

**ATLANTIC COAST PIPELINE, LLC
ATLANTIC COAST PIPELINE**

Stormwater Pollution Prevention Plan

APPENDIX F

Erosion and Sediment Control and Stormwater Management Plan

for

Elizabeth River M&R Station

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LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Atlantic Coast Pipeline
BMP	best management practice
BSRF	Belted Silt Retention Fence
CBPA	Chesapeake Bay Preservation Act
DETI	Dominion Energy Transmission, Inc. (formerly Dominion Transmission, Inc.)
DTI	Dominion Transmission, Inc. (now Dominion Energy Transmission, Inc.)
EI	Environmental Inspector
ESC	erosion and sediment control
ESC Plan	Erosion and Sediment Control Plan
FERC	Federal Energy Regulatory Commission
lb/ac/yr	pounds per acre per year
MBTA	Migratory Bird Treaty Act
M&R	metering and regulating
M&R Station	Elizabeth River M&R Station
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWP	Nationwide Permit
PCB	polychlorinated biphenyl
STA	Seal of Testing Assurance
SWM	stormwater management
SWM Plan	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality
VESCH	Virginia Erosion and Sediment Control Handbook
VESCP	Virginia Erosion and Sedimentation Control Program
VRRM	Virginia Runoff Reduction Method
VSMP	Virginia Stormwater Management

1.0 INTRODUCTION

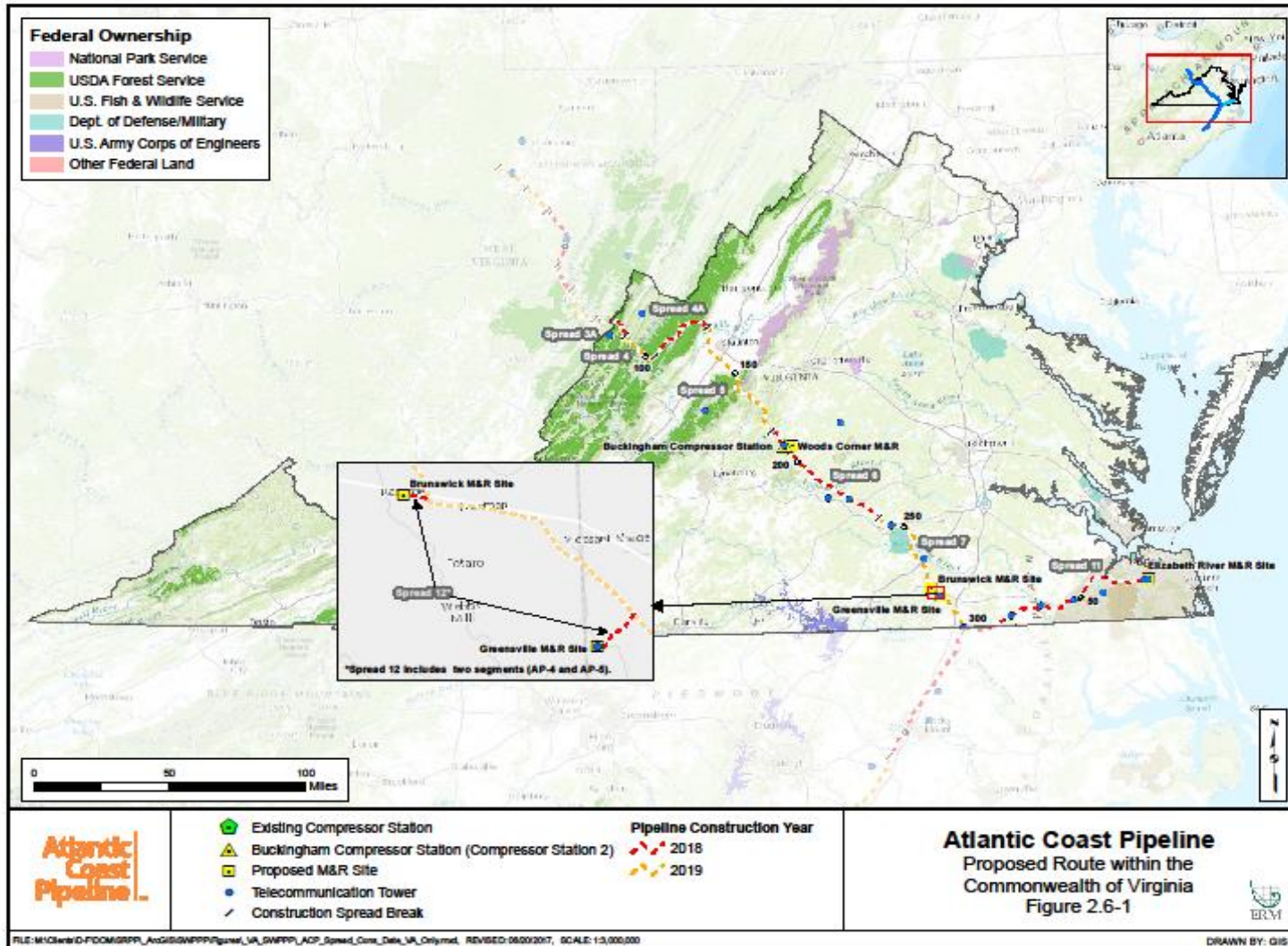
As part of the Atlantic Coast Pipeline (ACP), Dominion Energy Transmission, Inc. (DETI), formerly Dominion Transmission, Inc. (DTI), a subsidiary of Dominion, is proposing to construct an approximately 1.0-acre aboveground metering and regulating (M&R) station at 2516 South Military Highway in Chesapeake, Virginia.¹ This station, referred to as the Elizabeth River M&R Station (M&R Station), will be co-located with an existing natural gas storage and peak shaving facility.

The purpose of this Appendix is to specifically address existing site conditions; planned land-disturbing activities; construction sequence and procedures; erosion and sediment control (ESC) measures; and post-construction stormwater management (SWM) methods to be used at the M&R Station. This Appendix is intended to supplement the main body of the Stormwater Pollution Prevention Plan (SWPPP), which primarily addresses the linear portion of the Project. However, general provisions contained within the main body of the SWPPP, including pollution prevention practices and procedures; roles and responsibilities of personnel; inspection and maintenance; employee training; and notification, recordkeeping, and reporting will be followed during construction of the M&R Station, as applicable to the aboveground facility. Land-disturbing activities will conform, at a minimum, to the same regulations and guidelines listed in Section 2.0 of the SWPPP, as appropriate and applicable. In circumstances where multiple overlapping regulatory requirements and guidelines apply, DETI selected the more stringent or protective of the requirements and guidelines set forth by the Federal Energy Regulatory Commission (FERC) and the Virginia Department of Environmental Quality (VDEQ), unless otherwise agreed to in advance.

A description of the M&R Station is provided in the following sections. A Site Plan is provided in Attachment 1. Figure 1-1 below shows the location of the M&R Station in relation to the ACP.

¹ In May 2017, Dominion Transmission, Inc. (DTI) had a legal name change to Dominion Energy Transmission, Inc. (DETI).

Figure 1-1 Elizabeth River M&R Station Location



2.0 LOCATION AND DESCRIPTION

The M&R Station will be located at milepost 82.7 of the AP-3 lateral section of the ACP pipeline, within the City of Chesapeake. The approximately 1.0-acre rectangular tract of land is located along the northern property boundary of a larger parcel. The larger parcel is identified in the City of Chesapeake records as Parcel Number 026000000340 with a property address of 2516 South Military Highway. The general vicinity around the M&R Station is a mix of commercial/industrial development to the north and west and a mix of undeveloped/residential property to the east and south.

2.1 EXISTING SITE CONDITIONS

The M&R Station is mainly undeveloped with the westernmost portion (approximately one-third of the station) consisting of a grassy area and the remaining two-thirds consisting of wooded land. An existing natural gas pipeline right-of-way crosses the proposed M&R Station along the western boundary.

A drainage ditch is located adjacent to the western boundary of the M&R Station alongside an access road leading to the M&R Station from South Military Highway. Two drainage ditches are located in the forested portion of the property running in a roughly north-south direction and another along a portion of the M&R Station's northern boundary. A wetland is located at the southeastern corner of the M&R Station as described in Section 2.11 below.

2.2 EXISTING AND PROPOSED TOPOGRAPHY

The topography at the M&R Station is characterized by flat to gently sloping terrain with an elevation of approximately ten feet above mean sea level. The proposed development will retain the existing topography of flat to gently sloping terrain with grading to direct stormwater toward vegetated filter strips planned along the eastern and western sides of the property.

Existing topography of the M&R Station can be found in the topographical map, Attachment 2. In addition, the proposed grading plan for the M&R Station is provided in Attachment 1.

2.3 PROMINENT VEGETATION

The current M&R Station site location is undeveloped with the westernmost portion (approximately one-third of the site) consisting of a grassy area and the remaining two-thirds consisting of wooded land. The M&R station will be developed with one dekatherm building (used to house equipment such as gas chromatographs, communications equipment, etc.) as well as a regulation skid, a metering skid, a microwave tower, and a small supply building surrounded by a chain-link security fence. In addition, aboveground sections of piping, gas filter/separator, meters, a tank, and regulators will be present. The ground surface around the building structures and aboveground equipment will be covered with gravel with the exception of two vegetated grass filter strips along the western and eastern sides of the property. DETI will utilize an existing road to access the M&R station from South Military Highway. Vehicles will

then enter the M&R Station using a new gravel access road. The proposed Site Plan is provided in Attachment 1.

2.4 LAND-DISTURBING ACTIVITIES AND ASSOCIATED WORK AREAS

Construction of the M&R Station will affect approximately one acre of land. The one acre of land affected will be retained for operation of the new M&R Station. The Site Plan included in Attachment 1 depicts the proposed land use with a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, structures, roads, parking areas, SWM facilities, and easements.

2.5 CONSTRUCTION SCHEDULE

Subject to receipt of the required permits and regulatory approvals, initial construction activities are expected to commence in April 2018. DETI anticipates that the M&R Station construction will be completed in the third quarter of 2019.

2.6 ADJACENT PROPERTIES

The proposed Elizabeth River M&R Station will be located in a mixed commercial/industrial area. DETI will use a combination of management practices and control measures to limit the erosion and transport of soil to adjacent properties and waterbodies.

The following properties and associated land uses are located immediately adjacent to the M&R Station:

- Southeastern Equipment Corporation (2506 South Military Highway), a heavy equipment sales, rental, and parts facility is located to the north. According to the City of Chesapeake Real Estate website, the adjacent parcel is 8.9 acres in size and includes a 7,120-square-foot garage/storage building.
- Marine Specialty Painting (4411 Bainbridge Boulevard), a ship painting contractor, is located adjacent to the northwest corner of the site. According to the City of Chesapeake Real Estate website, a portion of the property (less than 0.1 acre) is leased for a cell phone tower. A cell tower is located in the southeast corner of the adjacent property, immediately diagonal from the subject Site. The portion of the property nearest the M&R Station appears to be primarily used for storage of trucks, trailers, land-sea containers and fill material.
- The larger parcel, within which the M&R Station will be located, is used as a propane storage and natural gas peak shaving plant. Plant operations are located immediately south and west of the M&R Station.
- The area east of the M&R Station is wooded.

2.7 OFF-SITE AREAS

This ESC and SWM Plan addresses land-disturbing activities within the M&R Station. Project plans do not include any additional off-site land-disturbing activities (such as borrow sites or disposal areas). Similar to adjacent properties, DETI will minimize any potential impact to off-site areas during the Project.

2.8 SOILS

Based on a review of the Virginia Division of Mineral Resources Geologic Map of Virginia (1993), the surficial geologic unit at the site is the Quaternary Period Lynnhaven Member of the Tabb Formation. According to the U.S. Geological Survey (USGS), the Lynnhaven Member consists of a pebbly to cobbly, fine to coarse gray sand grading upward into clayey and silty fine sand and sandy silt. Locally, at the base of the unit, medium to coarse cross-bedded sand and clayey silt containing abundant plant material fill channels cut into underlying stratigraphic units. The Lynnhaven Member is a surficial deposit of a broad swale that is traceable southward from Norfolk, and extensive low lands bounded on landward side by river-, bay-, and ocean-facing scarps having toe altitudes of 15 to 18 feet. Thickness of the unit ranges from 0 to 20 feet.

According to the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), soils beneath the wooded portion of the M&R Station are mapped as somewhat poorly drained to poorly drained (Dragston-Tomotley Complex) with depth to water table ranging from 0 to 30 inches. These soils consist of fine sand overlain by a 3 to 3.5 foot layer of fine sandy loam to a sandy clay loam. These soils stretch into the southern portion of the grassy area. The remaining portion of the grassy area is mapped in the Tomotley-Urban Land-Nimmo Complex. These soils are poorly drained with depth to water table ranging from 0 to 12 inches.

The NRCS assigns soils to one of four hydrologic soil groups based on estimates of runoff potential, as follows:

- **Group A:** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- **Group B:** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- **Group C:** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- **Group D:** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell

potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter applies to drained areas and the second applies to undrained areas.

The hydrologic soil groups assigned by NRCS for the soils mapped at the M&R Station are as follows: Dragston (Group C); Tomotley (Group B/D); and Nimmo: (Group D).

2.9 RECEIVING WATERS

The M&R Station drains south toward a former sandpit which is now filled with water. Water collected within the sandpit discharges into Newton Creek, located approximately 2,000 feet south of the proposed M&R Station. Newton Creek flows west into the Southern Branch of the Elizabeth River. The M&R Station is located within the Deep Creek-Southern Branch Elizabeth River watershed identified by the USGS as hydrologic unit code 020802080203. DETI does not intend to connect to and/or discharge into a municipal separate storm sewer system (MS4).

2.10 EXCEPTIONAL AND IMPAIRED WATERS

The proposed M&R Station does not impact Tier 3 exceptional waters identified in 9 VAC 25-260-30 A.

DETI reviewed the 2012 list of 305(b)/303(d) Impaired Waters for the Commonwealth of Virginia to identify waterbodies classified as impaired or for which a Total Maximum Daily Load (TMDL) wasteload allocation has been established and approved for (i) sediment or a sediment-related parameter (i.e., total suspended solids or turbidity) or (ii) nutrients (i.e., nitrogen or phosphorus) (VDEQ, 2015). The M&R Station drains to Newton Creek (a tributary of the Southern Branch of the Elizabeth River) which has been designated as impaired for dissolved oxygen, polychlorinated biphenyls (PCBs) in fish tissue, and dioxin. A dissolved oxygen TMDL has been established for Newton Creek; TMDLs are currently under development for PCBs and dioxin. Neither Newton Creek nor the Southern Branch of the Elizabeth River has a TMDL wasteload allocation for sediment or a sediment-related parameter or nutrients. However, the M&R Station will be located within the Chesapeake Bay watershed which has a wasteload allocation to reduce nitrogen, phosphorus, and sediment discharges into the Bay. The location of the Chesapeake Bay TMDL watershed is shown on Figure 2.18-1 of the main body of the SWPPP.

In accordance with the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law and their associated regulations, the following will be implemented for construction activities within the Chesapeake Bay TMDL Watershed:

- Permanent or temporary soil stabilization will be applied to denuded areas within seven days after final grade is reached on any portion of the site.

- Nutrients will be applied in accordance with manufacture’s recommendations or an approved nutrient management plan and will not be applied during rainfall events.
- Inspection requirements are as follows:
 - Inspections will be conducted at a frequency of (i) at least once every four business days or (ii) at least once every five business days and no later than 48 hours following a measurable storm event (a measurable storm event is defined as a rainfall event producing 0.25 inches of rain or greater over 24 hours). In the event a measurable storm event occurs when there are more than 48 hours between business days, the inspection will be conducted on the next business day; (see Section 8.1 of the SWPPP).
 - Representative inspections used by linear construction projects will include all outfalls discharging to surface waters identified as impaired or for which a TMDL wasteload allocation has been established. **Note that inspections of the M&R Station will include all disturbed areas (i.e., representative inspections are only applicable to the linear portion of the Project – not to aboveground facilities).**

2.11 CRITICAL/SENSITIVE AREAS

Pre-construction assessments and field surveys were completed by DETI to delineate the location of critical or sensitive environmental areas within the areas of land disturbance proposed by the M&R Station.

2.11.1 Wetlands and Waterbodies

M&R stations have been sited such that impacts to wetlands will be avoided and minimized to the maximum extent practicable. During the routing phase of the ACP Project, Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data, was used to provide a preliminary analysis of wetland resources and to assess where wetland impacts could be avoided or minimized. NWI data was also used to estimate the number, size, and locations of wetlands within the construction areas prior to conducting wetland delineations in the field.

DETI conducted field surveys during the 2015 field season to identify and delineate wetlands at the proposed Elizabeth River M&R Station. Temporary construction and operational activities at the Elizabeth River M&R station will impact approximately 0.1 acres of wetland located at the southeast corner of the M&R Station, as shown on the Site Plan in Attachment 1. Consultation with the U.S. Army Corps of Engineers (USACE) was initiated in 2015 for a Nationwide Permit (NWP) 12, and DETI is currently undergoing review and consultation with the USACE.

The portion of the wetland which extends beyond the area of land disturbance and onto the adjacent property will be protected from post-construction stormwater runoff with a vegetated filter strip, as discussed in Section 5.3 below.

2.11.2 Threatened and Endangered Species

DETI consulted with the USFWS Ecological Services Field Office in Virginia to identify federally and Commonwealth-listed endangered, threatened, and proposed species as potentially occurring in the ACP Project area. Field surveys and consultations with the USFWS regarding these species are ongoing. Virginia has separate laws protecting threatened and endangered species. DETI requested and received data on known occurrences of Commonwealth-listed species in Virginia from the Virginia Department of Conservation and Recreation Natural Heritage Program. DETI additionally has consulted and continues to consult with the Virginia Department of Game and Inland Fisheries and Virginia Department of Conservation and Recreation regarding impacts on Commonwealth-listed threatened and endangered species.

There are no endangered, threatened, or proposed species that are known to occur at the proposed M&R Station.

2.11.3 Chesapeake Bay Protection Areas

The Chesapeake Bay Preservation Act (CBPA) was enacted to protect, preserve, and improve the waters of the Chesapeake Bay and its tributaries. The CBPA is implemented through the Chesapeake Bay Preservation Area Designation and Management Regulations (9 VAC 25-830 et seq.) which requires localities within Tidewater Virginia² to enact ordinances to implement and enforce the requirements of the CBPA. In addition, any locality not included within Tidewater Virginia may elect to incorporate CBPA requirements into its local ordinances. The M&R Station is located within the City of Chesapeake which has a local CBPA ordinance.

In accordance with 9 VAC 25-830-150.B.1, DETI is compliant with the Chesapeake Bay Preservation Area Designation and Management Regulation by constructing, installing, operating, and maintaining the M&R Station in accordance with (i) regulations promulgated pursuant to the Erosion and Sediment Control Law and the Virginia Stormwater Management Act, (ii) an Erosion and Sediment Control Plan (ESC Plan) and a Stormwater Management Plan (SWM Plan) approved by the VDEQ, or (iii) local water quality protection criteria at least as stringent as the above Commonwealth requirements.

DETI will construct, install, operate, and maintain the M&R Station in accordance with VDEQ-approved Standards and Specifications which are consistent with the requirements of the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law and their associated regulations, where applicable. As such, the M&R Station will be compliant with the Chesapeake Bay Preservation Area Designation and Management Regulation. The ESC and SWM Plans contained in this SWPPP were prepared to ensure compliance with the Standards and Specifications as well as other federal regulations.

²

In accordance with §62.1-44.15:68 of the CBPA, "Tidewater Virginia" means the following jurisdictions: The Counties of Accomack, Arlington, Caroline, Charles City, Chesterfield, Essex, Fairfax, Gloucester, Hanover, Henrico, Isle of Wight, James City, King and Queen, King George, King William, Lancaster, Mathews, Middlesex, New Kent, Northampton, Northumberland, Prince George, Prince William, Richmond, Spotsylvania, Stafford, Surry, Westmoreland, and York, and the Cities of Alexandria, Chesapeake, Colonial Heights, Fairfax, Falls Church, Fredericksburg, Hampton, Hopewell, Newport News, Norfolk, Petersburg, Poquoson, Portsmouth, Richmond, Suffolk, Virginia Beach, and Williamsburg.

3.0 EROSION AND SEDIMENT CONTROL

All ESC measures to be undertaken as part of this Project will be done in accordance with the VDEQ-approved DETI Standards and Specifications. These standards and specifications will be met through the implementation of the FERC's Upland Erosion Control, Revegetation, and Maintenance Plan and Wetland and Waterbody Construction and Mitigation Procedures, Minimum Standards of the Virginia Erosion and Sedimentation Control Regulations (9 VAC 25-840-40), by the design, construction and maintenance of the Erosion and Sedimentation Controls in accordance with the Virginia Erosion and Sediment Control Handbook (VESCH) (1992, 3rd Edition), and the application of environmental site design principles.

3.1 GENERAL M&R STATION CONSTRUCTION

M&R Station construction stages and the ESC measures to be installed for each of these stages are described below. The ESC drawings for the M&R Station, including typical drawings of general ESC measures, are provided in Attachment 1.

During construction, the effectiveness of temporary erosion control devices will be monitored by DETI's Environmental Inspectors (EIs). The effectiveness of permanent erosion control measures will be monitored for the life of the project by DETI operating personnel during the long-term operation and maintenance of the M&R Station.

Site Preparation

- Survey and flag the construction site and mark environmentally-sensitive areas (i.e., boundary of wetland and vegetated filter strip).
- Only vehicular traffic used for vegetated filter strip construction will be allowed within ten feet of the vegetated filter strip boundary.
- Install temporary construction entrance.
- Install safety fences prior to ESC installation.
- Conduct initial clearing, limited to that necessary to install temporary sediment barriers.
- Install all perimeter ESCs prior to any bulk earth-moving activity (road grading, log skidding, grubbing, etc.) ESC measures will be inspected and maintained throughout construction.
- Construction runoff will be directed away from the proposed vegetated filter strips with silt fence.
- Clear and grub site.
- Segregate topsoil where necessary.

M&R Station Construction

- Begin site bulk grading.
- Grade entrance road, laydown areas, and parking areas.
- Grade building pads and dig excavations for footings, foundations, and utilities.
- Install utilities.
- Construct buildings and pipeline metering and regulation facilities.
- Spread topsoil on disturbed areas, as needed.
- Complete finish grading.
- Install gravel base around buildings and M&R facilities.

Restoration

- Conduct site restoration and cleanup. As soon as slopes, channels, ditches, and other disturbed areas reach final grade, they must be stabilized within seven days.
- Apply soil amendments, permanent seed, mulch, and/or erosion control fabric, as necessary.
- Restore temporary access roads or any paved surfaces to original condition.
- Remove temporary sediment barriers from an area when replaced by permanent erosion control measures or when the area has been successfully restored to uniform perennial vegetation. Temporary erosion control best management practices (BMPs) will not be removed until inspection by the EI to confirm site stabilization.

Vegetated Filter Strip Construction

- Construction of gravel diaphragm will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.
- Minimize soil compaction by lightly grading vegetated filter strips with tracked vehicles to achieve desired elevations and slopes.
- Spread topsoil and compost amendments across the filter strip areas, seed, and protect with mulch.
- Stormwater will not be diverted into the filter strip until turf cover is dense and well established.

3.1.1 Survey and Flagging

- The limits of the approved work areas, boundaries of the delineated wetland, boundaries of the vegetated filter strips, and the location of the underground utilities must be marked in the field prior to the start of mechanized activities.
- Orange plastic fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work will take place within critical areas and their buffers.
- Per VESCH **Std. & Spec. 3.01 (Safety Fence)**, safety fencing will be installed as needed during grading at public access points or around open unattended excavations to warn pedestrians of possible hazards. Stakes will be installed to the maximum extent of 18” as practical in the field to ensure the functionality of the safety fence. In areas where adequate embedment depth cannot be achieved, due to terrain/substrate constraints; additional measures including but not limited to sandbags, mounded earth, etc. will be utilized to secure the fence. In addition, lights, signs and other warnings are required at road entrances and road crossings (see Virginia Department of Transportation (VDOT) permits and regulations).
- Flagging or marking will be maintained throughout construction.
- Trees to be protected will be flagged by the EIs and if determined necessary, protected with fencing or armoring prior to clearing.
- Per VESCH **Std. & Spec. 3.38 (Tree Preservation and Protection)**, at a minimum the limits of clearing will be located outside the drip line of any tree to be retained within the LOD and, in no case, closer than five feet to the trunk of any tree to be retained within the LOD. In addition, heavy equipment, vehicular traffic, or stockpiles will not be permitted within the drip line of any tree to be retained within the LOD.

3.1.2 Construction Entrance

In accordance with VESCH **Std. & Spec 3.02 (Stone Construction Entrance)**, a construction entrance will be constructed at any point where construction equipment leaves the right-of-way and enters a paved public road or other paved surface. Typically, a construction entrance is comprised of filter fabric overlain by six inches of coarse aggregate (Virginia Department of Transportation #1) extending a minimum of 70 feet from the edge of the pavement. The area of the entrance must be excavated three inches prior to laying the filter fabric underliner. The entrance must extend the full width of the vehicular ingress and egress area and have a minimum 12-foot width. Conveyance of surface water through culverts under the entrance will be provided, as necessary. If such as conveyance is impossible, the construction of a “mountable” berm with 5:1 slopes will be permitted.

The construction entrance must function to remove mud from vehicles and equipment leaving the site. As mud accumulates on the entrance, clean stone must be added or the tire mats lifted and shaken to remove mud. Any mud that is carried onto the pavement must be thoroughly

removed by the end of the day by shoveling or sweeping. The mud will be returned to the site. The use of water to remove sediment tracked onto roadways is permitted only after sediment is removed as stated above.

If the majority of the mud is not removed by the vehicles traveling over the stone, then tires of the vehicles must be washed before entering the public road. A wash rack may be used to make washing more convenient and effective. Wash water must be carried away from the entrance to a settling area to remove sediment before discharge.

Maintenance of the construction entrance may require periodic top dressing with additional stone and cleanout of any structures used to trap sediment. If inadvertent sediment tracking occurs on the public roadway, the road will be cleaned thoroughly by the end of each day.

3.1.3 Wind Erosion Control

Consistent with VESCH Std. & Spec. 3.39 (Wind Erosion Control), the following temporary sediment controls will be used, as applicable, to minimize the surface and air movement of dust during land disturbing and construction activities:

- In areas with little or no construction traffic, a vegetatively stabilized surface will reduce dust emissions.
- Mulch will be used in areas without heavy traffic pathways.
- Tillage will be used only in an emergency situation before wind erosion begins. Plowing on the windward side of the site with chisel-type plows spaced approximately 12 inches apart.
- The contractors will have one or more water trucks available per spread that will load water from approved permitted sources to spray areas for dust control.
- Use of spray-on adhesives may be used on mineral soils only.
- Use crushed stone or coarse gravel to stabilize roads and other areas during construction.
- A board fence, wind fence, or sediment fence may be used to control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals of about 15 times the barrier height.
- Calcium chloride may be applied by a mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.

3.1.4 Silt Fencing

Silt Fencing constructed of synthetic filter fabric stretched across and attached to supporting posts, and in some cases a wire support fence, will be placed across or at the toe of a slope or in a minor drainage way to intercept and detain sediment and decrease flow velocities

from drainage areas of limited size. Silt fencing is applicable where sheet and rill erosion or small concentrated flows may be a problem. In accordance with VESCH **Std. & Spec 3.05 (Silt Fence)**, DETI will adhere to the following general construction and maintenance specifications if congruent with the manufacturer's recommended installation and use. In the event of conflicting specifications, DETI will always follow the manufacturer's recommendations on proper installation and use of a product.

- Silt fencing will be used where the size of the drainage area is not more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50 percent (2:1).
- Silt fencing can be used in minor swales or ditches where the maximum contributing drainage area is no greater than 1 acre and flow is no greater than one cubic feet per second. In ditches or swales where higher velocity flow is expected, rock check dams will be used in place of silt fence.
- Silt fencing will not be used in areas where rock or some other hard surface prevents the full and uniform depth anchoring of the barrier.
- If wooden stakes are utilized for silt fence construction, they must have a diameter of two inches when oak is used and four inches when pine is used. Wooden stakes must have a minimum length of five feet. Fabric will not be stapled to existing trees.
- If steel posts are utilized, they must have a minimum weight of 1.33 pounds per linear foot and have a minimum length of five feet. Posts will be placed a maximum of six feet apart.
- The height of the fence will be a minimum of 16 inches above grade and will not exceed 34 inches above ground elevation.
- Filter cloth will be spliced together only at support posts with a minimum 6-inch overlap.
- When wire support is not used, extra-strength filter fabric will be fastened to the upslope side of the posts using one inch long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric will be extended into the trench. The posts will be placed a maximum of six feet apart.
- When wire support is used, the wire mesh fence must be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tire wires or hog rings. The posts will be placed a maximum of ten feet apart.
- If silt fence is to be constructed across a ditch line or swale, the measure must be of sufficient length to eliminate end flow and the configuration will resemble an arc with the ends oriented upslope. Extra-strength filter fabric must be used for ditch lines or swales with a maximum three-foot spacing of posts.

- Remove accumulated sediments when sediment reaches half the aboveground height of the fence.
- Silt fences will be removed and discarded properly after project completion. Soils will be stabilized and seeded accordingly. Permanent erosion control protective measures will be utilized if seeding alone will not stabilize the site and provide soil stability.

Belted Silt Retention Fence (BSRF)

The primary silt fence product planned for use on the ACP, including the M&R Station, is a patented Belted Silt Retention Fence (BSRF) product which is available in two designs used to address different site conditions, as follows:

- BSRF Priority 1 (green band) is a heavy-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric with an internal scrim incorporated into the fabric for additional strength and durability. The system utilizes wood stakes spaced at 4-feet and a specific method of attachment. The system is functionally equivalent to wire back and metal steel post silt fence and is designed for the protection of high priority areas, including wetlands and waterbodies.
- BSRF Priority 2 (black band) is a medium-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric that is calendared on one side. The system utilizes wood stakes spaced at 6-feet and a specific method of attachment.

Drawings and specifications for BSRF are provided in Attachment 1.

3.1.5 Site Dewatering

Dewatering may be periodically conducted to remove accumulated groundwater or precipitation from the construction area, including from within excavations. The need for erosion controls as well as the type of control used will vary depending on the type and amount of sediment within the water, and volume and rate of discharge.

3.1.5.1 Geotextile Bag/Dewatering Filter Bag

DETI utilizes geotextile bags for dewatering and velocity reduction on a majority of pipeline construction projects as well as the straw bale dewatering practice illustrated in the **VESCH Std. & Spec. 3.26 (Dewatering Structure)**. The purpose, definition, conditions of application and planning considerations are identical. Design criteria and specifications vary by dewatering bag manufacturer; a variety of geotextile dewatering bag products are available on the market. The manufacturers' guidance on the use, design, sizing, maintenance, and application of the geotextile dewatering bag will be followed.

- Conduct dewatering (on or off the construction site) in such a manner that does not cause erosion and does not result in silt-laden water flowing into any waterbody, wetland, or off-site property.

- Elevate and screen the intake of each hose used to withdraw the water from the trench to minimize pumping of deposited sediments.
- A dewatering bag may not be needed if there is a well-stabilized, vegetated area on site to which water can be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. Per VESCH **Std. & Spec 3.26**, a minimum filtering length of 75 feet must be available in order for such a method to be feasible.
- Remove dewatering structures as soon as practicable after the completion of dewatering activities or sooner if sediment build-up prevents the bag from functioning properly. If the bag becomes half full of sediment, discard and replace with a new bag.

3.1.5.2 VESCH Standard Dewatering Structure

As warranted by site conditions, a standard dewatering structure may be used per the construction and maintenance specifications in VESCH **Std. & Spec 3.26 (Dewatering Structure)**, including the use of a portable sediment tank, filter box, or straw bale/silt fence pit. The dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed. The accumulated sediment which is removed from a dewatering device must be spread on site and stabilized or disposed of at an approved disposal site.

In some cases, DETI could use a modified dewatering structure in combination with a filter bag. The structure is similar to the straw bale/silt fence pit described in the VESCH, but the wet storage area is not excavated 3 ft. below the perimeter measures since the structures are placed off the right-of-way in well vegetated areas. The filter bag discharges into the dewatering structure for additional filtration through the straw bales. Additional energy dissipating devices may be installed downgradient of the dewatering structure, as necessary.

Installation and removal of the referenced dewatering practice does not involve ground disturbance.

3.2 SPECIAL CONSTRUCTION PROCEDURES

Sensitive areas (e.g., wetland) will be treated as separate construction entities. Sensitive areas require additional ESC procedures. Additional controls will be shown on the drawings in Attachment 1.

3.2.1 Winter Construction

DETI has developed and filed a project-specific winter construction plan with the FERC application.

The plan addresses:

- Winter construction procedures (e.g., snow handling and removal, soil handling under saturated or frozen conditions, topsoil stripping);
- Stabilization and monitoring procedures if ground conditions will delay restoration until the following spring (e.g., mulching and erosion controls, inspection and reporting, stormwater control during spring thaw conditions); and
- Where areas have been temporarily stabilized or land-disturbing activities will be suspended due to continuous frozen ground conditions and stormwater discharges are unlikely, the inspection frequency may be reduced to once per month. If weather conditions (such as above freezing temperatures or rain or snow events) make discharges likely, the operator will immediately resume the regular inspection frequency.

3.2.2 Wetlands

Construction procedures are to comply with the USACE, or its delegated agency, permit terms and conditions. Implement the following general requirements during planning and construction near or across wetlands, per the general conditions of the NWP:

- No activity will cause more than a minimal adverse effect on navigation.
- As required, a pre-construction notification will be obtained for discharges associated with the construction of utility line substations that result in the loss of greater than 5,000 square feet of waters of the United States.
- No activity will substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the wetland, including those species that normally migrate through the area. All permanent and temporary crossings of the wetland will be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species, except within the proposed portion of the wetland that will be filled in for the M&R Station.
- Activities during spawning seasons will be avoided to the maximum extent practicable. There will be no activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area. Per the USACE NWP 12 conditions for the project, Elizabeth River M&R Station does not have time of year restrictions for waters of the U.S.
- Activities in waters of the United States that serve as breeding areas for migratory birds will be avoided to the maximum extent practicable. DETI plans to clear the M&R station outside of the migratory bird nesting season to reduce potential impacts on migratory birds and other sensitive species. In the event that clearing is necessary within the nesting season, DETI will avoid impacts to nests observed

within the construction limits of disturbance (LOD) in accordance with the Migratory Bird Treaty Act (MBTA).

- No activity will use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged will be free from toxic pollutants in toxic amounts (Section 307 of the Clean Water Act).
- No activity will occur in the proximity of a public water supply intake, unless the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.
- To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters will be maintained for each activity, including stream channelization and stormwater management activities, except as provided below.
 - The activity will be constructed to withstand expected high flows, activity will not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows.
 - The activity may alter the pre-construction course; condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).
- The activity will comply with applicable Federal Emergency Management Agency-approved state or local floodplain management requirements.
- Heavy equipment working in wetlands or mudflats will be placed on mats, or other measures will be taken to minimize soil disturbance.
- Appropriate soil ESCs will be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, will be permanently stabilized at the earliest practicable date.
- Temporary fills will be removed in their entirety and the affected areas will be returned to pre-construction elevations. The affected areas will be revegetated, as appropriate.
- Any authorized structure or fill will be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.
- The activity will be a single and complete project. The same NWP will not be used more than once for the same single and complete project.

- Grubbing shall be limited to the permanent easement for underground utility lines. Outside of the permanent easement, wetland vegetation shall be removed at or above the ground surface unless written justification is provided and the impacts are reviewed and approved by the USACE.
- Whenever possible, excavated material will be placed on an upland site. However, when this is not feasible, temporary stockpiling will be placed with the following guidelines:
 - All excavated material stockpiled in a vegetated wetland area is placed on filter cloth, mats, or some other semi-permeable surface. The material will be stabilized with straw bales, filter cloth, etc. to prevent reentry into the waterway.

4.0 EROSION AND SEDIMENT CONTROL MINIMUM STANDARDS

The Virginia ESC regulations specify minimum standards that must be followed for all regulated land-disturbing activities, where applicable to a specific project. Modifying or waiving any of the ESC regulations, including the 19 minimum standards, on a project-specific basis, requires a written variance request to VDEQ for review and approval. DETI will construct the M&R Station in accordance with the following criteria, techniques, and methods per minimum standards set forth in 9 VAC 25-840-40, as applicable.

Minimum Standard 1 – Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

Minimum Standard 2 – During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

Minimum Standard 3 – A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

Minimum Standard 4 – Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

Minimum Standard 5 – Stabilization measures shall be applied to earthen structures such as dams, dikes, and diversions immediately after installation.

Minimum Standard 6 – Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

- 6.a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area and the trap shall only control drainage areas less than 3 acres.
- 6.b. Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to 3 acres shall be controlled by a sediment basin. The minimum storage capacity of a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25-year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall correspond to a bare earth condition or those conditions expected to exist while the sediment basin is utilized.

Minimum Standard 7 – Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

Minimum Standard 8 – Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume, or slope drain structure.

Minimum Standard 9 – Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

Minimum Standard 10 – All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

Minimum Standard 11 – Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

Minimum Standard 12 – When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport, and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

Minimum Standard 13 – When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

Minimum Standard 14 – All applicable federal, state, and local requirements pertaining to working in or crossing live watercourses shall be met.

Minimum Standard 15 – The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

Minimum Standard 16 – Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

- 16.a. No more than 500 linear feet of trench may be opened at one time.
- 16.b. Excavated material shall be placed on the uphill side of trenches.
- 16.c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

- 16.d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.
- 16.e. Restabilization shall be accomplished in accordance with this chapter.
- 16.f. Applicable safety requirements shall be complied with.

Minimum Standard 17 – Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

Minimum Standard 18 – All temporary ESC measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the Virginia Erosion and Sedimentation Control Program (VESCP) authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

Minimum Standard 19 – Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion, and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria. Stream restoration and relocation projects that incorporate natural channel design concepts are not man-made channels and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels:

19.a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe, or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

19.b. Adequacy of all channels and pipes shall be verified in the following manner:

19.b.(1) The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is one hundred times greater than the contributing drainage area of the project in question; or

19.b.(2)(a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks.

19.b.(2)(b) All previously constructed man-made channels shall be analyzed by the use of a 10-year storm to verify that stormwater will not overtop its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and

19.b.(2)(c) Pipes and storm sewer systems shall be analyzed by the use of a 10-year storm to verify that stormwater will be contained within the pipe or system.

19.c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:

19.c.(1) Improve the channels to a condition where a 10-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel, the bed, or the banks; or

19.c.(2) Improve the pipe or pipe system to a condition where the 10-year storm is contained within the appurtenances;

19.c.(3) Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel or will not cause the pre-development peak runoff rate from a 10-year storm to increase when runoff outfalls into a man-made channel; or

19.c.(4) Provide a combination of channel improvement, stormwater detention or other measures which is satisfactory to the VESCP authority to prevent downstream erosion.

19.d. The applicant shall provide evidence of permission to make the improvements.

19.e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development condition of the subject project.

19.f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the VESCP of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

19.g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

19.h. All on-site channels must be verified to be adequate.

19.i. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

- 19.j.** In applying these SWM criteria, individual lots or parcels in a residential, commercial, or industrial development shall not be considered to be separate development projects. Instead, the development, as a whole, shall be considered to be a single development project. Hydrologic parameters that reflect the ultimate development condition shall be used in all engineering calculations.
- 19.k.** All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical, and biological integrity of rivers, streams and other waters of the state.
- 19.l.** Any plan approved prior to July 1, 2014, that provides for SWM that addresses any flow rate capacity and velocity requirements for natural or man-made channels shall satisfy the flow rate capacity and velocity requirements for natural or man-made channels if the practices are designed to (i) detain the water quality volume and to release it over 48 hours; (ii) detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm; and (iii) reduce the allowable peak flow rate resulting from the 1.5-, 2-, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition, achieved through multiplication of the forested peak flow rate by a reduction factor that is equal to the runoff volume from the site when it was in a good forested condition divided by the runoff volume from the site in its proposed condition, and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels as defined in any regulations promulgated pursuant to §62.1-44.15:54 or 62.1-44.15:65 of the Act.
- 19.m.** For plans approved on and after July 1, 2014, the flow rate capacity and velocity requirements of §62.1-44.15:52 A of the Act and this subsection shall be satisfied by compliance with water quantity requirements in the Stormwater Management Act (§62.1-44.15:24 et seq. of the Code of Virginia) and attendant regulations, unless such land-disturbing activities are in accordance with 9 VAC 25-870-48 of the Virginia Stormwater Management Program (VSMP) Regulation or are exempt pursuant to subdivision C 7 of §62.1-44.15:34 of the Act.
- 19.n.** Compliance with the water quantity minimum standards set out in 9 VAC 25-870-66 of the VSMP Regulation shall be deemed to satisfy the requirements of this subdivision 19.

5.0 POST-CONSTRUCTION STORMWATER MANAGEMENT

Where pre-development land cover conditions are changed significantly, triggering post-construction stormwater quality and quantity, post-construction BMPs may be required to comply with water quality and water quantity criteria of the Stormwater Management Regulations and Minimum Standard 19 of the Erosion and Sediment Control Regulations.

The M&R Station, surfaced with gravel and designated to remain a post-construction impervious surface, potentially results in increases in nutrient loading, runoff volume and peak flow rate. At this location, the need for post-construction SWM BMPs was evaluated as discussed below.

5.1 PRE-DEVELOPMENT AND POST-DEVELOPMENT DRAINAGE AREAS

As noted in Sections 2.1 and 2.2, the pre-development conditions at the M&R Station are primarily characterized as undeveloped with the westernmost portion (approximately one-third of the M&R Station site) consisting of a grassy area and the remaining two-thirds consisting of wooded land. An existing drainage ditch is located adjacent to the western boundary of the site and two drainage ditches are located in the forested portion of the property to the east. The existing topography is characterized by flat to gently sloping terrain with an elevation of approximately 10 feet above mean sea level.

In the post-development condition approximately 0.6 acres of the M&R Station site will be surfaced with gravel to create a suitable foundation for the required structures and equipment. The proposed M&R Station structures will occupy approximately 0.02 acres. Additionally, minor grading will occur to direct stormwater runoff toward a vegetated filter strip that will be constructed within the existing vegetated area to the west of the gravel pad and toward a proposed vegetated filter strip and conserved open space to the east of the gravel pad.

Delineation of the drainage watersheds and proposed management practices are shown on the SWM drawings and supporting calculations in Attachment 1. The drawings depict the proposed land uses at the site, and a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and parking lots. The drawings also show the final drainage patterns and flow paths of the stormwater, in addition to the relationship of the site to upstream and downstream properties and drainage systems. The M&R Station is located within a 500-year Federal Emergency Management Agency floodplain.

Stormwater quality and quantity calculations were performed for pre- and post-development conditions and are described in Section 5.2 below.

5.2 PRE-DEVELOPMENT AND POST-DEVELOPMENT STORMWATER CALCULATIONS

5.2.1 Water Quantity

A hydrologic analysis for the existing (pre-development) and for the proposed (post-development) conditions, including runoff rates, volumes, and velocities, identifying the methodologies used and supporting calculations are presented in this section.

Channel protection and flood protection will be addressed in accordance with the minimum standards set forth in 9 VAC 25-870-66, which are established pursuant to the requirements of § 62.1-44.15:28 of the Code of Virginia. Compliance with the minimum standards set out in this section will be deemed to also satisfy the requirements of Minimum Standard 19 of 9 VAC 25-840-40 (Minimum standards; Virginia Erosion and Sediment Control Regulations, Section 4.0).

Channel Protection

Runoff from the western side of the site sheet flows to a ditch on the western boundary and the runoff from the eastern side of the site sheet flows to a forested area and wetland. Since stormwater flow from the M&R Station will be released into a natural stormwater conveyance system, the maximum peak flow rate from the one-year, 24-hour storm following the land-disturbing activity was calculated. The supporting calculations are provided in Attachment 1.

