SITE PLAN FOR
DAVIDSON DRIVE HOLDINGS, LLC

TOWN OF CHESTER
ORANGE COUNTY, NEW YORK

STORMWATER POLLUTION PREVENTION PLAN NARRATIVE

PREPARED FOR:

-DAVIDSON DRIVE HOLDINGS, LLC
-N.Y.S. DEPARTMENT OF ENVIRONMENTAL CONSERVATION
-THE TOWN OF CHESTER

September 8, 2021

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PROJECT: 20-030

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1. INTRODUCTION

1.1 Project Description

The site is located across from the intersection of Lake Station Road and Paradise Lane in the Town of Chester, Orange County, New York. The tax map designation for the parcel is Section 17, Block 1, Lots 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7 & 22.8. The general land use in the nearby vicinity of the project site is the IP Zoning District, with the SR1 zone also located nearby.

The portion of the site that is proposed for development is characterized by a westerly sloping topography that descends from the eastern portion of the site. Topography on the site reflects the local surrounding topography and the parcel is mostly wooded. The site was previously approved for a residential subdivision which was never completed.

The soils on the property were identified using the soil classifications of the USDA Soil Conservation Service (SCS), Soil Survey of Orange County, New York and the USGS Soil Survey Database. The site soils consist primarily of the Mardin (MdC) series and the Erie (ErA) series. The Mardin soils consist of moderately well-drained to excessively well drained soils, while Erie soils consist of somewhat poorly drained to very poorly drained soils. The approximate soil boundaries and types are shown on the attached Pre & Post Development Drainage Analysis Maps.

The current proposed project will consist of a 166,024 SF light industrial building. There is an access driveway proposed off Lake Station Road across from Paradise Lane. The building will contain parking, sidewalks, drainage facilities, a drilled well and a subsurface sewage disposal system. The proposed development will disturb more than one acre of soil. Under the requirements of the current SPDES General Permit for Stormwater Discharges from Construction Activity NYS GP-0-15-002, a Stormwater Pollution Prevention Plan (SWPPP) is required.

1.2 Existing Drainage Patterns

Generally, the pre-development site conditions are best described as mostly open woods, some small fields and NYSDEC wetlands.
There is one major watershed within the existing site that has been separated into two sub catchments. The pre-development runoff for sub catchment 1A & 1B drains to the NYSDEC wetland that surrounds most of the property. Runoff collects into this NYSDEC regulated wetland and ultimately leaves the site at the locations noted as Design Point 1A & 1B (DP1A & D1B) shown on the attached Pre Development Stormwater Analysis Map.

1.3 Proposed Drainage Patterns

There is one main watershed in the post development condition which is identical to the pre development watershed boundary. The proposed industrial building and associated improvements discussed above are also located within sub catchments 1A & 1B in the post development condition. The addition of the impervious surface increases post-developed runoff and pollutants in this watershed. To simplify the analysis for treatment and attenuation of post development stormwater flows, the watershed was divided into sub catchments 1A, 1B, 1C & 1D, all of which drain into the NYSDEC regulated wetland.

2. STORMWATER MANAGEMENT

2.1 General

In general, increased imperviousness can change the volume and rate of runoff as well as the amount of suspended or dissolved substances entering local streams. In some cases, a change in the amount of impervious surface can change the distribution of water in a given area, affecting local water bodies, wetlands and associated fauna and flora. The project design includes measures to reduce the level of runoff and pollutants in post-development runoff in compliance with New York State DEC requirements. This will be achieved by the installation of infiltration facilities and a Bayfilter™ combined with a wet pond.

2.2 Stormwater Quantity

The drainage report has been prepared to analyze the impact of stormwater runoff at the major discharge points on the property. The impact of the proposed development on existing drainage patterns was evaluated for both the pre and post development conditions.

Information and data to prepare this report was obtained from the following sources:

- Topographic, Boundary and Planimetric information from Heritage Land Surveying, P.C.
- Site Plan & Lot Line Combination for Davidson Drive Holdings, LLC as prepared by Arden Consulting Engineers, PLLC.
- The site soil information from Orange County Soil Conservation Service & USGS.
- Site evaluations as carried out by personnel from Arden Consulting Engineers, PLLC.

The TR-55 method was used to determine the pre-development and post-development runoff rates at the design points identified on the property, which is illustrated on the attached drawings entitled Pre Development Stormwater Analysis and Post Development Stormwater Analysis.

