

LOCATION AND DESIGN DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: MANAGEMENT OF STORMWATER	NUMBER: IIM-LD-195.5
SPECIFIC SUBJECT: ENGINEERING AND PLAN PREPARATION	DATE: FEBRUARY 12, 2003
	SUPERSEDES: IIM-LD-195.4 DDM 2 (Drainage Manual)
DIVISION ADMINISTRATOR APPROVAL: Mohammad Mirshahi, PE	

CURRENT REVISION

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- Guidelines for water quality and quantity control have been clarified in accordance with the Virginia Department of Conservation and Recreation's annual plan review process..
 - Shading has been omitted from this memorandum.
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EFFECTIVE DATE

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- This memo is effective upon receipt.
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BACKGROUND

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- Acts of the General Assembly have resulted in the issuance of Virginia Stormwater Management (SWM) Regulations and Virginia Erosion and Sediment Control (ESC) Regulations. The general application to highway operations associated with these regulations is addressed in this memorandum. Additional information and instructions for the incorporation of the erosion and sediment details in plan assemblies are contained in the current version of IIM-LD-11.
 - Additional details and examples of the engineering application of the Virginia SWM Regulations in the design of VDOT projects can be obtained from the VDOT Hydraulics Section in any of the various District offices or the Central Office in Richmond.

- Further information regarding the Virginia SWM Regulations or the Virginia ESC Regulations may be obtained from the Virginia Department of Conservation and Recreation (DCR) located at 203 Governor Street, Richmond, VA 23219 or at: <http://www.dcr.state.va.us/sw/index.htm>. Details may also be obtained from the Virginia SWM Handbook (Volume I and II) and the Virginia ESC Handbook published by DCR and available for reference in all VDOT Hydraulics Sections.
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OBJECTIVE

Stormwater Management

- To inhibit the deterioration of the aquatic environment by instituting a stormwater management program that maintains both water quantity and quality post development runoff characteristics, as nearly as practicable, equal to or better than pre-development runoff characteristics.
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Erosion and Sediment Control

- To effectively control soil erosion, sediment deposition, and post development runoff to minimize soil erosion and to prevent any sediment from escaping the project limits.
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CRITERIA

General

- The runoff control provisions of both regulations are complementary and will be addressed under a single set of criteria. The information and instructions contained in this memorandum supersede all previous departmental documents. Where there are conflicts with previous instructions, this memorandum shall take precedence.
- For the applicability of the Virginia Erosion and Sediment Control Regulations see the latest version of IIM-LD-11.
- The Virginia Stormwater Management Regulations are applicable to all state agency projects.
- “State Agency Projects” are those land development activities wherein VDOT has funded any portion of the design, right of way acquisition, or construction including those constructed under the Public/Private Transportation Act (PPTA) and Design/Build projects. Projects, such as subdivision streets, industrial access roads, etc., which are designed and constructed by other parties and which are eligible for acceptance into the state roadway system for maintenance after completion of construction are not considered state agency projects and must conform to

appropriate local regulations. Land development activities occurring within existing VDOT right of way, which are allowed by permit and which are designed, constructed, and funded by other parties, are not considered state agency projects and must conform to appropriate local regulations.

- “Land Development Project” is defined as a manmade change to the land surface that potentially changes its runoff characteristics as a permanent condition. The permanent condition should consider the effects of mature vegetative cover and should not be concerned with temporary changes due to construction activities. The temporary changes are addressed by the ESC regulations.
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Water Quantity Control