Flood Protection

Concentrated stormwater flow will be released into a stormwater conveyance system and will meet one of the following criteria as demonstrated by use of acceptable hydrologic and hydraulic methodologies:

1. Concentrated stormwater flow to stormwater conveyance systems that currently do not experience localized flooding during the 10-year, 24-hour storm event: The point of discharge releases stormwater into a stormwater conveyance system that, following the land-disturbing activity, confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system. Detention of stormwater or downstream improvements may be incorporated into the approved land-disturbing activity to meet this criterion, at the discretion of the VSMP authority.
2. Concentrated stormwater flow to stormwater conveyance systems that currently experience localized flooding during the 10-year, 24-hour storm event: The point of discharge either:
 - a. Confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system to avoid the localized flooding. Detention of stormwater or downstream improvements

may be incorporated into the approved land disturbing activity to meet this criterion, at the discretion of the VSMP authority; or

- b. Releases a post-development peak flow rate for the 10-year, 24-hour storm event that is less than the predevelopment peak flow rate from the 10-year, 24-hour storm event. Downstream stormwater conveyance systems do not require any additional analysis to show compliance with flood protection criteria if this option is utilized.
3. Limits of analysis. Unless the methodology identified in 2b above is utilized to comply with the flood protection criteria, stormwater conveyance systems will be analyzed for compliance with flood protection criteria to a point where:
 - a. The site's contributing drainage area is less than or equal to 1.0 percent of the total watershed area draining to a point of analysis in the downstream stormwater conveyance system;
 - b. Based on peak flow rate, the site's peak flow rate from the 10-year, 24-hour storm event is less than or equal to 1.0 percent of the existing peak flow rate from the 10-year, 24-hour storm event prior to the implementation of any stormwater quantity control measures; or
 - c. The stormwater conveyance system enters a mapped floodplain or other flood-prone area, adopted by ordinance, of any locality.

The supporting calculations are provided in Attachment 1.

5.2.2 Water Quality

In order to protect the quality of Commonwealth waters and to control the discharge of stormwater pollutants from regulated activities, the following minimum design criteria and statewide standards for SWM will be applied to the site in accordance with 9 VAC 25-870-63.

1. New development. The total phosphorus load of new development projects will not exceed 0.41 pounds per acre per year (lb/ac/yr), as calculated pursuant to 9 VAC 25-870-65.

The VSMP regulations suggest the use of the Virginia Runoff Reduction Method (VRRM) for compliance with the water quality criteria in accordance with 9 VAC 25-870-65. The VRRM New Development spreadsheet was utilized to calculate the runoff reduction and pollutant removal capabilities of the selected post-construction stormwater BMPs based on the proposed land cover characteristics.

The approximate one-acre M&R station will have the following land cover characteristics:

- 0.26 acres of Forest/Open Space – This total is inclusive of the preserved wetland and conserved open space on the eastern side of the site, the proposed vegetated

filter strip on the eastern side of the site and the proposed vegetated filter strip on the western side of the site.

- 0.00 acres of Managed Turf – This is inclusive of the disturbed and graded side slopes of the M&R station pad.
- 0.74 acres of Impervious Cover – This is inclusive of the M&R station pad, the equipment areas, and the paved access road.

Based on the land cover characteristics, the post-development treatment volume for the M&R station was calculated to be 2,599 cubic feet and the total phosphorus produced from the site was 1.63 lb/ac/yr. With a required phosphorus load of 0.41 lb/ac/yr for new development, the phosphorus load is required to be reduced by 1.22 lb/ac/yr.

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.26	0.26 *
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed					0.00
Impervious Cover (acres)				0.74	0.74
<i>* Forest/Open Space areas must be protected in accordance with the Virginia Runoff Reduction Method</i>					1.00

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
P _i (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	1.22
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The site is proposed to be graded in a way that a portion of the site and the access road sheet flows to the vegetated filter strip on the western side of the M&R Station site. The eastern portion of the site sheet flows to the vegetated filter strip and the conserved open space on the eastern side of the M&R Station site. Based on the grading and location of the BMPs, the contributing drainage areas in acres were entered into the appropriate rows in the VRRM spreadsheet for the selected BMPs. The selected BMPs were able to reduce the phosphorus load by 0.80 lb/ac/yr with 0.42 lb/ac/yr remaining and required to be reduced.

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	1.63
TP LOAD REDUCTION REQUIRED (lb/yr)	1.22
TP LOAD REDUCTION ACHIEVED (lb/yr)	0.80
TP LOAD REMAINING (lb/yr):	0.83
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.42

The supporting calculations are provided in Attachment 1.

5.2.3 Nutrient Trading Program

Pollutant load compliance calculations were performed using the VRRM worksheet for New Development requiring the post-development phosphorus loading to be reduced to 0.41 lb/ac/yr. After completing the water quality analysis for the M&R station, approximately 0.42 lb/ac/yr of phosphorus remains to be removed. This phosphorus removal requirement will be offset with the purchase of nutrient credits in accordance with the requirements below.

For that portion of a site's compliance with stormwater nonpoint nutrient runoff water quality criteria being obtained through nutrient credits, DETI will (i) comply with a 1:1 ratio of the nutrient credits to the site's remaining post-development nonpoint nutrient runoff compliance requirement being met by credit use and will (ii) use credits certified as perpetual credits pursuant to Article 4.02 (§ 62.1-44.19:12 et seq.).

Nutrient credits will be acquired in the same tributary as the M&R Station by identifying credits generated within the same or adjacent eight-digit hydrologic unit code as defined by the USGS. Nutrient credits outside the same or adjacent eight-digit hydrologic unit code may only be used if it is determined that no credits are available within the same or adjacent eight-digit hydrologic unit code. In such cases, credits available within the same tributary may be used. However, in no case will credits from another tributary be used.

Documentation of DETI's acquisition of nutrient credits will be provided to the VDEQ prior to the commencement of land-disturbing activities at the M&R Station in a certification from the credit provider documenting the number of phosphorus nutrient credits acquired at the credit-generating entity (see Attachment 4). Until the effective date of regulations establishing application fees in accordance with § 62.1-44.19:20, the credit provider will pay the VDEQ a water quality enhancement fee equal to six percent of the amount paid by DETI for the credits. Such fee will be deposited into the Virginia Stormwater Management Fund established by § 62.1-44.15:29.

5.3 POST-CONSTRUCTION/PERMANENT STORMWATER BMPS

5.3.1 Vegetated Filter Strip

In accordance with VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**) as provided in Attachment 3, DETI will adhere to the following general construction and maintenance specifications at the M&R Station to treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. Vegetated filter strips will be constructed on the western and eastern portions of the M&R Station. The vegetated filter strip on the eastern portion of the M&R Station site will drain to the adjacent wetland or tree line southeast of the site, as shown on the SWM drawings in Attachment 1.

By using the minimum design criteria specified in Table 5.3.1-1, the vegetated filter strips at the Elizabeth River M&R Station can achieve 50 percent reduction in runoff volume, total phosphorus load, and total nitrogen load. In addition, peak discharge rates are reduced.

TABLE 5.3.1-1

Filter Strip Design Criteria

Design Issue	Vegetated Filter Strip
Soil and vegetative cover	Amended soil and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall slope and width (perpendicular to the flow)	1% ^a to 4% slope – minimum 35 ft. width
Sheet flow	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas
Concentrated flow	Not applicable – only sheet flow at Elizabeth River M&R Station
Construction stage	Prevent soil compaction by heavy equipment
Typical applications	Treat small areas of impervious cover (e.g., 5,000 sf)
Compost amendments	Yes (B, C, and D soils)
Boundary spreader	Gravel diaphragm at top of filter Permeable berm at toe of filter

^a A minimum of 1% is recommended to ensure positive drainage.

In addition, the following constraints will be observed during design and construction:

- Vegetated filter strips are not appropriate for fill soils.
- Vegetated filter strips will not receive hotspot runoff, since the infiltrated runoff could cause groundwater contamination.
- Underground pipes and conduits that cross the vegetated filter strip are acceptable.
- Before site work begins, vegetated filter strip boundaries will be clearly marked.
- Only vehicular traffic used for filter strip construction will be allowed within 10 feet of the filter strip boundary.
- If existing topsoil is stripped during grading, it will be stockpiled for later use.
- Construction runoff will be directed away from the proposed filter strip site, using perimeter silt fence or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.
- Vegetated filter strips require light grading to achieve desired elevations and slopes. This will be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments will be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater will not be diverted into the filter strip until the turf cover is dense and well established.

- Vegetated filter strips will be planted at such a density to achieve a 90 percent grass/herbaceous cover after the second growing season. Filter strips will be seeded, not sodded. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90 percent coverage with grasses and/or other herbaceous plants is achieved. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, will be able to withstand both wet and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.
- **Compost Soil Amendments** Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:
 - The compost amendments will extend over the full length and width of the filter strip.
 - Depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing areas of impervious cover that it receives. VDEQ Stormwater Design Specification No. 4 (**Soil Compost Amendment**) Table 4.3, as provided in Attachment 3, provides general guidance for determining the required depth to which compost must be incorporated. In practice, it is expected that the depth to which compost is incorporated will be limited by the shallow depth to groundwater at the M&R Station site.
 - The projected quantity of approved compost material needed for the Elizabeth River M&R Station, calculated based on VDEQ Stormwater Design Specification No. 4 (see Attachment 3), is 5,700 cubic yards. The actual quantity will be dictated by the depth at which groundwater is encountered during construction.
 - Compost will be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program.
 - The compost will be the result of the biological degradation and transformation of plant derived materials under conditions that promote anaerobic decomposition. The material will be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost will have a moisture content that has no visible free water or dust produced when handling the material. It will meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
 - a. 100 percent of the material must pass through a half inch screen;

- b. The pH of the material will be between six and eight;
 - c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) will be less than 0 percent by weight;
 - d. The organic matter content will be between 35 and 65 percent;
 - e. Soluble salt content will be less than 6.0 milliMhos per centimeter;
 - f. Maturity will be greater than 80 percent;
 - g. Stability will be seven or less;
 - h. Carbon/nitrogen ratio will be less than 25:1;
 - i. Trace metal test result = “pass”; and
 - j. The compost will have a dry bulk density ranging from 40 to 50 pounds per cubic foot.
- Soil tests are required during two stages of the compost amendment process. An Initial test is used to determine soil properties to a depth one foot below the proposed amendment area, which will be conducted every 5,000 square feet, and used to characterize potential drainage problems and determine if any further soil amendments are needed. The second soil test is taken at least one week after the compost has been incorporated into the soils and used to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary.
 - Prior to construction, area will be deep tilled to a depth of two to three feet, creating rips perpendicular to the direction of flow, if applicable.
 - A 2nd deep tilling to a depth of 12 to 18 inches will be conducted after final grading.
 - Apply compost during dry conditions.
 - An acceptable compost mix is then incorporated into the soil using a rototiller or similar equipment at the volumetric rate of one part compost to two parts soil.
 - The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.
 - If slopes exceed three percent, a protective biodegradable fabric or matting (e.g., EC-2) will be installed to stabilize the site prior to runoff discharge.

The slopes at the Elizabeth River M&R Station are less than 3 percent; therefore, mulching methods other than biodegradable fabric or matting can be used.

- Compost amendments will not be incorporated until the gravel diaphragm and/or engineered level spreader are installed
- **Gravel Diaphragms:** A pea gravel (#8 or ASTM equivalent) diaphragm at the top of the slope is required for vegetated filter strips that receive sheetflow. The pea gravel diaphragm is created by excavating a two-foot wide and one-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip.
 - The flow will travel over the impervious area and to the practice as sheet flow and then drop at least three inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the filter strip).
 - A layer of filter fabric will be placed between the gravel and the underlying soil trench.
- **Permeable Berm:** Vegetated filter strips will be designed with a permeable berm at the toe of the filter strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm. The permeable berm will have the following properties:
 - A wide and shallow trench, 6 to 12 inches deep, will be excavated at the upstream toe of the berm, parallel with the contours.
 - Media for the berm will consist of 40 percent excavated soil, 40 percent sand, and 20 percent pea gravel.
 - The berm 6 to 12 inches high will be located downgradient of the excavated depression and will have gentle side slopes to promote easy mowing.
 - Stone may be needed to armor the top of berm to handle extreme storm events.
 - A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

5.3.2 Conserved Open Space

In accordance with VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**) as provided in Attachment 3, DETI will adhere to the following general construction and maintenance specifications at the M&R Station to treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The vegetated area in the northeast corner of the property will be utilized as conserved open space, as depicted on the SWM drawings in Attachment 1.

By using the minimum design criteria specified in Table 5.3.2-1, the conserved open space area at the Elizabeth River M&R Station can achieve a 50 to 75 percent reduction in runoff volume, total phosphorus load, and total nitrogen load. In addition, peak discharge rates are reduced.

TABLE 5.3.2-1 Conserved Open Space Design Criteria	
Design Issue	Conserved Open Space
Soil and Vegetative Cover	Undisturbed soil and native vegetation
Overall Slope and Width (perpendicular to the flow)	0.5% to 3% slope – minimum 35 ft. width
Sheet Flow	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow of 75 ft. from adjacent impervious areas
Concentrated Flow	Not applicable – only sheet flow at Elizabeth River M&R Station
Construction Stage	Located outside the limits of disturbance and protected by ESCs
Typical Applications	Adjacent to stream or wetland buffer or forest conservation area
Compost Amendments	No
Boundary Spreader	Gravel diaphragm at top of filter

In addition, the following constraints will be observed during design and construction:

- No clearing, grading or heavy equipment is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the conserved open space will be protected by super silt fence, chain link fence, orange safety fence or other measure to prevent sediment discharge.
- The limits of disturbance will be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence, snow fence or other protective barrier.
- Construction of the gravel diaphragm or engineered level spreader will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.

- A long-term vegetation management plan must be prepared to maintain the conserved open space in a natural vegetative condition. A specific plan will be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance, etc.
- The conserved open space must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.

5.4 LONG-TERM MAINTENANCE

In accordance with DETI's Standards and Specifications, long-term maintenance of structural SWM facilities must be conducted in accordance with 9 VAC 25-870-112. To be consistent with the provisions of 9 VAC 25-870-112, maintenance plans for the stormwater facilities is provided below in Section 5.5 and 5.6 must be submitted to DETI for formal review and approval prior to initiating the land disturbing activity, made available to VDEQ upon request, and must provide for inspections and maintenance and the submission of inspection and maintenance reports to the VDEQ. DETI transmission easements over land under which permanent SWM facilities will be placed must further assure the following:

- Be stated to run with the land;
- Provide for all necessary access to the property for purposes of maintenance and regulatory inspections; and
- Be enforceable by all appropriate governmental parties.

According to VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**), vegetated filter strips must be covered by a drainage easement to allow inspection and maintenance. Conserved open space areas must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.

5.5 MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal and spot revegetation. Ideally, inspections will be conducted in the non-growing season when it is easier to see the flow path.

Inspectors will check to ensure that:

- Flows through the filter strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the filter strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the filter strip; and
- Vegetative density exceeds a 90 percent cover in the boundary zone or grass filter.

Corrective measures must be carried out as soon as practicably feasible when needed.

5.6 ONGOING MAINTENANCE

Once established, vegetated filter strips have minimal maintenance needs outside of the spring clean-up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated filter strips that consist of grass/turf cover will be mowed at least twice a year to prevent woody growth.

6.0 POLLUTION PREVENTION PRACTICES AND PROCEDURES

The same pollution prevention practices and procedures provided in Section 6.0 of the main body of the SWPPP will be used at the M&R Station, as applicable.

7.0 ROLES AND RESPONSIBILITIES

DETI will use the same qualified personnel and Responsible Land Disturber at the M&R Station as identified in Section 7.0 in the main body of the SWPPP.

8.0 INSPECTION AND MAINTENANCE

The same inspection and maintenance requirements provided in Section 8.0 in the main body of the SWPPP are applicable to the M&R Station, with the exception of representative inspections which only apply to the pipeline right-of-way.

9.0 EMPLOYEE TRAINING

The employee training program described in Section 9.0 in the main body of the SWPPP applies to the M&R Station.

10.0 NOTIFICATION, RECORDKEEPING, AND REPORTING

Refer to Section 10.0 of the main body of the SWPPP for notification, recordkeeping, and reporting requirements.

In addition, according to DETI's Standards and Specifications for projects requiring post-construction SWM BMPs, DETI must report the following annually each year to VDEQ:

- Number and types of SWM BMPs installed;
- Geographic coordinates of each BMP;
- Drainage area or watershed size served; and
- Receiving stream or hydrologic unit.

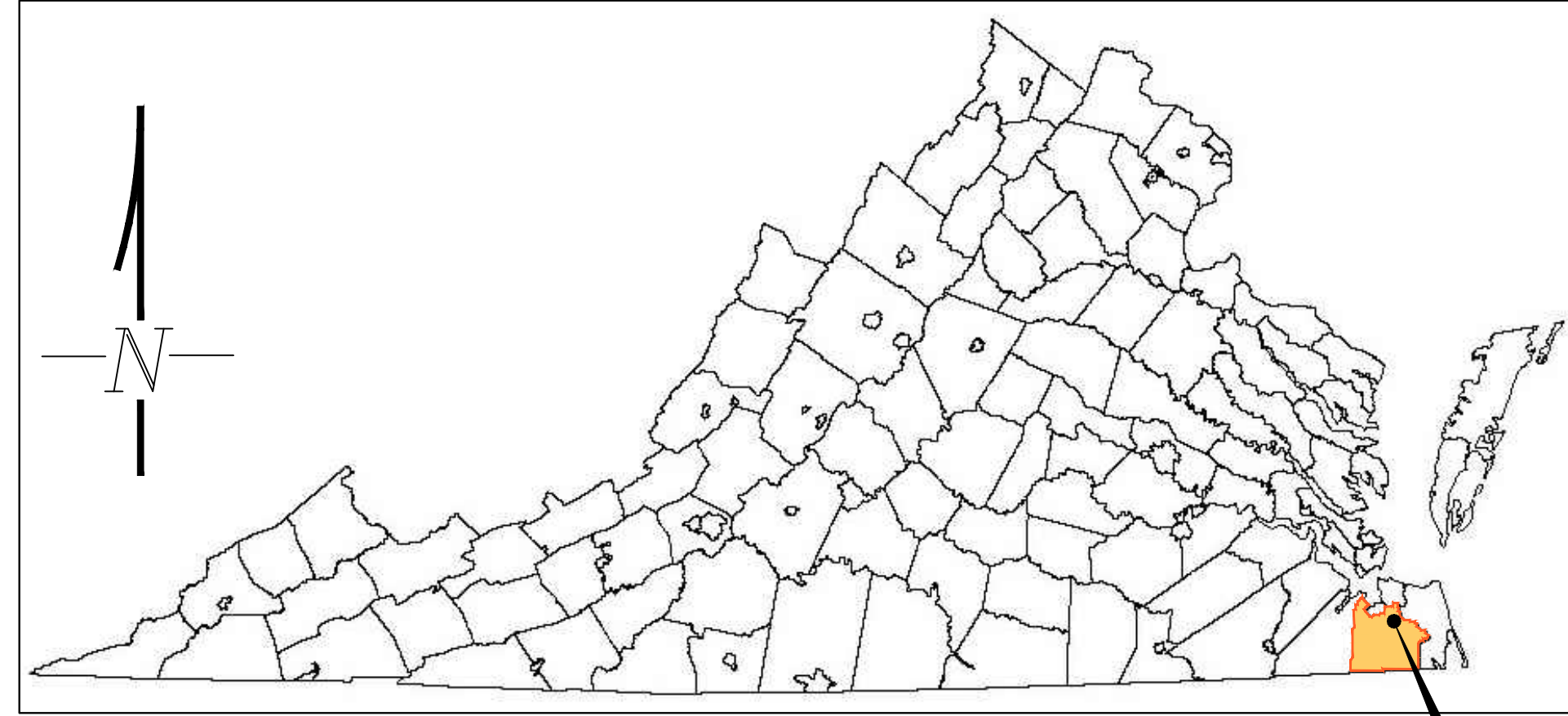
11.0 REFERENCES

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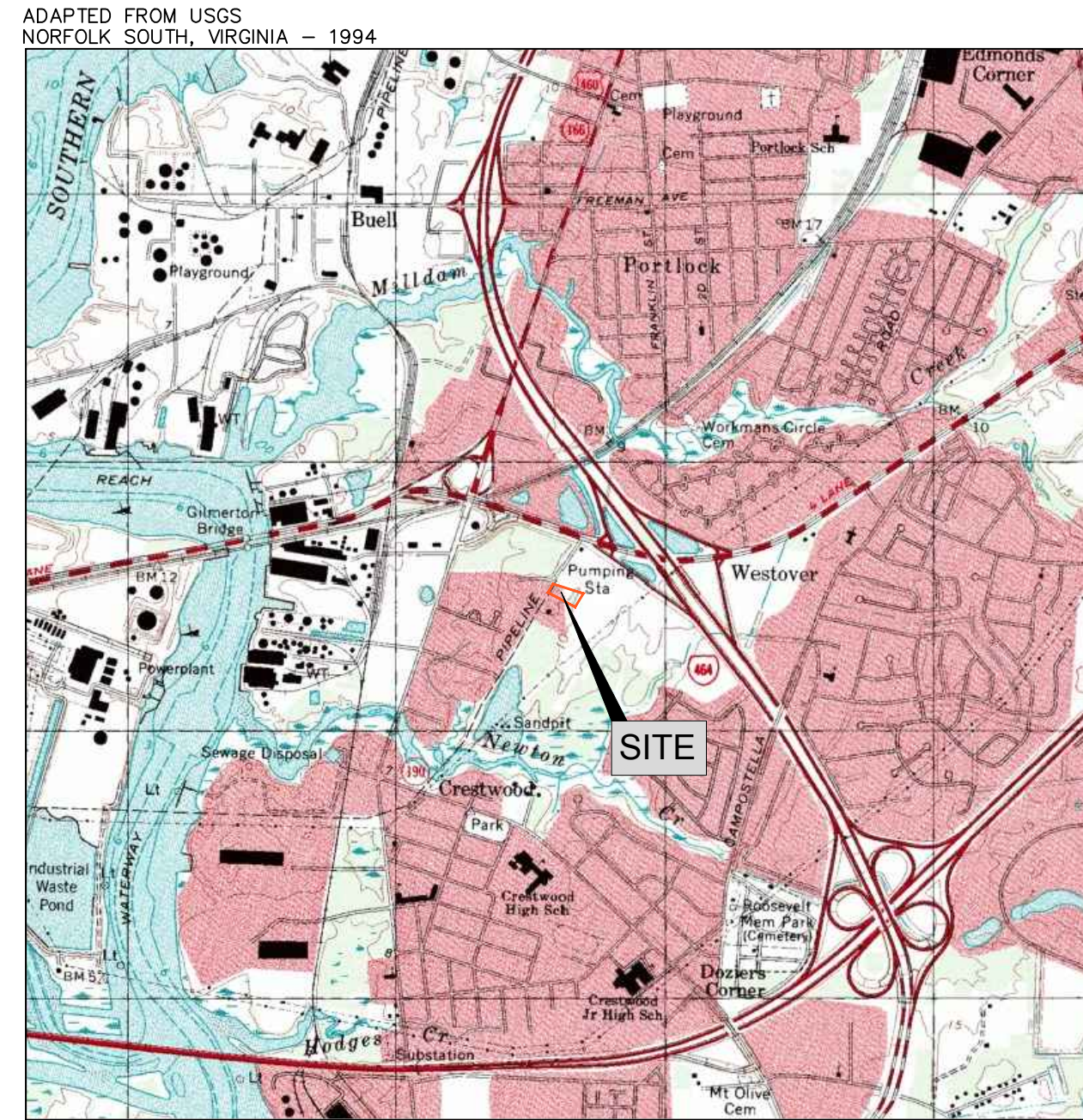
ATTACHMENT 1

Erosion and Sediment Control and Stormwater Management Drawings and
Supporting Calculations

ELIZABETH RIVER M&R STATION EROSION AND SEDIMENT CONTROL PLAN AND POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN



**CHESAPEAKE COUNTY
VIRGINIA**



36° 46' 25.87"N
76° 16' 54.34"W (NAD83)
CHESAPEAKE COUNTY, VIRGINIA
SITE LOCATION MAP

0 2000 4000
APPROXIMATE SCALE (IN FEET)



SITE VICINITY MAP

0 300 600
APPROXIMATE SCALE (IN FEET)

GENERAL NOTES

1. UNLESS OTHERWISE INDICATED, ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND VIRGINIA REGULATIONS 4VAC50-30 EROSION AND SEDIMENT CONTROL REGULATIONS.
2. THE PLAN APPROVING AUTHORITY MUST BE NOTIFIED ONE WEEK PRIOR TO THE PRE-CONSTRUCTION CONFERENCE, ONE WEEK PRIOR TO THE COMMENCEMENT OF LAND DISTURBING ACTIVITY, AND ONE WEEK PRIOR TO THE FINAL INSPECTION.
3. ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE PLACED PRIOR TO OR AS THE FIRST STEP IN CLEARING.
4. A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.
5. PRIOR TO COMMENCING LAND DISTURBING ACTIVITIES IN AREAS OTHER THAN INDICATED ON THESE PLANS (INCLUDING, BUT NOT LIMITED TO, OFF-SITE BORROW OR WASTE AREAS), THE CONTRACTOR SHALL SUBMIT A SUPPLEMENTARY EROSION CONTROL PLAN TO THE OWNER FOR REVIEW AND APPROVAL BY THE PLAN APPROVING AUTHORITY.
6. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION AS DETERMINED BY THE PLAN APPROVING AUTHORITY.
7. ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED SEDIMENT CONTROL MEASURES AT ALL TIMES DURING LAND DISTURBING ACTIVITIES AND DURING SITE DEVELOPMENT UNTIL FINAL STABILIZATION IS ACHIEVED.
8. DURING DEWATERING OPERATIONS, WATER WILL BE PUMPED INTO AN APPROVED FILTERING DEVICE.
9. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY.

LIST OF DRAWINGS

DRAWING NO.	TITLE
PD Z9951B	EROSION AND SEDIMENT CONTROL COVER SHEET
PD Z9951C	EROSION AND SEDIMENT CONTROL SITE PLAN
PD Z9951D	EROSION AND SEDIMENT CONTROL DETAILS
PD Z9951E	POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN
PD Z9951F	POST-CONSTRUCTION STORMWATER MANAGEMENT DETAILS

PROJECT NARRATIVE

PROJECT AND SITE DESCRIPTION

AS PART OF THE ATLANTIC COAST PIPELINE (ACP) PROJECT, DOMINION TRANSMISSION INC. (DTI) IS PROPOSING TO CONSTRUCT AN APPROXIMATELY 1.0-ACRE ABOVEGROUND METERING AND REGULATING STATION AT 2516 SOUTH MILITARY HIGHWAY IN CHESAPEAKE, VIRGINIA. THIS STATION, REFERRED TO AS THE ELIZABETH RIVER M&R STATION (M&R STATION), WILL BE CO-LOCATED WITH AN EXISTING NATURAL GAS STORAGE AND PEAK SHAVING FACILITY. THE M&R STATION WILL BE LOCATED AT MILEPOST 82.7 OF THE AP-3 LATERAL SECTION OF THE ACP PIPELINE, WITHIN THE CITY OF CHESAPEAKE. THE APPROXIMATELY 1.0-ACRE RECTANGULAR TRACT OF LAND IS LOCATED ALONG THE NORTHERN PROPERTY BOUNDARY OF A LARGER PARCEL. THE LARGER PARCEL IS IDENTIFIED IN THE CITY OF CHESAPEAKE RECORDS AS PARCEL NUMBER 026000000340 WITH A PROPERTY ADDRESS OF 2516 SOUTH MILITARY HIGHWAY. THE GENERAL VICINITY AROUND THE M&R STATION IS A MIX OF COMMERCIAL/INDUSTRIAL DEVELOPMENT TO THE NORTH AND WEST AND A MIX OF UNDEVELOPED/RESIDENTIAL PROPERTY TO THE EAST AND SOUTH.

EXISTING SITE CONDITIONS

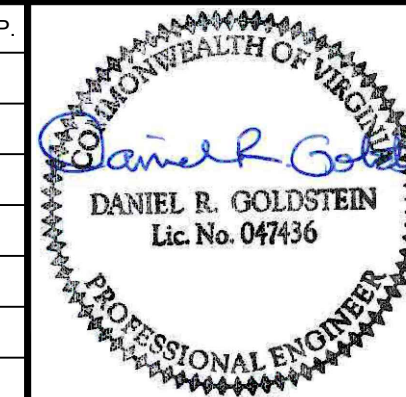
THE M&R STATION IS MAINLY UNDEVELOPED WITH THE WESTERNMOST PORTION (APPROXIMATELY ONE-THIRD OF THE STATION) CONSISTING OF A GRASSY AREA AND THE REMAINING TWO-THIRDS CONSISTING OF WOODED LAND. AN EXISTING NATURAL GAS PIPELINE RIGHT-OF-WAY (ROW) CROSSES THE PROPOSED M&R STATION ALONG THE WESTERN BOUNDARY. A DRAINAGE DITCH IS LOCATED ADJACENT TO THE WESTERN BOUNDARY OF THE M&R STATION ALONGSIDE AN ACCESS ROAD LEADING TO THE M&R STATION FROM SOUTH MILITARY HIGHWAY. TWO DRAINAGE DITCHES ARE LOCATED IN THE FORESTED PORTION OF THE PROPERTY RUNNING IN A ROUGHLY NORTH-SOUTH DIRECTION AND ANOTHER ALONG A PORTION OF THE M&R STATION'S NORTHERN BOUNDARY. A WETLAND IS LOCATED AT THE SOUTHEASTERN CORNER OF THE M&R STATION PROPERTY.

THE TOPOGRAPHY AT THE M&R STATION IS CHARACTERIZED BY FLAT TO GENTLY SLOPING TERRAIN WITH AN ELEVATION OF APPROXIMATELY 10 FEET ABOVE MEAN SEA LEVEL. THE PROPOSED DEVELOPMENT WILL RETAIN THE EXISTING TOPOGRAPHY OF FLAT TO GENTLY SLOPING TERRAIN WITH GRADING TO DIRECT STORMWATER TOWARD VEGETATED FILTER STRIPS PLANNED ALONG THE EASTERN AND WESTERN SIDES OF THE PROPERTY.

THE FULL PROJECT NARRATIVE HAS BEEN PROVIDED IN THE STORMWATER POLLUTION PREVENTION PLAN, APPENDIX F, EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT PLAN FOR THE ELIZABETH RIVER M&R STATION.

NOTE:
SITE VICINITY MAP PROVIDED BY ERM USING GOOGLE EARTH PRO VERSION 7.1.5.1557. IMAGE DATED 4/23/2014.
MAP ENTITLED CIVIL EROSION AND SEDIMENT CONTROL FINAL CONDITIONS DRAINAGE AREA MAP WAS PROVIDED FOR THE VIRGINIA ELECTRIC AND POWER COMPANY BRUNSWICK COUNTY POWER STATION OVERALL STORMWATER MANAGEMENT AND EROSION AND SEDIMENT CONTROL PLANS.

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
△	01/13/17	TS	ISSUED FOR REVIEW	0345197.011	SL



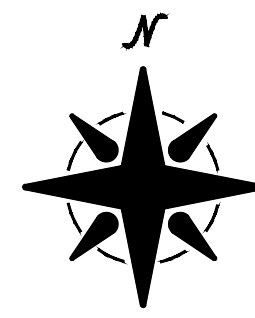
Environmental Resources Management	
DRWN: YMT	01/11/17
CHECKED: KC	01/13/17
APP. FOR BID:	
APP. FOR CONST.:	
SCALE:	AS NOTED

Atlantic Coast Pipeline, LLC
925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

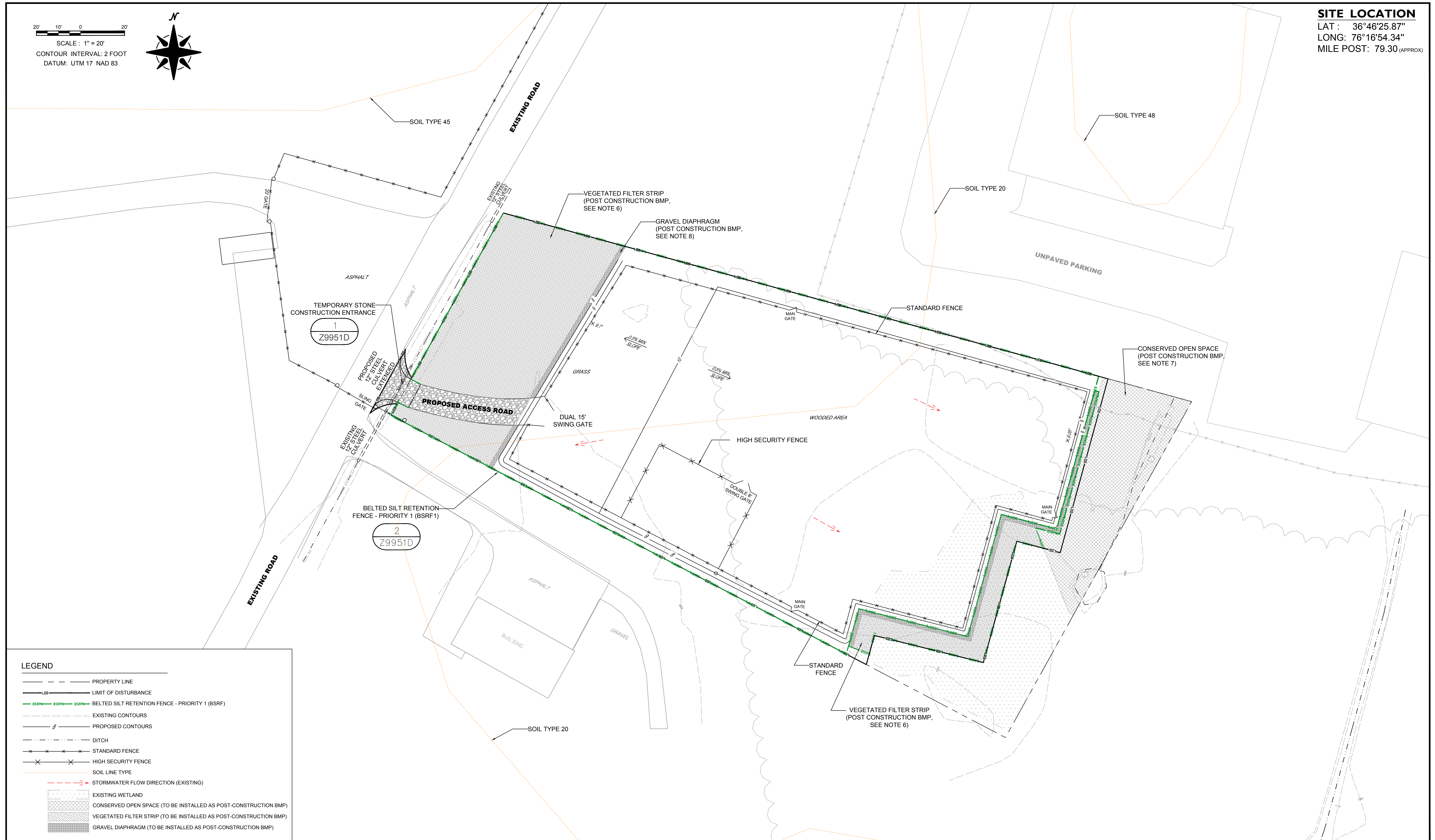
**ELIZABETH RIVER M&R STATION
EROSION AND SEDIMENT CONTROL COVER SHEET**

DISTRICT: CHESAPEAKE	COUNTY: CHESAPEAKE	STATE: VA	GROUP: PD	DWG. NO.: Z9951B	REV.: 0
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20' 10' 0' 20'
 SCALE: 1" = 20'
 CONTOUR INTERVAL: 2 FOOT
 DATUM: UTM 17 NAD 83



SITE LOCATION
 LAT : 36°46'25.87"
 LONG: 76°16'54.34"
 MILE POST: 79.30 (APPROX)



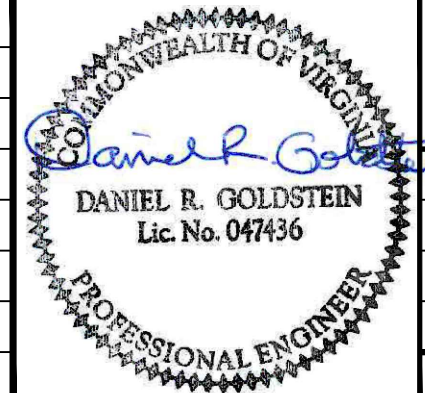
LEGEND

- — — — — PROPERTY LINE
- — — — — LIMIT OF DISTURBANCE
- — — — — BELTED SILT RETENTION FENCE - PRIORITY 1 (BSRF1)
- — — — — EXISTING CONTOURS
- — — — — PROPOSED CONTOURS
- — — — — DITCH
- x — x — x — STANDARD FENCE
- x — x — x — HIGH SECURITY FENCE
- — — — — SOIL LINE TYPE
- — — — — STORMWATER FLOW DIRECTION (EXISTING)
- — — — — EXISTING WETLAND
- — — — — CONSERVED OPEN SPACE (TO BE INSTALLED AS POST-CONSTRUCTION BMP)
- — — — — VEGETATED FILTER STRIP (TO BE INSTALLED AS POST-CONSTRUCTION BMP)
- — — — — GRAVEL DIAPHRAGM (TO BE INSTALLED AS POST-CONSTRUCTION BMP)

GENERAL NOTES AND COMMENTS:

1. BASE MAP PROVIDED BY ID ENGINEERING AND CONSULTING, LLC.
2. LIMITS OF CLEARING AND GRADING IS APPROXIMATELY 0.8 ACRES WITHIN THE LIMIT OF DISTURBANCE SHOWN (FULL SITE IS 1 ACRE).
3. A DRAINAGE DITCH IS CURRENTLY LOCATED ADJACENT TO THE WESTERN BOUNDARY OF THE MAR STATION ALONGSIDE AN ACCESS ROAD LEADING TO THE MAR STATION FROM SOUTH MILITARY HIGHWAY. TWO DRAINAGE DITCHES ARE LOCATED IN THE FORESTED PORTION OF THE PROPERTY RUNNING IN A ROUGHLY NORTH-SOUTH DIRECTION AND ANOTHER ALONG A PORTION OF THE MAR STATION'S NORTHERN BOUNDARY.
4. THE MAR STATION IS LOCATED WITHIN THE DEEP CREEK-SOUTHERN BRANCH ELIZABETH RIVER WATERSHED. THE SITE DRAINS SOUTH TOWARD A FORMER SANDPIT WHICH IS NOW FILLED WITH WATER AND DISCHARGES INTO NEWTON CREEK. NEWTON CREEK FLOWS WEST INTO THE SOUTHERN BRANCH OF THE ELIZABETH RIVER.
5. FINAL CONTOURS WILL BE GRADED AS SHOWN ON THIS SITE PLAN. A PORTION OF THE SITE WILL DRAIN TOWARDS THE DRAINAGE DITCH LOCATED ON THE WESTERN SIDE OF THE PROPERTY AND THE OTHER PORTION WILL DRAIN TOWARDS THE DRAINAGE DITCH AND WETLAND ON THE EASTERN SIDE OF THE PROPERTY.
6. THE PORTION OF THE WETLAND WHICH EXTENDS BEYOND THE AREA OF LAND DISTURBANCE AND ONTO THE ADJACENT PROPERTY WILL BE PROTECTED FROM POST-CONSTRUCTION STORMWATER RUNOFF WITH A VEGETATED FILTER STRIP. A VEGETATED FILTER STRIP WILL ALSO BE LOCATED ON THE WESTERN END OF THE SITE. DETAILS AND SPECIFICATIONS FOR THE VEGETATED FILTER STRIPS ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
7. A PORTION OF THE EASTERN SIDE OF THE SITE WILL BE PRESERVED AS CONSERVED OPEN SPACE AS A PART OF THE POST-CONSTRUCTION STORMWATER MANAGEMENT REQUIREMENTS. DETAILS AND SPECIFICATIONS FOR THE CONSERVED OPEN SPACE ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
8. POST-CONSTRUCTION RUNOFF WILL SHEET FLOW TO A GRAVEL DIAPHRAGM FOR PRE-TREATMENT BEFORE ENTERING THE VEGETATED FILTERS AND CONSERVED OPEN SPACE. THE GRAVEL DIAPHRAGM WILL PROVIDE EVEN DISTRIBUTION OF THE RUNOFF FLOW SO THAT SHEET FLOW IS MAINTAINED AS THE RUNOFF ENTERS THE VEGETATED FILTERS AND CONSERVED OPEN SPACE. DETAILS AND SPECIFICATIONS FOR THE GRAVEL DIAPHRAGM ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
9. SOIL TYPES THAT ARE PRESENT AT THE MAR STATION INCLUDE DRACOSTON/TOMTLETLEY COMPLEX AND TOMTLETLEY/URBAN LANE/NIMMO COMPLEX.

