Stormwater Division

MEMORANDUM

DATE: March 13, 2010

TO: Michael J. Gillis, Virginia Correctional Enterprises Document Management Services

FROM: Jo Anna Ripley, Stormwater

PO: 270712

RE: Files Approved for Scanning

General File ID or BMP ID: PC140

PIN: 3830100032A

Subdivision, Tract, Business or Owner Name (if known): Powhatan Secondary

Property Description: 2.53 AC CORNER OF NEWS RD & MONTICELLO AVE; POWHATAN ENTERPRISES, INC

Site Address: 231 Powhatan Secondary #A

(For internal use only) **Box** 4 **Drawer:** 3

Agreements: (in file as of scan date) **Y** **Book or Doc#:** 806 **Page:** 46

Comments

The Inspection/Maintenance of Drainage System Declaration is not the recorded copy. Document # is not known as of the date of the scan.
Deed of Easement in file

CERTIFICATE OF AUTHENTICITY

THIS IS TO CERTIFY THAT THE FOLLOWING ELECTRONIC RECORDS ARE TRUE AND ACCURATE REPRODUCTIONS OF THE ORIGINAL RECORDS OF JAMES CITY COUNTY GENERAL SERVICES DEPARTMENT- STORMWATER DIVISION; WERE SCANNED IN THE REGULAR COURSE OF BUSINESS PURSUANT TO GUIDELINES ESTABLISHED BY THE LIBRARY OF VIRGINIA AND ARCHIVES; AND HAVE BEEN VERIFIED IN THE CUSTODY OF THE INDIVIDUAL LISTED BELOW.

BMP NUMBER: **PC140**

DATE VERIFIED: **October 4, 2012**

QUALITY ASSURANCE TECHNICIAN: **Leah Hardenbergh**

Leah Hardenbergh

LOCATION: WILLIAMSBURG, VIRGINIA

DECLARATION OF COVENANTS

INSPECTION/MAINTENANCE OF DRAINAGE SYSTEM

THIS DECLARATION, made this _____ day of December, 1998, between POWHATAN ENTERPRISES, INC., and all successors in interest, hereinafter referred to as the "COVENANTOR(S)," owner(s) of the following property: See Exhibit A, Deed Book _____, Page No. _____ or Instrument No. _____, and James City County, Virginia, hereinafter referred to as the "COUNTY."

WITNESSETH:

We, the COVENANTOR(S), with full authority to execute deeds, mortgages, other covenants, and all rights, titles and interests in the property described above, do hereby covenant with the COUNTY as follows:

1. The COVENANTOR(S) shall provide maintenance for the drainage system including any runoff control facilities, conveyance systems and associated easements, hereinafter referred to as the "SYSTEM," located on (1) and serving the above-described property (2) to ensure that the SYSTEM is and remains in proper working condition in accordance with approved design standards, and with the law and applicable executive regulations. The SYSTEM shall not include any elements located within any Virginia Department of Transportation rights-of-way.

2. If necessary, the COVENANTOR(S) shall levy regular or special assessments against all present or subsequent owners of property served by the SYSTEM to ensure that the SYSTEM is properly maintained.

3. The COVENANTOR(S) shall provide and maintain perpetual access from public right-of-ways to the SYSTEM for the COUNTY, its agent and its contractor.

4. The COVENANTOR(S) shall grant the COUNTY, its agent and its contractor a right of entry to the SYSTEM for the purpose of inspecting, operating, installing, constructing, reconstructing, maintaining or repairing the SYSTEM.

5. If, after reasonable notice by the COUNTY, the COVENANTOR(S) shall fail to maintain the SYSTEM in accordance with the approved design standards and with the law and applicable executive regulations, the COUNTY may perform all necessary repair or maintenance work, and the COUNTY may assess the COVENANTOR(S) and/or all property served by the SYSTEM for the cost of the work and any applicable penalties.

6. The COVENANTOR(S) shall indemnify and save the COUNTY harmless from any and all claims for damages to persons or property arising from the installation, construction, maintenance, repair, operation or use of the SYSTEM.

7. The COVENANTOR(s) shall promptly notify the COUNTY when the COVENANTOR(S) legally transfers any of the COVENANTOR(S)' responsibilities for the SYSTEM. The COVENANTOR(S)' shall supply the COUNTY with a copy of any document of transfer, executed by both parties.

8. The covenants contained herein shall run with the land and shall bind the COVENANTOR(S) and the COVENANTOR(S)' heirs, executors, administrators, successors and assignees, and shall bind all present and subsequent owners of property served by the SYSTEM.

9. This COVENANT shall be recorded in the County Land Records.

(1) - (2) See Page 2

1. a portion of the property described on Exhibit A to this Declaration and more particularly identified as the "Drainage Easement Area" on that certain plat entitled "Plat of Storm Water Drainage Easement for Conveyance by Powhatan Enterprises, Inc. to Monticello Marketplace Associates, L.L.C." dated August 29, 1996 and recorded in the Clerk's Office of the Circuit Court of James City County, Virginia in Plat Book 64 at Page 95,

2. and also serving all of the property acquired by Monticello Marketplace Associates, L.L.C. from Powhatan Enterprises, Inc., as more particularly described on Exhibit B to this Declaration, by Deed dated September 4, 1996 and recorded in the aforesaid Clerk's Office in Deed Book 806 at Page 43,

IN WITNESS WHEREOF, the COVENANTOR(S) have executed this DECLARATION OF COVENANTS as of this _____ day of December, 19 98.