- Water quantity control shall be governed by the Virginia ESC Regulation MS-19 that requires an adequate receiving channel for stormwater outflows.
- Receiving channels, pipes and storm sewers shall be reviewed for adequacy based upon the following criteria:
 - Natural channels shall be analyzed by the use of a 2-year storm to verify that stormwater will not overtop channel banks or cause erosion of the channel bed and banks.
 - All previously constructed manmade channels shall be analyzed by the use of a 10-year frequency storm to verify that the stormwater will not overtop the banks and analyzed by the use of a 2-year storm to verify that the stormwater will not cause erosion of the bed or banks.
 - Pipes and storm sewer systems shall be analyzed by the use of a 10-year frequency storm to verify that the stormwater will be contained within the pipe or storm sewer system. The receiving channel at the outlet of the pipe or storm sewer shall be analyzed for adequacy of the 2 year storm for natural channels or the 10 year storm for man made channels.
- Water quantity control for the 1 year storm (in lieu of the 2 year storm as required by ESC Regulation MS-19) may be needed if there are existing or anticipated erosion concerns downstream. Control of the 1 year storm requires detaining the volume of runoff from the entire drainage area and releasing that volume over a 24 hour period. The computations are similar to those used for detaining the Water Quality Volume (WQV) and releasing over a 30 hour period. See the DCR SWM Handbook pages 1-23 and 5-38 thru 5-41 for additional information. When the 1 year storm is detained for 24 hours there will be no need to provide additional or separate storage for the WQV if it can be demonstrated that the WQV will be detained for approximately 24 hours. The control of the 1 year storm may require a basin size that is 1.5 to 2 times larger than a basin used to control the increase in the discharge from a 2 year or a 10 year storm.

- Pre-development conditions shall be considered that which exist (or is anticipated to exist) at the time the road plans are approved for right of way acquisition. All land cover shall be assumed to be in good condition regardless of actual conditions existing at the time the analysis is done.
- Impounding structures (dams) that are not covered by the Virginia Dam Safety Regulations shall be checked for structural integrity and floodplain impacts for the 100-year storm event.
- Outflows from stormwater management facilities shall be discharged into an adequate receiving channel as defined by the ESC Regulation MS-19.
- Existing swales being utilized as natural outfall conveyances for pre-development run-off will be considered as channels and, if the swale satisfactorily meets the criteria contained in the ESC Regulation MS-19 for post-development run-off, it will be considered as an adequate receiving channel.
- Construction of stormwater management facilities should be avoided in floodplains. When this is unavoidable, a special examination to determine the adequacy of the proposed stormwater management facilities during the passage of the 10-year flood will be required. The purpose of this analysis is to ensure that the stormwater management facility will operate effectively. The stormwater management facility shall also be examined for structural stability during the passage of the 100-year flood event on the floodplain and shall be examined for any possible impacts caused by the basin on the 100-year flood characteristics of the floodplain. The construction of stormwater management facilities shall be in compliance with all applicable regulations under FEMA's National Flood Insurance Program.
- If it can be demonstrated that the total drainage area to the point of analysis within the receiving channel is 100 times greater than the contributing drainage area within the project site, the receiving channel may be considered adequate, with respect to the channel capacity and stability requirements of the ESC Regulations, without further computations.
- Construction of stormwater management facilities within a sinkhole is prohibited. If stormwater management facilities are required along the periphery of a sinkhole, the design of such facilities shall comply with the guidelines in IIM-LD-228 (Sinkholes) and DCR's Technical Bulletin #2 (Hydrologic Modeling and Design in Karst) and applicable sections of the DCR's SWM Handbook.

Water Quality Control

- A water quality control plan shall be developed for each outfall or watershed where one acre or more of land is disturbed and one acre or greater of impervious area is added.

- At outfalls or watersheds where one acre or more of land is disturbed but less than one acre of impervious area is added, an assessment based on specific site characteristics/limitations shall be made to determine what opportunities exist to enhance water quality.
- Where two or more outfalls flow directly into an adjacent natural or manmade receiving system, or where two or more outfalls converge into one system some distance downstream of the project, the combined additional impervious area of all affected outfalls shall be considered when determining the applicability of VDOT's Annual SWM Plan and the water quality requirements of the Virginia SWM Regulations. The presence of wetlands, perennial streams, natural channels, or other environmentally sensitive areas at the convergence of the outfalls will typically require that the outfall impervious areas be considered in total when assessing the project's water quality impacts. Multiple project outfalls can be considered individually only when the convergence (if applicable) of flows is sufficiently far from the outfalls so as to effectively disconnect the impact of the total combined project impervious area.
- The following comments represent the significant points of the current regulations (the page numbers referenced are those in the DCR SWM Handbook):
 1. BMP (Best Management Practice) requirements for quality control are "Technology Based" (4VAC-3-20-71). The type of BMP required is determined by the percent of area within the project site (right of way and permanent easement) with new impervious cover, per outfall. Table 1 shows the relationship of the new impervious cover to the type of BMP required.