Drainage summaries have been shown on Table 1 & 2, which outline the runoff volume from the 1, 10 and 100 year storm events in the pre-development and post-development conditions, using a Type III storm distribution. The 24 hour rainfall values used for each storm occurrence were taken from the NYSDEC Stormwater Design Manual as follows:

1 year = 2.70 inches

10 year storm = 5.0 inches

100 year storm = 8.5 inches

Details of the proposed stormwater facilities have been included on the Pre & Post Development Drainage Analysis Maps and the project drawings. The Pre and Post Development Analysis Maps have been prepared to illustrate existing drainage areas and their configuration following construction on the site.

It is the overall goal of the SWPPP to provide for proper drainage control on a quality and quantity basis. The plan has been prepared so there will be no negative effect on downstream properties.

The hydrologic characteristics of the pre-development site conditions were modeled using HydroCAD computer software. The model analyzes watershed conditions and provides hydrograph generation and routing based on the Natural Resources Conservation Service (NRCS) Technical Release 55 (TR-55) procedures. These procedures take into account the land cover and use on site, the underlying soils, the general topography and local rainfall distribution to model stormwater runoff volumes and flow rates resulting from the site.

2.3 Increase in Stormwater Runoff Rates

The post-development HydroCAD modeling results for runoff from the site at the point where runoff reaches the various Design Points are shown in Table 1 below.

Table 1
Pre- vs. Post-Development Runoff to Watershed 1 (cfs)

Storm Frequency	DP1 Runoff (Pre)	DP1 Runoff (Post)
1 year	8.27	7.58
10 year	29.45	27.87
100 year	67.00	66.31

The post-development rates of runoff are less than the existing condition. This requirement meets the standards of the SPDES General Permit for Stormwater Discharges.

3. STORMWATER QUALITY

3.1 Impervious Surfaces

The impervious cover used in this analysis represents the land use as described and shown on the project plans. The supporting calculations for the sizing of the permanent features are presented at the end of this report in Appendix B.

The New York State DEC requires the use of "Unified Stormwater Sizing Criteria" to ensure that water quality, channel erosion reduction, overbank flood protection and safe conveyance of extreme storms is achieved (New York State Stormwater Management Design Manual, January 2015). Water quality volume criteria is based on the following formula:

WQv = [(P)(Rv)(A)]/12

where:

WQv = water quality volume (in acre-feet)
P = 90% rainfall event number (in inches)
Rv =0.05 + 0.009(I), where I is percent impervious cover, and
A =site area in acres

Using this formula for calculating water quality volumes, the following required water quality volumes (WQv) were calculated for the watershed. Suitable area and storage volume are provided in the proposed stormwater facilities to meet water quality goals as defined by the New York State DEC.

Runoff Reduction Volume (RRv) is the reduction of the total WQv by application of green infrastructure techniques and SMPs to replicate pre-development hydrology. The calculations for the RRv can be found in Appendix B. Without the use of stormwater quality management practices, the proposed expansion would result in an increase in the loadings of various chemical constituents to the receiving waters, potentially impairing the quality of those waters within the watershed. A summary has been provided below in Table 2.

TABLE 2
Water Quality Volume (WQv) & Runoff Reduction Volume (RRv) Summary

Watershed	WQv Required (cf)	WQv Provided (cf)	Min. RRv Required (cf)	RRv Provided (cf)
1	35,687	43,880	9,836	9,869

Outdoor loading docks are proposed within the watershed which qualifies this area as a hot-spot location. The outdoor loading area in watershed 1B will treat the WQv and provide RRv via the use of a Bioretention facility for which supporting calculations can be found in Appendix B. The Bioretention facility will then discharge into a Wet Pond to provide further attenuation of post development stormwater flows. If RRv can be treated elsewhere on the site, then the hotspot area can go directly to a stormwater basin or any other non-infiltration practice. It is proposed to provide additional RRv for the entire watershed by the Conservation of Natural Resources practice that consists of the protection of the NYSDEC Wetland and associated buffer.

Runoff from impervious surfaces related to roadways and parking lots poses a potential increase in road and vehicle-related contaminants in the stormwater diverted to treatment facilities. These include hydrocarbons derived primarily from crankcase oil drippings and uncombusted exhaust hydrocarbons. Furthermore, roadway runoff contains detectable levels of heavy and trace metal contaminants such as lead, zinc, copper, chromium and nickel. These types of potential impacts require appropriate mitigation measures to limit impacts to existing water quality.