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
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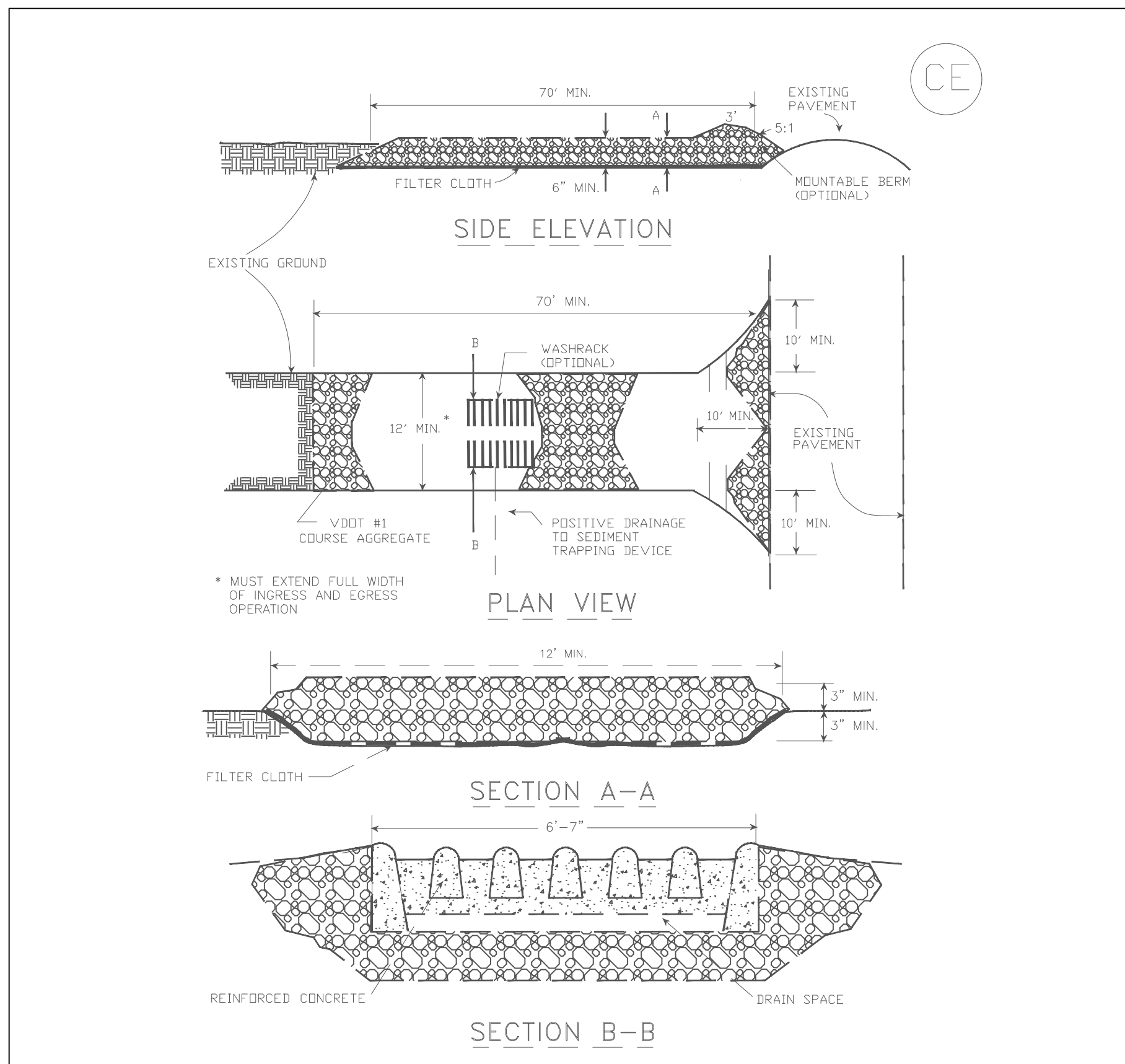


Environmental Resources Management	
DRAWN:	YMT 01/16/17
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APP. FOR BID:	
APP. FOR CONST.:	
SCALE:	AS NOTED

Atlantic Coast Pipeline, LLC
 925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

**ELIZABETH RIVER M&R STATION
 EROSION AND SEDIMENT CONTROL SITE PLAN**

DISTRICT: CHESAPEAKE	COUNTY: CHESAPEAKE	STATE: VA	GROUP: PD	DWG. NO.: Z9951C	REV.: 0
DIR/FILE: ACP/Virginia/M&R Stations/Elizabeth River/ESC					



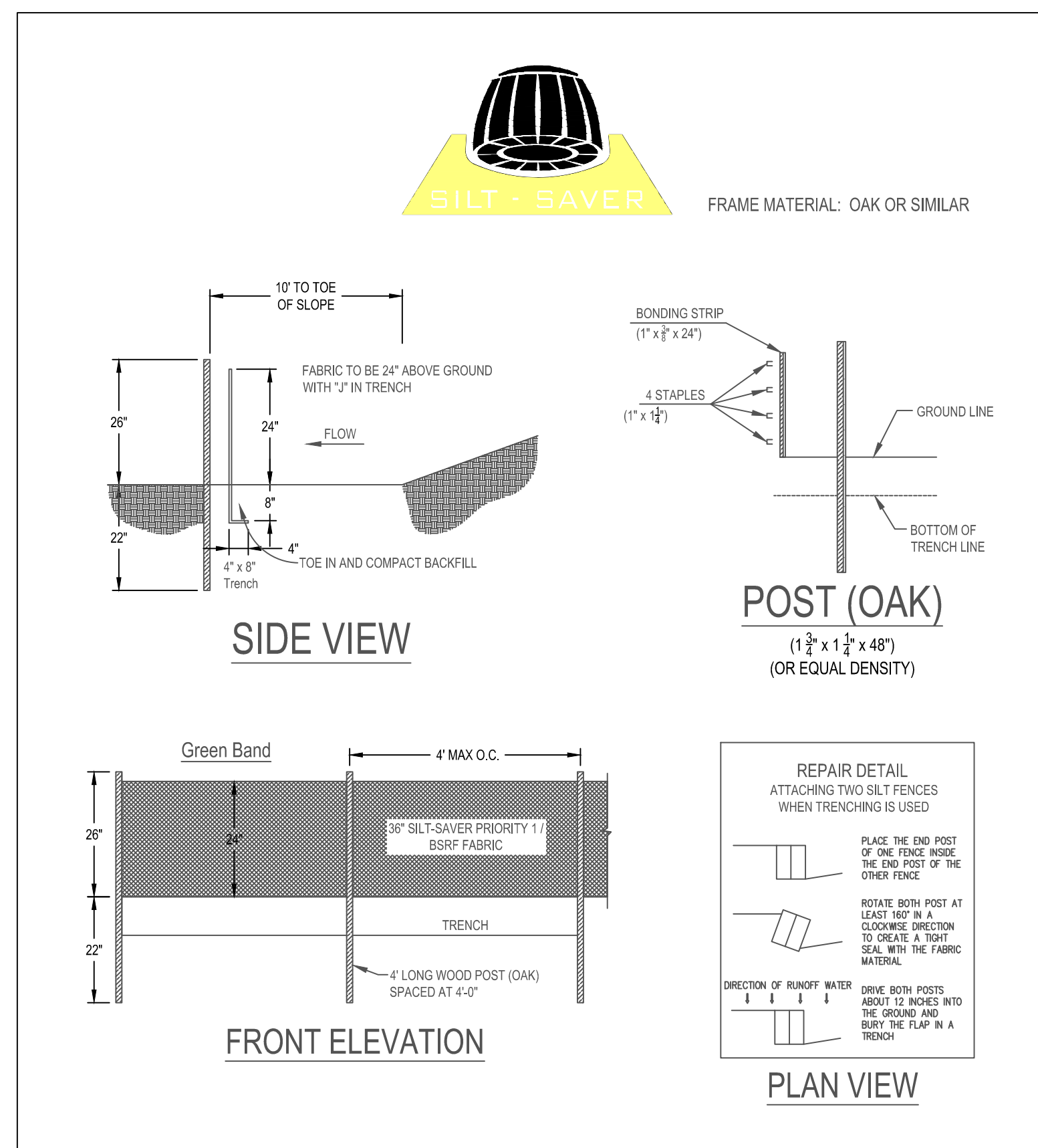
1 TEMPORARY STONE CONSTRUCTION ENTRANCE
Z9951C NOT TO SCALE

TEMPORARY STONE CONSTRUCTION ENTRANCE NOTES

- VDOT #1 COARSE AGGREGATE (2- TO 3-INCH STONE) SHOULD BE USED.
- AGGREGATE LAYER SHALL BE AT LEAST 6 INCHES THICK; A MINIMUM THREE INCHES OF AGGREGATE SHALL BE PLACED IN A CUT SECTION TO GIVE THE ENTRANCE ADDED STABILITY AND TO HELP SECURE FILTER CLOTH SEPARATOR. AGGREGATE LAYER MUST EXTEND THE FULL WIDTH OF THE VEHICULAR INGRESS AND EGRESS AREA AND HAVE A MINIMUM 12-FOOT WIDTH.
- LENGTH OF THE ENTRANCE SHALL BE AT LEAST 70 FEET.
- ENTRANCE SHALL BE EXCAVATED A MINIMUM OF 3 INCHES AND MUST BE CLEARED OF ALL VEGETATION, ROOTS, AND OTHER OBJECTIONABLE MATERIAL BEFORE FILTER FABRIC UNDERLINER IS PLACED.
- FILTER FABRIC UTILIZED SHALL BE A WOVEN OR NONWOVEN FABRIC CONSISTING ONLY OF CONTINUOUS CHAIN POLYMERIC FILAMENTS OR YARNS OF POLYESTER. FABRIC SHALL BE INERT TO COMMONLY ENCOUNTERED CHEMICALS AND HYDROCARBONS, BE MILDEW AND ROT RESISTANT, AND CONFORM TO THE PHYSICAL PROPERTIES NOTED IN TABLE 3.02-A OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK (VESCH) (1992, 3RD EDITION) STANDARDS AND SPECIFICATIONS.

TEMPORARY STONE CONSTRUCTION ENTRANCE MAINTENANCE NOTES

- ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOW OF MUD ONTO PUBLIC RIGHTS-OF-WAY.
- IF ANY INADVERTENT SEDIMENT TRACKING OCCURS ON THE PUBLIC ROADWAY, THE ROAD SHALL BE CLEANED THOROUGHLY BY THE END OF EACH DAY.
- ENTRANCE MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR THE WASHING AND REWORKING OF EXISTING STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY STRUCTURES USED TO TRAP SEDIMENT.
- ALL MATERIALS SPILLED, DROPPED, WASHED, OR TRACKED FROM VEHICLES ONTO ROADWAYS OR INTO STORM DRAINS MUST BE REMOVED IMMEDIATELY.
- THE USE OF WATER TRUCKS TO REMOVE MATERIALS DROPPED, WASHED, OR TRACKED ONTO ROADWAYS WILL NOT BE PERMITTED UNDER ANY CIRCUMSTANCES.



2 BELTED SILTS RETENTION FENCE PRIORITY 1 (BSRF1)
Z9951C NOT TO SCALE

BELTED SILTS RETENTION FENCE – PRIORITY 1 NOTES

- CONTRACTOR WILL UTILIZE THE BSRF1 MEDIUM-DUTY SILT FENCE CONSTRUCTED WITH A 36-INCH, NON-WOVEN, SPUN-BOND FABRIC WITH AN INTERNAL SCRIM INCORPORATED INTO THE FABRIC FOR ADDITIONAL STRENGTH AND DURABILITY.
- BSRF1 SHALL BE INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS AND INSTALLATION INSTRUCTIONS PROVIDED IN THE STORMWATER POLLUTION PREVENTION PLAN, APPENDIX F, EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT PLAN FOR ELIZABETH RIVER M&R STATION, APPENDIX A.

BELTED SILTS RETENTION FENCE – PRIORITY 1 MAINTENANCE NOTES

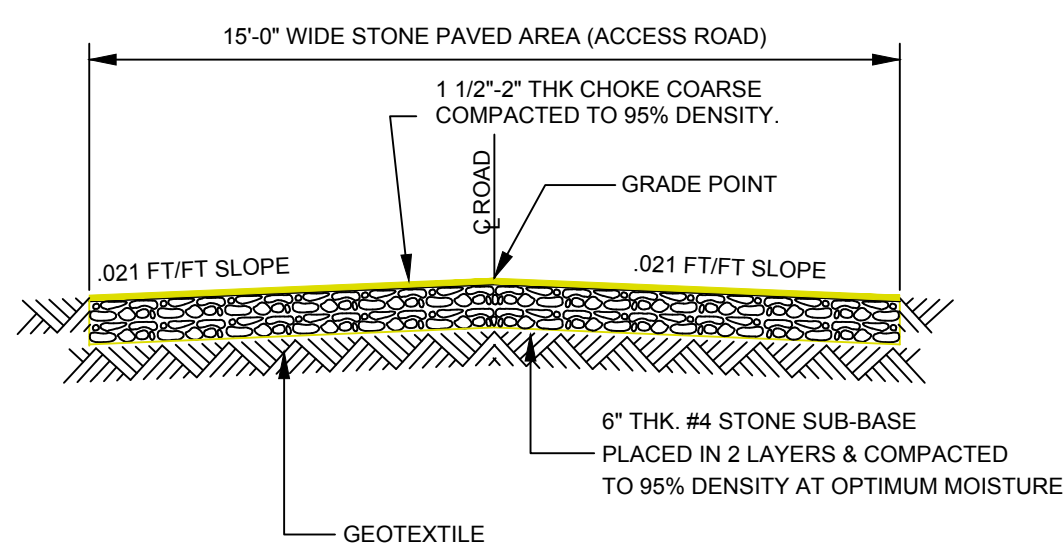
- BSRF1 SHALL BE INSPECTED AT THE END OF EACH WORK DAY AND IMMEDIATELY AFTER EACH RAINFALL EVENT. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY IN ACCORDANCE WITH THE DESIGN DETAILS AND SPECIFICATIONS.
- ACCUMULATED SEDIMENT SHOULD BE REMOVED AFTER EACH STORM EVENT AND WHEN DEPOSITS REACH APPROXIMATELY ONE-HALF THE HEIGHT OF THE FENCE TO PREVENT FAILURES.
- ANY DEPOSITS REMAINING IN PLACE AFTER THE FENCE IS NO LONGER REQUIRED SHALL BE DRESSED TO CONFORM WITH THE EXISTING GRADE, PREPARED AND SEEDDED.

SEQUENCE OF CONSTRUCTION:

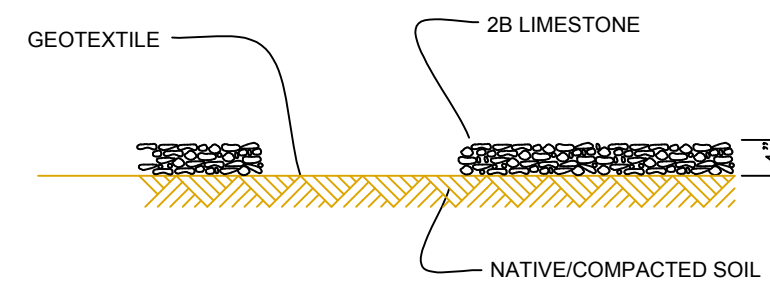
- A PRE-CONSTRUCTION MEETING SHALL TAKE PLACE PRIOR TO START OF CONSTRUCTION ACTIVITIES.
- INSTALL BELTED SILT RETENTION FENCE AS SHOWN ON PLANS. ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE PLACED PRIOR TO OR AS THE FIRST STEP IN CLEARING.
- BEGIN CLEARING AND GRUBBING SITE AS NEEDED.
- GRADE SITE ACCORDING TO THE CONTRACT DOCUMENTS. MAINTAIN EROSION CONTROL DEVICES AS NEEDED.
- GRASS OR OTHERWISE STABILIZE ALL AREAS AS THEY ARE BROUGHT TO FINAL GRADES.
- THE CONTRACTOR SHALL DILIGENTLY AND CONTINUOUSLY MAINTAIN ALL EROSION CONTROL DEVICES AND STRUCTURES TO MINIMIZE EROSION. INSPECT AND REPAIR MEASURES AFTER EACH RAINFALL AND AS NEEDED THROUGHOUT THE PROJECT.
- CONTRACTOR TO LEAVE ALL EROSION CONTROL DEVICES IN PLACE AT THE CONCLUSION OF THIS CONTRACT. CONTRACTOR IS TO CLEAN-OUT, REPAIR AND GRASS STABILIZE ALL DENUDED AREAS. ALL AREAS WILL BE RETURNED TO THE STATE OF EXISTING CONDITIONS PRIOR TO CONTRACT AS A MINIMUM.
- IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTAIN SEDIMENT ONSITE. ADDITIONAL EROSION CONTROL MEASURES MAY BE REQUIRED BY THE ENGINEER.
- ALL EROSION CONTROL MEASURES SHALL BE IN ACCORDANCE WITH THE VIRGINIA EROSION AND SEDIMENTATION CONTROL HANDBOOK (VESCH) (1992, 3RD EDITION) STANDARDS AND SPECIFICATIONS.

GENERAL NOTES AND COMMENTS:	SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.			Atlantic Coast Pipeline, LLC 925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000
	01/13/17	TS		ISSUED FOR REVIEW	0345197.011	SL			

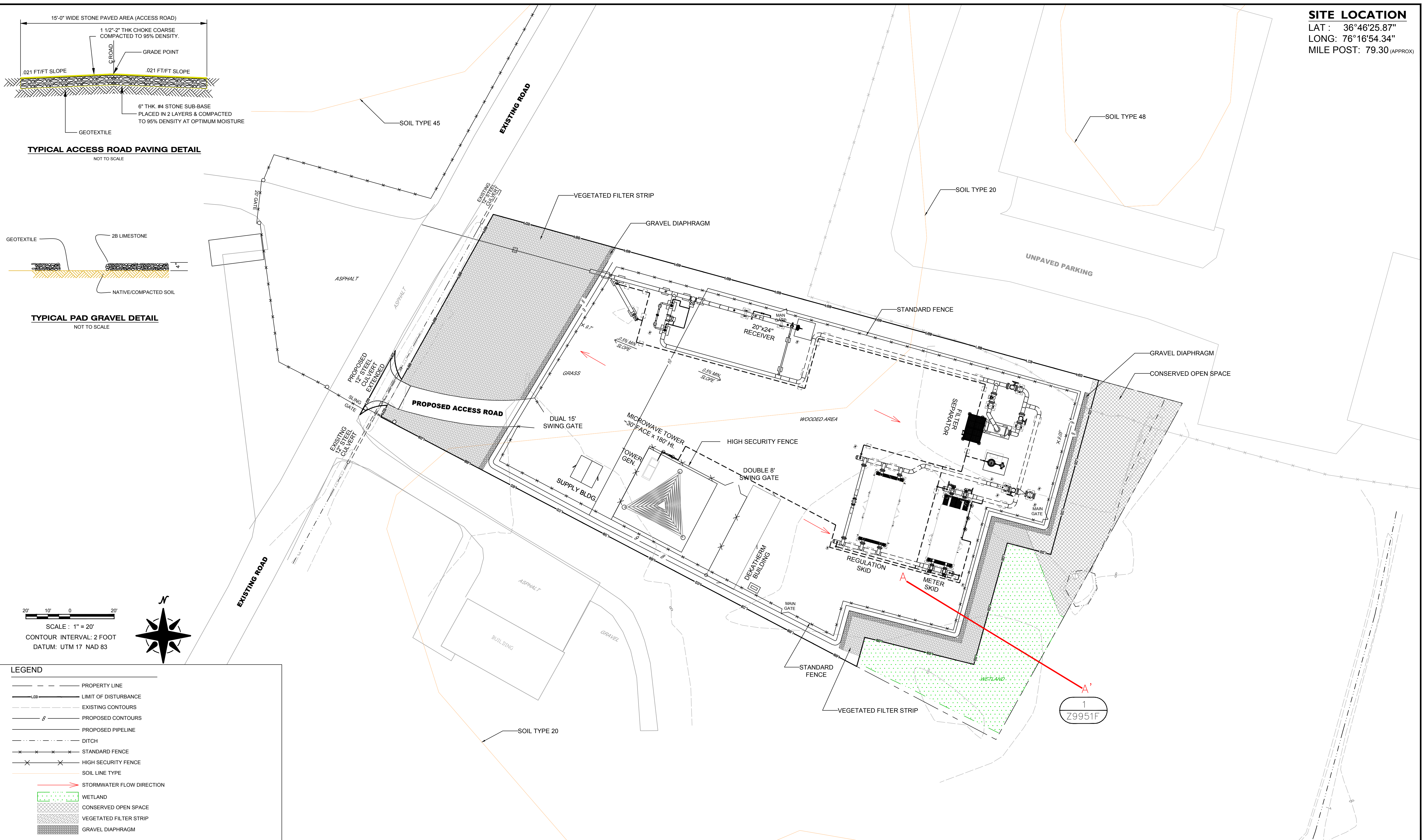
SITE LOCATION
 LAT : 36°46'25.87"
 LONG: 76°16'54.34"
 MILE POST: 79.30 (APPROX)



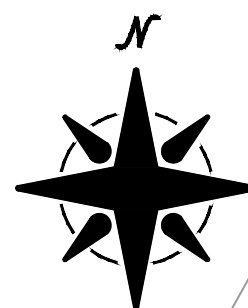
TYPICAL ACCESS ROAD PAVING DETAIL
 NOT TO SCALE



TYPICAL PAD GRAVEL DETAIL
 NOT TO SCALE



SCALE: 1" = 20'
 CONTOUR INTERVAL: 2 FOOT
 DATUM: UTM 17 NAD 83



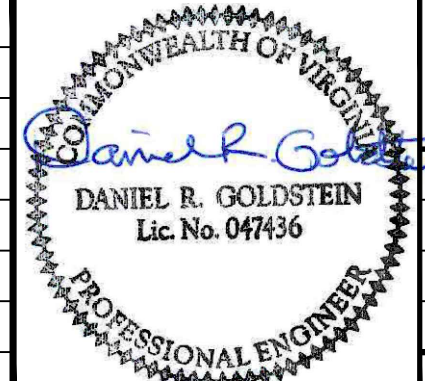
LEGEND

- PROPERTY LINE
- LIMIT OF DISTURBANCE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- PROPOSED PIPELINE
- DITCH
- STANDARD FENCE
- HIGH SECURITY FENCE
- SOIL LINE TYPE
- STORMWATER FLOW DIRECTION
- WETLAND
- CONSERVED OPEN SPACE
- VEGETATED FILTER STRIP
- GRAVEL DIAPHRAGM

GENERAL NOTES AND COMMENTS:

- BASE MAP PROVIDED BY ID ENGINEERING AND CONSULTING, LLC.
- LIMITS OF CLEARING AND GRADING IS APPROXIMATELY 0.8 ACRES WITHIN THE LIMIT OF DISTURBANCE SHOWN (FULL SITE IS 1 ACRE).
- A DRAINAGE DITCH IS CURRENTLY LOCATED ADJACENT TO THE WESTERN BOUNDARY OF THE MAR STATION ALONGSIDE AN ACCESS ROAD LEADING TO THE MAR STATION FROM SOUTH MILITARY HIGHWAY. TWO DRAINAGE DITCHES ARE LOCATED IN THE FORESTED PORTION OF THE PROPERTY RUNNING IN A ROUGHLY NORTH-SOUTH DIRECTION AND ANOTHER ALONG A PORTION OF THE MAR STATION'S NORTHERN BOUNDARY.
- THE MAR STATION IS LOCATED WITHIN THE DEEP CREEK/SOUTHERN BRANCH ELIZABETH RIVER WATERSHED. THE SITE DRAINS SOUTH TOWARD A FORMER SANDPIT WHICH IS NOW FILLED WITH WATER AND DISCHARGES INTO NEWTON CREEK. NEWTON CREEK FLOWS WEST INTO THE SOUTHERN BRANCH OF THE ELIZABETH RIVER.
- FINAL CONTOURS WILL BE GRADED AS SHOWN ON THIS SITE PLAN. A PORTION OF THE SITE WILL DRAIN TOWARDS THE DRAINAGE DITCH LOCATED ON THE WESTERN SIDE OF THE PROPERTY AND THE OTHER PORTION WILL DRAIN TOWARDS THE DRAINAGE DITCH AND WETLAND ON THE EASTERN SIDE OF THE PROPERTY.
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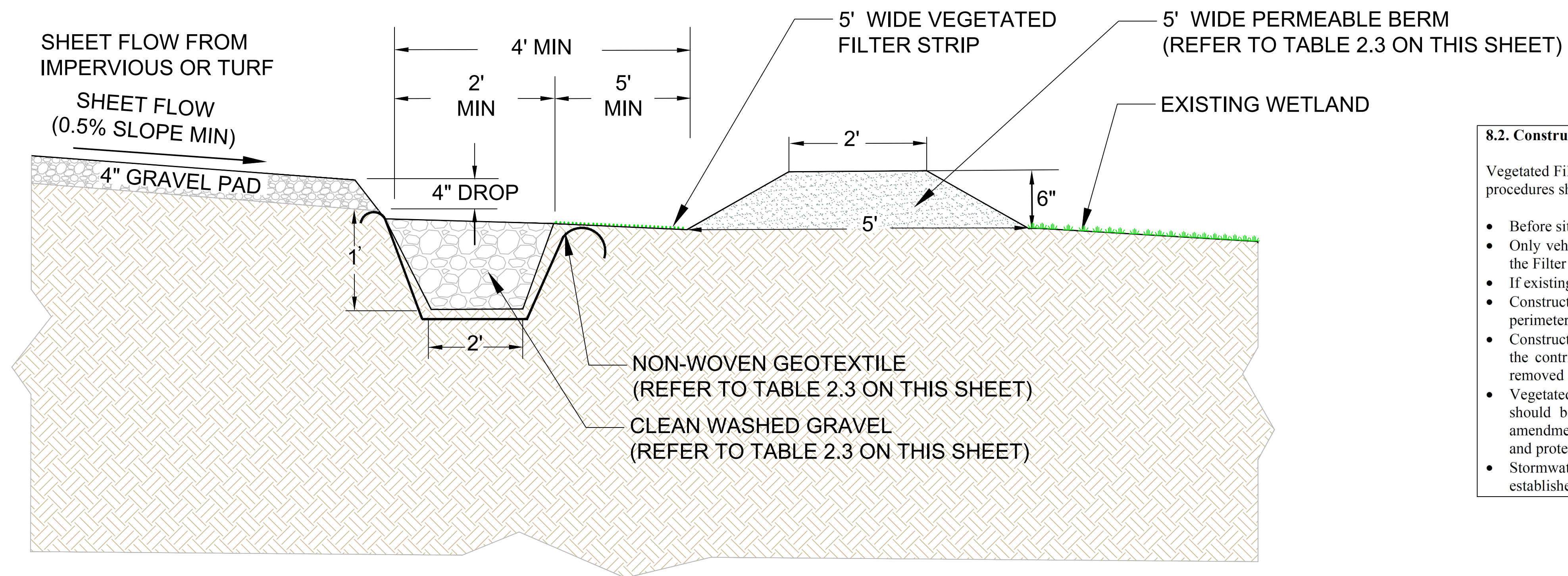


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SCALE:	AS NOTED	

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 925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

ELIZABETH RIVER M&R STATION POST CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN

DISTRICT: CHESAPEAKE	COUNTY: CHESAPEAKE	STATE: VA	GROUP: PD	DWG. NO.: Z9951E	REV.: 0
DIR/FILE: ACP/Virginia/M&R Stations/Elizabeth River/ESC					



A-A' SECTION THROUGH GRAVEL DIAPHRAGM AND VEGETATED FILTER STRIP
NOT TO SCALE

8.2. Construction Sequence for Vegetated Filter Strips

Vegetated Filter Strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, Vegetated Filter Strip boundaries should be clearly marked.
- Only vehicular traffic used for Filter Strip construction should be allowed within 10 feet of the Filter Strip boundary (City of Portland, 2004).
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed Filter Strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Vegetated Filter Strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the Filter Strip until the turf cover is dense and well established.

Table 2.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases ²	1% ¹ to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width 6% to 8% Slope – Minimum 65 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS ⁶ Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover ³ Length = 40 lin. ft. per 1 cfs for forested or re-forested Areas ⁴ (ELS ⁵ length = 13 lin.ft. min.; 130 lin.ft. max.)	Length of ELS ⁶ Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min.; 130 lin.ft. max.)
Construction Stage (Section 8)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications (Section 5)	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of IC (e.g., 5,000 sf) and/or turf-intensive land uses (sports fields, golf courses) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils) ⁵
Boundary Spreader (Section 6.3)	GD ⁶ at top of filter	GD ⁶ at top of filter PB ⁶ at toe of filter

¹ A minimum of 1% is recommended to ensure positive drainage.
² For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less.
³ Vegetative Cover is described in Section 6.2.
⁴ Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS⁶ Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to Section 6.3 for design criteria.
⁵ The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see Section 6.1).
⁶ ELS = Engineered Level Spreader, GD = Gravel Diaphragm, PB = Permeable Berm.

6.1. Compost Soil Amendments

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in Stormwater Design Specification No. 4.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.
- If slopes exceed 3%, a protective biodegradable fabric or matting (e.g., EC-2) should be installed to stabilize the site prior to runoff discharge.
- Compost amendments should not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see Section 6.3).
- The local plan approval authority may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.3. Diaphragms, Berms and Level Spreaders

Gravel Diaphragms: A pea gravel diaphragm at the top of the slope is required for both Conserved Open Space and Vegetated Filter Strips that receive sheetflow. The pea gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the Filter Strip. Refer to Figure 2.5.

- The flow should travel over the impervious area and to the practice as sheet flow and then drop at least 3 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the Filter Strip).
- A layer of filter fabric should be placed between the gravel and the underlying soil trench.
- If the contributing drainage area is steep (6% slope or greater), then larger stone (clean bank-run gravel that meets VDOT #57 grade) should be used in the diaphragm.
- If the contributing drainage area is solely turf (e.g., sports field), then the gravel diaphragm may be eliminated.

Permeable Berm: Vegetated Filter Strips should be designed with a permeable berm at the toe of the Filter Strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm (Cappiella *et al.*, 2006). The permeable berm should have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, should be excavated at the upstream toe of the berm, parallel with the contours.
- Media for the berm should consist of 40% excavated soil, 40% sand, and 20% pea gravel.
- The berm 6 to 12 inches high should be located downgradient of the excavated depression and should have gentle side slopes to promote easy mowing (Cappiella *et al.*, 2006).
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

6.4. Filter Design Material Specifications

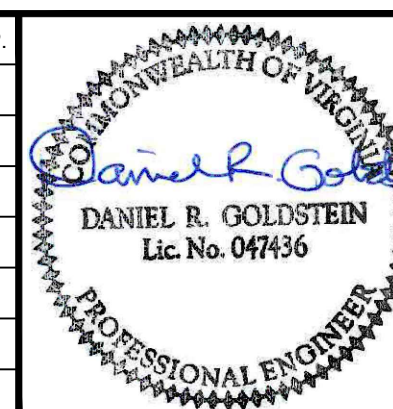
Table 2.3 describes materials specifications for the primary treatment within filter strips.

Table 2.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Pea Gravel (#8 or ASTM equivalent) or where steep (6%+) use clean bank-run VDOT #57 or ASTM equivalent (1-inch maximum).	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% pea gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, timber, or other rigid material; Reinforced channel on upstream of lip: VDOT EC-2 (or EC-3 if velocities require permanent reinforcing). See Hathaway and Hunt (2006) or Henrico County Program Manual.	
Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons. (e.g., VDOT Erosion Control matting EC-2).	
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches	
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in Stormwater Design Specification No. 4.	

GENERAL NOTES AND COMMENTS:
 1. GUIDANCE FOR THE CONSTRUCTION AND MAINTENANCE OF THE GRAVEL DIAPHRAGM, VEGETATED FILTER STRIP AND PERMEABLE BERM IS LOCATED IN THE VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY (VDEQ) STORMWATER DESIGN SPECIFICATIONS NO. 2 (SHEET FLOW TO A VEGETATED FILTER STRIP OR CONSERVED OPEN SPACE).

SYM.	DATE	BY	REVISION INFORMATION		PROJECT/TASK	APP.
			NO.	DESCRIPTION		
Δ	01/13/17	TS		ISSUED FOR REVIEW	0345197.011	SL



ERM
 Environmental Resources Management

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 Resources Management

DRAWN: YMT 01/17/17
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 APP. FOR CONST.:
 SCALE: AS NOTED

Atlantic Coast Pipeline, LLC
 925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

TITLE: **ELIZABETH RIVER M&R STATION POST-CONSTRUCTION STORMWATER MANAGEMENT DETAILS**

DISTRICT: CHESAPEAKE COUNTY: CHESAPEAKE STATE: VA GROUP: PD DWG. NO.: Z9951F REV.: 0



Calc. by TTS
✓'d by KC

Date 2/15/17
Date 2/17/17

Project ELIZABETH RIVER M&R STATION
Subject POST-CONST. SW QUANTITY CALCS

Page 1 of 16
Proj. 0345197

PURPOSE:

To demonstrate that the Elizabeth River M&R Station is compliant with the minimum standards set forth in 9VAC25-870-66 of the Virginia Administrative Code for channel and flood protection.

PROCEDURE:

Perform hydrologic analysis for the existing and proposed conditions, including runoff rates, volumes, and velocities using HydroCAD Stormwater Modeling System, Version 10 (Ref. 1) and the WinTR-55 Small Watershed Hydrology (Ref. 2) program.

The following steps will be taken:

1. Determine how many drainage areas are on site and the soil types.
2. Determine what subsection of 9VAC25-870-66-B (Channel Protection) is applicable to the site. Using WinTR-55, determine the existing and post condition peak discharge and runoff volume for the 1-year, 2-year, and 10-year frequency storm events to demonstrate compliance with that subsection.
3. Use HydroCAD to show that the velocity from the 1-year 24-hour storm is non-erosive to the stormwater conveyance channels.
4. Determine what subsection of 9VAC25-870-66-C (Flood Protection) is applicable to the site. Using HydroCAD, determine if the stormwater conveyance system contains the 10-year 24-hour storm within the channel.

1. Determine how many drainage areas are on site and soil types.

Based on the final site grading plan, the site was determined to have two drainage areas (see attached drainage map). The site was contoured so that approximately 0.24 acres drains to the western side of the site and 0.76 acres drain to the east.

Post Conditions, Drainage Area A (DA-A): Western portion of the site

- Gravel cover (including pea gravel): 0.12 acres
- Paved access road: 0.02 acres



Calc. by TTS
✓'d by KC

Date 2/15/17
Date 2/17/17

Project ELIZABETH RIVER M&R STATION
Subject POST-CONST. SW QUANTITY CALCS

Page 2 of 16
Proj. 0345197

- Vegetated Filter strip: 0.1 acres
- Total DA-A: 0.24 acres

Post Conditions, Drainage Area B (DA-B): Eastern portion of the site

- Gravel cover (including pea gravel): 0.6 acres
- Vegetated Filter strip: 0.029 acres
- Conserved Open Space: 0.068 acres
- Wetland: 0.063 acres
- Total DA-B: 0.76 acres

In order to compare exiting conditions to post conditions, it was assumed that the existing site drains in the same manner as the post conditions with 0.24 acres draining to the western ditch and 0.76 acres draining to the channel at the eastern side of the site.

Site soils are described in Appendix F of this SWPPP. According to the USDA's NRCS, soils beneath the wooded portion of the M&R Station are mapped as somewhat poorly drained to poorly drained (Dragston-Tomotley Complex) with depth to water table ranging from 0 to 30 inches. These soils consist of fine sand overlain by a 3 to 3.5 foot layer of fine sandy loam to a sandy clay loam. These soils stretch into the southern portion of the grassy area. The remaining portion of the grassy area is mapped in the Tomotley-Urban Land-Nimmo Complex. These soils are poorly drained with depth to water table ranging from 0 to 12 inches.

The hydrologic soil groups assigned by NRCS for the soils mapped at the M&R Station are as follows: Dragston (Group C); Tomotley: (Group B/D); Nimmo: (Group D). Based on this information, site soils were conservatively assumed to be Group D soils due to the high water table. Group D soils are described as such:

- Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

2. **Using WinTR-55, calculate the peak discharge and runoff volume for the 1-year, 2-year, and 10-year frequency storm events to determine compliance with 9VAC25-870-66-B, Channel Protection.**



Under 9VAC25-870-66-B, concentrated stormwater flow shall be released into a manmade, restored, or natural stormwater conveyance system and must meet the criteria in subdivision 1, 2, or 3. For the western portion of the site, it was determined that the existing channel is a restored stormwater conveyance system and therefore must meet the peak discharge requirements in subdivision 3 for concentrated stormwater flow to a natural system. This is due to the post-development conditions not being consistent with the pre-development conditions. The eastern portion of the site will drain to a natural conveyance system and must meet the requirements of subdivision 3 as well. Under subdivision 3, the maximum peak flow rate from the 1-year 24-hour storm shall be calculated using the following energy balance equation:

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed}) / RV_{Developed}$$

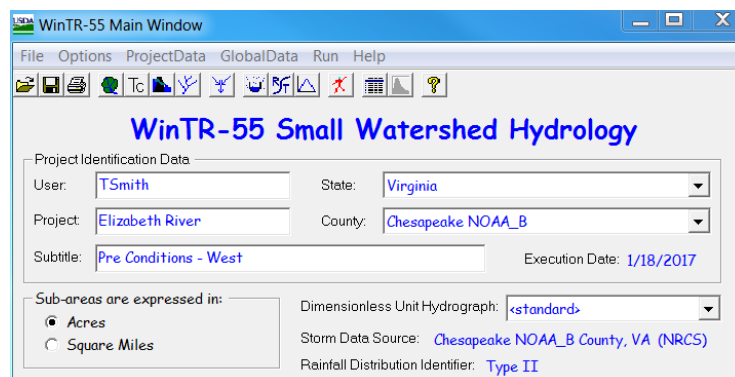
Where,

- Q_{Developed} = The allowable peak flow rate of runoff from the developed site
- I.F. = Improvement factor, equals 0.8 for sites > 1 acre and 0.9 for sites 1 acre
- RV_{Developed} = The volume of runoff from the site in the developed condition
- Q_{Pre-Developed} = The peak flow of runoff from the site in pre-developed condition
- RV_{Pre-Developed} = The volume of runoff from the site in the pre-developed condition

WinTR-55 was utilized to calculate the above parameters. Inputs are shown below for the existing conditions of DA-A.

Existing Conditions, Drainage Area A (DA-A): Western portion of the site

1. The State and county was entered and the storm data was selected from the NRCS Storm Data default database for the associated county. Sub-area name, description, and where the water leaving the sub-area flows was also entered.





Storm Data

Chesapeake NOAA_B County, VA (NRCS)

To replace these storm data with those compiled by the NRCS for Chesapeake NOAA_B County, VA, click on the command button below.

NRCS Storm Data

Please select a rainfall distribution type from the list below. The list includes the standard WinTR-20 / WinTR-55 types and any number of user-defined distributions.

Rainfall Distribution Type: Type II

Rainfall Return Period (yr)	24-Hr Rainfall Amount (in)
2	3.7
5	4.8
10	5.7
25	7
50	8.2
100	9.4
1	3

- Land use details were added into the land use window. WinTR-55 calculates the weighted curve number (CN) and drainage area based on the inputs. It was assumed that the site soils are D soils and that the existing conditions are open space, good condition.

Sub-area Name: DA-1

Land Use Categories: Urban Area

Cover Description	Condition	Area (Acres) for Hydrologic Soil Groups							
		A	CN	B	CN	C	CN	D	CN
FULLY DEVELOPED URBAN AREAS (Veq Est):									
Open space (Lawns, parks etc.)									
Poor condition; grass cover < 50%			68		79		86		89
Fair condition; grass cover 50% to 75%			49		69		79		84
Good condition; grass cover > 75%			39		61		74	0.240	80
Impervious Areas:									
Paved parking lots, roofs, driveways									
			98		98		98		98
Streets and roads:									
Paved; curbs and storm sewers									
			98		98		98		98
Paved; open ditches (w/right-of-way)									
			83		89		92		93
Gravel (w/ right-of-way)									
			76		85		89		91
Dirt (w/ right-of-way)									
			72		82		87		89
Urban Districts									
Commercial & business									
	Avg % Imperv		85		89		92		94
Project Area(ac)	Summary Screen	Sub-Area							
.24	<input checked="" type="radio"/> Off <input type="radio"/> On	Area (ac)	.24	Weighted CN:	80				

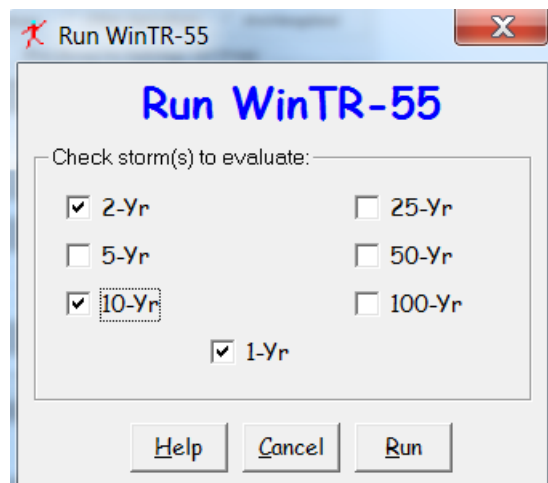
- The time of concentration details were entered. From the point water enters DA-A to the point of discharge is approximately 100 feet. The site is assumed to have a 0.5% slope based on existing contours. The surface was selected and the time of concentration was automatically calculated.



Sub-area Name: DA-1 2-Year Rainfall (in): 3.7 **Time of Concentration Details**

Flow Type	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	n	Area (ft ²)	WP (ft)	Velocity (f/s)	Time (hr)
Sheet	100	0.0050	Grass-Range, Short (0.15)					0.264
Shallow Concentrated								
Shallow Concentrated								
Channel								
Channel								
Total	100						0.1052	0.264

4. WinTR-55 was run for the 1-year, 2-year, and 10-year 24-hour storm events. The WinTR-55 output files provide the peak runoff amounts in cfs and the WinTR-20 output files provides the peak runoff amounts in inches.



Hydrograph Peak/Peak Time Table Close

TSmith Elizabeth River
 Pre Conditions - West
 Chesapeake NOAA_B County, Virginia

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period		
	2-Yr (cfs) (hr)	10-Yr (cfs) (hr)	1-Yr (cfs) (hr)
SUBAREAS			
DA-1	0.53 12.06	1.03 12.05	0.37 12.06
REACHES			
OUTLET	0.53	1.03	0.37



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STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow			
				Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-1	0.380E-03		0.628		12.06	0.37	966.33

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow			
				Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-1	0.380E-03		0.998		12.06	0.53	1399.18

STORM 10-Yr

WinTR-20 Version 1.10

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Elizabeth River
 Pre Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow			
				Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-1	0.380E-03		2.343		12.05	1.03	2720.15

The same steps were performed for the pre and post conditions of DA-A and DA-B. Runoff volume was determined by converting the runoff amount to feet, dividing that by the drainage area and converting the acre-feet to cubic feet. A summary of the runoff and volume amounts are provided in the table below. All output files are provided as an attachemnt.

Drainage Area A (DA-A): Western portion of the site

TR-55 Discharge and Volume Calculations

	Discharge (cfs)			Volume (cf)		
	Pre	Post	Increase	Pre	Post	Increase
1 year storm	0.37	0.76	0.39	547.11	1006.24	459.12
2 year storm	0.53	0.99	0.46	869.46	1445.32	575.86
10 year storm	1.03	1.65	0.62	2041.22	2809.62	768.40



Drainage Area B (DA-B): Eastern portion of the site

TR-55 Discharge and Volume Calculations

	Discharge (cfs)			Volume (cf)		
	Pre	Post	Increase	Pre	Post	Increase
1 year storm	0.6	2.64	2.04	2005.65	5156.20	3150.55
2 year storm	0.92	3.35	2.43	3332.63	7175.64	3843.01
10 year storm	1.92	5.37	3.45	8030.87	13214.65	5183.79

Based on the information provided by WinTR-55, the maximum peak flow rate from the 1-year 24-hour storm can be calculated using the energy balance equations provided in 9VAC25-870-66 subsection B, subdivision 3.

Drainage Area A (DA-A): Western portion of the site

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed}) / RV_{Developed}$$

$Q_{Developed} = 0.76$
 $I.F. = 0.9$
 $RV_{Developed} = 1006.24$
 $Q_{Pre-Developed} = 0.37$
 $RV_{Pre-Developed} = 547.11$

$$0.76 = 0.9 * (0.37 * 547.11) / 1006.24$$

$$0.76 <> 0.18$$

Drainage Area B (DA-B): Eastern portion of the site

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed}) / RV_{Developed}$$

$Q_{Developed} = 2.64$
 $I.F. = 0.9$
 $RV_{Developed} = 5156.20$
 $Q_{Pre-Developed} = 0.6$
 $RV_{Pre-Developed} = 2002.65$

$$2.64 = 0.9 * (0.6 * 2002.65) / 5156.20$$

$$2.64 <> 0.21$$



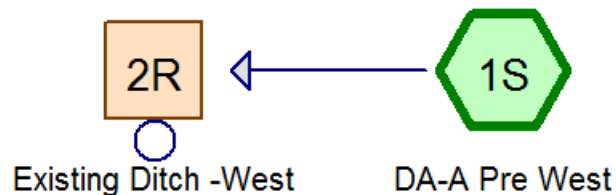
Based on the energy balance, DA-A and DA-B does not comply with 9VAC25-870-66 subsection B. The velocity of runoff from the 1-year 24-hour storm has to be calculated to show that the velocity is non-erosive to the channel.

3. Determine the velocity of runoff from the 1-year 24-hour storm to show that it is non-erosive to the stormwater conveyance system.

HydroCAD was utilized to calculate the velocity of runoff from the 1-year 24-hour storm event. Inputs are shown below for the existing conditions of DA-A.

Existing Conditions, Drainage Area A (DA-A): Western portion of the site

1. Construct the routing diagram to show the functional components that make up DA-A.



2. Describe each component or node in detail so that HydroCAD can calculate the outflow from the inflow inputs. For subcatchment 1S (DA-A), land use details and associated CN were selected and time of concentration was determined using the same parameters as shown in the WinTR-55 calculations. HydroCAD requires an input for the 2-year 24-hour storm to calculate the time of concentration. This is provided in the look up tables embedded into the program. Rainfall data was selected based on state and county (shown in step 3). For reach 2R (western channel), it was assumed that the channel was trapezoidal with a bottom width of 1 foot, depth of 1 foot, left/right slope of 0.5, and a manning's number of 0.022 for earth, clean and straight. For the purpose of these calculations, the inlet invert was set as 8 feet and the outlet invert at 7 feet with a profile length of 100 feet.



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Edit Subcat 1S - Pre-Conditions_West

General | Area | Tc | Notes

Node Name:
 Lock Node

General | Area | Tc | Notes

Line	Area (acres)	CN	Description
1	0.240	80	>75% Grass cover, Good, HSG D
2			
3			
4			
5			
6			
7			
8			

Total Area: (acres) Weighted CN:

Large areas Import areas automatically

General | Area | Tc | Notes

Line	Tc (minutes)	Method	Description
1	15.9	Sheet	Sheet Flow over existing
2			
3			
4			
5			
6			
7			
8			

Total Tc: (minutes)

Import Tc values automatically

Description:

1) Surface Description: 2) Mannings's No:

3) Flow Length: (feet) 4) P2 (2yr-24hr Rain) (inches)

5) Land Slope: (ft/ft) Use Common P2



General | Section | Profile | Tailwater | Advanced | Notes

Node Name: Existing Ditch -West Lock Node

Reach Type:

- None
- Pipe
- Rect/Vee/Trap Channel
- Parabolic Channel
- Custom Discharge
- Custom Wetted Perimeter
- Custom Cross Section

General | Section | Profile | Tailwater | Advanced | Notes

Bottom Width: (feet) 1.00

Channel Depth: (feet) 1.00

Left Side Slope(run/rise) 0.5

Right Side Slope(run/rise) 0.5

General | Section | Profile | Tailwater | Advanced | Notes

Length: (feet) 100.0

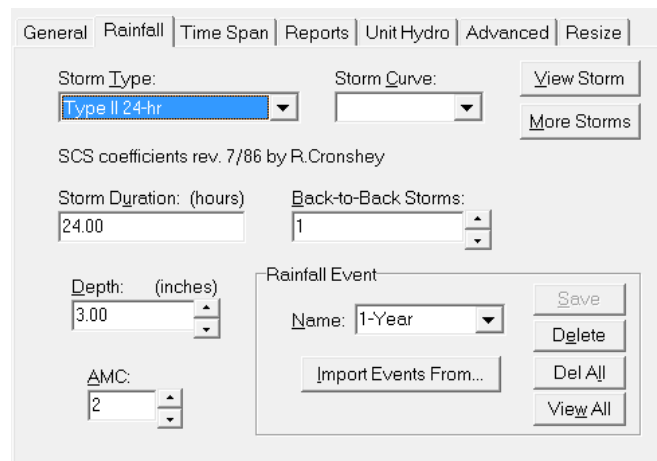
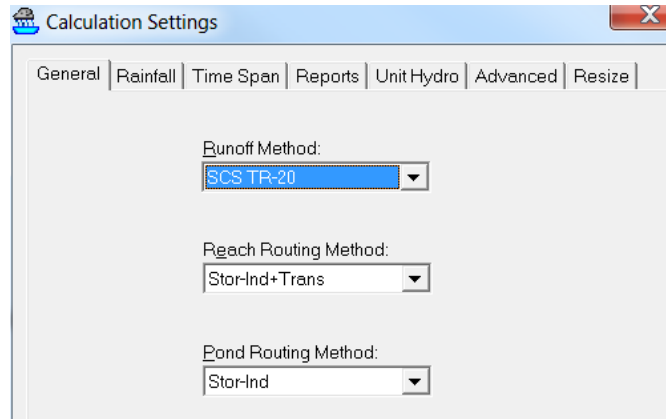
Manning's Number: 0.022

Inlet Invert: (feet) 8.00

Outlet Invert: (feet) 7.00

Slope: (ft/ft) 0.0100

- Rainfall data and calculations options were entered for runoff and routing calculations to be performed by HyrdoCAD. General runoff method and rainfall data were entered while all other parameters were left on default.