COVENANTOR(S)

POWHATAN ENTERPRISES, INC.

Print Name/Title By: _____
Lawrence E. Beamer
President

ATTEST:

_____

COVENANTOR(S)

_____

Print Name/Title _____

ATTEST:

_____

COMMONWEALTH OF VIRGINIA
CITY/COUNTY OF _____

I hereby certify that on this _____ day of December, 19 98, before the subscribed, a Notary Public of the State of Virginia, and for the City/County of _____, aforesaid personally appeared Lawrence E. Beamer* and did acknowledge the aforegoing instrument to be their Act. *President of Powhatan Enterprises, Inc.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal this _____ day of _____, 19_____.

_____
Notary Public

My Commission expires: _____

Approved as to form:

_____

This Declaration of Covenants prepared by:

Robert L. Dewey
(Print Name)

_____
(Title)
Willcox & Savage, P.C.
1800 NationsBank Center
(Address)

Norfolk	VA	23510
(City)	(State)	(Zip)

drainage.pre
Revised 2/97

DB 806 PG 76
See separate file

THIS DEED OF EASEMENT is made this 4th day of September, 1996, by and between POWHATAN ENTERPRISES, INC., a Virginia corporation ("Grantor"), as Grantor for purposes of indexing; and MONTICELLO MARKETPLACE ASSOCIATES, L.L.C., a Virginia limited liability company ("Grantee"), as Grantee for purposes of indexing.

RECITALS:

A. Grantor is the owner of an approximately 530 acre parcel of land located in James City County, Virginia, as more particularly described on Exhibit A attached hereto and incorporated by reference herein (the "Land").

B. Grantor is, by Deed of even date herewith and to be recorded simultaneously herewith, conveying to Grantee an approximately 44 acre portion of the Land, as more particularly described on Exhibit B attached hereto and incorporated by reference herein (the "Commercial Tract").

C. As a material inducement to, and as part of the consideration for, Grantee's agreement to purchase the Commercial Tract from Grantor, Grantor has agreed to grant and convey to Grantee the easements hereinafter described across certain portions of the Land as more particularly described herein that are not included in the Commercial Tract being conveyed to the Grantee, for the benefit of the Commercial Tract (that portion of the Land that is not included in the Commercial Tract being hereinafter referred to as the "Retained Land").

NOW, THEREFORE, that for and in consideration of the sum of Ten Dollars ($10.00), cash in hand paid, and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Grantor does hereby grant and convey with General Warranty and with English Covenants of Title unto the said Grantee, its successors and assigns, for the benefit of the Commercial Tract, the following described easements, to-wit:

> A temporary non-exclusive easement (the "Sewer Easement") 20 feet in width, in under, upon, through and beneath only those portions of the Retained Land that are identified as "Sanitary Sewer Easement" (the "Sewer Easement Area") on that certain plat (the "Sewer Easement Plat") entitled "Plat of Sanitary Sewer Easement for Conveyance from Powhatan Enterprises, Inc. to Monticello Marketplace Associates, L.L.C.", dated August 29, 1996, prepared by Langley and McDonald, P.C., which Sewer Easement Plat is to be recorded in the Clerk's Office of James City County, Virginia, simultaneously herewith, to which Easement Plat reference is made

This instrument was prepared by: Willcox & Savage, P.C.
1800 NationsBank Center
Norfolk, Virginia 23510

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for a more particular description of the Sewer Easement Area, for the installation and use of (1) underground sewer pipes and (2) at grade manhole covers related to such underground pipes and underground facilities, to carry sewage from the Commercial Tract across the Retained Land to the existing public sewer lines and facilities that are located on the Retained Land as shown on the Easement Plat.

AND ALSO Plat - PB 64 Page 95

A perpetual non-exclusive easement (the "Drainage Easement") in, under, upon, through and beneath (1) the 3.0249 acres of the Retained Land that are identified as "Drainage Easement Area" on that certain plat (the "Storm Water Easement Plat") entitled "Plat of Storm Water Drainage Easement for Conveyance by Powhatan Enterprises, Inc. to Monticello Marketplace Associates, L.L.C." dated August 29, 1996, prepared by Langley and McDonald, P.C., which Storm Water Easement Plat is to be recorded in the Clerk's Office of James City County, Virginia, simultaneously herewith, to which Storm Water Easement Plat reference is made for a more particular description thereof, on which a storm water detention basin ("Storm Water Detention Basin") will be located from time to time, for the installation and use of storm water drainage pipes and related facilities to carry storm and surface water drainage from the Commercial Tract to the Storm Water Detention Basin and for the use of the Storm Water Detention Basin and (2) such other portions of the Retained Land only upon which are located the retention/detention ponds and/or lakes and other drainage facilities to which or through which the storm water discharged from the Storm Water Detention Basin will flow, for the use thereof to drain the storm and surface water drainage from the Commercial Tract and the Storm Water Detention Basin and thence into the retention/detention ponds and/or lakes and other drainage facilities that are located on the Retained Land to the point of outfall for the drainage from the Retained Land.