Stormwater runoff will ultimately discharge as shown on the Post Development Stormwater Analysis Map. The facilities were designed to attenuate and bypass the 10 and 100 year rain event.

3.2 Sources of Pollutants

The New York State DEC lists several potential pollutants and their sources to be considered during site design. Nutrients, sediment, bacteria and various other components can potentially contribute to the reduction of water quality and impacts to downstream receiving waters and habitat for water dependent species.

Many of these constituents, i.e., nitrogen, phosphorus, bacteria and others, are expected to be accounted for in the capture and treatment of the water quality volume. The DEC guidelines have established that if the water quality volume from impervious surfaces is treated, the water quality goals of the State are met. A primary source of nutrients, i.e., the use of fertilizers, is discussed below.

Sediments are typically associated with runoff from unstabilized sites or are the result of erosion in watercourses that cannot handle the velocity of stormwater flows. They can also result from the sanding of impervious surfaces during winter storm events. Unstabilized sediments can be transported via storm flows to receiving wetlands and watercourses, altering the soil-water-air interface in wetlands and burying established vegetation. The current proposal will a sedimentation basin and an infiltration basin that will encourage infiltration of flows carrying unstabilized sediments.

Thermal impacts, i.e., the increase in water temperature caused by the process of water running off of parking lots, roofs and other impervious surfaces that are heated by the sun, are of greatest concern in areas where a site is directly tributary to a Class B creek, which is found on the site. The majority of the site runoff will be treated by means of infiltration. Based on this information, no special consideration was given to moderating the temperature of stormwater leaving the site.

3.3 Use of Fertilizers and Pesticides

The applicant proposes the use of a variety of construction and maintenance techniques reflecting best management practices in order to limit impacts of stormwater runoff. No fertilizers containing phosphorous will be utilized in order to limit pollutants from the project to the maximum extent possible. Use of an infiltration trench with a sediment basin will serve to remove pollutants and attenuate stormwater runoff.

Phosphorus from fertilizer runs off lawns via stormwater and can enter surface waters and ground water, both of which can reach other water bodies. Using phosphorus-free lawn fertilizers is one step that will be taken to protect water quality. The project sponsor therefore proposes that any fertilizers used during construction will be phosphorus-free.

These combined systems have been designed to treat the NYSDEC water quality volume, and control peak flow runoff rates from the 1-, 10- and 100-year storm events.

4. PERFORMANCE CRITERIA

The following paragraphs and bullets describe the required performance criteria that have been met for the proposed Stormwater Management Practices (SMP's) as set forth in Chapter 6 of the NYSDEC Stormwater Design Manual (January 2015).

4.1 Stormwater Wet Pond (P2)

4.1.1 Feasibility

Required Elements

- Stormwater ponds shall not be located within jurisdictional waters, including wetlands.
- Evaluate the site to determine the Hazard Class, and to determine what design elements are required to ensure dam safety (see Guidelines for Design of Dams). For the most recent copy of this document, contact the New York State Department of Environmental Conservation, Dam Safety Division, at: 518-402-8151.
- Avoid direction of hotspot runoff to design P-5.
- Provide a 2' minimum separation between the pond bottom and groundwater in sole source aquifer recharge areas.

Design Guidance

- Designs P-2, P-3, and P-4 should have a minimum contributing drainage area of 25 acres. A 10-acre drainage is suggested for design P-1.
- The use of stormwater ponds (with the exception of design P-1, Micropool Extended Detention Pond) on trout waters is strongly discouraged, as available evidence suggests that these practices can increase stream temperatures.
- Avoid location of pond designs within the stream channel, to prevent habitat degradation caused bythese structures.
- A maximum drainage area of five acres is suggested for design P-5.

4.1.2 Conveyance

Inlet Protection

<u>Required Elements</u>

- A forebay shall be provided at each pond inflow point, unless an inflow point provides less than 10%of the total design storm flow to the pond.

<u>Design Guidance</u>

- Inlet areas should be stabilized to ensure that non-erosive conditions exist for at least the 2-year frequency storm event.
- Except in cold regions of the State, the ideal inlet configuration is a partially submerged (i.e., ½ full) pipe.

4.1.3 Adequate Outfall Protection

<u>Required Elements</u>

- The channel immediately below a pond outfall shall be modified to prevent erosion and conform to natural dimensions in the shortest possible distance, typically by use of appropriately-sized rip-rap placed over filter cloth. Typical examples include submerged earthen berms, concrete weirs, and gabion baskets.
- A stilling basin or outlet protection shall be used to reduce flow velocities from the principal spillway to non-erosive velocities (3.5 to 5.0 fps). (See Appendix L for a table of erosive velocities for grass and soil).