Rainfall Event Lookup

To define rainfall events, select location and click OK

Event Lookup File: Atlas-14-Rain.txt Find State: []

ID	State	County	Storm	1-Year (inches)	2-Year (inches)	5-Year (inches)	10-Year (inches)	25-Year (inches)	50-Year (inches)	100-Year (inches)
3571	VA	Caroline	Type II.NOAA_C	2.70	3.30	4.20	5.00	6.30	7.30	8.60
3572	VA	Carroll ZONE-1	Type II.NOAA_B	2.30	2.70	3.40	4.00	4.80	5.50	6.10
6696	VA	Carroll ZONE-2	Type II.NOAA_C	2.60	3.20	4.00	4.70	5.60	6.40	7.20
6697	VA	Carroll ZONE-3	Type II.NOAA_D	3.00	3.60	4.60	5.30	6.50	7.50	8.50
6698	VA	Carroll ZONE-4	Type II.NOAA_D	3.40	4.10	5.20	6.10	7.50	8.60	9.90
3573	VA	Charles City	Type II.NOAA_C	2.80	3.40	4.40	5.20	6.50	7.60	8.80
3574	VA	Charlotte	Type II.NOAA_C	3.00	3.30	4.20	5.00	6.10	7.10	8.10
3575	VA	Chesapeake	Type II.NOAA_B	3.00	3.70	4.80	5.70	7.00	8.20	9.40
3576	VA	Chesterfield	Type II.NOAA_C	2.80	3.40	4.30	5.10	6.30	7.30	8.40
3577	VA	Clarke	Type II.NOAA_B	2.40	2.90	3.60	4.30	5.20	5.90	6.80

4. HyrdoCAD was run calculating the inflow and outflow of the channel for the 1-year 24-hour storm. HydroCAD outputs reports for each node and includes a hydrograph, inflow and out flow volumes and velocities, and channel storage.

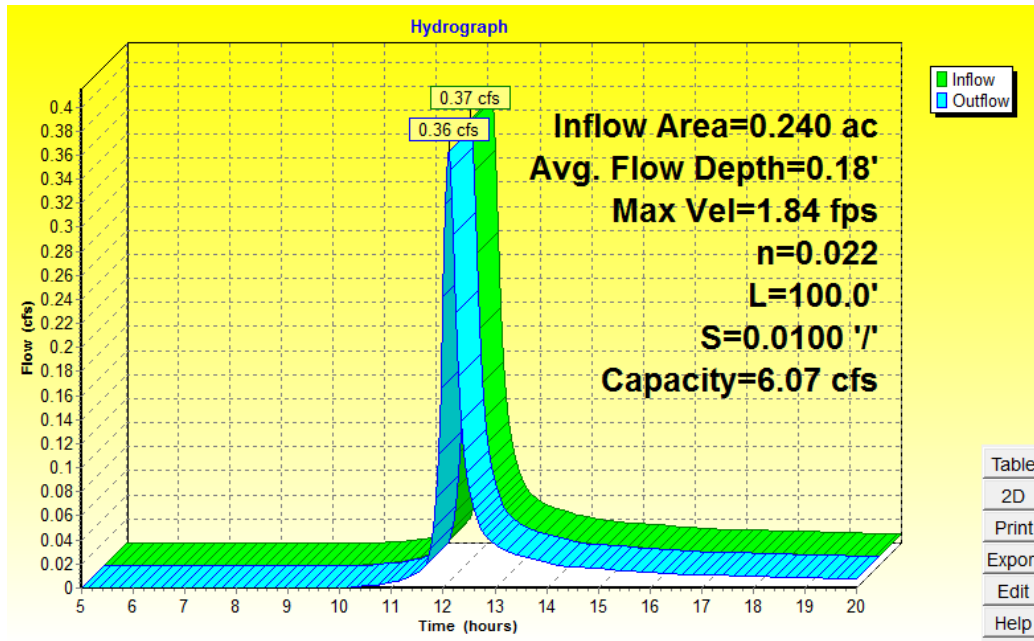


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Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.14" for 1-Year event
 Inflow = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af
 Outflow = 0.36 cfs @ 12.11 hrs, Volume= 0.023 af, Atten= 2%, Lag= 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 1.84 fps, Min. Travel Time= 0.9 min
 Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

Peak Storage= 20 cf @ 12.10 hrs
 Average Depth at Peak Storage= 0.18'
 Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
 Side Slope Z-value= 0.5 '/' Top Width= 2.00'
 Length= 100.0' Slope= 0.0100 '/'
 Inlet Invert= 8.00', Outlet Invert= 7.00'



The same steps were performed for the pre and post conditions of DA-A and DA-B. All output files are provided as an attachment. For the purpose of determining compliance with 9VAC25-870-66 subsection B, the maximum velocities for the pre and post conditions were compared to determine if the velocities were non-erosive to the channel. A summary of the velocities are provided in the table below.



HydroCAD Velocity Calculations

	Max Velocity (ft/s)		
	Pre	Post	Increase
DA-A	1.84	2.18	0.34
DA-B	1.17	2.1	0.93

The calculated velocities were compared to the Maximum non-scouring velocities for open channels provided in the table below (Ref. X). Based on the site soils described in Appendix F of this SWPPP, channel soils for the existing ditch for DA-A was assumed to be sandy soil with medium grass cover and the existing channel for DA-B was assumed to be sandy soil with medium grass cover. The 2.18 ft/s maximum velocity for DA-A and the 2.1 ft/s maximum velocity for DA-B for the 1-year 24-hour storm is non-erosive. Therefore, it was determined that the M&R station is compliant with the channel protection standards set forth in 9VAC25-870-66.

Material	Maximum non-scouring velocities for open channels		
	Maximum permissible velocities on established cover (ft/s)		
	Bare Soil	Medium grass cover	Good grass cover
Light silty sand	1.0	2.5	4.5
Light loose sand	1.5	3.0	5.0
Coarse sand	2.5	4.0	5.5
Sandy soil	2.5	4.5	6.5
Firm clay loam	3.5	5.5	7.5
Stiff clay or stiff gravelly soil	4.5	6.0	8.0
Coarse gravels	5.0	6.0	-
Shale, hardpan, soft rock	6.0	7.0	-
Hard cemented conglomerates	8.0	-	-

4. Using HydroCAD, calculate the volume of runoff contained within the conveyance system for the 10-year 24-hour storm to determine compliance with 9VAC25-870-66-C, Flood Protection.

Under 9VAC25-870-66-C, concentrated stormwater flow shall be released into a stormwater conveyance system and must meet the criteria in subdivision 1, 2, or 3. For the eastern and western portion of the site, it was conservatively assumed that the existing channels experience localized flooding. Based on this assumption, the



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site must be compliant with subdivision 2 and confine the post-development peak flow from the 10-year 24-hour storm within the channel to avoid localized flooding.

Compliance was illustrated using HydroCAD. Using the inputs from Step 3 above, HydroCAD was run to model the 10-year 24-hour storm event.

Existing Conditions, Drainage Area A (DA-A): Western portion of the site

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 3.25" for 10-Year event
Inflow = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af
Outflow = 1.03 cfs @ 12.10 hrs, Volume= 0.065 af, Atten= 1%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.54 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 2.2 min

Peak Storage= 41 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 ' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 ' / '
Inlet Invert= 8.00', Outlet Invert= 7.00'



Post Conditions, Drainage Area A (DA-A): Western portion of the site

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 4.37" for 10-Year event
Inflow = 1.38 cfs @ 12.06 hrs, Volume= 0.087 af
Outflow = 1.36 cfs @ 12.07 hrs, Volume= 0.087 af, Atten= 2%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 2.0 min

Peak Storage= 50 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 ' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 ' / '
Inlet Invert= 8.00', Outlet Invert= 7.00'





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Existing Conditions, Drainage Area B (DA-B): Eastern portion of the site

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 0.96" for 1-Year event
Inflow = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af
Outflow = 0.58 cfs @ 12.39 hrs, Volume= 0.060 af, Atten= 1%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.17 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.6 min

Peak Storage= 50 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 ' / ' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 ' / '
Inlet Invert= 8.00', Outlet Invert= 7.00'



Post Conditions, Drainage Area B (DA-B): Eastern portion of the site

Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.21" for 1-Year event
Inflow = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af
Outflow = 2.97 cfs @ 11.95 hrs, Volume= 0.140 af, Atten= 6%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.5 min

Peak Storage= 147 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 ' / ' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 ' / '
Inlet Invert= 8.00', Outlet Invert= 7.00'



For DA-A, the existing site's peak discharge from the 10-year 24-hour storm has a peak storage of 41 cf and an average depth at peak storage of 0.35 feet. The post conditions peak discharge from the 10-year 24-hour storm has a peak storage of 50 cf and an average depth at peak storage of 0.42 feet. DA-B existing conditions have a



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peak storage of 50 cf and an average depth at peak storage of 0.16 feet and the post conditions have a peak storage of 147 cf and an average depth at peak storage of 0.43 feet. Since the existing channel on the western edge and the natural channel on the eastern edge of the property both have a bank full depth of 1 foot, the HydroCAD modeling demonstrates that the peak discharge from the 10-yr 24-hour storm for the post conditions is confined within the channels during this storm event. The M&R station is compliant with the flood protection standards set forth in 9VAC25-870-66.

REFERENCES:

1)

WinTR-20 Printed Page File Beginning of Input Data List
 TR20.inp

WinTR-20: Version 1.10 0 0 0.05
 Elizabeth River
 Pre Conditions - East

SUB-AREA:
 DA-2 Outlet .00119 77. .608

STREAM REACH:

STORM ANALYSIS:
 2-Yr 3.7 Type II 2
 10-Yr 5.7 Type II 2
 1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
 2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
 Pre Conditions - East

Name of printed page file:
 TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	----- Rate (csm)
DA-2	0.001		1.208		12.26	0.92	773.20

Line Start Time (hr)	----- (cfs)	Flow Values @ time increment of 0.038 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.641	0.05	0.06	0.07	0.09	0.11	0.14	0.19	
11.909	0.25	0.32	0.41	0.51	0.61	0.71	0.80	
12.178	0.87	0.91	0.92	0.91	0.88	0.84	0.78	
12.447	0.72	0.66	0.60	0.54	0.49	0.45	0.41	
12.716	0.38	0.35	0.32	0.30	0.28	0.26	0.24	
12.985	0.23	0.21	0.20	0.19	0.18	0.17	0.17	
13.253	0.16	0.15	0.15	0.14	0.14	0.13	0.13	
13.522	0.12	0.12	0.12	0.11	0.11	0.11	0.11	
13.791	0.10	0.10	0.10	0.10	0.10	0.09	0.09	
14.060	0.09	0.09	0.09	0.09	0.08	0.08	0.08	
14.329	0.08	0.08	0.08	0.08	0.08	0.07	0.07	
14.597	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
14.866	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
15.135	0.07	0.06	0.06	0.06	0.06	0.06	0.06	
15.404	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
15.673	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
15.941	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
16.210	0.05	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	----- Rate (csm)
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WinTR-20: Version 1.10
beth River
Pre Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 77. .608

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.001		1.208		12.26	0.92	773.20

Line

Start Time (hr)	Flow Values @ time increment of 0.038 hr						
(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.641	0.05	0.06	0.07	0.09	0.11	0.14	0.19
11.909	0.25	0.32	0.41	0.51	0.61	0.71	0.80
12.178	0.87	0.91	0.92	0.91	0.88	0.84	0.78
12.447	0.72	0.66	0.60	0.54	0.49	0.45	0.41
12.716	0.38	0.35	0.32	0.30	0.28	0.26	0.24
12.985	0.23	0.21	0.20	0.19	0.18	0.17	0.17
13.253	0.16	0.15	0.15	0.14	0.14	0.13	0.13
13.522	0.12	0.12	0.12	0.11	0.11	0.11	0.11
13.791	0.10	0.10	0.10	0.10	0.10	0.09	0.09
14.060	0.09	0.09	0.09	0.09	0.08	0.08	0.08
14.329	0.08	0.08	0.08	0.08	0.08	0.07	0.07

Elizabeth River
Pre Conditions - East

Line

Start Time (hr)	Flow Values @ time increment of 0.038 hr						
(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.597	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.866	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.135	0.07	0.06	0.06	0.06	0.06	0.06	0.06
15.404	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 2-Yr

SUB-AREA:
 DA-2 Outlet .00119 77. .608

STREAM REACH:

15.673	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05
15.941	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.210	0.05	0.05						

STORM 10-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	----- Peak Flow Time (hr)	----- Rate (cfs)	----- Rate (csm)
DA-2	0.001		2.911		12.24	1.92	1611.61

Line

Start Time (hr)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)
10.665	0.05	0.05	0.06	0.06	0.06	0.06	0.06
10.934	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.203	0.09	0.09	0.10	0.10	0.11	0.11	0.12
11.472	0.12	0.13	0.14	0.15	0.16	0.18	0.20
11.741	0.24	0.28	0.35	0.44	0.55	0.70	0.87
12.009	1.07	1.28	1.48	1.66	1.80	1.89	1.92
12.278	1.90	1.84	1.75	1.63	1.50	1.37	1.24
12.547	1.12	1.01	0.92	0.84	0.77	0.71	0.65
12.816	0.60	0.55	0.51	0.48	0.45	0.42	0.39
13.085	0.37	0.35	0.33	0.32	0.30	0.29	0.28
13.353	0.27	0.26	0.25	0.24	0.23	0.23	0.22
13.622	0.21	0.21	0.20	0.20	0.19	0.19	0.18
13.891	0.18	0.18	0.17	0.17	0.17	0.16	0.16
14.160	0.16	0.15	0.15	0.15	0.15	0.14	0.14
14.429	0.14	0.14	0.14	0.14	0.13	0.13	0.13
14.697	0.13	0.13	0.13	0.13	0.13	0.12	0.12
14.966	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.235	0.12	0.11	0.11	0.11	0.11	0.11	0.11

Flow Values @ time increment of 0.038 hr

WinTR-20: Version 1.10
beth River
Pre Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 77. .608

STREAM REACH:

OUTLET 0.001 2.911 12.24 1.92 1611.61

Line Start Time (hr)	Flow (cfs)	Values @ time (cfs)	increment (cfs)	of 0.038 hr (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
10.665	0.05	0.05	0.06	0.06	0.06	0.06	0.06
10.934	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.203	0.09	0.09	0.10	0.10	0.11	0.11	0.12
11.472	0.12	0.13	0.14	0.15	0.16	0.18	0.20
11.741	0.24	0.28	0.35	0.44	0.55	0.70	0.87
12.009	1.07	1.28	1.48	1.66	1.80	1.89	1.92
12.278	1.90	1.84	1.75	1.63	1.50	1.37	1.24
12.547	1.12	1.01	0.92	0.84	0.77	0.71	0.65
12.816	0.60	0.55	0.51	0.48	0.45	0.42	0.39
13.085	0.37	0.35	0.33	0.32	0.30	0.29	0.28
13.353	0.27	0.26	0.25	0.24	0.23	0.23	0.22
13.622	0.21	0.21	0.20	0.20	0.19	0.19	0.18
13.891	0.18	0.18	0.17	0.17	0.17	0.16	0.16
14.160	0.16	0.15	0.15	0.15	0.15	0.14	0.14
14.429	0.14	0.14	0.14	0.14	0.13	0.13	0.13
14.697	0.13	0.13	0.13	0.13	0.13	0.12	0.12
14.966	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.235	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.504	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.773	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.09	0.09	0.09	0.09	0.09	0.09
16.310	0.09	0.09	0.09	0.09	0.09	0.09	0.08
16.579	0.08	0.08	0.08	0.08	0.08	0.08	0.08
16.848	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.117	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.385	0.08	0.08	0.08	0.08	0.08	0.07	0.07
17.654	0.07	0.07	0.07	0.07	0.07	0.07	0.07
17.923	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

18.192	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.461	0.07	0.07	0.07	0.07	0.07	0.07	0.06
18.729	0.06	0.06	0.06	0.06	0.06	0.06	0.06
18.998	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.267	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.536	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Pre Conditions - East

Line

Start Time (hr)	Flow Values @ time increment of 0.038 hr						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
19.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.073	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.342	0.05						

STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Flow Rate (csm)
DA-2	0.001		0.727		12.25	0.60	507.04

Line

Start Time (hr)	Flow Values @ time increment of 0.038 hr						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.787	0.05	0.07	0.10	0.13	0.18	0.23	0.30
12.055	0.37	0.44	0.50	0.55	0.59	0.60	0.60

WinTR-20: Version 1.10 0 0 0.05 (continued)
 beth River
 Pre Conditions - East

STORM 1-Yr

SUB-AREA:
 DA-2 Outlet .00119 77. .608

STREAM REACH:

12.324	0.59	0.56	0.53	0.49	0.45	0.41	0.37
12.593	0.34	0.31	0.29	0.26	0.24	0.23	0.21
12.862	0.20	0.18	0.17	0.16	0.15	0.14	0.14
13.131	0.13	0.12	0.12	0.11	0.11	0.11	0.10
13.399	0.10	0.10	0.09	0.09	0.09	0.08	0.08
13.668	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.937	0.07	0.07	0.07	0.07	0.06	0.06	0.06
14.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
14.475	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.743	0.05	0.05	0.05				

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Peak Flow ----- Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.001		0.727		12.25	0.60	507.04

Line Start Time (hr)	----- Flow Values @ time increment of 0.038 hr -----						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.787	0.05	0.07	0.10	0.13	0.18	0.23	0.30
12.055	0.37	0.44	0.50	0.55	0.59	0.60	0.60
12.324	0.59	0.56	0.53	0.49	0.45	0.41	0.37
12.593	0.34	0.31	0.29	0.26	0.24	0.23	0.21
12.862	0.20	0.18	0.17	0.16	0.15	0.14	0.14
13.131	0.13	0.12	0.12	0.11	0.11	0.11	0.10
13.399	0.10	0.10	0.09	0.09	0.09	0.08	0.08
13.668	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.937	0.07	0.07	0.07	0.07	0.06	0.06	0.06
14.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
14.475	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.743	0.05	0.05	0.05				

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Pre Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 77. .608

STREAM REACH:

WinTR-20 Version 1.10

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Elizabeth River
Pre Conditions - East

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm			-----	
			2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)
DA-2	0.001		0.92	1.92	0.60		
OUTLET	0.001		0.92	1.92	0.60		

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Pre Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet

.00119 77. .608

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
 TR20.inp

WinTR-20: Version 1.10 0 0 0.05
 Elizabeth River
 Pre Conditions - West

SUB-AREA:
 DA-1 Outlet .00038 80. .264

STREAM REACH:

STORM ANALYSIS:
 2-Yr 3.7 Type II 2
 10-Yr 5.7 Type II 2
 1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
 2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
 Pre Conditions - West

Name of printed page file:
 TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Rate (csm)
DA-1	0.380E-03		0.998		12.06	0.53	1399.18

Line	Start Time (hr)	Flow (cfs)	Values @ time increment (cfs)	of 0.017 hr (cfs)	Flow (cfs)	Rate (cfs)	Rate (cfs)	
	11.673	0.06	0.06	0.07	0.08	0.09	0.10	0.12
	11.789	0.13	0.15	0.17	0.19	0.21	0.24	0.27
	11.906	0.30	0.34	0.38	0.41	0.45	0.47	0.50
	12.023	0.52	0.53	0.53	0.53	0.51	0.49	0.47
	12.140	0.43	0.40	0.37	0.33	0.30	0.28	0.25
	12.256	0.23	0.21	0.19	0.18	0.17	0.16	0.15
	12.373	0.14	0.13	0.12	0.12	0.11	0.11	0.10
	12.490	0.10	0.09	0.09	0.09	0.08	0.08	0.08
	12.606	0.08	0.07	0.07	0.07	0.07	0.06	0.06
	12.723	0.06	0.06	0.06	0.06	0.06	0.06	0.05
	12.840	0.05	0.05	0.05	0.05	0.05	0.05	

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Rate (csm)
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WinTR-20: Version 1.10 0 0 0.05
 beth River (continued)
 Pre Conditions - West

STORM 10-Yr

SUB-AREA:
 DA-1 Outlet .00038 80. .264

STREAM REACH:

11.388	0.06	0.06	0.06	0.06	0.06	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.621	0.10	0.11	0.12	0.13	0.15	0.17	0.19
11.738	0.21	0.24	0.26	0.29	0.33	0.36	0.41
11.855	0.45	0.50	0.56	0.63	0.70	0.76	0.83
11.971	0.89	0.94	0.99	1.02	1.03	1.03	1.02
12.088	0.99	0.95	0.89	0.83	0.76	0.70	0.64
12.205	0.58	0.52	0.47	0.43	0.39	0.36	0.33
12.321	0.31	0.29	0.27	0.26	0.24	0.23	0.22
12.438	0.21	0.20	0.19	0.18	0.17	0.17	0.16
12.555	0.15	0.15	0.14	0.14	0.13	0.13	0.12
12.672	0.12	0.12	0.11	0.11	0.11	0.11	0.10
12.788	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.905	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.022	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.139	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.255	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.372	0.07	0.07	0.07	0.07	0.06	0.06	0.06
13.489	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.605	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.722	0.06	0.06	0.06	0.05	0.05	0.05	0.05
13.839	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.956	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	----- Rate (csm)
OUTLET	0.380E-03		2.343		12.05	1.03	2720.15

Line Start Time (hr)	----- (cfs)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.271	0.05	0.05	0.05	0.05	0.05	0.06	0.06	
11.388	0.06	0.06	0.06	0.06	0.06	0.07	0.07	
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09	
11.621	0.10	0.11	0.12	0.13	0.15	0.17	0.19	
11.738	0.21	0.24	0.26	0.29	0.33	0.36	0.41	
11.855	0.45	0.50	0.56	0.63	0.70	0.76	0.83	
11.971	0.89	0.94	0.99	1.02	1.03	1.03	1.02	
12.088	0.99	0.95	0.89	0.83	0.76	0.70	0.64	
12.205	0.58	0.52	0.47	0.43	0.39	0.36	0.33	
12.321	0.31	0.29	0.27	0.26	0.24	0.23	0.22	

WinTR-20: Version 1.10
beth River
Pre Conditions - West

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-1 Outlet .00038 80. .264

STREAM REACH:

Elizabeth River
Pre Conditions - West

Line	Flow Values @ time increment of 0.017 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.438	0.21	0.20	0.19	0.18	0.17	0.17	0.16
12.555	0.15	0.15	0.14	0.14	0.13	0.13	0.12
12.672	0.12	0.12	0.11	0.11	0.11	0.11	0.10
12.788	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.905	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.022	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.139	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.255	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.372	0.07	0.07	0.07	0.07	0.06	0.06	0.06
13.489	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.605	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.722	0.06	0.06	0.06	0.05	0.05	0.05	0.05
13.839	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.956	0.05						

STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Flow Rate (csm)
DA-1	0.380E-03		0.628		12.06	0.37	966.33

Line	Flow Values @ time increment of 0.017 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.745	0.06	0.06	0.07	0.08	0.10	0.11	0.12
11.862	0.14	0.16	0.18	0.21	0.23	0.26	0.28
11.979	0.31	0.33	0.35	0.36	0.37	0.37	0.36
12.096	0.35	0.34	0.32	0.30	0.27	0.25	0.23
12.212	0.21	0.19	0.17	0.16	0.14	0.13	0.12
12.329	0.12	0.11	0.10	0.10	0.09	0.09	0.08
12.446	0.08	0.08	0.07	0.07	0.07	0.06	0.06

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Pre Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet .00038 80. .264

STREAM REACH:

WinTR-20 Version 1.10

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01/25/2017 10:50

Elizabeth River
Pre Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm			-----	
			2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)

WinTR-55, Version 1.00.10

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1/25/2017 10:50:43 AM

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Pre Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet .00038 80. .264

STREAM REACH:

DA-1 0.380E-03 0.53 1.03 0.37
OUTLET 0.380E-03 0.53 1.03 0.37

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Pre Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet

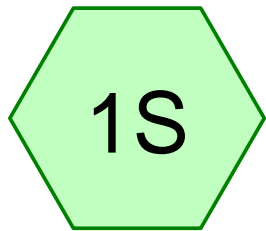
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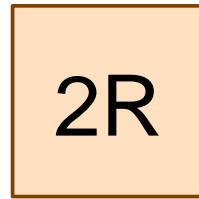
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Page 5

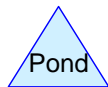
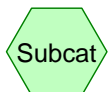
01/25/2017 10:50



DA-B East



Channel - East



Pre-Conditions_East

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.080	80	>75% Grass cover, Good, HSG D (1S)
0.680	77	Woods, Good, HSG D (1S)
0.760	77	TOTAL AREA

Pre-Conditions_East

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.760	HSG D	1S
0.000	Other	
0.760		TOTAL AREA

Pre-Conditions_East

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.080	0.000	0.080	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.680	0.000	0.680	Woods, Good	1S
0.000	0.000	0.000	0.760	0.000	0.760	TOTAL AREA	

Pre-Conditions_East

Type II 24-hr 1-Year Rainfall=3.00"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East

Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>0.96"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=0.58 cfs 0.061 af

Reach 2R: Channel - East

Avg. Flow Depth=0.16' Max Vel=1.17 fps Inflow=0.58 cfs 0.061 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=0.58 cfs 0.060 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.061 af Average Runoff Depth = 0.96"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_East

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 1S: DA-B East

Runoff = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af, Depth> 0.96"

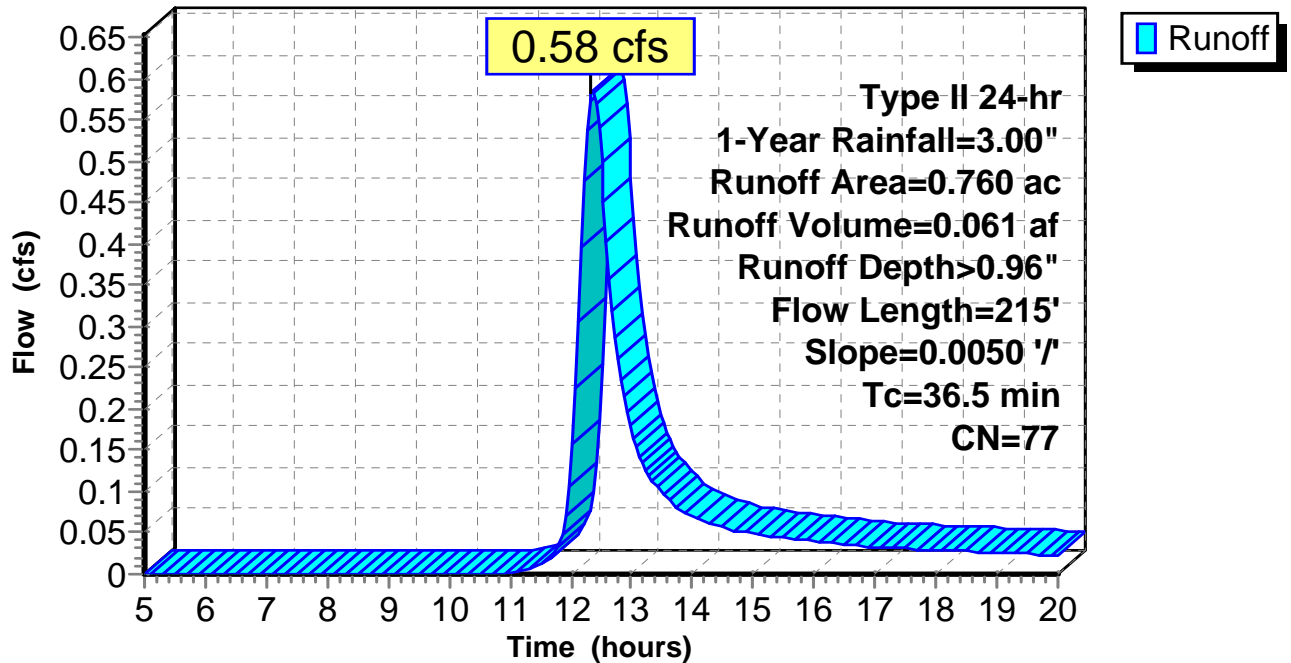
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		Sheet Flow, Sheet Flow grass/woods Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. Flow woods Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East

Hydrograph



Pre-Conditions_East

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Reach 2R: Channel - East

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 0.96" for 1-Year event
Inflow = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af
Outflow = 0.58 cfs @ 12.39 hrs, Volume= 0.060 af, Atten= 1%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.17 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.6 min

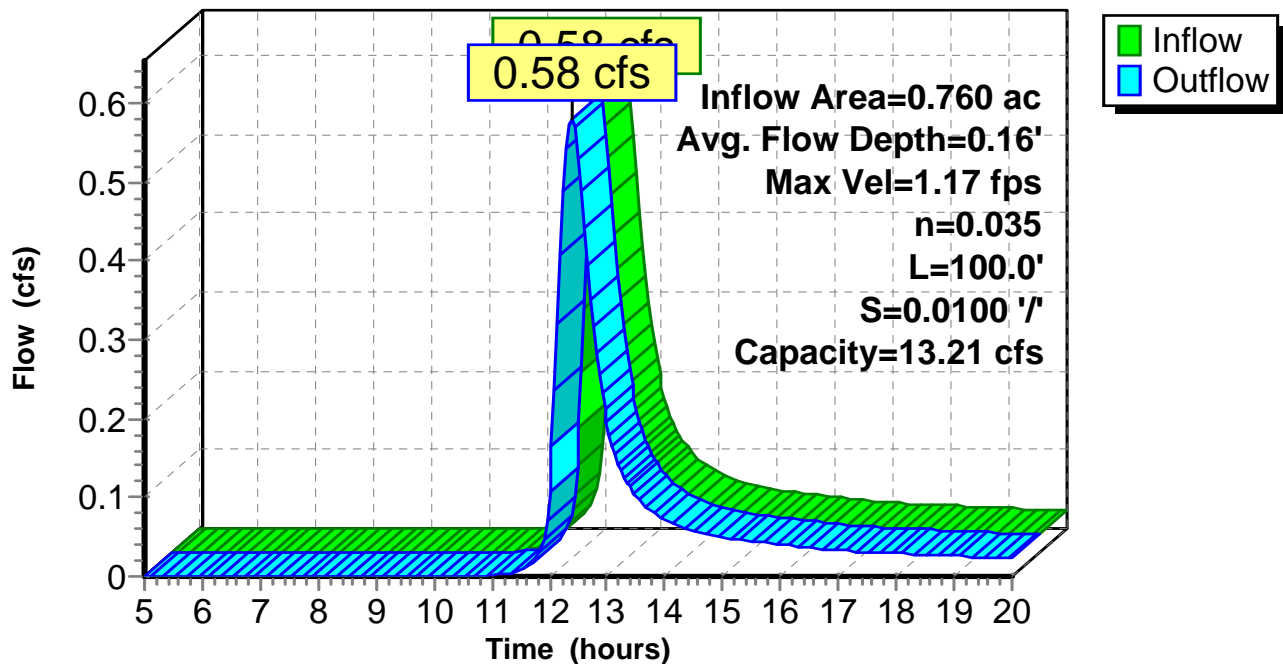
Peak Storage= 50 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - East

Hydrograph



Pre-Conditions_East

Type II 24-hr 2-Year Rainfall=3.70"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East

Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>1.43"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=0.89 cfs 0.090 af

Reach 2R: Channel - East

Avg. Flow Depth=0.20' Max Vel=1.36 fps Inflow=0.89 cfs 0.090 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=0.89 cfs 0.090 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.090 af Average Runoff Depth = 1.43"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_East

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Type II 24-hr 2-Year Rainfall=3.70"

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Summary for Subcatchment 1S: DA-B East

Runoff = 0.89 cfs @ 12.34 hrs, Volume= 0.090 af, Depth> 1.43"

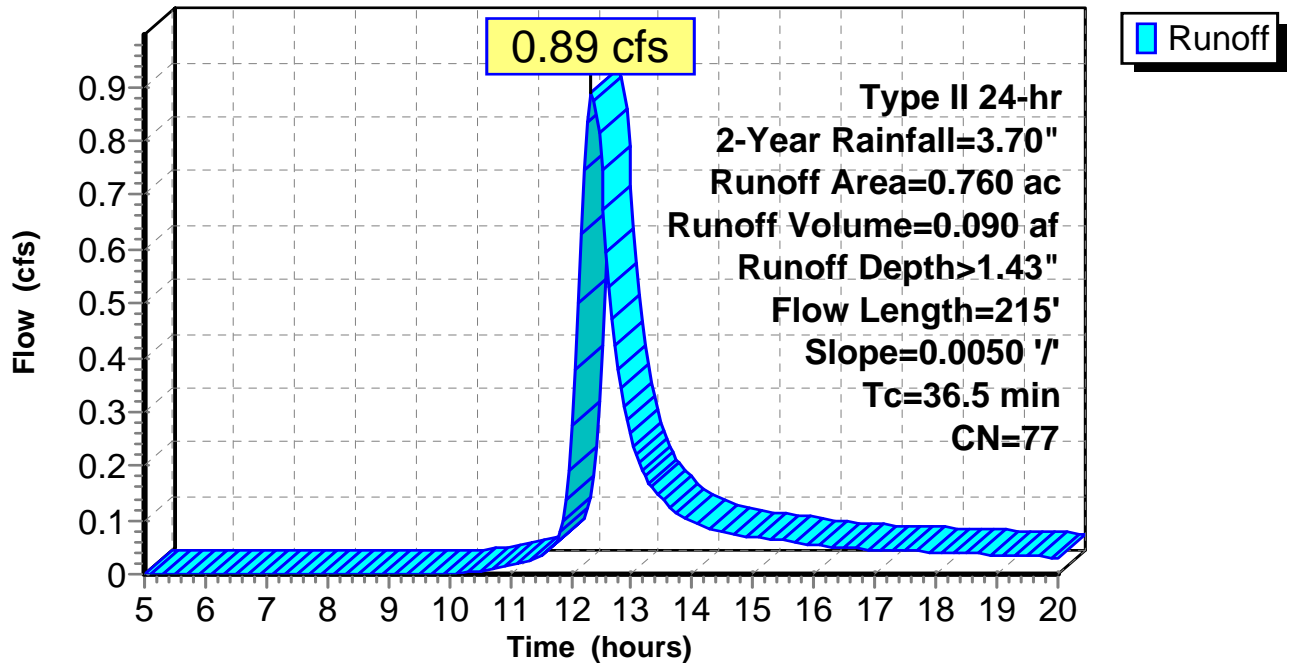
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		Sheet Flow, Sheet Flow grass/woods Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. Flow woods Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East

Hydrograph



Pre-Conditions_East

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Type II 24-hr 2-Year Rainfall=3.70"

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Summary for Reach 2R: Channel - East

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 1.43" for 2-Year event
Inflow = 0.89 cfs @ 12.34 hrs, Volume= 0.090 af
Outflow = 0.89 cfs @ 12.37 hrs, Volume= 0.090 af, Atten= 1%, Lag= 2.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.36 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 0.51 fps, Avg. Travel Time= 3.3 min

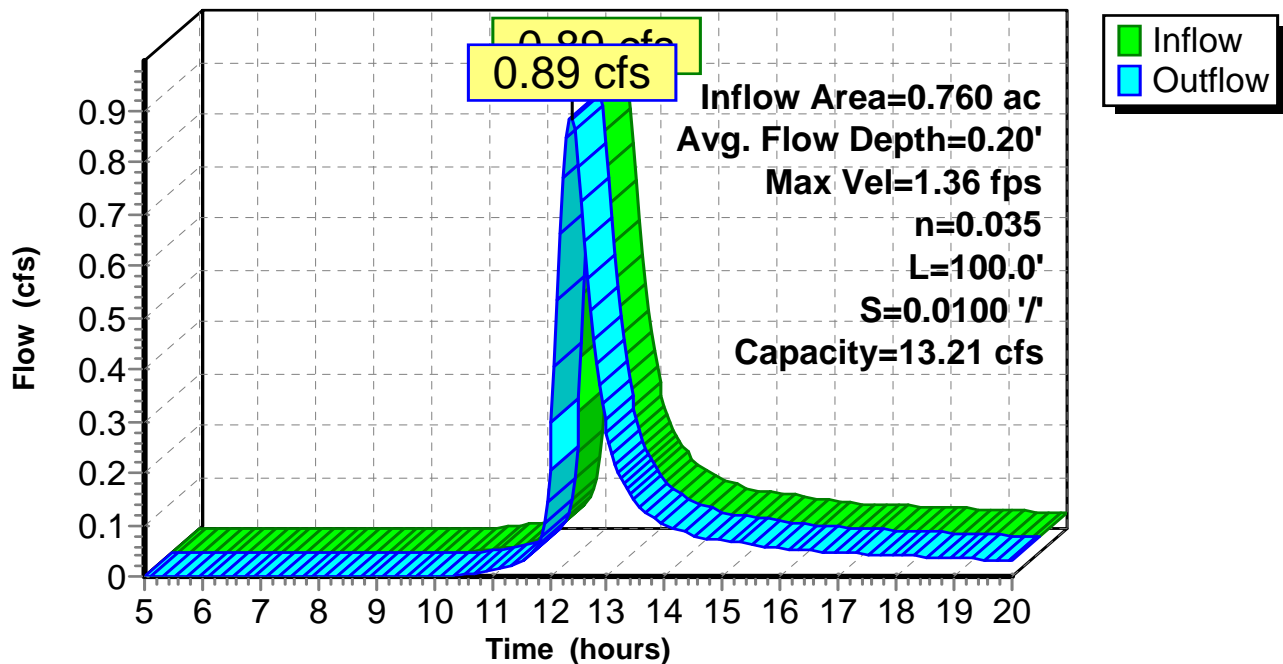
Peak Storage= 65 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - East

Hydrograph



Pre-Conditions_East

Type II 24-hr 10-Year Rainfall=5.70"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East

Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>2.95"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=1.86 cfs 0.187 af

Reach 2R: Channel - East

Avg. Flow Depth=0.32' Max Vel=1.77 fps Inflow=1.86 cfs 0.187 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=1.85 cfs 0.186 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.187 af Average Runoff Depth = 2.95"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_East

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Type II 24-hr 10-Year Rainfall=5.70"

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Summary for Subcatchment 1S: DA-B East

Runoff = 1.86 cfs @ 12.32 hrs, Volume= 0.187 af, Depth> 2.95"

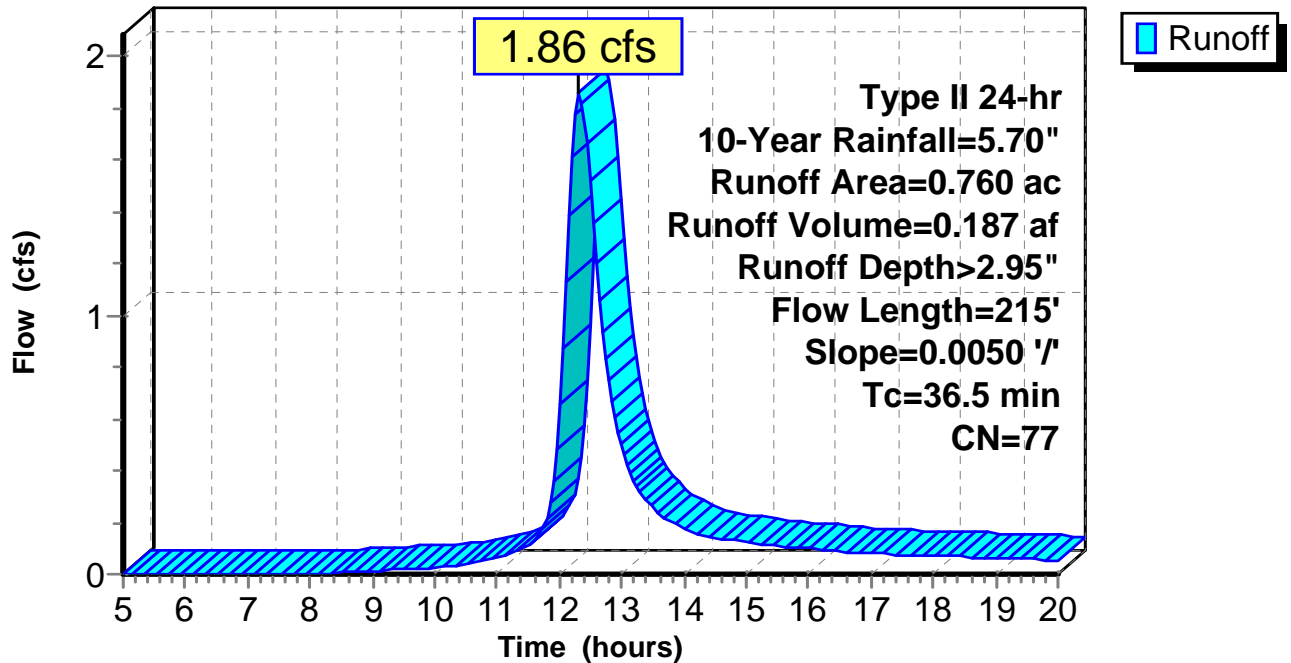
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		Sheet Flow, Sheet Flow grass/woods Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. Flow woods Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East

Hydrograph



Pre-Conditions_East

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Type II 24-hr 10-Year Rainfall=5.70"

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Summary for Reach 2R: Channel - East

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 2.95" for 10-Year event
 Inflow = 1.86 cfs @ 12.32 hrs, Volume= 0.187 af
 Outflow = 1.85 cfs @ 12.35 hrs, Volume= 0.186 af, Atten= 1%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Max. Velocity= 1.77 fps, Min. Travel Time= 0.9 min
 Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

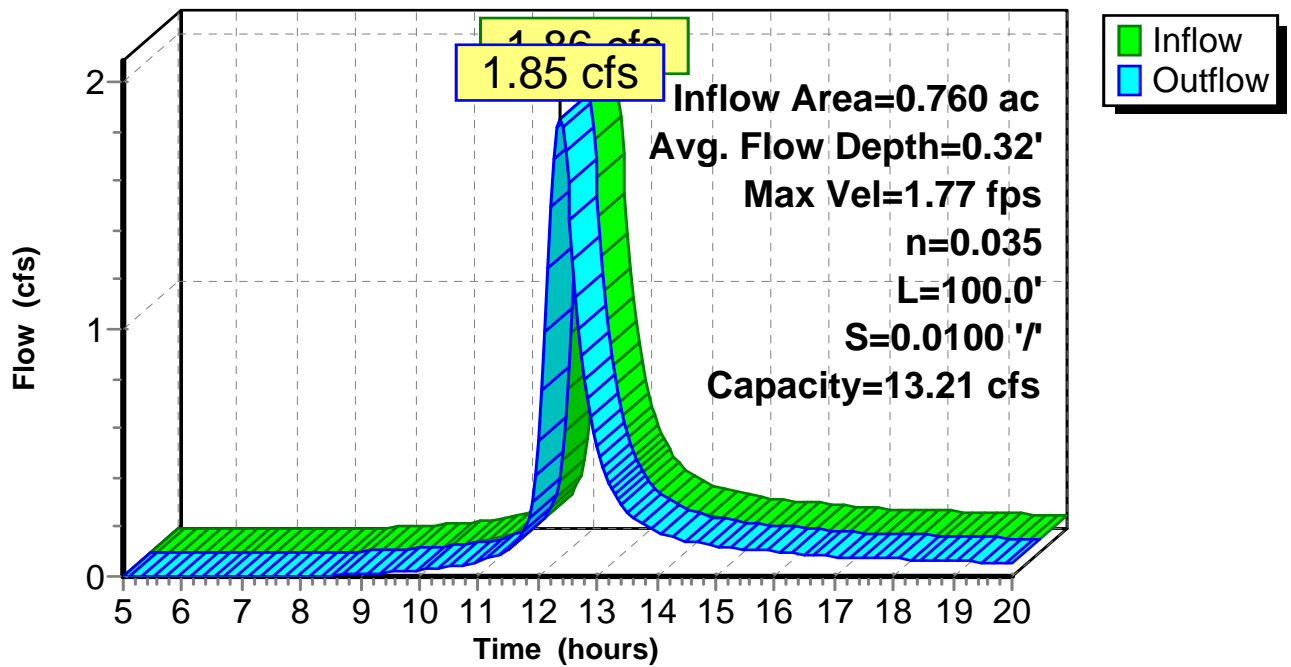
Peak Storage= 105 cf @ 12.33 hrs
 Average Depth at Peak Storage= 0.32'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