TABLE 1* BMP SELECTION TABLE		
Water Quality BMP	Target Phosphorus Removal Efficiency	Percent Impervious Cover**
Vegetated filter strip	10%	16-21%
Grassed swale	15%	
Constructed wetlands	30%	22-37%
Extended detention (2xWQV)	35%	
Retention basin I (3xWQV)	40%	
Bioretention basin	50%	38-66%
Bioretention filter	50%	
Extended detention-enhanced	50%	
Retention basin II (4xWQV)	50%	
Infiltration (1xWQV)	50%	
Sand filter	65%	67-100%
Infiltration (2xWQV)	65%	
Retention basin III (4xWQV with aquatic bench)	65%	

*Innovative or alternate BMPs not included in this table may be allowed at the discretion of DCR.

**Percent Impervious Cover: Relationship of the area of new impervious cover within the project site (right of way and permanent easement) to the total area of the project site (right of way and permanent easement), per outfall.

2. BMP requirements for flooding or quantity control are determined by the ESC Regulation MS-19 for adequate receiving channels.
3. Extended Detention Basins and Extended Detention Basins Enhanced require a Water Quality Volume (WQV) of 2 x the standard WQV or 1" of runoff from the new impervious area.
4. Extended Detention Basins and Extended Detention Basins Enhanced require a 30 hour drawdown time for the required WQV. The 3" minimum size water quality orifice previously allowed has been eliminated. If the required orifice size is found to be significantly less than 3", an alternative water quality BMP should be investigated for use, such as a linear facility that treats the first flush and allows larger storms to bypass. The calculation procedure for drawdown time and orifice sizing is shown on Pages 5-33 through 5-38 (SWM Handbook) and also in example problems available from VDOT.
5. Sediment Forebays should be used on Extended Detention Basins and Extended Detention Basins Enhanced. The volume of the Forebay should be 0.1" – 0.25" x the new impervious area or 10% of the required detention volume. See Pages 3.04-1 through 5 (SWM Handbook) for details. The overflow spillway shall be stabilized utilizing rip rap, concrete or other non-erodible material.
6. Suggested details for the Extended Detention Basin are shown on Pages 3.07-4 and 5 (SWM Handbook). The riprap lined low flow channel through the basin is not recommended due to maintenance concerns.
7. Suggested details for the Extended Detention Basin Enhanced are shown on Pages 3.07-6 and 7 (SWM Handbook). The geometric design will probably need to be more symmetrical than that shown in order to construct the basin to the dimensions needed.
8. Non-structural practices including, but not limited to, minimization of impervious areas and curbing requirements, open space acquisition, floodplain management, and protection of wetlands may be utilized as appropriate in order to at least partially satisfy the water quality requirements. Approval of such non-structural measures will be secured in advance from the Department of Conservation and Recreation.

MULTI-USE SWM BASINS

Quantity Control – Quality Control – Temporary Sediment Storage

- SWM basins may function as both quantity control and quality control facilities. Some basins may only be needed for quality control. Most swm basins are needed to serve as temporary sediment basins during the construction phase of the project and the design will need to address this dual function. The design that is needed for a permanent swm basin may need to be altered to provide additional temporary sediment storage volume that is in excess of the required WQV. For design purposes the two volumes (WQV and temporary sediment storage volume) should not be added together but rather the larger of the two should govern the basin design.