<u>Design Guidance</u>

- Outfalls should be constructed such that they do not increase erosion or have undue influence on the downstream geomorphology of the stream.
- Flared pipe sections that discharge at or near the stream invert or into a step-pool arrangement should be used at the spillway outlet.
- If a pond daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided to reduce stream warming.

Pond Liners

<u>Design Guidance</u>

- When a pond is located in gravelly sands or fractured bedrock, a liner may be needed to sustain a permanent pool of water. If geotechnical tests confirm the need for a liner, acceptable options include: (a) six to 12 inches of clay soil (minimum 50% passing the #200 sieve and a maximum permeability of 1 x 10-5 cm/sec), (b) a 30 mm poly-liner (c) bentonite, (d) use of chemical additives (*see NRCS Agricultural Handbook No. 386*, dated 1961, or *Engineering Field Manual*) or (e) a design prepared by a Professional Engineer registered in the State of New York.

4.1.4 Pretreatment

Required Elements

- A sediment forebay is important for maintenance and longevity of a stormwater treatment pond. Each pond shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall consist of a separate cell, formed by an acceptable barrier. Typical examples include earthen berms, concrete weirs, and gabion baskets.
- The forebay shall be sized to contain 10% of the water quality volume (WQv), and shall be four to six feet deep. The forebay storage volume counts toward the total WQv requirement.
- The forebay shall be designed with non-erosive outlet conditions, given design exit velocities.
- Direct access for appropriate maintenance equipment shall be provided to the forebay.
- In sole source aquifers, 100% of the WQv for stormwater runoff from designated hotspots shall be provided in pretreatment.

Design Guidance

- A fixed vertical sediment depth marker should be installed in the forebay to measure sediment deposition over time.
- The bottom of the forebay may be hardened to ease sediment removal.

4.1.5 Treatment

Minimum Water Quality Volume (WQv)

Required Elements

Provide water quality treatment storage to capture the computed WQv from the contributing drainage area through a combination of permanent pool, extended detention (WQv-ED) and marsh. A wet pond provides 100% of Water Quality Volume in the Permanent Pool.

- Although both CPv and WQv-ED storage can be provided in the same practice, WQv cannot be met by simply providing Cpv storage for the one-year storm.

Design Guidance

- It is generally desirable to provide water quality treatment off-line when topography, hydraulic head and space permit (i.e., apart from stormwater quantity storage; see Appendix K for a schematic).
- Water quality storage can be provided in multiple cells. Performance is enhanced when multiple treatment pathways are provided by using multiple cells, longer flowpaths, high surface area to volume ratios, complex microtopography, and/or redundant treatment methods (combinations of pool, ED, and marsh).

Minimum Pond Geometry

Required Elements

- The minimum length to width ratio for the pond is 1.5:1 (i.e., length relative to width).
- Provide a minimum Surface Area :Drainage Area of 1:100.

Design Guidance

- To the greatest extent possible, maintain a long flow path through the system, and design ponds with irregular shapes.

4.1.6 Landscaping

Pond Benches

Required Elements

- The perimeter of all deep pool areas (four feet or greater in depth) shall be surrounded by two benches:

- Except when pond side slopes are 4:1 (h:v) or flatter, provide a safety bench that generally extends 15 feet outward (10’ to 12’ allowable on sites with extreme space limitations) from the normal water edge to the toe of the pond side slope. The maximum slope of the safety bench shall be 6%.

- Incorporate an aquatic bench that generally extends up to 15 feet inward from the normal shoreline, has an irregular configuration, and a maximum depth of 18 inches below the normal pool water surface elevation. The slope proceeding from the aquatic bench to the pond basin floor *shall* not exceed 2:1 (h:v).

Landscaping Plan

Required Elements

- A landscaping plan for a stormwater pond and its buffer shall be prepared to indicate how aquatic and terrestrial areas will be vegetatively stabilized and established.
- Aquatic vegetation must be established in the aquatic and safety benches before the Pond is rendered in service.