1. The Sewer Easement is subject to the following terms and conditions:

(a) The owner of the Commercial Tract shall have the right to install and construct sewer pipes and related facilities in the Sewer Easement Area.

(b) The owner of the Commercial Tract shall be permitted to work in the area immediately adjacent to the Sewer Easement Area on the Retained Land (not to exceed a distance of ten (10) feet from the Sewer Easement Area) for purposes of installing and constructing such sewer pipes and related facilities in the Sewer Easement Area, to the extent that such adjacent area has not been improved with buildings and other permanent structures.

(c) The owner of the Retained Land shall have the right to use and connect to, without charge, the sewer pipes and facilities that are installed in the Sewer Easement Area, but only so long as such sewer pipes and facilities are adequate to serve both the improvements then existing or reasonably anticipated to be constructed on the Commercial Tract as well as the improvements on the Retained Land that are intended to be served by the sewer pipes and facilities located in the Sewer Easement Area.

(d) The owner of the Commercial Tract and the owner of the Retained Land agree to dedicate the Sewer Easement Area and the sewer pipes and facilities that are installed and constructed therein to the James City County Service Authority upon completion of the installation and construction thereof and agree to execute and deliver any deeds of dedication, plats or other documents reasonably necessary in connection therewith. The Sewer Easement shall remain in full force and effect until the acceptance of such dedication by the James City County Service Authority.

(e) The owner of the Commercial Tract shall, at its expense, maintain and repair all sewer pipes and related facilities now or hereafter located in the Sewer Easement Area, until the unconditional acceptance by the James City County Service Authority of the responsibility for the maintenance of the sewer pipes and facilities located in the Sewer Easement Area.

(f) If the owner of the Commercial Tract fails to maintain the sewer pipes and related facilities now or hereafter located in the Sewer Easement Area as herein provided, the owner of the Retained Land shall have the right, but not the obligation, to maintain and repair all sewer pipes and related facilities now or hereafter located in the Sewer Easement Area and to recover its costs and expenses incurred in connection therewith, together with reasonable attorney's fees incurred in the collection of such sums.

(g) The owner of the Retained Land shall have the right to landscape the Sewer Easement Area and to use the same for any other use or purpose which is not inconsistent with the rights of the owner of the Commercial Tract hereunder. Notwithstanding the foregoing, the owner of the Retained Land shall not erect any building or other improvements upon the surface of the Sewer Easement Area. If the owner of the Retained Land constructs any paving, sidewalks or like improvements on the Sewer Easement Area and the owner of the Commercial Tract disturbs any such improvements in the course of maintenance, the owner of the Commercial Tract shall restore any such improvements that are disturbed by any such maintenance of the sewer pipes and facilities installed in the Sewer Easement Area.

(h) If the location of the Sewer Easement Area interferes with the commercially reasonable development of the Retained Land, the owner of the Retained Land and the owner of the Commercial Tract shall cooperate in relocating the Sewer Easement Area to another reasonably suitable location on the Retained Land, so long as such relocation does not materially interfere with or require relocation or alteration of the sewer pipes and facilities that have been constructed on the

Commercial Tract. In the event of such relocation of the Sewer Easement Area, the owner of the Retained Land shall, at its sole cost and expense, remove and relocate the sewer pipes and facilities installed in the Sewer Easement Area and shall grant to the owner of the Commercial Tract an equivalent sewer easement on the same terms and conditions as the Sewer Easement herein provided, at another suitable location on the Retained Land. The owner of the Commercial Tract shall thereupon release and quitclaim the Sewer Easement to the owner of the Retained Land.

(i) In the event James City County shall require the relocation of the Sewer Easement Area in order to approve the development of the Commercial Tract in a commercially reasonable manner, the owner of the Retained Land and the owner of the Commercial Tract shall cooperate in relocating the Sewer Easement Area to another reasonably suitable location on the Retained Land, and the owner of the Retained Land shall grant to the owner of the Commercial Tract an equivalent sewer easement on the same terms and conditions as herein provided, at such substitute location. The owner of the Commercial Tract shall thereupon release and quitclaim the Sewer Easement to the owner of the Retained Land.

2. The Drainage Easement is subject to the following terms and conditions:

(a) The owner of the Commercial Tract shall have the right to install and construct all necessary storm water drain pipes and related facilities in the Drainage Easement Area for the purposes of carrying storm and surface water drainage from the Commercial Tract, to, through and across any retention/detention ponds and/or lakes and other drainage facilities that are now existing or hereafter constructed on the Retained Land and shall have the right to drain the storm and surface water drainage from the Commercial Tract into the retention/detention ponds and/or lakes and other drainage facilities that are located on the Retained Land to the point of outfall for the drainage from the Retained Land.