The additional volume needed for temporary sediment storage may be provided by excavating the bottom of the basin lower than that required for the WQV. The basin's permanent outlet control structure can be temporarily altered to serve as the control structure for the temporary sediment basin (See Standard SWM-DR of VDOT's Road and Bridge Standards and the DCR ESC Handbook). When the project is nearing completion and the basin is no longer needed for temporary sediment control, the basin can be readily converted to the permanent SWM basin by regarding (excavating and/or filling) and removing any temporary control structure appurtenances.

IMPLEMENTATION

Plan Preparation

- Standard and minimum plan projects shall show stormwater management and erosion control measures on the plans as directed in the latest version of IIM-LD-11 and the Road Design Manual.
 - No-plan, SAAP and other types of projects (including maintenance) that do not have a "formal" plan assembly must conform to the requirements of the Virginia Stormwater Management Regulations. For the definition of these types of projects, and the procedures for addressing both the erosion and sediment control and stormwater management requirements on such projects, see the latest version of IIM-LD-11.
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Foundation Data

- Foundation data (a soil boring) for the base of the dam should be requested for all stormwater management basins in order to determine if the native material will support the dam and not allow ponded water to seep under the dam. An additional boring near the center of the basin should also be requested if:
 1. Excavation from the basin may be used to construct the dam, or
 2. Rock may be encountered in the area of excavation, or
 3. A high water table is suspected that may alter the performance of the swm basin.

For large basins, more than one boring for the dam and one boring for the area of the basin may be needed. The number and locations of the borings are to be determined by the Hydraulics Engineer and/or the Materials Engineer.

- The foundation data for the swm basin should be requested by the Hydraulics Engineer at the same time that the request for culvert foundation data is initiated.

Right of Way

- Permanent stormwater management facilities may be placed in fee right of way or in permanent easements. It is recommended that all permanent stormwater management facilities (dams, ponds, risers, etc.) be placed within fee right of way initially. Ditches and similar features may initially be placed in permanent easements. The final decision on right of way versus permanent easement should be made prior to the Right of Way Stage of the project development process based on information obtained at the Field Inspection meeting and/or the Design Public Hearing. The Department will generally be amenable to the desires of affected landowners in this matter. The multiple use of property for stormwater management and such features as utilities is permissible. The decision on the advisability of such actions must be made on an individual site basis.

Design Details

- The following details are to be incorporated into the design of VDOT stormwater management basins in order to be in compliance with the Virginia SWM Regulation Revisions of 1998 and the DCR SWM Handbook. These details address concerns with seepage through the dam and along the culvert due to the ponding of water in the basins being of longer duration than previous designs that used a minimum 3" water quality orifice.
 1. Foundation data for the dam is to be secured by the Materials Division in order to determine if the native material will support the dam and not allow ponded water to seep under the dam.
 2. The foundation material under the dam and the material used for the embankment of the dam should be an AASHTO Type A-4 or finer and/or meet the approval of the Materials Division. If the native material is not adequate, the foundation of the dam is to be undercut a minimum of 4' or the amount recommended by the Materials Division. The backfill and embankment material must meet the above soil classification or the design of the dam may incorporate a trench lined with a membrane (such as bentonite penetrated fabric or an HDPE or LDPE liner) and be approved by the Materials Division.
 3. The pipe culvert under or through the dam is to be reinforced concrete pipe with rubber gaskets. Pipe: Specifications Section 232 (AASHTO M170), Gasket: Specification Section 212 (ASTM C443)
 4. A concrete cradle is to be used under the pipe to prevent seepage through the dam. The concrete cradle is to begin at the riser or inlet end of the pipe and extend the full length of the pipe.
 5. If the height of the dam is greater than 15' or if the basin includes a permanent water pool, the design of the dam is to include a homogenous embankment with seepage controls or zoned embankment or similar design in accordance with the DCR SWM Handbook and recommendations of the Materials Division.

