGNER TO SPECIFY VALVE OPEN/CLOSE PARAMETERS DURING AND AFTER CONSTRUCTION.]
4. IF ROD OR HOOK IS REQUIRED FOR OPENING AND CLOSING THE VALVE THE CONTRACTOR IS RESPONSIBLE FOR ACQUIRING THE DEVICE, VERIFYING IT OPERATES APPROPRIATELY, AND PROVIDING IT TO THE OWNER UPON COMPLETION OF THE WORK.

VALVE OUTLET CONTROL STRUCTURE

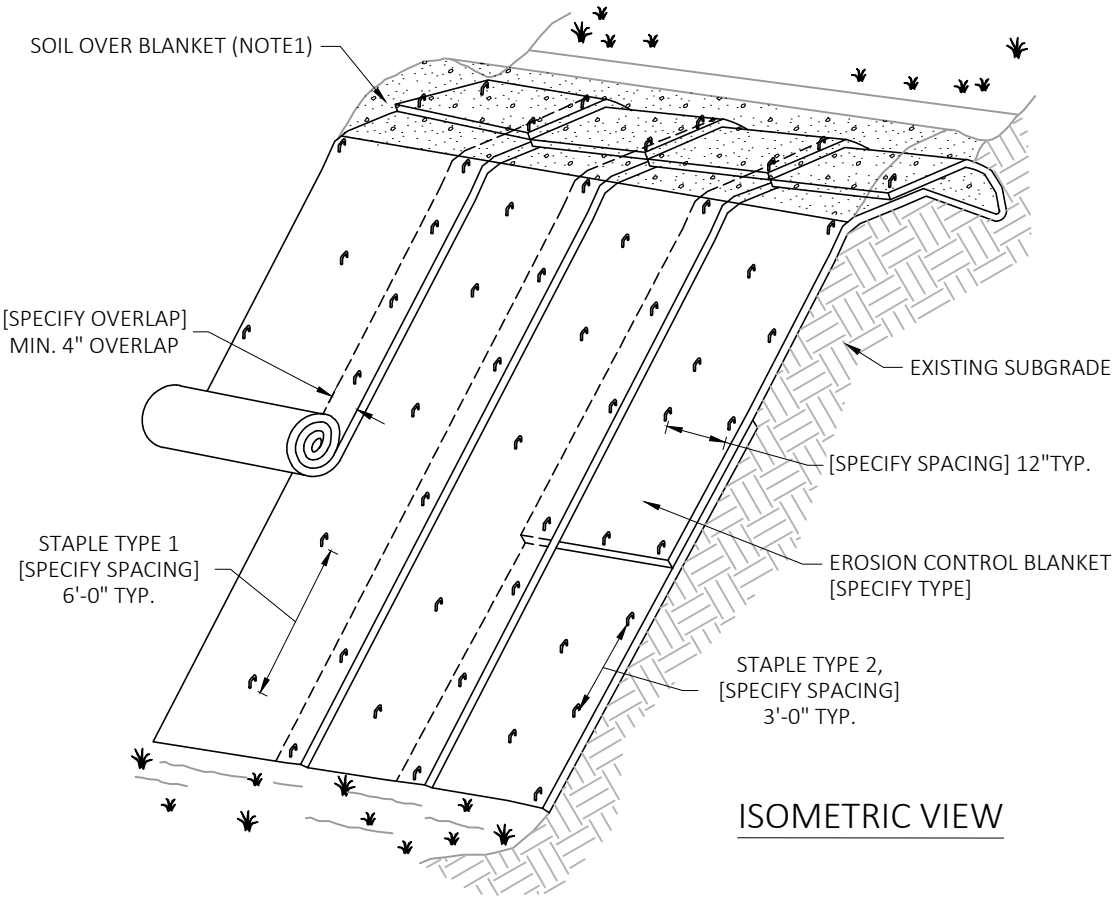
OCTOBER 2022

GSI-11.1.3

INTERNAL CONTROL, PROTECTION, & STABILIZATION



STAPLE ENLARGEMENT



ISOMETRIC VIEW

NOTES:

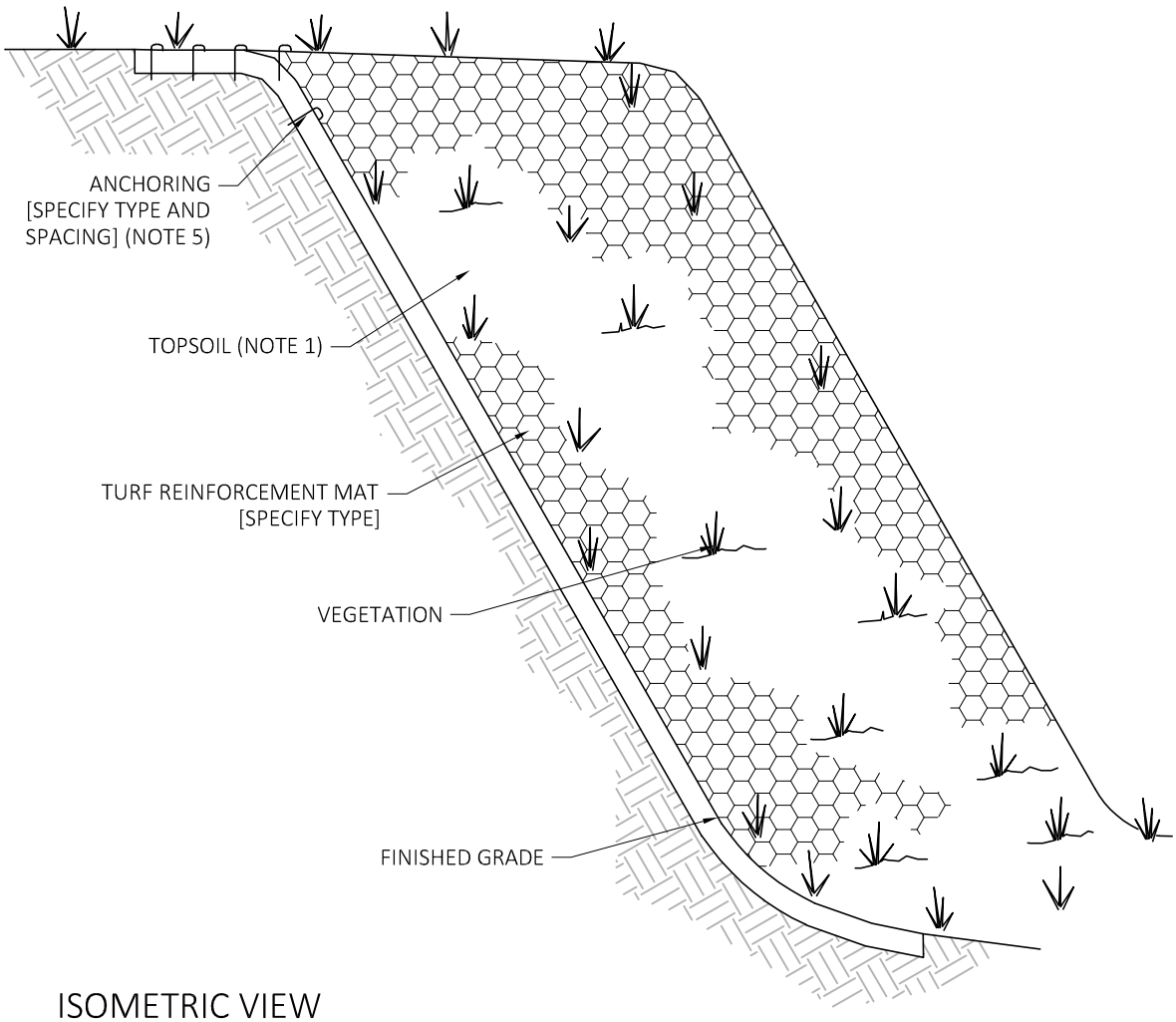
1. TAMP SOIL OVER BLANKET.
2. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. BLANKETS SHALL HAVE GOOD SOIL CONTACT.
3. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
4. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
5. INSTALL PER MANUFACTURER RECOMMENDATIONS. MANUFACTURER INSTRUCTIONS SUPERCEDE INFORMATION DEPICTED.

EROSION CONTROL BLANKET

OCTOBER 2022

GSI-11.1.4

INTERNAL CONTROL, PROTECTION, & STABILIZATION



ISOMETRIC VIEW

NOTES:

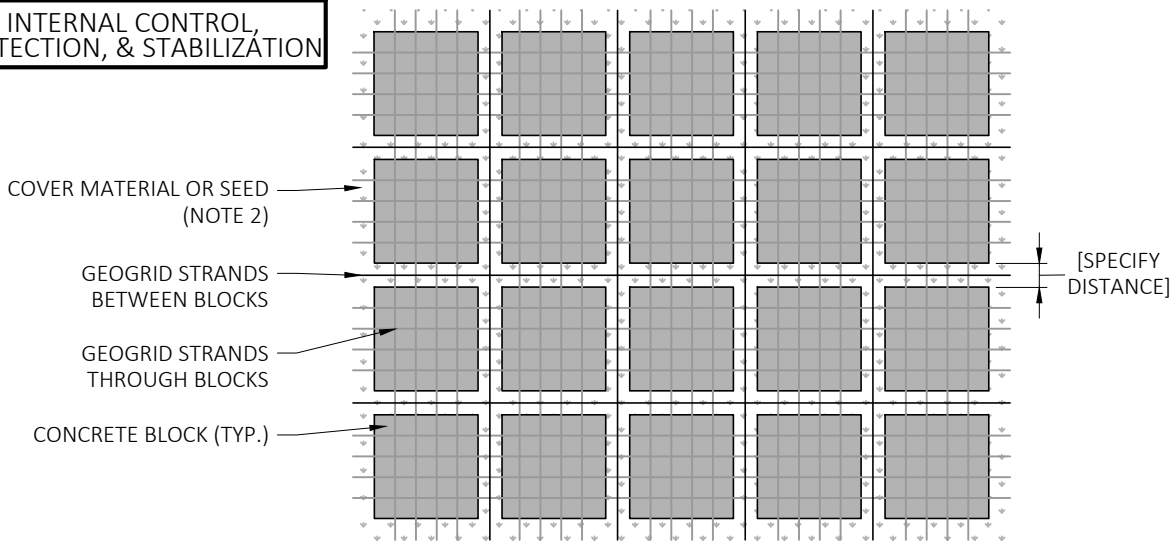
1. SHAPE AND PREPARE SUBGRADE SURFACES FOR TOPSOILING.
2. INSTALL SPECIFIED TOPSOIL TO FINISHED GRADE AND COMPACT PER SPECIFICATIONS.
3. IF SEEDING, INSTALL SEED PRIOR TO PLACEMENT OF TRM.
4. IF PLANTING, INSTALL COVER CROP SEED PRIOR TO PLACING TRM. FOLLOWING TRM PLACEMENT, INSTALL PLANTS ACCORDING TO PLANS AND SPECIFICATIONS.
5. INSTALL TRM PER MANUFACTURER RECOMMENDATIONS. MANUFACTURER'S INSTRUCTIONS SUPERCEDE INFORMATION DEPICTED.

TURF REINFORCEMENT MAT

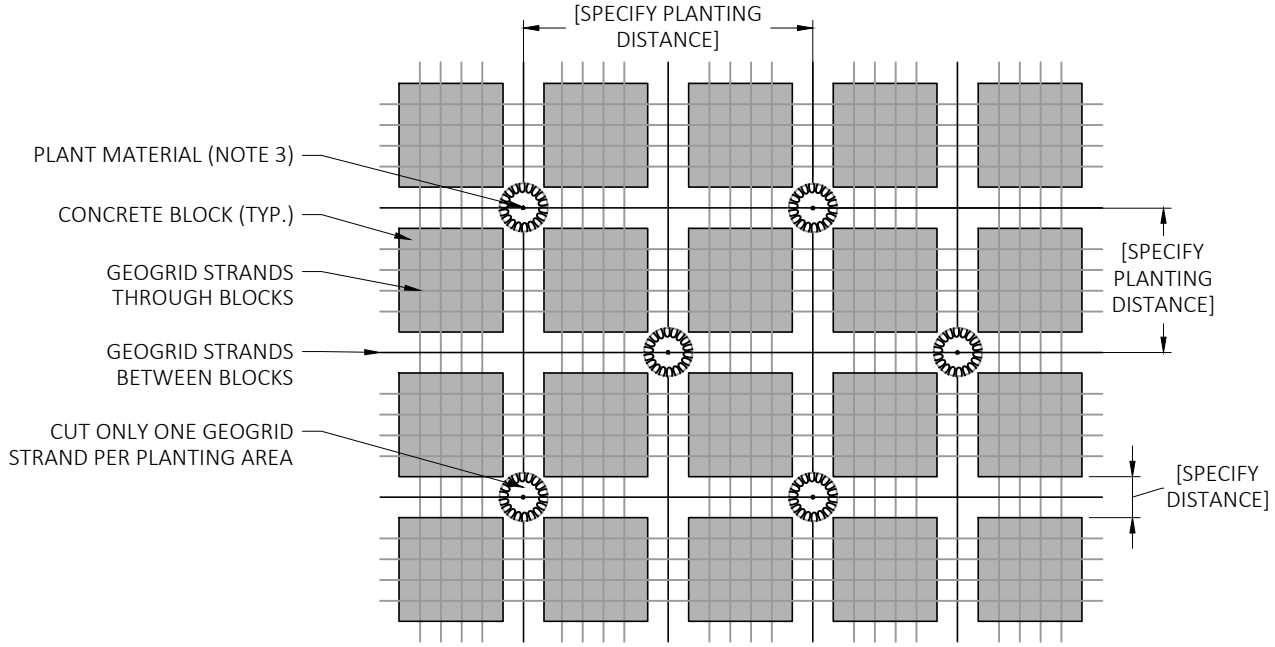
OCTOBER 2022

GSI-11.1.5

INTERNAL CONTROL, PROTECTION, & STABILIZATION



COVER MATERIAL OR SEED



PLANT MATERIAL

NOTES:

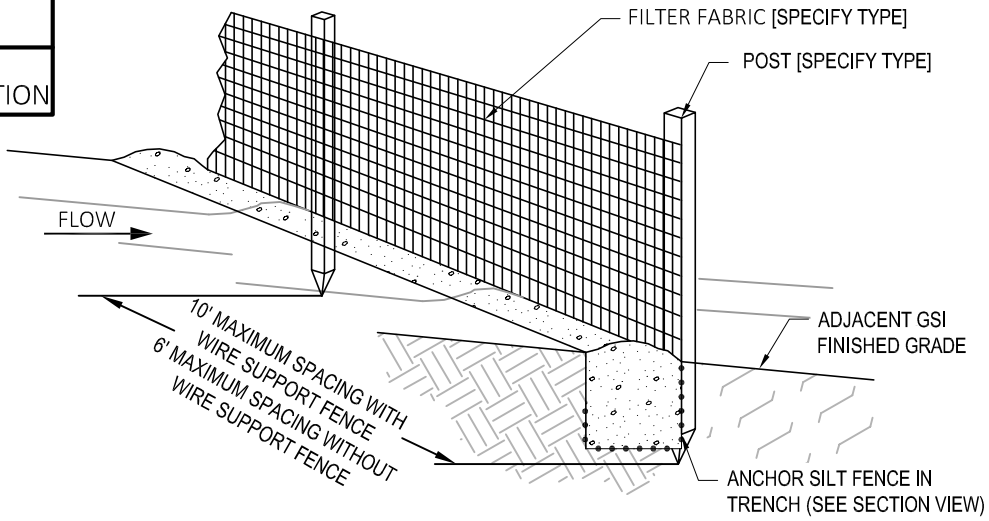
1. SPACING AND INSTALLATION PER MANUFACTURER RECOMMENDATIONS.
2. SEED SHALL BE PER SPECIFICATION 02952 AND 02953.
3. PLANT MATERIAL SHALL BE PER SPECIFICATION 02951.
4. CONTRACTOR TO WATER THOROUGHLY AFTER PLANTING (AS APPLICABLE).

TIED CONCRETE BLOCK MAT

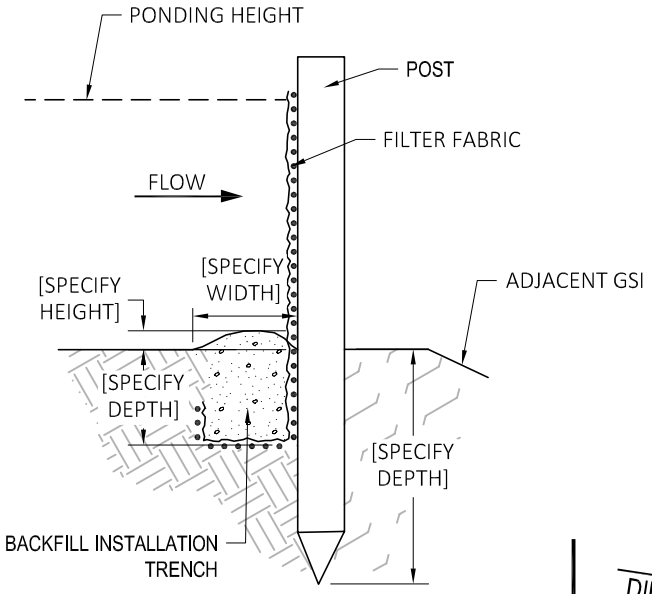
OCTOBER 2022

GSI-11.3.1

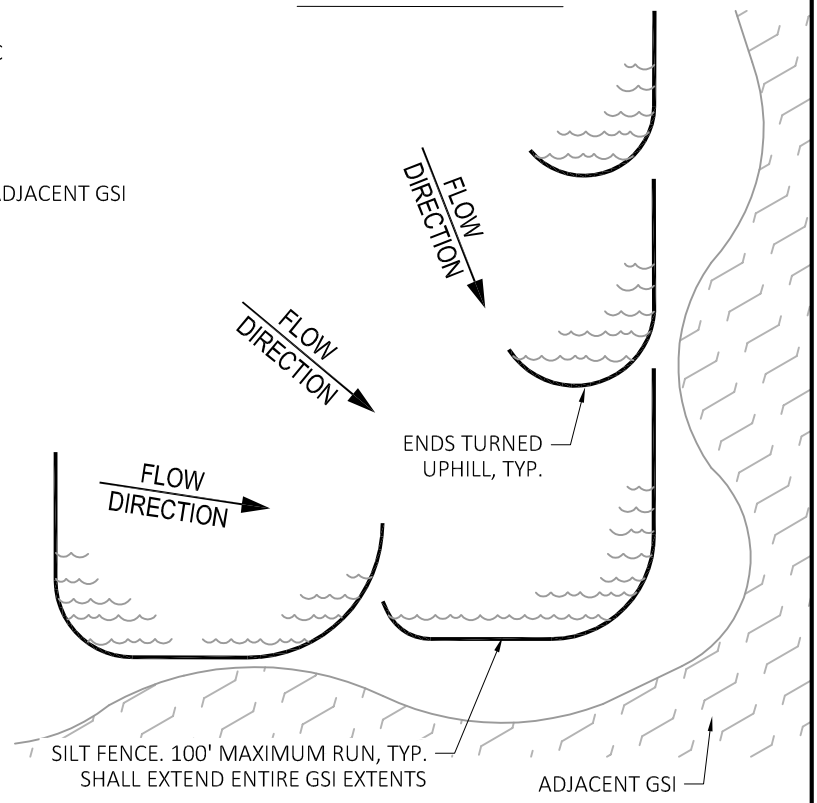
INTERNAL CONTROL, PROTECTION, & STABILIZATION



ISOMETRIC VIEW



SECTION



PLAN

NOTES:

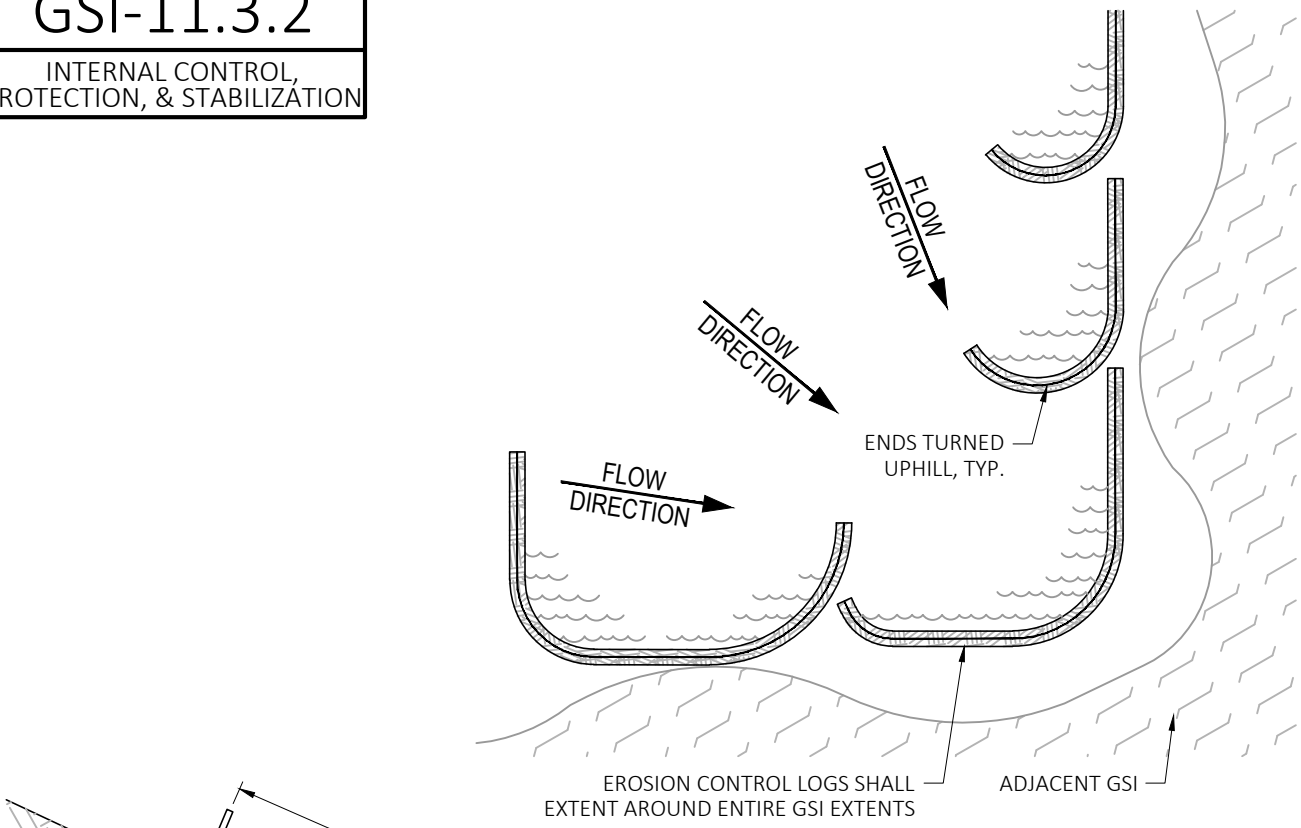
1. INSTALL PER MANUFACTURER RECOMMENDATION.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. 9" MAXIMUM RECOMMENDED STORAGE HEIGHT.

SILT FENCE

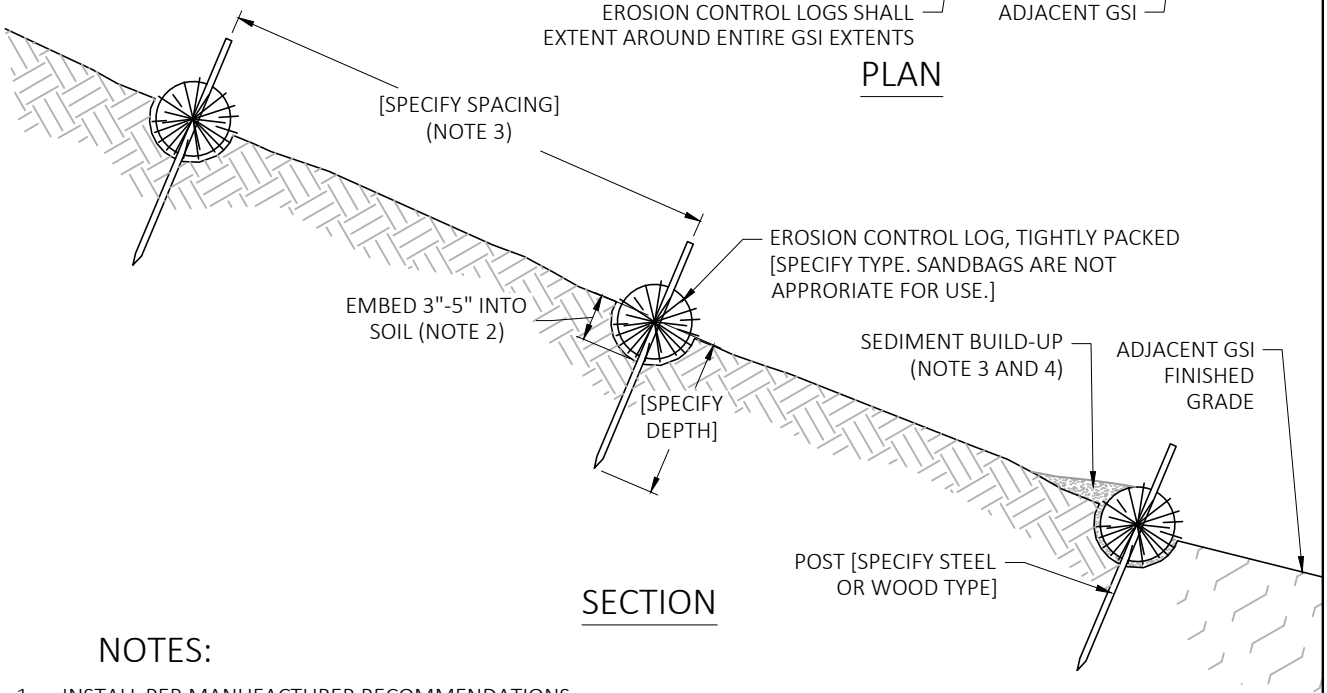
OCTOBER 2022

GSI-11.3.2

INTERNAL CONTROL, PROTECTION, & STABILIZATION



PLAN



SECTION

NOTES:

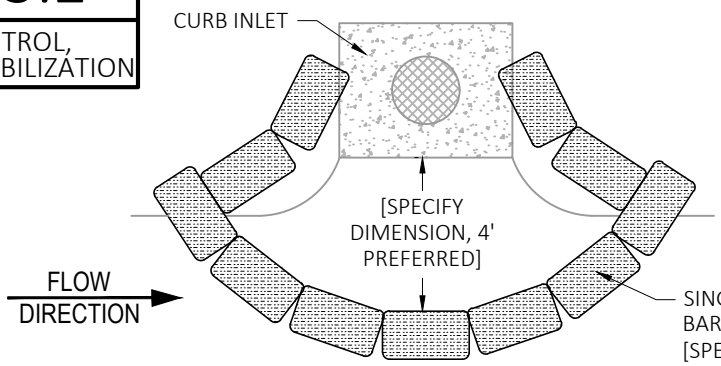
1. INSTALL PER MANUFACTURER RECOMMENDATIONS.
2. BARRIERS SHALL BE INSTALLED PERPENDICULAR TO THE DIRECTION OF FLOW.
3. SPACING DEPENDS ON SOIL TYPE AND SLOPE STEEPNESS.
4. INSPECT AND REPAIR BARRIERS AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.

EROSION CONTROL LOGS IN SOIL

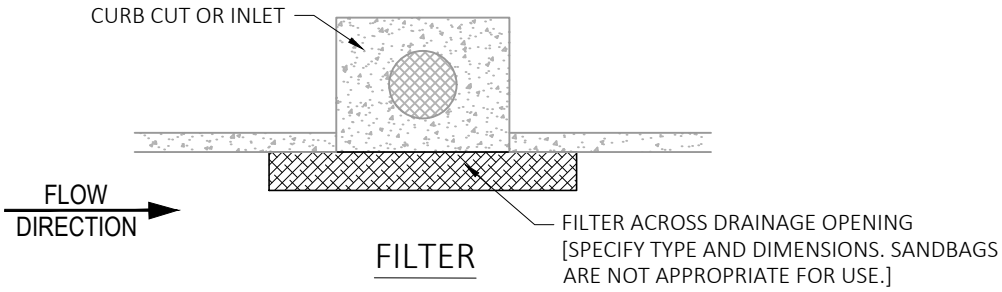
OCTOBER 2022

GSI-11.3.2

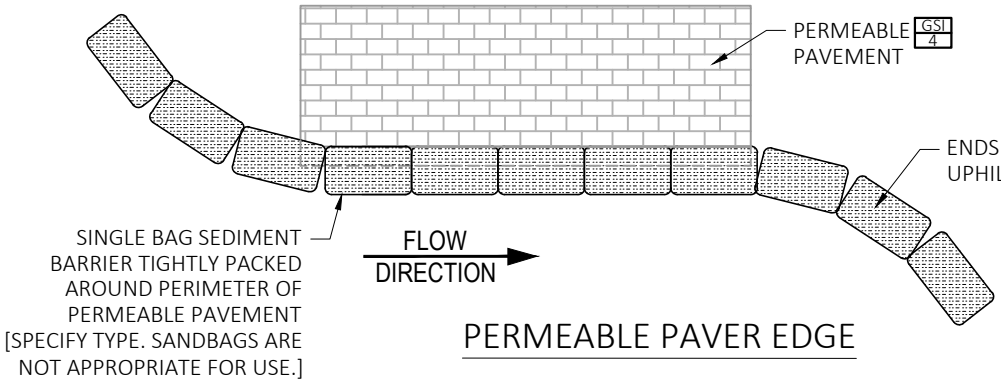
INTERNAL CONTROL, PROTECTION, & STABILIZATION



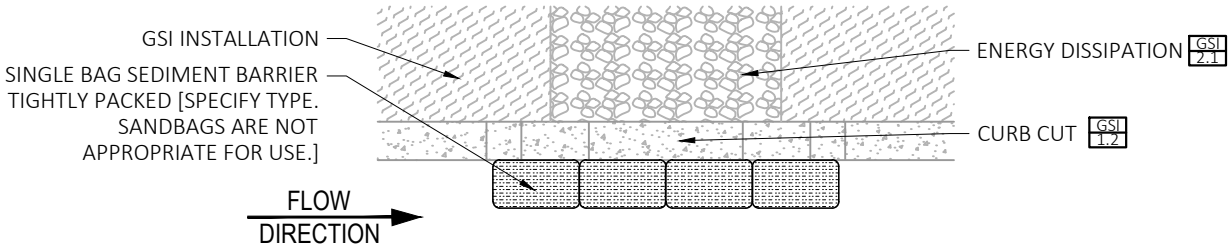
SEDIMENT BARRIER



FILTER



PERMEABLE PAVER EDGE



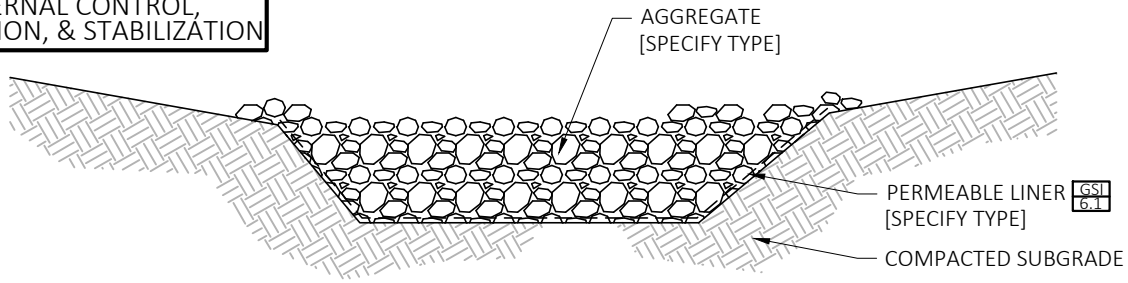
CURB CUT

EROSION CONTROL LOGS ON PAVEMENT

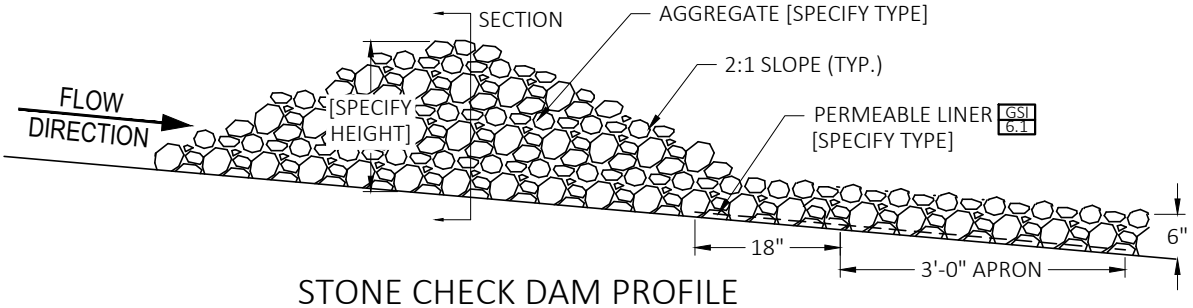
AUGUST 2022

GSI-11.4.1

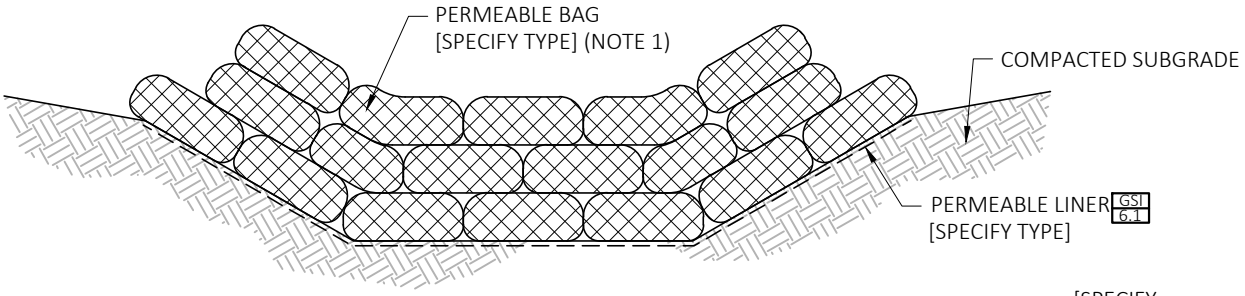
INTERNAL CONTROL, PROTECTION, & STABILIZATION



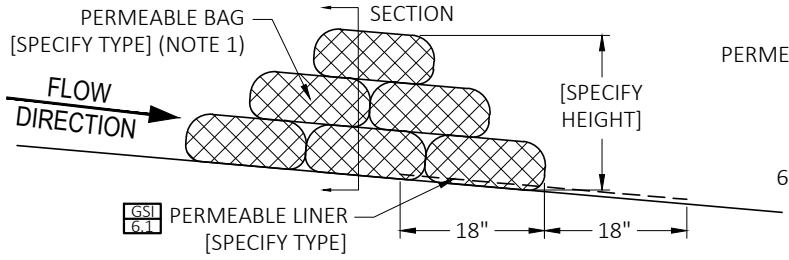
STONE CHECK DAM SECTION



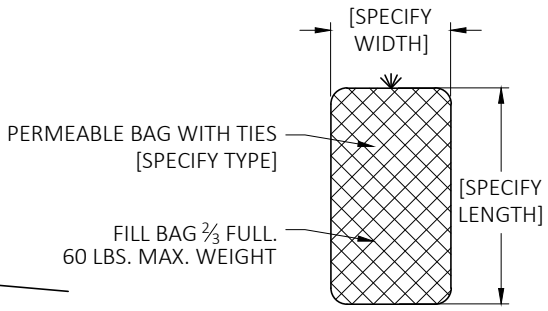
STONE CHECK DAM PROFILE



BAG CHECK DAM SECTION



BAG CHECK DAM PROFILE



PERMEABLE BAG

NOTES:

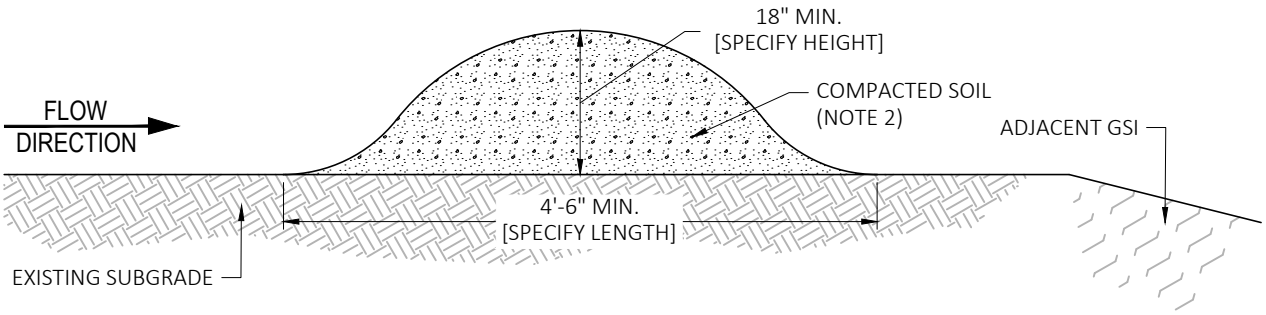
1. STAGGER SPACING OF BAGS SO THAT GAPS DO NOT ALIGN.

CHECK DAM

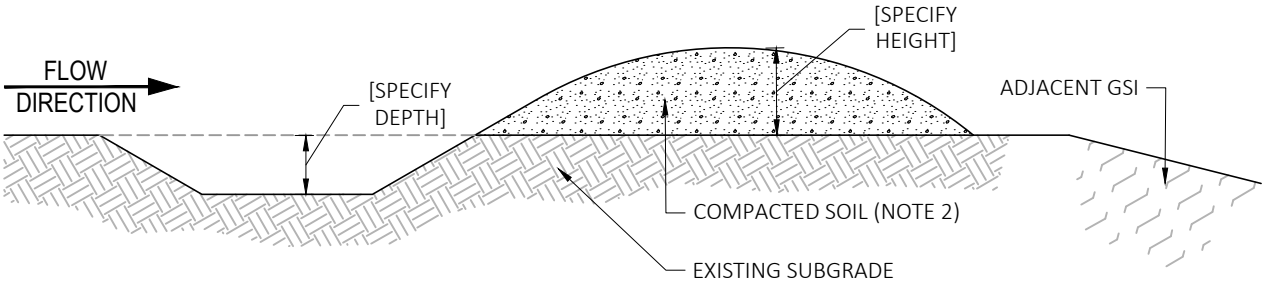
OCTOBER 2022

GSI-11.4.5

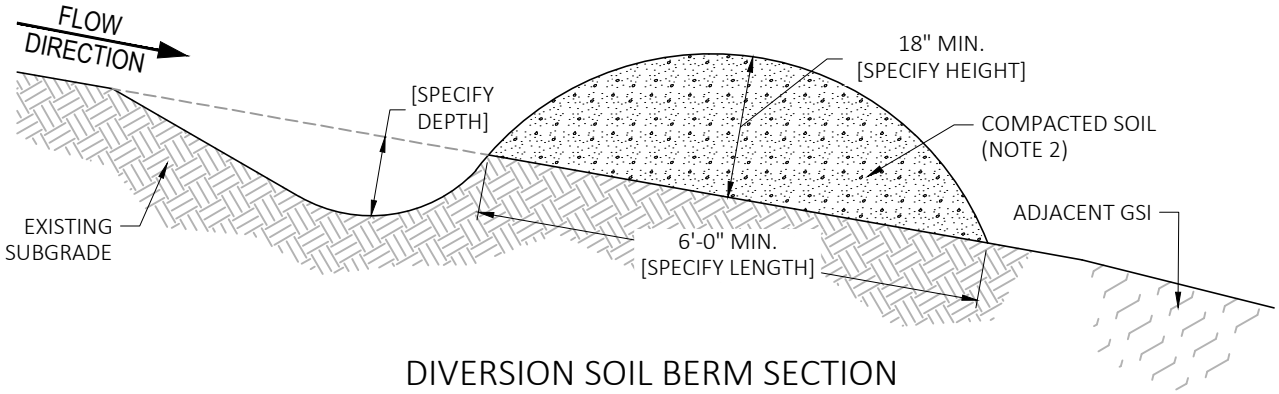
INTERNAL CONTROL, PROTECTION, & STABILIZATION



TEMPORARY SOIL BERM



TRAPEZOIDAL SOIL BERM



DIVERSION SOIL BERM SECTION

NOTES:

1. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS TO NOT INTERFERE WITH THE PROPER FUNCTION OF THE BERM.
2. FILLS SHALL BE COMPACTED AS NEEDED TO PREVENT UNEQUAL SETTLEMENT THAT WOULD CAUSE DAMAGE IN THE COMPLETED BERM. FILL SHALL BE COMPOSED OF SOIL WHICH IS FREE OF ORGANIC DEBRIS, ROCKS, OR OTHER OBJECTABLE MATERIALS.

SOIL BERM

OCTOBER 2022

APPENDIX H

GSI CONSTRUCTION SPECIFICATIONS

02937	GSI Site Activity Plan
02938	GSI Control and Protection
02939	GSI Earthwork
02940	GSI Inlets
02941	GSI Energy Dissipation and Pretreatment
02942	GSI Area Protection
02943	GSI Pervious Concrete
02944	GSI Porous Asphalt
02945	GSI Permeable Pavers
02946	GSI Aggregate Media
02947	GSI Growing Media and Soil Amendments
02948	GSI Media Liners
02949	GSI Existing Tree Protection
02950	GSI Selective Vegetation Removal
02951	GSI Plants
02952	GSI Native Grass and Wildflower Seeding
02953	GSI Non-Native Seeding and Sodding
02954	GSI Piping
02955	GSI Outlets
02956	GSI In-Situ Infiltration Testing
02957	GSI Establishment

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02937

GSI SPECIFICATIONS

****

SECTION 02937

GREEN STORMWATER INFRASTRUCTURE SITE ACTIVITY PLAN

****

NOTE: A training video for the GSI Manual and tools including instructions on how to use the Site Activity Plan is available on the MARC website.

****

****

NOTE: This guide specification includes requirements for the Site Activity Plan for the Project site(s). Design Professional shall include required Site Activity Plan forms provided in the Excel template with this specification.

Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable specification sections and their corresponding requirements, or, insert appropriate information within the bracketed areas. Specifications and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 Appendix H Site Activity Plan Forms & Instructions for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

****

NOTE: Design Professional to verify green stormwater infrastructure and components are defined in Front End specifications of Project Manual.

****

A. The purpose of Section 02937 Green Stormwater Infrastructure Site Activity Plan is to thoroughly plan construction sequencing, prepare, control and protect the green stormwater infrastructure sites, install the green stormwater infrastructure components (GSI Components), stabilize disturbed area, and establish the green stormwater infrastructure facilities.

B. Definitions

1. Green Stormwater Infrastructure (GSI): Elements of the Work that are designed and constructed with the purpose of stormwater management. GSI augments traditional inlet and pipe systems by collecting and infiltrating rainfall. GSI practices may include but not be limited to bioretention, permeable pavement systems, infiltration trenches, wetlands, wet detention basins, dry detention basins, subsurface storage, green roofs, blue roofs, cisterns, pretreatment, and other manufactured systems.

2. GSI Component: element of the GSI practice that supports the overall function of the facility through collection, routing, and/or storage of stormwater, protection of the practice, enhancement of the performance, or control of water movement within or away from the GSI.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of the Site Activity Plan shall be subsidiary to other project administrative costs.

1.03 RELATED SECTIONS

****

NOTE: These specifications use municipal terminology and requirements for Substantial Completion or Achievement of Full Operation and Correction Period as it relates to duration of Contractor's responsibility for establishment and maintenance of green stormwater infrastructure and its components. Design Professional to verify contract terms for project completion defined in the Front End specifications of the Project Manual.

****

A. The sections listed below form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

[02940 Green Stormwater Infrastructure Inlets]

[02941 Green Stormwater Infrastructure Energy Dissipation and Pollutant Removal]

[02942 Green Stormwater Infrastructure Above Grade Barriers]

[02943 Green Stormwater Infrastructure Pervious Concrete]

[02944 Green Stormwater Infrastructure Porous Asphalt]

[02945 Green Stormwater Infrastructure Permeable Pavers]

[02946 Green Stormwater Infrastructure Aggregate Media]

[02947 Green Stormwater Infrastructure Growing Media and Soil Amendments]

[02948 Green Stormwater Infrastructure Media Liners]

[02949 Green Stormwater Infrastructure Existing Tree Protection]

[02950 Green Stormwater Infrastructure Selective Vegetation Removal]

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

[02954 Green Stormwater Infrastructure Piping]

[02955 Green Stormwater Infrastructure Outlets]

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150 (2017) Division II Construction and Material Specification, Erosion and Sediment Control

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

SITE ACTIVITY PLAN

[GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE]

STORMWATER RUNOFF MANAGEMENT PLAN

SITE ACCESS AND UTILIZATION PLAN

[GREEN STORMWATER INFRASTRUCTURE MAINTENANCE PLAN]

QUALITY ASSURANCE QUALIFICATIONS

SD-10 Operation and Maintenance Data

SITE ACTIVITY PLAN UPDATES

1.06 QUALITY ASSURANCE

A. Qualifications

1. The Contractor shall develop and control the Site Activity Plan. The Contractor is responsible for installation and establishment of all green stormwater infrastructure components.

****

NOTE: Design Professional to insert Quality Assurance Qualifications form from GSI Site Activity Plan Excel template as an attachment to this specification section.

****

2. QUALITY ASSURANCE QUALIFICATIONS; [use the attached Green Stormwater Infrastructure Quality Assurance form to] submit qualifications with a minimum of three (3) references for related project work meeting the experience requirements and

documentation of required certifications described in Part 1.06 of the following Sections:[02939 Green Stormwater Infrastructure Earthwork,][02942 Green Stormwater Infrastructure Above Grade Barriers,][02943 Green Stormwater Infrastructure Pervious Concrete,][02944 Green Stormwater Infrastructure Porous Asphalt,][02945 Green Stormwater Infrastructure Permeable Pavers,][02946 Green Stormwater Infrastructure Aggregate Media,][02947 Green Stormwater Infrastructure Growing Media and Soil Amendments,][02949 Green Stormwater Infrastructure Existing Tree Protection,][02950 Green Stormwater Infrastructure Selective Vegetation Removal,][02951 Green Stormwater Infrastructure Plants,][02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding,][02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding,]02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. Qualifications shall include project location, name of firm executing work, owner name and contact number, completion date, and dollar value of work.

B. Erosion and Sediment Control

****

NOTE: Select the appropriate regulatory agency for the project's National Pollutant Discharge Elimination System (NPDES) permit applicability.

****

1. The Contractor shall assume that implementation measures specified in the Site Activity Plan are independent of erosion and sediment control as required under the Environmental Protection Agency's National Pollution Discharge Elimination System permit regulated by [Missouri Department of Natural Resources][Kansas Department of Health & Environment].

2. The Contractor shall utilize APWA 2150 in conjunction with Section 02938 Green Stormwater Infrastructure Control and Protection as part of this Site Activity Plan, and to the extent necessary to control and protect green stormwater infrastructure.

1.07 QUALITY CONTROL

A. The Contractor shall be responsible for updating the Site Activity Plan during the project at an interval at least as frequent as every 30 days.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Not applicable.

PART 2 PRODUCTS

2.01 MATERIALS AND METHODS

A. Materials and methods identified by Contractor in the Site Activity Plan are subject to approval by [Design Professional][Owner] prior to Part 3.

2.02 ALTERNATE SITE ACTIVITY PLAN MATERIALS OR METHODS

A. The Contractor may propose alternative methods or materials for implementation of the Site Activity Plan during the project, provided that such methods provide equal or

improved measures, as determined by the [Design Professional][Owner]. The Contractor shall submit documentation as requested by the [Design Professional][Owner] to evaluate the alternative.

PART 3 EXECUTION

3.01 PREPARATION

A. A Site Activity Plan is a collection of documents which [identify a detailed green stormwater infrastructure construction schedule,]address stormwater runoff during construction, summarize means of access to the Site, [and]identify the anticipated Site utilization [and][identify maintenance activities to be performed]. [The Contractor may combine the Site Activity Plan with requirements of APWA 2150, so long as the information required of both is clearly defined.]

B. All preconstruction submittals per Part 1.05, shall be submitted and accepted prior to commencement of Work.

3.02 INSTALLATION

A. The Contractor shall develop and submit a SITE ACTIVITY PLAN within 30 days of Notice to Proceed which shall include but not be limited to the information defined per the following:

****

NOTE: Design Professional to insert GSI Construction Schedule form from GSI Site Activity Plan Excel template as an attachment to this specification section.

****

B. GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE: Shall be included and maintained as part of the Project Schedule requirements per Section [Designer to input specification number where project schedule is defined][, following the attached Green Stormwater Infrastructure Construction Schedule form]. The Green Stormwater Infrastructure Construction Schedule shall include additional detail on specific phasing of construction activities for all GSI Components. The Green Stormwater Infrastructure Construction Schedule shall include but not be limited to timelines for all green stormwater infrastructure materials:

1. Procurement of Material including lead times for all green stormwater infrastructure materials to be used onsite;

2. Installation of GSI Components;

3. Bypass/Diversion of Stormwater Runoff;

4. Green Stormwater Infrastructure Establishment, per Section 02957 Green Stormwater Infrastructure Establishment;

5. Site Stabilization Activities

C. STORMWATER RUNOFF MANAGEMENT PLAN: Shall include a markup to a Drawing(s) with appropriate existing and proposed topographic information with notes to fully illustrate drainage patterns on the Site, and the impact of drainage patterns on the green stormwater infrastructure installation and establishment. Stormwater Runoff Management Plan shall be integrated with control and protection requirements as specified by Section 02938 Green Stormwater Infrastructure Control and Protection to manage stormwater runoff within the Site. Stormwater runoff shall not be allowed to discharge into a green stormwater infrastructure facility until authorized by the [Design Professional][Owner]. Unless approved by the Owner, green stormwater infrastructure shall not be used for collection or conveyance of stormwater during construction. Contractor shall provide means and methods to control stormwater and protect green stormwater infrastructure through the Establishment Period, including installation, inspection, and maintenance. Stormwater Runoff Management Plan shall include but not be limited to the following:

1. Delineation of Green Stormwater Infrastructure Boundaries including all green stormwater infrastructure components;

2. Site Drainage Patterns of stormwater runoff within the Site extents including means and methods to divert stormwater runoff away from green stormwater infrastructure extents;

3. Control of Stormwater Runoff as defined in Section 02938 Green Stormwater Infrastructure Control and Protection;

4. Protection of Green Stormwater Infrastructure as defined in Section 02938 Green Stormwater Infrastructure Control and Protection.

D. SITE ACCESS AND UTILIZATION PLAN: Shall include a markup to a Drawing(s) with appropriate existing and proposed topographic information to fully illustrate access routes and storage locations to limit Site compaction and sedimentation to retain the integrity of the green stormwater infrastructure facility. The Contractor shall coordinate with all trades to prevent vehicle travel across green stormwater infrastructure footprint, as defined in the Drawing(s) and/or within green stormwater infrastructure components. Site Access and Utilization Plan shall include but not be limited to the following:

1. Project Phasing identified graphically with the intent of protecting the green stormwater infrastructure;

2. Delineation of Green Stormwater Infrastructure Protection Boundaries per Section 02938 Green Stormwater Infrastructure Control and Protection;

3. Delineation of Tree Protection Zones including tree protection methods, addressing construction access within tree protection zones per Section 02949 Green Stormwater Infrastructure Existing Tree Protection;

4. Anticipated Site Traffic Patterns including Site access, haul roads, delivery of materials and any temporary facilities

5. Anticipated Compaction Areas and Contractor's plans for decompaction and/or removal and replacement of any soils not planned for excavation;

6. Maintenance of Utilities on Site during Work, including but not limited to, flow in sewers and water courses;

7. Identification of Storage Areas for material and fuel storage, laydown/equipment staging, material stockpiling, and temporary facility areas;

8. Material Schedule of how stored materials will be protected, including maximum permissible storage durations, and a description of how materials will be disposed of, if applicable;

9. Description of the Equipment and Methods used to for excavation and placement with respective materials within the limits of the green stormwater infrastructure, in a manner that does not put the function of the green stormwater infrastructure facility at risk per Section 02939 Green Stormwater Infrastructure Earthwork.

****

NOTE: Design Professional to insert GSI Maintenance Schedule form from GSI Site Activity Plan Excel template as an attachment to this specification section.

****

E. GREEN STORMWATER INFRASTRUCTURE MAINTENANCE PLAN: Shall include specific maintenance activities by green stormwater infrastructure component to be performed by the Contractor during the Establishment Period. Maintenance Plan shall include Contractor proposed frequency of activities[identified on the attached Green Stormwater Infrastructure Maintenance Form] to meet service level standards defined in Section 02957 Green Stormwater Infrastructure Establishment. Frequencies may include weekly, bi-weekly, monthly, quarterly, semi-annual, and annual maintenance activities, subject to approval by the [Design Professional][Owner]. The Contractor shall submit updated tasks and associated frequencies to meet Section 02957 Green Stormwater Infrastructure Establishment Part 3.06 as part of SITE ACTIVITY PLAN UPDATES for approval by [Design Professional][Owner]. Contractor shall use a standard template provided by Owner for Green Stormwater Infrastructure Maintenance Plan including but not limited to the following items:

1. Maintenance Activities proposed and associated frequency for each activity;

2. Inspection Log will be recorded at the time of the activity and shall include the following:

   a. Project identification including project name, contract number, inspector name and contact, date and time of inspection, and weather conditions at the time of inspection;

   b. Description of Tasks completed including objective of tasks, completion status, and related notes;

c. Cumulative rainfall during the previous 24 hours and the current week and observed water level in the green stormwater infrastructure footprint;

d. General inspection notes including but not limited to observed presence of mosquito larvae, animal burrowing, soil loss, sedimentation, invasive species, dying/dead plants, or general damage to the green stormwater infrastructure facility.

3. Material Log including quantities of materials used during inspection and maintenance activities. Material utilization documentation shall be recorded at the time of the activity.

3.03 TOLERANCES

A. Not applicable.

3.04 DISPOSAL OF MATERIAL

A. All debris and excess material shall be disposed of off Site by the Contractor in a manner complying with local ordinances and antipollution laws. Waste shall not be buried on the Site or disposed of into storm drains, sanitary sewers, streams or waterways.

B. Materials may be temporarily stockpiled in an area within the limits of construction that do not disrupt construction activities, create any nuisances or safety hazards, or otherwise restrict access to the Site.

C. Waste materials shall not be stored in areas designated for green stormwater infrastructure.

D. Burning of waste materials shall not be allowed within the Site extents unless Contractor obtains a permit for open burning of trade wastes from the appropriate regulating agency. Burning shall not be permitted within green stormwater infrastructure extents or tree protection zones.

3.05 PROTECTION

A. Protection of green stormwater infrastructure facility per Section 02938 Green Stormwater Infrastructure Control and Protection shall be included by Contractor in the Site Activity Plan, through all phases of construction and during the Establishment Period.

B. Areas serviced and/or maintained shall be promptly cleaned up on the same working day as Work is performed to a suitable condition. All equipment or tools used in the performance of this Work shall be removed from the location and any spillage swept and removed from the area the same working day as Work is performed.

C. Protect landscape from damage. Maintain protection during the Work and to meet requirements of Section 02957 Green Stormwater Infrastructure Establishment. Landscape damaged during construction shall be treated, repaired, or replaced within 48 hours by Contractor, weather and planting season permitting and as approved by [Design Professional][Owner].

3.06 MAINTENANCE

A. SITE ACTIVITY PLAN UPDATES shall be submitted with each Application for Payment at not more than [30-day][Design Professional to enter desired time period] intervals through Establishment Period. Updates to the Site Activity Plan should reflect any changes to the [schedule,]stormwater runoff management plan, Site access and utilization plan[, or maintenance plans] provided in previous Site Activity Plan submittals.

B. Maintenance of Site Activity Plan shall be the responsibility of the Contractor until Certificate of [Substantial Completion][Achievement of Full Operation], as defined in Section[Designer to input specification number where project Substantial Completion or Achievement of Full Operation is defined].

C. Green stormwater infrastructure facility shall be maintained per Part 3.02, E. through the duration of the Establishment Period.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall be responsible for maintaining record copies of all material verification forms such as load tickets, invoices, sales receipts, and/or similar items to verify type and quantity of material delivered to the Site. The Owner reserves the right to request verification of any material delivered to the Site throughout the duration of the Establishment Period.

-- End of Section --

GREEN STORMWATER INFRASTRUCTURE
SITE COMPONENTS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI SITES	
GSI Site Name	**GSI Type**

GSI COMPONENTS	
☐	GSI-1 Inlets
☐	GSI-2 Energy Dissipation & Pollutant Removal
☐	GSI-3 Above Grade Barriers
☐	GSI-4 Permeable Pavements
☐	GSI-5 Soil & Aggregate Media
☐	GSI-6 Media Liners
☐	GSI-7 Landscaping
☐	GSI-8 Piping
☐	GSI-9 Outlets
☐	GSI-10 Storage Chambers
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GREEN STORMWATER INFRASTRUCTURE
CONSTRUCTION SCHEDULE

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes

GREEN STORMWATER INFRASTRUCTURE
CONSTRUCTION SCHEDULE

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI Component	Required Tasks	Frequency	Time of Year	Responsible Party	GSI Sites Included	Required

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Frequency	Time of Year	Responsible Party	GSI Sites Included	Required

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Recommended Frequency
GSI-1 Inlets	Inspect for standing water, sediment, debris, trash, blockages, and structural integrity	Bi-Weekly
	Remove sediment, debris, trash, blockages	Bi-Weekly
	Repair damage	As Needed
GSI-2 Energy Dissipation & Pollutant Removal	Inspect integrity and record debris depth	Bi-Weekly
	Remove sediment, debris, and trash	Bi-weekly
	Repair erosion or other damage	As Needed
GSI-3 Above Grade Barriers	Inspect structural integrity	Annually
	Repair structural, erosion or other damage	As Needed
GSI-4 Permeable Pavements	Inspect for sediment, trash, debris, blockages, clogging, and check condition	Quarterly
	Remove surface sediment, debris and trash	Monthly
	Remove weeds	Quarterly
	Remove stains and other markings	Quarterly
	Vacuum with walk-behind unit	Semi-annually
	Deep clean with vacuum and pressure wash combination	As Needed
	Repair damage	As Needed
	Dress paver joints with aggregate	As Needed
GSI-5 Soil & Aggregate Media	Inspect 48-hours after 3-inches of rainfall in 24 hour period and record standing water depth	Annually
	Inspect during or immediately following rain event for trash, debris, flow blockages, erosion paths, and sedimentation	Seasonally
	Remove sediment, debris, and trash	Bi-weekly
	Replace settled or excavated materials, repair erosion/damage	Quarterly
GSI-7 Landscaping	Inspect for vegetation health, bare spots, weeds, overgrowth, unkept edges, and mulch coverage	Weekly
	Apply pre-emergent herbicide	Quarterly
	Remove weeds	Monthly
	Manage disease and pests	Monthly
	Remove algae and other aquatic weeds	Annually
	Maintain clean landscape edges, prune plants	Weekly
	Mow perimeter	Weekly
	Mow turf grass areas	Weekly
	Water vegetated areas	As Needed
	Remove dead plants	Semi-annually
	Install new plants	As Needed
	Refresh mulch	Semi-annually

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Recommended Frequency
GSI-8 Piping	Inspect for standing water, structural integrity, secure access points, record debris depth	Bi-Weekly
	Remove sediment, debris, trash, blockages	Monthly
	Repair damage	As Needed
GSI-9 Outlets	Inspect for sediment, trash, debris, blockages, structural integrity, and outlet control mechanism	Bi-Weekly
	Clear flow paths and remove sediment, trash, debris, and blockages	Monthly
	Repair damage	As Needed
GSI-10 Storage Chambers	Inspect for standing water, sediment, debris, trash, blockages, secure access points, structural integrity, outlet control	Monthly
	Remove sediment, debris, trash and blockages	Monthly
	Deep clean with jet wash and vacuum combination	Annually
	Repair damage	As Needed

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02939	GSI Earthwork	*Landscaping/ GSI experience, within previous 3 years*		1					
				2					
				3					
02942	GSI Above Grade Barriers	*ACI Certified Flatwork Finisher and Technician*		Attach list of ACI certified flatwork finisher and technican personnel dedicated to project.					
02942	GSI Above Grade Barriers	*5 years experience with type of above grade barrier specified*		1					
				2					
				3					
02943	GSI Pervious Concrete	*3 years recent pervious concrete experience; CPG or NRMCA credentials*		1					
				2					
				3					
				Attach list of CPG and/or NRMCA certified personnel dedicated to project.					
02944	GSI Porous Asphalt	*3 years recent porous asphalt experience*		1					
				2					
				3					
02945	GSI Permeable Pavers	*3 years recent permeable paver experience*		1					
				2					
				3					

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02946	GSI Aggregate Media	*3 years GSI installation experience*		1					
				2					
				3					
02947	GSI Growing Media & Soil Amendments	*5 years landscaping/GSI installation experience*		1					
				2					
				3					
02949	GSI Existing Tree Protection	*Experienced tree service firm; certified Arborist*		1					
				2					
				3					
				Attach list of certified arborist personnel dedicated to project.					
02950	GSI Selective Vegetation Removal	*Horticulturist; landscape removal experience; Experienced tree service firm*		1					
				2					
				3					
				Attach list of certified horticulturist personnel dedicated to project.					
02951	GSI Plants	*5 years landscaping/GSI experience*		1					
				2					
				3					
02952	GSI Native Grass and Wildflower Seeding	*5 years recent native seed install/ establishment experience; B.S. in related field*		1					
				2					
				3					
				Attach list of field supervisor personnel dedicated to the project with B.S. degree in Horticulture, Botany, Soil Physics, Agronomy, General Agriculture, Agricultural or Biological Engineering, or related field.					
02953	GSI Non-Native Seeding and Sodding	*Seeding/sodding experience*		1					
				2					
				3					

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02956	GSI In-Situ Infiltration Testing	*Infiltration testing experience*		1					
				2					
				3					
				1					
				2					
				3					
				1					
				2					
				3					
				1					
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GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
				1					
				2					
				3					
				1					
				2					
				3					
				1					
				2					
				3					
				1					
				2					
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				3					
				1					
				2					
				3					
				1					
				2					
				3					

GREEN STORMWATER INFRASTRUCTURE
MAINTENANCE ACTIVITIES

Project Title: _____

Project Number: _____

Contractor: _____

DATE OF ACTIVITY:		**APPEARANCE RATING**	Before:	
GSI SITE:			After:	
		FUNCTION RATING	Before:	
INSPECTOR:			After:	
			HOURS:	

GSI Component	Required Tasks	Frequency	Task Completed?	Notes + How will frequency be updated, if needed?

GREEN STORMWATER INFRASTRUCTURE
MAINTENANCE ACTIVITIES

GSI Component	Required Tasks	Frequency	Task Completed?	Notes + How will frequency be updated, if needed?

****

02938

GSI SPECIFICATIONS

****

SECTION 02938

GREEN STORMWATER INFRASTRUCTURE CONTROL AND PROTECTION

****

NOTE: Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 XXX for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02938 Green Stormwater Infrastructure Control and Protection is to provide control of stormwater collection, conveyance, and runoff to green stormwater infrastructure installations within the Site, and to protect the green stormwater infrastructure during construction and through the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment.

B. This section shall work in conjunction with the Stormwater Runoff Management Plan, as described in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

C. This section does not replace Owner or Contractor erosion and sediment control regulatory responsibilities. [Green stormwater infrastructure for protection shall be identified graphically in the Drawings.]

D. Definitions

1. Control of Stormwater Runoff: Measures, means, and methods of collection and conveyance of stormwater.

2. Protection of Green Stormwater Infrastructure: Measures, means, and methods of preserving the condition, stormwater management capabilities, and general landscape health of green stormwater infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of green stormwater infrastructure control and protection shall be subsidiary to Work being performed.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner][Design Professional][Owner].

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	(2017) Division II Construction and Material Specification, Erosion and Sediment Control

1.05 SUBMITTALS

A. Not applicable.

1.06 QUALITY ASSURANCE

A. Not applicable.

1.07 QUALITY CONTROL

A. Temporary Control of Stormwater Runoff measures and temporary Protection of Green Stormwater Infrastructure means and methods shall be evaluated by the Contractor with Site Activity Plan updates, as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan, through the duration of the Establishment Period.

B. Control and Protection measures evaluation and updates shall be recorded as follows for the specified periods:

1. Stormwater Runoff Management Plan from the Notice to Proceed until Certificate of [Substantial Completion][Achievement of Full Operation] is issued.

2. Green Stormwater Infrastructure Maintenance Plan from Certificate of [Substantial Completion][Achievement of Full Operation] through the Establishment Period.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Delivery, storage, and handling of materials associated with temporary Control of Stormwater Runoff and temporary Protection of Green Stormwater Infrastructure shall meet the requirements of APWA 2150, or as identified in the Drawings.

B. Manufactured products shall be delivered, stored and handled per the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials used for temporary Control of Stormwater Runoff and temporary Protection of Green Stormwater Infrastructure shall meet the requirements of APWA 2150, or as identified in the Drawings. The Contractor may propose alternative materials, provided that such methods provide equal or improved measures of Control as determined by [Design Professional][Owner].

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to Work, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area.

B. Contractor shall submit a description of measures for Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure proposed for all green stormwater infrastructure components, as identified in the Runoff Management Plan as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.02 INSTALLATION

A. Contractor shall provide all specific temporary Control of Stormwater Runoff measures and temporary Protection of Green Stormwater Infrastructure, means and methods as defined by the Site Activity Plan.

B. Control and protection shall be installed prior to Work performed upstream of any green stormwater infrastructure component per the schedule and sequencing identified in the Site Activity Plan

C. Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure shall include the following minimum methods for applicable green stormwater infrastructure components:

1. Flow control at green stormwater infrastructure inlets including protection of entire boundary for facilities accepting overland flow;

2. Flow control at green stormwater infrastructure outlets;

3. Sediment, debris and dust control within the green stormwater infrastructure.

3.03 TOLERANCES

A. Not applicable.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Not applicable.

3.06 MAINTENANCE

A. The Contractor shall maintain temporary Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure until the entire upstream area is fully stabilized.

B. The Contractor shall be responsible for removing, replacing, and cleaning of control and protection measures throughout the duration of Work to maintain control and protection of the green stormwater infrastructure facility. Contractor shall inspect and repair control and protection measures and remove sediment after each storm event. Removed sediment shall not be deposited to an area that will contribute sediment to the GSI. Removed sediment shall be disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

C. Excessive damage or lack of Control of Stormwater Runoff and/or Protection of Green Stormwater Infrastructure will result in not meeting required service level of performance per Section 02957 Green Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

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02939

GSI SPECIFICATIONS

****

SECTION 02939

GREEN STORMWATER INFRASTRUCTURE EARTHWORK

****

NOTE: This guide specification includes requirements for earthwork for green stormwater infrastructure components of the project. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 XXX for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02939 Green Stormwater Infrastructure Earthwork is to provide Site preparation, excavation and grading requirements for green stormwater infrastructure infiltration practices that require limited compaction of subgrade.

B. Earthwork for green stormwater infrastructure requiring compaction and areas outside of designated green stormwater infrastructure shall be in accordance with the APWA 2100, or as specified in the Drawings.

C. Definitions

1. Backfill: Placing of approved material in the green stormwater infrastructure facility area(s) to the lines and grades as shown in the Drawings.

2. Clearing: Cutting and disposal of trees, brush, and all other vegetation or combustible material found on or above the existing ground surface inside the limits of disturbance of the green stormwater infrastructure.

3. Excavation: Removal of materials from the construction area to the lines and grades shown in the Drawings. Excavation shall include all materials regardless of nature unless otherwise specified in the Drawings.

4. Finished Grade: Elevation of finished surface of soil media per Sections 02946 Green Stormwater Infrastructure Aggregate Media and/or 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

5. Grubbing: Removal and disposal of all tree stumps and roots within the limits of disturbance of the green stormwater infrastructure.

6. Subgrade: Surface or elevation of subsoil remaining after completing excavation.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material and equipment required for green stormwater infrastructure earthwork, depicted in the Drawings and specified herein. Earthwork shall be measured in the units of [Cubic Yards][Each] and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

[02949 Green Stormwater Infrastructure Existing Tree Protection]

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment Period

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2100	(2017, Revised 2019) Division II Construction and Material Specifications, Grading and Site Preparation

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

EXISTING GRADE SURVEY VERIFICATION

SITE INSPECTION

SD-06 Test Reports

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

SD-07 Certificates

COMPLETION OF EXCAVATION

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer whose work has resulted in the successful installation of green stormwater infrastructure facilities and establishment of plant life within the last three (3) years, with employees skilled in the landscape trade, and specifically skilled in green stormwater infrastructure.

1.07 QUALITY CONTROL

A. The Contractor shall notify the [Design Professional][Owner] within 48 hours of completion of excavation and prior to placement of all media, as specified in Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

B. Prior to procurement of material and delivery to the Site, the Contractor shall submit all required material to the testing agency and submit required testing results showing material is in conformance with the Contract Documents, as specified in Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. All materials shall be handled and stored in accordance with the respective specification sections.

C. Construction equipment and materials shall not be stored within the footprint of the green stormwater infrastructure facility at any time.

D. The Contractor shall field mark all excavation areas designated for green stormwater infrastructure prior to commencement of Work.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. The Contractor shall submit a description of equipment/methods used for excavation and placement of green stormwater infrastructure materials prior to the commencement of Work per Section 02937 Green Stormwater Infrastructure Site Activity Plan. The Contractor shall be solely responsible for determining the means and methods for meeting the requirements of excavation and placement of materials with the following conditions:

1. The Contractor shall use equipment and methods that minimize compaction of both the base of the green stormwater infrastructure facility as well as the installed materials unless otherwise specified in the Drawings.

2. Low ground-contact pressure equipment shall be used on green stormwater infrastructure facilities to minimize disturbance to established areas adjacent to perimeter of green stormwater infrastructure facility. No heavy equipment shall be used within the perimeter of the green stormwater infrastructure facility before, during, or after excavation and installation of materials, unless otherwise specified by [Design Professional][Owner].

3. Contractor shall abide by all compaction requirements as specified in the Drawings. Contractor shall not use equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high-pressure tires within the limits of the green stormwater infrastructure, unless otherwise specified by the [Design Professional][Owner].

4. Decompaction of the base of the green stormwater infrastructure facility can be completed by using a primary tilling operation of chisel plow, ripper, or sub-spoiler. Additional refracture methods may be substituted at the discretion of the [Design Professional][Owner].

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all green stormwater infrastructure locations and elevations. The contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. EXISTING GRADE SURVEY VERIFICATION; Notify the [Design Professional][Owner] if surveyed stake elevations vary from existing grade identified in the Drawings where proposed grade of green stormwater infrastructure facility ties into the existing grade. Surveyed stake elevations shall be taken at specific point locations identified in the Drawings.

B. Existing Utilities

1. The Contractor shall be responsible for protecting all existing items, utilities and/or structures above and below ground.

2. The Contractor shall contact utility owners and/or make exploratory excavations as necessary to determine the exact location of underground utilities and structures and the limits and character of soil and/or rock prior to construction.

3. If any items require relocation or replacement, the Contractor shall notify the utility or property owner in advance of the Work. The Contractor shall be responsible for all arrangements with the utility and/or property owner for relocation or replacement of the item.

C. Project Conditions

1. Green stormwater infrastructure earthwork shall not be conducted when the ambient temperature and/or ground temperature is less than or equal to 32 degrees Fahrenheit or in the presence of standing water for a minimum of three (3) days prior to installation, except by permission of the [Design Professional][Owner]. No material shall be installed on frozen surfaces, nor shall frozen material be placed in green stormwater infrastructure facilities.

2. Excavation permits shall be secured prior to any Work. In all instances, the Contractor agrees to perform all Work in accordance with the permit and to indemnify and hold harmless the Owner from all liability, judgments, costs, expenses and claims growing out of damages or alleged damages, of any nature to any person or property arising out of performance or non-performance of said Work or the existence of facilities and/or appurtenances thereof.

3. SITE INSPECTION: Prior to commencement of Work and delivery of materials, the Contractor and [Design Professional][Owner] shall conduct an inspection of the Site to verify the following is in accordance with Section 02937 Green Stormwater Infrastructure Site Activity Plan:

   a. Delineation of boundaries of green stormwater infrastructure excavation extents.

   b. Delineation for protection of existing trees and other vegetation per Section 02949 Green Stormwater Infrastructure Existing Tree Protection.

   c. Location for stockpiling all soil and aggregated materials and equipment and methods of protection.

   d. Location of erosion control measures.

4. The Contractor shall have acceptance on all fill materials and/or media per Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments to be used in the green stormwater infrastructure prior to commencement of excavation.

D. Control and Protection: Prior to earthwork activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per

Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Clearing and Grubbing

1. Contractor shall perform all clearing and grubbing within the limits of construction as required to complete the Work.

2. Clear and grub to a minimum depth of 18 inches within the footprint of green stormwater infrastructure facility.

3. Trees not specifically marked for removal shall be protected per Section 02949 Green Stormwater Infrastructure Existing Tree Protection.

B. Excavation

1. Excavation of green stormwater infrastructure facility shall be protected from heavy equipment that would result in compaction of soils within the footprint.

2. Excavation shall be to the dimensions, side slopes, elevations, and cross sections specified in the Drawings, as follows:

a. Contractor shall furnish, install and maintain such sheeting, bracing and other components as may be required to support any excavation per APWA 2100, Part 2102.3.

b. Excavation within one (1) foot of finished grade shall not be permitted if the soil is frozen or has been subjected to greater than 0.25 inches of precipitation in the previous 48 hours.

c. The Contractor shall provide dewatering equipment to remove and dispose of all surface water and groundwater entering excavations. Surface water shall be diverted or otherwise prevented from entering excavations, without causing damage to adjacent property.

d. The bottom of the excavation shall be mechanically scarified to a minimum depth of six (6) inches to alleviate any compaction of the facility bottom. Any ponded water shall be removed from the bottom of the facility and the soil shall be friable before mechanical scarification. Mechanical scarification shall not be done along piping alignment(s) and/or in locations where the soil supports the pipe aggregate material.

e. Any sediment deposited within the excavation extents shall be fully removed from the green stormwater infrastructure facility prior to placement of soil and/or aggregate media, per Sections 02946 Green Stormwater Infrastructure

Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

f. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of soil and/or aggregate materials. Submit PRE-CONSTRUCTION INFILTRATION TEST RESULTS.

3. Excavation Protection

a. Excavations shall be restored to the level of the adjacent surfaces as soon as practicable. Contractor shall provide effective protection to the public from any open excavation.

b. Excavations in roadways shall be protected and secured in accordance with existing federal, state and local codes and standards, including, but not limited to, the most current edition of the FHWA MUTCD.

c. A protective cover over an excavation shall be installed so that it can sustain the weight of any persons and/or objects placed upon it. The cover shall be fixed to the ground, so it cannot be moved. Protective covers shall have no opening(s) or protuberance(s) of sufficient size to cause a fall and/or injury. Advance warning devices shall be installed as necessary.

d. Any excavation that is not covered shall be fenced in so that it surrounds the entire excavation area and prevents entry. The fencing shall be a minimum of 42 inches in height. The fence shall be secured and upright at all times.

e. Protective excavation coverings and fences shall be inspected by the Contractor at least daily to assure integrity. Protective excavation coverings and fences in heavy traffic areas shall be inspected more often as necessary.

4. COMPLETION OF EXCAVATION; Notify the [Design Professional][Owner]within 48 hours of completion of excavation and prior to placement of all media as defined in Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

C. Subgrade Preparation

1. Clean subgrade and dispose of all debris prior to placement of aggregate or soil media. Remove all large clods, lumps, brush, roots, stumps, litter, trash, and other foreign material three (3) inches in diameter or larger.

2. Verify finished depth of facility and grade of surrounding area with Drawings and are within tolerances specified in Part 3.03.

3. Do not compact subgrade under green stormwater infrastructure facility unless specifically required per the Drawings.

D. Filling and Backfilling

1. Backfill material shall not be placed until PRE-CONSTRUCTION INFILTRATION TEST RESULTS have been accepted.

2. Green stormwater infrastructure facility shall be filled to the dimensions, side slopes, elevations, and cross sections specified in the Drawings.

3. Soil and Aggregate Backfill: Fill and backfill materials shall be placed in lifts to suit the lines and grades required, making allowances for settlement and placement of cover materials as specified in Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

4. Pipe and Structure Aggregate

   a. Aggregate shall be placed to the depth and extents shown in the Drawings.

   b. Place aggregate using methods that will not disturb or damage the piping material or the surrounding green stormwater infrastructure facility.

   c. Spread aggregate to provide uniform and continuous support beneath pipe or structures. Backfill around the pipe or structure uniformly in maximum six (6) inch lifts.

   d. Where required for stability, compaction shall be achieved using small, hand-held or walk behind compactors.

E. Fine Grading

1. Fine grading shall be performed immediately prior to planting operations.

2. Grading shall provide positive drainage to the green stormwater infrastructure facility and/or outlet structure within the facility, unless otherwise specified in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place materials based on the lines and grades specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

3. Vertical Tolerance: 0.1 feet

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

[B. Vegetation shall be installed immediately following installation of soil media per [Section 02951 Green Stormwater Infrastructure Plants][or][, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding][, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]. If Site conditions limit vegetation of facility immediately following installation of soil media, Contractor shall implement additional measures to cover and protect the green stormwater infrastructure facility for duration of exposure.]

C. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain green stormwater infrastructure facility through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. The Contractor shall be responsible for maintaining finished grade of materials within the tolerances defined in Part 3.03 for the duration of the Establishment Period. The Contractor shall make all repairs or replacements necessary to correct changes in finished grade within [30 days][Design Professional to enter desired time period] of notice from the Owner.

3.07 POST-CONSTRUCTION TESTING

A. Contractor shall verify that finished grade elevations of the facility surface, side slopes, and surrounding area are within tolerances defined in Part 3.03.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

****

02940

GSI SPECIFICATIONS

****

SECTION 02940

GREEN STORMWATER INFRASTRUCTURE INLETS

****

NOTE: This guide specification includes requirements for inlets including infiltration inlets, curb cuts, trench drains, or manufactured inlet products. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. An inlet is the collection point of stormwater. An inlet typically collects stormwater runoff and discharges this runoff either to the surface or below the surface of the green stormwater infrastructure facility. An inlet can range from simple openings in the curb line, to manufactured stormwater structures, to traditional inlet boxes.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the green stormwater infrastructure inlets as shown in the Drawings and as specified herein. Green Stormwater Infrastructure Inlets shall be measured in the units of Each and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

****
NOTE: Specification 02942 is only needed if curb cut inlet is used.
****

[02942 Green Stormwater Infrastructure Above Grade Barriers]

02946 Green Stormwater Infrastructure Aggregate Media

****
NOTE: Specifications 02947 and 02948 are only needed if infiltration inlet is used.
****

[02947 Green Stormwater Infrastructure Growing Media and Soil Amendments]

[02948 Green Stormwater Infrastructure Media Liners]

****
NOTE: Specification 02954 is only needed if infiltration inlet is used.
****

[02954 Green Stormwater Infrastructure Piping]

****
NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.
****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner][Design Professional][Owner].

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFD	AAHSHTO Load-Resistance-Factor Design Bridge Design Standards

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	(2017) Division II Construction and Material Specifications, Paving - Portland Cement Concrete Pavement
APWA 2604	(2017, Revised 2020) Division II Construction and Material Specifications, Storm Sewers - Structures

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-03 Product Data

MANUFACTURER INFORMATION

SHOP DRAWINGS

SD-06 Test Reports

GRADATION TEST RESULTS

SD-07 Certificates

CONCRETE MIX DESIGN

1.06 QUALITY ASSURANCE

[A. Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[B. Installer Qualifications: Design Professional to insert additional manufacturer/installer qualifications as applicable.]

[C. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

2. Personnel performing tests shall be ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency laboratory supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

3. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50 cubic yards of concrete placed and shall conform to the requirements of APWA 2208.]

C. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner][Design Professional][Owner]. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the [Design Professional][Owner][Design Professional][Owner], or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Materials shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[C. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 INFILTRATION INLET

A. Media Liner: Shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

B. Perforated Underdrain: Shall be the type specified in the Drawings and meet the requirements specified in Section 02954 Green Stormwater Infrastructure Piping.

C. Cleanout: Shall be the type specified in the Drawings and meet the requirements specified in Section 02954 Green Stormwater Infrastructure Piping.

D. Storage Aggregate Media: Shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.

E. Choker Course: Shall be the type specified in the drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.

F. Growing Media: Shall be the type specified in the Drawings and meet the requirements specified in Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

G. Topsoil: Shall meet the requirements specified in Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

H. Precast Inlet: Shall be the type specified in the Drawings and shall conform to APWA 2604.

I. Overflow Weir: Shall consist of a 24-inch solid wall HDPE pipe per Section 02954 Green Stormwater Infrastructure Piping, cut in half so that the cross-sectional shape is a semi-circle. Length of piping for overflow weir shall be equal to the specified depth of the weir per the Drawings. Stainless steel straps one-eighth (1/8) inch thick by two (2) inch wide shall be used at the top of HDPE pipe to anchor weir to precast inlet. Anchor with one-half (1/2) inch diameter by three (3) inch stainless steel adhesive anchors with HILTI HIT-RE500 epoxy or approved equal.]

[2.02 CURB CUT

A. Curb cuts shall be cast-in-place openings of new curb.

B. Concrete and reinforcement used with curb cuts shall meet the requirements for curbs specified in Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[2.03 TRENCH DRAIN

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

[A. Trench Drain shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer and product information] or approved equal.]

B. Trench drain shall be H-20 wheel rated per AASHTO LRFD Bridge Design Specifications. Grate material shall be [ductile iron][gray iron][stainless steel].

****

NOTE: 4,000 psi concrete is typical, but designer can specify different and/or requirements such as air entrainment, slump, mix design, (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

[C. Concrete Trench: Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal. Contractor shall submit CONCRETE MIX DESIGN prior to procurement of material including certification that mix design meets the requirements of the specified mix.

D. Reinforcement: Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M.

E. Aggregate Base: Concrete base shall have an underlying aggregate base, which shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media. Contractor shall submit GRADATION TEST RESULTS of aggregate base prior to procurement of material.]]

[2.04 MANUFACTURED INLET

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

[A. Manufactured Inlet shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer and product information] or approved equal.]

B. MANUFACTURER INFORMATION; Submit manufacturer information for product data and instruction for each product, including but not limited to structure type, size, material, effective open area, fabrication, delivery and handling, placement, installation, protection, and product warranty documentation.

[C. SHOP DRAWINGS; Submit shop drawings with a minimum of the following information, if applicable:

1. Suppler name, address and phone;

2. Structure dimensions (exterior and interior) including open area for inlet capacity;

3. Pipe connections and sizes;

4. Flow lines/flow directions.]

****

NOTE: 4,000 psi concrete is typical, but designer can specify different and/or requirements such as air entrainment, slump, mix design, (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

[D. Concrete Base: Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal. Contractor shall submit CONCRETE MIX DESIGN prior to procurement of material including certification that mix design meets the requirements of the specified mix. Concrete base shall have an underlying aggregate base.]

E. Aggregate Base: Aggregate base shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media. Contractor shall submit GRADATION TEST RESULTS of aggregate base prior to procurement of material.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

[B. Project Conditions

1. The [Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R][Design Professional to specify alternative project condition requirements].]

C. Control and Protection

1. Prior to installation of in green stormwater infrastructure inlets, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to connecting inlets to downstream drainage systems, temporary erosion control measures shall be in place.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation

1. Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork.

2. Excavation shall extend to a depth such that the specified invert elevation and top of structure elevation, once fully installed, is located at the elevation shown in the Drawings. If an invert elevation or top of structure elevation is not specified, the Contractor is to consult the [Design Professional][Owner][Design Professional][Owner] to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the structure at the grades shown.