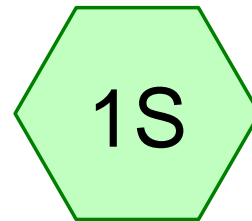
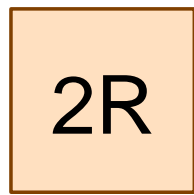
3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
 Side Slope Z-value= 1.0 '/' Top Width= 5.00'
 Length= 100.0' Slope= 0.0100 '/'
 Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - East

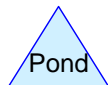
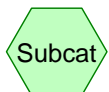
Hydrograph





Existing Ditch -West

DA-A Pre West



Pre-Conditions_West

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.240	80	>75% Grass cover, Good, HSG D (1S)
0.240	80	TOTAL AREA

Pre-Conditions_West

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.240	HSG D	1S
0.000	Other	
0.240		TOTAL AREA

Pre-Conditions_West

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.240	0.000	0.240	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.240	0.000	0.240	TOTAL AREA	

Pre-Conditions_West

Type II 24-hr 1-Year Rainfall=3.00"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West

Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>1.14"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=0.37 cfs 0.023 af

Reach 2R: Existing Ditch -West

Avg. Flow Depth=0.18' Max Vel=1.84 fps Inflow=0.37 cfs 0.023 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.36 cfs 0.023 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.023 af Average Runoff Depth = 1.14"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_West

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 1S: DA-A Pre West

Runoff = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 1.14"

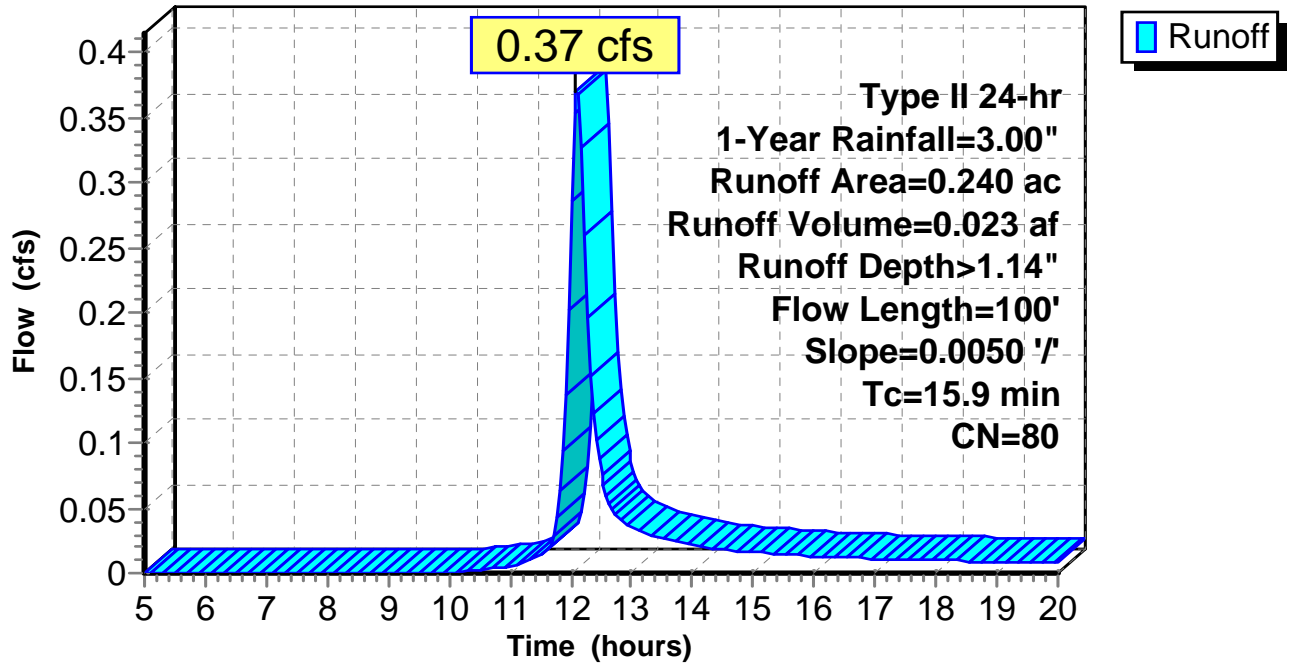
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		Sheet Flow, Sheet Flow over existing Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West

Hydrograph



Pre-Conditions_West

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Type II 24-hr 1-Year Rainfall=3.00"

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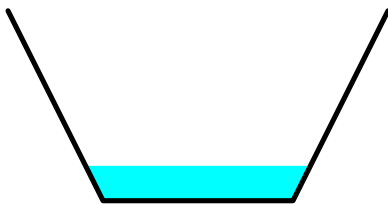
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.14" for 1-Year event
Inflow = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af
Outflow = 0.36 cfs @ 12.11 hrs, Volume= 0.023 af, Atten= 2%, Lag= 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.84 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

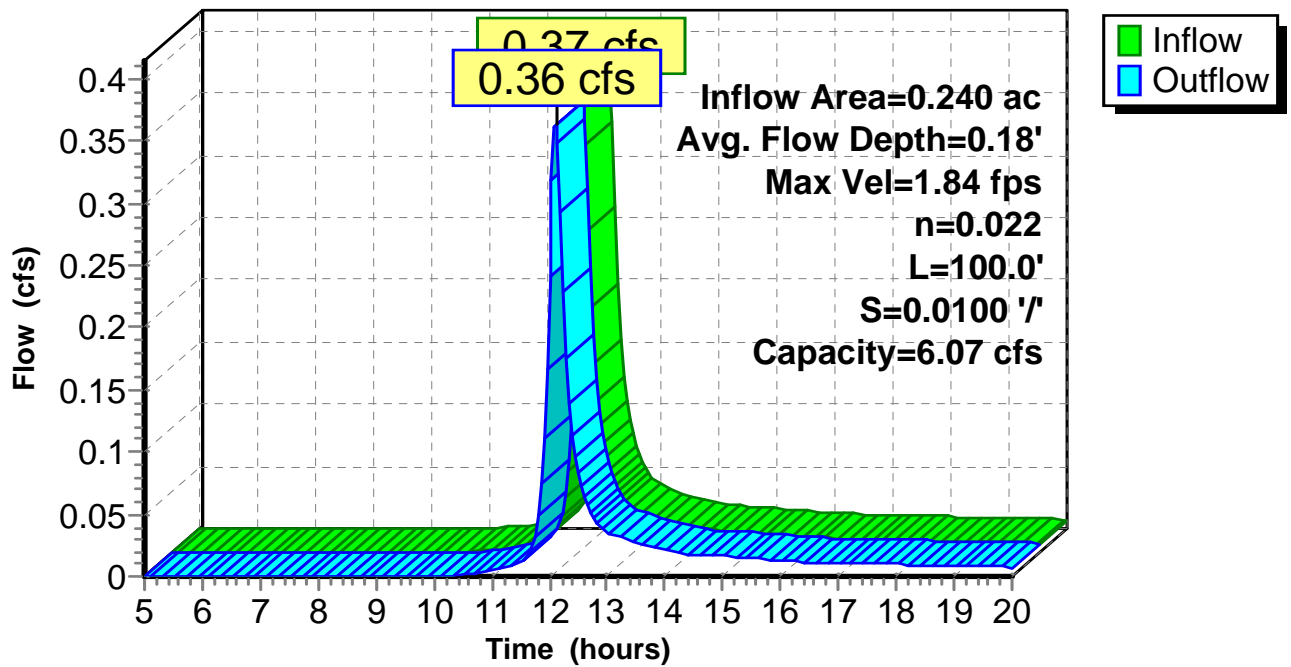
Peak Storage= 20 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/ Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



Pre-Conditions_West

Type II 24-hr 2-Year Rainfall=3.70"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West

Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>1.65"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=0.54 cfs 0.033 af

Reach 2R: Existing Ditch -West

Avg. Flow Depth=0.23' Max Vel=2.07 fps Inflow=0.54 cfs 0.033 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.53 cfs 0.033 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.033 af Average Runoff Depth = 1.65"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_West

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Type II 24-hr 2-Year Rainfall=3.70"

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Summary for Subcatchment 1S: DA-A Pre West

Runoff = 0.54 cfs @ 12.08 hrs, Volume= 0.033 af, Depth> 1.65"

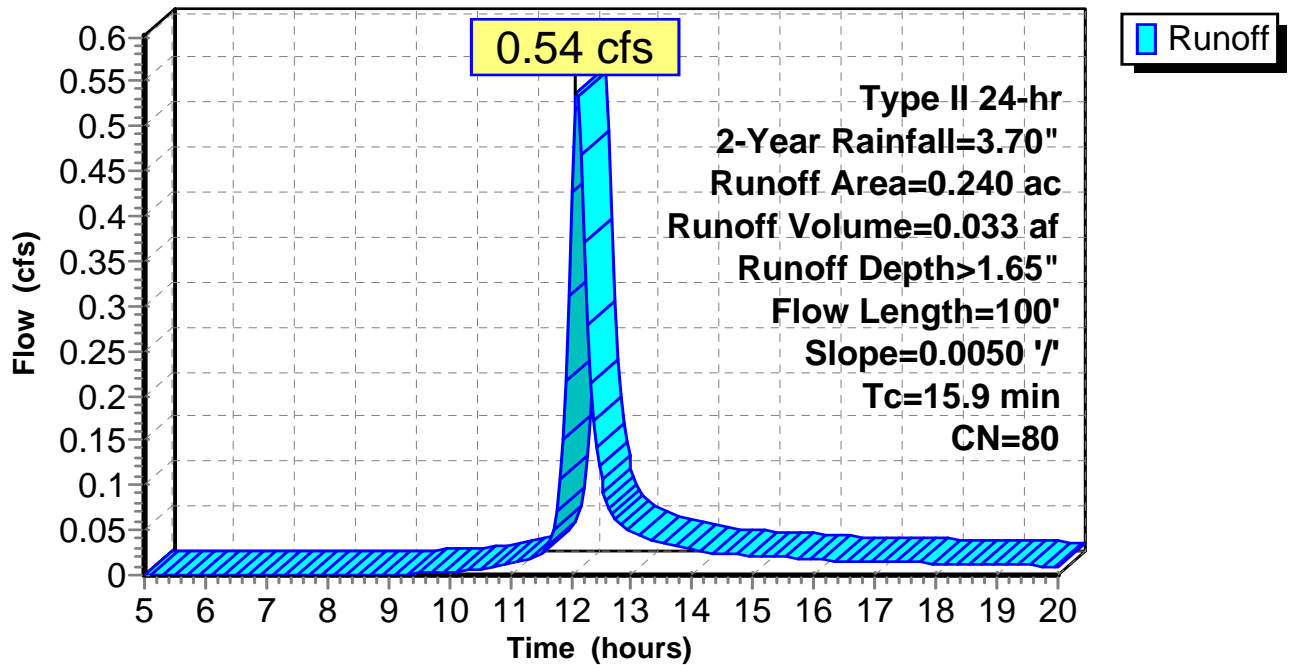
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		Sheet Flow, Sheet Flow over existing Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West

Hydrograph



Pre-Conditions_West

Prepared by ERM

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Type II 24-hr 2-Year Rainfall=3.70"

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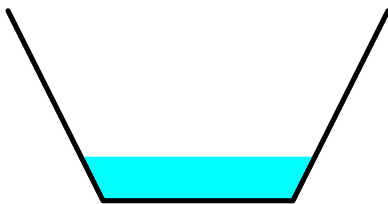
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.65" for 2-Year event
Inflow = 0.54 cfs @ 12.08 hrs, Volume= 0.033 af
Outflow = 0.53 cfs @ 12.11 hrs, Volume= 0.033 af, Atten= 2%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.07 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 2.5 min

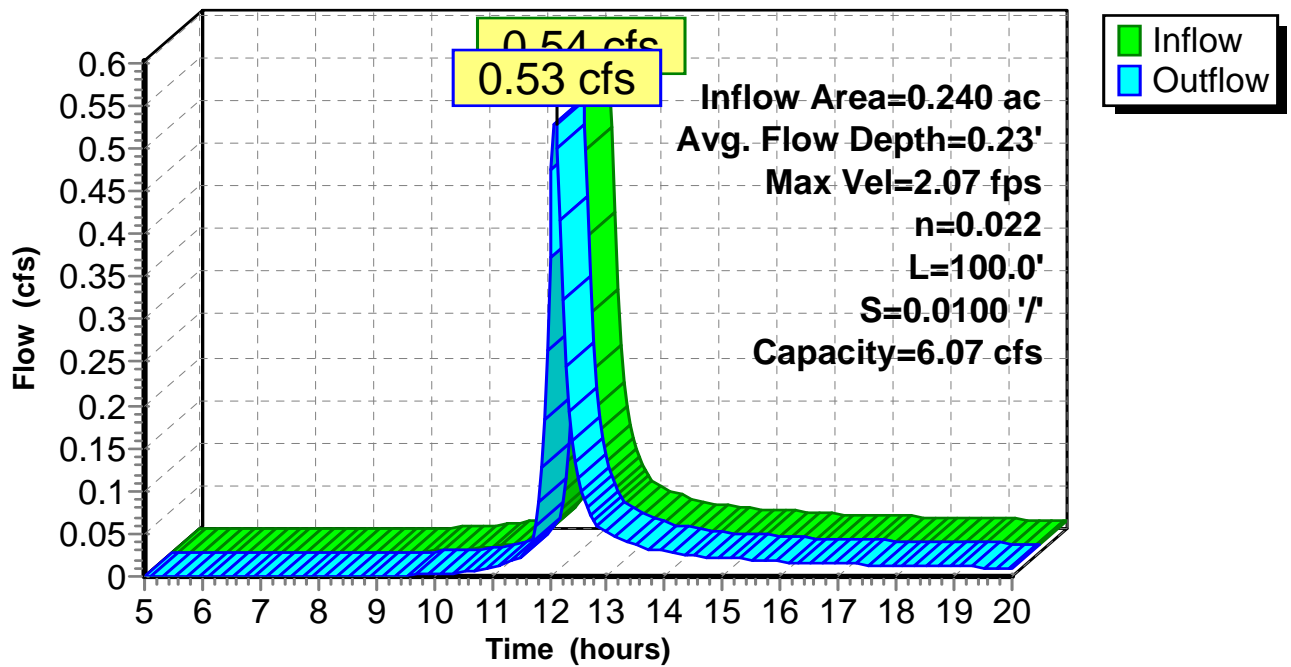
Peak Storage= 26 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



Pre-Conditions_West

Type II 24-hr 10-Year Rainfall=5.70"

Prepared by ERM

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West

Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>3.25"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=1.05 cfs 0.065 af

Reach 2R: Existing Ditch -West

Avg. Flow Depth=0.35' Max Vel=2.54 fps Inflow=1.05 cfs 0.065 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=1.03 cfs 0.065 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.065 af Average Runoff Depth = 3.25"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Pre-Conditions_West

Prepared by ERM

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Type II 24-hr 10-Year Rainfall=5.70"

Printed 2/1/2017

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Summary for Subcatchment 1S: DA-A Pre West

Runoff = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af, Depth> 3.25"

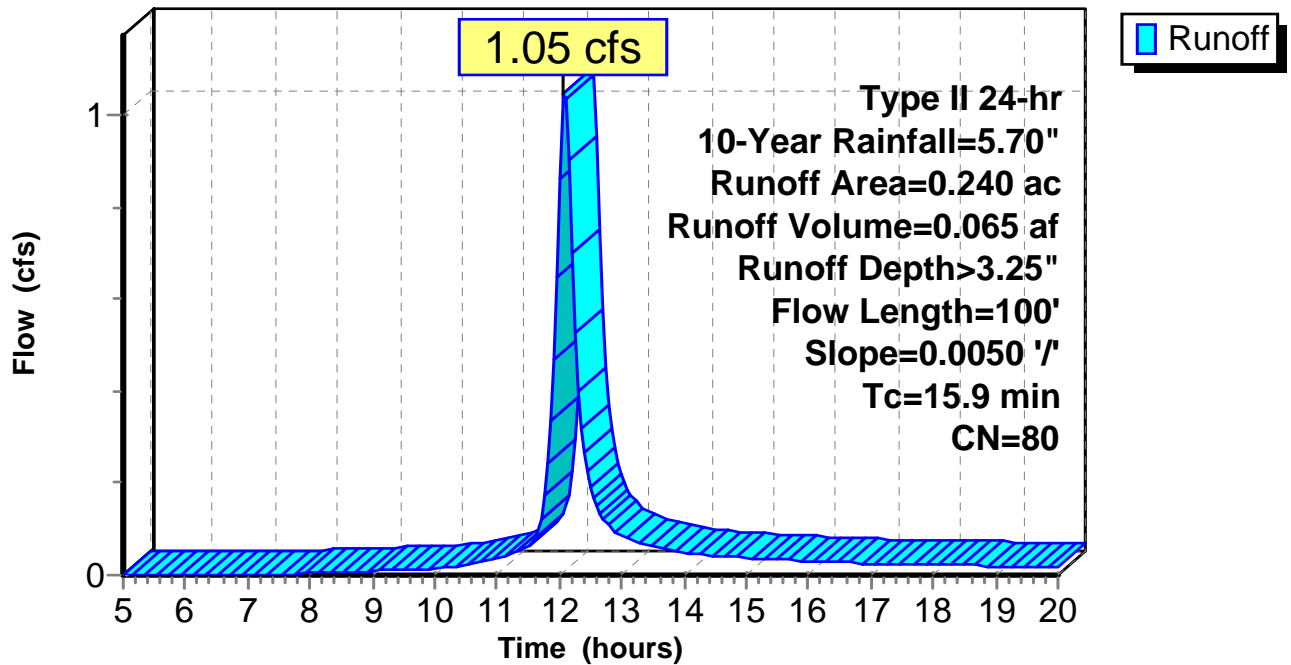
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		Sheet Flow, Sheet Flow over existing Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West

Hydrograph



Pre-Conditions_West

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Type II 24-hr 10-Year Rainfall=5.70"

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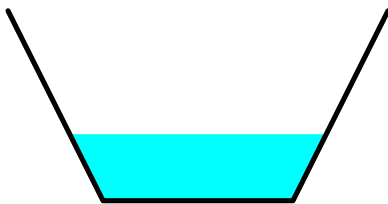
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 3.25" for 10-Year event
Inflow = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af
Outflow = 1.03 cfs @ 12.10 hrs, Volume= 0.065 af, Atten= 1%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.54 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 2.2 min

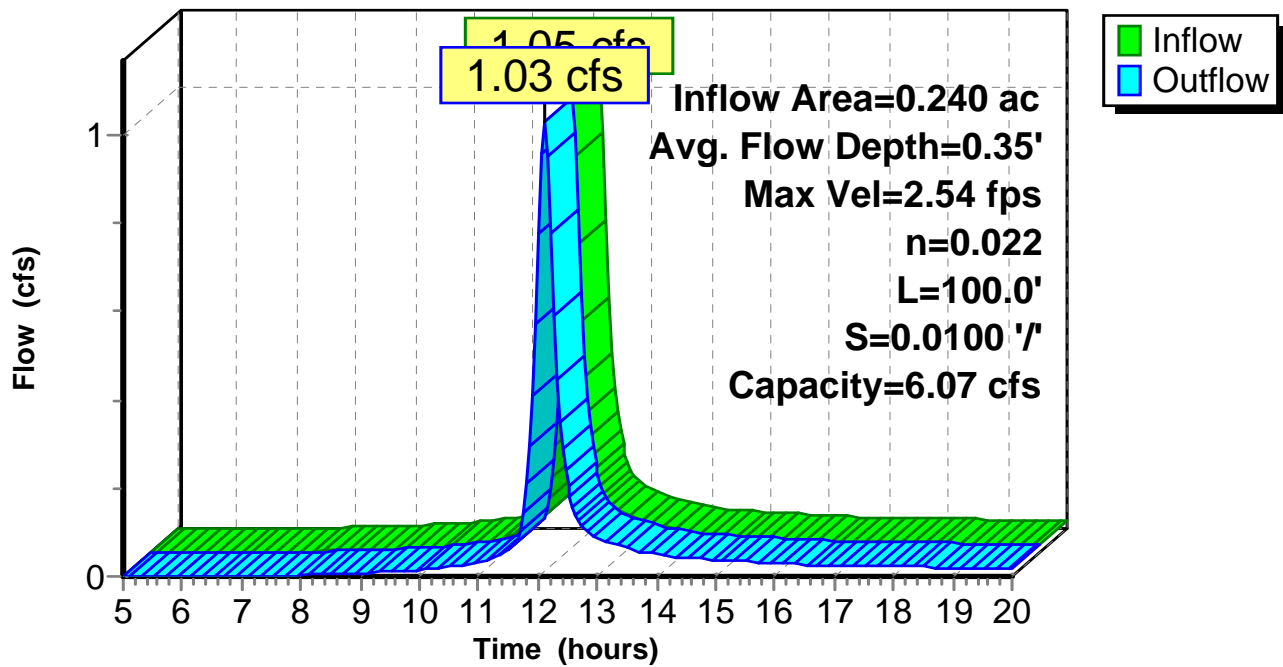
Peak Storage= 41 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



WinTR-20 Printed Page File Beginning of Input Data List
 TR20.inp

WinTR-20: Version 1.10 0 0 0.05
 Elizabeth River
 Post Conditions - East

SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:

STORM ANALYSIS:
 2-Yr 3.7 Type II 2
 10-Yr 5.7 Type II 2
 1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
 2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
 Post Conditions - East

Name of printed page file:
 TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Flow Time (hr)	Flow Rate (cfs)	----- Rate (csm)
DA-2	0.001		2.601		11.92	3.35	2816.55

Line Start Time (hr)	----- Flow (cfs)	Values @ time increment (cfs)	of 0.006 hr (cfs)	----- (cfs)	----- (cfs)	----- (cfs)
8.773	0.05	0.05	0.05	0.05	0.05	0.05
8.817	0.05	0.05	0.05	0.05	0.05	0.05
8.861	0.05	0.05	0.05	0.05	0.05	0.05
8.905	0.05	0.05	0.05	0.05	0.05	0.05
8.950	0.05	0.05	0.05	0.05	0.06	0.06
8.994	0.06	0.06	0.06	0.06	0.06	0.06
9.038	0.06	0.06	0.06	0.06	0.06	0.06
9.082	0.06	0.06	0.06	0.06	0.06	0.06
9.127	0.06	0.06	0.06	0.06	0.06	0.06
9.171	0.06	0.06	0.06	0.06	0.06	0.06
9.215	0.06	0.06	0.06	0.06	0.06	0.06
9.259	0.06	0.06	0.06	0.06	0.06	0.06
9.303	0.06	0.06	0.06	0.06	0.06	0.06
9.348	0.06	0.06	0.06	0.06	0.06	0.06
9.392	0.06	0.06	0.06	0.06	0.06	0.06
9.436	0.06	0.06	0.06	0.06	0.06	0.06
9.480	0.06	0.06	0.06	0.06	0.06	0.06
9.524	0.06	0.06	0.06	0.06	0.06	0.06
9.569	0.06	0.06	0.06	0.06	0.06	0.06
9.613	0.06	0.06	0.06	0.06	0.06	0.06
9.657	0.06	0.06	0.06	0.06	0.07	0.07
9.701	0.07	0.07	0.07	0.07	0.07	0.07
9.745	0.07	0.07	0.07	0.07	0.07	0.07
9.790	0.07	0.07	0.07	0.07	0.07	0.07
9.834	0.07	0.07	0.07	0.07	0.07	0.07
9.878	0.07	0.07	0.07	0.07	0.07	0.07
9.922	0.07	0.07	0.07	0.07	0.08	0.08
9.967	0.08	0.08	0.08	0.08	0.08	0.08
10.011	0.08	0.08	0.08	0.08	0.08	0.08
10.055	0.08	0.08	0.08	0.08	0.08	0.08
10.099	0.08	0.08	0.08	0.08	0.08	0.08
10.143	0.08	0.08	0.08	0.09	0.09	0.09
10.188	0.09	0.09	0.09	0.09	0.09	0.09

10.232	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.276	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.320	0.09	0.09	0.09	0.10	0.10	0.10	0.10
10.364	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.409	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.453	0.10	0.10	0.10	0.10	0.10	0.10	0.11
10.497	0.11	0.11	0.11	0.11	0.11	0.11	0.11

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Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.541	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.585	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.630	0.11	0.12	0.12	0.12	0.12	0.12	0.12
10.674	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10.718	0.12	0.12	0.12	0.13	0.13	0.13	0.13
10.762	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10.807	0.13	0.13	0.13	0.13	0.13	0.14	0.14
10.851	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.895	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.939	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.983	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11.028	0.16	0.16	0.16	0.16	0.16	0.16	0.16
11.072	0.16	0.16	0.17	0.17	0.17	0.17	0.17
11.116	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.160	0.18	0.18	0.18	0.19	0.19	0.19	0.19
11.204	0.19	0.19	0.19	0.19	0.20	0.20	0.20
11.249	0.20	0.20	0.20	0.21	0.21	0.21	0.21
11.293	0.21	0.21	0.22	0.22	0.22	0.22	0.22
11.337	0.22	0.22	0.23	0.23	0.23	0.23	0.23
11.381	0.23	0.24	0.24	0.24	0.24	0.24	0.24
11.425	0.24	0.24	0.25	0.25	0.25	0.25	0.25
11.470	0.26	0.26	0.26	0.26	0.26	0.26	0.27
11.514	0.27	0.28	0.28	0.30	0.31	0.33	0.35
11.558	0.37	0.40	0.42	0.44	0.46	0.47	0.49
11.602	0.50	0.52	0.53	0.55	0.57	0.60	0.64
11.647	0.68	0.72	0.77	0.82	0.86	0.90	0.94
11.691	0.98	1.01	1.03	1.06	1.08	1.11	1.15
11.735	1.19	1.24	1.30	1.36	1.42	1.49	1.54
11.779	1.60	1.65	1.70	1.73	1.77	1.81	1.85
11.823	1.90	1.97	2.06	2.17	2.29	2.41	2.54
11.868	2.67	2.79	2.91	3.01	3.11	3.18	3.25
11.912	3.30	3.33	3.35	3.35	3.33	3.29	3.24
11.956	3.18	3.12	3.05	2.98	2.92	2.87	2.82
12.000	2.78	2.74	2.70	2.65	2.58	2.49	2.37
12.044	2.24	2.08	1.92	1.76	1.60	1.45	1.32
12.089	1.19	1.09	1.00	0.92	0.86	0.81	0.76
12.133	0.72	0.69	0.65	0.63	0.60	0.58	0.56
12.177	0.55	0.53	0.52	0.51	0.50	0.49	0.48
12.221	0.48	0.47	0.47	0.46	0.45	0.45	0.44
12.265	0.43	0.43	0.42	0.42	0.41	0.41	0.41
12.310	0.40	0.40	0.40	0.40	0.39	0.39	0.38
12.354	0.38	0.37	0.37	0.36	0.36	0.35	0.35
12.398	0.35	0.34	0.34	0.34	0.34	0.33	0.33
12.442	0.32	0.32	0.31	0.31	0.30	0.30	0.30
12.487	0.29	0.29	0.28	0.28	0.28	0.28	0.28
12.531	0.27	0.27	0.27	0.26	0.26	0.26	0.25
12.575	0.25	0.25	0.24	0.24	0.24	0.24	0.24
12.619	0.24	0.24	0.23	0.23	0.23	0.23	0.23
12.663	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.708	0.22	0.22	0.22	0.22	0.22	0.22	0.21
12.752	0.21	0.21	0.21	0.21	0.21	0.21	0.21

WinTR-20 Version 1.10

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WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

SUB-AREA: STORM 2-Yr
DA-2 Outlet .00119 94. .1

STREAM REACH:

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.796	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.840	0.20	0.20	0.20	0.20	0.20	0.20	0.19
12.884	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.929	0.19	0.19	0.19	0.19	0.18	0.18	0.18
12.973	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.017	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.061	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.105	0.17	0.17	0.16	0.16	0.16	0.16	0.16
13.150	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.194	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.238	0.16	0.15	0.15	0.15	0.15	0.15	0.15
13.282	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.327	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.371	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.415	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.459	0.14	0.14	0.14	0.14	0.14	0.14	0.13
13.503	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.548	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.592	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.636	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.680	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.724	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.769	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.813	0.12	0.12	0.12	0.12	0.12	0.11	0.11
13.857	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.901	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.945	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.990	0.11	0.11	0.11	0.11	0.11	0.11	0.10
14.034	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.078	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

 STORM 2-Yr
SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:

14.122	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.167	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.211	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.255	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.299	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.343	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.388	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.432	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.520	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.564	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.609	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.653	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.697	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.741	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.785	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.830	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.874	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.918	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.962	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.007	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
15.051	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.095	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.139	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.183	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.228	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.272	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.316	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

15.360	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.404	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.449	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07
15.493	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.537	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.670	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.758	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.802	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.979	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06
16.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.068	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.112	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.156	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.200	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.244	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.289	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.333	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.377	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.421	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.465	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.510	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.554	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.598	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.642	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.687	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.731	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.775	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.819	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.863	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.908	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.952	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.996	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05 (continued)
beth River
Post Conditions - East

 STORM 2-Yr
SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:

17.040	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.084	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.129	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.173	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.217	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.261	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
17.305	0.06	0.06	0.06	0.06	0.06	0.05	0.05
17.350	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.394	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.438	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.482	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.527	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.571	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.615	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.659	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.703	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.748	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.792	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.836	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.880	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.924	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.969	0.05	0.05	0.05	0.05	0.05	0.05	0.05
18.013	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Rate (csm)
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WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

SUB-AREA:

STORM 2-Yr

DA-2 Outlet .00119 94. .1

STREAM REACH:

OUTLET 0.001 2.601 11.92 3.35 2816.55

Line

Start Time (hr)	Flow (cfs)	Values @ (cfs)	time increment (cfs)	of 0.006 hr (cfs)	Flow (cfs)	Values @ (cfs)	time increment (cfs)	of 0.006 hr (cfs)
8.773	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.817	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.861	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.905	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.950	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
8.994	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.038	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.082	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.127	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.171	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.215	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.259	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.303	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.348	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.392	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.436	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.480	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.524	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.569	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.613	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.657	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07
9.701	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.745	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Elizabeth River
Post Conditions - East

Line

Start Time (hr)	Flow (cfs)	Values @ (cfs)	time increment (cfs)	of 0.006 hr (cfs)	Flow (cfs)	Values @ (cfs)	time increment (cfs)	of 0.006 hr (cfs)
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WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

9.790	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.834	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.878	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.922	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
9.967	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.011	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.055	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.099	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.143	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09
10.188	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.232	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.276	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.320	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10
10.364	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.409	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.453	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11
10.497	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.541	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.585	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.630	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10.674	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10.718	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.13
10.762	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10.807	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14
10.851	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.895	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.939	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.983	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11.028	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
11.072	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17
11.116	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.18
11.160	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.19
11.204	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20
11.249	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21
11.293	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22
11.337	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23
11.381	0.23	0.24	0.24	0.24	0.24	0.24	0.24	0.24

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

11.425	0.24	0.24	0.25	0.25	0.25	0.25	0.25
11.470	0.26	0.26	0.26	0.26	0.26	0.26	0.27
11.514	0.27	0.28	0.28	0.30	0.31	0.33	0.35
11.558	0.37	0.40	0.42	0.44	0.46	0.47	0.49
11.602	0.50	0.52	0.53	0.55	0.57	0.60	0.64
11.647	0.68	0.72	0.77	0.82	0.86	0.90	0.94
11.691	0.98	1.01	1.03	1.06	1.08	1.11	1.15
11.735	1.19	1.24	1.30	1.36	1.42	1.49	1.54
11.779	1.60	1.65	1.70	1.73	1.77	1.81	1.85
11.823	1.90	1.97	2.06	2.17	2.29	2.41	2.54
11.868	2.67	2.79	2.91	3.01	3.11	3.18	3.25
11.912	3.30	3.33	3.35	3.35	3.33	3.29	3.24
11.956	3.18	3.12	3.05	2.98	2.92	2.87	2.82
12.000	2.78	2.74	2.70	2.65	2.58	2.49	2.37

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.044	2.24	2.08	1.92	1.76	1.60	1.45	1.32
12.089	1.19	1.09	1.00	0.92	0.86	0.81	0.76
12.133	0.72	0.69	0.65	0.63	0.60	0.58	0.56
12.177	0.55	0.53	0.52	0.51	0.50	0.49	0.48
12.221	0.48	0.47	0.47	0.46	0.45	0.45	0.44
12.265	0.43	0.43	0.42	0.42	0.41	0.41	0.41
12.310	0.40	0.40	0.40	0.40	0.39	0.39	0.38
12.354	0.38	0.37	0.37	0.36	0.36	0.35	0.35
12.398	0.35	0.34	0.34	0.34	0.34	0.33	0.33
12.442	0.32	0.32	0.31	0.31	0.30	0.30	0.30
12.487	0.29	0.29	0.28	0.28	0.28	0.28	0.28
12.531	0.27	0.27	0.27	0.26	0.26	0.26	0.25
12.575	0.25	0.25	0.24	0.24	0.24	0.24	0.24
12.619	0.24	0.24	0.23	0.23	0.23	0.23	0.23

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

12.663	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
12.708	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21
12.752	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
12.796	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
12.840	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.19
12.884	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.929	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18
12.973	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.017	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17
13.061	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.105	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16
13.150	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.194	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.238	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.282	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.327	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.371	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.415	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.459	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.13
13.503	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.548	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.592	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.636	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12
13.680	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.724	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.769	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.813	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11
13.857	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.901	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.945	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.990	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
14.034	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.078	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.122	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.167	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.211	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.255	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05 (continued)
beth River
Post Conditions - East

STORM 2-Yr

SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:
WinTR-20 Version 1.10 Page 7 01/25/2017 10:44

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr						
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.299	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.343	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.388	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.432	0.10	0.09	0.09	0.09	0.09	0.09	0.09
14.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.520	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.564	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.609	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.653	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.697	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.741	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.785	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.830	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.874	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.918	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.962	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.007	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.051	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.095	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.139	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.183	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.228	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.272	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.316	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.360	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.404	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.449	0.08	0.08	0.08	0.08	0.08	0.07	0.07
15.493	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.537	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

15.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.670	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.758	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.802	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.979	0.07	0.07	0.06	0.06	0.06	0.06	0.06
16.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.068	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.112	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.156	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.200	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.244	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.289	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.333	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.377	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.421	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.465	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.510	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - East

Line Start Time (hr)	----- (cfs)	Flow Values @ time (cfs)	increment of (cfs)	0.006 hr (cfs)	----- (cfs)	(cfs)	(cfs)
16.554	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.598	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.642	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.687	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.731	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.775	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 2-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

16.819	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.863	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.908	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.952	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.996	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.040	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.084	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.129	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.173	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.217	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.261	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.305	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
17.350	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.394	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.438	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.482	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.527	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.571	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.615	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.659	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.703	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.748	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.792	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.836	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.880	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.924	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.969	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
18.013	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

STORM 10-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	----- Rate (csm)
DA-2	0.001		4.790		11.93	5.37	4511.72

Line

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

 STORM 10-Yr
SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:

Start Time	Flow Values @ time increment of 0.006 hr						
(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
6.536	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.580	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.624	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.669	0.05	0.05	0.05	0.05	0.05	0.05	0.05

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Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
6.713	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.757	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.934	0.05	0.05	0.06	0.06	0.06	0.06	0.06
6.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.199	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.243	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.287	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.332	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.376	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.420	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.464	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.509	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.553	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.597	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

7.641	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.685	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.730	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07
7.774	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.818	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.862	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.906	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.951	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.995	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.039	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.083	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.127	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.172	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.216	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08
8.260	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.304	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.349	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.393	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.437	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.481	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09
8.525	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.570	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.614	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.658	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.702	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.746	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.791	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.835	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.879	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.923	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Elizabeth River
Post Conditions - East

Line
Start Time ----- Flow Values @ time increment of 0.006 hr -----

WinTR-20: Version 1.10
 beth River
 Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
8.967	0.10	0.10	0.10	0.10	0.11	0.11	0.11
9.012	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.056	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.100	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.144	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.189	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.233	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.277	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.321	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.365	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.410	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.454	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.498	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.542	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.586	0.11	0.11	0.11	0.11	0.11	0.12	0.12
9.631	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.675	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.719	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.763	0.12	0.12	0.13	0.13	0.13	0.13	0.13
9.807	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.852	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.896	0.13	0.13	0.13	0.13	0.13	0.13	0.14
9.940	0.14	0.14	0.14	0.14	0.14	0.14	0.14
9.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.029	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.073	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.117	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.161	0.15	0.15	0.15	0.16	0.16	0.16	0.16
10.205	0.16	0.16	0.16	0.16	0.16	0.16	0.16
10.250	0.16	0.16	0.16	0.16	0.16	0.17	0.17
10.294	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.338	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.382	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.426	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.471	0.18	0.18	0.19	0.19	0.19	0.19	0.19
10.515	0.19	0.19	0.19	0.19	0.19	0.19	0.19

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

10.559	0.19	0.19	0.20	0.20	0.20	0.20	0.20
10.603	0.20	0.20	0.20	0.20	0.20	0.20	0.20
10.647	0.21	0.21	0.21	0.21	0.21	0.21	0.21
10.692	0.21	0.21	0.22	0.22	0.22	0.22	0.22
10.736	0.22	0.22	0.22	0.22	0.22	0.23	0.23
10.780	0.23	0.23	0.23	0.23	0.23	0.23	0.23
10.824	0.23	0.23	0.24	0.24	0.24	0.24	0.24
10.869	0.24	0.24	0.25	0.25	0.25	0.25	0.25
10.913	0.25	0.25	0.25	0.25	0.25	0.25	0.26
10.957	0.26	0.26	0.26	0.26	0.26	0.26	0.26
11.001	0.26	0.27	0.27	0.27	0.27	0.27	0.27
11.045	0.27	0.28	0.28	0.28	0.28	0.28	0.29
11.090	0.29	0.29	0.29	0.29	0.29	0.29	0.30
11.134	0.30	0.30	0.30	0.31	0.31	0.31	0.32
11.178	0.32	0.32	0.32	0.33	0.33	0.33	0.33

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.222	0.33	0.33	0.34	0.34	0.34	0.35	0.35
11.266	0.35	0.36	0.36	0.36	0.36	0.37	0.37
11.311	0.37	0.37	0.37	0.37	0.38	0.38	0.38
11.355	0.39	0.39	0.39	0.40	0.40	0.40	0.40
11.399	0.41	0.41	0.41	0.41	0.41	0.42	0.42
11.443	0.42	0.42	0.43	0.43	0.43	0.44	0.44
11.487	0.44	0.44	0.45	0.45	0.45	0.46	0.48
11.532	0.49	0.52	0.55	0.59	0.62	0.66	0.70
11.576	0.73	0.76	0.79	0.82	0.84	0.86	0.88
11.620	0.91	0.95	0.99	1.05	1.12	1.19	1.27
11.664	1.35	1.42	1.49	1.55	1.61	1.66	1.71
11.709	1.75	1.79	1.83	1.89	1.96	2.04	2.13
11.753	2.23	2.33	2.42	2.52	2.61	2.69	2.76

WinTR-20: Version 1.10
 beth River
 Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

11.797	2.83	2.88	2.94	3.01	3.09	3.19	3.32
11.841	3.49	3.67	3.87	4.08	4.28	4.48	4.66
11.885	4.83	4.98	5.10	5.21	5.28	5.34	5.37
11.930	5.37	5.34	5.28	5.19	5.10	4.99	4.88
11.974	4.77	4.67	4.58	4.50	4.43	4.37	4.30
12.018	4.22	4.11	3.98	3.80	3.58	3.34	3.09
12.062	2.83	2.58	2.34	2.12	1.92	1.75	1.60
12.106	1.48	1.38	1.29	1.22	1.15	1.09	1.04
12.151	1.00	0.96	0.92	0.89	0.87	0.84	0.82
12.195	0.80	0.79	0.78	0.77	0.76	0.75	0.74
12.239	0.73	0.72	0.71	0.70	0.69	0.68	0.67
12.283	0.66	0.65	0.65	0.64	0.64	0.63	0.63
12.327	0.62	0.62	0.61	0.60	0.60	0.59	0.58
12.372	0.57	0.56	0.56	0.55	0.55	0.54	0.54
12.416	0.53	0.53	0.53	0.52	0.51	0.51	0.50
12.460	0.49	0.48	0.47	0.47	0.46	0.45	0.45
12.504	0.44	0.44	0.44	0.43	0.43	0.43	0.42
12.549	0.42	0.41	0.40	0.40	0.39	0.39	0.39
12.593	0.38	0.38	0.38	0.37	0.37	0.37	0.37
12.637	0.37	0.36	0.36	0.36	0.36	0.35	0.35
12.681	0.35	0.35	0.35	0.35	0.35	0.34	0.34
12.725	0.34	0.34	0.34	0.34	0.34	0.33	0.33
12.770	0.33	0.33	0.33	0.33	0.32	0.32	0.32
12.814	0.32	0.32	0.32	0.32	0.32	0.32	0.31
12.858	0.31	0.31	0.31	0.31	0.30	0.30	0.30
12.902	0.30	0.30	0.30	0.30	0.30	0.30	0.29
12.946	0.29	0.29	0.29	0.29	0.29	0.28	0.28
12.991	0.28	0.28	0.28	0.28	0.28	0.28	0.28
13.035	0.27	0.27	0.27	0.27	0.27	0.27	0.27
13.079	0.26	0.26	0.26	0.26	0.26	0.26	0.26
13.123	0.26	0.26	0.26	0.26	0.25	0.25	0.25
13.167	0.25	0.25	0.25	0.25	0.25	0.25	0.25
13.212	0.25	0.25	0.25	0.24	0.24	0.24	0.24
13.256	0.24	0.24	0.24	0.24	0.24	0.24	0.24
13.300	0.24	0.24	0.23	0.23	0.23	0.23	0.23
13.344	0.23	0.23	0.23	0.23	0.23	0.23	0.23
13.389	0.22	0.22	0.22	0.22	0.22	0.22	0.22
13.433	0.22	0.22	0.22	0.22	0.22	0.22	0.21

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr
SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Elizabeth River
Post Conditions - East

Line	Start Time	Flow Values @ time increment of 0.006 hr					
(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
13.477	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.521	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.565	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.610	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.654	0.20	0.20	0.19	0.19	0.19	0.19	0.19
13.698	0.19	0.19	0.19	0.19	0.19	0.19	0.19
13.742	0.19	0.19	0.19	0.19	0.19	0.19	0.19
13.786	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.831	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.875	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.919	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.963	0.17	0.17	0.17	0.17	0.17	0.17	0.17
14.007	0.17	0.17	0.16	0.16	0.16	0.16	0.16
14.052	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.096	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.140	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.184	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.229	0.16	0.15	0.15	0.15	0.15	0.15	0.15
14.273	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.317	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.361	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.405	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.450	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.494	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.538	0.15	0.15	0.15	0.15	0.14	0.14	0.14
14.582	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.626	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.671	0.14	0.14	0.14	0.14	0.14	0.14	0.14

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

14.715	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.759	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.803	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.847	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.892	0.14	0.13	0.13	0.13	0.13	0.13	0.13
14.936	0.13	0.13	0.13	0.13	0.13	0.13	0.13
14.980	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.024	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.069	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.113	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.157	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.201	0.13	0.13	0.13	0.13	0.13	0.12	0.12
15.245	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.290	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.334	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.378	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.466	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.511	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.555	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.643	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.687	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
15.732	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.776	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.820	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.864	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.909	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

15.953	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.997	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.085	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.130	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.174	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.218	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.262	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.306	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.351	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.395	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.439	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.483	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.527	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.572	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.616	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.660	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.704	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.749	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.793	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.837	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.881	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.970	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.014	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.058	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.102	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.146	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.191	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.235	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.279	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.323	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.367	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08
17.412	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.456	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.500	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.544	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.589	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05 (continued)
beth River
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

17.633	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.677	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.721	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.765	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.810	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.854	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.898	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.942	0.08	0.08	0.08	0.08	0.08	0.08	0.08