Design Guidance

- Wherever possible, wetland plants should be encouraged in a pond design, either along the aquatic bench (fringe wetlands), the safety bench and side slopes (ED wetlands) or within shallow areas of the pool itself.
- The best elevations for establishing wetland plants, either through transplantation or volunteer colonization, are within six inches (plus or minus) of the normal pool.
- The soils of a pond buffer are often severely compacted during the construction process to ensurestability. The density of these compacted soils is so great that it effectively prevents root penetration, and therefore, may lead to premature mortality or

loss of vigor. Consequently, it is advisable to excavate large and deep holes around the proposed planting sites, and backfill these with uncompacted topsoil.

  - As a rule of thumb, planting holes should be three times deeper and wider than the diameter of the rootball (of balled and burlap stock), and five times deeper and wider for container grown stock. This practice should enable the stock to develop unconfined root systems. Avoid species that require full shade, are susceptible to winterkill, or are prone to wind damage. Extra mulching around the base of the tree or shrub is strongly recommended as a means of conserving moisture and suppressing weeds.

Pond Buffers and Setbacks

<u>Required Elements</u>

- A pond buffer shall be provided that extends 25 feet outward from the maximum water surface elevation of the pond. The pond buffer shall be contiguous with other buffer areas that are required by existing regulations (e.g., stream buffers). An additional setback may be provided to permanent structures.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment and 25 feet from the principal spillway structure.

<u>Design Guidance</u>

- Existing trees should be preserved in the buffer area during construction. It is desirable to locate forest conservation areas adjacent to ponds. To help discourage resident geese populations, the buffer can be planted with trees, shrubs and native ground covers.
- Annual mowing of the pond buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest.

4.1.7 Maintenance

<u>Required Elements</u>

- Maintenance responsibility for a pond and its buffer shall be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.
- The principal spillway shall be equipped with a removable trash rack, and generally accessible from dry land.
- Sediment removal in the forebay shall occur every five to six years or after 50% of total forebay capacity has been lost.
- All required safety elements must be inspected and maintained on an annual basis, unless prior inspections indicate more frequent maintenance is required.
- All required maintenance elements must be included in a comprehensive operation and maintenance plan.

Design Guidance

- Sediments excavated from stormwater ponds that do not receive runoff from designated hotspots are generally not considered toxic or hazardous material, and can be safely disposed by either land application or land filling. Sediment testing may be required prior to sediment disposal when a hotspot land use is present (see Section 4.8 for a list of potential hotspots).
- Sediment removed from stormwater ponds should be disposed of according to an approved comprehensive operation and maintenance plan.

Maintenance Access

Required Elements

- A maintenance right of way or easement shall extend to the pond from a public or private road.

Design Guidance

- Maintenance access should be at least 12 feet wide, have a maximum slope of no more than 15%, and be appropriately stabilized to withstand maintenance equipment and vehicles.
- The maintenance access should extend to the forebay, safety bench, riser, and outlet and be designed to allow vehicles to turn around.

Non-clogging Low Flow Orifice

Required Elements

- A low flow orifice shall be provided, with the size for the orifice sufficient to ensure that no clogging shall occur. (See Appendix K for details of a low flow orifice and trash rack options).

Design Guidance

- The low flow orifice should be adequately protected from clogging by either an acceptable external trash rack (recommended minimum orifice of 3") or by internal orifice protection that may allow for smaller diameters (recommended minimum orifice of 1").
- The preferred method is a submerged reverse-slope pipe that extends downward from the riser to an inflow point one foot below the normal pool elevation.
- Alternative methods are to employ a broad crested rectangular, V-notch, or proportional weir, protected by a half-round CMP that extends at least 12 inches below the normal pool.

  The use of horizontally extended perforated pipe protected by geotextile fabric and gravel is not recommended. Vertical pipes may be used as an alternative if a permanent pool is present.

Riser in Embankment

Required Elements

- The riser shall be located within the embankment for maintenance access, safety and aesthetics.

Design Guidance

• Access to the riser should be provided by lockable manhole covers, and manhole steps within easy reachof valves and other controls. The principal spillway opening should be "fenced" with pipe or rebar at 8-inch intervals (for safety purposes).

Pond Drain

Required Elements

- Except where local slopes prohibit this design, each pond shall have a drain pipe that can completely or partially drain the pond. The drain pipe shall have an elbow or protected intake within the pond to prevent sediment deposition, and a diameter capable of draining the pond within 24 hours.

Design Guidance

- Care should be exercised during pond drawdowns to prevent rapid drawdown and minimize downstream discharge of sediments or anoxic water. The approving jurisdiction should be notified before draining a pond.