[B. Infiltration Inlet

1. Media Liner: Shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

2. Perforated Underdrain: Shall be installed per Section 02954 Green Stormwater Infrastructure Piping.

3. Cleanout: Shall be installed per Section 02954 Green Stormwater Infrastructure Piping.

4. Storage Aggregate Media: Shall be installed per Section 02946 Green Stormwater Infrastructure Aggregate Media.

5. Choker Course: Shall be installed per Section 02946 Green Stormwater Infrastructure Aggregate Media.

6. Growing Media: Shall be installed per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

7. Topsoil: Shall be installed per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

8. Precast Inlet: Structure shall be per APWA 2604.

9. Overflow Weir: Shall be affixed to the wall of the precast structure using stainless steel straps and adhesive anchors so that the top elevation of the overflow weir matches the elevation of the crown of the perforated underdrain pipe.]

[C. Curb Cut

1. Curb cuts shall be cast-in-place, installed as concrete curb per Section 02942 Green Stormwater Infrastructure Above Grade Barriers with opening dimensions as specified in the Drawings.

2. If modifying an existing curb line, the existing curb shall be removed to the nearest contraction or expansion (isolation) joint and the curb cut shall be cast-in-place with a throat and directional veins to divert flows through the curb cut as opposed to running parallel with the curb line.

3. Concrete shall be poured such that the finished grade of the inlet is flush with the adjacent pavement and shall have positive drainage toward the green stormwater infrastructure facility, as specified in the Drawings.]

[D. Trench drain shall be installed per manufactuerer's requirements.]

[E. Manufactured Inlet

[1. Concrete Base, Aggregate Base and Anchoring

a. Unless otherwise specified by the manufacturer/[Design Professional][Owner][Design Professional][Owner], all manufactured inlets require a concrete base and aggregate base for stability.

b. Aggregate base shall be placed to the depth and extents shown in the Drawings/recommended by the manufacturer. Place aggregate using methods that will not disturb or damage the structure itself or the surrounding piping/green stormwater infrastructure facility.

c. Compaction shall be achieved using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.

d. Concrete base size and thickness shall be as specified in the Drawings/by manufacturer. Concrete base shall be constructed per APWA 2208, Part 2208.4. Concrete must be cured seven (7) days prior to placement of inlet.]

[2. Manufactured Inlet Structure Placement

a. Place manufactured inlet on concrete base and level vertically. Verify critical elevations, including but not limited to top of structure, inverts in/out and [overflow][weir] elevations.]]

F. Backfill

1. Prior to backfilling, cover inlet opening(s) to protect from material deposition inside the structure during placement. Provide protection of inlet per Section 02938 Green Stormwater Infrastructure Control and Protection.

2. Backfill around inlet and compact uniformly in maximum six (6) inch lifts by hand using small, hand-held or walk behind compactors to prevent damage to the inlet or over-compaction of surrounding areas intended for infiltration.

3. Install soil and/or aggregate media around structure to finished grade per Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments as shown in the Drawings. All green stormwater infrastructure media shall be in[place including mulch] prior to removal of protective covering and installation of grated cover.

3.03 TOLERANCES

A. Inlet structure installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings, including but not limited to invert elevations, top of structure elevation, and [weir][overflow] elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the inlet structure until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the [Design Professional][Owner][Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain green stormwater infrastructure inlets through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the inlet. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

****

02941

GSI SPECIFICATIONS

****

SECTION 02941

GREEN STORMWATER INFRASTRUCTURE ENERGY DISSIPATION AND POLLUTANT REMOVAL

****

NOTE: This guide specification includes requirements for energy dissipation and manufactured pretreatment devices for pollutant removal. Energy dissipation includes considerations for permeable liner, aggregate bedding, aggregate or concrete base, and surface material components. For manufactured pretreatment devices, Design Professional should input manufacturer information and shall follow manufacturer requirements. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Energy dissipation is used to decrease the velocity of stormwater to prevent erosion and scouring of green stormwater infrastructure facility surface materials. Pretreatment captures sediment, trash, and debris prior to entering the green stormwater infrastructure facility.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the [energy dissipation][and][manufactured pretreatment device] as shown in the Drawings and as specified herein. [Energy dissipation][and][manufactured pretreatment device] shall be measured by [Unit Price][Lump Sum Price] as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Energy Dissipation and Pretreatment Measurement and Payment Units

Item	Unit
[Surface Stone]	[Cubic Yard][Ton]
[Surface Brick]	[Each]
[Concrete Base]	[Cubic Yard]
[Manufactured Pretreatment Device]	[Each]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

****

NOTE: Reference to Specification 02939 is only required if referenced in Section 3.02 A Excavation.

****

[02939 Green Stormwater Infrastructure Earthwork]

****

NOTE: Reference to Specification 02946 is only required if referenced in Section 2.01 C Aggregate Base.

****

[02946 Green Stormwater Infrastructure Soil and Aggregate Media]

****

NOTE: Reference to Specification 02948 is only required if referenced in Section 2.01 A Permeable Liner.

****

[02948 Green Stormwater Infrastructure Media Liners]

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C33/C33M	Standard Specification for Concrete Aggregates
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C902	Standard Specification for Pedestrian and Light Traffic Paving Brick
ASTM D5519	Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	(2017) Division II Construction and Material Specifications, Paving - Portland Cement Concrete Pavement

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INFORMATION

****

NOTE: Surface Material Samples is only to be used if 2.01 F Surface Material is specified.

****

[SURFACE MATERIAL LAYOUT]

SHOP DRAWINGS

****

NOTE: Surface Material Layout is only to be used if 2.01 F Surface Material is specified.

****

[SD-04 Samples

SURFACE MATERIAL]

[SD-07 Certificates

****

NOTE: Aggregate Bedding Media Certification is only to be used if 2.01 B Aggregate Bedding is specified.

****

[AGGREGATE BEDDING MEDIA CERTIFICATION]

****

NOTE: Aggregate Base Media Certification is only to be used if 2.01 C Aggregate Base is specified.

****

[AGGREGATE BASE MEDIA CERTIFICATION]

****

NOTE: Concrete Mix Design is only to be used if 2.01 D is specified.

****

[CONCRETE MIX DESIGN]

****

NOTE: Surface Stone Media Certification is only to be used if 2.01 F Surface Material (Stone) is specified.

****

[SURFACE STONE MEDIA CERTIFICATION]]

1.06 QUALITY ASSURANCE

****

NOTE: Stone/brick manufacturer and manufactured pretreatment device qualifications are only applicable if those respective components are used.

****

[A. Manufacturer Qualifications

[1. A qualified manufacturer or supplier of specified [stone][brick] units similar to those specified in the Drawings with adequate production capacity to manufacture required units.]

[2. A qualified manufacturer or supplier of specified manufactured pretreatment device similar to those specified in the Drawings with adequate production capacity to manufacture required units.]]

[B. Installer Qualifications

[1. Manufactured pretreatment device installation shall be completed by the manufacturer or an installer certified by the manufacturer to install the product.]

[2. Design Professional to insert additional manufacturer/installer qualifications as applicable.]]

[C. Testing Agency Qualifications: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50 cubic yards of concrete placed and shall conform to the requirements of APWA 2208, Part 2208.3.]

C. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the [Design Professional][Owner], or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[C. Manufactured pretreatment devices shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 ENERGY DISSIPATION

[A. Permeable Liner: Permeable liner shall be per Section 02948 Green Stormwater Infrastructure Media Liners.]

[B. Aggregate Bedding

1. Aggregate bedding material shall be double-washed, of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious material.

2. Aggregate bedding shall be meet the quality requirements of ASTM C33/C33M and shall be reasonably well graded within the following limits:

Aggregate Bedding Gradation Requirements

Sieve Size	Passing (Percent by Weight)
75 mm (3 inch)	100
37.5 mm (1-1/2 inch)	75 - 95
12.5 mm (1/2 inch)	40 - 60
4.75 mm (No. 4)	5 - 25

3. AGGREGATE BEDDING MEDIA CERTIFICATION; Submit gradation test results of aggregate bedding prior to procurement of material.]

[C. Aggregate Base

1. Aggregate base material shall be double-washed, of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious material.

2. Aggregate base shall be per Section 02946 Green Stormwater Infrastructure Aggregate Media.

3. AGGREGATE BASE MEDIA CERTIFICATION; Submit gradation test results of aggregate base prior to procurement of material.]

[D. Concrete Base

****

NOTE: 4,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

1. Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements.] or approved equal.

2. CONCRETE MIX DESIGN; Submit certification that concrete mix design for concrete base meets the requirements of the specified mix prior to procurement of material.]

[E. Reinforcement: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.]

[F. Surface Material

1. SURFACE MATERIAL; Submit sample surface [stone][brick] to be used for energy dissipation. Include supplier name, address and phone as well as material color, color range, and texture options for surface [stone][brick].

2. SURFACE MATERIAL LAYOUT; Submit proposed surface material layout with a minimum of the following information, if applicable:

a. Approximate dimensions of individual surface [stone][brick];

b. Approximate spacing between individual [stone][brick];

c. Approximate spacing of [stone][brick] from the edge of the of the concrete base.

[3. Surface Stone

a. Surface stone material shall be double-washed and shall be free from sand, silt, clay, excess fines, and other deleterious material.

b. Surface stone shall be of the size, material and dimensions specified in the Drawings.

c. Unless otherwise specified, surface stone shall be hard and angular or subangular with elongation no greater than 3:1 length to width ratio. Stone shall be uniformly graded with an average stone diameter as specified in the Drawings.

d. SURFACE STONE MEDIA CERTIFICATION; Submit gradation test results of surface stone prior to procurement of material.]

[4. Surface Brick

a. Surface brick material shall be Type I Class SX per ASTM C902. Material provided shall consist of a mixture of full and half size bricks, or to the dimensions specified in the Drawings.

b. Brick shall be free of cracks or other imperfections detracting from the appearance. Contractor shall submit samples of all surface brick to be used to the [Design Professional][Owner].]

[5. Mortar shall be Type S per ASTM C270 or approved equal by [Design Professional][Owner].]]]

[2.02 MANUFACTURED PRETREATMENT DEVICES

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

A. Manufactured Pretreatment Device shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer and product information.] or approved equal.

B. MANUFACTURER INFORMATION; Submit manufacturer information for product data, and instructions for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, placement, installation, protection, and product warranty documentation.

C. SHOP DRAWINGS; submit shop drawings with a minimum of the following information, if applicable:

1. Supplier name, address and phone;

2. Structure dimensions (exterior and interior);

3. Pipe connections and sizes;

4. Flow lines and flow directions.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

[B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R.]

[2. [Design Professional to specify additional project conditions, as applicable.].]]

C. Control and Protection

1. Prior to installation of [energy dissipation][and][manufactured pretreatment device], the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of [energy dissipation][and][manufactured pretreatment device].

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation

****

NOTE: Design Professional to provide details on when Section 02939 applies (e.g. when installation of energy dissipation and manufactured pretreatment device occurs within green stormwater infrastructure facility extents) if at all.

****

[1. [Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork][Design Professional to specify alternative excavation requirements, as applicable].]

2. Excavation shall extend to a depth such that the specified invert elevation and top of structure elevation, once fully installed, is located at the elevation shown in the Drawings. If an invert elevation or top of structure elevation is not specified, the Contractor is to consult the [Design Professional][Owner] to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the [energy dissipation][and][manufactured pretreatment device].

[B. Concrete Embedded Splash Pad

1. Aggregate base shall be placed to the depth and extents specified in the Drawings. Aggregate base shall extend a minimum of four (4) inches beyond the extends of the concrete base.

2. Concrete base shall be constructed per APWA 2208, Part 2208.4.

3. Surface [stone][brick] shall be placed per the SURFACE MATERIAL LAYOUT. Contractor shall notify the [Design Professional][Owner] at least 48 hours prior to placement of surface material.

[a. Surface stones shall be placed into the plastic concrete base to the specified depths and spacing per the SURFACE MATERIAL LAYOUT. After the concrete base has cured, the surface stone should not be removable.]

[b. After the concrete base has cured for seven (7) days, mortar shall be used to bind the surface brick onto the concrete base per the SURFACE MATERIAL LAYOUT. After the mortar has hardened, the surface brick should not be removable from the concrete base.]]

[C. Surface Stone Splash Pad

1. Permeable liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners prior to placement of aggregate bedding and surface stone.

2. Aggregate bedding shall be spread uniformly to depth and extents specified in the Drawings. Aggregate bedding shall be placed using methods which avoid damage to the permeable liner or subgrade.

3. Surface stone shall be placed over aggregate bedding to the depth and extents specified in the Drawings.]

[D. Manufactured Pretreatment Device

1. All manufactured pretreatment devices shall be installed per manufacturer requirements and recommendations.]

3.03 TOLERANCES

A. [Energy dissipation][and][manufactured pretreatment device] installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings, including but not limited to invert elevations and top of structure elevation elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

[C. Surface brick size shall be within one-fourth (1/4) inch of the size specified.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the [energy dissipation][and][manufactured pretreatment device] until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain [energy dissipation][and][manufactured pretreatment device] through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the [energy dissipation][and][manufactured pretreatment device]. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure energy dissipation materials through the duration of the Establishment Period.]

[D. If at any time during the Establishment Period the material becomes damaged due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the material and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.]

-- End of Section --

****

02942

GSI SPECIFICATIONS

****

SECTION 02942

GREEN STORMWATER INFRASTRUCTURE AREA PROTECTION

****

NOTE: This guide specification includes requirements for concrete curbs, fencing, bollards and stone barriers, as well as concrete footing and reflectors that may be required as part of these above grade barrier components. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements.

Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Area protection are physical or visual barriers placed at the edge of the green stormwater infrastructure to protect the facility from traffic, pedestrians, and improper maintenance activities. Area protection also increase safety for the public by providing a visual delineation between pedestrian/vehicular space and the green stormwater infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the barrier as shown in the Drawings and as specified herein. Area protection shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:.

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Above Grade Barriers Measurement and Payment Units

Item	Unit
[Concrete Curb]	[Cubic Yard][Linear Foot]
[Fencing]	[Linear Foot]
[Bollards]	[Each]
[Concrete Footing]	[Cubic Yard]
[Reflector]	[Each]
[Stone Boulder]	[Each][Ton]
[Ledgestone]	[Each][Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301 Specifications for Structural Concrete

ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI SP66	ACI Detailing Manual

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2200	(2017) Division II Construction and Material Specification, Paving

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	Standard Specification for Chroumium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
ASTM A500/A500M	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C97/C97M	Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone

ASTM C99/C99M	Standard Test Method for Modulus of Rupture of Dimension Stone
ASTM C170/C170M	Standard Test Method for Compressive Strength of Dimension Stone
ASTM C241/C241M	Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D1784	Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F2408	Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.6	Structural Welding Code - Stainless Steel

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI	American Iron and Steel Institute

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

[1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

[SD-01 Preconstruction Submittals

LOCATION NOTIFICATION]

[SD-03 Product Data

[MANUFACTURER INSTRUCTIONS]

[MANUFACTURER DATA SHEET]

[DESIGN DATA]

[SHOP DRAWINGS]

[CONCRETE STEEL REINFORCEMENT SHOP DRAWINGS]

[REFLECTOR SHOP DRAWINGS]]

[SD-04 Samples

ABOVE GRADE BARRIER VERIFICATION SAMPLES]

[SD-07 Certificates

[CONCRETE MIX DESIGN]

[STONE BARRIER MATERIAL]]]

1.06 QUALITY ASSURANCE

[A. Manufacturer Qualifications

[1. Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[2. [Fence][and][Bollard] Manufacturer: A firm engaged in the manufacture of products of types and sizes specified, and whose products have been in satisfactory use in similar service for a minimum of three (3) years.]

[3. MANUFACTURER INSTRUCTIONS; Submit manufacturer instructions for each product, including, but not limited to fabrication, delivery and handling, installation, protection, and product warranty documentation.]]

[B. Installer Qualifications

[1. Concrete Installer: ACI Certified Flatwork Finisher and Technician.]

[2. Above Grade Barrier Installer: A firm with minimum of five (5) years of successful installation experience with projects utilizing products similar in type and size to that required for this project.]]

[C. Testing Agency Qualifications

[1. Concrete Testing Agency Personnel

a. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

b. Personnel performing tests shall be ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

2. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

[3. Welding: Qualified procedures and personnel according to AWS D1.1 or AWS D1.6.]]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50-cubic yard of concrete placed and shall conform to the requirements of APWA 2200, Part 2208.3.]

C. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site at once.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the [Design Professional][Owner], or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that

the correct material was delivered and providing the Owner with appropriate documentation.

B. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[C. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 CONCRETE CURBS

****

NOTE: 4,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

A. Concrete: Concrete mix shall be [minimum 4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal for curbs unless otherwise specified in the Drawings.

B. Reinforcement: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.

[C. Curb Guard: [Shall be hot dipped galvanized structural steel per ASTM A36/A36M or AISI Type 316 stainless steel plate. Headed studs or wedge anchors shall match the material of the curb guard plate. Hot dip galvanizing shall conform to ASTM A123/A123M and stainless steel shall conform to ASTM A240/A240M. Welding shall conform to AWS D1.1 for carbon steel and AWS D1.6 for stainless steel.][Shall be Neenah R3262-4 or approved equal.]]

D. CONCRETE MIX DESIGN; Certification that concrete mix design meets the requirements of the specified mix.

E. CONCRETE STEEL REINFORCEMENT SHOP DRAWINGS; Submit steel reinforcement drawings conforming to ACI SP66 and ACI 318 including but not limited to bar schedules, erection drawings, bar details, concrete protective cover, steel grade, lap splice lengths, and supports for concrete reinforcement.]

[2.02 FENCING

A. The manufactured fence/rail system shall be capable of meeting the vertical load and infill performance requirements for commercial weight fences under ASTM F2408.

B. At a minimum, fencing material shall meet the following parameters:

[1. Metal: Fencing product shall be [Montage Plus All Terrain Flexibility (ATF) Ornamental Steel Majestic design by Ameristar Fence Products or approved equal]. Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections on finished units. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 pounds per square inch (310 megapascal) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 ounces per square foot (184 grams per square meter), Coating Designation G-60. Fencing sections and panels shall be biasable to follow site slopes.]

[2. Wood: Provide wood timber post with chamfer tops and lumber rail with metered ends to abut cleanly along front edge. All lumber shall be pressure treated for in-ground use. All fasteners shall be hot-dipped galvanized steel. All lumber shall be pressure treated and suitable for in-ground use.]

[3. Plastic: Product shall be poly vinyl chloride (PVC) formulated to resist impact and for Ultra Violet stabilization. Extruded products meet or exceeds ASTM D1784.]

4. Material and size for pickets, fence posts, gate posts, rails shall be as specified in the Drawings and details.

[C. The manufactured panels and posts shall be subjected to an inline electrode position coating process consisting of multistage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be two (2) mils. The coating shall meet performance criteria of ASTM F2408.]

D. MANUFACTURER DATA SHEET; Submit product data for manufacturer product lines assembled from standard components, including, but not limited to:

1. Supplier name, address, and phone;

2. Grout, anchoring cements and paint products;

3. Preparation instructions and recommendations;

4. Storage and handling requirements and recommendations;

5. Installation methods;

6. Available guidelines and instructions on operations and maintenance of materials installed.

[E. DESIGN DATA; For installed fences indicated to comply with certain design loadings, submit structural analysis data signed and sealed by the Professional Engineer licensed in

the state for which the work is being performed, who was responsible for their preparation.]

F. SHOP DRAWINGS; Submit shop drawings showing fabrication and installation of fence. Include colors, plans, elevations, sections, details, field conditions and attachments to other Work.

G. ABOVE GRADE BARRIER VERIFICATION SAMPLES; Submit manufacturer's color charts showing the full range of colors available for products. For each type of exposed finish required, prepared on components and of same thickness and metal indicated for the Work. If finish involves normal color and texture variations, include sample sets showing the full range of variations expected.]

[2.03 BOLLARDS

[A. Wood Bollards

[1. [Southern yellow pine][Cedar] [square][round] bollards treated with Alkaline Copper Quaternary (ACQ) at 0.40 pounds chemical retention. Surface finish shall be stained as approved by the Owner. All lumber shall be pressure treated and suitable for in-ground use. All fasteners shall be [hot-dipped galvanized steel][stainless steel].]

[2. Design Professional to specify recommended product and manufacturer, or approved equal.]

[3. Top Mounted Bollard: Secure wood bollard to post with post installed stand off type bracket [Simpson Strong Tie Product ABA or approved equal] with a galvanized wedge or adhesive anchor. [Epoxy shall be Hilti Hit-HY 200 or approved equal.]]

[4. Removable Bollards: Wood bollard shall insert into a galvanized steel receiver sleeve attached to a stainless steel locking plate.]]

[B. Metal Bollards

1. Metal bollard material shall be a minimum schedule 40 steel pipe per ASTM A53/A53M or ASTM A500/A500M Grade B structural steel.

[2. Top Mounted Bollards: Fabricate bollards with three-eigths (3/8) inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for concrete anchors. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.]

[3. Removable Bollards: Fabricate sleeves for bollard anchorage from steel pipe or tubing with one-quarter (1/4) inch thick steel plate. Sleeve inner diamter shall not be larger than the bollard outside diameter plus three-quarters (3/4) of an inch. Bollard shall include stainless steel locking plate.]

****

NOTE: 3,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air

entrainment, slump, mix design (e.g. MCIB 479-1-4-0.626, 3,000 psi with 4-inch slump per MCIB, etc.) as applicable.

****

[4. Concrete-Filled Metal Bollards: Steel pipe shall be filled [with a minimum 3,000 psi concrete with 4-6 slump or approved equal][per manufacturer recommendations][Design Professional to specify desired concrete mix requirements].]

5. Color Coating: Prime bollards with zinc-rich epoxy primer. Color coating shall be polyester powder of the color specified in the Drawings.]

[C. Precast Concrete Bollards

1. Concrete bollard shall be precast concrete with a minimum 5,000 psi 28 day design compressive strength.

2. Reinforcing and anchoring shall be per manufacturer requirements.]

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

[D. Manufactured/Specialty Bollards

[1. Bollards shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer and product information] or approved equal.]

[2. Bollards shall be removable.]]

E. MANUFACTURER DATA SHEET; Submit product data for manufacturer product lines assembled from standard components, including, but not limited to:

1. Supplier name, address, and phone;

2. Grout, anchoring cements and paint products;

3. Preparation instructions and recommendations;

4. Storage and handling requirements and recommendations;

5. Installation methods;

6. Available guidelines and instructions on operations and maintenance of materials installed.

[F. DESIGN DATA; For installed bollards indicated to comply with certain design loadings, submit structural analysis data signed and sealed by the Professional Engineer who was responsible for their preparation.]

[G. SHOP DRAWINGS; Submit shop drawings showing fabrication and installation of bollards. Include colors, plans, elevations, sections, details, field conditions and attachments to other Work.]

H. ABOVE GRADE BARRIER VERIFICATION SAMPLES; Submit manufacturer's color charts showing the full range of colors available for products. For each type of exposed finish required, prepared on components and of same thickness and metal indicated for the Work. If finish involves normal color and texture variations, include sample sets showing the full range of variations expected.]

[2.04 CONCRETE FOOTING

A. CONTRACTOR SHALL COORDINATE INSTALLATION DRAWINGS, DIAGRAMS, TEMPLATES, INSTRUCTIONS, AND DIRECTIONS FOR INSTALLING ANCHORS, SUCH AS SLEEVES, CONCRETE INSERTS, ANCHOR BOLTS, AND MISCELLANEOUS ITEMS HAVING INTEGRAL ANCHORS THAT ARE TO BE EMBEDDED IN CONCRETE OR MASONRY CONSTRUCTION.

****

NOTE: 4,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

B. Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal.

C. CONCRETE MIX DESIGN; Submit certification that concrete mix design meets the requirements of the specified mix.]

[2.05 REFLECTOR

A. Reflectors shall be [water drop][round][square][rectangular] shaped with aluminum base and a round white reflector.

B. REFLECTOR SHOP DRAWINGS; Submit shop drawings showing reflector and fastener materials and dimensions.]

[2.06 STONE BARRIERS

[A. STONE BOULDER

1. Stone boulder shall be intact without open fractures, foliation, or other planes of weakness.

2. Stone boulder shall be natural limestone materials. Contractor shall provide weathered natural carbonate stone in thicknesses and general dimensions as shown in the Drawings.]

[B. Ledgestone

1. Ledgestone shall be solid, sound, unweathered limestone without visible voids.

2. Ledgestone shall exhibit a hard, massive, solid appearance and shall lack the presence of clay seams, solution cavities, and broken, rubble, or weathered rock conditions.

3. Ledgestone shall be obtained from the same formation or rock unit.

4. Ledgestone shall be uniform dimension with a minimum unit weight of 140 pounds per cubic foot.]

C. Provide stone barrier material from within 100-mile radius from project Site.

D. Stone barrier material shall meet the following physical characteristics:

Stone Barrier Testing Requirements

Characteristic	Requirement	Test Method (or Approved Equal)
Compressive Strength	4,000 psi (minimum)	ASTM C170/C170M
Modulus of Rupture	700 psi (minimum)	ASTM C99/C99M
Absorption	7.5% (maximum)	ASTM C97/C97M

Characteristic	Requirement	Test Method (or Approved Equal)
Abrasive Hardness	10 (minimum)	ASTM C241/C241M

E. STONE BARRIER MATERIAL; Submit certification that stone material is within the parameters specified including the following:

1. Supplier name, phone and address;

2. Type of Material;

3. Compressive Strength;

4. Modulus of Rupture;

5. Absorption;

6. Abrasive Hardness.

F. ABOVE GRADE BARRIER VERIFICATION SAMPLES; Submit photographs depicting size and geometry of stone prior to selection of sample material. Submit sample of stone barrier material after approval of photographs depicting size and geometry of stone by [Design Professional][Owner].

G. SHOP DRAWINGS; Submit shop drawings showing stone barrier dimensions, sizing, and finish. Include colors, plans, elevations, sections, details, field conditions and attachments to other Work, as applicable.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The contractor shall set construction stakes, establishing all structure locations and elevations. The contractor shall establish all

necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. LOCATION NOTIFICATION; Notify the [Design Professional][Owner] once all area protection are located and staked in the field prior to installation for review and approval.

[B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement ACI 306R requirements shall apply.]

[2. [Design Professional to specify additional project conditions, as applicable]]]

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[A. Concrete Curbs: Shall be constructed in accordance with **APWA 2200**, Part 2209.4 to the configuration, lines and grades as indicated in the Drawings.]

[B. [Fence][and][Bollards]

1. Install as indicated in the Drawings and per manufacturer recommendations, as applicable.

2. Fit exposed connections together to form tight, hairline joints.

3. Set posts accurately in location, alignment, and elevation measured from established lines and levels and free from rock.

4. Adjust posts before anchoring to ensure alignment at abutting joints. Space posts at interval indicated.

5. Anchor posts to concrete as required by the manufacturer or as specified in the Drawings.

6. Provide isolation as recommended by manufacturer on concealed surfaces of steel that will be in contact with grout, concrete, masonry, wood, or dissimilar metals.

7. Do not weld, cut, or scratch coated or finished material that is intended for field connection by mechanical or other means without further cutting or fitting.

8. Touch-up Painting and Restoring Finishes

a. Touch-Up Painting: Immediately after erection, clean field welds, bolted

connections, and abraded areas of shop paint, and apply same material to exposed areas.

b. Restoring Finishes: Restore finishes damaged during installation and work so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.]

[C. Concrete Footing: Install as indicated in the Drawings and per manufacturer recommendations, as applicable.]

[D. Reflector: [Mechanically fasten][or][Chemically adhere] reflector to [each [bollard][and][fence post]][[bollards][and][fence posts] at locations specified in the Drawings].]

[E. Stone Barriers

1. Layout of stone shall be as specified in the Drawings. Location of stone shall be field adjusted by actual stone size and shape, with final approval by the [Design Professional][Owner].

2. Stone shall be set in stable conditions with no rocking. Backfill around stone shall be as specified in the Drawings.]

3.03 TOLERANCES

[A. Concrete Curbs: Locations and elevations shall not exceed 0.1 foot vertical and 0.1 foot horizontal.]

[B. [Fences][and][Bollards]: Align so variations from level or parallel alignment do not exceed one-fourth (1/4) inch in 12 feet.]

[C. Concrete Footing: Locations and elevations shall not exceed 0.1 foot vertical and 0.1 foot horizontal.]

[D. Reflector: Place within one-fourth (1/4) inch of locations specified in Drawings.]

[E. Stone Barriers: Shall have a surface tolerance of 0.1 foot vertical and 0.1 foot horizontal.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Contractor shall protect finishes and integrity of fences and bollards from damage during construction period with temporary protective coverings approved by [manufacturer][Design Professional][Owner].

3.06 MAINTENANCE

A. The Contractor shall maintain above grade barrier through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the above grade barrier. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure above grade barrier materials through the duration of the Establishment Period.]

[D. If at any time during the Establishment Period the material becomes damaged due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the material and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no cost to the Owner.]

-- End of Section --

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02943

GSI SPECIFICATIONS

****

SECTION 02943

GREEN STORMWATER INFRASTRUCTURE PERVIOUS CONCRETE

****

NOTE: This guide specification includes requirements for pervious concrete and associated components. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Pervious concrete is a specialty concrete mix consisting of approximately 20 to 25 percent voids. Pervious concrete functions as the surface material in a permeable pavement green stormwater infrastructure facility, allowing water to pass through the voids in the surface as opposed to ponding and running off the pavement. A storage aggregate media layer is located below the pervious concrete, which allows for the temporary storage of stormwater and serves as the structural subbase.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install pervious concrete as depicted in the Drawings and specified herein. Pervious concrete shall be measured in the units of [Cubic Yards][Square Yards] and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C33/C33M	Standard Specification for Concrete Aggregates
ASTM C42/C42M	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete

ASTM C138/C138M	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C150/C150M	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C260/C260M	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494/C494M	Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1116/C1116M	Standard Specification for Fiber-Reinforced Concrete
ASTM C1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1688/C1688M	Standard Test Method For Density And Void Content Of Freshly Mixed Pervious Concrete

ASTM C1747/C1747M	Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion
ASTM C1754/C1754M	Standard Test Method for Density and Void Content of Hardened Pervious Concrete

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

WEATHER PLACEMENT CURING AND PROCEDURAL PLAN

PERVIOUS CONCRETE PLACEMENT NOTIFICATION

SD-04 Samples

TEST PANEL

SD-06 Test Reports

POST-CONSTRUCTION INFILTRATION TEST RESULTS

MORTAR-BAR METHOD TEST RESULTS

SD-07 Certificates

MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of pervious concrete with a minimum of three (3) years recent experience, with employees skilled in the pervious concrete trade, and specifically skilled in green stormwater infrastructure.

2. At least one (1) qualified installer with current Concrete Promotional Group (CPG) Pervious Concrete Certification Program Installer credentials and/or National Ready

Mixed Concrete Association (NRMCA) Pervious Concrete Contractor Certification Program Installer credentials [or approved equal as determined by Design Professional] shall be on-site for installation.

B. Testing Agency Qualifications

1. The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

C. All materials which have been damaged after delivery or installation shall be rejected, removed and replaced at the Contractor's expense.

D. TEST PANEL; Install a test panel on the Site at a location approved by the [Design Professional][Owner] per the material and construction requirements of this specification. [Test panel may be omitted based on contractor experience with written approval of the Design Professional.] Accepted test panels in like new condition, as determined by the [Design Professional][Owner], may be used in the Work.

1. The test panel shall be a minimum of [100 square feet].

2. Contractor shall test the panel and submit results for fresh unit weight, infiltration rate, hardened density, hardened void content, and potential ravel by impact or abrasion per the following requirements:

a. The fresh unit weight of pervious concrete for the test panel shall be tested per ASTM C1688/C1688M.

b. The infiltration rate of the in-place pervious concrete for the test panel shall be tested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after the seven (7) day curing period at a minimum of [three (3)] locations within the test panel. The infiltration rate at each of the [three(3)] testing locations shall be greater than [350 inches per hour].

c. The test panel shall be cored per ASTM C42/C42M, and the cores shall be tested per ASTM C1754/C1754M after the seven (7) day curing period at a minimum of [three (3)] locations within the test panel for density and void content of the hardened pervious concrete.

d. The potential raveling made by impact or abrasion for the test panel shall be tested per ASTM C1747/C1747M.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

2.03 PERVIOUS CONCRETE

A. MIX DESIGN; Submit certification that pervious concrete mix design meets the specified parameters prior to procurement of material. Submittal shall include but not be limited to the following:

1. Aggregate type, source, gradation, specific gravity, and adsorption;

2. Supplementary cementitious materials: Supplementary cementitious materials shall not exceed 25 percent replacement by weight of fly ash nor 50 percent total combined replacement by mass of the Portland cement;

3. Water-to-cement ratio: Water-to-cement ratio between 0.30 and 0.34;

4. Void content: Void content between 15 percent and 25 percent per ASTM C138/C138M;

5. Fiber properties;

6. Accelerated mortar-bar method test results demonstrating that alkali silica reaction produces less than 0.10 percent expansion of pervious concrete test specimens at 28 days per ASTM C1567 (Accelerated mortar-bar method).

7. Manufacturer product instructions including supplier name, address and phone for cement, supplementary cementitious material, and admixtures;

B. Aggregate: Aggregate used in pervious concrete mix shall comply with the following:

1. No. 8 aggregate per ASTM C33/C33M;

2. Sand, included in the total combined aggregate gradation, no more than 7 percent of the total gradation;

3. Specific gravity greater than 2.5;

4. Absorption less than 2.5 percent;

5. MORTAR-BAR METHOD TEST RESULTS; Submit test results demonstrating that alkali silica reaction produces less than 0.10 percent expansion of test specimens at 28 days per ASTM C1260 (Mortar-bar method) for No. 8 aggregate and sand tested separately.

C. Cement

1. Portland Cement Type I and Type II shall conform to ASTM C150/C150M. [A local blend of Type I/II Portland cement that meets Type I or Type II requirements per ASTM C150/C150M is permitted.]

2. Blended Hydraulic Cement Type IS or Type IP shall conform to ASTM C595/C595M.

D. Supplementary Cementitious Material

1. Fly Ash: Fly ash shall conform to ASTM C618.

2. Silica Fume: Silica fume shall conform to ASTM C1240.

3. Ground Granulated Blast Furnace Slag: Ground granulated blast furnace slag shall conform to ASTM C989/C989M, Grade 100 or Grade 120, and shall be no more than 15 percent replacement of cementitious materials.

E. Admixtures

1. Air-Entraining Admixtures: Air-entraining admixtures shall conform to ASTM C260/C260M and shall be used in accordance with manufacturer's recommendations.

2. Chemical Admixtures

a. Polycarboxylate Water Reducing Admixtures: Polycarboxylate water reducing admixtures shall conform to ASTM C494/C494M Type A or Type F and shall be used in accordance with manufacturer's recommendations.

b. Extended Control Admixtures/Hydration Stabilizers: Extended control admixtures/hydration stabilizers shall conform to ASTM C494/C494M Type B or Type D. All pervious concrete shall have extended control admixtures/hydration stabilizers, which shall be available at the Site for redosing

as needed. Dosage of extended control admixtures/hydration stabilizers shall be in accordance with manufacturer's recommendations.

[c. Viscosity Modifying Admixtures: Viscosity modifying admixtures are permitted, pending approval of the [Design Professional][Owner].]

3. Fibers: Fibers shall be used in pervious concrete, conform to ASTM C1116/C1116M, and comply with the following:

a. Polypropylene or cellulose fibers < 1.5 inch fibrillated or micro fiber type;

b. Fiber dosage rate of 1.5 pounds per cubic yard;

c. Fibers shall be removed from bags and distributed in two (2) to three (3) gallons of water before addition to the mix to prevent balling materials and to promote even distribution.

F. Water: Water shall conform to ASTM C1602/C1602M.

2.04 CURING AND SEALING MATERIALS

A. Pervious concrete shall be cured by the placement of a waterproof covering, polyethylene sheeting per ASTM C171, with a minimum thickness of six (6) mils.

B. Soybean oil shall be used for curing, and shall be applied in manner and quantities per manufacturer's recommendation. Soybean oil shall also be used on formwork as a bond breaker and sprayed on roller screed as well as other placement tools and equipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking
1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profiles grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. If the air temperature is forecasted by the National Weather Service to be above 90 degrees Fahrenheit or below 40 degrees Fahrenheit for seven (7) consecutive days after placement at the Site, the Contractor shall not place pervious concrete[, unless approved by the[Design Professional][Owner]]. Pervious concrete shall not be placed

on frozen subgrade. Heated water to mitigate cold weather concreting is not permitted for pervious concrete.

2. WEATHER PLACEMENT CURING AND PROCEDURAL PLAN; Submit hot/cold weather placement curing and procedural plan to monitor and protect the pervious concrete when the air temperature is above 90 degrees or below 40 degrees Fahrenheit for seven (7) consecutive days after placement.

3. PERVIOUS CONCRETE PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of pervious concrete.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the [Design Professional][Owner]to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the pervious concrete.

4. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

D. Pervious Concrete

1. Pervious concrete shall be placed to the lines, grades and depths specified in the Drawings.

2. Mixing and Hauling

a. Production: Pervious concrete shall be manufactured and delivered in accordance with ASTM C94/C94M.

b. Mixing: Pervious concrete shall be central-mixed or truck-mixed concrete that is mixed for the minimum time as specified in ASTM C94/C94M.

c. Transportation: Pervious concrete may be transported to the Site and the discharge of individual loads shall be completed within one (1) hour of the introduction of mix water to the cement. Delivery times may be extended to exceed 90 minutes when dosages of hydration stabilizer are increased to maintain the concrete, as approved by the [Design Professional][Owner].

d. Adjustments: Each truckload of pervious concrete shall be visually inspected for consistency of pervious concrete mixture. Water addition and re-dosing of hydration stabilizers to adjust the consistency of the pervious concrete is permitted at the point of discharge. Prior to further discharge, a minimum of 70 revolutions at the manufacturer's designated mixing speed shall be counted following the addition of any water to the mix.

3. Placing and Finishing

a. Formwork: Formwork shall consist of wood, steel, or other material sufficient to support placement. Forms shall extend to the full depth of the pervious concrete. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan and profile following spreading, strike off and compaction operations.

b. Sub-Base: Moisten sub-base at the time of placement to ensure no reduction in strength of the pavement.

c. Pervious Concrete

1) Deposit pervious concrete into the forms by mixer truck chute, conveyor or buggy. Pervious concrete shall not be pumped into the forms.

2) Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed plastic concrete.

3) Place the pervious concrete with a roller screed properly weighted with water in the roller. [The Contractor may place the pervious

concrete with an alternate screed, as approved by Design Professional.]

4) Use a pervious pan skip float to finish the pervious concrete surface after placement with the roller screed [or approved equal] and prior to curing.

4. Jointing

a. Isolation joints shall be used when abutting driveways, manholes, light poles, signage poles, and maximum 250-foot on center.

[b. Contraction joints may be installed at the Contractor's discretion, as approved by Design Professional. Contraction joints shall be saw cut no more than 24 hours after installation and shall be a minimum one-fourth (1/4) of the pavement thickness. Slurry/dust shall be immediately vacuumed or washed following jointing.]

5. Curing

a. Curing procedures shall begin three (3) to five (5) minutes behind the roller screed [or approved equal] by spraying soybean oil onto the pavement from both sides of the paving operation.

b. The pervious concrete surface shall then be covered with a minimum of six (6) mil thick polyethylene sheeting [or approved equal], following the soybean oil spray. Any holes, tears, or cuts in the sheeting shall be repaired to prevent moisture loss and to prevent air infiltration under the sheeting. The polyethylene sheeting shall be rolled over the fresh pervious concrete and to the width of the forms. There shall be a minimum of 12 inches of overhang on each side of the form, to have sufficient sheeting to properly anchor down the sides.

c. Cross rollers with a maximum weight of 100 pounds shall be used behind the roller screed (and on top of the polyethylene sheeting) to aid in rolling out the ridges left by the roller screed and for final compaction.

d. Curing of pervious concrete shall last seven (7) days. No vehicular traffic shall be permitted on the pavement until curing is complete (seven (7) days) and no truck traffic shall be permitted for at least 14 days.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

C. Fresh Unit Weight: Fresh unit weight shall be tested per ASTM C1688/C1688M and shall be within three (3) percent of design unit weight.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

B. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the [Design Professional][Owner], per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after curing and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of curing.

B. Average post-construction infiltration rate shall be [between 350 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the [Design Professional][Owner]. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the [Design Professional][Owner].

3.08 WARRANTY

A. The Contractor shall warrant the pervious concrete through the duration of the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

B. If at any time during the Establishment Period the pervious concrete spalls, settles or fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the pervious concrete and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

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02944

GSI SPECIFICATIONS

****

SECTION 02944

GREEN STORMWATER INFRASTRUCTURE POROUS ASPHALT

****

NOTE: This guide specification includes requirements for porous asphalt and associated components. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Porous asphalt is a specialized hot mix asphalt consisting of 16 to 22 percent voids. Porous asphalt allows water to pass through the voids in the asphalt surface as opposed to ponding and running off the pavement surface. A storage aggregate media layer is located below the porous asphalt to stabilize the surface and provide temporary stormwater storage.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install porous asphalt as depicted in the Drawings and specified herein. Porous asphalt shall be measured in the units of [Cubic Yards][Square Yards] and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T283	Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D2172	Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures

ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D6390	Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
ASTM D7064/D7064M	Standard Practice for Open-Graded Friction Course (OGFC) Mix Design

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

POROUS ASPHALT PLACEMENT NOTIFICATION

[SD-06 Test Reports

[POST-CONSTRUCTION INFILTRATION TEST RESULTS]]

SD-07 Certificates

MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer whose work has resulted in the successful installation of porous asphalt with a minimum of three (3) years recent experience and specifically skilled in green stormwater infrastructure.

B. Testing Agency Qualifications: The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, meeting requirements of ASTM D3666, with technicians certified in the discipline of Hot Mix Asphalt (HMA) Plant Technician.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

C. All materials which have been damaged after delivery or installation shall be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 CHOKER COURSE

A. Choker course media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.

2.03 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.