(b) The owner of the Commercial Tract shall be permitted to work in the area immediately adjacent to the Drainage Easement Area on the Retained Land (not to exceed a distance of ten (10) feet from the Drainage Easement Area) for purposes of installing such drain pipe and related facilities in the Drainage Easement Area, to the extent that such adjacent area has not been improved with buildings and other permanent structures.

(c) The owner of the Retained Land shall not allow any use (other than as herein contemplated for the benefit of the Commercial Tract) of the lakes and/or retention/detention ponds and other drainage facilities that are currently located on the Retained Land beyond the current use of such lakes and/or retention/detention ponds and other drainage facilities and will not allow any use of the retention/detention pond that is anticipated to be hereafter constructed by or on behalf of the Virginia Department of Transportation on the Retained Land, if such use, when combined with the flow or anticipated flow from the Commercial Tract in its fully developed state, will exceed the capacity of such lakes and/or retention/detention ponds and other drainage facilities unless such lakes

and/or retention/detention ponds and other drainage facilities are expanded to handle such additional requirements, at no cost or expense to the owner of the Commercial Tract.

(d) The owner of the Retained Land shall, at its expense (subject to partial reimbursement from the owner of the Commercial Tract as hereinafter set forth) maintain and repair all lakes and/or retention/detention ponds and related drainage pipes and facilities now or hereafter located on the Retained Land (to the extent the Virginia Department of Transportation or some other governmental agency or authority is not responsible for such maintenance).

(e) If the owner of the Retained Land fails to maintain the lakes and/or retention/detention ponds and related drainage pipes and facilities now or hereafter located on the Retained Land as herein provided, the owner of the Commercial Tract shall have the right, but not the obligation, to maintain and repair such lakes and/or retention/detention ponds and related drainage pipes and facilities now or hereafter located on the Retained Land and to recover its costs and expenses incurred in connection therewith, together with reasonable attorney's fees incurred in the collection of such sums, and the owner of the Commercial Tract, its agents employees and contractors, shall be permitted to enter upon the Retained Land to perform such maintenance.

(f) The owner of the Retained Land shall have the right to landscape the Drainage Easement Area and to use the same for any other use or purpose which is not inconsistent with the rights of the owner of the Commercial Tract hereunder. Notwithstanding the foregoing, the owner of the Retained Land shall not erect any building upon the surface of the Drainage Easement Area. If the owner of the Retained Land constructs any paving, sidewalks or like improvements on the Drainage Easement Area and the owner of the Commercial Tract disturbs any such improvements in the course of maintenance, the owner of the Commercial Tract shall restore any such improvements that are disturbed by any such maintenance of the drainage pipes and facilities installed in the Drainage Easement Area. Furthermore, the owner of the Retained Land shall not modify any lakes and/or retention/detention ponds and related drainage pipes and facilities located on the Retained Land if such modification would adversely affect the flow of drainage from the Commercial Tract to the point of outfall.

(g) The owner of the Commercial Tract shall pay its Proportionate Share (as hereinafter defined) of all reasonable costs incurred by the owner of the Retained Land which directly relate to the maintenance and repair of the retention/detention ponds and/or lakes and related drainage pipes and facilities located on the Retained Land that are utilized to provide drainage for the Commercial Tract. The Proportionate Share of the owner of the Retained Land of such costs shall be determined by Langley and McDonald, P.C. or other reputable engineers selected by the owner of the Retained Land and approved by the owner of the Commercial Tract in accordance with good engineering practice based on the relative use of such retention/detention ponds and/or lakes and related drainage pipes and facilities by all property served thereby. Such Proportionate Share shall be adjusted from time to time as necessary to reflect any change in the utilization of the retention/detention ponds and/or lakes and related drainage pipes and facilities located on the

Retained Land. The owner of the Commercial Tract shall reimburse the owner of the Retained Land, within thirty (30) days after receipt of the annual statement described below, for its Proportionate Share of such costs, unless the owner of the Commercial Tract makes objection to such charges, in which event any such dispute will be resolved as set forth below.

(h) The owner of the Retained Land will keep books and records reflecting the costs of maintenance and repair of the retention/detention ponds and/or lakes and related drainage pipes and facilities located on the Retained Land and utilized to provide drainage for the Commercial Tract in accordance with generally accepted accounting principles and reflecting the utilization of such drainage facilities by all property served thereby and shall deliver to the owner of the Commercial Tract together with an annual demand for payment under Paragraph 2(g) a statement of the costs incurred during the period covered by such statement for the maintenance and repair of the retention/detention ponds and/or lakes and related drainage pipes and facilities located on the Retained Land and utilized to provide drainage for the Commercial Tract as well as the basis on which the Proportionate Share of such costs was determined. For a period of 150 days following its receipt of the statement described above, the owner of the Commercial Tract or its agent or accounting firm shall have the right to inspect such books and records upon reasonable notice to the owner of the Retained Land, and the owner of the Retained Land shall make such books and records available to the owner of the Commercial Tract. Within such 150 day period, the owner of the Commercial Tract shall set forth any objection that it may have to the form or content of the annual statement, to the reasonableness of any item or items set forth therein or to the basis on which the Proportionate Share of such costs was determined. If the owner of the Retained Land and the owner of the Commercial Tract are unable to resolve by agreement the objections asserted by the owner of the Commercial Tract, any dispute shall be resolved pursuant to the rules and procedures of the American Arbitration Association.