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Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
17.986	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.031	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.075	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.119	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.163	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.207	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.252	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.296	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.340	0.08	0.08	0.07	0.07	0.07	0.07	0.07
18.384	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.429	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.473	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.517	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.561	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.605	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.650	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.694	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.738	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.782	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.826	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

18.871	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.915	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.959	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.003	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.047	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.092	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.136	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.180	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.224	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.269	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.313	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.357	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.401	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.445	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.490	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.534	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.578	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.622	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.666	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.711	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.755	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.799	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.843	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.887	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.932	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.976	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.020	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.064	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.153	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.197	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - East

Line

WinTR-20: Version 1.10
 beth River
 Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

Start Time (hr)	Flow Values @ time increment of 0.006 hr						
(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
20.241	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.285	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.330	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.374	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.418	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.462	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.506	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.551	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.595	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.639	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.683	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.727	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.772	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.816	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.860	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.904	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.949	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.993	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.037	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.081	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.125	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.170	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.214	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.258	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.302	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.346	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.391	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.435	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.479	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.523	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.567	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.612	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.656	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.700	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.744	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

21.789	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.833	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.877	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.921	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.965	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.010	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.054	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.098	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.142	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.186	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.231	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.275	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.319	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.363	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.407	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.452	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
22.496	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.540	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.584	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.629	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.673	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.717	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.761	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.850	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.938	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Rate (csm)
OUTLET	0.001		4.790		11.93	5.37	4511.72

Line Start Time (hr)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
6.536	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.580	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.624	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.669	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.713	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.757	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.934	0.05	0.05	0.06	0.06	0.06	0.06	0.06
6.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.199	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.243	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.287	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.332	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.376	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.420	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.464	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.509	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.553	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.597	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.641	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.685	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.730	0.06	0.06	0.06	0.06	0.06	0.06	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:
 7.774 0.07 0.07 0.07 0.07 0.07 0.07 0.07

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Elizabeth River
Post Conditions - East

Line Start Time (hr)	----- (cfs)	Flow Values @ time (cfs)	increment (cfs)	of (cfs)	0.006 hr (cfs)	----- (cfs)	----- (cfs)
7.818	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.862	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.906	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.951	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.995	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.039	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.083	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.127	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.172	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.216	0.07	0.07	0.07	0.07	0.07	0.08	0.08
8.260	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.304	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.349	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.393	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.437	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.481	0.08	0.08	0.08	0.09	0.09	0.09	0.09
8.525	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.570	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.614	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.658	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.702	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.746	0.09	0.10	0.10	0.10	0.10	0.10	0.10
8.791	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.835	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.879	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.923	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.967	0.10	0.10	0.10	0.10	0.11	0.11	0.11

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

9.012	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.056	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.100	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.144	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.189	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.233	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.277	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.321	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.365	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.410	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.454	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.498	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.542	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.586	0.11	0.11	0.11	0.11	0.12	0.12	0.12
9.631	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.675	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.719	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.763	0.12	0.12	0.13	0.13	0.13	0.13	0.13
9.807	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.852	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.896	0.13	0.13	0.13	0.13	0.13	0.13	0.14
9.940	0.14	0.14	0.14	0.14	0.14	0.14	0.14
9.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.029	0.14	0.14	0.14	0.14	0.14	0.14	0.15

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.073	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.117	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.161	0.15	0.15	0.15	0.16	0.16	0.16	0.16
10.205	0.16	0.16	0.16	0.16	0.16	0.16	0.16

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

10.250	0.16	0.16	0.16	0.16	0.16	0.17	0.17
10.294	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.338	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.382	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.426	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.471	0.18	0.18	0.19	0.19	0.19	0.19	0.19
10.515	0.19	0.19	0.19	0.19	0.19	0.19	0.19
10.559	0.19	0.19	0.20	0.20	0.20	0.20	0.20
10.603	0.20	0.20	0.20	0.20	0.20	0.20	0.20
10.647	0.21	0.21	0.21	0.21	0.21	0.21	0.21
10.692	0.21	0.21	0.22	0.22	0.22	0.22	0.22
10.736	0.22	0.22	0.22	0.22	0.22	0.23	0.23
10.780	0.23	0.23	0.23	0.23	0.23	0.23	0.23
10.824	0.23	0.23	0.24	0.24	0.24	0.24	0.24
10.869	0.24	0.24	0.25	0.25	0.25	0.25	0.25
10.913	0.25	0.25	0.25	0.25	0.25	0.25	0.26
10.957	0.26	0.26	0.26	0.26	0.26	0.26	0.26
11.001	0.26	0.27	0.27	0.27	0.27	0.27	0.27
11.045	0.27	0.28	0.28	0.28	0.28	0.28	0.29
11.090	0.29	0.29	0.29	0.29	0.29	0.29	0.30
11.134	0.30	0.30	0.30	0.31	0.31	0.31	0.32
11.178	0.32	0.32	0.32	0.33	0.33	0.33	0.33
11.222	0.33	0.33	0.34	0.34	0.34	0.35	0.35
11.266	0.35	0.36	0.36	0.36	0.36	0.37	0.37
11.311	0.37	0.37	0.37	0.37	0.38	0.38	0.38
11.355	0.39	0.39	0.39	0.40	0.40	0.40	0.40
11.399	0.41	0.41	0.41	0.41	0.41	0.42	0.42
11.443	0.42	0.42	0.43	0.43	0.43	0.44	0.44
11.487	0.44	0.44	0.45	0.45	0.45	0.46	0.48
11.532	0.49	0.52	0.55	0.59	0.62	0.66	0.70
11.576	0.73	0.76	0.79	0.82	0.84	0.86	0.88
11.620	0.91	0.95	0.99	1.05	1.12	1.19	1.27
11.664	1.35	1.42	1.49	1.55	1.61	1.66	1.71
11.709	1.75	1.79	1.83	1.89	1.96	2.04	2.13
11.753	2.23	2.33	2.42	2.52	2.61	2.69	2.76
11.797	2.83	2.88	2.94	3.01	3.09	3.19	3.32
11.841	3.49	3.67	3.87	4.08	4.28	4.48	4.66
11.885	4.83	4.98	5.10	5.21	5.28	5.34	5.37

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

11.930	5.37	5.34	5.28	5.19	5.10	4.99	4.88
11.974	4.77	4.67	4.58	4.50	4.43	4.37	4.30
12.018	4.22	4.11	3.98	3.80	3.58	3.34	3.09
12.062	2.83	2.58	2.34	2.12	1.92	1.75	1.60
12.106	1.48	1.38	1.29	1.22	1.15	1.09	1.04
12.151	1.00	0.96	0.92	0.89	0.87	0.84	0.82
12.195	0.80	0.79	0.78	0.77	0.76	0.75	0.74
12.239	0.73	0.72	0.71	0.70	0.69	0.68	0.67
12.283	0.66	0.65	0.65	0.64	0.64	0.63	0.63

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.327	0.62	0.62	0.61	0.60	0.60	0.59	0.58
12.372	0.57	0.56	0.56	0.55	0.55	0.54	0.54
12.416	0.53	0.53	0.53	0.52	0.51	0.51	0.50
12.460	0.49	0.48	0.47	0.47	0.46	0.45	0.45
12.504	0.44	0.44	0.44	0.43	0.43	0.43	0.42
12.549	0.42	0.41	0.40	0.40	0.39	0.39	0.39
12.593	0.38	0.38	0.38	0.37	0.37	0.37	0.37
12.637	0.37	0.36	0.36	0.36	0.36	0.35	0.35
12.681	0.35	0.35	0.35	0.35	0.35	0.34	0.34
12.725	0.34	0.34	0.34	0.34	0.34	0.33	0.33
12.770	0.33	0.33	0.33	0.33	0.32	0.32	0.32
12.814	0.32	0.32	0.32	0.32	0.32	0.32	0.31
12.858	0.31	0.31	0.31	0.31	0.30	0.30	0.30
12.902	0.30	0.30	0.30	0.30	0.30	0.30	0.29
12.946	0.29	0.29	0.29	0.29	0.29	0.28	0.28
12.991	0.28	0.28	0.28	0.28	0.28	0.28	0.28
13.035	0.27	0.27	0.27	0.27	0.27	0.27	0.27
13.079	0.26	0.26	0.26	0.26	0.26	0.26	0.26
13.123	0.26	0.26	0.26	0.26	0.25	0.25	0.25

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

13.167	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
13.212	0.25	0.25	0.25	0.24	0.24	0.24	0.24	0.24
13.256	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
13.300	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23
13.344	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
13.389	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
13.433	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21
13.477	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.521	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.565	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.610	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.654	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.19
13.698	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
13.742	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18
13.786	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.831	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.875	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17
13.919	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.963	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
14.007	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16
14.052	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.096	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.140	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.184	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.229	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.273	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.317	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.361	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.405	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.450	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.494	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.538	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14

WinTR-20: Version 1.10
 beth River
 Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.582	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.626	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.671	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.715	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.759	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.803	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.847	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.892	0.14	0.13	0.13	0.13	0.13	0.13	0.13
14.936	0.13	0.13	0.13	0.13	0.13	0.13	0.13
14.980	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.024	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.069	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.113	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.157	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.201	0.13	0.13	0.13	0.13	0.13	0.12	0.12
15.245	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.290	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.334	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.378	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.466	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.511	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.555	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.643	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.687	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.732	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.776	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.820	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.864	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.909	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.953	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.997	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
 beth River (continued)
 Post Conditions - East

STORM 10-Yr

SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:

16.085	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.130	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.174	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.218	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.262	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.306	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.351	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.395	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.439	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.483	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.527	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.572	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.616	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.660	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.704	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.749	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.793	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Elizabeth River
 Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
16.837	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.881	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.970	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.014	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.058	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.102	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.146	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.191	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.235	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.279	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

17.323	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.367	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08
17.412	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.456	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.500	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.544	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.589	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.633	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.677	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.721	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.765	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.810	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.854	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.898	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.942	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.986	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.031	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.075	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.119	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.163	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.207	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.252	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.296	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.340	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
18.384	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.429	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.473	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.517	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.561	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.605	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.650	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.694	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.738	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.782	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.826	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.871	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.915	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.959	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:
19.003 0.07 0.07 0.07 0.07 0.07 0.07 0.07
19.047 0.07 0.07 0.07 0.07 0.07 0.07 0.07

WinTR-20 Version 1.10 Page 22 01/25/2017 10:44

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
19.092	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.136	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.180	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.224	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.269	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.313	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.357	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.401	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.445	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.490	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.534	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.578	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.622	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.666	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.711	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.755	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.799	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.843	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.887	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.932	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.976	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.020	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.064	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.153	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.197	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

20.241	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.285	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.330	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.374	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.418	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.462	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.506	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.551	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.595	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.639	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.683	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.727	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.772	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.816	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.860	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.904	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.949	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.993	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.037	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.081	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.125	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.170	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.214	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.258	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.302	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
21.346	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.391	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.435	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

21.479	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.523	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.567	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.612	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.656	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.700	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.744	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.789	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.833	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.877	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.921	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.965	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.010	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.054	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.098	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.142	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.186	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.231	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.275	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.319	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.363	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.407	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.452	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.496	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.540	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.584	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.629	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.673	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.717	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.761	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.850	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.938	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

STORM 1-Yr

Area or Drainage Rain Gage Runoff ----- Peak Flow -----

WinTR-20: Version 1.10 0 0 0.05 (continued)
 beth River
 Post Conditions - East

STORM 1-Yr

SUB-AREA:
 DA-2 Outlet .00119 94. .1

STREAM REACH:							
Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-2	0.001		1.869		11.93	2.64	2216.42

Elizabeth River
 Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
9.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.934	0.05	0.05	0.05	0.05	0.05	0.05	0.06
9.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.199	0.06	0.06	0.06	0.06	0.06	0.06	0.07
10.243	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.287	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.332	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.376	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.420	0.07	0.07	0.07	0.07	0.07	0.07	0.08
10.464	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.509	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.553	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

10.597	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09
10.641	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.685	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.730	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10
10.774	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.818	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.862	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11
10.906	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.951	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.995	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12
11.039	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.083	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.13
11.127	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14
11.172	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.216	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11.260	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
11.304	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.349	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.393	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
11.437	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20
11.481	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.21
11.525	0.21	0.22	0.23	0.25	0.26	0.28	0.28	0.30
11.570	0.31	0.33	0.35	0.36	0.37	0.38	0.38	0.39
11.614	0.40	0.41	0.43	0.45	0.48	0.51	0.51	0.55
11.658	0.58	0.62	0.65	0.69	0.72	0.74	0.74	0.77
11.702	0.79	0.81	0.83	0.85	0.88	0.91	0.91	0.95
11.746	0.99	1.04	1.09	1.14	1.19	1.23	1.23	1.27
11.791	1.31	1.34	1.37	1.40	1.43	1.47	1.47	1.52
11.835	1.59	1.67	1.76	1.86	1.97	2.07	2.07	2.17
11.879	2.26	2.34	2.42	2.49	2.54	2.58	2.58	2.62
11.923	2.63	2.64	2.63	2.60	2.56	2.52	2.52	2.47
11.967	2.42	2.37	2.32	2.28	2.24	2.21	2.21	2.18
12.012	2.14	2.11	2.05	1.99	1.90	1.79	1.79	1.67

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.056	1.55	1.42	1.29	1.18	1.07	0.97	0.88
12.100	0.81	0.74	0.69	0.65	0.61	0.58	0.55
12.144	0.52	0.50	0.48	0.46	0.45	0.44	0.42
12.189	0.41	0.41	0.40	0.39	0.39	0.38	0.38
12.233	0.37	0.37	0.36	0.36	0.35	0.35	0.34
12.277	0.34	0.33	0.33	0.33	0.32	0.32	0.32
12.321	0.32	0.32	0.31	0.31	0.31	0.30	0.30
12.365	0.29	0.29	0.29	0.28	0.28	0.28	0.27
12.410	0.27	0.27	0.27	0.27	0.26	0.26	0.26
12.454	0.25	0.25	0.24	0.24	0.24	0.23	0.23
12.498	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.542	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.586	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.631	0.19	0.19	0.18	0.18	0.18	0.18	0.18
12.675	0.18	0.18	0.18	0.18	0.18	0.18	0.17
12.719	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.763	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.807	0.16	0.16	0.16	0.16	0.16	0.16	0.16
12.852	0.16	0.16	0.16	0.16	0.16	0.15	0.15
12.896	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12.940	0.15	0.15	0.15	0.15	0.15	0.14	0.14
12.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.029	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.073	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.117	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.161	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.205	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.250	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.294	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.338	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.382	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.426	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.471	0.11	0.11	0.11	0.11	0.11	0.11	0.11

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

14.753	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.797	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.841	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.885	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.930	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.974	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.018	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.062	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.106	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.151	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.195	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.239	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.372	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.416	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.460	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.504	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.549	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.593	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.637	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.681	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.725	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.770	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
15.814	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.858	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.902	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.946	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.991	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.035	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.079	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.123	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.167	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.212	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	----- Peak Flow Time (hr)	----- Rate (cfs)	----- Rate (csm)
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WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

SUB-AREA:
DA-2

Outlet

STORM 1-Yr

.00119 94. .1

STREAM REACH:

OUTLET 0.001 1.869 11.93 2.64 2216.42

WinTR-20 Version 1.10

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Elizabeth River
Post Conditions - East

Line	Start Time (hr)	Flow (cfs)	Values (cfs)	@ time (cfs)	increment (cfs)	of (cfs)	0.006 hr (cfs)	----- (cfs)
	9.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	9.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	9.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	9.934	0.05	0.05	0.05	0.05	0.05	0.05	0.06
	9.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	10.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	10.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	10.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	10.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	10.199	0.06	0.06	0.06	0.06	0.06	0.06	0.07
	10.243	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	10.287	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	10.332	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	10.376	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	10.420	0.07	0.07	0.07	0.07	0.07	0.07	0.08
	10.464	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	10.509	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	10.553	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	10.597	0.08	0.08	0.08	0.08	0.08	0.08	0.09
	10.641	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	10.685	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	10.730	0.09	0.09	0.09	0.09	0.09	0.09	0.10
	10.774	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	10.818	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	10.862	0.10	0.10	0.10	0.10	0.11	0.11	0.11

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

10.906	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.951	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.995	0.11	0.11	0.11	0.11	0.12	0.12	0.12
11.039	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.083	0.12	0.12	0.13	0.13	0.13	0.13	0.13
11.127	0.13	0.13	0.13	0.13	0.13	0.13	0.14
11.172	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.216	0.14	0.15	0.15	0.15	0.15	0.15	0.15
11.260	0.15	0.15	0.16	0.16	0.16	0.16	0.16
11.304	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.349	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.393	0.18	0.18	0.18	0.18	0.18	0.18	0.18
11.437	0.19	0.19	0.19	0.19	0.19	0.19	0.20
11.481	0.20	0.20	0.20	0.20	0.20	0.20	0.21
11.525	0.21	0.22	0.23	0.25	0.26	0.28	0.30
11.570	0.31	0.33	0.35	0.36	0.37	0.38	0.39
11.614	0.40	0.41	0.43	0.45	0.48	0.51	0.55
11.658	0.58	0.62	0.65	0.69	0.72	0.74	0.77
11.702	0.79	0.81	0.83	0.85	0.88	0.91	0.95
11.746	0.99	1.04	1.09	1.14	1.19	1.23	1.27
11.791	1.31	1.34	1.37	1.40	1.43	1.47	1.52
11.835	1.59	1.67	1.76	1.86	1.97	2.07	2.17
11.879	2.26	2.34	2.42	2.49	2.54	2.58	2.62
11.923	2.63	2.64	2.63	2.60	2.56	2.52	2.47
11.967	2.42	2.37	2.32	2.28	2.24	2.21	2.18
12.012	2.14	2.11	2.05	1.99	1.90	1.79	1.67

Elizabeth River
Post Conditions - East

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.056	1.55	1.42	1.29	1.18	1.07	0.97	0.88
12.100	0.81	0.74	0.69	0.65	0.61	0.58	0.55

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

12.144	0.52	0.50	0.48	0.46	0.45	0.44	0.42
12.189	0.41	0.41	0.40	0.39	0.39	0.38	0.38
12.233	0.37	0.37	0.36	0.36	0.35	0.35	0.34
12.277	0.34	0.33	0.33	0.33	0.32	0.32	0.32
12.321	0.32	0.32	0.31	0.31	0.31	0.30	0.30
12.365	0.29	0.29	0.29	0.28	0.28	0.28	0.27
12.410	0.27	0.27	0.27	0.27	0.26	0.26	0.26
12.454	0.25	0.25	0.24	0.24	0.24	0.23	0.23
12.498	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.542	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.586	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.631	0.19	0.19	0.18	0.18	0.18	0.18	0.18
12.675	0.18	0.18	0.18	0.18	0.18	0.18	0.17
12.719	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.763	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.807	0.16	0.16	0.16	0.16	0.16	0.16	0.16
12.852	0.16	0.16	0.16	0.16	0.16	0.15	0.15
12.896	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12.940	0.15	0.15	0.15	0.15	0.15	0.14	0.14
12.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.029	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.073	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.117	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.161	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.205	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.250	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.294	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.338	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.382	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.426	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.471	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.515	0.11	0.11	0.11	0.11	0.11	0.11	0.10
13.559	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.603	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.647	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.692	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.736	0.10	0.10	0.10	0.10	0.10	0.09	0.09
13.780	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr
SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

13.824	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.869	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.913	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.957	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08
14.001	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.045	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.090	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.134	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.178	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.222	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.266	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line

Start Time (hr) ----- Flow Values @ time increment of 0.006 hr ----- (cfs) (cfs) (cfs) (cfs) (cfs) (cfs) (cfs)

14.311	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.355	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.399	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.443	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.487	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
14.532	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.576	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.620	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.664	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.708	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.753	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.797	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.841	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.885	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.930	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.974	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.018	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

15.062	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.106	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.151	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.195	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.239	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.372	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.416	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.460	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.504	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.549	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.593	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.637	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.681	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.725	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.770	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
15.814	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.858	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.902	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.946	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.991	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.035	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.079	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.123	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.167	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.212	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet .00119 94. .1

STREAM REACH:

Post Conditions - East

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm			
			2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)
DA-2	0.001		3.35	5.37	2.64	
OUTLET	0.001		3.35	5.37	2.64	

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Post Conditions - East

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-2 Outlet

.00119 94. .1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
 TR20.inp

WinTR-20: Version 1.10 0 0 0.05
 Elizabeth River
 Post Conditions - West

SUB-AREA:
 DA-1 Outlet .00038 91. .1

STREAM REACH:

STORM ANALYSIS:
 2-Yr 3.7 Type II 2
 10-Yr 5.7 Type II 2
 1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
 2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
 Post Conditions - West

Name of printed page file:
 TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Flow Time (hr)	----- Rate (cfs)	----- Rate (csm)
DA-1	0.380E-03		1.659		11.93	0.99	2614.35

Line Start Time (hr)	----- Flow (cfs)	Values @ time increment (cfs)	of 0.006 hr (cfs)	----- (cfs)	----- (cfs)	----- (cfs)
11.194	0.05	0.05	0.05	0.05	0.05	0.05
11.239	0.05	0.05	0.05	0.05	0.05	0.06
11.283	0.06	0.06	0.06	0.06	0.06	0.06
11.327	0.06	0.06	0.06	0.06	0.06	0.06
11.371	0.06	0.06	0.06	0.06	0.06	0.06
11.415	0.07	0.07	0.07	0.07	0.07	0.07
11.460	0.07	0.07	0.07	0.07	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.09
11.548	0.09	0.10	0.10	0.11	0.12	0.13
11.592	0.13	0.14	0.14	0.14	0.15	0.16
11.636	0.17	0.18	0.19	0.21	0.22	0.24
11.681	0.26	0.27	0.28	0.28	0.29	0.31
11.725	0.32	0.33	0.34	0.36	0.37	0.41
11.769	0.43	0.45	0.46	0.48	0.49	0.51
11.813	0.52	0.54	0.56	0.58	0.61	0.68
11.857	0.72	0.76	0.79	0.83	0.86	0.92
11.902	0.95	0.96	0.98	0.99	0.99	0.99
11.946	0.97	0.96	0.94	0.92	0.90	0.87
11.990	0.85	0.84	0.83	0.82	0.81	0.77
12.034	0.74	0.70	0.66	0.61	0.56	0.47
12.079	0.42	0.38	0.35	0.32	0.29	0.25
12.123	0.24	0.23	0.21	0.20	0.20	0.18
12.167	0.17	0.17	0.16	0.16	0.16	0.15
12.211	0.15	0.15	0.14	0.14	0.14	0.14
12.255	0.14	0.13	0.13	0.13	0.13	0.13
12.300	0.12	0.12	0.12	0.12	0.12	0.12
12.344	0.12	0.12	0.11	0.11	0.11	0.11
12.388	0.11	0.11	0.11	0.10	0.10	0.10
12.432	0.10	0.10	0.10	0.10	0.10	0.09
12.476	0.09	0.09	0.09	0.09	0.09	0.09
12.521	0.08	0.08	0.08	0.08	0.08	0.08
12.565	0.08	0.08	0.08	0.08	0.07	0.07
12.609	0.07	0.07	0.07	0.07	0.07	0.07

12.653	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.697	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.742	0.07	0.07	0.07	0.06	0.06	0.06	0.06
12.786	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.830	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.874	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.919	0.06	0.06	0.06	0.06	0.06	0.06	0.06

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Elizabeth River
Post Conditions - West

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.963	0.06	0.06	0.06	0.06	0.05	0.05	0.05
13.007	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.051	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.095	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.140	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Elevation (ft)	Time (hr)	Flow Rate (cfs)	Rate (csm)
OUTLET	0.380E-03		1.659		11.93	0.99	2614.35

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.194	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.239	0.05	0.05	0.05	0.05	0.05	0.06	0.06
11.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.371	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.415	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.460	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.548	0.09	0.10	0.10	0.11	0.12	0.12	0.13
11.592	0.13	0.14	0.14	0.14	0.15	0.15	0.16
11.636	0.17	0.18	0.19	0.21	0.22	0.23	0.24
11.681	0.26	0.27	0.28	0.28	0.29	0.30	0.31
11.725	0.32	0.33	0.34	0.36	0.37	0.39	0.41
11.769	0.43	0.45	0.46	0.48	0.49	0.50	0.51
11.813	0.52	0.54	0.56	0.58	0.61	0.64	0.68
11.857	0.72	0.76	0.79	0.83	0.86	0.90	0.92
11.902	0.95	0.96	0.98	0.99	0.99	0.99	0.99
11.946	0.97	0.96	0.94	0.92	0.90	0.89	0.87
11.990	0.85	0.84	0.83	0.82	0.81	0.79	0.77
12.034	0.74	0.70	0.66	0.61	0.56	0.51	0.47
12.079	0.42	0.38	0.35	0.32	0.29	0.27	0.25
12.123	0.24	0.23	0.21	0.20	0.20	0.19	0.18
12.167	0.17	0.17	0.16	0.16	0.16	0.15	0.15
12.211	0.15	0.15	0.14	0.14	0.14	0.14	0.14
12.255	0.14	0.13	0.13	0.13	0.13	0.13	0.13
12.300	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.344	0.12	0.12	0.11	0.11	0.11	0.11	0.11
12.388	0.11	0.11	0.11	0.10	0.10	0.10	0.10
12.432	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.521	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.565	0.08	0.08	0.08	0.08	0.07	0.07	0.07
12.609	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.653	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.697	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20 Version 1.10

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WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-1 Outlet .00038 91. .1

STREAM REACH:

10.759	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.803	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.980	0.07	0.07	0.07	0.07	0.08	0.08	0.08
11.024	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.068	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.112	0.08	0.08	0.08	0.08	0.09	0.09	0.09
11.156	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.201	0.09	0.09	0.09	0.09	0.10	0.10	0.10
11.245	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.289	0.10	0.10	0.11	0.11	0.11	0.11	0.11
11.333	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.378	0.11	0.12	0.12	0.12	0.12	0.12	0.12
11.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.466	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.510	0.13	0.13	0.14	0.14	0.15	0.16	0.17
11.554	0.18	0.19	0.20	0.21	0.22	0.23	0.24
11.599	0.24	0.25	0.26	0.26	0.27	0.29	0.30
11.643	0.32	0.34	0.36	0.39	0.41	0.43	0.45

Elizabeth River
Post Conditions - West

Line Start Time (hr)	----- (cfs)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.687	0.47	0.49	0.50	0.51	0.52	0.54	0.55
11.731	0.57	0.60	0.62	0.65	0.68	0.71	0.74
11.775	0.77	0.80	0.82	0.84	0.86	0.88	0.90
11.820	0.92	0.95	0.99	1.03	1.09	1.15	1.21
11.864	1.28	1.34	1.40	1.45	1.50	1.54	1.58
11.908	1.61	1.63	1.64	1.65	1.64	1.63	1.61
11.952	1.58	1.55	1.52	1.49	1.45	1.43	1.40

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 10-Yr
SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

11.996	1.38	1.36	1.34	1.32	1.29	1.25	1.20
12.041	1.14	1.07	0.99	0.91	0.83	0.76	0.69
12.085	0.62	0.57	0.52	0.48	0.44	0.41	0.39
12.129	0.37	0.35	0.33	0.32	0.30	0.29	0.28
12.173	0.27	0.27	0.26	0.25	0.25	0.24	0.24
12.218	0.24	0.23	0.23	0.23	0.22	0.22	0.22
12.262	0.21	0.21	0.21	0.21	0.20	0.20	0.20
12.306	0.20	0.20	0.20	0.20	0.19	0.19	0.19
12.350	0.19	0.18	0.18	0.18	0.18	0.17	0.17
12.394	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.439	0.16	0.16	0.16	0.15	0.15	0.15	0.15
12.483	0.14	0.14	0.14	0.14	0.14	0.14	0.14
12.527	0.13	0.13	0.13	0.13	0.13	0.13	0.13
12.571	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.615	0.12	0.12	0.12	0.11	0.11	0.11	0.11
12.660	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.704	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.748	0.11	0.10	0.10	0.10	0.10	0.10	0.10
12.792	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.836	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.881	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.969	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.013	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.058	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.102	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.146	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.190	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.234	0.08	0.08	0.08	0.08	0.08	0.08	0.07
13.279	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.323	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.367	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.411	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.455	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.500	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.544	0.07	0.06	0.06	0.06	0.06	0.06	0.06
13.588	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.632	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05 (continued)
beth River
Post Conditions - West

 STORM 10-Yr
SUB-AREA:
 DA-1 Outlet .00038 91. .1

Line	Start Time (hr)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
13.676	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.721	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.765	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.809	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.853	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.898	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - West

Line	Start Time (hr)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
13.942	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.986	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.030	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.074	0.05	0.05	0.05	0.05	0.05	0.05	0.05	

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Flow Rate (csm)
OUTLET	0.380E-03		3.225		11.93	1.65	4338.34

Line	Start Time (hr)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
10.449	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.493	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.538	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.582	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.626	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.670	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.714	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-1 Outlet .00038 91. .1

STREAM REACH:

10.759	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.803	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.980	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08
11.024	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.068	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.112	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
11.156	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.201	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10
11.245	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.289	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11
11.333	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.378	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.466	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.510	0.13	0.13	0.14	0.14	0.15	0.16	0.17	0.17
11.554	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.24
11.599	0.24	0.25	0.26	0.26	0.27	0.29	0.30	0.30
11.643	0.32	0.34	0.36	0.39	0.41	0.43	0.45	0.45
11.687	0.47	0.49	0.50	0.51	0.52	0.54	0.55	0.55
11.731	0.57	0.60	0.62	0.65	0.68	0.71	0.74	0.74
11.775	0.77	0.80	0.82	0.84	0.86	0.88	0.90	0.90
11.820	0.92	0.95	0.99	1.03	1.09	1.15	1.21	1.21
11.864	1.28	1.34	1.40	1.45	1.50	1.54	1.58	1.58
11.908	1.61	1.63	1.64	1.65	1.64	1.63	1.61	1.61
11.952	1.58	1.55	1.52	1.49	1.45	1.43	1.40	1.40
11.996	1.38	1.36	1.34	1.32	1.29	1.25	1.20	1.20

Elizabeth River
Post Conditions - West

Line

Start Time (hr)	Flow Values @ time increment of 0.006 hr						
(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-1 Outlet .00038 91. .1

STREAM REACH:

12.041	1.14	1.07	0.99	0.91	0.83	0.76	0.69
12.085	0.62	0.57	0.52	0.48	0.44	0.41	0.39
12.129	0.37	0.35	0.33	0.32	0.30	0.29	0.28
12.173	0.27	0.27	0.26	0.25	0.25	0.24	0.24
12.218	0.24	0.23	0.23	0.23	0.22	0.22	0.22
12.262	0.21	0.21	0.21	0.21	0.20	0.20	0.20
12.306	0.20	0.20	0.20	0.20	0.19	0.19	0.19
12.350	0.19	0.18	0.18	0.18	0.18	0.17	0.17
12.394	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.439	0.16	0.16	0.16	0.15	0.15	0.15	0.15
12.483	0.14	0.14	0.14	0.14	0.14	0.14	0.14
12.527	0.13	0.13	0.13	0.13	0.13	0.13	0.13
12.571	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.615	0.12	0.12	0.12	0.11	0.11	0.11	0.11
12.660	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.704	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.748	0.11	0.10	0.10	0.10	0.10	0.10	0.10
12.792	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.836	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.881	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.969	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.013	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.058	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.102	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.146	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.190	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.234	0.08	0.08	0.08	0.08	0.08	0.08	0.07
13.279	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.323	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.367	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.411	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.455	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.500	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.544	0.07	0.06	0.06	0.06	0.06	0.06	0.06
13.588	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.632	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 10-Yr

SUB-AREA:

DA-1 Outlet .00038 91. .1

STREAM REACH:

13.676	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.721	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.765	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.809	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.853	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.898	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.942	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.986	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.030	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.074	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

STORM 1-Yr

Elizabeth River
Post Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	----- Elevation (ft)	Peak Flow Time (hr)	Flow Rate (cfs)	----- Rate (csm)
DA-1	0.380E-03		1.155		11.93	0.76	2006.82

Line

Start Time (hr)	----- (cfs)	Flow Values @ time increment of 0.006 hr (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)	----- (cfs)
11.472	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.516	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
11.560	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.10
11.604	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13
11.649	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.20
11.693	0.20	0.21	0.21	0.22	0.23	0.23	0.24	0.24
11.737	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.33
11.781	0.34	0.36	0.37	0.37	0.38	0.39	0.40	0.40

WinTR-20: Version 1.10 0 0 0.05
 beth River (continued)
 Post Conditions - West

STORM 1-Yr

SUB-AREA:
 DA-1 Outlet .00038 91. .1

STREAM REACH:

11.825	0.42	0.43	0.46	0.48	0.51	0.54	0.57
11.870	0.60	0.63	0.66	0.68	0.70	0.72	0.74
11.914	0.75	0.76	0.76	0.76	0.76	0.75	0.74
11.958	0.73	0.71	0.70	0.68	0.67	0.66	0.65
12.002	0.64	0.64	0.63	0.61	0.60	0.57	0.55
12.046	0.51	0.48	0.44	0.40	0.37	0.33	0.30
12.091	0.27	0.25	0.23	0.21	0.20	0.19	0.18
12.135	0.17	0.16	0.15	0.15	0.14	0.14	0.13
12.179	0.13	0.13	0.12	0.12	0.12	0.12	0.11
12.223	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.268	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.312	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.356	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.400	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.444	0.08	0.08	0.07	0.07	0.07	0.07	0.07
12.489	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.533	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.577	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.621	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.665	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.710	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.754	0.05	0.05	0.05	0.05	0.05		

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Elevation (ft)	Peak Time (hr)	Flow Rate (cfs)	Flow Rate (csm)
OUTLET	0.380E-03		1.155		11.93	0.76	2006.82

Line

Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.472	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.516	0.05	0.05	0.06	0.06	0.06	0.07	0.07
11.560	0.08	0.08	0.08	0.09	0.09	0.10	0.10
11.604	0.10	0.10	0.11	0.11	0.12	0.12	0.13

Flow Values @ time increment of 0.006 hr

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 1-Yr

SUB-AREA:
 DA-1 Outlet .00038 91. .1

STREAM REACH:
WinTR-20 Version 1.10

Elizabeth River
Post Conditions - West

Line	Flow Values @ time increment of 0.006 hr						
Start Time (hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.649	0.14	0.15	0.16	0.17	0.18	0.19	0.20
11.693	0.20	0.21	0.21	0.22	0.23	0.23	0.24
11.737	0.25	0.26	0.28	0.29	0.30	0.32	0.33
11.781	0.34	0.36	0.37	0.37	0.38	0.39	0.40
11.825	0.42	0.43	0.46	0.48	0.51	0.54	0.57
11.870	0.60	0.63	0.66	0.68	0.70	0.72	0.74
11.914	0.75	0.76	0.76	0.76	0.76	0.75	0.74
11.958	0.73	0.71	0.70	0.68	0.67	0.66	0.65
12.002	0.64	0.64	0.63	0.61	0.60	0.57	0.55
12.046	0.51	0.48	0.44	0.40	0.37	0.33	0.30
12.091	0.27	0.25	0.23	0.21	0.20	0.19	0.18
12.135	0.17	0.16	0.15	0.15	0.14	0.14	0.13
12.179	0.13	0.13	0.12	0.12	0.12	0.12	0.11
12.223	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.268	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.312	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.356	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.400	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.444	0.08	0.08	0.07	0.07	0.07	0.07	0.07
12.489	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.533	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.577	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.621	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.665	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.710	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.754	0.05	0.05	0.05	0.05	0.05		

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet .00038 91. .1

STREAM REACH:

WinTR-20 Version 1.10

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Elizabeth River
Post Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	----- Peak Flow by Storm -----			(cfs)	(cfs)
			2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)		
DA-1	0.380E-03		0.99	1.65	0.76		
OUTLET	0.380E-03		0.99	1.65	0.76		

WinTR-55, Version 1.00.10

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WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet

.00038 91. .1

STREAM REACH:

WinTR-20 Printed Page File
TR20.inp

Beginning of Input Data List

WinTR-20: Version 1.10
beth River
Post Conditions - West

0 0 0.05

(continued)

STORM 1-Yr

SUB-AREA:

DA-1 Outlet

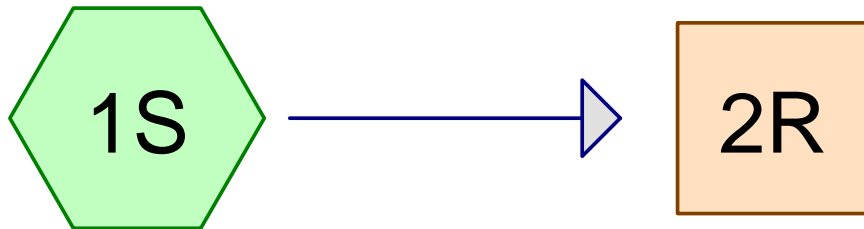
.00038 91. .1

STREAM REACH:

WinTR-20 Version 1.10

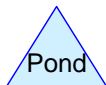
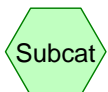
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DA-B East Post

Channel - West



Post-Conditions_East

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.029	80	>75% Grass cover, Good, HSG D (1S)
0.600	98	Paved roads w/curbs & sewers, HSG D (1S)
0.131	77	Woods, Good, HSG D (1S)
0.760	94	TOTAL AREA

Post-Conditions_East

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.760	HSG D	1S
0.000	Other	
0.760		TOTAL AREA

Post-Conditions_East

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.029	0.000	0.029	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.600	0.000	0.600	Paved roads w/curbs & sewers	1S
0.000	0.000	0.000	0.131	0.000	0.131	Woods, Good	1S
0.000	0.000	0.000	0.760	0.000	0.760	TOTAL AREA	

Post-Conditions_East

Type II 24-hr 1-Year Rainfall=3.00"

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post

Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>2.21"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=3.15 cfs 0.140 af

Reach 2R: Channel - West

Avg. Flow Depth=0.43' Max Vel=2.10 fps Inflow=3.15 cfs 0.140 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=2.97 cfs 0.140 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.140 af Average Runoff Depth = 2.21"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Post-Conditions_East

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af, Depth> 2.21"

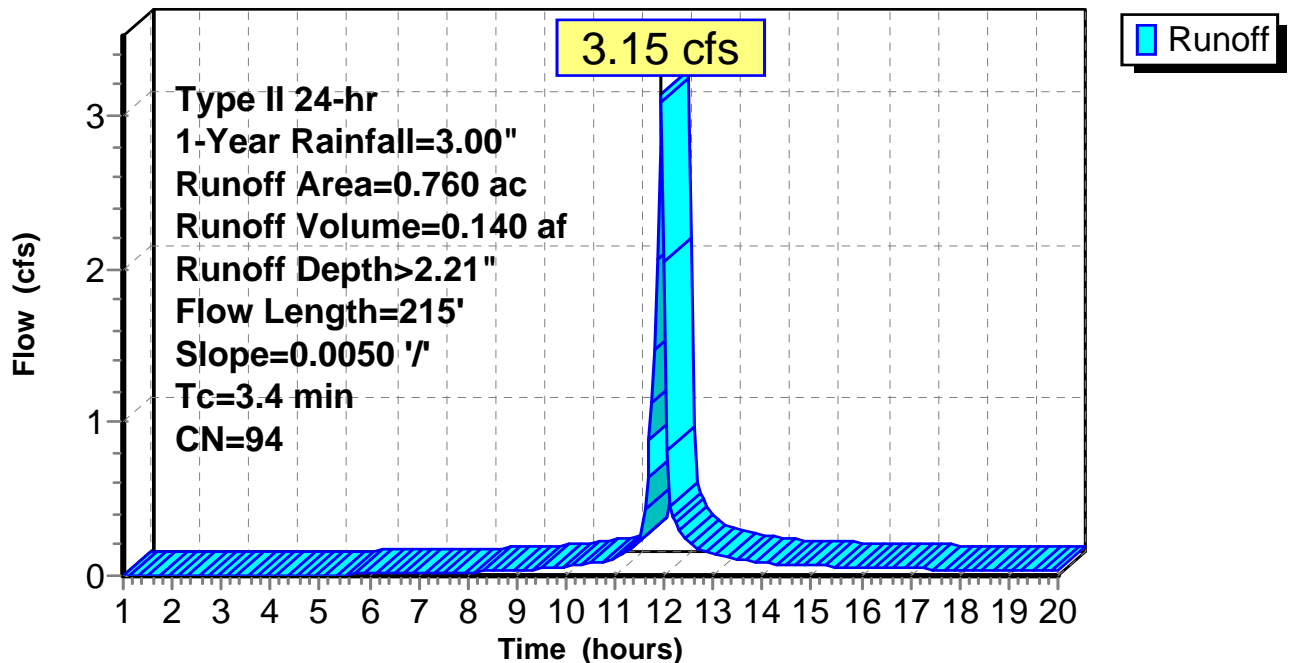
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		Sheet Flow, Sheet Flow gravel Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		Shallow Concentrated Flow, Shallow Conc. gravel Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. VF/Open Space Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post

Hydrograph



Post-Conditions_East

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Reach 2R: Channel - West

Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.21" for 1-Year event
Inflow = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af
Outflow = 2.97 cfs @ 11.95 hrs, Volume= 0.140 af, Atten= 6%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.5 min

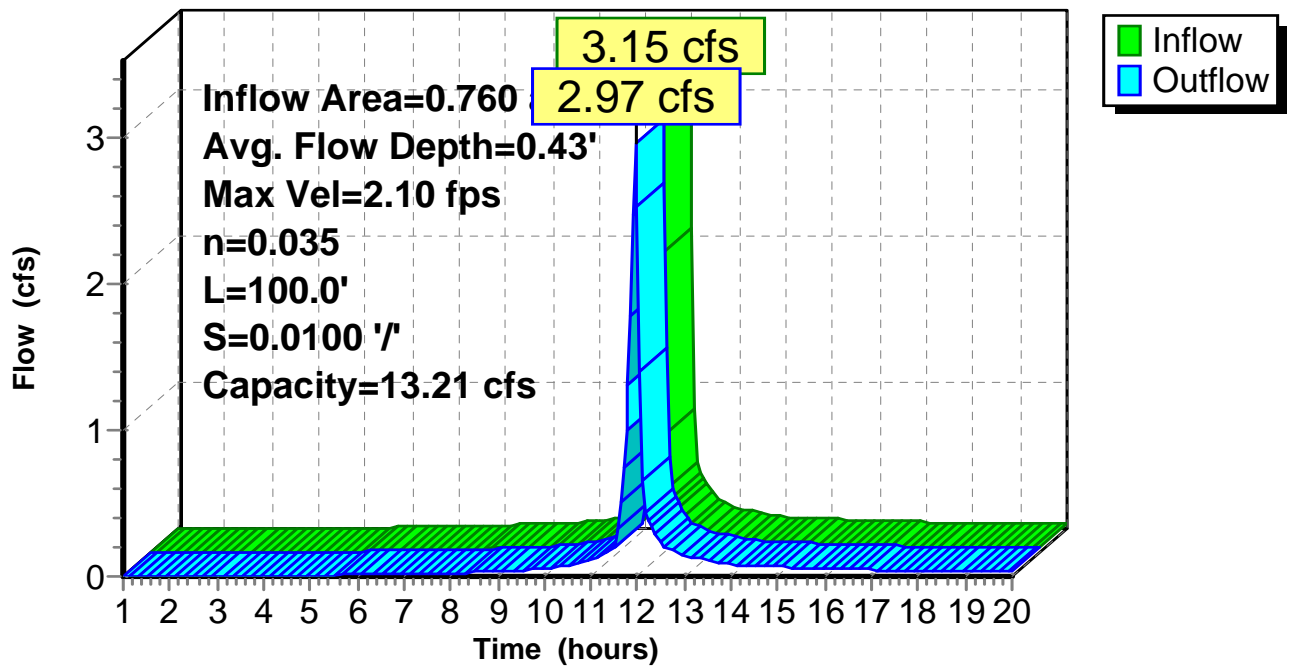
Peak Storage= 147 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - West

Hydrograph



Post-Conditions_East

Type II 24-hr 2-Year Rainfall=3.70"

Prepared by ERM

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>2.86"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=3.99 cfs 0.181 af

Reach 2R: Channel - West Avg. Flow Depth=0.49' Max Vel=2.27 fps Inflow=3.99 cfs 0.181 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=3.78 cfs 0.181 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.181 af Average Runoff Depth = 2.86"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Post-Conditions_East

Prepared by ERM

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Type II 24-hr 2-Year Rainfall=3.70"

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Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.99 cfs @ 11.94 hrs, Volume= 0.181 af, Depth> 2.86"