2.04 POROUS ASPHALT

A. MIX DESIGN; Submit certification that the porous asphalt mix design meets the specified parameters. Porous asphalt mix shall be tested the greater of twice per day or three (3) times per job. Include material supplier name, address and phone, and the following:

1. Aggregate type, source, and gradation;

2. Content of binder;

3. Content of additives;

4. Void content: Void content between 16 percent and 22 percent per ASTM D3203;

5. Draindown: Draindown less than 0.3 percent per ASTM D6390;

6. Cantabro Abrasion Tests: Cantabro Abrasion Test on unaged samples less than 20 percent per ASTM D7064/D7064M; Cantabro Abrasion Test on seven (7) day aged samples less than 30 percent per ASTM D7064/D7064M;

7. Tensile Strength Ratio (TSR): TSR shall be greater than or equal to 80 percent per AASHTO T283.

B. Aggregate: Aggregate used in porous asphalt mix shall comply with the following gradation:

Porous Asphalt Aggregate Gradation Requirements

Sieve Size	Passing (Percent by Weight)
19.0 mm (3/4 inch)	100
12.5 mm (1/2 inch)	85 - 100
9.5 mm (3/8 inch)	35 - 60
4.75 mm (No. 4)	10 - 25
2.36 mm (No. 8)	5 - 10
75 um (No. 200)	2 - 4

C. Binder

1. Binder content shall be between 6 and 6.5 percent per ASTM D2172 and shall be tested the greater of once per 500 tons, once per day, or once per job.

2. Rubber solids content by weight of bitumen shall be between 1.5 and 3 percent per ASTM D2172.

D. Additives: Fiber content by total mixture mass shall be [0.3 percent cellulose][0.3 percent cellulose or 0.4 percent mineral][0.4 percent mineral].

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profiles grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Porous asphalt shall not be placed when the ambient air temperature is less than 60 degrees Fahrenheit, when the ground temperature is less than 50 degrees Fahrenheit, or when precipitation is forecasted by the National Weather Service at the Site[, unless approved by the [Design Professional][Owner]].

2. POROUS ASPHALT PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement porous asphalt.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the [Design Professional][Owner] to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the porous asphalt.

4. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

D. Porous Asphalt

1. Porous asphalt shall be placed to the lines, grades and depths specified in the Drawings.

2. Mixing and Hauling

a. Production: Mixing plants shall be a Hot Mix Asphalt (HMA) Plant recognized by the State of Missouri.

b. Transportation: Porous asphalt shall be transported in covered, clean dump beds that have been sprayed with a non-petroleum release agent to prevent the porous asphalt mixture from adhering to the dump beds. Mineral filler, fine aggregate, and slag dust shall not be used to dust truck beds. Haul distances shall be limited so that porous asphalt is placed within 90 minutes of loading.

3. Placing and Finishing

a. Place the porous asphalt in lifts up to four (4) inches thick via truck pavers, compacting with up to four (4) passes of the ten (10) ton static roller.

b. No vehicular traffic shall be permitted on the porous asphalt pavement within 48 hours of placement or until the placed porous asphalt has cooled to a temperature below 100 degrees Fahrenheit, whichever is a longer duration.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the [Design Professional][Owner], per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after cooling and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of cooling.

B. Average post-construction infiltration rate shall be [between 250 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the [Design Professional][Owner]. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the [Design Professional][Owner].

3.08 WARRANTY

A. The Contractor shall warrant the porous asphalt through the duration of the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

B. If at any time during the Establishment Period the porous asphalt spalls, settles or fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the porous asphalt and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

****

02945

GSI SPECIFICATIONS

****

SECTION 02945

GREEN STORMWATER INFRASTRUCTURE PERMEABLE PAVERS

****

NOTE: This guide specification includes requirements for permeable pavers including sand, storage aggregate media, choker course, jointing material, bedding material, and aggregate base components. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Permeable pavers are unit paver systems that allow water to pass through the joints or openings between the individual pavers. Permeable pavers typically incorporate a choker course and a storage aggregate media layer beneath the paver surface that allows for the temporary storage of stormwater. Permeable pavers may also incorporate jointing and bedding material.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install permeable pavers as depicted in the Drawings and specified herein. Permeable pavers shall be measured in the units of [Square Feet] and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: . If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: Design Professional to include reference standards required for permeable paver products selected. Design Professional shall precede those reference standards with this statement "The publications are referred to within the text by basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design Professional/Owner." If not including reference standards select "Not applicable." option instead.

****

[A. Design Professional to include reference standards required for paver products selected.

The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Owner.]

[B. Not applicable.]]

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

PERMEABLE PAVER PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INSTRUCTIONS

SHOP DRAWINGS

SD-04 Samples

PERMEABLE PAVER SAMPLES

[SD-06 Test Reports

[POST-CONSTRUCTION INFILTRATION TEST RESULTS]]

SD-07 Certificates

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of permeable pavers with a minimum of three (3) years recent experience, with employees skilled in green stormwater infrastructure.

B. Testing Agency Qualifications: The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or the Site after delivery.

C. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

D. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

C. Manufactured products shall be delivered, stored and handled per manufacturer recommendations.

[D. Furnish an excess of [100 square feet] of [permeable paver type] to [Design Professional][Owner]. Furnish products from the same production run as installed.]

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be, per the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.

[2.03 CHOKER COURSE

A. Choker course media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.]

[2.04 JOINTING AND BEDDING MATERIAL

A. Jointing and bedding material shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Aggregate Media.]

2.05 PERMEABLE PAVERS

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

[A. Permeable Pavers shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer and product information] or approved equal.]

B. MANUFACTURER INSTRUCTIONS; Submit manufacturer instructions for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, installation and protection information, and product warranty documentation.

C. PERMEABLE PAVER SAMPLES; Submit photographs depicting size and geometry of permeable pavers prior to selection of sample material. Include physical sample of the permeable pavers for [Design Professional][Owner].

D. SHOP DRAWINGS; Submit Shop Drawings that indicate the size, location, placement pattern, anchoring details, termination details, and connection details, as applicable. Shop Drawings shall include supplier name, address and phone.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Permeable pavers shall not be installed when ambient air temperature and/or ground temperature is less than or equal to 32 degrees Fahrenheit or in the presence of standing water for a minimum of three (3) days prior to installation. No material shall be installed on frozen surfaces, nor shall frozen material be placed in green stormwater infrastructure facilities.

2. PERMEABLE PAVER PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of permeable pavers.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the [Design Professional][Owner] to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the permeable pavers.

[4. [Design Professional to include manufacturer specific subgrade compaction requirements, as applicable]]

5. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

[D. Choker Course: Choker course media shall be installed per Section 02946 Green Stormwater Infrastructure Aggregate Media.]

[E. Jointing and Bedding Material: Jointing and bedding material shall be installed per Section 02946 Green Stormwater Infrastructure Aggregate Media.]

F. Permeable Pavers

1. Permeable pavers shall be placed to the lines, grades and depths specified in the Drawings and according to manufacturer instructions.

2. Pavers shall be mixed from [three (3)] pallets or cubes as they are placed to produce a uniform blend of colors and textures as applicable.

3. Pavers shall be cut with a motor-driven masonry saw to provide clean, sharp, unchipped, edges, or by manufacturer instructions, to the extents identified in the Drawings. [Note: Pavers may settle up to one-half (1/2) inch in the first six (6) to twelve months after placement. Obtain [Design Professional][Owner] approval to place pavers at an elevation up to one-half (1/2) inch above desired finished grade elevation if settling tolerance is not dictated in Drawings.]

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Unit-to-Unit Vertical Offset (from Flush): one-sixteenth (1/16) inch

2. Unit-to-Unit Horizontal Offset (Gap): one-fourth (1/4) inch

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

3. Finished surface of paving whichever is less, one-eighth (1/8) inch in 24 inches and one-quarter (1/4) inch in ten (10) feet from level, or indicated slope.

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the [Design Professional][Owner], per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after installation and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of installation.

B. Average post-construction infiltration rate shall be [between 250 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the [Design Professional][Owner]. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the [Design Professional][Owner].

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the permeable pavers. The Contractor shall be

responsible for coordination with the Warrantor for replacement of any defective products or material.]

C. The Contractor shall warrant the permeable pavers through the duration of the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

D. If at any time during the Establishment Period the permeable pavers settle or fail to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the permeable pavers and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

****

02946

GSI SPECIFICATIONS

****

SECTION 02946

GREEN STORMWATER INFRASTRUCTURE AGGREGATE MEDIA

****

NOTE: This guide specification includes requirements for aggregate media including sand, storage aggregate media, choker course, jointing material, bedding material, and aggregate base components. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Aggregate media serves as one of the primary storage and filtration media in a green stormwater infrastructure facility. Voids in the media allow for stormwater to move through it, providing filtration, infiltration and storage functions. Aggregate media may also provide separation between coarser and finer media or provide structural stability for other components. Typically, aggregate layers should have decreasing particle size for each successive layer beneath it.

B. Definitions

[1. Sand: A fine aggregate with particles finer than 3/8-inch sieve.]

[2. Storage Aggregate Media: Layer of double-washed aggregate, designed for stormwater storage. (In permeable pavement applications, storage aggregate media may also need to be designed for traffic load.)]

[3. Choker Course: Layer of double-washed aggregate, placed above the storage aggregate media, that filters out sediment particles prior to the storage aggregate media. (In permeable pavement applications, the choker course fills some of the surface voids of the larger sized storage aggregate media and stabilizes the surface prior to paving.)]

[4. Jointing Material: Double-washed aggregate, typically used to fill the joints between pavers.

[5. Bedding Material: Thin layer of double-washed aggregate, typically used to level pavers.]

[6. Aggregate Base: Double-washed aggregate that provides structural support.]

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for aggregate media installation and testing, dictated in the Drawings and specified herein. Aggregate media shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Aggregate Media Measurement and Payment Units

Item	Unit
[Sand]	[Cubic Yard]
[Storage Aggregate]	[Cubic Yard][Ton]
[Choker Course]	[Cubic Yard][Ton]
[Jointing Material]	[Cubic Yard][Ton]
[Bedding Material]	[Cubic Yard][Ton]
[Aggregate Base]	[Cubic Yard][Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02948 Green Stormwater Infrastructure Media Liners

02949 Green Stormwater Infrastructure Existing Tree Protection

02950 Green Stormwater Infrastructure Selective Vegetation Removal

[02954 Green Stormwater Infrastructure Piping]

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of Contract Documents, unless otherwise indicated by the [Design Professional][Owner].

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C33/C33M	Standard Specification for Concrete Aggregates

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

COMPLETION OF EXCAVATION NOTIFICATION

COMPLETION OF MEDIA INSTALLATION NOTIFICATION

SD-06 Test Reports

TESTING AGENCY CONTACT

SD-07 Certificates

[SAND CERTIFICATION]

[STORAGE AGGREGATE MEDIA CERTIFICATION]

[CHOKER COURSE CERTIFICATION]

[JOINTING MATERIAL CERTIFICATION]

[BEDDING MATERIAL CERTIFICATION]

[AGGREGATE BASE CERTIFICATION]

[FINISHED GRADE SURVEY VERIFICATION]

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer whose work has resulted in the successful installation of green stormwater infrastructure facilities with a minimum of three (3) years recent experience.

B. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated.

2. TESTING AGENCY CONTACT; All testing and analysis shall be at the expense of the Contractor. Submit all material testing results specified including the following contact information for the testing agency used:

a. Testing Agency Name;

b. Testing Agency Address;

c. Testing Agency Phone;

d. Material Tested.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit required testing results showing material is in conformance with this Specification.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Contractor shall prevent mixing of dissimilar materials during unloading, stockpiling, and placement activities.

C. All stockpiled material shall be covered and protected from contaminants, wind and water erosion. Stockpiles shall be located away from stormwater drainage paths and low-lying areas that collect water or are susceptible to erosion.

D. Any graded aggregate that has been stored shall be remixed prior to delivery to Site to provide sufficient retention of gradation requirements.

E. After delivery and prior to placement, the Owner reserves the right to collect samples of the aggregate media. If the media is found to be outside the parameters specified in Part 2, or outside the accepted testing submittals, the Contractor shall replace the media at no additional cost to the Owner.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 SAND

A. Sand shall be clean, double washed fine aggregate meeting the following gradation requirements:

Sand Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Weight)
9.5 mm (3/8 inch)	100
4.75 mm (No. 4)	95 - 100
2.36 mm (No. 8)	80 - 100
1.18 mm (No. 16)	50 - 85
600 um (No. 30)	25 - 60

Sieve Size	Passing (Percent by Weight)
300 um (No. 50)	5 - 30
150 um (No. 100)	0 - 10
75 um (No. 200)	0 - 3

B. SAND CERTIFICATION; Submit certification that sand is clean, double washed and meeting the specified gradation requirements Submittal shall include material supplier name, address and phone.]

[2.02 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be No. 2, No. 3, No. 56, No. 57, or No. 67 stone as specified in the Drawings.

B. Storage aggregate media shall be double-washed, hard, durable, rounded, or sub-angular particles of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious materials.

C. Storage aggregate media shall meet ASTM C33/C33M grading requirements for coarse aggregates as follows:

Storage Aggregate Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)				
	No. 2	No. 3	No. 56	No. 57	No. 67
75 mm (3 inch)	100	-	-	-	-
63 mm (2-1/2 inch)	90 - 100	100	-	-	-
50 mm (2 inch)	35 - 70	90 - 100	-	-	-
37.5 mm (1-1/2 inch)	0 - 15	65 - 70	100	100	-
25 mm (1 inch)	-	0 - 15	90 - 100	95 - 100	100
19 mm (3/4 inch)	0 - 5	-	40 - 85	-	90 - 100
12.5 mm (1/2 inch)	-	0 - 5	10 - 40	25 - 60	-
9.5 mm (3/8 inch)	-	-	0 - 15	-	20 - 55
4.75 mm (No. 4)	-	-	0 - 5	0 - 10	0 - 10
2.36 mm (No. 8)	-	-	-	0 - 5	0 - 5

1.18 mm (No. 16)	-	-	-	-	-
300 um (No. 50)	-	-	-	-	-
75 um (No. 200)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2

D. STORAGE AGGREGATE MEDIA CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. No. 2]

[2. No. 3]

[3. No. 56]

[4. No. 57]

[5. No. 67]]

[2.03 CHOKER COURSE

A. Choker course shall be No. 57, No. 7, No. 8, No. 89 or No. 9 stone, or sand, as specified in the Drawings.

B. Choker course material shall be double-washed, hard, durable, particles of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious material.

[C. Stone Choker course shall meet ASTM C33/C33M gradation requirements as follows:

Choker Course Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)				
	No. 57	No. 7	No. 8	No. 89	No. 9
37.5 mm (1-1/2 inch)	100	-	-	-	-
25 mm (1 inch)	95 - 100	-	-	-	-
19 mm (3/4 inch)	-	100	-	-	-
12.5 mm (1/2 inch)	25 - 60	90 - 100	100	100	-
9.5 mm (3/8 inch)	-	40 - 70	85 - 100	90 - 100	100

4.75 mm (No. 4)	0 - 10	0 - 15	10 - 30	20 - 55	85 - 100
2.36 mm (No. 8)	0 - 5	0 - 5	0 - 10	5 - 30	10 - 40
1.18 mm (No. 16)	-	-	0 - 5	0 - 10	0 - 10
300 um (No. 50)	-	-	-	0 - 5	0 - 5
75 um (No. 200)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2

[D. Sand shall be per Part 2.01]]

E. CHOKER COURSE CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. No. 57]

[2. No. 7]

[3. No. 8]

[4. No. 89]

[5. No. 9]

[6. Sand]]

****

NOTE: Decision points are provided for jointing and bedding material if Design Professional specifies a product that only requires a jointing or a bedding material, or both.

****

[2.04 [JOINTING][AND][BEDDING] MATERIAL

A. [Jointing][and][Bedding] Material shall be No. 7, No. 8, No. 89, or No. 9 stone, or sand, as specified in the Drawings.

B. [Jointing][and][Bedding] Material shall be double-washed, hard, durable particles of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious material.

[C. [Jointing][and][Bedding] Material shall meet ASTM C33/C33M gradation requirements as follows:

[Jointing][and][Bedding] Material Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)

	No. 7	No. 8	No. 89	No. 9
19 mm (3/4 inch)	100	-	-	-
12.5 mm (1/2 inch)	90 - 100	100	100	-
9.5 mm (3/8 inch)	40 - 70	85 - 100	90 - 100	100
4.75 mm (No. 4)	0 - 15	10 - 30	20 - 55	85 - 100
2.36 mm (No. 8)	0 - 5	0 - 10	5 - 30	10 - 40
1.18 mm (No. 16)	-	0 - 5	0 - 10	0 - 10
300 um (No. 50)	-	-	0 - 5	0 - 5
75 um (No. 200)	0 - 2	0 - 2	0 - 2	0 - 2

[D. Sand shall be per Part 2.01.]

E. JOINTING MATERIAL CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. No. 7]

[2. No. 8]

[3. No. 89]

[4. No. 9]

[5. Sand]

[F. BEDDING MATERIAL CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. No. 7]

[2. No. 8]

[3. No. 89]

[4. No. 9]

[5. Sand]]]

[2.05 AGGREGATE BASE

A. Aggregate base shall be No. 57, No. 7, or No. 8 stone as specified in the Drawings.

B. Aggregate base material shall be double-washed, hard, durable particles of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious material

C. Aggregate base shall meet ASTM C33/C33M gradation requirements as follows:

Aggregate Base Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)		
	No. 57	No. 7	No. 8
37.5 mm (1-1/2 inch)	100	-	-
25 mm (1 inch)	95 - 100	-	-
19 mm (3/4 inch)	-	100	-
12.5 mm (1/2 inch)	25 - 60	90 - 100	100
9.5 mm (3/8 inch)	-	40 - 70	85 - 100
4.75 mm (No. 4)	0 - 10	0 - 15	10 - 30
2.36 mm (No. 8)	0 - 5	0 - 5	0 - 10
1.18 mm (No. 16)	-	-	0 - 5
300 um (No. 50)	-	-	-
75 um (No. 200)	0 - 2	0 - 2	0 - 2

D. AGGREGATE BASE CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Gradation reports shall include the following aggregates:

[1. No. 57]

[2. No. 7]

[3. No. 8]]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions: Project conditions shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.

C. Control and Protection

1. The footprint of the facility shall be kept reasonably dry and stormwater runoff to the facility shall be limited throughout the duration of Work to the maximum extent practicable. Prior to aggregate media placement activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Blocking of curbs, curb cuts, inlets, and other temporary protection and control measures may be necessary to divert stormwater away from the green stormwater infrastructure facility during construction.

3. Unless designated for removal in the Drawings, protect all trees and vegetation per Sections 02949 Green Stormwater Infrastructure Existing Tree Protection and 02950 Green Stormwater Infrastructure Selective Vegetation Removal, respectively.

3.02 INSTALLATION

A. Excavation

1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.

2. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of soil and/or aggregate materials.

3. COMPLETION OF EXCAVATION NOTIFICATION; Notify the [Design Professional][Owner] within 48 hours of completion of excavation and prior to placement of all media layers.

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision

point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[B. [Storage Aggregate Media][and][Choker Course] Placement

1. Contractor shall place aggregate media in loose six (6) inch lifts, hand-raked to the lines and grades specified in the Drawings.

2. COMPLETION OF MEDIA INSTALLATION NOTIFICATION; Notify the [Design Professional][Owner] within 48 hours of completion of installation of each media layer and prior to placement of any additional aggregate media layers.]

[C. [Jointing][and][Bedding] Material Placement

1. Contractor shall place aggregate media in loose lifts, hand-raked to the lines and grades specified in the Drawings.

2. COMPLETION OF MEDIA INSTALLATION NOTIFICATION; Notify the [Design Professional][Owner] within 48 hours of completion of installation of each media layer and prior to placement of any additional aggregate media layers.]

3.03 TOLERANCES

A. The Contractor must place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****

NOTE: If aggregate media represents the finished surface of the GSI facility, Design Professional should require finished grade survey verification and should designate specific grade verification points in the Drawings. If growing media is to be installed on top of aggregate, Design Professional can omit the finished grade survey verification from this section.

****

[B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Immediately protect the aggregate media from contamination by undesired materials, trash, debris, water containing cement, clay, silt or materials that will alter the composition of the material by covering with plastic or plywood.

B. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until vegetation is fully established.

C. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Owner reserves the right to collect a sample of the material for independent testing at any time during the Establishment Period.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure aggregate media through the duration of the Establishment Period.

B. If at any time during the Establishment Period the media fails to infiltrate due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the media and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

****

02947

GSI SPECIFICATIONS

****

SECTION 02947

GREEN STORMWATER INFRASTRUCTURE GROWING MEDIA AND SOIL AMENDMENTS

****

NOTE: This guide specification includes requirements for growing media including bioretention soil media, amended native soil media, topsoil, and structural soil media, as well as soil amendments including compost, lime, and sulfur. This guide specification should at a minimum include topsoil for restoration of disturbed areas. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Growing media serves as one of the primary storage and filtration media in a green stormwater infrastructure facility that includes a well-mixed blend of soil to support vegetation. Voids in the media allow for stormwater to move through it, providing filtration, infiltration and storage function.

B. This section also includes topsoil material and testing requirements and provisions for stripping of existing topsoil, removal of soil horizons, materials, substitutions and supplements, storage, redistribution, and fine grading. Approved topsoil shall be placed in all landscape areas to be planted unless otherwise specified in the Drawings.

C. Definitions

1. Growing Media: Soil that has been designed to meet specific engineering properties including, but not limited to infiltration, strength, and nutrient levels.

[2. Bioretention Soil Media: An engineered soil media with specific proportions of topsoil and compost designed to encourage infiltration and promote plant growth.]

[3. Amended Native Soil Media: An engineered soil media where soil from the site has been modified to provide specific engineering properties.]

4. Topsoil: The uppermost layer of soil that contains a majority of the soil's organic matter and microorganisms, making the soil more amenable to sustaining vegetation. Topsoil can be used independently as a native site soil or imported material, or as a component of the bioretention soil media.

[5. Soil Amendment: A material added to a soil to improve its physical properties. Soil amendments included in this specification are compost, lime, and sulfur.]]

****

NOTE: Compost is required to meet bioretention soil media or amended native soil media submittal requirements. Do not delete if specifying bioretention soil media and/or amended native soil media.

****

[6. Compost: A product resulting from the controlled biological decomposition of organic matter that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth. Compost can be used as a soil amendment, or as a component of bioretention soil media and/or amended native soil media.]

[7. Lime: A soil amendment typically used to increase the pH of the growing media.]

[8. Sulfur: A soil amendment used to decrease the pH of the growing media.]

[9. Structural Soil Media: An engineered soil media that includes crushed stone to meet strength and stability requirements.]

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for growing media installation and testing, dictated in the Drawings and specified herein. Growing media shall be paid for by [Unit Price][Lump Sum Price] and measured by Cubic Yard.

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Soil Media Measurement and Payment Units

[Bioretention Soil Media]	[Cubic Yard]
[Amended Native Soil]	[Cubic Yard]
[Topsoil]	[Cubic Yard]
[Compost]	[Cubic Yard]

[Bioretention Soil Media]	[Cubic Yard]
[Lime]	[Pounds]
[Sulfur]	[Pounds]
[Structural Soil]	[Cubic Yard]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

[02946 Green Stormwater Infrastructure Aggregate Media]

02949 Green Stormwater Infrastructure Existing Tree Protection

02950 Green Stormwater Infrastructure Selective Vegetation Removal

****

NOTE: Design Professional to select all vegetation related specifications applicable to project.

****

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of Contract Documents, unless otherwise indicated by the [Design Professional][Owner].

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T-99	Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
ASTM D4972	Standard Test Method for pH of Soils
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5268	Standard Specification for Topsoil Used for Landscaping and Construction Purposes
ASTM D6913	Standard Specification for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D7503	Standard Test Method for Measuring the Exchange Complex and Cation Exchange Capacity of Inorganic Fine-Grained Soils

ASTM F1632	Standard Test Method for Particle Size Analysis and Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes
ASTM F1647	Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes

TESTING METHODS FOR THE EXAMINATION OF COMPOSTING AND COMPOST (TMECC)

TMECC 2.02	Laboratory Sample Preparation
TMECC 3.09	Total Solids and Moisture
TMECC 4.02	Nitrogen
TMECC 4.03	Phosphorus
TMECC 4.04	Potassium
TMECC 4.05	Secondary and Micro-Nutrient Content
TMECC 4.06	Heavy Metals and Hazardous Elements
TMECC 4.07	Other Elements
TMECC 4.10	Electrical Conductivity for Compost
TMECC 4.11	Electrometric pH Determinations for Compost
TMECC 5.02	Indicator Ratios
TMECC 5.07	Loss on Ignition Organic Matter Method
TMECC 5.08	Respirometry
TMECC 7.01	Coliform Bacteria

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA NRCS	Natural Resources Conservation Service, United States Department of Agriculture, Soil Classification System

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR	Title 40: Protection of Environment

1.05 SUBMITTALS

****
NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.
****

SD-01 Preconstruction Submittals

COMPLETION OF EXCAVATION NOTIFICATION

[SD-04 Samples

[BIORETENTION SOIL MEDIA SAMPLE]

[AMENDED NATIVE SOIL MEDIA SAMPLE]

[TOPSOIL MEDIA SAMPLE]

[STRUCTURAL SOIL MEDIA SAMPLE]]

SD-06 Test Reports

TESTING AGENCY CONTACT

POST-CONSTRUCTION INFILTRATION TEST RESULTS

SD-07 Certificates

[IMPORTED TOPSOIL CERTIFICATION]

[NATIVE TOPSOIL CERTIFICATION]

[COMPOST CERTIFICATION]

[BIORETENTION SOIL MEDIA CERTIFICATION]

[AMENDED NATIVE SOIL MEDIA CERTIFICATION]

[STRUCTURAL SOIL CERTIFICATION]

FINISHED GRADE SURVEY VERIFICATION

SD-11 Closeout Submittals

MATERIAL VERIFICATION FORMS

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer with a minimum five (5) years of recent experience whose work has resulted in the successful installation of green stormwater infrastructure facilities, establishment of plant life, grading and shaping of landscape features, planting beds, lakes and wetlands or other comparable amenities. Installer shall be skilled in the landscape trade and specifically skilled in green stormwater infrastructure. Contractor shall maintain a qualified field supervisor on site at all times.

B. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated. The testing agency shall be accredited by the American Association for Laboratory Accreditation and on the United States Golf Association (USGA) preferred labs list.

2. TESTING AGENCY CONTACT; All testing and analysis shall be at the expense of the Contractor. Submit all material testing results specified including the following contact information for the testing agency used:

a. Testing Agency Name;

b. Testing Agency Address;

c. Testing Agency Phone;

d. Material Tested.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit required testing results showing material is in conformance with this Specification.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Contractor shall prevent mixing of dissimilar materials during unloading, stockpiling, and placement activities.

C. Materials shall not be delivered to the site and work cannot proceed until the submittals have been accepted by the [Design Professional][Owner].

D. All stockpiled material shall be covered and protected from contaminants, wind and water erosion. Stockpiles shall be located away from stormwater drainage paths and low-lying areas that collect water or are susceptible to erosion. Soil material shall not be stockpiled

to a height exceeding four (4) feet, or for greater than 14 days. [Where soil is stockpiled for greater than 14 days, the Contractor shall re-sample material and submit for testing per Part 1.05.] [Where stockpiling of topsoil for greater than 14 days is required, the [Design Professional][Owner] may approve the temporary distribution of the soil materials to an approved area within the Site. Such action will not permanently diminish the capability of the topsoil of the host site. The material shall be distributed in a condition more suitable for redistribution than if stockpiled long-term.]

E. The Contractor shall not handle, move, or work growing media when saturated or frozen.

F. After delivery and prior to placement, the [Design Professional][Owner] reserves the right to collect samples of the growing media. If the media is found to be outside the parameters specified in Part 2, or outside the submitted test reports and/or certificates, the Contractor shall replace the media at no additional cost to the Owner.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 BIORETENTION SOIL MEDIA

A. Bioretention soil media shall be a mixture of topsoil and compost. Material tests are required for each individual component of the bioretention soil media prior to mixing as specified in Parts 2.03 and 2.04.

****

NOTE: If Design Professional elects to use bioretention soil media outside the parameters of this specification, Design Professional to provide mix design, individual component testing and submittal requirements and parameters that replace subparagraphs B and C below.

****

[B. Bioretention soil media shall be certified to meet the following mixing composition of each component:

Bioretention Soil Media Components

Component	Composition (Percent by Volume)
Topsoil	85 - 90
Compost	10 - 15

1. Topsoil component of the bioretention soil media shall be per Part 2.03. Contractor shall provide topsoil certification submittal for topsoil component prior to mixing of bioretention soil media.

2. Compost component of the bioretention soil media shall be per Part 2.04. Contractor shall provide compost certification submittal for compost component prior to mixing of bioretention soil media.

C. The bioretention soil media shall meet the following requirements after thorough mixing of all components:

****

NOTE: Design Professional to input design saturated hydraulic conductivity (infiltration rate) minimum requirements based on design assumptions.

****

Bioretention Soil Media Testing Requirements

Item	Criteria	Test Method (or Approved Equal)
Very Fine Sand	</= 15% by weight passing 0.10 millimeter (No. 140) sieve and retained on the 0.05 millimeter (No. 270) sieve	ASTM F1632
Silt (0.05 - 0.002 mm)+ Very Fine Sand	</= 40% by weight	ASTM F1632
Saturated Hydraulic Conductivity	>/= [Design Professional to specify minimum value] inches/hour	ASTM D5084 compacted to 85 percent density per ASTM D698
pH	6.0 - 8.0	ASTM D4972
Total Phosphorus (P2O5)	</= 60 ppm	TMECC 4.03-A
Total Potassium (K2O)	>/= 78 ppm	TMECC 4.04-A
Magnesium	>/= 32 ppm	TMECC 4.05-Mg
Conductivity (Soluable Salts)	</= 1.5 mmhos/cm (dS/m)	TMECC 4.10-A
Cation Exchange Capacity	>/= 15	ASTM D7503

[D. Design Professional to input mix design and individual component testing and submittal requirements and parameters if Design Professional elects to use bioretention soil media mix outside the parameters of this specification.]

E. BIORETENTION SOIL MEDIA CERTIFICATION; Submit testing agency certification that the bioretention soil media is within the parameters specified after thorough mixing of all components. Test reports shall be specific to bioretention soil media designated for project use and shall be dated within three (3) months of submittal date. At a minimum, test report shall include the following:

1. Material supplier name, address and phone;
2. Percent by volume mix ratio of topsoil and compost components;
3. Percent by volume composition of sand, silt, clay and organic matter;
4. Percent by weight of very fine sand passing 0.10 millimeter (No. 140) sieve and retained on 0.05 millimeter (No. 270) sieve;
5. Saturated Hydraulic Conductivity;
6. pH;
7. Total Phosphorus;
8. Total Potassium;
9. Magnesium;
10. Conductivity (Soluble Salts);
11. Cation Exchange Capacity.

[12. Design Professional to input additional submittal requirements, as applicable]

F. BIORETENTION SOIL MEDIA SAMPLE; One (1) gallon sample of soil mixture.

[2.02 AMENDED NATIVE SOIL MEDIA

A. Amended native soil may be used in place of bioretention soil media only when specified by the [Design Professional][Owner].

****
NOTE: If native topsoil is included, Design Professional to specify required native topsoil to compost ratio.
****

B. Amended native soil shall consist of [50][Design Professional to input percent composition] percent native topsoil meeting the requirements of Part 2.03 and [50][

Design Professional to input percent composition] percent compost meeting the requirements of Part 2.04.

C. Native soil shall be mechanically scarified to the depth specified in the Drawings and thoroughly mixed with compost.

D. AMENDED NATIVE SOIL MEDIA CERTIFICATION; Submit testing agency certification that the amended native soil media was mixed using specified by volume composition of native topsoil and compost.

E. AMENDED NATIVE SOIL MEDIA SAMPLE; One (1) gallon sample of soil mixture.]

2.03 TOPSOIL

A. Imported Topsoil

1. Topsoil shall be fertile, friable and free of weeds, weed propagules, roots, rock, clay lumps, cinders, concrete, brick, plastics, metals, litter, debris, herbicides, and other deleterious material.

2. Topsoil requirements shall be consistent with loam, sandy clay loam, or clay loam soil properties.

3. Topsoil pH shall be between 6 and 8 per ASTM D4972

4. Topsoil shall be between 10 percent and 20 percent organic matter by dry weight per ASTM F1647.

5. Topsoil gradation shall be determined per ASTM D6913 or approved equal meeting the following gradation requirements:

Topsoil Gradation Requirements

Sieve Size	Passing (Percent by Weight)
19.0 mm (3/4 inch)	100
75 micrometers (No. 200)	0 - 25

6. Topsoil composition shall be determined per ASTM F1632 or approved equal meeting the following requirements:

Topsoil Composition Requirements

Component (Particle Size)	Composition (Percent by Weight)
Sand (2.0 - 0.05 mm)	35 - 60
Silt (0.05 - 0.002 mm)	20 - 30
Clay (<0.002 mm)	20 - 35

7. IMPORTED TOPSOIL CERTIFICATION; At least 30 days prior to starting Work, submit testing agency certification that topsoil is within the parameters specified prior to mixing with other growing media components. Test reports shall be specific to topsoil media designated for project use and shall be dated within six (6) months of submittal date. At a minimum certification shall include the following:

   a. Material supplier name, address and phone;

   b. Gradation;

   c. Percent by volume composition of sand, silt, clay and organic matter;

   d. pH.

8. TOPSOIL MEDIA SAMPLE; One (1) gallon sample of soil mixture.

****

NOTE: Design Professional to include native topsoil component if native soil is acceptable given project site conditions.

****

[B. Native Topsoil

1. Native site topsoil may be used in lieu of imported topsoil if material meets the requirements of Part 2.03, A., and/or is deemed acceptable by the [Design Professional][Owner].

2. Native topsoil may only be obtained from well-draining sites with onsite topsoil depths of four (4) inches or greater.

3. If native topsoil does not meet requirements of Part 2.03, A., native topsoil shall be amended at the Contractor's expense by amendments identified herein per testing agency recommendations.

4. If native topsoil is amended, resubmit test results after the topsoil mixture has been thoroughly blended. If the material is deemed unsuitable by the [Design Professional][Owner], the material shall be reconditioned as recommended by the testing agency.

5. NATIVE TOPSOIL CERTIFICATION; At least 30 days prior to starting Work, submit testing agency certification that topsoil is within the parameters specified prior to mixing with other growing media components. At a minimum test report shall include the following:

   a. Gradation;

   b. Percent by volume composition of sand, silt, clay and organic matter;

c. pH;

d. Amendment product data and mix ratios.]

2.04 SOIL AMENDMENTS

****

NOTE: Compost requirements listed here are necessary to meet bioretention soil media or amended native soil media submittal requirements. Do not delete if specifying bioretention soil media and/or amended native soil media.

****

[A. Compost

1. Compost shall be a locally sourced homogeneous and friable mixture of partially decomposed organic matter, resulting from composting.

2. Compost supplier shall participate in the US Composting Council's Seal of Testing Assurance (STA) Program, which requires testing through specific approved labs using test methods from the TMECC manual to characterize compost.

3. The Compost shall meet the following requirements:

Compost Testing Requirements

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Stability (Carbon Dioxide Evolution Rate)	< 4 mg CO2-C/g OM per day	TMECC 5.08-B
Oxygen Uptake	< 150 mg O2/kg volatile solids per hour	TMECC 5.08-A
pH	6.0 - 8.5	TMECC 4.11-A
Conductivity (Soluable Salts)	< 4.0 mmhos/cm (dS/m)	TMECC 4.10-A
Particle Size	98 percent passing 3/8" (10 mm) sieve (by dry weight)	TMECC 2.02-B
Organic Matter	30 percent - 60 percent (by mass)	TMECC 5.07-A

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Foreign Matter*	< 1 percent (by mass)	*Foreign matter is defined as any matter over 2 mm in any dimension that results from human intervention and having organic or inorganic constituents such as metal, glass, clay and synthetic polymers (i.e. plastic and rubber).
Trace Metals	< Ceiling Concentrations	40 CFR 503.13 or TMECC 4.06
Moisture Content (percent dry weight)	40 percent - 60 percent	TMECC 3.09-A
Salmonella (Pathogen)	< 3 MPN/4 grams (by dry weight)	TMECC 7.01-B
Fecal Coliform Bacteria (Pathogen)	< 1,000 MPN/gram (by dry weight)	TMECC 7.01-B

4. COMPOST CERTIFICATION; Submit testing agency certification that compost is within the parameters specified prior to mixing with other growing media components. Test reports shall be specific to media designated for project use and shall be dated within six (6) months of submittal date. At a minimum test report shall include the following:

   a. Material supplier name, address, phone, and verification of participation in the STA Certified Compost program;

   b. Stability (Carbon Dioxide Evolution Rate);

   c. Oxygen Uptake;

   d. pH;

   e. Conductivity (Soluble Salts);

   f. Particle Size;

   g. Organic Matter;

   h. Foreign Matter;

   i. Trace metals;

   j. Moisture Content;

   k. Salmonella;

l. Fecal Coliform Bacteria.]

[B. Lime shall be ground agricultural limestone, a minimum of 90 percent passing the 2.36 millimeter (No. 8) sieve and a minimum of 65 percent calcium carbonate equivalent.]

[C. Sulfur

1. Sulfur shall be granular and biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through 3.35 millimeter (No. 6) sieve and a maximum of ten (10) percent passing through 425 micrometer (No. 40) sieve.

2. Iron sulfate shall be granulated ferrous sulfate, containing a minimum of 20 percent iron and a minimum of ten (10) percent sulfur.

3. Aluminum sulfate shall be commercial grade and unadulterated.]

[D. Not applicable]

[2.05 STRUCTURAL SOIL

A. Structural soil shall be CU-Structural Soil®, a proprietary material patented by Cornel University (US Patent # 5,849,069), or approved equal. Only licensed producers are allowed to supply this material, meeting the specifications described.

B. Material tests are required for each individual component of the structural soil media prior to mixing as specified specified herein.

C. Structural soil shall be a uniformly blended mixture of Crushed Stone, Clay Loam and Hydrogel, mixed to the following proportion:

Structural Soil Media Composition Requirements

Material	Composition (Percent by Weight)
Clay Loam	20 units dry weight
Crushed Stone	100 units by dry weight
Hydrogel	0.03 units dry weight
Moisture Content	AASHTO T-99 optimum moisture

D. Structural soil mixing shall be performed at the licensed producer's yard using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. No mixing of structural soil at the project Site shall be permitted.

E. Clay Loam

1. Soil shall be a "clay loam" or "loam" based on the USDA NRCS as determined by mechanical analysis per ASTM D5268 and it shall be uniform composition, without admixture of subsoil. Mechanical analysis for the clay loam shall be as follows:

Structural Soil - Mechanical Analysis of Clay Loam

Textural Class (Particle Size)	Composition (Percent by Weight)
Gravel (>2.0 mm)	< 5
Sand (2.0 - 0.05 mm)	20 - 45
Silt (0.05 - 0.002 mm)	20 - 50
Clay (<0.002 mm)	20 - 40

2. Clay loam shall be free of stones greater than one-half (1/2) inch, lumps, plants and their roots, debris and other extraneous matter over one (1) inch in diameter or excess of smaller pieces of the same materials as determined by the [Design Professional][Owner].

3. Clay loam shall be obtained from naturally well-drained areas, which have never been stripped of topsoil before and have a history of satisfactory vegetative growth. Clay loam shall be the product of a commercial processing facility specializing in production of stripped natural topsoil. No topsoil shall come from USDA - classified prime farmland.

4. Clay loam shall contain not less than two (2) percent nor more the five (5) percent organic matter as determined by ASTM D5268.

5. The Contractor shall submit soil testing agency results meeting the following chemical requirements:

Structural Soil - Soil Testing Requirements

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Carbon-to-Nitrogen Ratio	< 33:1	TMECC 5.02-A
pH	5.5 - 6.5	TMECC 4.11-A or ASTM D4972
Conductivity (Soluable Salts)	< 1.0 mmhos/cm (dS/m)	TMECC 4.10-A
Cation Exchange Capacity	> 10	ASTM D7503

6. Contractor shall submit analysis for nutrient levels by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, iron, zinc, calcium and extractable aluminum. Nutrient test shall include the testing agency recommendations for supplemental additions to the soil as calculated by the amount of material to be added per volume of soil for the type of plants to be grown in the soil.

7. Contractor shall submit analysis for levels of toxic elements and compounds including arsenic, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, zinc and PCB. Test results shall be cited in milligrams per kilogram.

F. Crushed Stone

1. Stone shall be granite or limestone and angular in shape with dimensions not exceeding 2.5:1.0 for any two(2) dimensions.

2. The Contractor shall submit testing agency certification of the crushed stone gradation meeting the following requirements:

Structural Soil - Crushed Stone Composition Requirements

Sieve Size	Passing (Percent by Weight)
75 mm (3 inch)	100
37.5 mm (1.5 inch)	90
25 mm (1 inch)	20 - 55
20 mm (0.75 inch)	10

G. Hydrogel

1. Hydrogel shall be potassium propenoate-propenamide copolymer Hydrogel.

2. Hydrogel shall be Gelscape® Hydrogel Tackifier as manufactured by Amereq. Corp. (800) 832-8788, or approved equal.

H. STRUCTURAL SOIL CERTIFICATION; Submit testing agency certification that the clay loam, crushed stone and hydrogel used in the structural soil mix is within the parameters specified prior to mixing. Test reports shall be specific to structural soil media designated for project use and shall be dated within six (6) months of submittal date. At a minimum test report shall include test results for the following:

1. Material supplier name, address and phone;

2. Soil percent by volume composition of sand, silt, clay and organic matter;

3. Soil chemical properties:

a. Carbon-to-Nitrogen Ration;

b. pH;

c. Conductivity (Soluble Salts);

d. Soil absorption ratio;

e. Nutrient and chemical content by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, iron, zinc, calcium and extractable aluminum per appropriate TMECC test method;

f. Toxic Element/Compound content in milligrams per kilogram for Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Zinc, and Polychlorinated Biphenyls (PCB) per appropriate TMECC test method;

4. Crushed stone gradation;

5. Optimum compaction moisture content per AASHTO T-99 test results for structural soil mix without removing oversized aggregate;

6. Measured dry-weight percentage of stone in mixture;

7. California Bearing Ratio test results for each structural soil sample compacted to peak standard density.

I. STRUCTURAL SOIL MEDIA SAMPLE; One (1) gallon sample of soil mixture.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Project conditions shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.