(i) In the event it shall be necessary to relocate the Drainage Easement Area in order to develop the Commercial Tract in a commercially reasonable manner, the owner of the Retained Land and the owner of the Commercial Tract shall cooperate in relocating the Drainage Easement Area to another reasonably suitable location on the Retained Land, and the owner of the Retained Land shall grant to the owner of the Commercial Tract an equivalent drainage easement on the same terms and conditions as herein provided, at such substitute location. The owner of the Commercial Tract shall thereupon release and quitclaim the Drainage Easement to the owner of the Retained Land.

(j) The owner of the Commercial Tract shall have the right to designate the lakes and/or retention/detention ponds now or hereafter located on the Retained Land as a BMP serving the Commercial Tract. Such designation may be made in all plans and permit applications submitted to James City County for approval for site preparation work and the construction of improvements on the Commercial Tract.

3. (a) All notices or any other communications which are required or may be given hereunder shall be in writing and sent by certified or registered mail, return receipt requested, postage prepaid, addressed as follows:

If to the owner of the Commercial Tract:	Monticello Marketplace, L.L.C. 1000 NationsBank Center One Commercial Place Norfolk, VA 23510 **With a copy to:** Thomas G. Johnson, Jr., Esquire Willcox & Savage, P.C. 1800 NationsBank Center Norfolk, VA 23510
If to the owner of the Retained Land:	Powhatan Enterprises, Inc. 13441 Warwick Boulevard Newport News, VA 23602 **With a copy to:** Alvin P. Anderson, Esquire Anderson, Franck & Davis, P.C. Post Office Drawer Q Williamsburg, VA 23187

(b) The address for either such party may be changed from time to time by supplement hereto executed by such party alone and recorded in the Clerk's Office of the Circuit Court of James City County, Virginia.

(c) Any notice hereunder shall be deemed given on the day of deposit thereof in a mailbox under the control of the United States Post Office Department.

4. The owner of the Commercial Tract shall indemnify, defend and hold harmless the owner of the Retained Land, its successors and assigns, and the Retained Land from and against any and all claims and liens arising out of any work done by the owner of the Commercial Tract or its agents, employees and contractors on the Retained Land pursuant hereto. Notwithstanding the foregoing, the indemnification provided in this Paragraph 4 shall not be deemed to relieve the owner of the Retained Land of any of its obligations under the Second Amendment to Option Agreement of even date herewith between Grantor and Grantee, and nothing contained in this Paragraph 4 shall be deemed to limit or otherwise affect the parties' rights and obligations under the Second

Amendment to Option Agreement. Furthermore, the indemnification provided in this Paragraph 4 shall not be deemed to relieve the owner of the Retained Land of any of its obligations under this Deed of Easement.

5. The owner of the Retained Land will execute and deliver any deeds of easement, plats or other documents reasonably necessary to carry out the terms of the Sewer Easement and/or the Drainage Easement, but nothing contained in this Paragraph 5 shall be deemed to expand the scope of the Sewer Easement and/or the Drainage Easement granted hereby.

6. Nothing contained herein shall be construed as creating personal liability whatsoever against any present or future owner of the Retained Land or the Commercial Tract (or any part thereof), their heirs, personal representatives, successors or assigns, or any of them, and in particular, notwithstanding anything contained herein to the contrary, there shall be no personal liability on the part of any present or future owner, their heirs, personal representatives, successors or assigns, or any of them, to pay any indebtedness accruing in connection with the Sewer Easement and/or Drainage Easement or to perform any covenant, express or implied, relating to the Sewer Easement and/or Drainage Easement, and all personal liability is hereby expressly waived. The obligee of any indebtedness accruing under the terms of the Sewer Easement and/or Drainage Easement shall look solely to the property owned by the obligor (or a part thereof), and any buildings or other improvements thereon for the payment of such indebtedness or liability; provided, however, that nothing contained herein shall deprive anyone of the right to enforce the obligations contained herein except as aforesaid. The provisions of this Paragraph 6 are not designed to relieve any present or future owner, their heirs, personal representatives, successors and assigns, or any of them, from the performance of any of their obligations hereunder, but rather are designed to limit their liability as aforesaid.

7. The Sewer Easement and the Drainage Easement and the terms and conditions hereof shall be appurtenant to and shall run with the land as between the Retained Land as a servient tenement and the Commercial Tract as a dominant tenement and shall be binding upon and inure to the benefit of the successors and assigns of Grantor and Grantee and any person claiming by, through or under any of them or their respective successors or assigns, as though the provisions of this Deed of Easement were recited and stipulated at length in each and every deed of conveyance, lease and sublease of the Retained Land, the Commercial Tract or any portion thereof. At the time any sale, transfer or conveyance results in any change in ownership of the Retained Land or any portion thereof, any grantee, transferee, successor or assignee of Grantor shall take such interest subject to the covenants contained herein. Any obligations contained herein with regard to Sewer Easement and/or the Drainage Easement shall be construed as covenants and not as conditions, and a violation of any said covenants shall not result in a forfeiture or reversion of title or of the Sewer Easement and/or Drainage Easement.