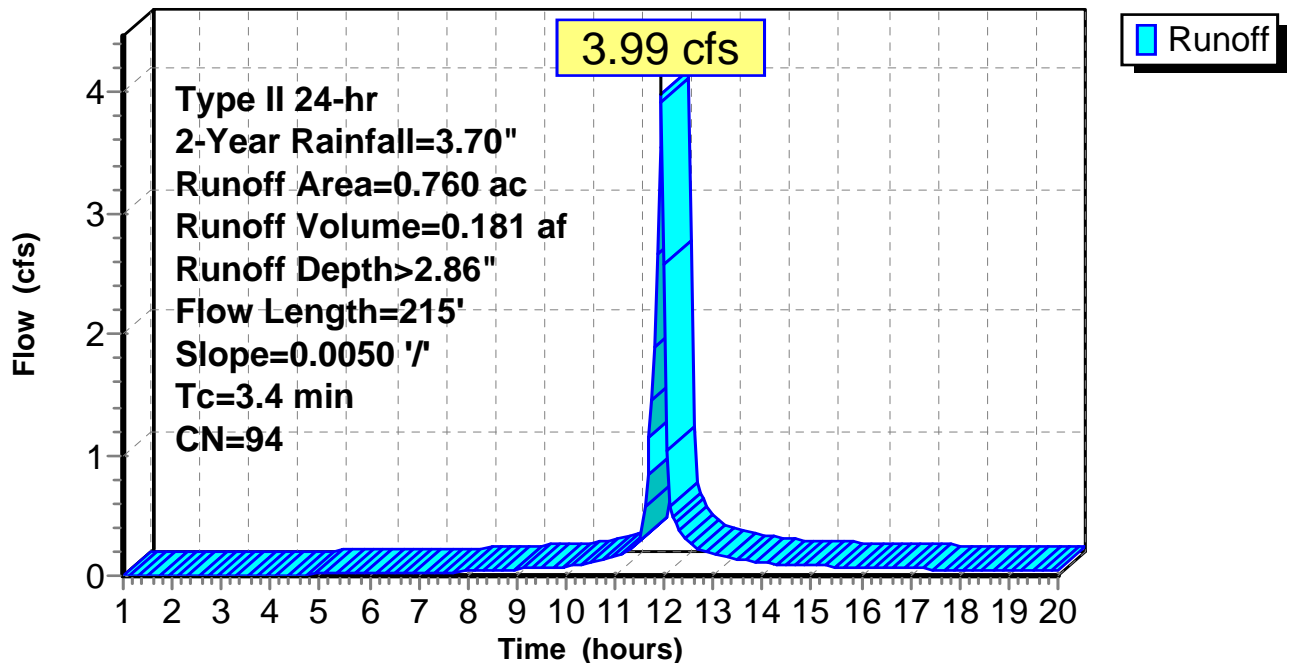
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		Sheet Flow, Sheet Flow gravel Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		Shallow Concentrated Flow, Shallow Conc. gravel Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. VF/Open Space Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post

Hydrograph



Post-Conditions_East

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Type II 24-hr 2-Year Rainfall=3.70"

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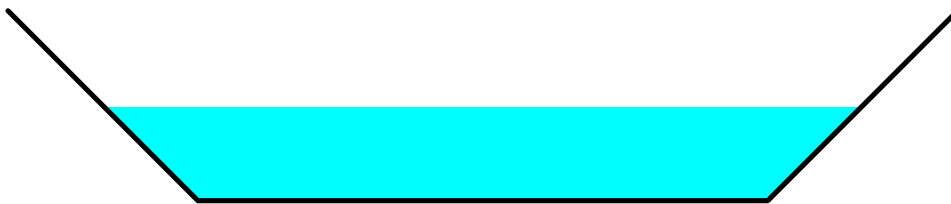
Summary for Reach 2R: Channel - West

Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.86" for 2-Year event
Inflow = 3.99 cfs @ 11.94 hrs, Volume= 0.181 af
Outflow = 3.78 cfs @ 11.95 hrs, Volume= 0.181 af, Atten= 5%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 3.2 min

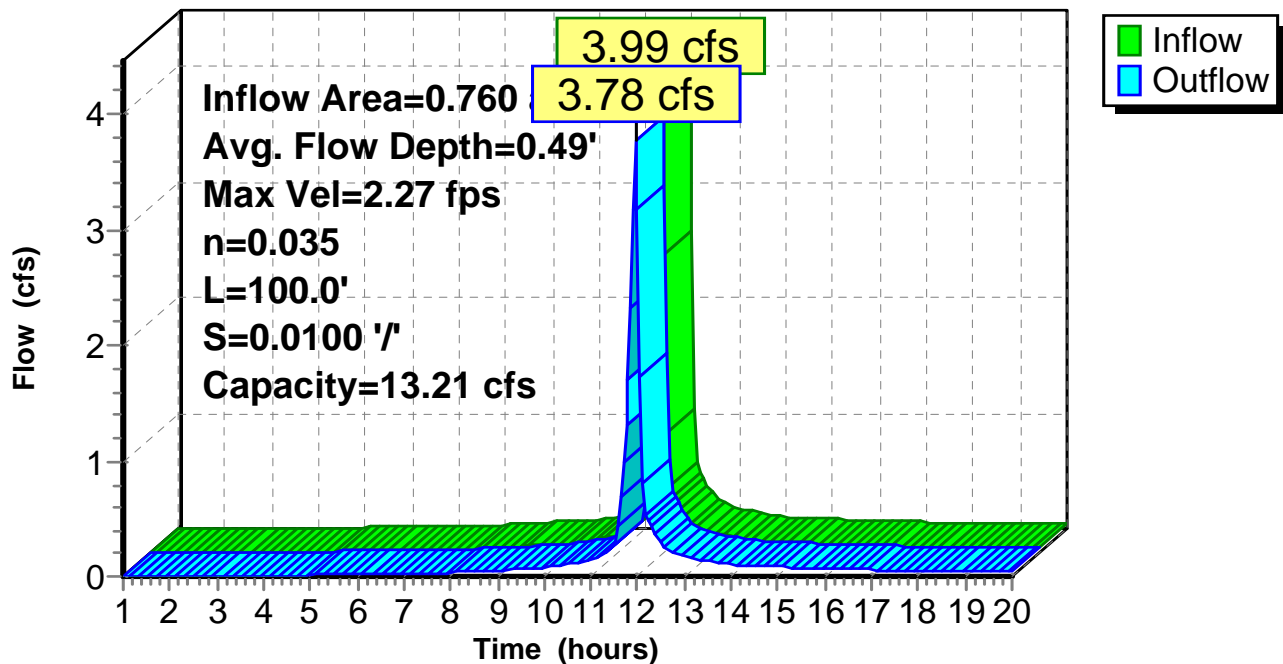
Peak Storage= 172 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/ Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - West

Hydrograph



Post-Conditions_East

Type II 24-hr 10-Year Rainfall=5.70"

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>4.73"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=6.36 cfs 0.299 af

Reach 2R: Channel - West Avg. Flow Depth=0.65' Max Vel=2.64 fps Inflow=6.36 cfs 0.299 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=6.07 cfs 0.299 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.299 af Average Runoff Depth = 4.73"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Post-Conditions_East

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Type II 24-hr 10-Year Rainfall=5.70"

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Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.36 cfs @ 11.94 hrs, Volume= 0.299 af, Depth> 4.73"

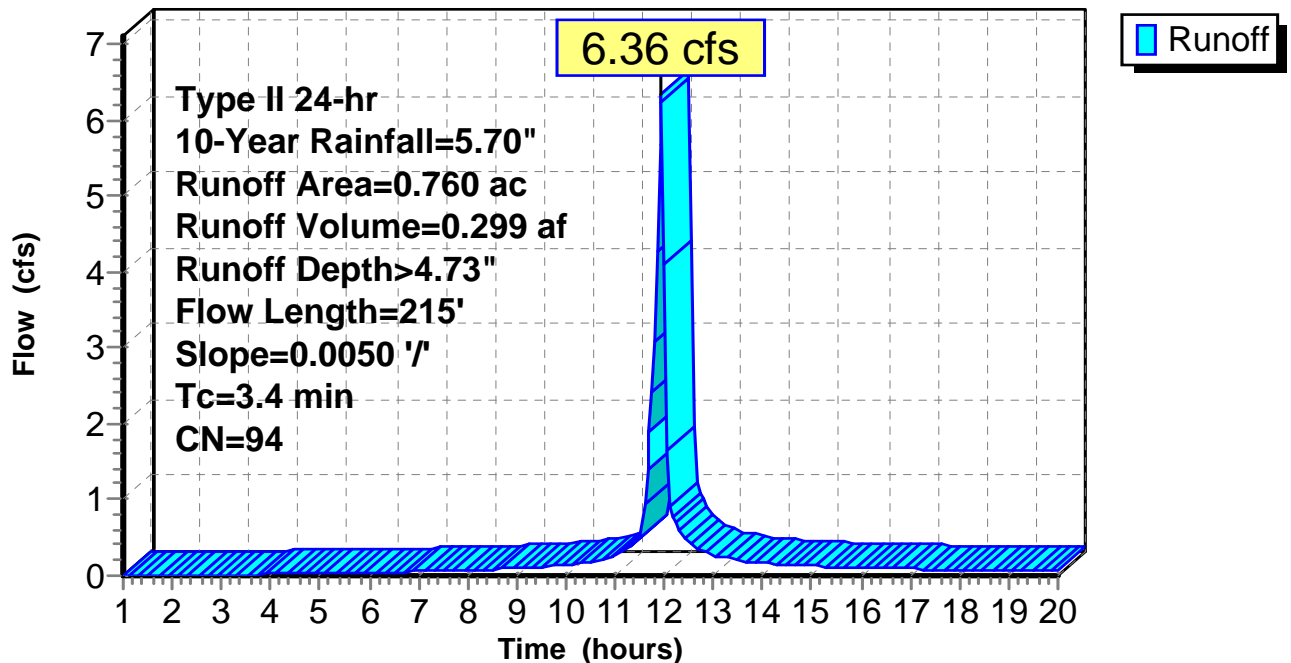
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		Sheet Flow, Sheet Flow gravel Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		Shallow Concentrated Flow, Shallow Conc. gravel Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		Shallow Concentrated Flow, Shallow Conc. VF/Open Space Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post

Hydrograph



Post-Conditions_East

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Type II 24-hr 10-Year Rainfall=5.70"

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Summary for Reach 2R: Channel - West

Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 4.73" for 10-Year event
Inflow = 6.36 cfs @ 11.94 hrs, Volume= 0.299 af
Outflow = 6.07 cfs @ 11.95 hrs, Volume= 0.299 af, Atten= 4%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.64 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 2.7 min

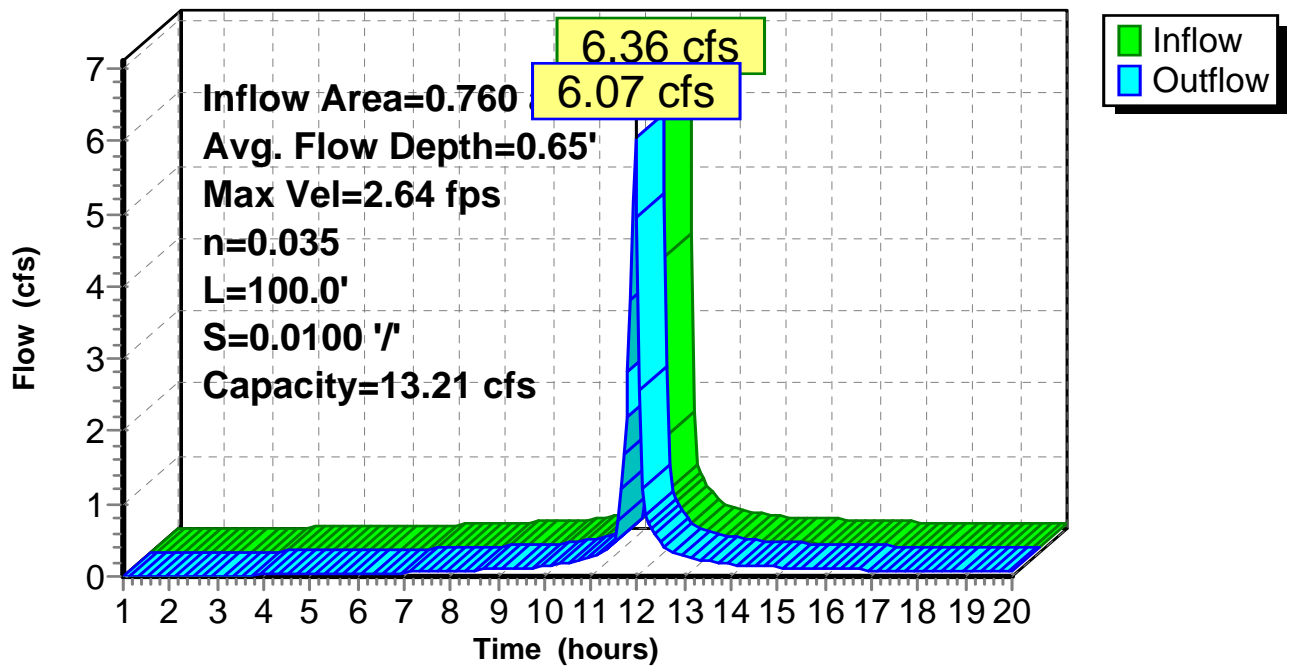
Peak Storage= 237 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

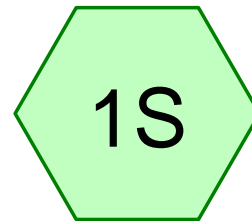
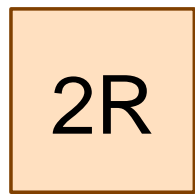
3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - West

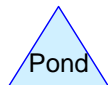
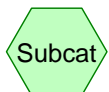
Hydrograph





Existing Ditch -West

DA-A Post West



Post-Conditions_West

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.100	80	>75% Grass cover, Good, HSG D (1S)
0.020	98	Paved parking, HSG D (1S)
0.120	98	Paved roads w/curbs & sewers, HSG D (1S)
0.240	91	TOTAL AREA

Post-Conditions_West

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.240	HSG D	1S
0.000	Other	
0.240		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.100	0.000	0.100	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.020	0.000	0.020	Paved parking	1S
0.000	0.000	0.000	0.120	0.000	0.120	Paved roads w/curbs & sewers	1S
0.000	0.000	0.000	0.240	0.000	0.240	TOTAL AREA	

Post-Conditions_West

Type II 24-hr 1-Year Rainfall=3.00"

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West

Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>1.93"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=0.64 cfs 0.039 af

Reach 2R: Existing Ditch -West

Avg. Flow Depth=0.26' Max Vel=2.18 fps Inflow=0.64 cfs 0.039 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.63 cfs 0.039 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.039 af Average Runoff Depth = 1.93"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Post-Conditions_West

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 1S: DA-A Post West

Runoff = 0.64 cfs @ 12.06 hrs, Volume= 0.039 af, Depth> 1.93"

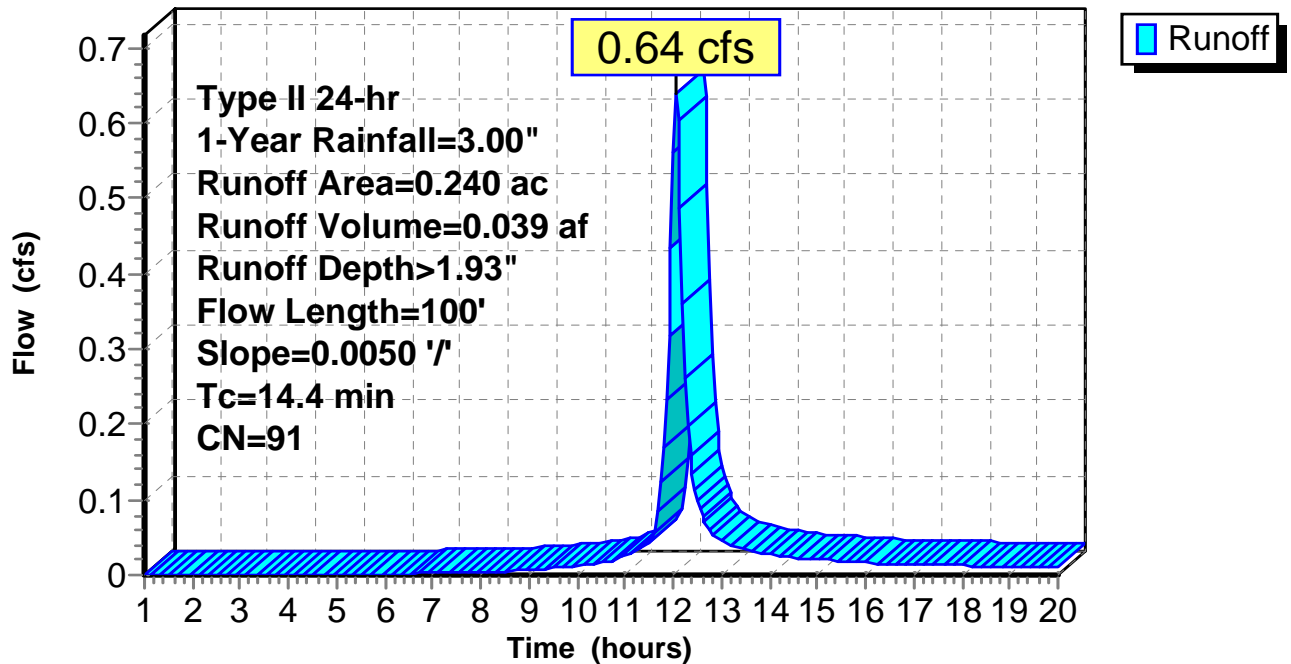
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		Sheet Flow, Sheet Flow over gravel Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		Sheet Flow, Sheet Flow over VF Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



Post-Conditions_West

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Type II 24-hr 1-Year Rainfall=3.00"

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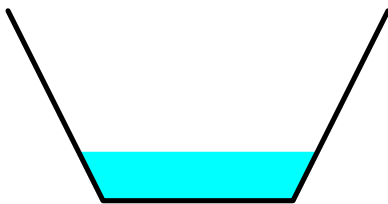
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 1.93" for 1-Year event
Inflow = 0.64 cfs @ 12.06 hrs, Volume= 0.039 af
Outflow = 0.63 cfs @ 12.08 hrs, Volume= 0.039 af, Atten= 2%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.18 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 2.7 min

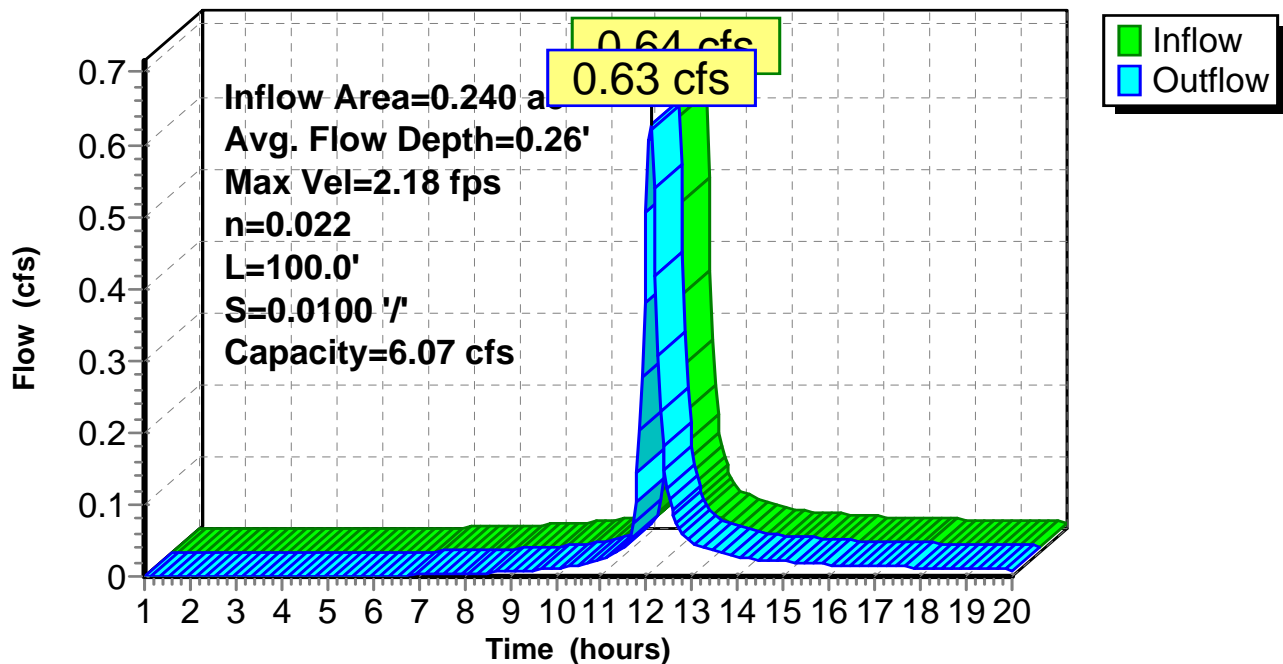
Peak Storage= 29 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



Post-Conditions_West

Type II 24-hr 2-Year Rainfall=3.70"

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West

Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>2.55"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=0.83 cfs 0.051 af

Reach 2R: Existing Ditch -West

Avg. Flow Depth=0.30' Max Vel=2.37 fps Inflow=0.83 cfs 0.051 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.82 cfs 0.051 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.051 af Average Runoff Depth = 2.55"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Post-Conditions_West

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Type II 24-hr 2-Year Rainfall=3.70"

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Summary for Subcatchment 1S: DA-A Post West

Runoff = 0.83 cfs @ 12.06 hrs, Volume= 0.051 af, Depth> 2.55"

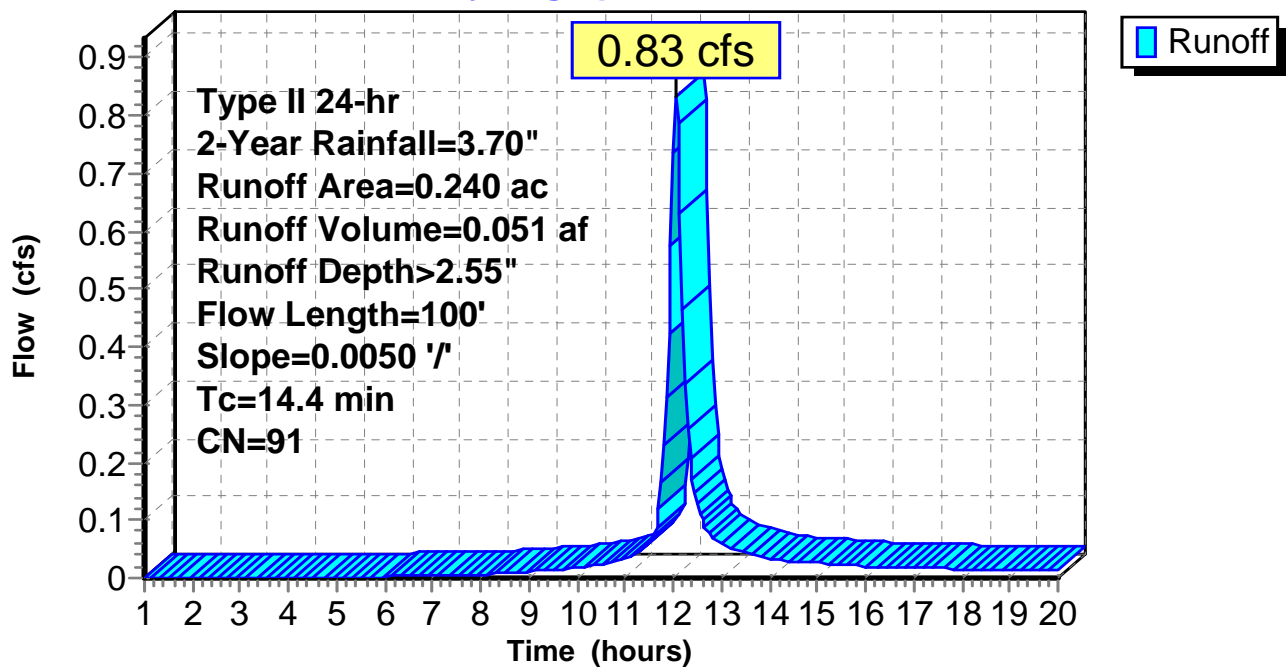
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		Sheet Flow, Sheet Flow over gravel Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		Sheet Flow, Sheet Flow over VF Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



Post-Conditions_West

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Type II 24-hr 2-Year Rainfall=3.70"

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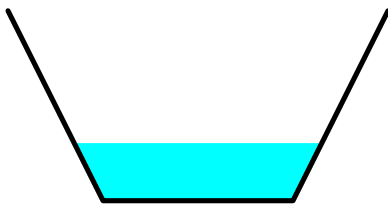
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 2.55" for 2-Year event
Inflow = 0.83 cfs @ 12.06 hrs, Volume= 0.051 af
Outflow = 0.82 cfs @ 12.08 hrs, Volume= 0.051 af, Atten= 2%, Lag= 1.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.37 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 2.5 min

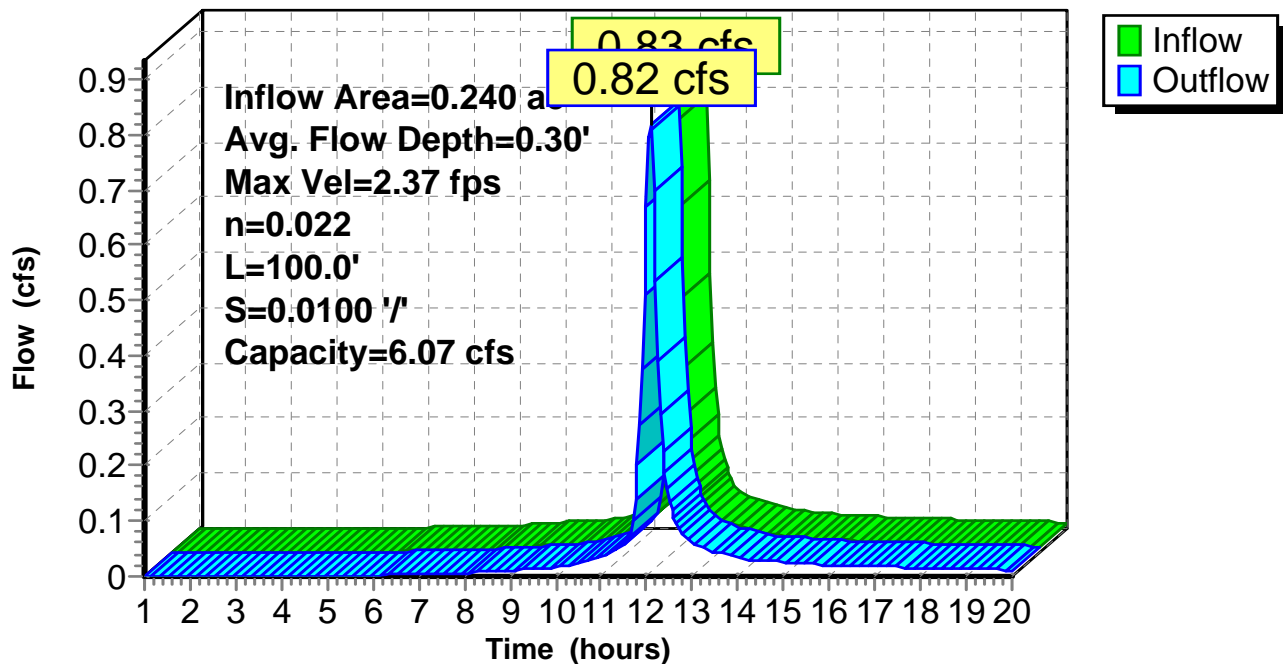
Peak Storage= 35 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



Post-Conditions_West

Type II 24-hr 10-Year Rainfall=5.70"

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Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>4.38"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=1.38 cfs 0.088 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.42' Max Vel=2.75 fps Inflow=1.38 cfs 0.088 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=1.36 cfs 0.088 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.088 af Average Runoff Depth = 4.38"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Post-Conditions_West

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Type II 24-hr 10-Year Rainfall=5.70"

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Summary for Subcatchment 1S: DA-A Post West

Runoff = 1.38 cfs @ 12.06 hrs, Volume= 0.088 af, Depth> 4.38"

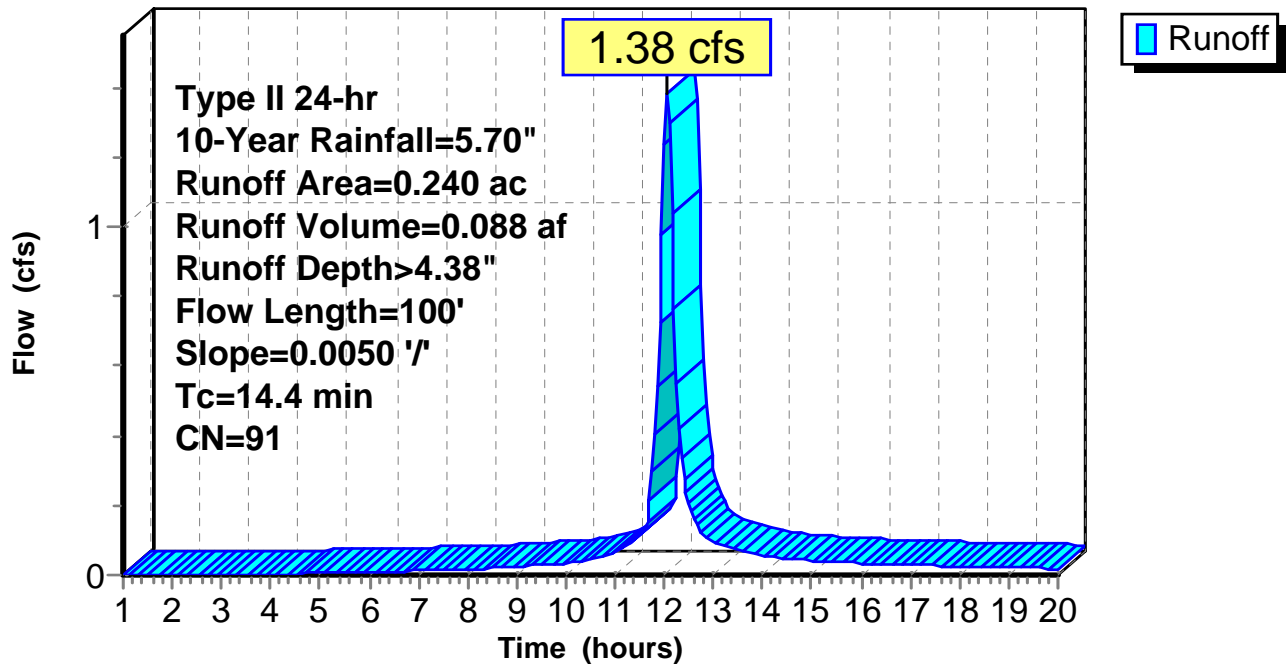
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		Sheet Flow, Sheet Flow over gravel Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		Sheet Flow, Sheet Flow over VF Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



Post-Conditions_West

Prepared by ERM

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Type II 24-hr 10-Year Rainfall=5.70"

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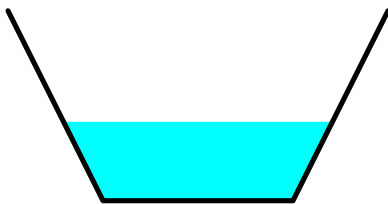
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 4.38" for 10-Year event
Inflow = 1.38 cfs @ 12.06 hrs, Volume= 0.088 af
Outflow = 1.36 cfs @ 12.07 hrs, Volume= 0.088 af, Atten= 2%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 2.1 min

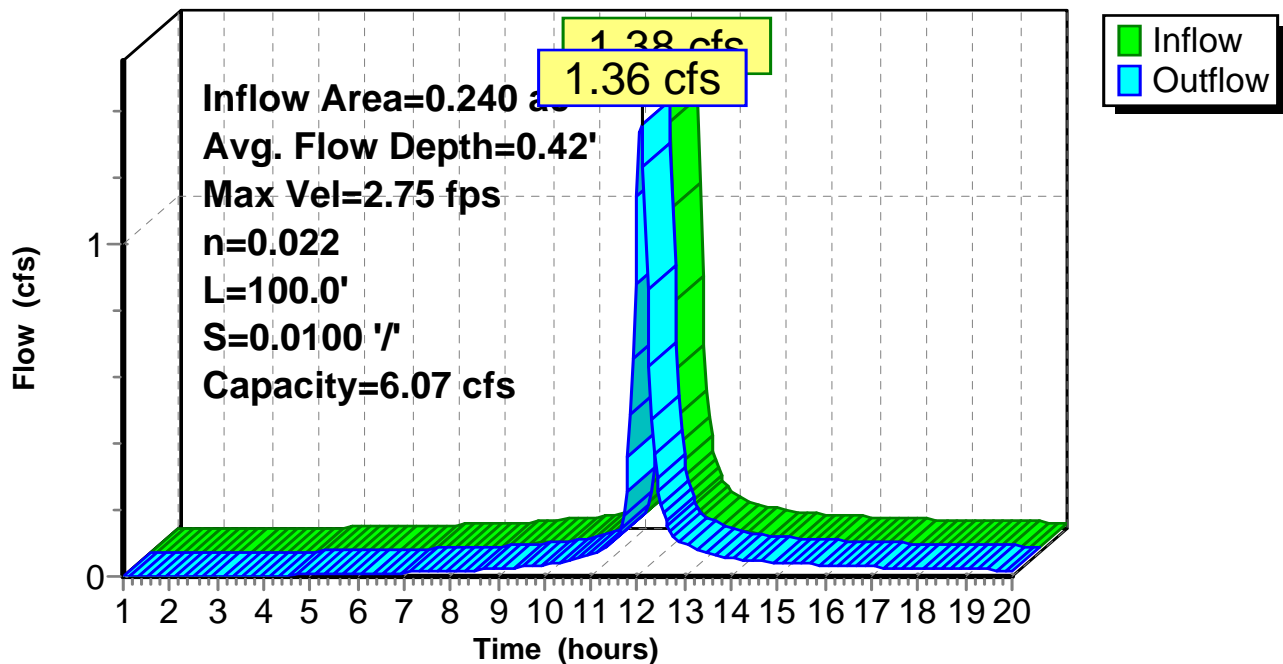
Peak Storage= 50 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West

Hydrograph



ATTACHMENT 2

Topo Map



Atlantic Coast Pipeline SM

- Milepost
- Proposed Route
- ▣ Elizabeth River M and R Site
- NHD Waterbodies

Atlantic Coast Pipeline
 Elizabeth River M and R Site
 USGS Topo Overview



ATTACHMENT 3

Stormwater Design Criteria

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 2

SHEET FLOW TO A VEGETATED FILTER STRIP OR CONSERVED OPEN SPACE

VERSION 1.9
March 1, 2011



SECTION 1. DESCRIPTION

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

SECTION 2. PERFORMANCE

With proper design and maintenance, these practices can provide relatively high runoff reduction as shown in **Table 2.1**.

Table 2.1: Summary of Stormwater Functions Provided by Filter Strips ¹

Stormwater Function	Conservation Area		Vegetated Filter Strip	
	HSG Soils A and B	HSG Soils C and D	HSG Soils A	HSG Soils B ⁴ , C and D
	Assume no CA ² in Conservation Area		No CA ³	With CA ²
Annual Runoff Vol. Reduction (RR)	75%	50%	50%	50%
Total Phosphorus (TP) EMC Reduction ⁵ by BMP Treatment Process	0		0	
Total Phosphorus (TP) Mass Load Removal	75%	50%	50%	50%
Total Nitrogen (TN) EMC Reduction by BMP Treatment Process	0		0	
Total Nitrogen (TN) Mass Load Removal	75%	50%	50%	50%
Channel Protection and Flood Mitigation	Partial. Designers can use the RRM spreadsheet to adjust curve number for each design storm for the contributing drainage area; <i>and</i> designers can account for a lengthened Time-of-Concentration flow path in computing peak discharge.			
¹ CWP and CSN (2008); CWP (2007) ² CA = Compost Amended Soils (see Design Specification No. 4) ³ Compost amendments are generally not applicable for undisturbed A soils, although it may be advisable to incorporate them on mass-graded A or B soils and/or filter strips on B soils, in order to maintain runoff reduction rates. ⁴ The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see Section 6.2 below) ⁵ There is insufficient monitoring data to assign a nutrient removal rate for filter strips at this time.				

SECTION 3. DESIGN TABLE

Conserved Open Space and Vegetated Filter Strips do not have two levels of design. Instead, each must meet the appropriate minimum criteria outlined in **Table 2.2** (next page) and **Section 6** (below) to qualify for the indicated level of runoff reduction. In addition, designers must conduct a site reconnaissance prior to design to confirm topography and soil conditions.

SECTION 4. TYPICAL DETAILS

Figure 1 shows a typical approach for sheetflow to a Conserved Open Space (Cappiella *et al.*, 2006). **Figures 2 and 3** provide standard details for an engineered level spreader developed by North Carolina State University (Hathaway and Hunt, 2006). An alternative design for an “energy dissipater” can be found in Henrico County’s *Environmental Program Manual* (Chapter 9, Minimum Design Standard 9.01) at: <http://www.co.henrico.va.us/works/eesd/>

Table 2.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases ²	1% ¹ to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width 6% to 8% Slope – Minimum 65 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS ⁶ Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover ³ Length = 40 lin. ft. per 1 cfs for forested or re-forested Areas ⁴ (ELS ⁶ length = 13 lin.ft. min; 130 lin.ft. max.)	Length of ELS ⁶ Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min; 130 lin.ft. max.)
Construction Stage (Section 8)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications (Section 5)	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of IC (e.g., 5,000 sf) and/or turf-intensive land uses (sports fields, golf courses) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils) ⁵
Boundary Spreader (Section 6.3)	GD ⁶ at top of filter	GD ⁶ at top of filter PB ⁶ at toe of filter
¹ A minimum of 1% is recommended to ensure positive drainage. ² For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less. ³ Vegetative Cover is described in Section 6.2 . ⁴ Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS ⁶ Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to Section 6.3 for design criteria ⁵ The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see Section 6.1). ⁶ ELS = Engineered Level Spreader; GD = Gravel Diaphragm; PB = Permeable Berm.		

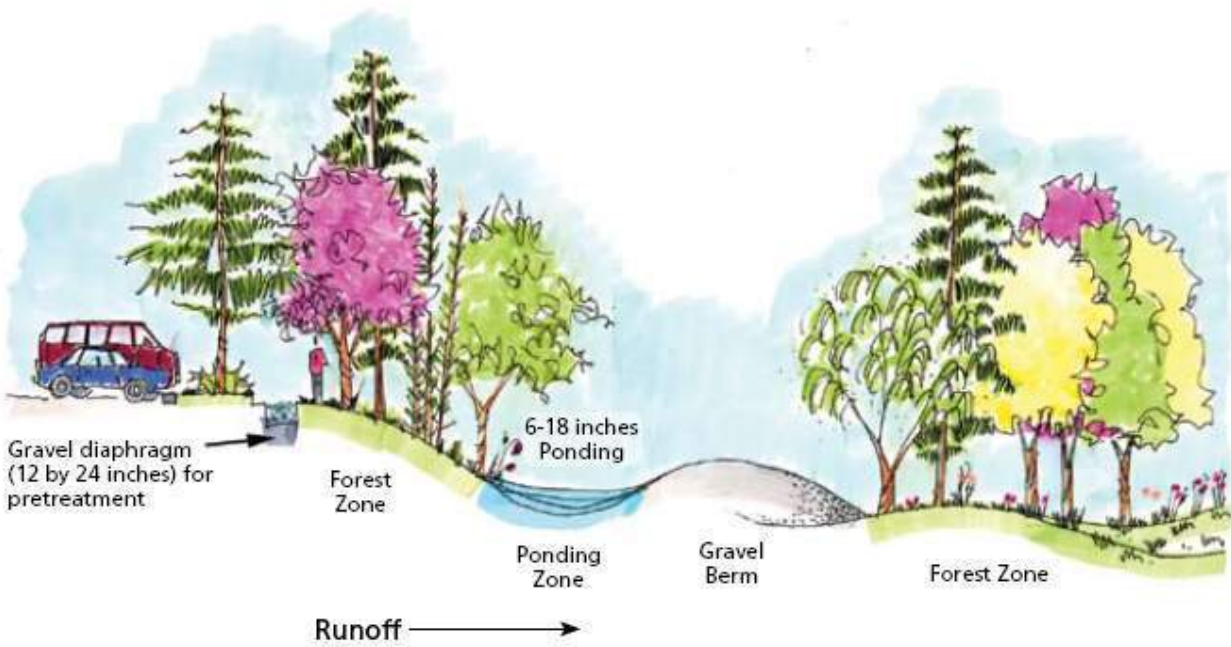


Figure 2.1. Typical Sheetflow to Conserved Open Space

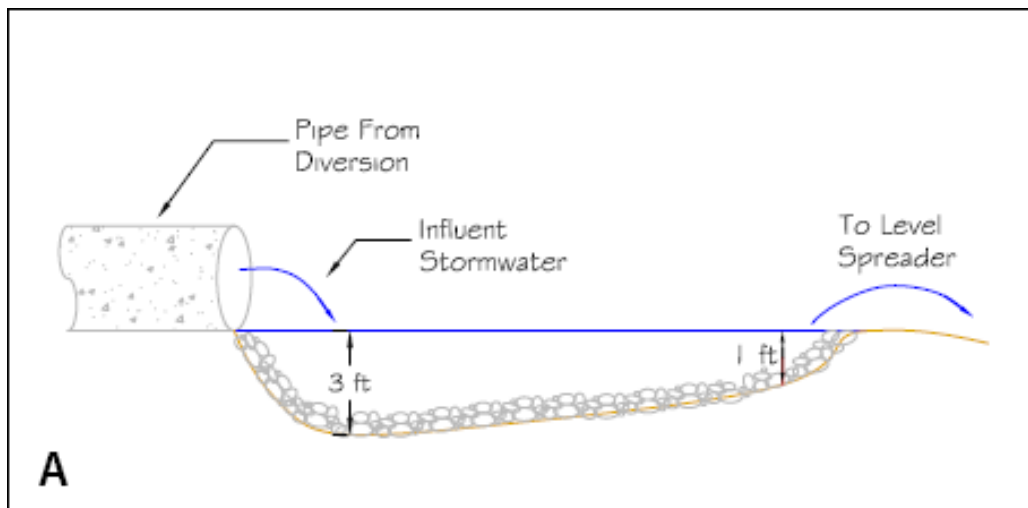


Figure 2.2. Level Spreader Forebay (Hathaway and Hunt 2006)