2. When conditions detrimental to the proper growth of plant material are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the [Design Professional][Owner] prior to installation.

C. Control and Protection

1. The footprint of the facility shall be kept reasonably dry and stormwater runoff to the facility shall be limited throughout the duration of Work to the maximum extent practicable. Prior to growing media placement activities, the perimeter of the Site shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Blocking of curbs, curb cuts, inlets, and other temporary protection and control measures may be necessary to divert stormwater away from the Site during construction.

3. Unless designated for removal in the Drawings, protect all trees and vegetation per Sections 02949 Green Stormwater Infrastructure Existing Tree Protection and 02950 Green Stormwater Infrastructure Selective Vegetation Removal.

3.02 INSTALLATION

A. Excavation

1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.

2. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of soil and/or aggregate materials.

3. COMPLETION OF EXCAVATION NOTIFICATION; Notify the [Design Professional][Owner] within 48 hours of completion of excavation and prior to placement of all media layers.

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[B. Bioretention Soil Media Placement

1. The growing media shall have a moisture content low enough to prevent visible clumping and compaction during placement.

2. Contractor shall place engineered soil media in horizontal lifts not to exceed six (6) inches for the entire green stormwater infrastructure facility. Each lift shall be lightly watered to encourage settling.

3. If the growing media becomes contaminated with undesired materials during construction, the undesired materials shall be removed and replaced with uncontaminated growing media at the Contractor's expense. If the [Design Professional][Owner] deems that any of the material placed is not in conformance with this specification, then the Contractor shall remove the material in question and replace with clean material meeting requirements of part 2.01.

4. To account for settling, Contractor shall install a two (2) to three (3) inch surcharge lift of growing media over the entire green stormwater infrastructure facility. Surcharge lift shall be allowed to settle for a minimum of 48 hours prior to bringing green stormwater infrastructure to finished grade.

5. Mechanical compaction of the growing media is not permitted. Compaction of the growing media shall not exceed 85 percent density per ASTM D698.]

[C. Amended Native Soil Media Placement

1. The growing media shall have a moisture content low enough to prevent visible clumping and compaction during placement.

2. Native soil shall be mechanically scarified to the depth specified in the Drawings and thoroughly mixed with compost.

3. If the growing media becomes contaminated with undesired materials during construction, the undesired materials shall be removed and replaced with uncontaminated growing media at the Contractor's expense. If the [Design Professional][Owner] deems that any of the material placed is not in conformance with this specification, then the Contractor shall remove the material in question and replace with clean material meeting requirements of part 2.01.

4. Mechanical compaction of the growing media is not permitted. Compaction of the growing media shall not exceed 85 percent density per ASTM D698.]

[D. Topsoil Placement

1. Topsoil that is a component of the bioretention soil media shall be mixed as specified per part 2.01.

2. Stripping of native topsoil shall be as follows:

a. The full depth of topsoil shall be stripped from all grading areas, using a phased approach where appropriate.

b. Topsoil up to a minimum depth of six (6) inches or the entire "A" horizon of the applicable soil series being disturbed as published in the Published County Soil

Survey or other detailed soil survey, shall be stripped and stockpiled from all areas to be excavated or filled.

3. Imported or native topsoil to be used independently shall be placed on the as follows:

a. Scarify subgrade to a depth of six (6) inches.

b. Place Topsoil to a minimum depth of six (6) inches. Limit excavation to areas that will be installed within the same day.

c. Contractor shall not leave pits open and will be required to clearly mark or warn the public of their locations.

d. Backfill topsoil with amendments thoroughly mixed to a minimum depth to meet grades as shown in the Drawings. Do not backfill or excavate if fill or sub-grade is frozen.

4. Topsoil Distribution

a. Place topsoil in three (3) inch lifts. Achieve an approximately uniform, stable thickness, finished grading, and surface-water drainage systems. Lightly water topsoil after placement to encourage settling.

b. Prevent excess compaction of the materials.

c. Protect the materials from wind and water erosion before and after seeding or planting.

d. Maintain positive surface drainage. Fill low spots with topsoil except where depressions are indicated in the Drawings.

e. Manually spread topsoil around trees, permanent structures, and paving to prevent damage to adjacent trees and structures.]

[E. Structural Soil Media Placement

1. Do not proceed with installation of structural soil material until all walls, curb, footings, and utility work in the area have been installed unless Site elements depend on structural soil for foundation support. Do not over-excavate compacted subgrades of adjacent pavement or structures.

[2. Underdrain shall be installed within aggregate media as specified in the Drawings and per Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02954 Green Stormwater Infrastructure Piping.]

3. Install Structural Soil in six (6) inch lifts and compact each lift. Compact all materials to peak dry density from a standard compaction curve per AASHTO T-99. No compaction shall occur when moisture content exceeds maximum defined in the Structural Soil Media Composition Requirements specified herein. Delay compaction 48 hours if moisture content exceeds maximum allowable and protect Structural Soil during delays in compaction with plastic or plywood.]

3.03 TOLERANCES

A. The Contractor must place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Immediately protect the growing media from contamination by undesired materials, trash, debris, water containing cement, clay, silt or materials that will alter the composition of the material by covering with media liner, plastic or plywood.

B. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the Site until vegetation is fully established.

C. Vegetation shall be installed immediately following installation of topsoil per Section [02951 Green Stormwater Infrastructure Plants][,][and][02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding][and][, and/or][02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]. If Site conditions limit vegetation of facility immediately following installation of soil, Contractor shall implement additional measures to cover and protect the growing media for duration of exposure.

D. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

E. Fully clean all non-vegetated areas where growing media has deposited, including but not limited to pavement.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period as defined in Section

02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing at up to [three (3)] testing locations once all soil and aggregate media has been installed and prior to installation of vegetation. Contractor shall conduct testing within ten (10) days of installation of surface media and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS.

****

NOTE: Design Professional to input design infiltration rate minimum requirements based on design assumptions. Coordinate infiltration rate minimum between Sections 3.06 and 2.01.

****

B. Average post-construction infiltration rate shall meet or exceed pre-construction infiltration rates and shall be no less than [0.25 inches per hour][Design Professional to specify design infiltration rate] with no single test less than [0.25 inches per hour][Design Professional to specify design infiltration rate].

C. Owner reserves the right to collect a sample of the material for independent testing at any time during the Establishment Period.

D. Growing media that fails to meet post-construction infiltration requirements shall be remediated as recommended by the [Design Professional][Owner]. Amended media shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the media meets post-construction infiltration requirements at the discretion of the [Design Professional][Owner].

3.08 WARRANTY

A. MATERIAL VERIFICATION FORMS; At least 10 working days prior to the Final Inspection, the Contractor shall submit copies of material verification forms, such as load tickets, invoices, sales receipts, and/or similar items to verify quantity of material delivered to the site.

B. The Contractor shall warrant the green stormwater infrastructure growing media through the duration of the Establishment Period. A random five (5) gallon sample of growing media may be collected by the [Design Professional][Owner] anytime during the first year after placement for testing and verification.

C. If at any time during the Establishment Period soil loss occurs or media fails to infiltrate due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the media and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

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02948

GSI SPECIFICATIONS

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SECTION 02948

GREEN STORMWATER INFRASTRUCTURE MEDIA LINERS

****

NOTE: This guide specification includes requirements for both permeable and impermeable media liners including geotextile, geogrid, geomembrane, and clay liner. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Media liners are synthetic or clay liners used to provide stabilization and/or separation of soil and aggregate media within a green stormwater infrastructure facility, and to limit mixing of media layers. Media liners can be permeable or impermeable, allow or prevent stormwater infiltration, stabilize media layers, and protect adjacent infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install media liners as depicted in the Drawings and as specified herein. Media liners shall be measured in the units of [Square Yards][Square Feet] and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

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NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
ASTM D751	Standard Test Methods for Coated Fabrics
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D3786/D3786M	Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D4491/D4491M	Standard Test Method for Water Permeability of Geotextiles by Permittivity

ASTM D4533/D4533M	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5884/D5884M	Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
ASTM D5885/D5885M	Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7003/D7003M	Standard Test Method for Strip Tensile Properties of Reinforced Geomembranes
ASTM D7004/D7004M	Standard Test Method for Grab Tensile Properties of Reinforced Geomembranes
ASTM D7238	Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
ASTM E96/E96M	Standard Test Method for Water Vapor Transmission of Materials

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI GM 22	Standard Specification for Test Methods, Required Properties and Testing Frequencies for Scrim Reinforced Polyethylene Barriers Used in Exposed Temporary Applications

GRI GT 13(a) Standard Specification for Test Methods and Properties for Geotextiles Used as Separation between Subgrade Soil and Aggregate

1.05 SUBMITTALS

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NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

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SD-01 Preconstruction Submittals

MEDIA LINER PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INFORMATION

SD-06 Test Reports

IMPERMEABLE CLAY LINER FIELD VERIFICATION

SD-07 Certificates

MANUFACTURER QUANTITY CERTIFICATION

MANUFACTURER QUALITY CERTIFICATION

IMPERMEABLE CLAY LINER MATERIAL CERTIFICATION

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. The manufacturer shall have previously demonstrated ability to produce the media liner by having at least two (2) years continuous experience in the manufacturing of the media liner and successfully manufactured a minimum of ten (10) million square feet of the media liner.

2. MANUFACTURER QUANTITY CERTIFICATION; Submit manufacturer certification verifying a minimum of 10 million square feet of the media liner being manufactured as of the date of the submittal.

3. MANUFACTURER QUALITY CERTIFICATION; Submit manufacturer certification, verifying that the quality of the resin used to manufacture the media liner meets the requirements specified in Part 2.

1.07 QUALITY CONTROL

A. Quality control certificates, signed by the manufacturer's quality assurance manager, shall be documented for each roll delivered to the Site and shall include the following:

1. Manufacturer Name;
2. Product Identification;
3. Thickness;
4. Roll Dimension;
5. Roll Number;
6. Lot Number;
7. Sampling Procedures;
8. Sampling Frequency;
9. Test Results of conformance sampling.

B. Conformance sampling shall be completed at a minimum frequency of one (1) sample every 50,000 square feet of media liner delivered. If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality assurance at no additional cost to the Owner.

C. MANUFACTURER INFORMATION; Submit manufacturer instructions for each product, including, but not limited to fabrication, delivery and handling, installation and protection. Include the following manufacturer information:

1. Supplier name, address and phone;
2. Documents for material warranty;
3. Documents for media liner workmanship, including, but not limited to batch identifications and associated roll numbers;
4. Origin, identification and production information for the resin used in the media liner, including, but not limited to the supplier's name, brand name and production plant for the resin;
5. Media liner properties including but not limited to weight, grab tensile strength, grab tensile elongation, tongue tear, California Bearing Ratio (CBR) puncture, bursting strength, water vapor transmission, high pressure oxidative induction time, and ultraviolet resistance as specified in Part 2.
6. Product warranty documentation

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Materials shall be wrapped with a protective cover to avoid damage due to handling, water, sunlight, and contaminants. The Contractor shall be responsible for replacement of damaged or unacceptable material as identified by the [Design Professional][Owner] at no additional cost to the Owner.

C. During storage, the media liner shall be elevated off the ground and adequately covered to protect them from dirt, grease, moisture, mud, mechanical abrasions, and excessive heat that may damage the media liner material. The Contractor shall avoid dragging the media liner on rough soil subbase. Media liner shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two (2) rolls high.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 PERMEABLE GEOTEXTILE LINER

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

A. Permeable geotextile liner shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer name and product information] or approved equal.

B. Permeable geotextile liner shall be comprised of non-woven (with elongation greater than or equal to 50 percent) polypropylene staple fibers, conforming to the following property requirements, as specified in GRI GT 13(a).

Permeable Geotextile Liner Required Properties

Property(unit)(min/max)	Class 1	Class 2	Class 3	Test Method (or approved equal)
Grab Tensile Strength (lb) (min)	203	158	113	ASTM D4632/D4632M

Property(unit)(min/max)	Class 1	Class 2	Class 3	Test Method (or approved equal)
Trapezoid Tear Strength (lb) (min)	79	56	41	ASTM D4533/D4533M
CBR Puncture Strength (lb) (min)	440	320	230	ASTM D6241
Permittivity (sec-1) (min)	1.0	1.0	1.0	ASTM D4491/D4491M
Apparent Opening Size (inches) (max)	0.024	0.024	0.024	ASTM D4751
Ultraviolet Stability (% of strength retained at 500 light hours) (min)	80	70	60	ASTM D7238

[2.02 PERMEABLE GEOGRID LINER

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

A. Permeable geogrid liner shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer name and product information] or approved equal.]

[2.03 IMPERMEABLE GEOMEMBRANE LINER

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

A. Impermeable geomembrane liner shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer name and product information] or approved equal.

B. The impermeable geomembrane liner shall meet the following property requirements, as specified in GRI GM 22.

Impermeable Geomembrane Liner Required Properties

Property(unit) (min/max value)	Category 120 mil	Category 212 mil	Category 38 mil	Test Method (or approved equal)
Weight(lb/1000 ft2)(min)	94	53	34	ASTM D751
Grab Tensile Strength (lb)(min)	114	76	59	ASTM D7004/D7004M
Grab Tensile Elongation (%)(min)	14	14	14	ASTM D7004/D7004M
Tongue Tear (lb)(min)	53	40	15	ASTM D5884/D5884M
CBR Puncture (lb)(min)	320	220	150	ASTM D6241
Bursting Strength (lb/in2)(min)	130	85	60	ASTM D3786/D3786M
Water Vapor Transmission (WVT) (g/m2-day)(max)	0.4	0.7	1.7	ASTM E96/E96M
High Pressure Oxidative Induction Time (OIT) (minute)(min)	1000	1000	1000	ASTM D5885/D5885M
Ultraviolet (UV) Resistance (Florescent light method) [% of strength and elongation retained after 10,000 light hours](min)	50	50	50	ASTM D7238ASTM D7003/D7003M

C. The resin from which the impermeable geomembrane liner is made shall have a density greater than or equal to 0.932 grams per milliliter, and have a melt index value per ASTM D1238 of less than 1.0 grams per ten (10) minutes. Formulated sheet density shall be greater than or equal to 0.94 grams per milliliter.]

[2.04 IMPERMEABLE CLAY LINER

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

[A. Impermeable clay liner shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer name and product information] or approved equal.]

[B. Impermeable clay liner shall have a hydraulic conductivity less than or equal to [1x10^7 cm/s][Design Professional to specify allowable hydraulic conductivity], as measured per ASTM D5084, when compacted at [95% Standard][Design Professional to specify required compaction at which hydraulic conductivity is to be measured.] proctor.]

[C. IMPERMEABLE CLAY LINER MATERIAL CERTIFICATION; Submit testing agency report at least [60 days prior to installation][Design Professional to specify desired time frame] demonstrating that Impermeable Clay Liner meets requirements specified. At a minimum test report shall include the following:

1. Material supplier name, address, and phone

2. Compaction Curve per ASTM D698

3. Maximum Dry Unit Weight per ASTM D698

4. Optimum water content per ASTM D698

5. Hydraulic Conductivity per ASTM D5084 in cm/s at specified compaction per ASTM D698 at water content less than optimum water content

6. Hydraulic Conductivity per ASTM D5084 in cm/s at specified compaction per ASTM D698 at water content greater than optimum water content]]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

B. Soil Preparation: Remove and dispose of stones larger than one (1) inch in any dimension, sticks, roots, litter, debris, extraneous matter per Part 3.04.

C. Project Conditions

1. Media liner placement shall not proceed at an ambient temperature below 32 degrees Fahrenheit or above 100 degrees Fahrenheit [unless authorized, in writing, by the [Design Professional][Owner]]. Media liner placement shall not be performed during precipitation, in an area of ponded water, or excessive winds that adversely affect the media liner placement.

2. MEDIA LINER PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of media liner.

D. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation: Facility shall be excavated [per Section 02939 Green Stormwater Infrastructure Earthwork] to the dimensions, side slopes, and elevations specified in the Drawings.

B. Anchor Trench: Anchor trench shall be constructed as shown in the Drawings [or as recommended by the manufacturer].

C. Liner Placement

[1. Permeable Geotextile Liner

a. Permeable geotextile liner shall be placed loosely with no wrinkles or folds, and with no void space between the permeable geotextile liner and adjacent surface.

b. Successive sheets of permeable geotextile liner shall overlap [per manufacturer's recommendations][at a minimum of 12 inches][Design Professional to specify desired length], with the upstream (higher in elevation) sheet overlapping the downstream (lower in elevation) sheet.

c. All seams and overlaps shall be subject to the approval of the [Design Professional][Owner].

d. Prior to covering the permeable geotextile liner with materials, the permeable geotextile liner shall be inspected for any damage (e.g. holes, tears, rips etc.) incurred during placement. [The inspection shall be performed by the [Design Professional][Owner].]

e. Damaged permeable geotextile liner, as identified by the [Design Professional][Owner], shall be repaired or replaced immediately by the Contractor per manufacturer's recommendations at no additional cost to the Owner.]

[2. Permeable Geogrid Liner

a. Permeable geogrid liner shall be placed with no wrinkles or folds, and with no void space between the permeable geogrid liner and adjacent surface.

b. Successive sheets of permeable geogrid liner shall overlap [per manufacturer's recommendations][at a minimum of 12 inches][Design Professional to specify desired length], with the upstream (higher in elevation) sheet overlapping the downstream (lower in elevation) sheet. All seams and overlaps shall be subject to the approval of the [Design Professional][Owner].

c. Prior to covering the permeable geogrid liner with materials, the permeable geogrid liner shall be inspected for any damage (e.g. tears, rips, etc.) incurred during placement. [The inspection shall be performed by the [Design Professional][Owner].]

d. Sub TitleDamaged permeable geogrid liner, as identified by the [Design Professional][Owner], shall be repaired or replaced immediately by the Contractor per manufacturer's recommendation at no additional cost to the Owner.]

[3. Impermeable Geomembrane Liner

a. Impermeable geomembrane liner shall be installed in accordance with manufacturer's recommendations. The layout shall have consistent field seams, kept to a minimum.

b. For impermeable geomembrane liner placed at 4:1 slopes (horizontal:vertical) or steeper, impermeable geomembrane liner seams shall be oriented in the direction of the slope (e.g. perpendicular to top of slope). Seams shall be subject to the approval of the [Design Professional][Owner].

c. Impermeable geomembrane liner shall be anchored per manufacturer's recommendations.

d. Edges of impermeable geomembrane liner shall be properly weighted to avoid uplift due to wind.

e. Damaged impermeable geomembrane liner, as identified by the [Design Professional][Owner], shall be repaired or replaced immediately by the Contractor per manufacturer's recommendations at no additional cost to the Owner.]

[4. Impermeable Clay Liner

****

NOTE: Design Professional shall include installation requirements for impermeable clay liner or direct contractor to a project-specific specification developed by Design Professional. Design Professional to include compaction requirements based on minimum allowable

hydraulic conductivity or specify alternate installation requirements. Design professional to specify frequency of field testing.

****

[a. Impermeable clay liner shall be installed in accordance with manufacturer's recommendations.]

[b. Install impermeable clay liner [in up to 12-inch lifts and compact each lift][Design Professional to specify desired thickness].]

[c. Compact each lift to attain a hydraulic conductivity required based on results of IMPERMEABLE CLAY LINER MATERIAL CERTIFICATION.]

[d. IMPERMEABLE CLAY LINER FIELD VERIFICATION; Conduct at least one (1) nuclear density test per ASTM D6938 for every [5,000 square feet of impermeable clay liner installed][Design Professional to specify frequency] at the time of installation. Submit report demonstrating that installed impermeable clay liner meets requirements specified. At a minimum test report shall include the following:

1) Material supplier name, address, and phone

2) Operator name, organization, address, and phone

3) Test location transcribed on Drawing with Test Number or Test Identification

4) Dry density for each test conducted

5) Water content for each test conducted

6) Percent compacted for each test conducted]

e. Impermeable clay liner that is damaged or does not meet requirements shall be repaired or replaced immediately by the Contractor at no additional cost to the Owner.]

D. Backfill: [Backfill shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.] Install [soil][and][aggregate media] over media liner to finished grade per Section [02946 Green Stormwater Infrastructure Aggregate Media][and][02947 Green Stormwater Infrastructure Growing Media and Soil Amendments], as shown in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place product(s) based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

[A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified Section 02937 Green Stormwater Infrastructure Site Activity Plan.]

[B. Not Applicable]

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the media liner. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

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02949

GSI SPECIFICATIONS

****

SECTION 02949

GREEN STORMWATER INFRASTRUCTURE EXISTING TREE PROTECTION

****

NOTE: This guide specification includes requirements for existing tree protection. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically deleted from this specification.

Reference to City of APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. This Section includes the protection and trimming of existing trees that interfere with, or are affected by, execution of the Work, whether temporary or permanent construction.

B. Definitions

1. Tree Protection Zone: Area surrounding individual trees or groups of trees to remain during Work, and defined by the Drip Line of individual trees or the perimeter Drip Line of groups of trees, unless otherwise indicated.

2. Drip Line: Area defined by the outermost circumference of the tree canopy.

3. Diameter Breast Height (DBH): The outside bark diameter of an existing tree measured 4.5 feet above the ground, on the uphill side of the tree.

4. Caliper: Diameter of the stem or trunk of a tree measured above existing grade. For trees up to 4.5 inches in diameter, Caliper shall be measured six (6) inches above existing grade. If the Caliper measured at six (6) inches is greater than 4.5 inches, the Caliper shall be measured at 12 inches above existing grade.

5. Tree Removal: Demolition of existing tree, including cutting down the tree, grubbing the stump, and removing and disposing of the demolished tree material from the Site.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for protection of existing trees, dictated in the Drawings and specified herein. Existing tree protection shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

Existing Tree Protection Measurement and Payment Units

Item	Unit
Tree Protection Fencing	Linear Feet
Tree Removal	Each
Tree Replacement	Each 2-inch caliper replacement tree

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

02948 Green Stormwater Infrastructure Media Liners

02951 Green Stormwater Infrastructure Plants

02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1	The American Standard for Nursery Stock
ANSI A300	Tree Care Operations: Standard Practices for Tree, Shrub and Other Woody Plant Maintenance

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

TREE REPLACEMENT PLAN

TREE REMOVAL IDENTIFICATION

TREE PROTECTION PRE-CONSTRUCTION CONFERENCE

1.06 QUALITY ASSURANCE

A. Tree Service Qualifications: Work shall be performed by an experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Work and that will assign an experienced, qualified Arborist to the Work. The Arborist shall be certified by the International Society of Arboriculture.

B. Tree Pruning Standards: Comply with ANSI A300 Part 1, "Trees, Shrubs and other Woody Plant Maintenance-Standard Practices (Pruning)."

1.07 QUALITY CONTROL

A. A qualified Arborist as identified in Part 1.06, A. shall be on the Site on a full-time basis during execution of tasks related to tree protection.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Do not store construction materials, debris, or excavated material inside Tree Protection Zone(s).

B. Site utilization shall protect root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials, and, protecting root systems from ponding, eroding, compaction or excessive wetting caused by dewatering operations.

C. Do not permit vehicles or foot traffic within Tree Protection Zone(s).

PART 2 PRODUCTS

2.01 TREE PROTECTION FENCING

A. Tree protection fencing shall be Mesh Construction Fencing by Conweed or approved equal. Tree protection fencing shall be orange in color and minimum 48 inches in height Fence posts shall be Metal T-Posts.

2.02 TREE REPLACEMENT

A. TREE REMOVAL IDENTIFICATION; Submit any trees to be removed not specifically identified for removal in the Drawings. Tree removal identification submittal shall include the following:

1. Location of tree with northing/easting points;
2. Species of tree;
3. DBH of tree;
4. And purpose for removal.

B. TREE REPLACEMENT PLAN; Contractor shall submit a tree replacement plan for all trees removed not specifically identified for removal in the Drawings. Tree replacement plan shall include the following:

1. Location of replacement tree(s) with northing/easting points;
2. Species of replacement tree(s);
3. And Caliper of replacement tree(s).

C. Replacement trees shall be in accordance with Section 02951 Green Stormwater Infrastructure Plants.

PART 3 EXECUTION

3.01 PREPARATION

A. Trees, tree roots and limbs within the construction limits shall be protected against injury or damage through the duration of the Work. All trees and vegetation shall remain and be protected unless designated otherwise by the [Design Professional][Owner].

B. Any trees damaged or destroyed during construction due to construction activities shall be treated or removed at the Contractor's expense per Part 3.02, E. and/or F.

C. Construction Access

1. Submit construction access location and duration of temporary access within Tree Protection Zone(s) per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

2. There shall be no construction traffic within the Tree Protection Zone(s). If no other access is obtainable, place four (4) foot by eight (8) foot sheets of three-quarter (3/4) inch plywood atop nine (9) inches of shredded wood pulp or mulch over entire area proposed for vehicular traffic.

3. After removal of mulch and plywood, Contractor shall aerate the surface soil, per Part 3.02, E.

4. All disturbed areas shall be re-sodded per Section 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding or pavement restored in-kind.

D. Project Conditions

1. Tree protection fencing shall be installed prior to construction operations.

2. Proceed with Work only when existing and forecasted weather conditions are suitable for Work.

E. TREE PROTECTION PRE-CONSTRUCTION CONFERENCE: Before tree protection and trimming operations begin, the Contractor shall conduct a meeting with the [Design Professional][Owner] at the Site to review tree protection and trimming procedures and responsibilities. Contractor shall submit tree protection methods to be used during construction.

3.02 INSTALLATION

A. Tree Protection

1. Install tree protection fencing around Tree Protection Zone(s) to protect remaining trees and vegetation from damage due to Work. Maintain tree protection fencing and remove when Work is complete.

2. Preferred Fencing Installation Method: Where trees are located in open areas not constricted by existing pavement, utilities or proposed grading, the tree protection fencing shall be installed a minimum of one (1) foot outside the Drip Line of the tree.

3. Alternative Fencing Installation Method 1: Where trees are located in areas constricted by utilities or proposed grading, the tree protection fencing shall be installed as close to the Drip Line as possible OR as follows:

Alternative Fencing Installation Method 1 by Tree Size

Tree Size (DBH)	Fence Placement Requirement
Small Trees (<9 inches)	Minimum of 5 feet from face of tree along the side of constriction. All other sides shall be 1 foot outside the dripline of the tree.
Medium (10 inches to 15 inches)	Minimum of 10 feet from the face of the tree along the side of constriction. All other sides shall be 1 foot outside the Drip Line of the tree.
Large (>15 inches)	Minimum of 15 feet from the face of the tree along the side of constriction. All other sides shall be 1 foot outside the Drip Line of the tree.

4. Alternative Fencing Installation Method 2: Where trees are located adjacent to existing pavement, install tree protection fencing adjacent to pavement. All other sides shall be a minimum of one (1) foot outside the Drip Line of the tree.

5. Alternative fencing installation method shall be submitted to the [Design Professional][Owner].

B. Excavation

1. Do not excavate within Tree Protection Zone(s), unless otherwise indicated in the Drawings or approved by the [Design Professional][Owner].

2. Install shoring or other protective support systems to minimize sloping excavations within the vicinity of the Tree Protection Zone(s). Do not allow soil loss from Tree Protection Zone(s) in instances where the Drip Line is a point of beginning for excavation or grading operations. If soil loss occurs, Contractor shall correct the problem within 24 hours of occurrence.

3. Where excavation is required within the Drip Line of the tree, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

4. Where utility trenches are required within Tree Protection Zone(s), tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

5. Roots damaged during excavation or trenching activities shall be pruned per Part 3.02, D.

C. Regrading

1. Regrading in the vicinity of an existing tree shall be based on lowering, minor and moderate fill conditions, as defined in the following subsections. Roots damaged by regrading activities shall be pruned per Part 3.02, D.

2. Grade Lowering: Where new finished grade is indicated below existing grade around trees, slope grade away from trees as recommended by Arborist, unless otherwise indicated in the Drawings.

3. Minor Fill: Where existing grade is six (6) inches or less below finished grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations. Do not operate equipment within Tree Protection Zone(s) when fine grading topsoil is placed above existing grade.

4. Moderate Fill: Where existing grade is more than six (6) inches but less than 12 inches below finished grade, place storage aggregate media No. 57 stone per Section 02946 Green Stormwater Infrastructure Aggregate Media, permeable liner per Section 02948 Green Stormwater Infrastructure Media Liners, and topsoil per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments on existing grade as follows:

   a. Carefully place storage aggregate media No. 57 stone against tree trunk approximately two (2) inches above finished grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within Drip Line, place storage aggregate media No. 57 stone up to six (6) inches below finished grade.

   b. Place permeable liner with edges overlapping 6 inches minimum.

   c. Place remaining fill layer of topsoil to finished grade. Do not compact storage aggregate media No. 57 stone or topsoil. Hand grade to required finish elevations.

D. Root Pruning

1. Root Pruning shall take place only where the roots of existing trees have been damaged by regrading or trenching operations and as directed by the Arborist.

2. If construction is to occur within the root zone of existing plant material, root pruning and special plant care, including fertilizing and watering, will be required.

3. Do not cut main lateral roots or taproots. Cut only smaller roots that interfere with installation of Work. Do not break or chop.

4. Prior to root pruning, remove all weeds.

5. Root prune using an approved mechanical root pruning saw prior to regrading operations, as directed by the Arborist. Air Spading excavation consisting of hand and/or pneumatic excavation may be required as directed by Arborist.

6. For plant material that is to remain in place, if the roots of that plant material are exposed during construction, the damaged root ends are to be removed by cutting them off cleanly.

7. Initial watering shall be performed on all trees, which are designated for root pruning. Water trees immediately after pruning by thoroughly saturating root balls and continue to keep root balls thoroughly saturated during first three (3) weeks following root pruning. After the first three (3) weeks, water as required, according to weather conditions, to keep root balls in a moist condition during growing seasons, through the duration of the Work. Test root balls for optimal moisture once per week using a soil auger.

8. All pruning shall be overseen by an Arborist. All pruning shall be done according to the National Arborist Association's Pruning Standards.

9. Any damage to the root zone, as determined by the Arborist, will be compensated by pruning an equivalent amount of the top vegetative growth of the material within one (1) week following root damage, fertilization and supplemental watering.

E. Tree Repair

1. Promptly repair trees damaged by construction operations within 24 hours of occurrence. Treat damaged trunks, limbs, and roots according to Arborist's written instructions.

2. If soil within the Tree Protection Zone(s) becomes compacted during construction, aerate the surface soil a minimum of ten (10) feet outside of the Drip Line and no closer than three (3) feet from the tree trunk. Drill holes two (2) inches in diameter a minimum of 12 inches deep at 24 inches on center or use a turf aerator that is approved by the [Design Professional][Owner]. Backfill holes with an equal mix of augered soil and sand.

F. Tree Replacement

1. Contractor shall obtain written approval from the [Design Professional][Owner] prior to removal of trees not specifically indicated for removal in the Drawings.

2. Trees not indicated for removal in the Drawings that die or are damaged during construction operations shall be removed and replaced at the Contractor's expense if the [Design Professional][Owner] determines that the trees are incapable of restoring to normal growth pattern.

3. Trees removed shall be replaced with [two (2) inch Caliper tree(s)][Design Professional to specify required diameter] at a rate, as follows:

****

NOTE: Tree replacement requirements per City AR No.5-7 Tree Canopy Preservation and Expansion

****

Tree Replacement Requirements

Size of Tree Removed (DBH)	Rate of Replacement (2-inch Caliper)
1 inch - 5 inches	2:1
6 inches - 10 inches	3:1
11 inches - 16 inches	4:1
17 inches - 23 inches	5:1
24 inches - 31 inches	6:1
32+ inches	8:1

4. Replacement trees shall be planted per Section 02951 Green Stormwater Infrastructure Plants and maintained per Section 02957 Green Stormwater Infrastructure Establishment.

3.03 TOLERANCES

A. Trees shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position.

B. Do not prune to obtain required sizes.

C. Replacement tree Calipers shall measure equal to or greater than size specified in Part 3.02, F.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall maintain tree protection through the duration of Work in the vicinity of the Tree Protection Zone(s) per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.06 MAINTENANCE

A. Remove tall grass or weeds by mowing and pickup all trash within the Tree Protection Zone(s) for the duration of Work.

B. Contractor shall be responsible for the health of the tree(s) identified for protection through the duration of the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment.

C. Vegetative maintenance shall be per Section 02957 Green Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Trees, tree roots and limbs within the extents of Work shall be protected against injury or damage through the duration of the Establishment Period. Any trees located in the Tree Protection Zone(s) that die or show more than 25 percent canopy dieback shall be removed and replaced at Contractor's expense per Part 3.02, F.

B. Contractor is responsible for installed plant material warranty per Section 02951 Green Stormwater Infrastructure Plants.

-- End of Section --

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02950

GSI SPECIFICATIONS

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SECTION 02950

GREEN STORMWATER INFRASTRUCTURE SELECTIVE VEGETATION REMOVAL

****

NOTE: This guide specification includes requirements for selective vegetation removal. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02950 Green Stormwater Infrastructure Selective Vegetation Removal is to manage areas noted in the Drawings as Tree Protection Zones in which no clearing and grubbing activities, construction, or staging areas are to occur. Areas shall be maintained free from invasive species and structural and/or maintenance concerns of existing tree stands. Within these areas, desirable vegetation, including grasses, wildflowers, shrubs, or trees are to be protected from construction activities.

B. Definitions

1. Selective Vegetation Removal: Areas within Tree Protection Zone [designated in the Drawings] outside of normal clearing and grubbing, where the Contractor shall remove selected trees less than 2-inch diameter breast height and invasive plant undergrowth.

2. Diameter Breast Height (DBH): The outside bark diameter of an existing tree measured 4.5 feet above the ground, on the uphill side of the tree.

3. Glyphosate: A non-selective herbicide that absorbs into the plant tissue and is carried to the roots. Caution must be taken to minimize off-target impacts when applying non-selective herbicides.

4. Triclopyr: A selective herbicide for broadleaf plants (forbs, shrubs, and trees).

5. Invasive Species: Shall be determined by the Missouri Department of Conservation Invasive Plant Species List.

6. Wooded Area Cleanup: Work within the Tree Protection Zone where the Contractor shall remove debris, partially dead or broken vegetation, stumps, loose roots, trash and leaf litter.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of Selective Vegetation Removal shall be subsidiary to Work being performed.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02949 Green Stormwater Infrastructure Existing Tree Protection

02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding

02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150 (2017) Division II Construction and Material Specification, Erosion and Sediment Control

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1 The American Standard for Nursery Stock

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

MEANS/METHODS OF SELECTIVE VEGETATION REMOVAL

SELECTIVE VEGETATION FIELD ASSESSMENT

FIELD HABITAT ASSESSMENT

SD-07 Certificates

MANUFACTURER CERTIFICATIONS

SD-10 Operation and Maintenance Data

SELECTIVE VEGETATION REMOVAL MAINTENANCE REPORT

1.06 QUALITY ASSURANCE

A. Contractor Qualifications: A qualified horticulturist who has completed work similar in material, design, and extent to that indicated for this Work and with a record of successful landscape removal.

B. Tree Service Qualifications: Work shall be performed by an experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Work and that will assign an experienced, qualified Arborist to the Work. The Arborist shall be certified by the International Society of Arboriculture.

1.07 QUALITY CONTROL

A. MEANS/METHODS OF SELECTIVE VEGETATION REMOVAL; Submit means and methods to be used for Selective Vegetation Removal and Wooded Area Cleanup.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Deliver herbicides in manufacturer's original unopened and undamaged containers. They shall be clearly marked to identify brand name, concentration, contents, and order number on each package. Store all materials in a protected, dry location at temperatures in accordance with manufacturer's recommendation. Materials shall be stacked and stored in accordance with manufacturer's recommendation.

B. Additional manufactured products shall be delivered, stored and handled per the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 HERBICIDES

A. Use of chemical treatment for removal or cause of death for Selective Vegetation Removal must be approved by the [Design Professional][Owner] prior to use.

B. Do not use herbicides that could harm existing plant material intended to remain when applied per Contractor's means and methods per Part 1.07. Contractor shall be responsible for removal and replacement of any and all prematurely defoliated trees within six (6) months of observed damage intended.

1. Woody Plants and Cut Stumps: Contractor shall submit suitable herbicide for approval.

2. Groundcovers and Broadleaf Plants (non-woody): Contractor shall submit suitable herbicide for approval.

C. MANUFACTURER CERTIFICATIONS: Contractor shall submit for approval all products being used and/or stored on the Site prior to delivery or use. Submit product certificates signed by manufacturer, certifying that product complies with these Selective Vegetation Removal requirements. Include manufacturer certified analysis for standard products.

2.02 SEED

A. Seed operations shall follow Section 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding and/or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding as documented per Drawings.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. SELECTIVE VEGETATION FIELD ASSESSMENT; Contractor shall be responsible for performing a Selective Vegetation Field Assessment of the Site with the [Design Professional][Owner] and qualified Arborist to assess the existing vegetation. The Selective Vegetation Field Assessment submittal shall include, but is not limited to, the following:

    a. Contractor shall survey and tag trees, as necessary, for selective removal with final approval given by the [Design Professional][Owner].

    b. Provide figure(s), identifying existing vegetation to remain, invasive species for removal, detailing the species, size, condition, and location of vegetation.

    c. Coordinate with utility(s) and [Design Professional][Owner] for Work that impacts the existing Tree Protection Zone.

    d. Opportunities for vegetation preservation, or selective removal of vegetation as an alternative to standard clearing and grubbing;

    e. Construction limits and the anticipated impacts on surrounding vegetation. Tree protection fencing per Section 02949 Green Stormwater Existing Tree Protection shall be installed around all Selective Vegetation Removal areas.

2. SELECTIVE VEGETATION REMOVAL MAINTENANCE REPORT: Submit a written or graphic report for the care and maintenance of the Tree Protection Zone and Selective Vegetation Removal. This Selective Vegetation Removal Maintenance Report shall convey the activities required for the selective removal and preservation of vegetation. Contractor shall be responsible for coordination with a qualified Arborist for the care of the vegetation during construction and during pruning and vegetation removal activities. All removal and maintenance activities must have approval prior to execution of Work.

3. FIELD HABITAT ASSESSMENT; Submit report for Migratory Bird Nests and State Identified Endangered Bat Habitat. Perform 'Field Habitat Assessment for Active Migratory Bird Nests and Northern Long-eared Bat Habitat' prior to proceeding with any site clearing or plant species removal. The Endangered Species Act (ESA) (16 U.S.C. 1531) provides protection to species that are listed as threatened or endangered or have critical habitat designated for the persistence of the species. The Northern Long-eared Bat (NLEB) is protected as a threatened species under the ESA within Final 4(d) Rule for the Northern Long eared Bat (4(d) rule). The NLEB hibernates in caves or abandoned mines during the winter. During the summer, the NLEB may roost beneath loose bark of live, dead, or dying trees. Roosting or foraging habitat include forests, wooded fence rows, and riparian areas.

4. Delineate areas for herbicide application and obtain [Design Professional][Owner] acceptance of delineated areas prior to herbicide applications. Adjust areas for herbicide application as requested.

5. All trees not designated for removal shall remain in place. The Contractor shall protect and preserve all vegetation designated to remain.

B. Project Conditions

1. Selective Vegetation Removal shall be limited to September 1st through February 15th to discourage migratory birds from nesting within area of construction.

2. Vegetation must be cleared to a height less than 12 inches. Cleared material should be removed by the Contractor prior to February 15th. If Selective Vegetation Removal is performed between February 16th and August 31st, the Contractor shall employ a qualified wildlife biologist or ecologist to conduct survey for migratory bird activity prior to commencing Selective Vegetation Removal operations.

3. Where migratory bird activity is identified, the Contractor shall obtain the required permits under the Federal Migratory Bird Treaty Act prior to commencing activities. If no migratory bird activity is identified, the contractor may commence activities. Selective Vegetation Removal must be completed within seven (7) calendar days after inspection, including removal of all downed vegetation material from the site. If Selective Vegetation Removal is not completed within seven (7) calendar days of inspection, the contractor's qualified wildlife biologist or ecologist must resurvey the site as required above.

4. Selective Vegetation Removal activities in the Tree Protection Zones shall be completed three (3) months prior to Site clearing, grubbing and earthwork activities. After Selective Vegetation Removal activities have been completed, Contractor shall protect the entire area as specified in Sections 02949 Green Stormwater Infrastructure Existing Tree Protection. Contractor shall take care to limit activities that would conflict with the restoration of Tree Protection Zones.

C. Control and Protection

1. This section shall work in conjunction with the Stormwater Runoff Management Plan, as described in Section 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by operations.

3. Provide erosion control measures in accordance with APWA 2150, to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways. This section does not replace erosion and sediment control regulatory responsibilities.

4. Examine areas for compliance with requirements and conditions affecting performance of Work. Proceed with Selective Vegetation Removal only after unsatisfactory conditions have been corrected.

5. Temporary roadways shall be located to minimize damage to shrub and tree stands per the requirements of 02937 Green Stormwater Infrastructure Site Activity Plan.

6. Soil stabilization measures shall be located at the limits of clearing to prevent sediment deposition within the Tree Protection Zone per 02938 Green Stormwater Infrastructure Control and Protection.

7. Equipment must be kept away from trees to be preserved to avoid trunk damage caused by equipment nicking or scarring the trunk.

3.02 INSTALLATION

A. Vegetation Removal Methods

1. Preservation of Existing Trees: Work within the Tree Protection Zone shall be by hand clearing and power raking only. Do not use heavy equipment. Do not mechanically scarify the surface.

2. Mechanical Vegetation Removal: Mechanical removal involves use of loppers, hand saws and other hand tools to cut down plants and hand pulling. Caution needs to be taken when manually removing plants so that soil is not highly disturbed leading to erosion. Many invasive plants can spread via rhizomes and thus taking out the entirety of the root is imperative.

3. Chemical Vegetation Removal: Contractor shall use common systemic herbicides (active ingredients either glyphosate or triclopyr) for chemical vegetation removal, or approved equal. Contractor shall use basal bark treatment and/or foliar treatment or other approved control method. Contractor shall apply systemic herbicide during times and/or seasons that minimize risk for translocation in the plant.

B. Selective Vegetation Removal

1. All trees less than 2-inch caliper and species deemed as invasive shall be cleared and removed. Stumps shall be cut to two (2) inches above the ground and treated with approved herbicide to discourage regrowth. Do not excavate root mass or disturb adjacent tree roots.