Adjustable Gate Valve

Required Elements

- Both the WQv-ED outlet and the pond drain shall be equipped with an adjustable gate valve (typically a handwheel activated knife gate valve). A gate valve is not required if the WQv is discharged through a weir.
- Valves shall be located inside of the riser at a point where they (a) will not normally be inundated and (b) can be operated in a safe manner.

Design Guidance

- Both the WQv-ED pipe and the pond drain should be sized one pipe size greater than the calculated design diameter.
- To prevent vandalism, the handwheel should be chained to a ringbolt, manhole step or other fixed object.

Safety Features

Required Elements

- Side slopes to the pond shall not exceed 3:1 (h:v), and shall terminate at a safety bench.

- Side slope proceeding from aquatic bench to pond basin floor shall not exceed 2:1 (h:v).
- Both the safety bench and the aquatic bench must be landscaped to prevent access to the deep pool. The vegetation must be established before pond is rendered in-service.
- Warning signs must be posted prohibiting swimming, wading, and skating, warning of possible contamination or pollution of pond water, and indicating maximum depth of pond.
- The principal spillway opening shall not permit access by small children, and endwalls above pipe outfalls greater than 48 inches in diameter shall be fenced to prevent a hazard.
- When the pond slope requirements or any other required safety feature cannot be met perimeter fencing is required at or above the maximum water surface level provided that all required maintenance can still be performed.

4.2 Bioretention

4.2.1 Feasibility

Design Guidance

- Most stormwater filters require four to six feet of head, depending on site configuration and land area available. The perimeter sand filter (F-3), however, can be designed to function with as little as 18” to 24” of head.

- The recommended maximum contributing area to an individual stormwater filtering system is usually less than 10 acres. In some situations, larger areas may be acceptable.

- Sand and organic filtering systems are generally applied to land uses with a high percentage of impervious surfaces. Sites with imperviousness less than 75% will require full sedimentation pretreatment techniques.

4.2.2 Conveyance

Required Elements

- If runoff is delivered by a storm drain pipe or is along the main conveyance system, the filtering practice shall be designed off-line (see Appendix K).

- An overflow shall be provided within the practice to pass a percentage of the WQ_v to a stabilized water course. In addition, overflow for the ten-year storm shall be provided to a non-erosive outlet point (i.e., prevent downstream slope erosion).

- A flow regulator (or flow splitter diversion structure) shall be supplied to divert the WQ_v to the filtering practice, and allow larger flows to bypass the practice.

- Stormwater filters shall be equipped with a minimum 4" perforated pipe underdrain (6" is preferred) in a gravel layer. A permeable filter fabric shall be placed between the gravel layer and the filter media.

- Require a minimum 2’ separation between the filter bottom and groundwater.

4.2.3 Pretreatment

Required Elements

- Dry or wet pretreatment shall be provided prior to filter media equivalent to at least 25% of the computed WQ_v. The typical method is a sedimentation basin that has a length to width ratio of 1.5:1. The Camp-Hazen equation is used to compute the required surface area for sand and organic filters requiring full sedimentation for pretreatment (WSDE, 1992) as follows:

- The required sedimentation basin area is computed using the following equation:

$$A_s = -1 * \left(\frac{Q_0}{W}\right) \ln(1 - E)$$

Where:

A_s	=	Sedimentation basin surface area (ft^2)
E	=	sediment trap efficiency (use 90%)
W	=	particle settling velocity (ft/sec) use 0.0004 ft/sec for imperviousness (I) ≤ 75% use 0.0033 ft/sec for I > 75%
Qo	=	Discharge rate from basin = (WQ_v/24hr/3600s)
WQv	=	Water Quality Volume (cf)

This equation reduces to:

A_s	=	(0.066) (WQv) ft2 for I ≤ 75%
A_s	=	(0.0081) (WQ_v) ft^2 for I > 75%

Design Guidance

- Adequate pretreatment for bioretention systems should incorporate all of the following: (a) grass filter strip below a level spreader or grass channel, (b) gravel diaphragm and (c) a mulch layer.

- The grass filter strip should be sized using the guidelines in Table 6.2.

Table 4.2 Guidelines for Filter Strip Pretreatment Sizing

Parameter	Impervious Parking Lots				Residential Lawns			
Maximum Inflow Approach Length (ft.)	35		75		75		150	
Filter Strip Slope	≤ 2%	≥ 2%	≤ 2%	≥ 2%	≤ 2%	≥ 2%	≤ 2%	≥ 2%
Filter Strip Minimum Length	10’	15’	20’	25’	10’	12’	15’	18’

- The grass channel should be sized using the following procedure:

  1- Determine the channel length needed to treat the WQ_v, using sizing techniques described in the Grass Channel Fact Sheet (Chapter 5).