8. Nothing contained herein is intended to create, nor shall the Sewer Easement and/or Drainage Easement be deemed as creating, any rights in or for the benefit of the general public in

all or any portion of the Retained Land or the Commercial Tract. Upon dedication of the Sewer Easement to James City County the limitation of this Paragraph 8 shall not apply to such dedicated Sewer Easement.

9. The Sewer Easement and the Drainage Easement and the terms and conditions thereof as set forth hereinabove may be amended, modified, released, rescinded or waived (hereinafter collectively "Modification"), in whole or in part, at any time and from time to time, by written instrument in recordable form executed by the owners of that portion of the Retained Land on which the Sewer Easement and/or the Drainage Easement, as applicable, is located and the owner of the Commercial Tract, at the time of the Modification, without the consent, approval or joinder of any person, firm, corporation or other entity whatsoever.

This conveyance is made expressly subject to the conditions, restrictions and easements and reservations contained in the duly recorded deeds, plats and other instruments constituting constructive notice in the chain of title to said property hereby conveyed which have not expired by time limitation contained therein or otherwise become ineffective.

WITNESS the following signatures and seals:

POWHATAN ENTERPRISES, INC.,
a Virginia corporation

By: _____(SEAL)
Lawrence E. Beamer, President

MONTICELLO MARKETPLACE ASSOCIATES,
L.L.C., a Virginia limited liability company

By: S. L. Nusbaum Realty Co., a Virginia corporation, Manager

By: _____(SEAL)
Miles B. Leon, President

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COMMONWEALTH OF VIRGINIA
CITY/~~COUNTY~~ OF Norfolk, to-wit:

The foregoing instrument was acknowledged before me this 4th day of September, 1996 by Lawrence E. Beamer, President of Powhatan Enterprises, Inc., a Virginia corporation, for and on behalf of the corporation.

Sandra L. Freeman
Notary Public

My Commission Expires: 3-31-98

COMMONWEALTH OF VIRGINIA
CITY OF NORFOLK, to-wit:

The foregoing instrument was acknowledged before me this 4th day of September, 1996 by Miles B. Leon, as President of S. L. Nusbaum Realty Co., a Virginia corporation, Manager of Monticello Marketplace Associates, L.L.C., a Virginia limited liability company, on behalf of the company.

Sandra L. Freeman
Notary Public

My Commission Expires: 3-31-98

1-69572.8/SRH:SLF
9/3/96

EXHIBIT A
TO
DEED OF EASEMENT BETWEEN
POWHATAN ENTERPRISES, INC. and
MONTICELLO MARKETPLACE ASSOCIATES, L.L.C.

LEGAL DESCRIPTION

All that certain tract, piece or parcel of land situate in Berkeley District, James City County, Virginia, containing 539.3534 acres, more or less, as shown and set forth on a plat entitled "PLAT OF A SURVEY OF THE PROPERTY STANDING IN THE NAME OF D. C. RENICK, IRONBOUND ROAD, BERKELEY DISTRICT, JAMES CITY COUNTY, VIRGINIA," dated April 1968, and made by Martin, Clifford & Associates, Engineers & Consultants, a copy of which plat is recorded in the Clerk's Office of the Circuit Court of the City of Williamsburg and County of James City in Plat Book 28, Page 56.

LESS AND EXCEPT the following:

1. 1.13 acres, more or less, conveyed to the Commonwealth of Virginia by Deed dated September 21, 1978, and recorded October 19, 1978, in James City County Deed Book 189, Page 39.

2. Four parcels aggregating 2.44 acres, more or less, conveyed to the Commonwealth of Virginia by Deed dated January 31, 1979, and recorded May 17, 1979, in James City County Deed Book 194, Page 115.

3. .3006 acre, more or less, conveyed to James City Service Authority for a well site by Deed December 19, 1980, and recorded May 5, 1981, in James City County Deed Book 213, Page 226.

4. 18.4 acres, more or less, conveyed to The County of James City by Deed dated February 3, 1981, and recorded May 5, 1981, in James City County Deed Book 213, Page 228.

5. 34.538 acres, more or less, as shown and described on a certain Plat entitled "POWHATAN ENTERPRISES, PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY" dated October 20, 1980, made by Langley and McDonald, Engineers-Planners-Surveyors, and recorded in James City County Plat Book 36, Page 80.

6. 15.7143 acres, more or less, identified as "PARCEL II" and 3.40 acres, more or less, identified as "AREA WITHIN R/W" as shown and described on a Plat entitled "PLAT OF PARCEL II & ACCESS ROAD, BEING A SUBDIVISION OF POWHATAN ENTERPRISES, JAMES CITY COUNTY, VIRGINIA" dated September 25, 1985, made by Langley and McDonald, Engineers-Planners-Surveyors, and recorded in James City County Plat Book 41, Page 85.