2. All woody shrubs, including both invasive and non-invasive, shall be cleared and removed. Hand dig roots or treat with herbicide to discourage regrowth. Contractor shall take caution not to disturb adjacent tree roots.

3. All groundcovers deemed invasive shall be cleared and removed. All non-invasive groundcovers shall remain.

C. Tree Preservation Understory Restoration

1. Contractor shall, by broadcasting, seed all areas that have been cleared during Selective Vegetation Removal within the Tree Protection Zone with seed mixes as denoted in the Drawings.

2. Contractor shall install seed, following applicable Sections 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding and/or 02953 Green Stormwater

Infrastructure Non-Native Seeding and Sodding, except that it shall be applied by broadcasting.

D. Trees that lose more than fifty percent of their leaves within Establishment Period shall be replaced per Tree Replacement Requirements, described in 02949 Green Stormwater Infrastructure Existing Tree Protection.

3.03 TOLERANCES

A. Trees shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Not applicable.

3.06 MAINTENANCE

A. The Contractor shall maintain temporary Tree Protection Zone through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

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02951

GSI SPECIFICATIONS

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SECTION 02951

GREEN STORMWATER INFRASTRUCTURE PLANTS

****

NOTE: This guide specification includes requirements for plants and components needed for planting operations. Requirements are included for trees, shrubs, groundcovers, grasses, and perennials plantings. Requirements are also included for mulch, media liner, stakes and guys, landscape edging, fertilizers/miscellaneous products, and watering. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02951 Green Stormwater Infrastructure Plants is to provide requirements for landscaping vegetation and materials including but not limited to trees, shrubs, groundcovers, grasses and perennials, fertilizer, mulches and landscape edgings.

B. Definitions

1. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes as shown in the Drawings; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

2. Container-Grown Stock: Healthy, vigorous, well-rooted Plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container, but free from circling or girdling roots. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of plant required.

3. Finished Grade: Elevation of finished surface of soil and aggregate media per Section 02946 Green Stormwater Infrastructure Aggregate Media or Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments, as applicable.

4. Plants: As referenced herein is applicable to trees, shrubs, groundcovers, grasses and perennials. Plants producing wood as a structural tissue are categorized as woody plants. Plants that have no persistent woody stem above ground are categorized as herbaceous plants.

5. Root Flare: Place where the topmost root emerges from the trunk.

6. Tree Crown: Mass of foliage and branches growing outward from the trunk of the tree.

7. Caliper: Diameter of the stem or trunk of a tree measured above existing grade. For trees up to 4.5 inches in diameter, Caliper shall be measured six (6) inches above existing grade. If the Caliper measured at six (6) inches is greater than 4.5 inches, the Caliper shall be measured at 12 inches above existing grade.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for Plants, depicted in the Drawings and specified herein. Plants shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Plants Measurement and Payment Units

Item	Unit
[Trees]	[Each]
[Shrubs]	[Each]
[Grasses]	[Each]
[Perennials]	[Each]
[Groundcovers]	[Each]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

****

NOTE: These specifications use City terminology and requirements for Substantial Completion or Achievement of Full Operation and Correction Period as it relates to duration of Contractor's responsibility for establishment and maintenance of green stormwater infrastructure and its components. Design Professional to verify contract terms for project completion defined in the Front End specifications of the Project Manual.

****

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02942 Green Stormwater Infrastructure Above Grade Barriers

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

02947 Green Stormwater Infrastructure Topsoil

02948 Green Stormwater Infrastructure Media Liners

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1 The American Standard for Nursery Stock

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

PLANTING LAYOUT

SD-03 Product Data

MISCELLANEOUS PRODUCTS DATA

SD-04 Samples

LANDSCAPE EDGING SAMPLE

MULCH SAMPLE

SD-07 Certificates

PLANT MATERIAL CERTIFICATION

SD-11 Closeout Submittals

AS-BUILT DRAWINGS

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Installer: A qualified landscape installer who has completed landscaping work similar in material, design, and extent to that indicated for this Work and with a record of successful landscape establishment.

2. Field Supervisor: Installer's field supervision is required to maintain an experienced full-time supervisor on Site when planting is in progress. Field supervisor shall have

at a minimum five (5) years of experience supervising landscaping work similar in material, design, and extent to that indicated for this project and with a record of successful landscape establishment.

1.07 QUALITY CONTROL

A. Contractor shall notify the [Design Professional][Owner] of sources of planting materials a minimum of 30 days in advance of delivery to Site per requirements of Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. The [Design Professional][Owner] may observe Plants either at place of growth or at Site before planting for compliance with requirements for genus, species, variety, size, and quality.

C. The [Design Professional][Owner] retains right to observe Plants further for size and condition of ball and root systems, insects, injuries, and latent defects, and to reject unsatisfactory or defective material at any time during progress of Work. The Contractor shall remove rejected Plants immediately from Site.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. The Contractor shall notify the [Design Professional][Owner] of the location of plant materials to be used and allow the Design Professional the opportunity to inspect them either at the place of growth or at the site before planting, for compliance with requirements for genus, species, variety, size, and quality. The Design Professional retains the right to further inspect trees and shrubs for size and condition of root balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work.

C. Provide protective covering to prevent wind damage during transportation to Site. Do not drop any plant materials during loading, unloading, transportation, and delivery. Plant materials shall be tightly packed during transportation; if a full load of Plants is not required, packaging substitutes and braces shall be placed in such a way as to prevent any rolling or movement during the transportation period. Acceptable braces include: wood cross members, large stable rocks, shredded landscape mulch, and topsoil.

D. All planting material shall be delivered with certificates of inspection required by USDA and State of Missouri. Comply with regulations applicable to planting material. Deliver Plants freshly dug or well rooted in their containers, to conditions specified in Part 2. All plants delivered to the site must be clearly labeled with botanical and common names for proper identification. A minimum of one (1) label per species or container is required. Trees and shrubs shall be individually labeled.

E. Deliver Plants after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set planting materials in a sheltered location, protect from weather and mechanical damage, and keep roots moist.

1. Handle Balled and Burlapped Stock only by root ball; never move stock by gripping stems or foliage.

2. Set balled stock on ground and cover ball with planting soil, wood mulch, or other acceptable material.

3. Do not remove Container-Grown Stock from containers before time of planting.

4. Water plant materials as often as necessary to maintain root systems in a moist condition.

[F. Trees and Shrubs

1. Do not prune trees and shrubs before delivery, except as approved by the [Design Professional][Owner]. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage.

2. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.]

G. Deliver fertilizers, herbicides, fungicides and pesticides in manufacturer's original unopened and undamaged containers. They shall be clearly marked to identify brand name, contents and order number on each package. Store all materials in a protected, dry location at temperatures in accordance with manufacturer's recommendation. Materials shall be stacked and stored in accordance with manufacturer's recommendation.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

2.01 PLANTS

A. Plants shall be of quantity, size, genus, species, and variety shown in the Drawings and in compliance with ANSI Z60.1. Plant material of a larger size may be used (at no additional cost to the Owner) if acceptable to the Owner, with a proportionate increase in size of roots or balls.

B. Furnish nursery-grown Plants complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald,

injuries, abrasions, and disfigurement. All plant materials shall be grown at recognized nurseries located within the same USDA Plant Hardiness Zone as the project Site.

C. Plant material shall be grown from the project site eco-region per the Missouri Department of Natural Resources office. Resale plant suppliers shall not be used as sources unless the Contractor can certify that the required plant materials are not available from a growing nursery. When utilized, the Contractor shall submit the name and location of the growing nursery from where the trees or shrubs were obtained.

D. Planting materials shall not be substituted unless otherwise approved by the [Design Professional][Owner]. If specified landscape material is not available, Contractor shall submit proof of non-availability together with a request for Substitute Item, per Section [Designer to input specification number where allowable substitutes are defined].

[E. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.]

F. PLANT MATERIAL CERTIFICATION; Submit product certificates signed by supplier certifying that plant materials comply with specified requirements and at a minimum include the following:

1. Nursery name, address and phone;

2. List of Plants to be supplied including botanical name, common name, and size;

3. Three (3) digital photographs of each plant species containing height reference and identification;

4. Certificates of inspections as required by governmental authorities;

5. Certification that plant materials comply with specified requirements.

6. Plant warranty documentation.

[2.02 TREES

A. All trees provided must be balled and burlapped. Contractor shall submit supplier certifications for all trees, shrubs and related material.

[B. Shade Trees: Shade trees shall be single-stem trees with straight trunk, well-balanced Tree Crown, and intact leader, of height and caliper indicated in the Drawings, complying with ANSI Z60.1 for type of trees required. Shade Tree Crowns shall be equal to one-third (1/3) to one-half (1/2) of tree height.]

[C. Small Upright or Spreading Trees: Small upright or spreading trees shall be branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1. See Drawings for stem form type.]

[D. Multistem Trees: Multistem trees shall be branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1. Multistem trees shall have clump stem form.]

[E. Coniferous Evergreen Trees: Coniferous evergreen trees, including bald cypress, shall comply with ANSI Z60.1. Trees shall be normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required. Contractor shall provide balled and burlapped coniferous evergreen trees.]]

[2.03 SHRUBS

A. Shrubs shall be container grown with the following form and size: deciduous and evergreen shrubs with not less than the minimum number of canes/spread required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.]

[2.04 GROUNDCOVERS

A. Provide groundcovers established and well rooted in removable containers, flats, or integral biodegradable pots as indicated in the Drawings. Refer to schedule in the planting Drawings for type and condition.]

[2.05 GRASSES AND PERENNIALS

A. Provide grasses and perennials established and well rooted in removable containers, flats, integral biodegradable pots, or deep cell plugs as indicated in the Drawings. Refer to schedule in the planting Drawings for type and condition.]

2.06 PLANTING SOIL

A. Planting soil shall be growing media or topsoil material as specified in the Drawings within landscaping areas and in accordance with Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments shall be used.

2.07 FERTILIZER

A. Fertilizer shall be granular fertilizer consisting of nitrogen, phosphorus, potassium, and other nutrients in proportions and amounts recommended in soil reports, as required per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments, from a qualified soil-testing agency.

B. Fertilizer shall be slow release or quick release as per the soil report.

[2.08 MULCH

A. MULCH SAMPLE; Submit small one-fourth (1/4) pound sample of mulch material(s) to be used for all landscaping areas.

[B. Organic Mulch

1. Green Stormwater Infrastructure Planting Beds: Organic mulch shall be double ground aged hardwood, free from deleterious materials, suitable as a top dressing for

proposed plant material, and large enough to prevent displacement. Mulch shall be brown to dark brown in color. Size of particles may vary from minimum of three (3) inches to maximum of four (4) inches in length.

2. Adjacent Planting Beds: Organic mulch shall be double ground aged hardwood, free from deleterious materials and suitable as a top dressing for proposed plant material used adjacent to green stormwater infrastructure facilities. Mulch shall be brown to dark brown in color. Size of particles may vary from minimum of one-quarter (1/4) inch to maximum of two (2) inches in length.]

[C. Pine Straw Mulch

1. Pine straw mulch shall be nine (9) inch minimum pine needle sourced from Slash Pine (Pinus Elliottii) or Longleaf Pine (Pinus Palustris). Pine straw shall be fresh, dry, and bright in color, free of weeds, twigs, pine cones, dirt, gravel, and insects.

2. Needles from Loblolly Pine will not be accepted.]

D. Walnut bark or chips are not acceptable.

****

NOTE: If decorative gravel is to be used within or is tributary to a green stormwater infrastructure facility, then decorative gravel shall be clean and free of fines to prevent clogging of the green stormwater infrastructure facility.

****

[E. Decorative Gravel

[1. Decorative gravel shall be double-washed, free from sand, silt, clay, excess fines, and other deleterious material.]

2. Gravel shall be regionally sourced (within 200-mile radius or Site) decorative gravel, [river rock][angular brown cobbles], [three (3) to eight (8) inches in diameter with an equal gradation of each size][of the type and size specified in the Drawings] or approved equal.]]

[2.09 MEDIA LINER

A. Permeable liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners, or approved equal.]

[2.10 STAKES AND GUYS

****

NOTE: Studded steel T-post should be used on public projects. Lodgepole may be applicable for private development projects.

****

A. Upright and Guy Stakes: Shall be [studded steel T-post][Lodgepole Pine stakes (untreated)], six (6) feet length minimum.

B. Guy and Tie Wire: Shall be per ASTM A641/A641M, Class 1, galvanized-steel wire, two (2) strand, twisted, 0.106-inch diameter.

****

NOTE: Strap Chafing Guard should be used on public projects. Hose Chafing Guard may be applicable for private development projects.

****

[C. Strap Chafing Guard: Shall be reinforced Nylon or Canvas at least 1.5 inches with grommets to protect tree trunks from damage.]

[D. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2 inch in diameter, black, cut to lengths required to protect tree trunks from damage.]]

[2.11 LANDSCAPING EDGING

****

NOTE: Steel landscape edging requirements listed here are necessary to meet decorative gravel edging requirements. Do not delete if specifying decorative gravel edging.

****

[A. Steel Landscape Edging

1. Steel edging shall be standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

2. Steel edging shall meet the following requirements:

a. Edging Size: Three-sixteenths (3/16) inch wide by six (6) inches deep.

b. Stakes: Ten (10) gauge Tapered steel, a minimum of 15 inches long.

c. Accessories: Standard tapered ends, corners, and splicers.

d. Finish: Powder Coat Finish.

****

NOTE: Green steel landscape edging should be used on public projects. Black may be applicable for private development projects.

****

e. Color: [Green][Black]]

[B. Concrete Ribbon Curb Edging:

1. Monolithic concrete curb per dimensions as detailed.

2. Concrete shall meet the requirements of Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[C. V-Cut Edging

1. V-Cut edging shall be a natural cut trench backfilled with specified mulch.]

[D. Decorative Gravel

****

NOTE: Determine if permeable liner is desired, then specify product and manufacturer or approved equal.

****

[1. Permeable Liner shall be [Mirafi 140N][Design Professional to specify manufacturer name and product information] or approved equal.]

****

NOTE: If decorative gravel edging surrounds or is directly adjacent to green stormwater infrastructure facility, then decorative gravel shall be clean and free of fines to prevent clogging of the green stormwater infrastructure facility.

****

[2. Decorative gravel shall be double-washed, free from sand, silt, clay, excess fines, and other deleterious material.]

3. Gravel shall be regionally sourced (within 200-mile radius of project location) decorative gravel, [river rock][angular brown cobbles], [three (3) to eight (8) inches in diameter with an equal gradation of each size] [of the type and size specified in the Drawings] or approved equal.

[4. Steel edging shall be per Part 2.11, A.]]

[E. LANDSCAPE EDGING SAMPLE; Submit landscape edging sample including the following:

1. Supplier name, address and phone;

2. Product name;

[3. One 12-inch section of steel edging with one stake[;][.]]

[4. Five (5) pounds of decorative gravel for each color and texture of stone required, labeled accordingly.]]]

2.12 MISCELLANEOUS PRODUCTS

A. Anti-desiccant: Natural water-insoluble emulsion, permeable moisture retarder, film forming, acting as a protective coating for the leaf or needle of the plant, substantially reducing water loss during high period of stress. Can be used under hot summer conditions and in cold weather conditions for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, four (4) inches wide minimum, with stretch factor of 33 percent.

C. Plastic Tree Protector: Each tree shall be protected after planting with an 18-inch nominal height, four (4) inch minimum diameter plastic protector. Material shall be vented polyethylene or equivalent and shall be gray in color.

D. Herbicide: Provide a non-selective, systemic herbicide suitable for use with the plant material specified on the Plans. Provide ROUNDUP Weed and Grass Killer, manufactured by the Monsanto Company, Lawn and Garden Products, or approved equivalent.

E. Pre-Emergent Herbicide: Provide pre-emergent herbicide Pre M 60 DG (granular), or approved equivalent.

F. Mycorrhizal Fungi: Dry, granula inoculant containing at least 6,810 spores per pound. (0.45 kilograms) of vesicular-arbuscular mycorrhizal fungi and 60 million spores per pound (0.45 kilograms) of ectomycorrhizal fungi, and a maximum particle size of 2 milimeters. Apply per manufacturer's recommendation.

G. All other materials, not specifically described but required for a complete and proper installation, shall be as selected by the Contractor subject to the approval of the [Design Professional][Owner].

H. MISCELLANEOUS PRODUCTS DATA; Submit product information for miscellaneous products related to plants including but not limited to anti-desiccant, trunk-wrap tape, fertilizers, pesticides, and herbicides.

2.13 WATER

A. Water used in this Work shall be furnished by the Contractor and will be suitable for irrigation and free from ingredients harmful to plant life.

B. All watering equipment shall be furnished by the Contractor.

C. Water from adjacent fire hydrants, public or private water lines shall be metered. Written approval from the property owner shall be obtained prior to the use of suitable water from ponds, creeks or private owners.

D. Watering bags shall be used to water trees. Provide slow release, UV stabilized, polyethylene watering bag with black polypro straps and nylon zippers.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. Contractor shall lay out individual plant locations and areas for plantings.

2. PLANTING LAYOUT: Notify the [Design Professional][Owner] once plant locations are staked, and vegetation areas are outlined prior to installation of Plants. Contractor shall adjust locations when requested, and obtain acceptance of layout before planting.

B. Project Conditions

1. Contractor shall coordinate planting per Section 02937 Green Stormwater Infrastructure Site Activity Plan. Planting seasons shall be as follows:

a. Trees and shrubs (woody plants):

1) Spring: February 15th to May 15th

2) Fall: October 15th to November 30th

b. Grasses and perennials (herbaceous plants):

1) Spring: April 15th to May 15th

2) Fall: September 15th to October 30th

2. Proceed with and complete landscape work as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required.

3. Planting dates outside of the specified planting seasons must be approved by the [Design Professional][Owner]. Contractor shall notify the [Design Professional][Owner] in the event of planting discrepancies and if seasonal conditions become abnormal. Planting operations shall not be performed during time of extreme drought, when ground is frozen, or during times of other unfavorable weather. Proceed with planting only when existing and forecasted weather conditions permit. Contractor shall assume full and complete responsibility for all such plantings and operations.

4. Contractor shall examine areas to receive Plants for compliance with requirements and conditions affecting installation and performance. When unsatisfactory conditions for plant growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the [Design Professional][Owner]

before planting. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the [Design Professional][Owner].

5. At time of planting, the top six (6) inches of all areas to be planted shall be free of stones greater than one-half (1/2) inch, weeds and foreign matter.

C. Control and Protection

1. Prior to planting activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by planting operations.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Fine Grading: Grade planting areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be planted in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if soil loss has occurred or planting area has otherwise been disturbed after finished grading, before planting.

B. Planting Pit Excavation

[1. Trees and Shrubs:

a. Excavate circular pits of the dimensions as shown on the tree and shrub details in the Drawings. Scarify sides of plant pit smoothed during excavation.

[b. Trees: Excavate pit one (1) inch shallower than root ball depth.]

[c. Shrubs: Excavate pit two (2) inches shallower than root ball depth.]]

[2. Grasses and Perennials: Dig holes large enough to allow spreading of roots as shown on the grasses and perennials detail.]

3. Contractor shall notify the [Design Professional][Owner] if the following conditions are encountered:

a. Obstructions: Unexpected rock or obstructions detrimental to trees or shrub placement or growth are encountered in excavations. Where hardpan layer is encountered, drill six (6) inch diameter holes into free-draining strata or to a depth of ten (10) feet from subgrade, whichever is less, and backfill holes with three-quarter (3/4) inch storage aggregate media.

b. Drainage: Subsurface soil conditions reveal unexpected water seepage or retention in tree or shrub pits.

C. Planting

1. Installation shall be per the Drawings.

2. Only as many Plants as can be planted and watered on that same day shall be distributed in a planting area. Do not prune trees and shrubs at time of installation except to remove damaged growth.

[3. Treat entire plant pit or bed with pre-emergent herbicide in accordance with manufacturer's recommendations.]

[4. Tree and Shrub Planting

a. Balled and Burlap Stock: Do not use ball and burlap stock if root ball is cracked or broken before or during planting operations. Locate Root Flare and remove any extra soil prior to placing tree or shrub into pit to locate final elevation.

1) Set root ball plumb and in center of pit or trench with the Root Flare flush above adjacent Finished Grades.

2) Remove burlap twine and cage from top two-thirds (2/3) of root balls and partially from sides after gentle placement in planting holes, but do not remove from under root balls. Remove pallets, if any, before setting.

3) Place planting soil around root ball in layers, tamping to settle mix and eliminate voids and air pockets.

4) When pit is approximately one-half (1/2) backfilled, water thoroughly before placing remainder of backfill.

5) Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil.

b. Container-Grown Stock: Container shall not be removed from Plants prior to Plants being set out in the designated planting area. Plants shall be removed in

such a manner that the root ball is not broken. Refer to detail for correct installation.

1) If circling or diving roots are found, shave all sides of the root ball including the bottom to prevent root girdling.

2) Set Plants plumb and hold rigidly in position until planting soil has been tamped firmly around root ball.

3) After the plant has been placed, additional backfill consistent with planting soil shall be added to the hole to cover approximately one-half (1/2) of the height of the root ball. At this stage, water shall be added to the top of the partly filled hole to thoroughly saturate the root ball and adjacent planting soil. Finish filling the hole with planting soil and tamp firmly.

4) All Plants which settle deeper than specified on the planting details shall be raised to the correct level.]

[5. Grasses and Perennial Planting

a. Containers or flats shall not be removed from Plants prior to Plants being set out in the designated planting area as specified in the Drawings.

b. Plant shall be removed in such a manner that the root ball is not broken.

c. Remove Plants from containers with enough soil around roots to form a plug. Do not damage roots.

d. Place plant in hole, and work planting soil around roots to eliminate air pockets. Leave a slight saucer indentation around Plants to hold water.

e. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

f. Protect Plants from hot sun and wind; remove protection if Plants show evidence of recovery from transplanting shock.]

[D. Guying and Staking

1. Installation shall be per the Drawings.

2. Stake trees with a two (2) inch caliper and less.

3. Use a minimum of two (2) stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 54 inches above grade.

4. Set stakes vertically and space to avoid penetrating root balls or root masses.

5. Support trees with straps at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

6. Set stakes in line with, and on opposite sides of the trunk placed in North/South direction so that the line between stakes is perpendicular to the direction of the prevailing wind.

7. Contractor shall return one (1) week after trees have been staked to adjust the guy wire and stakes so the tree trunk is plumb and vertical.]

[E. Mulch

1. [Mulch shall be placed to the lines, grades, and depths specified in the Drawings.][Mulch shall be utilized at a minimum three (3) inch depth.]

[2. Mulch extents shall be equal to planting pit disturbance area. Place mulch away from trunk and trunk flare. Berm outer edges of mulch ring to create a saucer form.]]

[F. Landscaping Edging

****

NOTE: Steel landscape edging requirements listed here are necessary to meet decorative gravel edging requirements. Do not delete if specifying decorative gravel edging.

****

[1. Steel Edging Installation

a. Install steel edging where indicated according to manufacturer's installation recommendations.

b. Anchor with steel stakes spaced approximately 48 inches apart, driven below top elevation of edging.

c. Steel edging shall not be visible above sod or organic wood mulch upon completion of plantings and sod installation.

d. Touch-up Painting and Restoring Finishes

1) Touch-up Painting: Immediately after installation, clean field seams, connections, and abraded areas of shop paint, and apply same material to exposed areas.

2) Restoring Finishes: Restore finishes damaged during installation and during work so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.]

[2. Concrete Ribbon Curb Edging: Install concrete ribbon curb edging per Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[3. V-Cut Edging: Dig or machine cut natural 30 degree bevel cut, [eight (8) inch minimum in width and six (6) inch minimum in depth][to the depths and dimensions detailed in the Drawings].]

[4. Decorative Gravel

[a. Install permeable liner a minimum four (4) inches below Finished Grade, with edges wrapped a minimum of four (4) inches.]

[b. Install steel edging per Part 3.02, F., 1.]

c. Place decorative gravel to the lines, grades, and depths specified in the Drawings. Decorative gravel shall cover all fabric, fabric shall not be visible through gravel layers.]]

G. Installation of Miscellaneous Products

1. As directed by the [Design Professional][Owner], apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two (2) weeks after planting.

2. If planted in fall, wrap trees of two (2) inch caliper or larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Remove trunk-wrap tape in March and dispose of trunk-wrap tape per Part 3.04. Do not use trunk-wrap tape for trees planted in spring.

H. Watering

1. Container Plants: Water container plant materials at the following rate and frequency:

a. First Week: One (1) inch per day, every other day.

b. Second Week: One (1) inch per day, every third day.

c. Third Week: One (1) inch per day, every fourth day.

2. Trees: Water trees at the following rate and frequency:

****
NOTE: Design Professional to specify watering frequency if irrigation is used in lieu of bags.
****

[a. Two (2) inch caliper trees: Fill bag one (1) time per week]

[b. Greater than two (2) inch caliper to three (3) inch caliper trees: Fill bag two (2) times per week.]

[c. Greater than three (3) inch caliper to five (5) inch caliper: Fill bag three (3) times per week.]

[d. [Design Professional to specify additional or alternative watering requirements]

3. After the third week and prior to Certificate of [Substantial Completion][Achievement of Full Operation], water as needed to ensure healthy and vigorous plants.

4. Contractor shall adjust watering rate and frequency as necessary to adapt to rainfall and to prevent puddles, ponding, or runoff. Do not water to the point of runoff.

3.03 TOLERANCES

[A. Trees and shrubs shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes.

1. Tree size shall be greater than or equal to specified caliper. Take caliper measurements six (6) inches above ground for trees up to 4.5-inch caliper size, and 12 inches above ground for larger sizes.

2. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.]

B. Acceptable trees and shrubs shall be in a vigorous, thriving condition as determined by the Owner prior to the end of the Establishment Period. Plants shall be free of dead or dying branches or branch tips, and shall bear foliage of a normal density, size and color.

C. Acceptable perennial and ornamental grass stands will consist of 90 percent coverage over the entire area and contain health mature or developing plants representative of the original species planted prior to the end of the Establishment Period.

D. Plant materials are to be inspected to certify that all Plants have been installed according to the Drawings and are acceptable. [Design Professional][Owner] will inspect Plants upon written request from the Contractor.

E. Any plant that is dead, or is not in satisfactory health as determined by the [Design Professional][Owner] will be replaced by the Contractor at no additional cost to the Owner.

F. AS-BUILT DRAWINGS; During the course of installation, carefully record in red line on a print of the planting drawings all changes made to the planting layout during installations; approved by the [Design Professional][Owner].

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of Plants from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection, including temporary seeding, to protect the green stormwater infrastructure facility until vegetation is fully established and the entire upstream tributary area is stabilized.

C. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

D. Erect visible barricades and warning signs as required to protect newly planted areas from traffic. Maintain visible barricades throughout Establishment Period or until substantial and healthy stand of grass is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

[B. Remove tree stakes after one growing season if root system is stable. If root system is not stable enough for tree to remain upright, reattach and adjust connection to accommodate for new growth and leave stakes for one more growing season.]

3.07 POST-CONSTRUCTION TESTING

A. The [Design Professional][Owner] reserves the right to take and analyze samples of materials for conformity to specifications at any time. Rejected materials shall be immediately removed from the Site at the Contractor's expense. The cost of testing of materials not meeting specifications shall be paid by the Contractor.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure Plants through the duration of the Establishment Period.

B. If at any time during the Establishment Period the plantings become damaged due to improper erosion control[, administration of maintenance activities, or frequency of maintenance activities], the Contractor shall replace the Plants and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

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02952

GSI SPECIFICATIONS

****

SECTION 02952

GREEN STORMWATER INFRASTRUCTURE NATIVE GRASS AND WILDFLOWER SEEDING

****

NOTE: This guide specification includes requirements for native grass and wildflower seeding as well as nurse crop. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 or additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding is to provide requirements for seeding native grasses and wildflowers.

B. Definitions

1. Dormant Seeding: Seeding in fall time when ground is not frozen but cold enough so that germination of seed will not occur until the following spring.

2. Nurse Crop: Temporary vegetation to help suppress weeds and manage soil erosion when project conditions are outside of the native grass and wildflower seeding planting seasons.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for native and wildflower seed installation, depicted in the Drawings and specified herein. Seed shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Native Grass and Wildflower Seeding Measurement and Payment Units

Item	Unit
[Nurse Crop Seed]	[Pounds/Acre][Pounds/Square Foot]
[Native Seed]	[Pounds/Acre][Pounds/Square Foot]
[Wildflower Seed]	[Pounds/Acre][Pounds/Square Foot]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150 (2017) Division II Construction and Material Specification, Erosion and Sediment Control

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA FSA	United States Department of Agriculture, Federal Seed Act

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

SEEDING NOTIFICATION

NURSE CROP SEEDING NOTIFICATION

SD-03 Product Data

PRODUCT DATA

SD-07 Certificates

SEED CERTIFICATION

NURSE CROP SEED CERTIFICATION

1.06 QUALITY ASSURANCE

A. Supplier Qualifications; Seed supplier shall have certificates of inspection as required by governmental authorities.

B. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, specialized in native seed installation and establishment with five (5) years recent experience, whose work has resulted in the successful installation of native seeding, similar in material, design, and extent.

2. The field supervisor shall have a Bachelor of Science Degree in Horticulture, Botany, Soil Physics, Agronomy, General Agriculture, Agricultural or Biological Engineering, or a related field [as determined by the [Design Professional][Owner]]. The field supervisor shall be identified by the Contractor and shall be on the Site during the following Work:

a. Soil preparation for native grass and wildflower seeding;

b. Native grass and wildflower seeding;

c. Native grass and wildflower establishment.

C. Ecological Consultant (Third Party); Contractor shall engage an experienced Ecological Consultant who has successfully completed quality assurance and construction oversight of native seed installation with the Work. The Ecological Consultant shall not be affiliated with the contracted seed installer or the primary landscape Contractor for the Work. The Ecological Consultant shall report directly to the Contractor, shall be present during both onsite and at meetings, and shall issue daily progress reports during preparation and seeding operations to the [Design Professional][Owner]. [Ecological Consultant shall provide maintenance recommendations to be implemented by the installation and maintenance Contractor to be included in required submittals per Section 02957 Green Stormwater Infrastructure Establishment.]

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. SEED CERTIFICATION; Submit certification from seed vendor for sources of seed blend at least seven (7) days in advance of delivery to Site. Certification shall include:

1. The botanical and common name and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Master label, year of production, and date of packaging.

C. PRODUCT DATA; Submit product data for the following, including but not limited to product name, product instructions, supplier name, address, and phone:

1. Organic Soil Conditioner;

2. Straw Mulch;

3. Erosion Control Blanket.

D. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or the Site after delivery.

E. Seed shipments shall include the following information:

1. State of Origin;

2. Year of Harvest;

3. Genus and Species Identification;
4. Seed Lot Number;
5. Packaged Quantity;
6. Identification of Seed Supplier;
7. Supplier Certification Number;
8. State of Supplier Registration;
9. Percent Pure Live Seed (PLS) Per Seed Lot;
10. Percent Germination;
11. Percent Weed Seed;
12. Percent Hard Seed;
13. Percent Foreign Matter;
14. Identification of Noxious Weed Seed;
15. Date of Seed Testing;
16. Identification of Seed Testing Agency.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Deliver packaged seed materials in original sealed, labeled, and undamaged containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at Site.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

2.01 [NATIVE GRASS][AND][WILDFLOWER] SEED

A. Seed shall be fresh, clean, dry, pure-live seed, complying with USDA FSA and Missouri Department of Agriculture regulations for purity, germination, and noxious weeds.

B. Seed lots, unblended, shall be provided to Ecological Consultant in original unopened containers for agro-histological determination and re-testing.

C. The Master label shall be produced by the horticulturist, and shall be sealed according to the appropriate laws and regulations.

D. Provide fresh, clean, new-crop seed complying with tolerances for purity and germination as established by Association of Official Seed Analysts.

E. Provide seed composed of grass and wildflower species and varieties, proportions by weight, minimum percentages of purity, germination, and maximum percentage of weed seed as specified in the Drawings.

2.02 NURSE CROP SEED

A. Seed shall be a nurse crop species of Grain Rye with 80 percent minimum pure live seed.

B. NURSE CROP SEED CERTIFICATION; Submit certification from seed vendor including:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

2.03 PLANTING SOIL

A. Planting soil within landscaping areas shall be growing media as specified in the Drawings and in accordance with Section 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

2.04 FERTILIZER

A. Fertilizer shall be slow-release, granular or pelleted fertilizer, consisting of 50 percent water-insoluble nitrogen.

B. Fertilizer shall be commercial fertilizer of neutral character with some elements derived from organic sources, containing:

1. Phosphoric Acid: Not less than four (4) percent

2. Potassium: Not less than two (2) percent

3. Nitrogen: Not less than three (3) pounds of actual Nitrogen per 1,000 square feet of turf area in a form that will be available during initial growth period

C. Do not use fertilizer between May 1st and September 15th.

D. Native seed stands shall not be fertilized for the first one (1) year after planting, as approved by [Design Professional][Owner].

E. Use of fertilizers shall be based upon soil testing need, as approved by [Design Professional][Owner].

2.05 EROSION CONTROL BLANKET

A. Erosion control blanket shall be used on seeding areas with slopes exceeding 6:1 (horizontal:vertical). Erosion control blanket shall meet the requirements of APWA 2150 and shall have a biodegradable classification, not a photodegradable classification.

2.06 ORGANIC SOIL CONDITIONER

A. Organic soil conditioner shall be mycorrhizal inoculant for seed bed preparation and used per manufacturer's specifications.

2.07 STRAW MULCH

A. Straw mulch shall be air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley and used where erosion control blanket is not required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. Contractor shall lay out seeding areas.

2. SEEDING NOTIFICATION; Contractor shall notify the [Design Professional][Owner] once locations are staked and vegetation areas are outlined. Contractor shall adjust locations when requested, and obtain acceptance of layout before seeding.

B. Project Conditions

1. Contractor shall coordinate seeding per the Site Activity Plan. Fall planting season allows for Dormant Seeding. Planting seasons shall be as follows:

a. Spring: March 15th to May 31st

b. Fall: November 15th to December 30th

2. Seeding dates outside of the specified planting seasons shall be approved by the [Design Professional][Owner]. Contractor shall notify the [Design Professional][Owner] in the event of seeding discrepancies and if seasonal conditions become abnormal. Proceed with seeding only when existing and forecasted weather conditions permit.

3. Contractor shall examine areas to be seeded for compliance with requirements and conditions affecting installation and performance. When unsatisfactory conditions for native plant growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the [Design Professional][Owner] before seeding. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the [Design Professional][Owner].

C. Control and Protection

1. Prior to planting activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Install erosion control blanket and nurse crop seeding when Site conditions do not allow for timely seeding of native grass and wildflowers and soil in areas to receive native seed may be subject to erosion.

3. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by seeding operations.

3.02 INSTALLATION

A. Soil Preparation

1. Prior to seeding operation in areas with a temporary seeding installation, the Contractor shall mow the nurse crop to two (2) inches in height, remove thatch and any remaining erosion control blanket, and drill seed into the nurse crop with a 'Truax' brand type drill seeder or approved equal.

2. Prior to seeding operations in fine grade areas, the Contractor shall prepare the areas to receive native seed by cultivating the soils to a depth of two (2) inches to produce a fine seed bed. The seed bed shall be smooth, reasonably free of rocks, soil clods, trash, and other debris.

3. Broadcast the organic soil conditioner and inoculants onto the prepared seed bed at the rate of 20 pounds per 1,000 square feet with equipment approved by the [Design Professional][Owner].

B. Fine Grading: Grade seeding areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be seeded in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if eroded or otherwise disturbed after fine grading, before seeding.

C. Nurse Crop Seeding

1. Nurse Crop seeding shall be installed when site and/or seasonal conditions do not allow for seeding or sodding of the type specified.

2. NURSE CROP SEEDING NOTIFICATION; Notify [Design Professional][Owner] when nurse crop seeding is warranted.

3. Nurse crop seeding shall be installed at 30 pounds per acre to produce a nurse crop until the permanent seed per Part 2.01 or sod per Part 2.02 can be installed per Part 3.01.

D. Seeding

1. Drill Seeding: Sow seeds Truax-type seeding machine that accurately meters the seed types and mixes all seeds uniformly during seeding.

a. The seeding machine shall have the following features:

1) Minimum of two (2) seed boxes to separate fine seeds from large/fluffy seeds;

2) Special feed mechanisms and agitators to evenly distribute the native seeds at a uniform depth;

3) Disc furrow openers and packer wheels or a cultipacker roller to cover the seed and firm the soil after seed placement;

4) Scrapers on the disc openers to prevent moist soil from building up;

5) Maximum row spacing of eight (8) inches.

b. Deliver seed from all boxes and place uniformly into the soil to obtain a final planting depth of one-fourth (1/4) inches.

c. The path of the drill seeding shall be done at a right angle to that of the drainage patterns. Contractor shall make two (2) passes over the entire area, 90 degrees to each other for full coverage.

2. Broadcast Seeding: Use broadcast or drop seed methods where restricted by steep slopes or other areas not accessible to a seeding machine.

a. The broadcast seeder shall have the following features:

1) Dual seed compartments for small seed and large/fluffy seed;

2) Auger agitator and picker wheels to handle fluffy seed;

3) Agitator in small seed compartment;

4) Slide control gate to set feeding rate for the small seed compartment;

5) Ten (10) inch diameter disc to sling seed uniformly on the soil surface.

b. After broadcast seeding, incorporate seed into soil by a light dragging, raking, or harrowing.

c. Roll or pack area to press the soil tightly against the seed and firm the seedbed.

E. Seed Protection

1. Protect seeded slopes greater than 6:1 (horizontal:vertical) with erosion control blanket installed and stapled per manufacturer's recommendations.

2. Protect seeded slopes less than 6:1 (horizontal:vertical) by spreading straw mulch as specified in Part 2.07, after completion of seeding operations.

F. Mulching: Mulching shall be done within 24 hours following the seeding operation except in the case of wood cellulose type mulch.

1. Straw mulch shall be spread uniformly in a continuous blanket at a depth of not less than 1.5 inches and not more than two (2) inches loose measurement (approximately 1.5 to 2 tons per acre).

2. Mulch shall be spread by hand or by a blower type mulch spreader.

3. Blower type mulch spreaders shall be adjusted and operated in such a manner as to prevent excessive breakage of the mulch material. If this cannot be accomplished, the mulch shall be spread by hand.

4. Care shall be exercised to ensure that all wire from baled hay is collected as it is removed from the bale.

5. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered.

6. The mulch shall not be bunched.

7. No mulch shall be spread unless it can be anchored on the same day. The straw mulch shall be anchored in the soil to a depth of 2 to 3 inches be a notched disk set straight or a mulch crimping machine. The machine shall be weighted and operated in such a manner to secure the mulch firmly in the ground to form a soil binding mulch and

prevent loss or bunching of the hay by wind. Two (2) or more passes may be required to anchor the mulch to the satisfaction of the [Design Professional][Owner].

3.03 TOLERANCES

A. Finished Grade: The Contractor shall place materials based on the line and grade specified in the Drawings within 0.1 feet vertical tolerance.

B. Satisfactory Seed Areas

1. Native grass and wildflower stand shall control erosion through root mass development. There shall be no occurrence of rills or gullies.

2. Native grass and wildflower stand shall contain no less than 85 percent healthy mature or developing plants per square foot with a population distribution per 10,000 square feet representative of ratios in the original blend.

3. Weeds shall be controlled through competition with the desired plants, and that mowed bio-mass is not accumulating in such a manner to be detrimental to existing plant materials as determined by the [Design Professional][Owner].

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of seed from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

C. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

D. Erect visible barricades and warning signs to protect newly seeded areas from traffic. Maintain barricades throughout Establishment Period and until substantial and healthy stand of specified plants is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure [native grass][and][wildflower] seeding through the duration of the Establishment Period.

B. If at any time during the Establishment Period the facility becomes damaged due to improper erosion control, maintenance activities, or frequency of maintenance activities, the Contractor shall restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

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02953

GSI SPECIFICATIONS

****

SECTION 02953

GREEN STORMWATER INFRASTRUCTURE NON-NATIVE SEEDING AND SODDING

****

NOTE: This guide specification includes requirements for non-native seeding and sodding including temporary seed, turfgrass seed, and turfgrass sod. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding is to provide requirements for furnishing and applying limited soil amendments, seeding, sodding, reconditioning existing lawn areas, and replanting unsatisfactory or damaged lawns affected by execution of the Work.

B. Definitions

1. Certified Seed: Progeny of breeder, foundation or registered seed, handled under procedures acceptable to the Department of Agriculture and Forestry to maintain satisfactory genetic purity and identity. Certification color is Blue Tag or Gold Tag.

2. Cover Crop: Temporary vegetation to help suppress weeds and manage soil erosion when project conditions are outside of the non-native seeding and sodding planting seasons.

3. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath topsoil.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for seeding and sodding, depicted in the Drawings and specified herein. Seed and sod shall be paid for by [Unit Price][Lump Sum Price] measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Non-Native Seeding and Sodding Measurement and Payment Units

Item	Unit
[Temporary Seed]	[Pounds/Acre][Pounds/Square Foot]
[Turfgrass Seed]	[Pounds/Acre][Pounds/Square Foot]
[Turfgrass Sod]	[Square Feet][Square Yards]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

02951 Green Stormwater Infrastructure Plants

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	(2017) Division II Construction and Material Specification, Erosion and Sediment Control

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI	Guideline Specifications to Turfgrass Sodding

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA FSA	United States Department of Agriculture, Federal Seed Act

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

TEMPORARY SEEDING NOTIFICATION

SD-03 Product Data

SOIL AMENDMENTS

SD-07 Certificates

TURFGRASS SEED CERTIFICATION

TURFGRASS SOD SEED CERTIFICATION

TEMPORARY SEED CERTIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of seeding and sodding, similar in material, design, and extent.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or the Site after delivery.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Turfgrass Seed: Deliver turfgrass seed in original sealed, labeled, and undamaged containers.