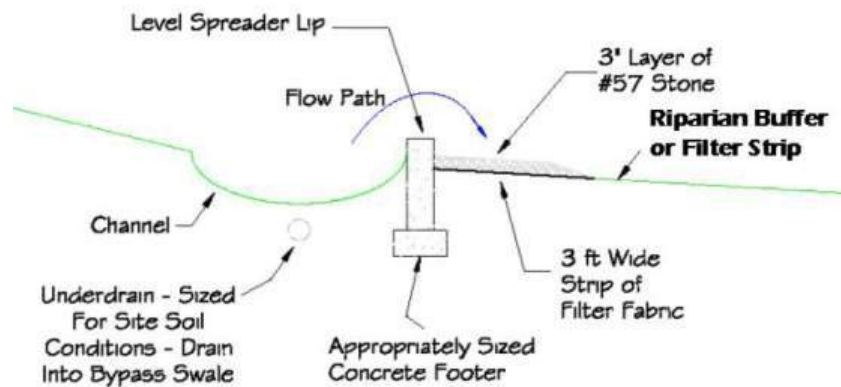
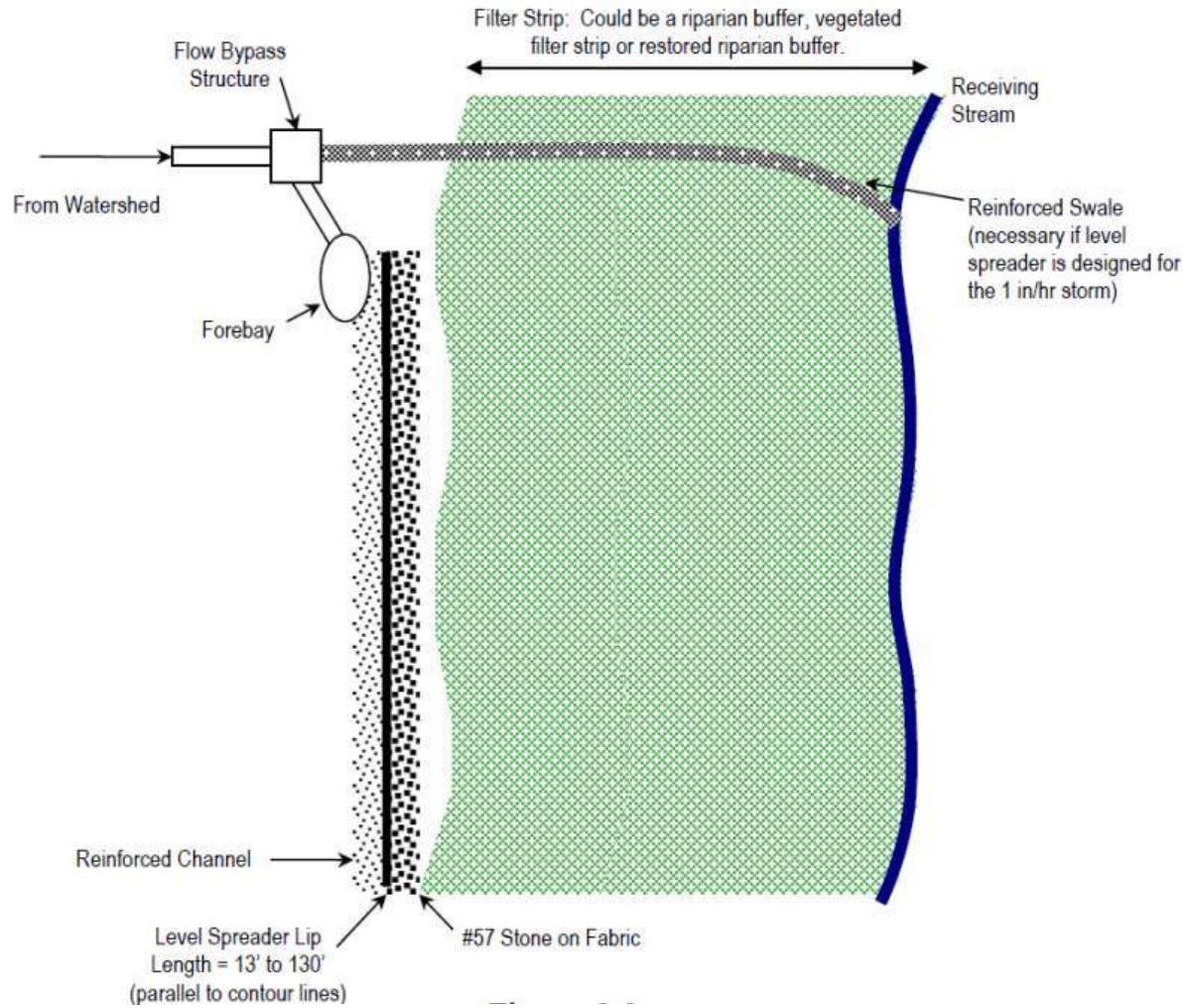


Figure 2.3: Plan and Cross Section of Engineered Level Spreader (ELS)
(Hathaway 2006)

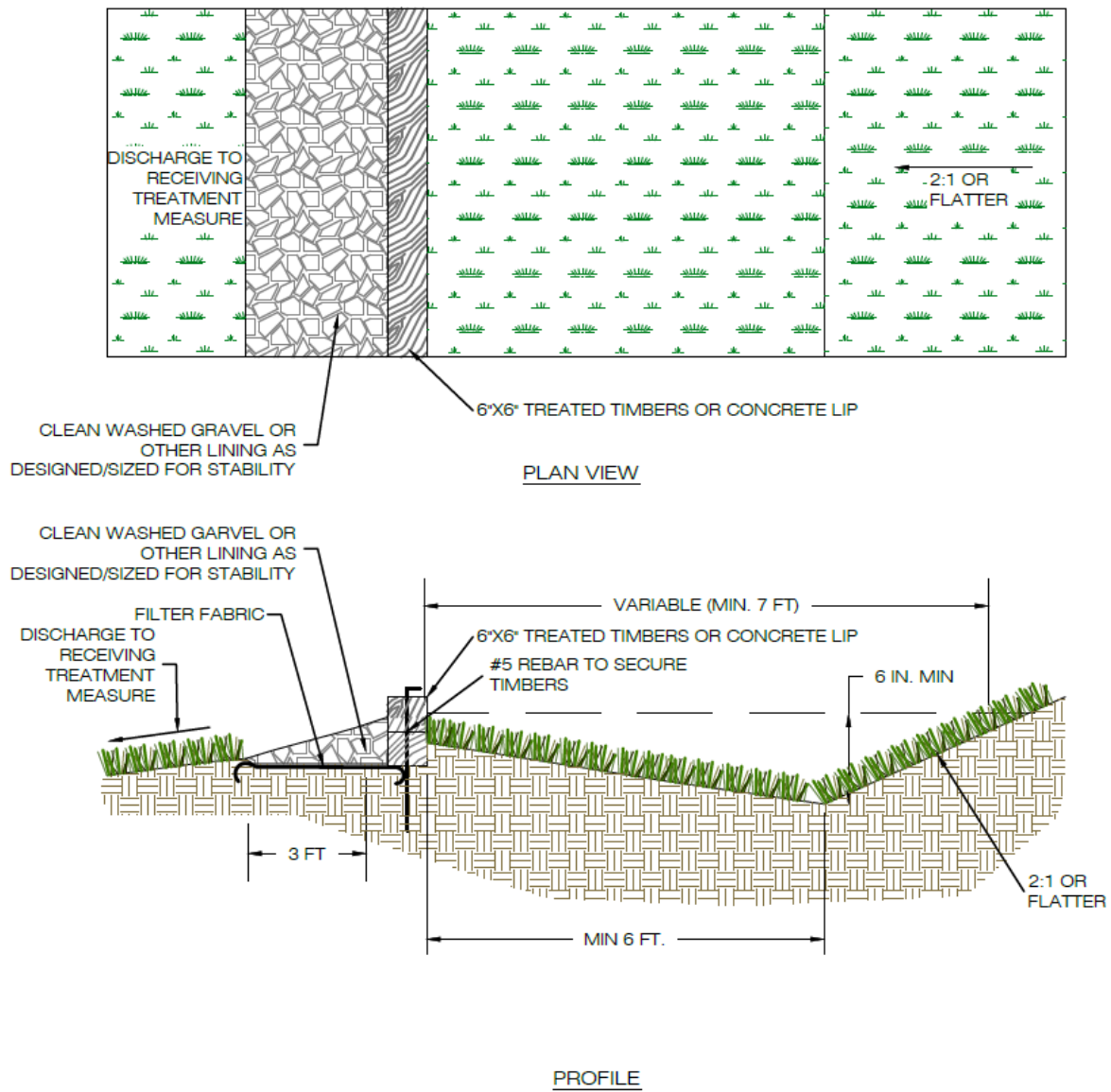


Figure 2.4A: Section - Level Spreader with Rigid Lip

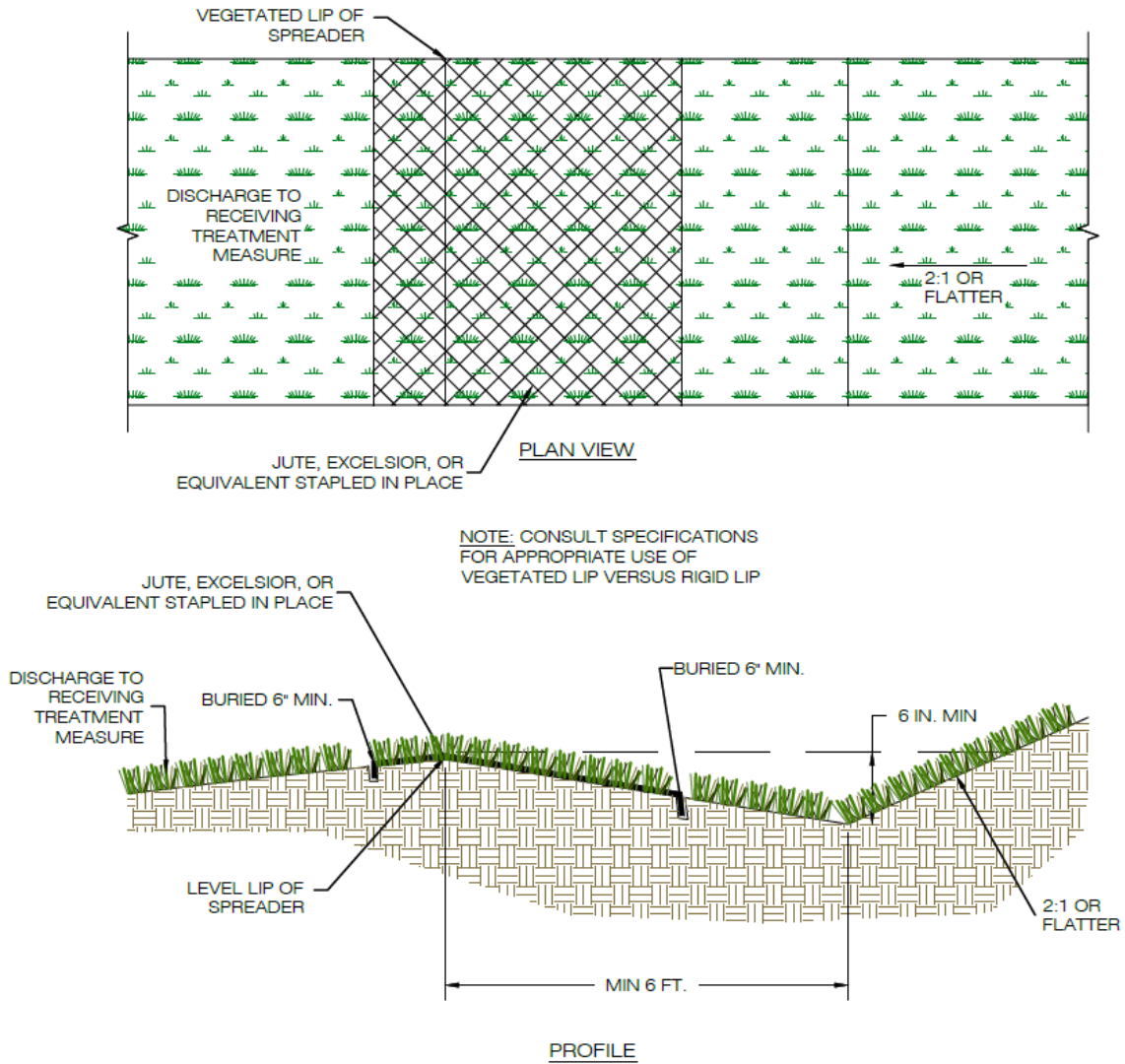


Figure 2.4B: Section - Alternative Level Spreader with Vegetated Lip

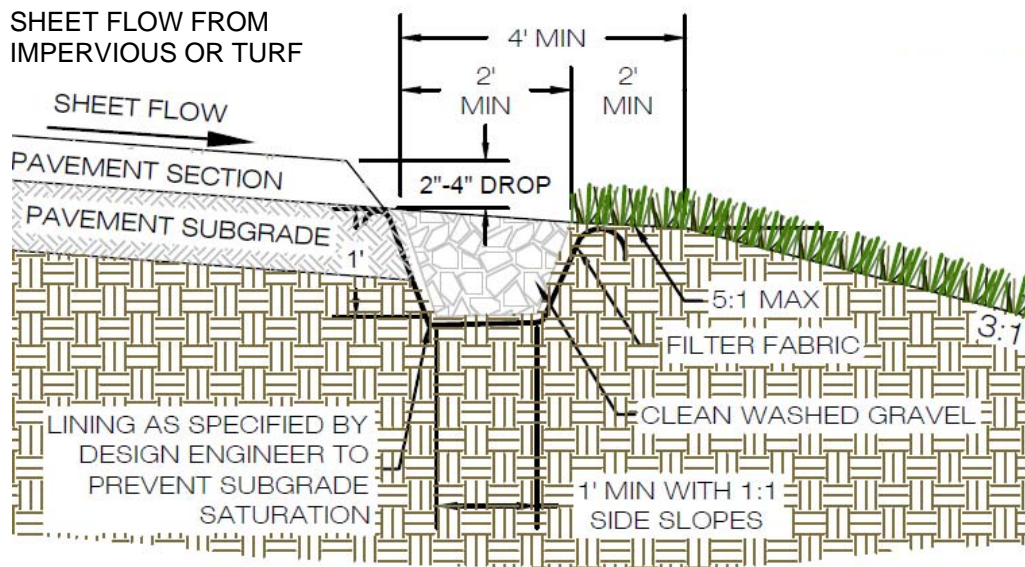


Figure 2.5 – Gravel Diaphragm – Sheet Flow Pre-treatment

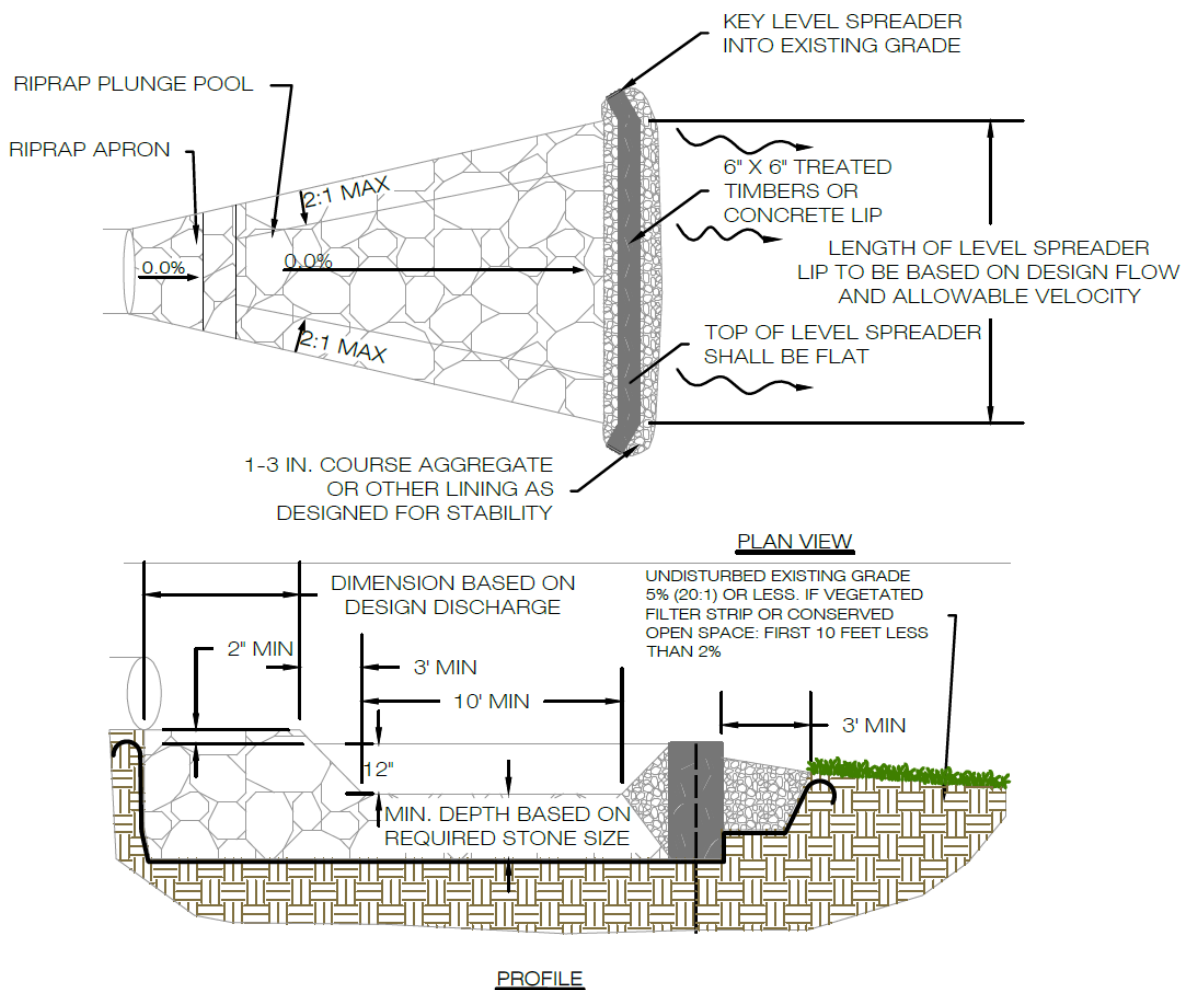
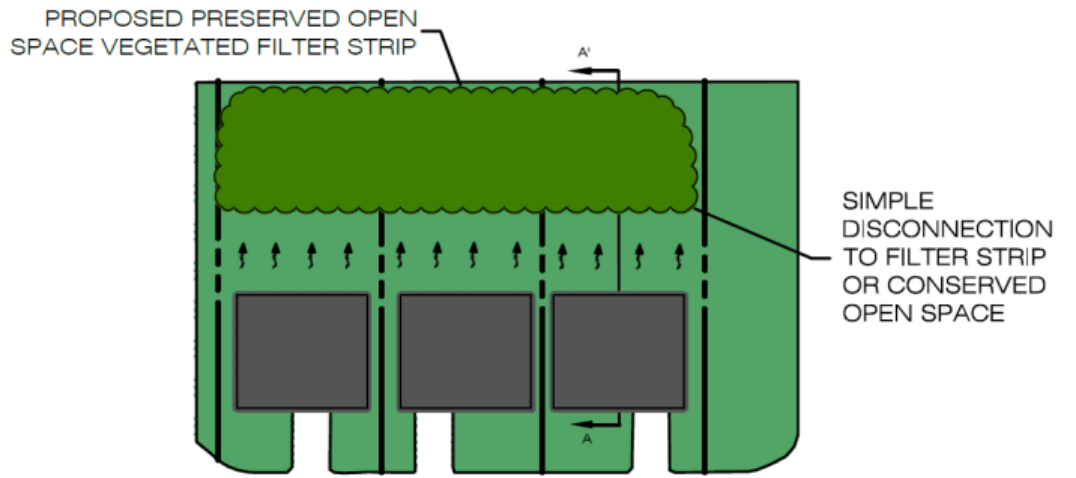


Figure 2.6: Level Spreader: Pipe or Channel Flow to Filter Strip or Preserved Open Space



PLAN VIEW

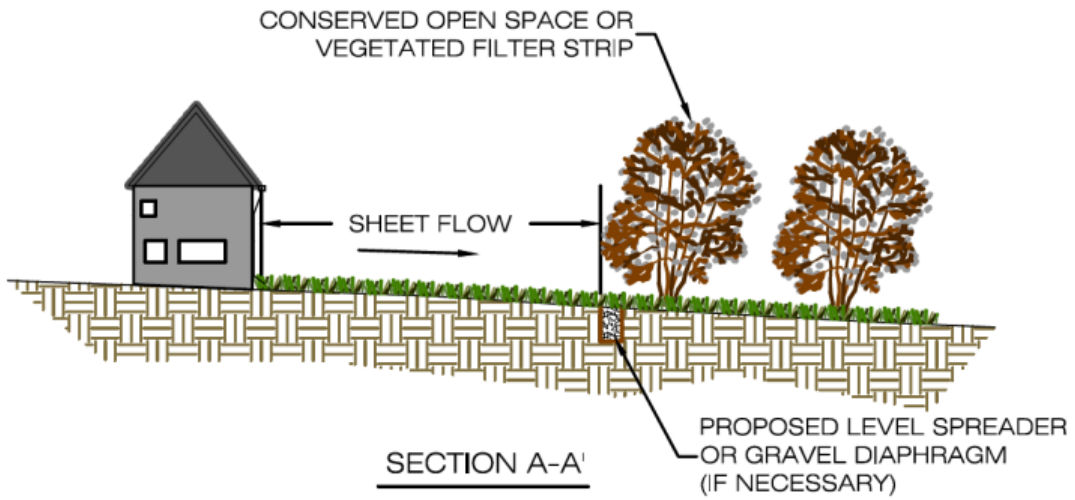


Figure 2.7: Simple Disconnection to downstream Preserved Open Space or Vegetated Filter Strip

SECTION 5. PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 Conserved Open Space

The most common design applications of Conserved Open Space are on sites that are hydrologically connected to a protected stream buffer, wetland buffer, floodplain, forest conservation area, or other protected lands. Conserved open space is an ideal component of the "outer zone" of a stream buffer, such as a Resource Protection Area (as is required in some parts of the state), which normally receives runoff as sheetflow. Care should be taken to locate all energy dissipaters or flow spreading devices outside of the protected area.

Designers may apply a runoff reduction credit to any impervious or managed turf cover that is hydrologically connected and effectively treated by a protected Conserved Open Space that meets the following eligibility criteria:

- The goal of establishing Conserved Open Space is to protect a vegetated area contiguous to a receiving system, such as a stream or natural channel, for treating stormwater runoff. Establishing isolated Conserved Open Space pockets on a development site may not achieve this goal unless they effectively serve to connect the surface runoff to the receiving system. Therefore, a locality may choose to establish goals for minimum acreage to be conserved (in terms of total acreage or percentage of the total project site), and the physical location (adjacent to a stream, or other criteria) in order for the cumulative conserved open space to qualify for the RRM credit.
- No major disturbance may occur within the conserved open space during or after construction (i.e., no clearing or grading is allowed except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation). The Conserved Open Space area shall not be stripped of topsoil. Some light grading may be needed at the boundary using tracked vehicles to prevent compaction.
- The limits of disturbance should be clearly shown on all construction drawings and protected by acceptable signage and erosion control measures.
- A long term vegetation management plan must be prepared to maintain the Conserved Open Space in a natural vegetative condition. Generally, Conserved Open Space management plans do not encourage or even allow any active management. However, a specific plan should be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance, etc. Managed turf is not considered an acceptable form of vegetative management, and only the passive recreation areas of dedicated parkland are eligible for the practice (e.g., the actively used portions of ball fields and golf courses are not eligible), although conservation areas can be ideal treatment practices at the edges of turf-intensive land uses.
- The Conserved Open Space must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.
- The practice does *not* apply to jurisdictional wetlands that are sensitive to increased inputs of stormwater runoff (e.g., bogs and fens).

5.2 Vegetated Filter Strips

Vegetated Filter Strips are best suited to treat runoff from small segments of impervious cover (usually less than 5,000 sq. ft.) adjacent to road shoulders, small parking lots and rooftops. Vegetated Filter Strips may also be used as pretreatment for another stormwater practice such as a dry swale, bioretention, or infiltration areas. If sufficient pervious area is available at the site, larger areas of impervious cover can be treated by vegetated filter strips, using an engineered level spreader to recreate sheet flow. Vegetated Filter Strips are also well suited to treat runoff from turf-intensive land uses, such as the managed turf areas of sports fields, golf courses, and parkland.

Conserved Open Space and Vegetated Filter Strips can be used in a variety of situations; however there are several constraints to their use:

- ***Filter Slopes and Widths.*** Maximum slopes for Conserved Open Space and Vegetated Filter Strips are 6% and 8% respectively, in order to maintain sheet flow through the practice. In addition, the overall contributing drainage area must likewise be relatively flat to ensure sheet flow draining into the filter. Where this is not possible, alternative measures, such as an engineered level spreader, can be used. Minimum widths (flow path) for Conserved Open Space and Vegetated Filter Strips are dependent on slope, as specified in **Table 2.2** above.
- ***Soils.*** Vegetated Filter Strips are appropriate for all soil types, except fill soils. The runoff reduction rate, however, is dependent on the underlying Hydrologic Soil Groups (see **Table 2.1** above) and whether soils receive compost amendments.
- ***Contributing Flow Path to Filter.*** Vegetated Filter Strips are used to treat very small drainage areas of a few acres or less. The limiting design factor is the length of flow directed to the filter. As a rule, flow tends to concentrate after 75 feet of flow length for impervious surfaces, and 150 feet for pervious surfaces (Claytor, 1996). When flow concentrates, it moves too rapidly to be effectively treated by a Vegetated Filter Strip, unless an engineered level spreader is used. When the existing flow at a site is concentrated, a vegetated swale should be used instead of a Vegetated Filter Strip (Lantin and Barrett, 2005).
- ***Hotspot Land Uses.*** Vegetated Filter Strips should not receive hotspot runoff, since the infiltrated runoff could cause groundwater contamination.
- ***Turf-Intensive Land Uses.*** Both Conserved Open Space and Vegetated Filter Strips are appropriate to treat managed turf and the actively-used areas of sports fields, golf courses, parkland, and other turf-intensive land uses.
- ***Proximity of Underground Utilities.*** Underground pipes and conduits that cross the Vegetated Filter Strip are acceptable.

SECTION 6. DESIGN CRITERIA

6.1. Compost Soil Amendments

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in Stormwater Design Specification No. 4.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.
- If slopes exceed 3%, a protective biodegradable fabric or matting (e.g., EC-2) should be installed to stabilize the site prior to runoff discharge.
- Compost amendments should not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see **Section 6.3**).
- The local plan approval authority may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.2. Planting and Vegetation Management

Conserved Open Space . No grading or clearing of native vegetation is allowed within the Conserved Open Space. An invasive species management plan should be developed and approved by the local plan approval authority.

Reforested Conserved Open Space. At some sites, the proposed stream buffer or Conserved Open Space may be in turf or meadow cover, or overrun with invasive plants and vines. In these situations, a landscape architect or horticulturalist should prepare a reforestation or restoration plan for the Conserved Open Space. The entire area can be planted with native trees and shrubs or planted to achieve a gradual transition from turf to meadow to shrub and forest. Trees and shrubs with deep rooting capabilities are recommended for planting to maximize soil infiltration capacity (PWD, 2007). Over-plant with seedlings for fast establishment and to account for mortality. Plant larger stock at desired spacing intervals (25 to 40 feet for large trees) using random spacing (Cappiella *et al.*, 2006). Plant ground cover or a herbaceous layer to ensure rapid vegetative cover of the surface area.

Vegetated Filter Strips. Vegetated Filter Strips should be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Filter strips should be seeded, not sodded. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration (Wisconsin DNR, 2007). The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should

choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, should be able to withstand both wet and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

6.3. Diaphragms, Berms and Level Spreaders

Gravel Diaphragms: A pea gravel diaphragm at the top of the slope is required for both Conserved Open Space and Vegetated Filter Strips that receive sheetflow. The pea gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the Filter Strip. Refer to **Figure 2.5**.

- The flow should travel over the impervious area and to the practice as sheet flow and then drop at least 3 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the Filter Strip).
- A layer of filter fabric should be placed between the gravel and the underlying soil trench.
- If the contributing drainage area is steep (6% slope or greater), then larger stone (clean bank-run gravel that meets VDOT #57 grade) should be used in the diaphragm.
- If the contributing drainage area is solely turf (e.g., sports field), then the gravel diaphragm may be eliminated.

Permeable Berm: Vegetated Filter Strips should be designed with a permeable berm at the toe of the Filter Strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm (Cappiella *et al.*, 2006). The permeable berm should have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, should be excavated at the upstream toe of the berm, parallel with the contours.
- Media for the berm should consist of 40% excavated soil, 40% sand, and 20% pea gravel.
- The berm 6 to 12 inches high should be located downgradient of the excavated depression and should have gentle side slopes to promote easy mowing (Cappiella *et al.*, 2006).
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

Engineered Level Spreaders. The design of engineered level spreaders should conform to the following design criteria based on recommendations of Hathaway and Hunt (2006), or a locally approved standard that meets the intent of these criteria, in order to ensure non-erosive sheet flow into the vegetated buffer area. **Figure 2.3** above represents a configuration that includes a bypass structure that diverts the design storm to the level spreader, and bypasses the larger storm events around the Conserved Open Space or Vegetated Filter Strip through an improved channel.

An alternative approach is that utilized by Henrico County, where pipe or channels discharge at the landward edge of a floodplain or stream (Resource Protection Area or RPA) buffer. The entire flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow through the buffer. (Refer to Henrico County's *Environmental Program Manual*; Chapter 9, Minimum Design Standard 9.01 "Energy Dissipator": <http://www.co.henrico.va.us/works/eesd/>.)

Key design elements of the engineered level spreader, as provided in **Figures 2 and 3**, include the following:

- High Flow Bypass provides safe passage for larger design storms through the filter strip. The bypass channel should accommodate all peak flows greater than the water quality design flow.
- A Forebay should have a maximum depth of 3 feet and gradually transition to a depth of 1 foot at the level spreader lip (**Figure 2**). The forebay is sized such that the surface area is 0.2% of the contributing impervious area. (A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice).
- The length of the level spreader should be determined by the type of filter area and the design flow:
 - 13 feet of level spreader length per every 1 cubic foot per second (cfs) of inflow for discharges to a Vegetated Filter Strip or Conserved Open Space consisting of native grasses or thick ground cover;
 - 40 feet of level spreader length per every 1 cfs of inflow when the spreader discharges to a Conserved Open Space consisting of forested or reforested buffer (Hathaway and Hunt, 2006).
 - Where the Conserved Open Space is a mix of grass and forest (or re-forested), establish the level spreader length by computing a weighted average of the lengths required for each vegetation type.
 - The minimum level spreader length is 13 feet and the maximum is 130 feet.
 - For the purposes of determining the Level Spreader length, the peak discharge shall be determined using the Rational Equation with an intensity of 1-inch/hour.
- The level spreader lip should be concrete, wood or pre-fabricated metal, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The width of the level spreader channel on the up-stream side of the level lip should be three times the diameter of the inflow pipe, and the depth should be 9 inches or one-half the culvert diameter, whichever is greater.
- The level spreader should be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a 3-foot long section of VDOT # 3 stone, underlain by filter fabric, should be installed just below the spreader to transition from the level spreader to natural grade.

- Vegetated receiving areas down-gradient from the level spreader must be able to withstand the force of the flow coming over the lip of the device. It may be necessary to stabilize this area with temporary (VDOT EC-2) or permanent (VDOT EC-3) materials in accordance with the calculated velocity (on-line system peak, or diverted off-line peak) and material specifications, along with seeding and stabilization in conformance with the Virginia Erosion and Sediment Control Handbook.

6.4. Filter Design Material Specifications

Table 2.3 describes materials specifications for the primary treatment within filter strips.

Table 2.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Pea Gravel (#8 or ASTM equivalent) or where steep (6% +) use clean bank-run VDOT #57 or ASTM equivalent (1-inch maximum).	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% pea gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, timber, or other rigid material; Reinforced channel on upstream of lip: VDOT EC-2 (or EC-3 if velocities require permanent reinforcing). See Hathaway and Hunt (2006) or Henrico County Program Manual.	
Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons. (e.g., VDOT Erosion Control matting EC-2).	
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches	
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in Stormwater Design Specification No. 4.	

SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

7.1. Karst Terrain

Conserved Open Space areas are highly recommended in karst terrain, particularly when storm flow discharges to the outer boundary of a karst protection area (see CSN, 2009).

Vegetated Filter Strips can also be used to treat runoff from small areas of impervious cover (e.g., less than 5,000 square feet). Some communities use wide grass filter strips to treat runoff from the roadway shoulder.

In no case should the use of a Conserved Open Space or Vegetated Filter Strip be considered as a replacement for an adequate receiving system for developed-condition stormwater discharges, unless the adequacy of the design has been demonstrated consistent with the the Virginia Stormwater Management Handbook.

7.2. Coastal Plain

The use of Conserved Open Space areas and Vegetated Filter Strips are highly recommended in the coastal plain, particularly when sheetflow (or concentrated flow with an appropriately-sized level spreader) discharges to the outer boundary of a shoreline, stream or wetland buffer. Vegetated Filter Strips can also be used to treat runoff from small areas of impervious cover (e.g., less than 5,000 square feet). In both cases, however, the designer must consider the depth to the water table. In general, shallow water tables may inhibit the function of Vegetated Filter Strips.

7.3. Linear Highway Sites

Vegetated Filter Strips are highly recommended to treat highway runoff if the median and/or road shoulder is wide enough to provide an adequate flow path.

SECTION 8: CONSTRUCTION

8.1. Construction Sequence for Conserved Open Space Areas

The Conserved Open Space must be fully protected during the construction stage of development and kept outside the limits of disturbance on the Erosion and Sediment (E&S) Control Plan.

- No clearing, grading or heavy equipment access is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the Conserved Open Space shall be protected by super silt fence, chain link fence, orange safety fence, or other measures to prevent sediment discharge.
- The limits of disturbance should be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence, snow fence or other protective barrier.

- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Some light grading may be needed at the Filter Strip boundary; this should be done with tracked vehicles to prevent compaction.
- Stormwater should not be diverted into the Vegetated Filter Strip until the gravel diaphragm and/or level spreader are installed and stabilized.

8.2. Construction Sequence for Vegetated Filter Strips

Vegetated Filter Strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, Vegetated Filter Strip boundaries should be clearly marked.
- Only vehicular traffic used for Filter Strip construction should be allowed within 10 feet of the Filter Strip boundary (City of Portland, 2004).
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed Filter Strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Vegetated Filter Strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the Filter Strip until the turf cover is dense and well established.

8.3. Construction Inspection

Construction inspection is critical to obtain adequate spot elevations, to ensure the gravel diaphragm or ELS is completely level, on the same contour, and constructed to the correct design elevation. As-built surveys should be required to ensure compliance with design standards. Inspectors should evaluate the performance of the Filter Strip after the first big storm to look for evidence of gullies, outflanking, undercutting or sparse vegetative cover. Spot repairs should be made, as needed.

An example construction phase inspection checklist for Sheet Flow to a Filter Strip or Conserved Open Space can be found on the Center for Watershed Protection website at:

http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm
(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

SECTION 9. MAINTENANCE

9.1. Maintenance Agreements

Section 4 VAC 50-60-124 of the regulations specifies the circumstances under which a maintenance agreement must be executed between the owner and the local program. This section sets forth inspection requirements, compliance procedures if maintenance is neglected, notification of the local program upon transfer of ownership, and right-of-entry for local program personnel.

All Vegetated Filter Strips must be covered by a drainage easement to allow inspection and maintenance. If the filter area is a natural Conserved Open Space, it must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance or clearing may occur within the area, except as stipulated in the vegetation maintenance plan.

If the Vegetated Filter Strip is located on a residential private lot, the existence and purpose of the Filter Strip shall be noted on the deed of record. Homeowners will need to be provided a simple document that explains the purpose of the Filter Strip and routine maintenance needs. A deed restriction or other mechanism enforceable by the qualifying local program must be in place to help ensure that Filter Strips are maintained and Conserved Open Space Areas are not converted or disturbed. The mechanism should, if possible, grant authority for local agencies to access the property for inspection or corrective action.

9.2. Maintenance Inspections

Annual inspections are used to trigger maintenance operations such as sediment removal, spot re-vegetation and level spreader repair. Ideally, inspections should be conducted in the non-growing season when it is easier to see the flow path. Example maintenance inspection checklists for Sheet Flow to a Filter Strip or Conserved Open Space areas can be accessed in Appendix C of Chapter 9 of the Virginia Stormwater Management Handbook or at the Center for Watershed Protection's website at:

http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm
(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

Inspectors should check to ensure that:

- Flows through the Filter Strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the Filter Strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the Filter Strip;
- Sediments are cleaned out of Level Spreader forebays and flow splitters; and
- Vegetative density exceeds a 90% cover in the boundary zone or grass filter.

9.3. Ongoing Maintenance

Once established, Vegetated Filter Strips have minimal maintenance needs outside of the spring clean up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated Filter Strips that consist of grass/turf cover should be mowed at least twice a year to prevent woody growth.

SECTION 10. REFERENCES

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VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 4

SOIL COMPOST AMENDMENT

VERSION 1.9

March 1, 2011

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SECTION 1: DESCRIPTION

Soil restoration is an Environmental Site Design (ESD) practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips (**Table 4.1**).

SECTION 2: PERFORMANCE**Table 4.1: Stormwater Functions of Soil Compost Amendments ¹**

Stormwater Function	HSG Soils A and B		HSG Soils C and D	
	No CA ²	With CA	No CA	With CA
Annual Runoff Volume Reduction (RR)				
Simple Rooftop Disconnection	50%	NA ³	25%	50%
Filter Strip	50%	NA ³	NA ⁴	50%
Grass Channel	20%	NA ³	10%	30%
Total Phosphorus (TP) EMC Reduction ⁴ by BMP Treatment Practice	0		0	
Total Phosphorus (TP) Mass Load Removal	Same as for RR (above)		Same as for RR (above)	
Total Nitrogen (TN) EMC Reduction by BMP Treatment Practice	0		0	
Total Nitrogen (TN) Mass Load Removal	Same as for RR (above)		Same as for RR (above)	
Channel Protection & Flood Mitigation	Partial. Designers can use the RRM spreadsheet to adjust the curve number for each design storm for the contributing drainage area, based on annual runoff volume reduction achieved.			
¹ CWP and CSN (2008), CWP (2007)				
² CA = Compost Amended Soils, see Stormwater Design Specification No. 4.				
³ Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded B soils to maintain runoff reduction rates.				
⁴ Filter strips in HSG C and D should use composted amended soils to enhance runoff reduction capabilities. See Stormwater Design Specification No. 2: Sheetflow to Vegetated Filter Strip or Conserved Open Space.				

SECTION 3: DESIGN TABLE

Not applicable.

SECTION 4: TYPICAL DETAILS

Not applicable.

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Compost amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- Reduce runoff from compacted lawns.
- Enhance rooftop disconnections on poor soils.
- Increase runoff reduction within a grass channel.
- Increase runoff reduction within a vegetated filter strip.
- Increase the runoff reduction function of a tree cluster or reforested area of the site.

SECTION 6: DESIGN CRITERIA

6.1. Performance When Used in Conjunction With Other Practices

As referenced in several of the other specifications, soil compost amendments can be used to enhance the runoff reduction capabilities of allied practices. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Rooftop (impervious) Disconnection – see Stormwater Design Specification No. 1, Section 3.2.
- Vegetated Filter Strips – see Stormwater Design Specification No. 2, Section 6.1.
- Grass Channels – see Stormwater Design Specification No. 3, Section 6.5.
- Site Reforestation – see Appendix A of this design specification.

6.2. Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain pre-construction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

6.3. Runoff Volume Reduction

The runoff volume reduction achieved by soil restoration depends on the site application and the pre-construction hydrologic soil group. When compost amendments are used simply to reduce runoff volume from compacted lawns, the lower runoff coefficients shown in **Table 4.2** can be used to lower the total treatment volume for the site as a whole. If the soil restoration area accepts runoff from adjacent impervious areas, the higher runoff reduction rates outlined in **Table 4.1** above may be used for the indicated practices.

Table 4.2. Runoff Coefficients for Use for Different Pervious Areas

Hydrologic Soil Group	Undisturbed Soils ¹	Disturbed Soils ²	Restored and Reforested ³
A	0.02	0.15	0.02
B	0.03	0.20	0.03
C	0.04	0.22	0.04
D	0.05	0.25	0.05

Notes:
¹ Portions of a new development site, outside the limits of disturbance, which are not graded and do not receive construction traffic.
² Previously developed sites, and any site area inside the limits of disturbance as shown on the E&S Control plan.
³ Areas with restored soils that are also reforested to achieve a minimum 75% forest canopy

6.4. Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. **Table 4.3** presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998) and others.

Table 4.3. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio ¹			
	IC/SA = 0 ²	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 ³
Compost (in) ⁴	2 to 4 ⁵	3 to 6 ⁵	4 to 8 ⁵	6 to 10 ⁵
Incorporation Depth (in)	6 to 10 ⁵	8 to 12 ⁵	15 to 18 ⁵	18 to 24 ⁵
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler
Notes:				
¹ IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)				
² For amendment of compacted lawns that do not receive off-site runoff				
³ In general, IC/SA ratios greater than 1 should be avoided				
⁴ Average depth of compost added				
⁵ Lower end for B soils, higher end for C/D soils				

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$C = A * D * 0.0031$$

Where: C = compost needed (cu. yds.)
A = area of soil amended (sq. ft.)
D = depth of compost added (in.)

6.5. Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.
- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
 - a. 100% of the material must pass through a half inch screen
 - b. The pH of the material shall be between 6 and 8
 - c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
 - d. The organic matter content shall be between 35% and 65%
 - e. Soluble salt content shall be less than 6.0 mmhos/cm
 - f. Maturity should be greater than 80%
 - g. Stability shall be 7 or less

- h. Carbon/nitrogen ratio shall be less than 25:1
- i. Trace metal test result = “pass”
- j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu. ft³.

SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

7.1. Karst Terrain

No special adaptations are needed in karst terrain, but the designer should take soil tests to ensure that soil pH is adjusted to conform to pre-existing soil conditions found in limestone dominated areas.

7.2. Coastal Plain

Designers should evaluate drainage and water table elevations to ensure the entire depth of soil amendment will not become saturated (i.e., a minimum separation depth of 2 feet from groundwater). Compost amendments are most cost effective when used to boost the runoff reduction capability of grass vegetated filter strips, grass channels and rooftop disconnections.

7.3. Steep Terrain

Compost amendments are ineffective when longitudinal slopes exceed 5%, so some terracing may be needed on steeper slopes.

7.4. Cold Climate and Winter Performance

Soil restoration is not recommended for areas that will be used for snow storage.

7.5. Linear Highway Sites

Soil amendments can improve the runoff reduction of drainage swales in open section rights-of-way and highway medians.

SECTION 8: CONSTRUCTION

8.1. Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

Step 1. Prior to building, the proposed area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. (This step is usually omitted when compost is used for narrower filter strips.)

Step 2. A second deep tilling to a depth of 12 to 18 inches is needed after final building lots have been graded.

Step 3. It is important to have dry conditions at the site prior to incorporating compost.

Step 4. An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of 1 part compost to 2 parts soil.

Step 5. The site should be leveled and seeds or sod used to establish a vigorous grass cover. Lime or irrigation may initially be needed to help the grass grow quickly.

Step 6. Areas of compost amendments exceeding 2500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment.

8.2. Construction Inspection

Construction inspection involves digging a test pit to verify the depth of mulch, amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at one location per 10,000 square feet.

SECTION 9: MAINTENANCE

9.1. Maintenance Agreements

When soil compost amendments are applied on private residential lots, homeowners will need to be educated on their routine maintenance needs, understand the long-term maintenance plan, and be subject to a deed restriction or other mechanism enforceable by the qualifying local program to ensure that infiltrating areas are not converted or disturbed. The mechanism should, ideally, grant authority for local agencies to access the property for inspection or corrective action. In addition, the GPS coordinates for all amended areas should be provided upon facility acceptance to ensure long term tracking.

A simple maintenance agreement should be provided if soil restoration is associated with more than 10,000 square feet of reforestation. A conservation easement or deed restriction, which also identifies a responsible party, may be required to make sure the newly developing forest cannot be cleared or developed management is accomplished (i.e., thinning, invasive plant removal, etc.). Soil compost amendments within a filter strip or grass channel should be located in a public right-of-way, or within a dedicated stormwater or drainage easement.

9.2. First Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

Initial inspections. For the first six months following the incorporation of soil amendments, the site should be inspected at least once after each storm event that exceeds 1/2-inch of rainfall.

Spot Reseeding. Inspectors should look for bare or eroding areas in the contributing drainage area or around the soil restoration area and make sure they are immediately stabilized with grass cover.

Fertilization. Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.

Watering. Water once every three days for the first month, and then weekly during the first year (April-October), depending on rainfall.

9.3. Ongoing Maintenance

There are no major on-going maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. An example maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2010).

SECTION 10. COMMUNITY & ENVIRONMENTAL CONCERNS

Not applicable.

SECTION 11: REFERENCES

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APPENDIX 4-A

INITIAL MINIMUM DESIGN CRITERIA FOR REFORESTATION, DISCONNECTION, FILTER STRIPS AND GRASS CHANNELS

SECTION 4-A.1: SITE REFORESTATION

Several design criteria apply when compost amendments are used to enhance the performance of reforested areas. Site reforestation involves planting trees on existing turf or barren ground at a development site with the explicit goal of establishing a mature forest canopy that will intercept rainfall, increase evapotranspiration rates, and enhance soil infiltration rates. Reforestation areas at larger development sites (and individual trees at smaller development sites) are eligible under the following qualifying conditions.

- The minimum contiguous area of reforestation must be greater than 5,000 square feet.
- A long term vegetation management plan must be prepared and filed with the local review authority in order to maintain the reforestation area in a natural forest condition.
- The reforestation area must be protected by a perpetual stormwater easement or deed restriction which stipulates that no future development or disturbance may occur within the area.
- Reforestation methods must achieve 75% forest canopy within ten years.
- The planting plan must be approved by the appropriate local forestry or conservation authority, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least 3 growing seasons, to ensure adequate growth and survival of the plant community.
- The reforestation area shall be shown on all construction drawings and E&S Control plans during construction.

SECTION 4-A.2: SIMPLE DOWNSPOUT DISCONNECTION

See VA DEQ Stormwater Design Specification No. 1.

SECTION 4-A.3: FILTER STRIP

See VA DEQ Stormwater Design Specification No. 2.

SECTION 4-A.4: GRASS CHANNEL

See VA DEQ Stormwater Design Specification No. 3.

ATTACHMENT 4

Letter of Availability for Nutrient Credits

[Will Be Provided Prior to Land Disturbance Activities]