7. 22.43 acres, more or less, as shown and described on a Plat entitled "PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY, PHASE II, A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated July 7, 1989, made by Langley and McDonald, Engineers-Planners-Surveyors, and recorded in James City County Plat Book 51, Pages 37 and 38.

Legal Description continued:

8. Lot 17 (0.7291 acre, more or less) and Lot 18 (0.6752 acre, more or less) as shown and described on a Plat entitled "POWHATAN ENTERPRISES, PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY, PHASE III, JAMES CITY COUNTY, VIRGINIA" dated October 29, 1992, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 57, Page 98.

9. 4.2983 acres, more or less, as shown and described on a certain Plat entitled "PLAT OF 4.2983 ACRE RECREATION SITE BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., HEREBY CONVEYED TO POWHATAN COMMUNITY SERVICES ASSOCIATION, POWHATAN DISTRICT-JAMES CITY COUNTY, VIRGINIA" dated August 31, 1990, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 55, Page 65.

10. Eight (8) parcels aggregating 7.737 acres, more or less, containing landscape protection zones and conservation easements conveyed to the Powhatan Community Services Association by Deed dated March 3, 1993, and recorded in James City County Deed Book 615, Page 287 and described as Parcel II in said Deed and as also shown on a certain Plat entitled "PLAT OF PROPERTY TO BE CONVEYED BY POWHATAN ENTERPRISES, INC. TO POWHATAN COMMUNITY SERVICES ASSOCIATION, POWHATAN DISTRICT-JAMES CITY COUNTY, VIRGINIA" dated July 31, 1990, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 55, Page 64.

11. .3562 acre, more or less, designated as Lot 1 as shown and described on a Plat entitled "PLAT OF LOT 1, POWHATAN OF WILLIAMSBURG SECONDARY, PHASE IV-A, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated August 6, 1993, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 58, Page 2.

12. 7.353 acres, more or less, as shown and described on a Plat entitled "PLAT OF THE CLUSTERS, POWHATAN OF WILLIAMSBURG SECONDARY, PHASE III, BEING A SUBDIVISION OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated October 15, 1993, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 59, Pages 63, 64 and 65.

Legal Description continued:

13. 10.3053 acres, more or less, as shown and described on a Plat entitled "PLAT OF WILLIAMSBURG SECONDARY, PHASE IV-A, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated December 20, 1993, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 58, Page 94.

14. Parcel identified as "ENTRANCE EASEMENT TO BE DEDICATED TO V.D.O.T." as shown and described on a Plat entitled "PLAT OF POWHATAN SECONDARY RIGHT OF WAY, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated March 14, 1994, made by Langley and McDonald, P. C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, and recorded in James City County Plat Book 59, Page 66.

15. 1.6432 acres, more or less; as shown and described on a plat entitled "PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY, PHASE I-A, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., BERKELEY DISTRICT, JAMES CITY COUNTY, VIRGINIA" dated August 22, 1995, made by Langley and McDonald, P.C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, recorded in James City County Plat Book 63, Page 33.

16. 8.9001 acres, more or less, as shown and described on a plat entitled "PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY, PHASE V-A, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., BERKELEY DISTRICT, JAMES CITY COUNTY, VIRGINIA" dated August 30, 1995, made by Langley and McDonald, P.C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, recorded in James City County Plat Book 63, Page 31.

17. 9.5572 acres, more or less, as shown and described as plate entitled "PLAT OF POWHATAN OF WILLIAMSBURG SECONDARY, PHASE IV-B, BEING A SUBDIVISION OF PROPERTY OF POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA" dated September 15, 1995, made by Langley and McDonald, P.C., Engineers-Surveyors-Planners of Virginia Beach and Williamsburg, Virginia, recorded in James City County Plat Book 63, Page 32.

The property described herein is a portion of the property conveyed to Powhatan Enterprises, Inc. by Deed dated December 23, 1977, and recorded in James City County Deed Book 181, Page 361, Deed dated January 24, 1978, and recorded in James City County Deed Book 182, Page 416, and by Deed dated February 19, 1981, and recorded in James City County Deed Book 214, Page 176. It includes parcels (38-3)(1-9), (38-3)(1-9A), (38-3)(1-11), (38-3)(1-12) and (38-3)(1-21) on the James City County tax map.

All those certain tracts, pieces or parcels of land situate in Berkeley District, James City County, Virginia, generally shown as "Parcel P20", "Parcel P18" and "Parcel P21" on a plat entitled "PLAT OF PARCELS ALONG RELOCATED ROUTE 5 CORRIDOR, IN, THROUGH AND ADJACENT TO POWHATAN SECONDARY OF WILLIAMSBURG, BERKELEY DISTRICT, JAMES CITY COUNTY, VIRGINIA" dated 3/15/96, prepared by Langley and McDonald, P.C.

Being the same property conveyed to Powhatan Enterprises, Inc. by Deed dated April 24, 1996, and recorded in James City County ~~Deed Book _____, Page _____~~.
as Document # 12933.