C. Turf Sod: Harvest, deliver, store, and handle turf sod according to requirements of the TPI.

PART 2 PRODUCTS

2.01 TURFGRASS SEED

A. Seed shall be fresh, clean, dry, new-crop seed, complying with the USDA FSA regulations.

B. TURFGRASS SEED CERTIFICATION; Submit certificates and supplier seed label for turfgrass seed including the following:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

C. Seed shall meet the following requirements for germination, purity, and weed seed:

1. Germination: 85 percent (min)

2. Purity: 98 percent (min)

3. Weed Seed: 0 percent (max)

D. Seed shall have Blue Tag certification.

E. Moldy seed or seed that has been damaged in storage shall not be used.

F. Seeded areas shall be a blend of 90 percent Turf-Type Tall Fescue and ten (10) percent Kentucky Bluegrass fulfilling the following requirements:

1. Blend shall be at least three (3) improved Turf-Type Tall Fescue species combined with at least one (1) Kentucky Bluegrass species.

2. Blend shall not include aggressive Kentucky Bluegrass cultivars.

3. Blend shall not include Forage-Type Tall Fescues.

4. Turf-Type Tall Fescues shall have a 70 percent average endophyte level minimum.

2.02 TURFGRASS SOD

A. Sod shall be certified turfgrass sod complying with TPI specifications for machine-cut thickness, size, strength, moisture content, and mowed height, free of weeds.

B. TURFGRASS SOD SEED CERTIFICATION; Provide certificates and supplier seed label for turfgrass sod seed including:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

C. Sod shall meet the following requirements for germination, purity, and weed seed:

1. Germination: 85 percent (min)

2. Purity: 98 percent (min)

3. Weed Seed: 0 percent (max)

D. Seed used for sod shall have Gold Tag certification. [If Gold Tag certification seed is not available, then seed shall be the highest quality Blue Tag certification seed available, at the discretion of the [Design Professional][Owner].]

E. Sod shall have uniform density, color, and texture of the turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

F. Sodded areas shall be a blend of 90 percent Turf-Type Tall Fescue and ten (10) percent Kentucky Bluegrass:

1. Blend shall be at least three (3) improved Turf Type Tall Fescues combined with at least two (2) Kentucky Bluegrass species.

2. Turf-Type Tall Fescues shall have a 70 percent average endophyte level minimum.

2.03 TEMPORARY SEED

A. Temporary seeding shall be installed when site and/or seasonal conditions do not allow for seeding or sodding of the type specified.

B. TEMPORARY SEEDING NOTIFICATION; Notify [Design Professional][Owner] when temporary seeding is warranted.

C. Temporary seed shall be per APWA 2150, Part 2153.5, A.

D. TEMPORARY SEED CERTIFICATION; Submit certificates and supplier seed label for temporary seed including:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

2.04 TOPSOIL

A. Topsoil shall be per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

B. SOIL AMENDMENTS; Submit product data of the following soil amendments, including but not limited to product name, product instructions, and supplier name, address, and phone:

1. Lime;

2. Sulfur;

3. Herbicides.

2.05 HERBICIDE

A. Herbicides shall be per Section 02951 Green Stormwater Infrastructure Plants.

2.06 SEED COAT

A. Seed Coat shall be cross-linked, modified acrylic polymer (CAS# 71042-87-0) with graphite (CAS#7782-42-5).

2.07 FERTILIZER

A. Fertilizer shall be slow-release, granular or pelleted fertilizer, consisting of 50 percent water-insoluble nitrogen.

B. Fertilizer shall be commercial fertilizer of neutral character with some elements derived from organic sources, containing:

1. Phosphoric Acid: Not less than four (4) percent

2. Potassium: Not less than two (2) percent

3. Nitrogen: Not less than three (3) pounds of actual Nitrogen per 1,000 square feet of turf area in a form that will be available during initial growth period

C. Do not use fertilizer between May 1st and September 15th.

2.08 MULCH

A. Straw mulch shall be air-dry, clean, mildew and seed free salt hay or threshed straw of wheat, rye, oats or barely.

2.09 WATER

A. Water used in this Work shall be furnished by the Contractor and will be suitable for irrigation and free from ingredients harmful to plant life.

B. All watering equipment shall be furnished by the Contractor.

C. Water from adjacent fire hydrants, public or private water lines shall be metered. Written approval from the property owner shall be obtained prior to the use of suitable water from ponds, creeks or private owners.

PART 3 EXECUTION

3.01 PREPARATION

A. Project Conditions

1. Contractor shall coordinate seeding per the Site Activity Plan. Planting seasons shall be as follows:

    a. Seed

        1) Spring: [March 15th to May 15th][Design Professional to specify Spring planting season dates][(or once temperatures are 60 degrees Fahrenheit and higher)][Design Professional to specify Spring planting temperature requirements].

        2) Fall: [September 15th to October 15th][Design Professional to specify Fall planting season dates] [(or once temperatures are 75 degrees Fahrenheit and lower)][Design Professional to specify Fall planting temperature requirements].

    b. Sod: [Sod as temperatures allow and when irrigation for establishment is available. Do not sod when ground is frozen or ambient air temperatures are greater than 90 degrees Fahrenheit or less than 50 degrees Fahrenheit][Design Professional to specify alternative sod temperature requirements].

2. Seeding or sodding dates outside of the specified planting seasons shall be approved by the [Design Professional][Owner]. Contractor shall notify the [Design Professional][Owner] in the event of seeding discrepancies and if seasonal conditions become abnormal. Proceed with seeding only when existing and forecasted weather conditions permit.

3. Contractor shall examine areas to be seeded or sodded for compliance with requirements and conditions affecting installation and performance. When unsatisfactory conditions for seed or sod growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the [Design Professional][Owner] before seeding or sodding. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the [Design Professional][Owner].

B. Control and Protection

1. Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by seeding and sodding operations.

3.02 INSTALLATION

A. Soil Preparation

1. Newly Graded Subgrades: Limit subgrade preparation to areas that will be planted in the immediate future.

    a. For seed application only, apply starter fertilizer directly to subgrade before scarifying.

    b. Mechanically scarify subgrade to a minimum depth of two (2) inches, four (4) inches preferred.

    c. Remove and dispose of stones larger than one (1) inch in any dimension, sticks, roots, litter, debris, and extraneous matter per Part 3.04.

    d. Apply soil amendments per Section 02947, and thoroughly blend topsoil before spreading.

    e. Spread topsoil to a minimum depth of six (6) inches but not less than required to meet finished grades after light rolling and natural settlement. Do not spread if topsoil or subgrade is frozen, muddy, or excessively wet.

2. Unchanged Subgrades: If areas are to be seeded or sodded in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare soil as follows:

    a. Remove and dispose of existing vegetation per Part 3.04.

    b. Mechanically scarify in-situ soil to a minimum depth of six (6) inches.

    c. Remove and dispose of stones larger than one (1) inch in any dimension, sticks, roots, litter, debris, and extraneous matter per Part 3.04.

    d. Apply soil amendments per Section 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments and fertilizers and mix thoroughly into top six (6) inches of soil. Mix soil to a homogeneous mixture of fine texture.

B. Fine Grading: Grade seeding and sodding areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be planted in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if eroded or otherwise disturbed after finished grading, before seeding or sodding.

C. Temporary Seeding: Temporary seeding shall be installed per APWA 2150, Part 2153.5, B. to produce a cover crop until the permanent seed per Part 2.01 or sod per Part 2.02 can be installed per Part 3.01.

D. Seeding

1. Sow seed at five (5) to six (6) pounds per 1,000 square feet.

a. Drill Seeding: Sow seed with a Brillion type seeding machine where applicable.

1) Evenly distribute seed by sowing equal quantities in two (2) directions at right angles to each other[, or three (3) directions in high maintenance areas, as directed by Design Professional].

b. Broadcast Seeding: Use broadcast or drop seed methods where restricted by steep slopes or other areas not accessible to a seeding machine.

1) Do not broadcast or drop seed when wind velocity exceeds five (5) miles per hour.

2) Rake seed lightly into top one-eighth (1/8) inch of topsoil, roll lightly, and water with fine spray.

c. Hydroseeding: Apply hydroseeding in a uniform and consistent manner.

1) Mix seed, fertilizer and pulverized mulch with water, agitating constantly. Do not add seed to water greater than four (4) hours prior to application.

2) On slopes of 2:1 (horizontal:verical) or flatter, apply seed separately from fertilizer. Rake soil over seed to an average depth of one-half (1/2) inch.

3) On slopes steeper than 2:1 (horizontal:verical) apply seed and fertilizer in a single operation.

2. Seed Protection

a. Protect seeded slopes 4:1 (horizontal:vertical) or greater with erosion-control blankets installed and stapled per manufacturer's recommendations.

b. Protect seeded slopes less than 4:1 (horizontal:vertical) by spreading straw mulch as specified in Part 2.08, after completion of seeding operations. Spread uniformly to form continuous cover over seeded areas. Spread by hand, blower, or as approved by [Design Professional][Owner].

c. Protect seeded areas against hot, dry weather or drying winds by applying compost within 24 hours after completion of seeding operations. Scatter compost uniformly to a depth of one-quarter (1/4) inch thick and roll to a smooth surface. Soak compost after spreading.

E. Sodding

1. Lay sod within 24 hours of harvesting. Do not lay sod if sod is dormant or if subgrade is frozen or muddy.

    a. Remove plastic netting from sod rolls during placement.

    b. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap.

    c. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation.

    d. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface.

    e. Work sifted topsoil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

2. Lay sod across angle of slopes exceeding 3:1 (horizontal:vertical). Anchor sod on slopes exceeding 4:1 (horizontal:vertical) with steel staples spaced per manufacturer recommendations but not less than two (2) anchors per sod strip to prevent slippage.

3. Saturate sod with fine water spray within one (1) hour of planting. For first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1.5 inches below sod.

F. Mulching: Mulching shall be done within 24 hours following the seeding operation except in the case of wood cellulose type mulch.

1. Straw mulch shall be spread uniformly in a continuous blanket at a depth of not less than 1.5 inches and not more than two (2) inches loose measurement (approximately 1.5 to 2 tons per acre).

2. Mulch shall be spread by hand or by a blower type mulch spreader.

3. Blower type mulch spreaders shall be adjusted and operated in such a manner as to prevent excessive breakage of the mulch material. If this cannot be accomplished, the mulch shall be spread by hand.

4. Care shall be exercised to ensure that all wire from baled hay is collected as it is removed from the bale.

5. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered.

6. The mulch shall not be bunched.

7. No mulch shall be spread unless it can be anchored on the same day. The straw mulch shall be anchored in the soil to a depth of 2 to 3 inches be a notched disk set straight or a mulch crimping machine. The machine shall be weighted and operated in such a manner to secure the mulch firmly in the ground to form a soil binding mulch and

prevent loss or bunching of the hay by wind. Two (2) or more passes may be required to anchor the mulch to the satisfaction of the [Design Professional][Owner].

3.03 TOLERANCES

A. Finished Grade: The Contractor shall place materials based on the line and grade specified in the Drawings within 0.1 feet vertical tolerance.

B. Satisfactory Seed and Sod Areas

1. Area shall be uniform and free of weeds, bare spots exceeding five (5) by five (5) inches, and surface irregularities.

2. Reestablish areas that do not comply with requirements and continue maintenance until areas are satisfactory as determined by the [Design Professional][Owner].

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of seed or sod from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection, including temporary seeding, to protect the green stormwater infrastructure facility until vegetation is fully established and the entire upstream drainage area is stabilized.

C. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

D. Erect visible barricades and warning signs to protect newly seeded or sodded areas from traffic. Maintain barricades throughout Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment, and until substantial and healthy stand of specified plants is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure seeding and sodding through the duration of the Establishment Period.

B. If at any time during the Establishment Period the facility becomes damaged due to improper erosion control, maintenance activities, or frequency of maintenance activities, the Contractor shall restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.

-- End of Section --

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02954

GSI SPECIFICATIONS

****

SECTION 02954

GREEN STORMWATER INFRASTRUCTURE PIPING

****

NOTE: This guide specification includes requirements for underdrains, distribution piping, fittings, cleanouts, observation wells, anti-seep collars, utility sleeves, concrete collar. Piping material types covered in this specification include reinforced concrete pipe (RCP), ductile iron pipe (DIP), solid and perforated high density polyethylene (HDPE) pipe, and solid and perforated polyvinyl chloride (PVC) pipe. Anti-seep collar products covered in this specification include HDPE and composite bentonite aggregate. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements.

Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Piping consists of all piping and appurtenances within a green stormwater infrastructure facility. Piping is primarily intended to convey stormwater to or away from the green stormwater infrastructure facility and to provide access or observation to the subsurface. Piping is also used to protect utilities from water damage, as well as to protect the green stormwater infrastructure facility from contamination from the utility.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for piping installation and testing, dictated in the Drawings and specified herein. Piping shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Piping Measurement and Payment Units

Item	Unit
[HDPE Piping]	[Linear Feet]
[PVC Piping]	[Linear Feet]
[Reinforced Concrete Pipe (RCP)]	[Linear Feet]
[Ductile Iron Pipe (DIP)]	[Linear Feet]
[Fittings]	[Each]
[Cleanout]	[Each]
[Observation Well]	[Each]
[Anti-Seep Collar]	[Each]
[Utility Sleeves]	[Linear Feet]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

****

NOTE: If alternative establishment requirements are specified, replace all references to Section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	(2017) Division II Construction and Material Specification, Erosion and Sediment Control
APWA 2208	(2017) Division II Construction and Material Specifications, Paving - Portland Cement Concrete Pavement
APWA 2500	(2017, Revised 2019) Division II Construction and Material Specifications, Sanitary Sewers
APWA 2602	(2017, Revised 2020) Division II Construction and Material Specifications, Storm Sewers - Pipe Sewer Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM D1784	Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F758	Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F1760	Standard Specification for Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

PLACEMENT NOTIFICATION

BACKFILL NOTIFICATION

SD-02 Shop Drawings

SHOP DRAWINGS

SD-03 Product Data

MANUFACTURER INFORMATION

SD-07 Certificates

CONCRETE MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. [Design Professional to specify manufacturer specific quality assurance requirements, as applicable][Not applicable].

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or the Site after delivery.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

C. MANUFACTURER INFORMATION; Submit manufacturer information for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, placement, installation, protection, and product warranty documentation.

D. SHOP DRAWINGS; Submit shop drawings with a minimum of the following information, if applicable:

1. Structure dimensions (exterior and interior);

2. Pipe connections and sizes;

3. Flow lines and flow directions.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Piping and appurtenances shall be delivered, stored, and handled such that the material is installed in sound, undamaged condition.

C. Plastic piping and appurtenances shall be protected from direct sunlight and other heat sources to prevent curvature and/or deformation.

D. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

2.01 [UNDERDRAIN][AND][DISTRIBUTION] PIPE MATERIAL

[A. Reinforced Concrete Pipe (RCP): RCP, fittings and joints shall conform to APWA 2602, Part 2602.2, A.]

[B. Ductile Iron Pipe (DIP): DIP, fittings and joints shall conform to APWA 2500, Part 2502.2, B.]

[C. High Density Polyethylene (HDPE)

1. All HDPE pipe, fitting and joints shall be provided by manufacturers certified through the Plastic Pipe Institute (PPI) and/or the National Transportation Product Evaluation Program (NTPEP) third party certification program.

[2. Solid Wall HDPE Pipe

a. Solid wall HDPE pipe, fittings and joints shall conform to APWA 2602 Part 2602.2, D.]

[3. Perforated HDPE Pipe

a. Perforated HDPE pipe, fittings and joints shall conform to APWA 2602 Part 2602.2, D. for 12 inch to 60 inch diameter pipe and AASHTO M252 for three

(3) inch to ten (10) inch diameter pipe and shall have AASHTO Class II perforations.]]

[D. Polyvinyl Chloride (PVC) Pipe

1. Plastic pipe, fittings and joints shall contain an ultraviolet inhibitor to provide protection from exposure to direct sunlight per ASTM D3034, ASTM F758, ASTM F679, or ASTM F1760.

[a. Solid Wall PVC Pipe: PVC solid wall gravity pipe shall be Type PSM, PVC minimum SDR [35] with full diameter dimensions and shall conform to ASTM D3034. Straight pipe shall be furnished in lengths per ASTM D3034.]

[b. Perforated PVC Pipe

1) Perforated PVC pipe shall be Type PS-46 PVC and shall conform to ASTM F758 or ASTM F679. Straight pipe shall be furnished in lengths per ASTM D3034.

2) Solid PVC pipe per ASTM D3034 or ASTM F1760 with drilled perforations may be used in lieu of perforated PVC pipe as approved by the [Design Professional][Owner]. Perforations shall be adequately sized to maintain the design flow and to prevent migration of soil and aggregate material into the pipe.

3) Perforations shall be two (2) rows of one-half (1/2) inch diameter holes spread longitudinally, maximum six (6) inch spacing and shall be oriented 120 degrees apart (60 degrees either side of the pipe bottom). The top of pipe shall be marked for ease of installation.]

[c. Slotted PVC Pipe

1) Slotted PVC pipe shall be Type 1, Grade 1, PVC compound with a cell classification of 12454-B per ASTM D1784 and meet the requirements of ASTM D1785

2) All PVC well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. Slotted underdrains shall have [Design Professional to specify slot size]-inch slot size. The length of the slots measured on the inside of the pipe shall be [Design Professional to specify length] inches. There shall be a total open area of not less than [Design Professional to specify minimum open area] square inches per linear foot of slotted pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot, normal to the axis of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot normal to the axis of the pipe. Slots shall be adequately sized to maintain the design flow and prevent the migration of soil and aggregate material into the pipe.]

[2. PVC Fittings and Joints

a. Fittings for perforated PVC pipe shall be bell and spigot push-on joints meeting applicable requirements of ASTM D3212 (Exception: Internal pressure test and vacuum test are not required). The bell-end and spigot-end may be unperforated for a length equal to the depth of the socket and/or shoulder.

b. Gasket-type joints shall conform to ASTM D3212. Solvent-cement-type joints shall conform to ASTM F758 or ASTM F679.]]

[2.02 CLEANOUT

A. Cleanout shall be constructed of HDPE or PVC material.

B. Cleanout cap shall be threaded.

[C. For cleanout in pavement, cleanout frame and cover shall be Neenah R-1976 or approved equal. Cleanout shall be anchored to a minimum four (4) inch thick concrete collar atop minimum six (6) inch aggregate base per the respective requirements specified here-in.]]

[2.03 OBSERVATION WELL

A. Observation well shall be constructed of HDPE or PVC.

B. Slotted well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. Slotted well screen shall have [Design Professional to specify slot size]-inch slot size. The length of the slots measured on the inside of the pipe shall be [Design Professional to specify length] inches. There shall be a total open area of not less than [Design Professional to specify minimum open area] square inches per linear foot of slotted pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot, normal to the axis of the pipe.

[C. Observation well cap shall be threaded.]

[D. For observation well in pavement, observation well frame and cover shall be Neenah R-1976 or approved equal. Observation well shall be anchored to a minimum four (4) inch thick concrete collar atop minimum six (6) inch thick aggregate base per the respective requirements specified here-in.]]

[2.04 HDPE ANTI-SEEP COLLAR

A. Anti-seep collar shall be constructed of HDPE material with a minimum thickness of one-fourth (1/4) inch.

B. Bolt shall be stainless steel.

C. Manufacturer shall be [Scheib Drainage Products][Design Professional to specify manufacturer name and product information] or approved equal.]

[2.05 COMPOSITE BENTONITE AGGREGATE ANTI-SEEP COLLAR

A. Composite bentonite aggregate shall be [Design Professional to specify material requirements].

B. Manufacturer shall be [AquaBlok][Design Professional to specify manufacturer name and product information] or approved equal.]

[2.06 UTILITY SLEEVE

A. Contractor shall coordinate with appropriate Utility Owner to verify special requirements regarding protection of utility. Contractor is responsible for procurement of all necessary materials to provide required utility protection.]

2.07 AGGREGATE BASE

A. Aggregate base shall be of the material specified in the Drawings, and shall meet the requirements of Section 02946 Green Stormwater Infrastructure Aggregate Media.

[2.08 CONCRETE COLLAR

****

NOTE: 3,500 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A529-1-4-0.567, 3,500 psi with 4-inch slump per MCIB, KCMMB 4k, etc.) as applicable.

****

A. Concrete mix shall be minimum [3,500 psi with 4-6 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal for concrete collar unless otherwise specified in the Drawings. Submit CONCRETE MIX DESIGN certifying that concrete mix design for concrete collar meets the requirements of the specified mix.

B. Reinforcement: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

B. Project Conditions

1. Piping shall be installed only when weather and/or trench conditions are suitable. Water may be removed from pipe trench via sump pumping or other methods as approved by [Design Professional][Owner].

[2. [Design Professional to specify additional project conditions, as applicable]]

C. Control and Protection

1. Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to installing the underdrain system, temporary erosion control shall be in place to protect any existing downstream drainage system to which the underdrain system connects.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation. Contractor is responsible for proper filtering and disposal from dewatering activities per APWA 2150.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified invert elevations, once fully installed, are located at the elevation shown in the Drawings. If an invert elevation is not specified, the Contractor shall consult the [Design Professional][Owner] to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the piping to the lines and grades shown in the Drawings.

B. Permeable Liner: Permeable liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners to the lines and grades specified in the Drawings.

C. Aggregate Base

1. Aggregate base shall be installed per Section 02946 Green Stormwater Infrastructure Aggregate Media to the lines, grades and depths specified in the Drawings.

2. Place aggregate base using methods that will not disturb or damage the piping material or the surrounding green stormwater infrastructure facility.

[3. Compaction shall be achieved using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.]

D. Piping

1. Piping materials shall be inspected prior to placement, rejecting any damaged or defective pipe.
2. PLACEMENT NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of piping materials.

3. Piping shall be installed to the lines, grades and depths specified in the Drawings.

   a. Pipe laying shall commence at the lowest point with continuous slope to provide unrestricted flow and eliminate low spots that could retain water.

   b. Pipe shall be laid with ends abutting. Bell-and spigot type pipe shall be installed with the bell end upstream.

4. Cutting shall be performed in a manner to provide smooth, straight, cuts at right angles to the pipe axis, without damage to the pipe. Cuts shall be performed with mechanical pipe cutters, or as approved by the [Design Professional][Owner].

5. The interior of all piping and appurtenances shall be clear of all foreign matter and debris.

6. Surfaces shall be wiped clean, dry, and free from oil and grease prior to jointing. Jointing shall be watertight.

7. Perforated pipe shall be laid as to center the perforations on the bottom of the pipe.

8. Piping materials damaged during installation shall be removed from the Site and replaced per Part 3.04 at the Contactor's expense.

[9. Contractor shall comply with detailed installation requirements as follows:

   [a. RCP shall be installed per APWA 2602 Part 2602.3, B.]

   [b. DIP shall be installed per APWA 2500 Part 2505.3, B.]

   [c. HDPE shall be installed per APWA 2602 Part 2602.3, B.]

   [d. PVC shall be installed per APWA 2500 Part 2505.3, A.]]

[E. Concrete: Shall be constructed per APWA 2208.]

[F. Cleanout

1. Cleanouts shall be installed to the lines, grades and depths specified in the Drawings.

2. Pipe connection shall be made watertight.]

[G. Observation Well: Observation wells shall be installed to the lines, grades and depths specified in the Drawings.]

[H. HDPE Anti-Seep Collar

1. Install anti-seep collar as specified in the Drawings.

2. Affix HPDE around pipe using bolts or other manufacturer required products.

3. Anti-seep collar shall be made watertight using appropriate non-shrink grout or other manufacturer required products.]

[I. Composite Bentonite Aggregate Anti-Seep Collar

1. Install anti-seep collar [as specified in the Drawings][per manufacturer requirements].]

[J. Utility Sleeve

1. Install utility sleeve as specified in the Drawings.

2. Contractor shall coordinate with appropriate Utility Owner to verify special requirements regarding protection of utility. Contractor is responsible for installation of all necessary materials to provide required utility protection.]

K. Backfill

1. BACKFILL NOTIFICATION; Notify the [Design Professional][Owner] at least 48 hours prior to placement of backfill.

2. Contractor shall receive approval of all in-place pipes from the [Design Professional][Owner] prior to backfilling.

3. Backfill shall be placed to the lines, grades and depths specified in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

****
NOTE: Design Professional shall designate specific grade verification points in the Drawings.
****

[B. A maximum tolerance of one-fourth (1/4) inch on hole spacing and size will be allowed.]

C. FINISHED GRADE SURVEY VERIFICATION; Survey finished elevation of green stormwater infrastructure piping and submit to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings, including but not limited to invert elevations and top of structure elevations.

3.04 DISPOSAL OF MATERIALS

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary protection and control measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the piping. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure piping through the duration of the Establishment Period.

D. If at any time during the Establishment Period the piping fails to function due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the

piping and fully restore the green stormwater infrastructure facility and any damaged components as determined by the [Design Professional][Owner], at no additional cost to the Owner.]

-- End of Section --

****

02955

GSI SPECIFICATIONS

****

SECTION 02955

GREEN STORMWATER INFRASTRUCTURE OUTLETS

****

NOTE: This guide specification includes requirements for outlets including PVC or HDPE overflow risers and manufactured outlet products. For manufactured products, Design Professional should input manufacturer information and shall follow manufacturer requirements. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable components and their corresponding requirements, or, insert appropriate information within the bracketed areas. Components and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Outlets allow excess stormwater to exit the green stormwater infrastructure facility when the capacity of the facility is exceeded. The outlet structure can control water levels both at the surface and in the subsurface of the green stormwater infrastructure facility. Stormwater above the finished grade of the green stormwater infrastructure is controlled with an overflow riser that is overtopped once the ponding elevation in the facility is exceeded.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material and equipment required to install the outlet as shown in the Drawings and as specified herein. Outlet shall be paid for by [Unit Price][Lump Sum Price] and measured as follows:

****

NOTE: If blank rows result from the table edits, the blank rows will have to be manually deleted.

****

Outlets Measurement and Payment Units

Item	Unit
[PVC Riser Pipe]	[Linear Feet]
[HDPE Riser Pipe]	[Linear Feet]
[Fittings]	[Each]
[Metal Grate]	[Each]
[Manufactured Outlet Structure]	[Each]
[Concrete Base]	[Cubic Yard]
[Aggregate Base]	[Cubic Yard][Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Aggregate Media

[02951 Green Stormwater Infrastructure Plants]

02954 Green Stormwater Infrastructure Piping

****

NOTE: If alternative establishment requirements are specified, replace all references to section 02957 accordingly.

****

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner].

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	(2017) Division II Construction and Material Specifications, Paving - Portland Cement Concrete Pavement

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-03 Product Data

MANUFACTURER INFORMATION

SHOP DRAWINGS

SD-07 Certificates

CONCRETE BASE MIX DESIGN

CONCRETE COLLAR MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

[A. Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94Mrequirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[B. Installer Qualifications: Design Professional to insert additional manufacturer/installer qualifications as applicable.]

[C. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

2. Personnel performing tests shall be ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency laboratory supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

D. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50-cubic yard of concrete placed and shall conform to the requirements of APWA 2208.]

C. SHOP DRAWINGS: Submit shop drawings with a minimum of the following information, if applicable:

1. Supplier name, address and phone;

2. Structure dimensions (exterior and interior);

3. Pipe connections and sizes;

4. Flow lines/flow directions;

5. Grate and/or screening details including effective open area for outlet capacity. Approved or equal products must provide grate effective open area that is within an acceptable range to the specified product, as determined by the [Design Professional][Owner].

D. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the [Design Professional][Owner]. Such inspection may be made at the place of manufacture or on the Site after delivery.

E. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

F. All materials which have been damaged after delivery will be rejected and replaced at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the [Design Professional][Owner], or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Upon delivery to the Site, the Contractor shall submit material delivery receipts to the Owner for record. Delivery receipts must include sufficient information to verify the material delivered is consistent with the approved submittals. If delivery receipts do not provide sufficient detail, the Contractor is responsible for verifying with the supplier that the correct material was delivered and providing the Owner with appropriate documentation.

B. Materials shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[C. Manufactured products shall be delivered, stored and handled per manufacturer recommendations.]

PART 2 PRODUCTS

****

NOTE: Applicable components and corresponding requirements selected here should match previous selections made. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[2.01 OVERFLOW RISER

A. Plastic Pipe and Fittings: Shall be solid PVC or HDPE pipe per Section 02954 Green Stormwater Infrastructure Piping of the size and depth specified in the Drawings.

B. Metal Frame and Grate: Shall be ductile iron per ASTM A536 Grade 70-50-05 and of the size and shape specified in the Drawings.

****

NOTE: 4,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

C. Concrete Collar: Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal. Submit CONCRETE COLLAR MIX DESIGN certifying that concrete mix design for concrete collar meets the requirements of the specified mix.]

[2.02 MANUFACTURED OUTLET STUCTURE

****

NOTE: Design Professional to specify recommended product and manufacturer or direct contractor to Drawings.

****

A. Manufactured Outlet Structure shall be [of the product type and manufacturer specified in the Drawings][Design Professional to specify manufacturer name and product information] or approved equal.

B. MANUFACTURER INFORMATION; Submit manufacturer information, product data and instructions for each product, including but not limited to structure type, size, material, effective open area, fabrication, delivery and handling, placement, installation, protection, and product warranty documentation.

[C. Structure Coating Material: All exposed plastic surfaces of structures shall have a black textured rubberized coating applied to the outer surface. Coating shall extend a minimum of 12 inches below the finished grade.]

****

NOTE: 4,000 psi concrete is typical, but designer may specify different and/or more additional requirements such as air entrainment, slump, mix design (e.g. MCIB A558-1-2-0.421, 4,000 psi with 2-inch slump per MCIB, etc.) as applicable.

****

[D. Concrete Base: Concrete mix shall be [4,000 psi with 2-4 inches of slump][Design Professional to specify desired concrete mix requirements] or approved equal. [Reinforcing bars shall be ASTM A615/A615M Grade 60 or approved equal.] Concrete cover requirements shall conform to ACI 318.

1. CONCRETE BASE MIX DESIGN; Submit certification that concrete mix design for concrete base meets the requirements of the specified mix.]

E. Aggregate Base: Concrete shall have an underlying aggregate base per Section 02946 Green Stormwater Infrastructure Aggregate Media.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

[B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R.]

[2. [Design Professional to specify additional project conditions, as applicable]]]

C. Control and Protection

1. Prior to installation of green stormwater infrastructure outlets, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to connecting the outlet to downstream drainage systems, temporary erosion control measures shall be in place.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation.

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable components selected in previous sections. Components and requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

A. Excavation

[1. Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified overflow elevation, once fully installed, is located at the elevation shown in the Drawings. If an overflow elevation is not specified, the Contractor is to consult the [Design Professional][Owner] to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the outlet to the lines and grades shown in the Drawings.

[B. Overflow Riser

1. Underdrain and/or outlet piping shall be installed prior to construction of overflow riser. Attach riser piping to underdrain and/or outlet piping using appropriate pipe fittings per Section 02954 Green Stormwater Infrastructure Piping. Cut vertical piping riser to the overflow elevation specified in the Drawings. Backfill piping immediately following installation to prevent damage to the vertical riser pipe.

2. Pour concrete collar at connection of overflow riser piping to connected pipe to seal pipe connections and prevent floating of overflow riser. The collar shall be a minimum of six (6) inches thick on all sides of the pipe and shall be properly supported.

3. Place grate over top of overflow riser and attach per manufacturer's instructions.]

[C. Manufactured Outlet Structure

[1. Concrete Base and Anchoring

a. Unless otherwise specified by the [manufacturer][Design Professional][Owner], all manufactured outlet structures require anchoring to prevent floating during periods of inundation.

b. Aggregate base shall be placed to the depth and extents shown in the Drawings. Place aggregate using methods that will not disturb or damage the outlet structures the surrounding piping, or the green stormwater infrastructure facility.

c. Compaction shall be achieved using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.

d. Concrete base size and thickness shall be as specified [in the Drawings][by manufacturer].

e. Anchoring: Outlet structure shall be encased in concrete or otherwise securely attached to the concrete base to resist buoyancy and flotation. Concrete encasement or other attachments shall not inhibit the function of the structure. If manufactured outlet structure includes aluminum accessories, apply bituminous coating to all aluminum surfaces in contact with concrete. Manufactured outlet structures with stainless steel accessories do not require bituminous coating for concrete encasement.]

2. Manufactured Outlet Structure Placement

a. Place outlet structure on concrete base and level vertically. Verify critical elevations, including but not limited to top of structure, inverts in/out and [overflow][weir][orifice][valve] elevations.

b. Connection of underdrain and/or outlet pipes to outlet structure shall provide watertight connections per [manufacturer's instructions][Section 02954 Green Stormwater Infrastructure Piping].

c. Anchor or encase outlet structure to concrete base.]

D. Backfill

1. Prior to backfilling, cover structure openings to protect from material deposition inside the structure during placement. Provide protection of outlet per Section 02938 Green Stormwater Infrastructure Control and Protection.

2. Backfill around structure and compact uniformly in six (6) inch lifts by hand using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of surrounding areas intended for infiltration.

3. Install soil and/or aggregate media around structure to finished grade per Section 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments, as shown in the Drawings. All green stormwater infrastructure media shall be in place [including

mulch per Section 02951 Green Stormwater Infrastructure Plants]prior to removal of protective covering and installation of grated cover.

3.03 TOLERANCES

A. Outlet structure installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings including but not limited to invert elevations, top of structure elevation and [overflow][weir][orifice][valve] elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

****

NOTE: Design Professional shall designate specific grade verification points in the Drawings.

****

C. FINISHED GRADE SURVEY VERIFICATION; Survey finished elevation of green stormwater infrastructure outlet and submit to the [Design Professional][Owner] for review. Survey elevation shall be taken at specific point locations identified in the Drawings, including but not limited to invert elevations, top of structure elevation and [overflow][weir][orifice][valve] elevations.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary protection and control measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the outlet until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the [Design Professional][Owner] for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain outlet through the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the outlet. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

****

02956

GSI SPECIFICATIONS

****

SECTION 02956

GREEN STORMWATER INFRASTRUCTURE IN-SITU INFILTRATION TESTING

****

NOTE: This guide specification includes requirements for double-ring infltrometer, percolation, Modified Philip Dunne, and permeable pavement in-situ infiltration testing methods. Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable test methods and their corresponding requirements, or, insert appropriate information within the bracketed areas. Requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

****

NOTE: The Double-Ring Infiltrometer Test is the preferred infiltration testing method except for infiltration testing on permeable pavements.

****

A. The purpose of Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing is to provide specific testing methods to measure performance of a green stormwater infrastructure facility via [Double-ring Infiltrometer Testing][and][Percolation Testing][and][Modified Philip Dunne Infiltrometer Testing][and][Infiltration Testing on Permeable Pavements].

1.02 MEASUREMENT AND PAYMENT

A. Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the Work. Testing shall be measured per testing site and shall be paid for by [Unit Price][Lump Sum Price].

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

1.04 REFERENCE STANDARDS

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, and title. References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by [Design Professional][Owner][Design Professional][Owner].

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C1701/C1701M	Standard Test Method for Infiltration Rate of In Place Pervious Concrete
ASTM C1781/C1781M	Standard Test Method for Infiltration Rate of Permeable Unit Pavement Systems
ASTM D3385	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer
ASTM D8152	Standard Practice for Measuring Field Infiltration Rate and Calculating Field Hydraulic Conductivity Using the Modified Philip Dunne Infiltrometer Test

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-01 Preconstruction Submittals

TESTING SITE IDENTIFICATION FIGURE(S)

TESTING NOTIFICATION

SD-06 Test Reports

INFILTRATION TEST RESULTS

1.06 QUALITY ASSURANCE

A. Testing shall be completed by a qualified professional per Section 02937 Green Stormwater Infrastructure Site Activity Plan, with experience in infiltration testing.

1.07 QUALITY CONTROL

A. TESTING NOTIFICATION; Notify the [Design Professional][Owner][Design Professional][Owner] at least 48 hours prior to scheduled testing.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Not Applicable.

PART 2 PRODUCTS

****

NOTE: Applicable test methods and corresponding requirements selected here should match previous selections made. Requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

2.01 TESTING EQUIPMENT

A. Contractor shall provide testing equipment.

1. Contractor utilize alternative equipment, provided that such equipment provides equal testing results, as determined by the [Design Professional][Owner][Design Professional][Owner].

[2. Double-Ring Infiltrometer Testing: Infiltration testing equipment shall meet the requirements of ASTM D3385.]

[3. Percolation Testing: Percolation testing equipment shall fulfill requirements to complete test per Part 3.02.]

[4. Modified Philip Dunne Infiltrometer Testing: Infiltration testing equipment shall meet the requirements of ASTM D8152.]

[5. Infiltration Testing on Permeable Surfaces: Infiltration testing equipment shall meet the requirements of ASTM C1701/C1701M for pervious concrete and porous asphalt,

and ASTM C1781/C1781M for permeable pavers. The test ring shall be 12 inches in diameter and a minimum of eight (8) inches in height.]

PART 3 EXECUTION

3.01 PREPARATION

A. TESTING SITE IDENTIFICATION FIGURE(S); Submit a figure of proposed sites for both pre-construction and post-construction testing, including a unique identifier for each location tested. Post-construction testing sites shall be as close (in proximity) as possible to the pre-construction testing sites.

B. Site Preparation: Mulch, sediment and other debris that inhibit the installation of the testing equipment shall be brushed aside prior to installation.

C. Project Conditions: Testing shall not be performed when the surface being tested is frozen, when ambient air temperature is at or forecasted to be less than or equal to 32 degrees Fahrenheit during the time of testing, during a precipitation event, nor while an irrigation system is activated. [Infiltration testing on permeable surfaces shall not be conducted when the pavement surface temperature exceeds 100 degrees Fahrenheit.]

3.02 INSTALLATION

****

NOTE: Installation requirements should only be included for applicable test methods selected in previous sections. Requirements not selected during decision point process will be automatically redlined from and not included in the specification printed for inclusion in the Project Manual.

****

[A. Double-Ring Infiltrometer Testing

1. Install infiltration rings per ASTM D3385 driven to a depth of approximately four (4) inches.

2. Perform infiltration test per ASTM D3385.]

[B. Percolation Testing

1. Excavate a round test hole nine (9) inches in diameter and no less than nine (9) inches deep at each percolation testing site.

2. Install a test ring with a minimum diameter of six (6) inches and a height no less than the depth of the excavated hole.

3. Measure and record the depth to the bottom of the test ring.

4. Saturate testing site by completely filling the test ring with water and allowing it to drain completely.

5. When the testing site has completely drained and the bottom of the test hole is still saturated (no more than 24 hours after the testing site has drained), completely refill the test ring; measure and record the initial depth of water. Record the start time of test.

6. Measure and record drawdown at regular intervals until the test ring has completely drained, reporting percolation test results in inches of drawdown per time.]

[C. Modified Philip Dunne Infiltrometer Testing: Perform test per ASTM D8152.]

[D. Infiltration Testing on Permeable Surfaces: Complete permeable surface infiltration test per ASTM C1701/C1701M for pervious concrete and porous asphalt, and ASTM C1781/C1781M for permeable pavers.]

E. INFILTRATION TEST RESULTS; Submit test results within ten (10) days of testing. Results shall include site identification figure(s) showing northing and easting points of test sites, photographs of the testing sites (before, during, and after testing), date of test, test start and end times, data points collected, weather conditions from the beginning to end of testing, and conclusive result.

F. Alternative Testing: Contractor may propose alternative methods for testing, provided that such methods provide equal testing results, as determined by the [Design Professional][Owner][Design Professional][Owner].

3.03 TOLERANCES

[A. Double-Ring Infiltrometer Testing

1. Record the volume of liquid infiltrated during a period of up to six (6) hours or until a relatively constant rate of infiltration is obtained. A relatively constant rate of infiltration as it relates to terminating infiltration testing shall be a minimum of four (4) consecutive infiltration rate measurements of the inner ring within ten (10) percent of each other.

2. Volume shall be recorded to the nearest twenty-five (25) milliliters at an approximate interval of ten (10) minutes for green stormwater infrastructure.

3. Elapsed time shall be recorded to the nearest second.]

[B. Percolation Testing: Drawdown shall be measured and recorded at regular intervals until the test hole has completely drained. Drawdown shall be measured within 0.1 inch of accuracy.]

[C. Modified Philip Dunne Infiltrometer Testing

1. Record the initial and final volumetric soil water content to the nearest percent.

2. Record water level to the nearest millimeter at regular intervals per ASTM D8152.]

[D. Infiltration Testing on Permeable Surfaces: Elapsed time until the test ring has completely drained shall be recorded to the nearest second.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Contractor shall return the testing site to pre-test conditions.

3.06 MAINTENANCE

A. Not applicable.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

3.09 FINAL ACCEPTANCE

A. If testing results are inconsistent with defined procedures, re-testing shall occur at the discretion of the [Design Professional][Owner][Design Professional][Owner].

-- End of Section --

****

02957

GSI SPECIFICATIONS

****

SECTION 02957

GREEN STORMWATER INFRASTRUCTURE ESTABLISHMENT

****

NOTE: This guide specification includes requirements for the establishment and maintenance of green infrastructure projects. Section 02957 is written to correlate to terms defined in the Front End sections of the Project Manual. Establishment Period and requirements may vary, and this section should be modified accordingly. If this section is to be removed from the Project Manual, Design Professional must revise all references to the Establishment Period within other green stormwater infrastructure specification sections accordingly.

Edit this guide within bracketed areas of the specification during the decision point process. When selecting replace bracket text, select only applicable specification sections and their corresponding requirements, or, insert appropriate information within the bracketed areas. Specifications and requirements not selected during decision point process will be automatically deleted from this specification.

Reference to APWA 5600 for additional guidance.

****

PART 1 GENERAL

1.01 PURPOSE

A. Contractor shall provide all equipment, material and labor required for servicing, maintaining, and establishing green stormwater infrastructure facilities and project landscaping, as identified in Green Stormwater Infrastructure Maintenance Plan, submitted per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

****

NOTE: These specifications use City terminology and requirements for Substantial Completion or Achievement of Full Operation and Correction Period as it relates to duration of Contractor's responsibility for establishment and maintenance of green stormwater infrastructure and its components. Design Professional to verify contract terms for project completion defined in the Front End specifications of the Project Manual.