6. The top width of the dam should be 10' (3m) minimum to facilitate both construction and maintenance.
 7. The side slopes of the basin should be no steeper than 3:1 to permit mowing and maintenance access.
 8. The longitudinal bottom slope through the basin should be no more than 2% nor less than 0.5%.
 9. The depth of the basin from bottom to the primary outflow point (top of riser, or invert of orifice or weir) should be no more than 3' (1m), if possible, in order to reduce the hazard potential. If the depth needs to be more than about 3' (1m), fencing of the basin site should be considered.
 10. The primary control structure (riser or weir) should be designed to operate in weir flow conditions for the full range of design flows. Where this is not possible or feasible and the control structure will operate in orifice flow conditions at some point within the design flow range, an anti-vortex device, consistent with the design recommendations in the DCR SWM Handbook, shall be utilized.
 11. The length to width ratio of the basin should be about 3:1 (wider at the outlet end). If the ratio is less than about 2:1, and if there is concern that the velocity of flow through the basin will be high, consideration should be given to using baffles within the basin to reduce velocity. Baffles should be constructed of "pervious" type material, such as snow fence, rather than earth berms that tend not to reduce the velocity.
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Perimeter Controls

All SWM basins should be reviewed for the needs of fencing, barricades and no trespassing signs in accordance with the following guidelines:

- Fencing of SWM Basins
 1. Fencing of stormwater management basins is normally not required and should not be considered for most basins due to:
 - Insignificant Hazard - Ponding of water in the basin should only occur with very heavy storms and be noticeable for only a few hours. The ponded depth will normally be no more than about 3' (1m). Ponds and lakes are almost never fenced, even though they may be located in subdivisions and have deep, permanent pools.
 - Limits Maintenance - Fencing will limit maintenance operations and could deter the frequency of maintenance. Fencing could become damaged during major maintenance operations.

2. Fencing of SWM basins may occasionally be needed and should be considered when:
- The basin is deep with ponded depth greater than about 3' (1m) and/or has steep side slopes with 2 or more sides steeper than 3:1, or
 - The basin is in close proximity to schools, playgrounds or similar areas where children may be expected to frequent, or
 - It is recommended on the Field Inspection Report, the Resident Engineer or the City/County (where City/County will take over maintenance responsibility.)

- Barricades

A chain barricade (See Standard CR-1 of VDOT's Road and Bridge Standards) or gate may be needed on some basins to prohibit vehicular access if there is concern with illegal dumping or other undesirable access.

- Signs

"No Trespassing" signs shall be considered for use on all basins, whether fenced or unfenced, and should be recommended, as needed, on the Field Inspection Report.

Regional Facilities

- There are many cases where it is more feasible to develop one major stormwater management facility to control a large watershed area rather than a number of small individual facilities controlling small drainage basins. The concept of regional stormwater management facilities is endorsed by VDOT provided that certain requirements are met.
- Development and use of regional stormwater management facilities must be a joint undertaking by VDOT and the local governing body. The site must be part of a master stormwater management plan developed and/or approved by the local governing body and any agreements related to these facilities must be consummated between VDOT and the local governing body. VDOT may enter into an agreement with a private individual or corporation provided the local governing body has a swm program that complies with the Virginia SWM Regulations and the proper agreements for maintenance and liability of the regional facility have been executed between the local governing body and the private individual or corporation.
- Where the roadway embankment serves as an impounding structure, the right of way line will normally be set at the inlet face of the drainage structure. The local government would be responsible for the maintenance and liabilities outside of the right of way and VDOT would accept the same responsibilities inside the right of way.
- Hydraulic design of regional stormwater management facilities must address any mitigation needed to meet the water quality and quantity requirements of the roadway project. Stormwater management facilities located upstream of the roadway project

shall provide sufficient mitigation for the water quality and quantity impacts of run-off from the roadway project which may bypass the facility.