  2- Determine the volume directed to the channel for pretreatment

  3- Determine the channel length by multiplying the length determined in step 1 above by the ratio of the volume in step 2 to the WQ_v.

4.2.4 Treatment

Required Elements

- The entire treatment system (including pretreatment) shall be sized to temporarily hold at least 75% of the WQ_v prior to filtration.
- The filter media shall consist of a medium sand (meeting ASTM C-33 concrete sand). Media used for organic filters may consist of peat/sand mix or leaf compost. Peat shall be a reed-sedge hemic peat.
- Bioretention systems shall consist of the following treatment components: A four foot deep planting soil bed, a surface mulch layer, and a six inch deep surface ponding area. Soils shall meet the design criteria outlined in Appendix H.

Design Guidance

- The filter bed typically has a minimum depth of 18". The perimeter filter may have a minimum filter bed depth of 12".
- The filter area for sand and organic filters should be sized based on the principles of Darcy’s Law. A coefficient of permeability (k) should be used as follows:

Sand: 3.5 ft/day (City of Austin 1988)

Peat: 2.0 ft/day (Galli 1990)

Leaf compost: 8.7 ft/day (Claytor and

Schueler, 1996) Bioretention Soil: 0.5 ft/day

(Claytor and Schueler, 1996)

The required filter bed area is computed using the following equation

$$A_f = \frac{WQ_v d_f}{k(h_f + d_f)t_f}$$

Where:

Af	=	Surface area of filter bed (ft2)
WQv	=	Water Quality Volume(cf)
df	=	Filter bed depth (ft)
k	=	Coefficient of permeability of filter media (ft/day)
hf	=	Average height of water above filter bed (ft)
tf	=	Design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum t_f for sand filters, two days for bioretention)

4.2.5 Landscaping

Required Elements

- A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility.
- Landscaping is critical to the performance and function of bioretention areas. Therefore, a landscaping plan must be provided for bioretention areas.

Design Guidance

- Surface filters can have a grass cover to aid in pollutant adsorption. The grass should be capable of withstanding frequent periods of inundation and drought.
- Planting recommendations for bioretention facilities are as follows:
  - Native plant species should be specified over non-native species.
  - Vegetation should be selected based on a specified zone of hydric tolerance.
  - A selection of trees with an understory of shrubs and herbaceous materials should be provided.
  - Woody vegetation should not be specified at inflow locations.

- Trees should be planted primarily along the perimeter of the facility.

- A tree density of approximately one tree per 100 square feet (i.e., 10 feet on-center) is recommended. Shrubs and herbaceous vegetation should generally be planted at higher densities (five feet on-center and 2.5 feet on center, respectively).

4.2.6 Maintenance

Required Elements

- A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the local review authority to ensure the following:

  - Sediment shall be cleaned out of the sedimentation chamber when it accumulates to a depth of more than six inches. Vegetation within the sedimentation chamber shall be limited to a height of 18 inches. The sediment chamber outlet devices shall be cleaned/repaired when drawdown times exceed 36 hours. Trash and debris shall be removed as necessary.

  - Silt/sediment shall be removed from the filter bed when the accumulation exceeds one inch.
    When the filtering capacity of the filter diminishes substantially (i.e., when water ponds on the surface of the filter bed for more than 48 hours), the top few inches of discolored material shall be removed and shall be replaced with fresh material. The removed sediments shall be disposed in an acceptable manner (i.e., landfill).

- A stone drop (pea gravel diaphragm) of at least six inches shall be provided at the inlet of bioretention facilities (F-6). Areas devoid of mulch shall be re-mulched on an annual basis. Dead or diseased plant material shall be replaced.

Design Guidance

- Organic filters or surface sand filters that have a grass cover should be mowed a minimum of three times per growing season to maintain maximum grass heights less than 12 inches.