****

B. The Green Stormwater Infrastructure Establishment Period consists of both the GSI Construction Period and the Correction Period as defined in Part 1.01, C. Substantial Completion is defined at the time of Owner's issuance of Certificate of [Substantial Completion][Achievement of Full Operation][Substantial Completion][Achievement of Full Operation] per Section [Designer to input specification number where project Substantial Completion or Achievement of Full Operation is defined].

C. Definitions

1. Establishment Period: Period in which the Contractor shall be responsible for the performance of the green stormwater infrastructure facility and associated green stormwater infrastructure components as defined in Section 02937 GSI Site Activity Plan to achieve and sustain Service Levels of Performance defined in Part 3.06. Establishment Period shall commence at the start of GSI Construction Period and shall extend through the duration of the Correction Period.

2. GSI Construction Period: Portion of the Establishment Period for green stormwater infrastructure components placed in continuous service before [Substantial Completion][Achievement of Full Operation], as specified in Section[Designer to input specification number where project Substantial Completion or Achievement of Full Operation is defined]. Period shall commence when green stormwater infrastructure facility construction commences, as defined as when the first green stormwater infrastructure component is installed, and shall extend through issuance of Certificate of [Substantial Completion][Achievement of Full Operation].

3. Correction Period: Period shall commence at issuance of Certificate of [Substantial Completion][Achievement of Full Operation] and shall extend for a period as defined in Section [Designer to input specification number where project Correction Period is defined].

4. Establishment: Establishment is used to describe the length of time prior to green stormwater infrastructure being fully capable of managing stormwater runoff. During this period of time, Service and Maintenance activities are necessary to promote landscape health for plant maturity and full integration of green stormwater infrastructure components.

5. Service: Service is described as replenishing materials that are deteriorated, lost to erosion, removed or damaged through exposure to elements, or resulting from use, to achieve and sustain Service Levels of Performance defined in Part 3.06.

6. Maintenance: Maintenance is described as Work that is appropriate and necessary to achieve and sustain Service levels of performance defined in Part 3.06.

1.02 MEASUREMENT AND PAYMENT

A. Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the Work.

B. Contractor shall submit an Application for Payment quarterly. During Correction period, each Application for Payment shall be for one-twelfth (1/12) of the remaining contracted amount for this Work.

C. Each Application for Payment shall include Inspection Log and Material Log per the Green Stormwater Infrastructure Maintenance Plan, as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

01290.13 Punch List

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Aggregate Media

02947 Green Stormwater Infrastructure Growing Media and Soil Amendments

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seedingand Sodding]

****

NOTE: If alternative infiltration requirements are specified, replace all references to Section 02956 accordingly.

****

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

1.04 REFERENCES STANDARDS

A. Not applicable.

1.05 SUBMITTALS

****

NOTE: The following list should reflect submittal requirements referenced within this specification. Detailed requirements for each submittal listed here is specified within subsequent text. Applicable submittals should match subsequent selections made during decision point process.

****

SD-05 Design Data

INSPECTION LOG AND MATERIAL LOG

SD-06 Test Reports

POST-CONSTRUCTION INFILTRATION TEST RESULTS

1.06 QUALITY ASSURANCE

A. Service, Maintenance, and Establishment activities to be performed by the Contractor shall be identified in the Green Stormwater Infrastructure Maintenance Plan.

1.07 QUALITY CONTROL

A. Contractor shall use an Inspection Log per Section 02937 Green Stormwater Infrastructure Site Activity Plan to record and report all inspection activities as part of the Green Stormwater Infrastructure Maintenance Plan.

B. Contractor shall use a Material Log per Section 02937 Green Stormwater Infrastructure Site Activity Plan to maintain a record of all material used as part of the Green Stormwater Infrastructure Maintenance Plan.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Contractor shall have proper identification while onsite at all times. Identification may include but is not limited to an authorization letter from Owner, business cards, or labeled vehicles or uniforms.

PART 2 PRODUCTS

2.01 MATERIALS AND METHODS

A. This specification includes recording and documentation of Service, Maintenance, and Establishment activities as defined by the Green Stormwater Infrastructure Maintenance Plan. Recording and documentation requires Contractor utilization of an INSPECTION LOG AND MATERIAL LOG.

B. Materials and methods identified in the Green Stormwater Infrastructure Maintenance Plan are subject to approval by [Design Professional][Owner].

2.02 ALTERNATE MATERIALS OR METHODS

A. Contractor may use alternate materials and methods subject to approval by the [Design Professional][Owner].

PART 3 EXECUTION

3.01 PREPARATION

A. Not applicable.

3.02 INSTALLATION

A. Not applicable.

3.03 TOLERANCES

A. The Contractor is responsible for maintaining finished grade of green stormwater infrastructure facility within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. If green stormwater infrastructure finished grade varies from required tolerances, Contractor shall add additional surface material as specified in the Drawings and per Sections 02946 Green Stormwater Infrastructure Aggregate Media and 02947 Green Stormwater Infrastructure Growing Media and Soil Amendments.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

3.06 MAINTENANCE

A. The Contractor is responsible for Maintenance of green stormwater infrastructure components through the duration of the Establishment Period.

B. Maintenance activities and frequencies shall be sufficient to meet the following standards for service levels of performance:

Establishment Period Service Levels of Performance

Appearance	Weeds, Pests, Disease	Mulch, Erosion	Drainage

Vegetation healthy with tidy appearance Vegetation watered during dry periods over two (2) weeks in length Vegetation confined to planted areas Clean, distinct planting bed edges Litter/trash removed Fallen/blown foliage removed (leaves, nuts, sticks, lawn clippings, fallen branches) Little to no sediment or silt on surface No cracking, settling, or damage to of green stormwater infrastructure components	Weeds are not acceptable Every effort should be made to control and eliminate all weeds Pests or diseases that threaten vegetation should be removed with gentlest method possible. If problem is limited to less than 5% of plants, remove infected plants and replace with different species Mosquito larvae removed	Mulch evenly distributed, two (2) inches to four (4) inches deep No evidence of erosion Little to no sediment or silt on mulch surface	Zero ponding depth observed 48 hours following a rain event Clear, open flow paths for water (inlet, outlet, overflow)

C. Maintenance activities and frequencies provided in the Contract Documents or listed in the Green Stormwater Infrastructure Manual do not take precedence over the levels of performance described in Part 3.06, A.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing at up to [three (3)] testing locations prior to Final Inspection of work as described in Part 3.08, C. Contractor shall conduct testing within ten (10) days of Final Inspection and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS.

B. Post-construction infiltration rates shall meet or exceed pre-construction infiltration rates and shall be no less than [0.25 inches per hour].

C. Media that fails to meet post-construction infiltration requirements shall be remediated as recommended by the [Design Professional][Owner]. Amended media shall then be

retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the media meets post-construction infiltration requirements at the discretion of the [Design Professional][Owner].

3.08 WARRANTY

A. Service, Maintenance, and Establishment activities shall be for the full duration of the Establishment Period.

B. For vegetative green stormwater infrastructure components, the Contractor shall be responsible for the health of all plants. Contractor shall replace all dead or dying plants within the green stormwater infrastructure facility. Any plant that is dead, or is not in satisfactory health as determined by the [Design Professional][Owner] will be replaced by the Contractor at no additional cost to the Owner. All dead plants shall be replaced a maximum of once per year during the Establishment Period, not to exceed three (3) replacements per plant. Replacement plants shall be installed during the appropriate planting season as defined in [Sections 02951 Green Stormwater Infrastructure Plants][, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding][, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding].

C. The Contractor shall complete a Final Inspection of the Work with the Owner to determine Service level performance within 60 days of termination of the Establishment Period. The Owner shall notify the Contractor in writing of any deficiencies in meeting the Service level performance in the final Punch List per Section 01290.13 Punch List. The Contractor shall correct any identified deficiencies and document remedial action taken in the final Punch List. Affidavit for Final Payment shall not be accepted until all deficiencies have been corrected by the Contractor.

-- End of Section --

SITE ACTIVITY PLAN INSTRUCTIONS

Site Activity Plan Instructions

- Design Professionals
- Contractors

Site Activity Plan Templates

- GSI Sites & Components Form
- GSI Construction Schedule Form
- GSI Maintenance Schedule Form
- GSI Quality Assurance Qualifications Form
- GSI Maintenance Activity/Inspection Forms

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GSI SITE ACTIVITY PLAN INSTRUCTIONS

A spreadsheet tool is provided along with this manual to help develop the **Site Activity Plan** per the GSI Specification (02937). This tool should be used to develop the GSI Construction Schedule, GSI Maintenance Schedule, and GSI Quality Assurance Qualifications. Additionally the tool generates Maintenance Inspection/ Activity forms based on the GSI Maintenance Schedule that the contractor can use to document work at each GSI site.

Detailed instructions on how to use the spreadsheet to develop the Site Activity Plan, including examples of required forms and submittals are included in this Appendix. The instructions are divided by steps that should be taken by the design professional to generate the project-specific forms when compiling the Project Manual, and steps that should be taken by the contractor to complete the forms. The forms included in this Appendix are included for informational purposes only; the digital spreadsheet version should be used to complete all forms. Steps listed below are broken into tasks for each responsible party.

INSTRUCTIONS FOR DESIGN PROFESSIONAL

The design professional will need to insert information on the first four tabs of the spreadsheet. The cells requiring designer input are colored light green. The spreadsheet can be filtered to only view these tabs by clicking the "See Designer Tabs" button at the top of Tab 1.

- **Tab 1:** GSI Sites & Components
- **Tab 2:** GSI Construction Schedule
- **Tab 3:** GSI Maintenance Schedule
- **Tab 4:** QA Qualifications

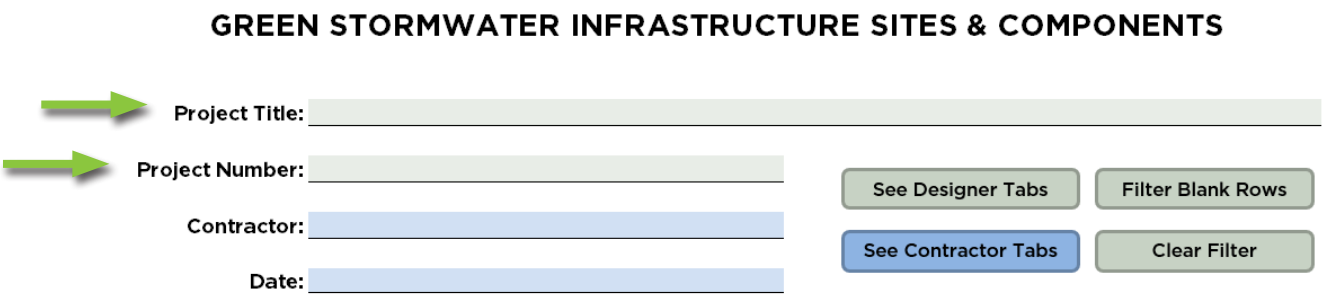
Upon completion of the following steps, the design professional should create PDFs of the forms and include them as attachments to Section 02937 Green Stormwater Infrastructure Site Activity Plan, so they become part of the contract documents. Additionally, the digital version should be submitted as well so that the contractor can complete their part of each form. The spreadsheet includes the baseline GSI Construction Specifications only, and should be modified per specific project requirements.

Before exporting to PDF or printing, care should be taken ensure all information is visible once printed using the "Page Break Preview" and adjusting the page breaks as needed. Additionally, make sure row heights and column widths are sufficient to show all text.

GSI Sites & Components (Tab 1):

1) Fill in the project header information at the top of the form: Project Title and Project Number.
    a) **Note:** Project header information will auto-populate the header on each subsequent tab.

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)



2) Click the "See Designer Tabs" button to only view the tabs that require designer input (Tabs 1 through 4).
3) **GSI Site Name (column B/C):** Insert all GSI site names for the project. Site names should be representative of each individual GSI Practice, plan identifier, and location.
    a) **Note:** The GSI Site Names will auto-populate in the GSI Construction Schedule (Tab 2) and the GSI Maintenance Schedule (Tab 3).
4) **GSI Practice (column D):** Select the applicable GSI Practice for each site from the drop-down menu.
5) **GSI Components (columns F and G)**: Select all applicable GSI Components for the entire project by clicking the checkmark boxes. If there are any additional components that are not listed (for example, proprietary features or a new technology type) add those components to the list. If no additional components are added, delete the *red italicized text* as needed.

GSI SITES	
GSI Site Name	**GSI Practice**
(R1) - 1400 Main St	Rain Garden
(B1) - 1424 Main St	Bioretention
(PP1-PP8) - W 13th St	Permeable Pavement System

	GSI COMPONENTS
☑	GSI-1 Inlets
☑	GSI-2 Energy Dissipation & Pollutant Removal
☑	GSI-3 Above Grade Barriers
☑	GSI-4 Permeable Pavements
☑	GSI-5 Soil & Aggregate Media
☑	GSI-6 Media Liners
☑	GSI-7 Landscaping
☑	GSI-8 Piping
☑	GSI-9 Outlets
☐	GSI-10 Storage Chambers
☐	*(Insert Additional Component)*
☐	

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

6) Once all GSI Sites, Practices, and Components are entered, click the "Filter Blank Rows" button. To view the blank rows again, in the event that more sites or additional components need to be added, click the "Clear Filter" button. Repeat this step as needed.

7) Once complete, it is recommended that the design professional lock the GSI Sites and GSI Component cells (columns B/C, D, F, and G) to avoid any future unintentional changes by the contractor.

GSI Construction Schedule (Tab 2):

General Tab Notes:

- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).
- Rows will auto-populate in this tab as sites are added on Tab 1. If a GSI Practice has been selected on Tab 1 but the site name hasn't been entered, this tab will populate rows for the site but the corresponding cells in column B will highlight red and direct the user to enter the site name in the correct cell on Tab 1.
- **GSI Site Names** (column B): Column will auto-populate the GSI Site Names entered on Tab 1. If a site name is missing or needs to be revised, those edits must be done on Tab 1.

1) **GSI Component Category (column C/D):** For each GSI site, use the drop-down list to select the applicable components (rows are gray until a component is selected). Each unique component product requires its own row. If a site has multiple products that fall under one component category, then use two separate rows with the same GSI Component selected on each row (for example, if the site includes bioretention soil media and No. 57 aggregate, then select GSI-5 Soil & Aggregate Media products in two different rows so that the contractor can fill out information for each product on separate rows).

    a) **Note:** The component options in the drop-down list will only show those selected on Tab 1. If a component is not listed in the drop-down list, go back to Tab 1 to make sure the selection box was marked in the GSI Component list and that a name is typed in. If the selection box is checked on Tab 1 but there is no name for the component, the drop-down list will direct the user to type the name in the correct cell (i.e. "Insert Component Name on Tab 1, Cell G24").

2) Once all GSI Component Categories are entered, click the "Filter Blank Component Rows" button. To view the blank rows again, in the event that more components need to be added, click the "Clear Filter" button. Repeat this step as needed.

3) **GSI Component Product/Description (column E):** For each unique component product, provide a description of the specified material (i.e. No. 57 aggregate). If a proprietary product is being used, provide the product name that is specified on the plans. The GSI Component Product/Description should correlate with the Schedule of Values per Section 00700 Construction General Conditions.

4) Once complete, it is recommended that the design professional lock the GSI Component Category and GSI Component Product/Description cells (columns C/D and E) to avoid any future unintentional changes by the contractor. The contractor will fill out the remaining blue columns.

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

Filter Blank Component Rows | Clear Filter

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes
(R1) - 1400 Main St	GSI-1 Inlets	Rain Guardian Turret				
	GSI-2 Energy Dissipation & Pollutant Removal	Rock Splash Pad				
	GSI-3 Above Grade Barriers	Ribbon Curb				
	GSI-5 Soil & Aggregate Media	Amended Native Soil				
	GSI-7 Landscaping	Native Plants				
(B1) - 1424 Main St	GSI-1 Inlets	Rain Guardian Turret				
	GSI-2 Energy Dissipation & Pollutant Removal	Rock Splash Pad				
	GSI-3 Above Grade Barriers	Straight Curb & Gutter				
	GSI-5 Soil & Aggregate Media	Bioretention Soil Media				
	GSI-5 Soil & Aggregate Media	No. 57 Aggregate				
	GSI-5 Soil & Aggregate Media	No. 8 Aggregate				
	GSI-7 Landscaping	Native Plants				
	GSI-8 Piping	PVC Underdrain				
	GSI-9 Outlets	Agridrain WCS				

GSI Maintenance Schedule (Tab 3):

General Tab Notes:

- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).
- GSI Sites Included (column J): Column will auto-populate based on the components selected for each site in the GSI Construction Schedule tab (Tab 2).

1) Click the "Filter Applicable Components" button to filter for the GSI Components selected on Tab 1. When components are added or removed on Tab 1, click the button again to refilter the components. To view all components, click the "See All Components" button. Note that this clears all filters in the tab, including filters on the required tasks (column I), which are discussed on step 3. If all components are being viewed, those that are not selected on Tab 1 will be grayed out.

Filter Applicable Components | See All Components

GSI Component	Required Tasks
GSI-1 Inlets	Inspect for standing water, sediment, debr and structural integrity
	Remove sediment, debris, trash, blockages
	Repair damage

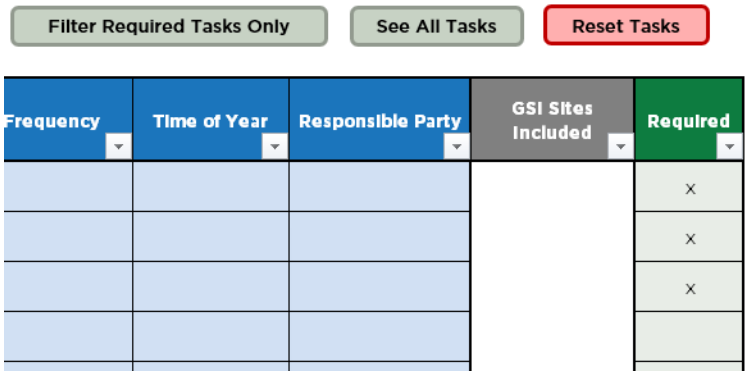
GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

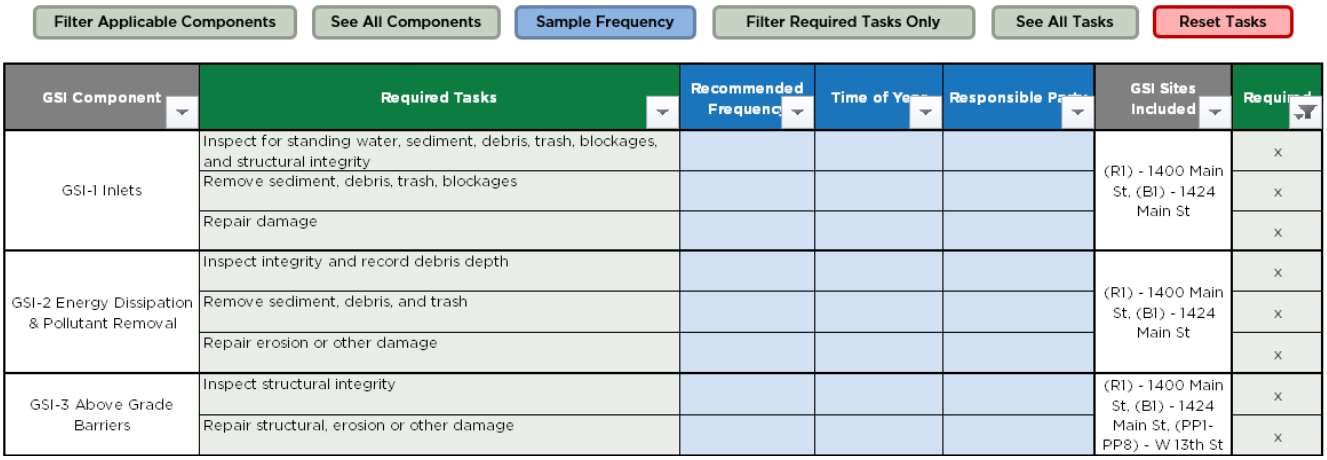
2) **Required Tasks (columns D and I):** Review typical maintenance tasks in column D for each component. Add additional maintenance tasks for specialty products or components outside of the standard GSI Components list. Indicate which maintenance tasks are required for each component by typing an "x" in the "Required" column (column I).

   a) **Note:** Tasks marked as required on this tab will auto-populate the required tasks in the contractor Maintenance Activity Forms (Tabs 5 through 10).

3) After the maintenance tasks have been reviewed/added and required tasks have been marked with an "x", click the "Filter Required Tasks Only" button to remove any unused tasks (and blank rows). To view all tasks again, click the "See All Tasks" button. To clear all "x"s and start over, click the "Reset Tasks" button.

4) Once complete, it is recommended that the design professional lock the Required tasks cells (column I) and any cells that were added for additional tasks in column D to avoid any future unintentional changes by the contractor.





GSI Component	Required Tasks	Recommended Frequency	Time of Year	Responsible Party	GSI Sites Included	Required
GSI-1 Inlets	Inspect for standing water, sediment, debris, trash, blockages, and structural integrity				(R1) - 1400 Main St, (B1) - 1424 Main St	x
	Remove sediment, debris, trash, blockages					x
	Repair damage					x
GSI-2 Energy Dissipation & Pollutant Removal	Inspect integrity and record debris depth				(R1) - 1400 Main St, (B1) - 1424 Main St	x
	Remove sediment, debris, and trash					x
	Repair erosion or other damage					x
GSI-3 Above Grade Barriers	Inspect structural integrity				(R1) - 1400 Main St, (B1) - 1424 Main St, (PP1-PP8) - W 13th St	x
	Repair structural, erosion or other damage					x

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

QA Qualifications (Tab 4):

General Tab Notes:

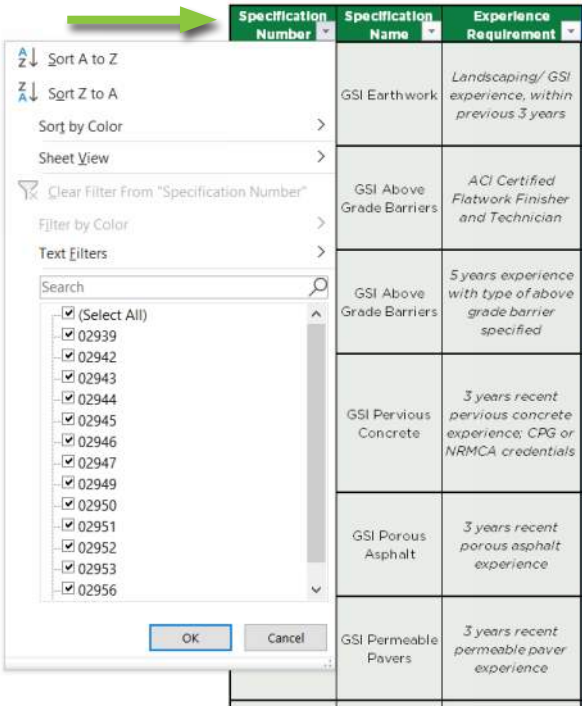
- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).

1) If additional specifications are included in the project outside of those included in the Green Stormwater Infrastructure Manual, add the specification number, name, and the experience requirement to the bottom of the table.

02953	GSI Non-Native Seeding and Sodding	*Seeding/sodding experience*		1						
				2						
				3						
02956	GSI In-Situ Infiltration Testing	*Infiltration testing experience*		1						
				2						
				3						
				1						
				2						
				3						
				1						
				2						
				3						

2) **Specification Number and Name** (columns B and C): Using the filter drop-down arrows on either the "Specification Number "or "Specification Name" columns, select the project's applicable specifications. Remove (Blanks) from the filter as well. The selected specifications should match the Project Manual Table of Contents for all GSI Construction Specifications.

3) Once complete, it is recommended that the design professional lock the Specification Number, Specification Name, and Experience Requirement cells (columns B C, and D) to avoid any future unintentional changes by the contractor.



GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

INSTRUCTIONS FOR CONTRACTOR

Prior to the start of the project, the contractor should request the editable digital version of the Site Activity Plan if it has not been provided. The forms should include all GSI design specific information, as provided by the design professional.

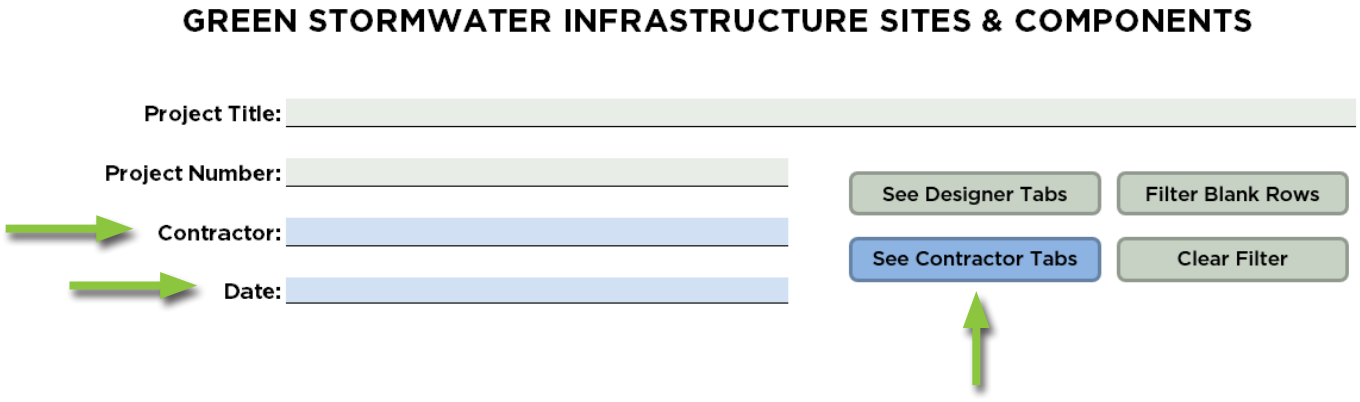
The contractor will need to insert information on the first four tabs of the spreadsheet. The cells requiring contractor input are colored light blue. Additionally, the last six tabs of the spreadsheet are forms for the contractor to use to document maintenance work and inspection activities that occur at each site. The spreadsheet can be filtered to view all of these tabs by clicking the "See Contractor Tabs" button at the top of Tab 1.

- **Tab 1:** GSI Sites & Components
- **Tab 2:** GSI Construction Schedule
- **Tab 3:** GSI Maintenance Schedule
- **Tab 4:** QA Qualifications
- **Tab 5:** Weekly Maintenance
- **Tab 6:** Bi-Weekly Maintenance
- **Tab 7:** Monthly Maintenance
- **Tab 8:** Quarterly Maintenance
- **Tab 9:** Semi-Annual Maintenance
- **Tab 10:** Annual Maintenance

Before exporting to PDF or printing, care should be taken ensure all information is visible once printed using the "Page Break Preview" and adjusting the page breaks as needed. Additionally, make sure row heights and column widths are sufficient to show all text.

GSI Sites & Components (Tab 1):

1) Fill in project header information at the top of the form: enter Contractor Name and Site Activity Plan Submittal/Revision Date.
   a) **Note:** Project header information will auto-populate the header on each subsequent tab.
2) Click the "See Contractor Tabs" button to view the tabs that require contractor input (Tabs 1 through 4) and the contractor Maintenance Activity Forms (Tabs 5 through 10).



GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

GSI Construction Schedule (Tab 2):

General Tab Notes:

- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).

1) **Material Procurement Lead Time** (column F): Enter estimated procurement time based on product manufacturer/material producer coordination.
2) **Begin Installation Date** (column G): Enter date the contractor intends to start construction for the component, including any site prep or excavation necessary for the Work.
3) **End Installation Date** (column H): Enter date intended to complete install of the component, including any backfilling or post-construction testing required.
4) **Notes** (column I): Add any applicable notes, regarding the components and associated construction schedule

Filter Blank Component Rows | Clear Filter

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes
(R1) - 1400 Main St	GSI-1 Inlets	Rain Guardian Turret	2 weeks	2/19/2023	2/23/2023	
	GSI-2 Energy Dissipation & Pollutant Removal	Rock Splash Pad	1 week	3/12/2023	3/23/2023	
	GSI-3 Above Grade Barriers	Ribbon Curb	2 weeks	2/26/2023	3/9/2023	
	GSI-5 Soil & Aggregate Media	Amended Native Soil	2 months	3/12/2023	3/23/2023	
	GSI-7 Landscaping	Native Plants	3 months	3/16/2023	3/21/2023	

GSI Maintenance Schedule (Tab 3):

The maintenance schedule is intended to be updated regularly with the Site Activity Plan, as needed to maintain a level one rating (excellent appearance) per the Service Levels of Performance in the GSI Manual. If the site is not rated a one after completing maintenance tasks, then the frequency of the tasks must be updated to achieve a level one rating.

General Tab Notes:

- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).
- Information entered on this tab including maintenance task frequency and time of year will auto-populate in the contractor Maintenance Activity Forms (Tabs 5 through 10).

1) **Frequency** (column E): Click the "Sample Frequency" button to populate the "Frequency" column with the recommended frequencies for the typical maintenance tasks. The frequency should be reviewed for each of the tasks, and changed as needed using the drop-down options.

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

GSI Component	Required Tasks	Frequency	Time of Year	Responsible Party	GSI Sites Included	Required
GSI-7 Landscaping	Inspect for vegetation health, bare spots, weeds, overgrowth, unkept edges, and mulch coverage	Weekly		123 Constructio Co	(R1) - 1400 Main St, (B1) - 1424 Main St	x
	Apply pre-emergent herbicide	Quarterly	Mar, Jul, Oct	ABC Landscaping		x
	Remove weeds	Monthly		ABC Landscaping		x
	Manage disease and pests	Monthly		ABC Landscaping		x
	Remove algae and other aquatic weeds	Annually	Winter, as needed	ABC Landscaping		x
	Maintain clean landscape edges, prune plants	Weekly		ABC Landscaping		x
	Mow perimeter	Weekly		123 Constructio Co		x
	Mow turf grass areas	Weekly		123 Constructio Co		x
	Water vegetated areas	As Needed		ABC Landscaping		x
	Remove dead plants	Weekly Bi-Weekly Monthly Quarterly Semi-Annually Annually As Needed Seasonally	Mar, Oct	ABC Landscaping		x
	Install new plants			ABC Landscaping		x
	Refresh mulch		Mar, Oct	ABC Landscaping		x

a) **Note:** If the "Sample Frequency" button is clicked after revising the frequencies, all of the frequencies in column E for the standard GSI Components will be reset (tasks with recommended frequencies will show the recommendations, and tasks without recommended frequencies will be blank). If it is desired to only reset some frequencies, review the GSI Manual and use the drop-down options in column E to manually reset individual frequencies.

2) **Time of Year** (column F): If the frequency is greater than monthly, select the correct Time of Year information. If the frequency is less than monthly, leave this cell blank.

3) **Responsible Party** (column G): Add the responsible party information. If a subcontractor and contractor are responsible for providing different tasks, put the name of the firm responsible for each individual task.

QA Qualifications (Tab 4):

General Tab Notes:

- Project header information at the top of the form will auto-populate from information entered in the GSI Sites & Components tab (Tab 1).

1) For each specification included in the Project Manual, the contractor shall provide 3 references to demonstrate compliance with the experience requirements summarized in column D, and described in detail in Part 1.06 of each specification.

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

2) **Responsible Prime/Subcontractor**: Indicate who will be responsible for completing the work for each specification in column E.

3) Fill in project location (Project Area, City and State), project owner name, contact number, project completion date and total dollar value of the project in columns G through K.

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02939	GSI Earthwork	*Landscaping/ GSI experience, within previous 3 years*		1					
				2					
				3					
02942	GSI Above Grade Barriers	*ACI Certified Flatwork Finisher and Technician*		Attach list of ACI certified flatwork finisher and technican personnel dedicated to project.					
02942	GSI Above Grade Barriers	*5 years experience with type of above grade barrier specified*		1					
				2					
				3					

Maintenance Activities/Inspection Forms (Tabs 5 - 10):

The remaining sheets (Tabs 5 through 10) are forms for the contractor to use to document maintenance work and inspection activities that occur at each site. A separate sheet should be used for each individual site. These sheets are broken into frequency of maintenance work and are based on the selections entered in the GSI Maintenance Schedule (Tab 3). Some projects may use Computerized Maintenance Management Systems (CMMS) in lieu of forms, but similar content is recommended for computerized forms.

PRIOR TO EACH USE: The maintenance schedule is intended to be updated regularly with the Site Activity Plan, as needed to maintain a level one rating (excellent appearance) per the Service Levels of Performance in the GSI Manual. If the site is not rated a one after completing maintenance tasks, then the frequency of the tasks must be updated to achieve a level one rating. Updates to frequencies must be made in the GSI Maintenance Schedule tab (Tab 3). Any changes made on Tab 3 will automatically update each of the contractor Maintenance Activity Forms (Tabs 5 through 10).

General Tab Notes:

- Each sheet is automatically filtered to show the required tasks and associated frequencies on Tab 3. If a change needs to be made to the frequencies, update Tab 3 and the sheet will automatically reflect any changes made.
- Project Title, Project Number, and contractor will update automatically from the GSI Sites and Components (Tab 1).

1) Fill in the **date** the activities were performed. Use the same **GSI Site Name** that was used on the form in the GSI Site & Component tab (Tab 1). Add the name of the **inspector** and/or maintenance supervisor names and contact information.

GSI SITE ACTIVITY PLAN INSTRUCTIONS (CONTINUED)

2) **Appearance and Function Rating**: Fill in the GSI Appearance Rating and the GSI Function Rating for each site. These rating systems are explained in the maintenance section of the GSI Manual with examples provided. A rating should be assigned in the "**before**" cell based on the condition upon arrival to the site, and in the "**after**" cell based on the condition once activities are completed. Each site should achieve a level one rating (no litter/excellent appearance) when the regularly scheduled maintenance visit is complete, to meet the Service Levels of Performance requirements.

3) **Task Completed** (column F): Use the "Task Completed" column to indicate which tasks were completed for the reported visit.

4) **Notes** (column G): Add any comments or observations made during the site visit. If a task frequency needs to be updated to achieve a level one rating, then comment on how that frequency will be adjusted here. This column may also be used to track material used at each site.

5) Once all tasks for that visit are complete, record the **total hours**. This should be a cumulative total of hours for all the workers at the site. For example, if two workers spent a half hour maintaining the site, record 1.0 hour.

GREEN STORMWATER INFRASTRUCTURE BI-WEEKLY MAINTENANCE ACTIVITIES

Project Title: _____

Project Number: _____

Contractor: _____

DATE OF ACTIVITY:		**APPEARANCE RATING**	Before:	
GSI SITE:			After:	
		FUNCTION RATING	Before:	
INSPECTOR:			After:	
			HOURS:	

GSI Component	Required Tasks	Frequency	Task Completed?	Notes + How will frequency be updated, if needed?
GSI-3 Above Grade Barriers	Repair structural, erosion or other damage	As Needed		
GSI-4 Permeable Pavements	Deep clean with vacuum and pressure wash combination	As Needed		
	Repair damage	As Needed		
	Dress paver joints with aggregate	As Needed		
GSI-5 Soil & Aggregate Media	Remove sediment, debris, and trash	Bi-weekly		
GSI-7 Landscaping	Water vegetated areas	As Needed		
	Install new plants	As Needed		
GSI-8 Piping	Inspect for standing water, structural integrity, secure access points, record debris depth	Bi-Weekly		
	Repair damage	As Needed		
GSI-9 Outlets	Inspect for sediment, trash, debris, blockages, structural integrity, and outlet control mechanism	Bi-Weekly		
	Repair damage	As Needed		

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GSI SITE ACTIVITY PLAN
EXAMPLE TEMPLATES

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GREEN STORMWATER INFRASTRUCTURE
SITE COMPONENTS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI SITES	
GSI Site Name	**GSI Type**

GSI COMPONENTS	
☐	GSI-1 Inlets
☐	GSI-2 Energy Dissipation & Pollutant Removal
☐	GSI-3 Above Grade Barriers
☐	GSI-4 Permeable Pavements
☐	GSI-5 Soil & Aggregate Media
☐	GSI-6 Media Liners
☐	GSI-7 Landscaping
☐	GSI-8 Piping
☐	GSI-9 Outlets
☐	GSI-10 Storage Chambers
☐	
☐	
☐	
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GREEN STORMWATER INFRASTRUCTURE
CONSTRUCTION SCHEDULE

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes

GREEN STORMWATER INFRASTRUCTURE
CONSTRUCTION SCHEDULE

GSI Site Name	GSI Component Category	GSI Component Product/Description	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI Component	Required Tasks	Frequency	Time of Year	Responsible Party	GSI Sites Included	Required

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Frequency	Time of Year	Responsible Party	GSI Sites Included	Required

GREEN STORMWATER INFRASTRUCURE
MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Recommended Frequency
GSI-1 Inlets	Inspect for standing water, sediment, debris, trash, blockages, and structural integrity	Bi-Weekly
	Remove sediment, debris, trash, blockages	Bi-Weekly
	Repair damage	As Needed
GSI-2 Energy Dissipation & Pollutant Removal	Inspect integrity and record debris depth	Bi-Weekly
	Remove sediment, debris, and trash	Bi-weekly
	Repair erosion or other damage	As Needed
GSI-3 Above Grade Barriers	Inspect structural integrity	Annually
	Repair structural, erosion or other damage	As Needed
GSI-4 Permeable Pavements	Inspect for sediment, trash, debris, blockages, clogging, and check condition	Quarterly
	Remove surface sediment, debris and trash	Monthly
	Remove weeds	Quarterly
	Remove stains and other markings	Quarterly
	Vacuum with walk-behind unit	Semi-annually
	Deep clean with vacuum and pressure wash combination	As Needed
	Repair damage	As Needed
	Dress paver joints with aggregate	As Needed
GSI-5 Soil & Aggregate Media	Inspect 48-hours after 3-inches of rainfall in 24 hour period and record standing water depth	Annually
	Inspect during or immediately following rain event for trash, debris, flow blockages, erosion paths, and sedimentation	Seasonally
	Remove sediment, debris, and trash	Bi-weekly
	Replace settled or excavated materials, repair erosion/damage	Quarterly
GSI-7 Landscaping	Inspect for vegetation health, bare spots, weeds, overgrowth, unkept edges, and mulch coverage	Weekly
	Apply pre-emergent herbicide	Quarterly
	Remove weeds	Monthly
	Manage disease and pests	Monthly
	Remove algae and other aquatic weeds	Annually
	Maintain clean landscape edges, prune plants	Weekly
	Mow perimeter	Weekly
	Mow turf grass areas	Weekly
	Water vegetated areas	As Needed
	Remove dead plants	Semi-annually
	Install new plants	As Needed
	Refresh mulch	Semi-annually

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

GSI Component	Required Tasks	Recommended Frequency
GSI-8 Piping	Inspect for standing water, structural integrity, secure access points, record debris depth	Bi-Weekly
	Remove sediment, debris, trash, blockages	Monthly
	Repair damage	As Needed
GSI-9 Outlets	Inspect for sediment, trash, debris, blockages, structural integrity, and outlet control mechanism	Bi-Weekly
	Clear flow paths and remove sediment, trash, debris, and blockages	Monthly
	Repair damage	As Needed
GSI-10 Storage Chambers	Inspect for standing water, sediment, debris, trash, blockages, secure access points, structural integrity, outlet control	Monthly
	Remove sediment, debris, trash and blockages	Monthly
	Deep clean with jet wash and vacuum combination	Annually
	Repair damage	As Needed

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02939	GSI Earthwork	*Landscaping/ GSI experience, within previous 3 years*		1					
				2					
				3					
02942	GSI Above Grade Barriers	*ACI Certified Flatwork Finisher and Technician*		Attach list of ACI certified flatwork finisher and technican personnel dedicated to project.					
02942	GSI Above Grade Barriers	*5 years experience with type of above grade barrier specified*		1					
				2					
				3					
02943	GSI Pervious Concrete	*3 years recent pervious concrete experience; CPG or NRMCA credentials*		1					
				2					
				3					
				Attach list of CPG and/or NRMCA certified personnel dedicated to project.					
02944	GSI Porous Asphalt	*3 years recent porous asphalt experience*		1					
				2					
				3					
02945	GSI Permeable Pavers	*3 years recent permeable paver experience*		1					
				2					
				3					

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02946	GSI Aggregate Media	*3 years GSI installation experience*		1					
				2					
				3					
02947	GSI Growing Media & Soil Amendments	*5 years landscaping/GSI installation experience*		1					
				2					
				3					
02949	GSI Existing Tree Protection	*Experienced tree service firm; certified Arborist*		1					
				2					
				3					
				Attach list of certified arborist personnel dedicated to project.					
02950	GSI Selective Vegetation Removal	*Horticulturist; landscape removal experience; Experienced tree service firm*		1					
				2					
				3					
				Attach list of certified horticulturist personnel dedicated to project.					
02951	GSI Plants	*5 years landscaping/GSI experience*		1					
				2					
				3					
02952	GSI Native Grass and Wildflower Seeding	*5 years recent native seed install/ establishment experience; B.S. in related field*		1					
				2					
				3					
				Attach list of field supervisor personnel dedicated to the project with B.S. degree in Horticulture, Botany, Soil Physics, Agronomy, General Agriculture, Agricultural or Biological Engineering, or related field.					
02953	GSI Non-Native Seeding and Sodding	*Seeding/sodding experience*		1					
				2					
				3					

GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02956	GSI In-Situ Infiltration Testing	*Infiltration testing experience*		1					
				2					
				3					
				1					
				2					
				3					
				1					
				2					
				3					
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GREEN STORMWATER INFRASTRUCTURE
QUALITY ASSURANCE QUALIFICATIONS

Specification Number	Specification Name	Experience Requirement	Responsible Prime/ Subcontractor	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
				1					
				2					
				3					
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GREEN STORMWATER INFRASTRUCTURE
MAINTENANCE ACTIVITIES

Project Title: _____

Project Number: _____

Contractor: _____

DATE OF ACTIVITY:		**APPEARANCE RATING**	Before:	
GSI SITE:			After:	
		FUNCTION RATING	Before:	
INSPECTOR:			After:	
			HOURS:	

GSI Component	Required Tasks	Frequency	Task Completed?	Notes + How will frequency be updated, if needed?

GREEN STORMWATER INFRASTRUCTURE
MAINTENANCE ACTIVITIES

GSI Component	Required Tasks	Frequency	Task Completed?	Notes + How will frequency be updated, if needed?

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