Maintenance

- Requirements for maintenance of stormwater management facilities, the recommended schedule of inspection and maintenance, and the identification of persons responsible for the maintenance will be addressed in VDOT's "Stormwater Management Annual Plan" as approved by DCR.
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Future Reconstruction

- If a stormwater management facility is constructed to address the water quality and quantity requirements of a current project and, at some time in the future, is displaced to accommodate future roadway construction, the new stormwater management facility constructed at that time must address the water quality and quantity requirements due to the future construction and the water quality and quantity requirements that were mitigated by the original stormwater management facility.
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Reporting

- VDOT is required to submit an annual report to the Department of Conservation and Recreation (DCR) that identifies the location, number and type of stormwater management facilities installed during the preceding year, their storage capacities, the affected water body, and a summary of any water quality monitoring data associated with the facility. A database has been established on the Hydraulics Section's telecommunication file system to record this type of data for all projects. It shall be the responsibility of the district drainage engineer and the hydraulic design engineers in the Central office to ensure that the required information is logged on the database for all stormwater management facilities that are designed for roadway projects. In order for the database to reflect those facilities constructed during the preceding year, it is recommended that the required information be logged at the time of the first submission of plans to the Construction Division. The reporting period will be from July 1 to June 30.
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PLAN DETAILS

Stormwater Management Drainage Structure Standard SWM-1

- To be used at all applicable locations where a riser type of control structure is desired.

Stormwater Management Dam

- To be used at locations where a wall type control structure is desired (includes modifications to standard endwalls). Normally used for shallow depths of ponding.
 - Details to be provided for individual locations.
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Copies of the control structures other than those above shall be submitted to the office of the State Hydraulics Engineer to facilitate future development or modification of standard details.

Stormwater Management Details Standard SWM-DR

- Specify at each location requiring a water quality orifice and/or where modifications are required in order to provide for a temporary sediment basin during the construction phase of the project. The size opening for the water quality orifice or other required openings in the control structure shall be specified in the description for the control structure for each basin.
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Access

- A means of access for inspection and maintenance personnel shall be provided at each SWM facility location. The Standard PE-1 details shown in VDOT's Road and Bridge Standards should be used for vehicular entrances.
 - A turnaround should be provided on each vehicular entrance.
 - Appropriate all weather surface material shall be provided for each vehicular entrance.
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Method of Measurement – Basis of Payment

Stormwater Management Drainage Structure (SWM-1):

- Basis of payment to be linear feet (meters) measured from invert of structure to top of concrete.

Stormwater Management Dam:

- Basis of payment to be cubic yards (m³) of Concrete Class A3 Miscellaneous and pounds (kilograms) of Reinforcing Steel.

Grading:

- Excavation for stormwater management basins will be measured and paid for as cubic yards (m³) of Stormwater Management Basin Excavation.
- Fill material needed for dams or berms will be measured and paid for as cubic yards (m³) of Regular Excavation, Borrow Excavation or Embankment.
- The Grading Diagram is to reflect how the cubic yards (m³) of Stormwater Management Basin Excavation and cubic yards (m³) of Embankment or Borrow is to be distributed.

Stormwater Management Summary

- All drainage items related to the construction of stormwater management facilities shall be summarized, by location, in the Drainage Summary for the project.
- All incidental items related to the construction of stormwater management facilities shall be summarized, by location, in the Incidental Summary for the project.
- Stormwater Management Excavation and Borrow or Embankment, if needed, is to be included in the totals on the Grading Diagram and Summary.

PAY ITEMS

The following pay items are established:

PAY ITEM	UNIT		ITEM CODE
	Metric	Imperial	
SWM Basin Excavation	m ³	Cu. Yds.	27545
SWM Drainage Structure (SWM-1)	m	Lin. Ft.	27550

For SWM Dam:

Conc. Cl. A3 Misc.	m ³	Cu. Yds.	00525
Reinf. Steel	Kg.	Lbs.	00540

SPECIAL PROVISIONS

The current Special Provision/Copied Note for measurement and payment for stormwater management items is available for applicable projects as follows:

<http://www.virginiadot.org/business/manuals-default.asp>

INSERTABLE SHEETS

The following insertable sheets (English and Metric) are available on Falcon DMS, under the PPMS# eng-ser, Division, minsert and insert, for insertion into applicable plan assemblies:

- SWM Details – SD/MSD # 2209.
- SWM Drainage Structure (SWM-1) – SD/MSD # 2216.
- SWM Trash Rack – SD/MSD # 2216A