4.2.7 Cold Climate Design Considerations

In cold climates, stormwater filtering systems need to be modified to protect the systems from freezing and frost heaving. The primary cold climate concerns to address with regards to filtering systems are:

- Freezing of the filter bed
- Pipe freezing
- Clogging of filter

NOTE

ALTHOUGH FILTERING SYSTEMS ARE NOT AS EFFECTIVE DURING THE WINTER, THEY ARE OFTEN EFFECTIVE AT TREATING STORM EVENTS IN AREAS WHERE OTHER SMPS ARE NOT PRACTICAL, SUCH AS IN HIGHLY URBANIZED REGIONS. THUS, THEY MAY BE A GOOD DESIGN OPTION, EVEN IF WINTER FLOWS CANNOT BE TREATED. IT IS ALSO IMPORTANT TO REMEMBER THAT THESE SMPS ARE DESIGNED FOR HIGHLY IMPERVIOUS AREAS. IF THE SNOW FROM THEIR CONTRIBUTING AREAS IS TRANSPORTED TO ANOTHER AREA, SUCH AS A PERVIOUS INFILTRATION AREA, A PRACTICE'S PERFORMANCE DURING THE WINTER SEASON MAY BE LESS CRITICAL TO OBTAIN WATER QUALITY GOALS.

Freezing of the Filter Bed

- Place filter beds for underground filter below the frost line to prevent the filtering medium from freezing during the winter.
- Discourage organic filters using peat and compost media, which are ineffective during the winter in cold climates. These organic filters retain water, and consequently can freeze solid and become completely impervious during the winter.
- Combine treatment with another SMP option that can be used as a backup to the filtering system to provide treatment during the winter when the filter is ineffective

Pipe Freezing

- Use a minimum 8" underdrain diameter in a 1' gravel bed. Increasing the diameter of the underdrain makes freezing less likely, and provides a greater capacity to drain standing water from the filter. The porous gravel bed prevents standing water in the system by promoting drainage. Gravel is also less susceptible to frost heaving than finer grained media.
- Replace standpipes with weirs, which can be "frost free." Although weir structures will not always provide detention, they can provide retention storage (i.e., storage with a permanent pool) in the pretreatment chamber.

Clogging of Filter with Excess Sand from Runoff

- If a filter is used to treat runoff from a parking lot or roadway that is frequently sanded during snow events, there is a high potential for clogging from sand in runoff. In these cases, the size of the pretreatment chamber should be increased to 40% of the treatment volume. For bioretention systems, a grass strip, such as a swale, of at least twenty-five feet in length should convey flow to the system.
- Filters should always be inspected for sand build-up in the filter chamber following the spring melt event

5. EROSION & SEDIMENT CONTROL

5.1 General

During construction of the Project, extensive erosion and sediment control consisting of vegetative and structural measures will be implemented. These practices will be included in the final plans and will show the location and details of these controls. Among the techniques to be utilized are:

1. Staked haybales and silt fences around the downhill perimeter of the construction.
2. A stabilized construction entrance installed at the access point to the site.
3. Temporary seeding of all disturbed areas if they will remain bare for more than three weeks.
4. Permanent seeding and mulching as soon as possible after final grading.
5. Water spray for dust control.
6. The plans will indicate the proposed controls to be implemented during construction. However, adjustment of these controls may be required to accommodate localized field conditions.
7. Disturbed areas will be permanently stabilized by establishing a permanent vegetative cover. The exposed area will receive a minimum of 4-inch topsoil prior to seeding.

6. MAINTENANCE OF STORMWATER MANAGEMENT FACILITIES

6.1 General

The storm water management facilities shall be maintained by the Owner of the Project during and after construction. All storm water management facilities shall be routinely inspected and any necessary repairs made immediately in order to maintain all practices as designed. The Contractor and Owner shall utilize good housekeeping methods for all litter and debris that is generated during construction. This shall include for example, placing all wastes in a dumpster on a daily basis and emptying dumpsters on a regular basis. It is also recommended to store any chemicals that are utilized during construction in a safe place according to manufacturer's safety data sheets (MSDS).

7. SUMMARY

7.1 General

Drainage from the proposed impervious surfaces will be collected primarily by the wet pond. The Soil Conservation Service TR-55 method has been utilized to evaluate the changes in stormwater runoff rates as a result of development of the site. The storm drainage system has been designed to collect and convey stormwater in a manner that would provide no increase in stormwater runoff rates downstream from the property. On-site retention, recharge and filtration via the use of infiltration facilities is necessary and has been provided to mitigate the increases in stormwater runoff rates and pollutants that would otherwise impact downstream conditions.

The proposed project has also been designed to minimize the extent of proposed grading and disturbance. The construction activity on the site will therefore not result in additional pollutant loadings and post development runoff to downstream water bodies. The proposed erosion and sediment practices will prevent the erosion and sediment deposits to downstream properties.