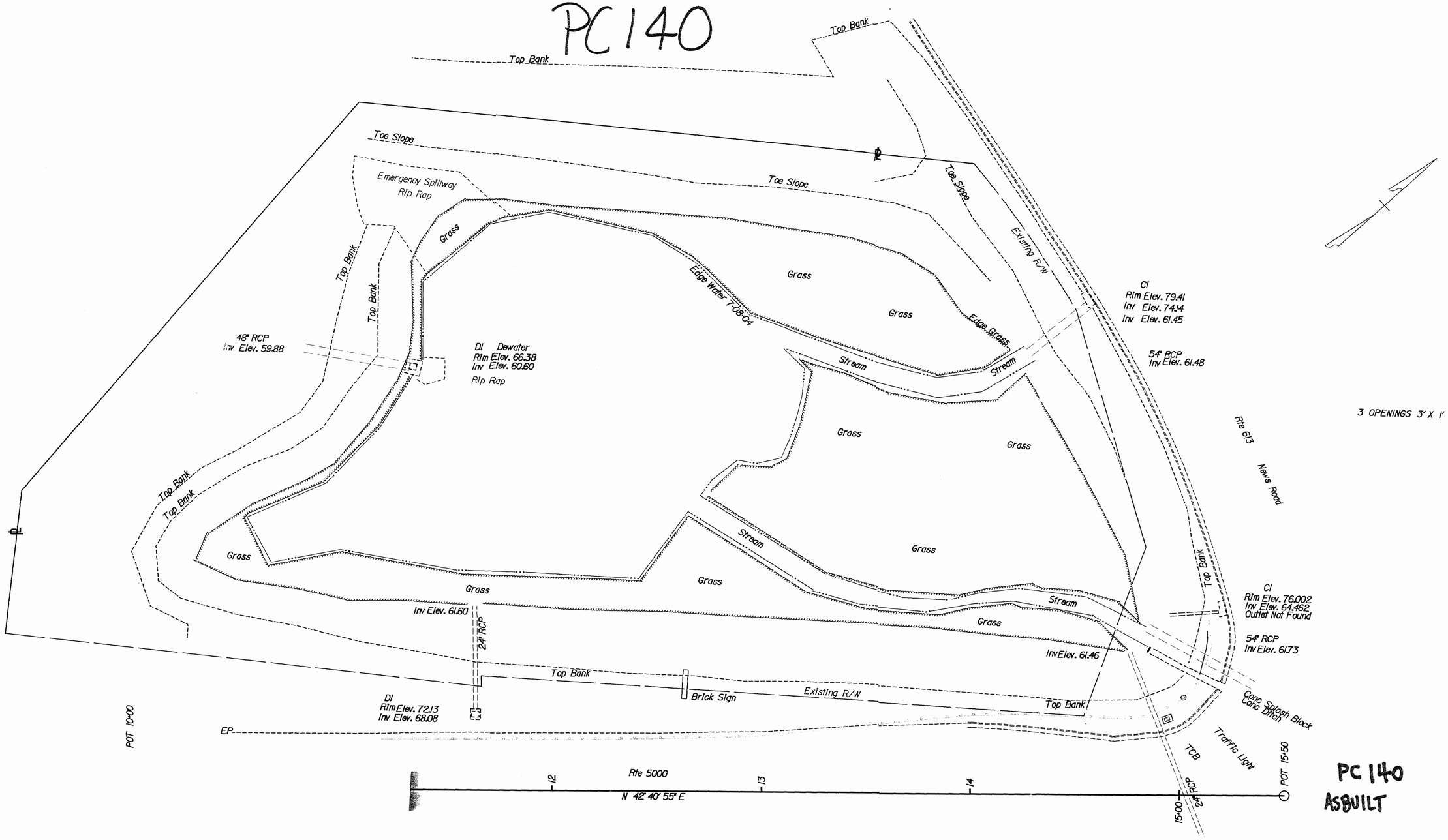
EXHIBIT B
TO
DEED OF EASEMENT BETWEEN
POWHATAN ENTERPRISES, INC. and
MONTICELLO MARKETPLACE ASSOCIATES, L.L.C.

THAT certain real property and the buildings and improvements thereon, if any, located in James City County, Virginia and being known, numbered and designated as PARCEL 1, consisting of 36.9907 acres, and PARCEL 2, consisting of 6.2747 acres, as shown on that certain subdivision plat (the "Subdivision Plat") entitled "PLAT OF SUBDIVISION OF 2 PARCELS OF LAND FOR CONVEYANCE TO MONTICELLO MARKET PLACE ASSOCIATES, L.L.C. FROM POWHATAN ENTERPRISES, INC., JAMES CITY COUNTY, VIRGINIA", dated August 26, 1996, made by Langley and McDonald, P.C., said plat being duly recorded in the Clerk's Office of the Circuit Court of James City County, Virginia in Plat Book 64, at page 93-94, to which Subdivision Plat reference is made for a more particular description of the property.

1-71641.1

Survey VDOT SP#58 07-08-04
Vertical & Horizonal Datum Based on Project: 0199-047-F03,C503

PC140



PC 140
ASBUILT

SUPERVISED BY
DESIGNED BY
CADD OPERATOR
REVISED BY

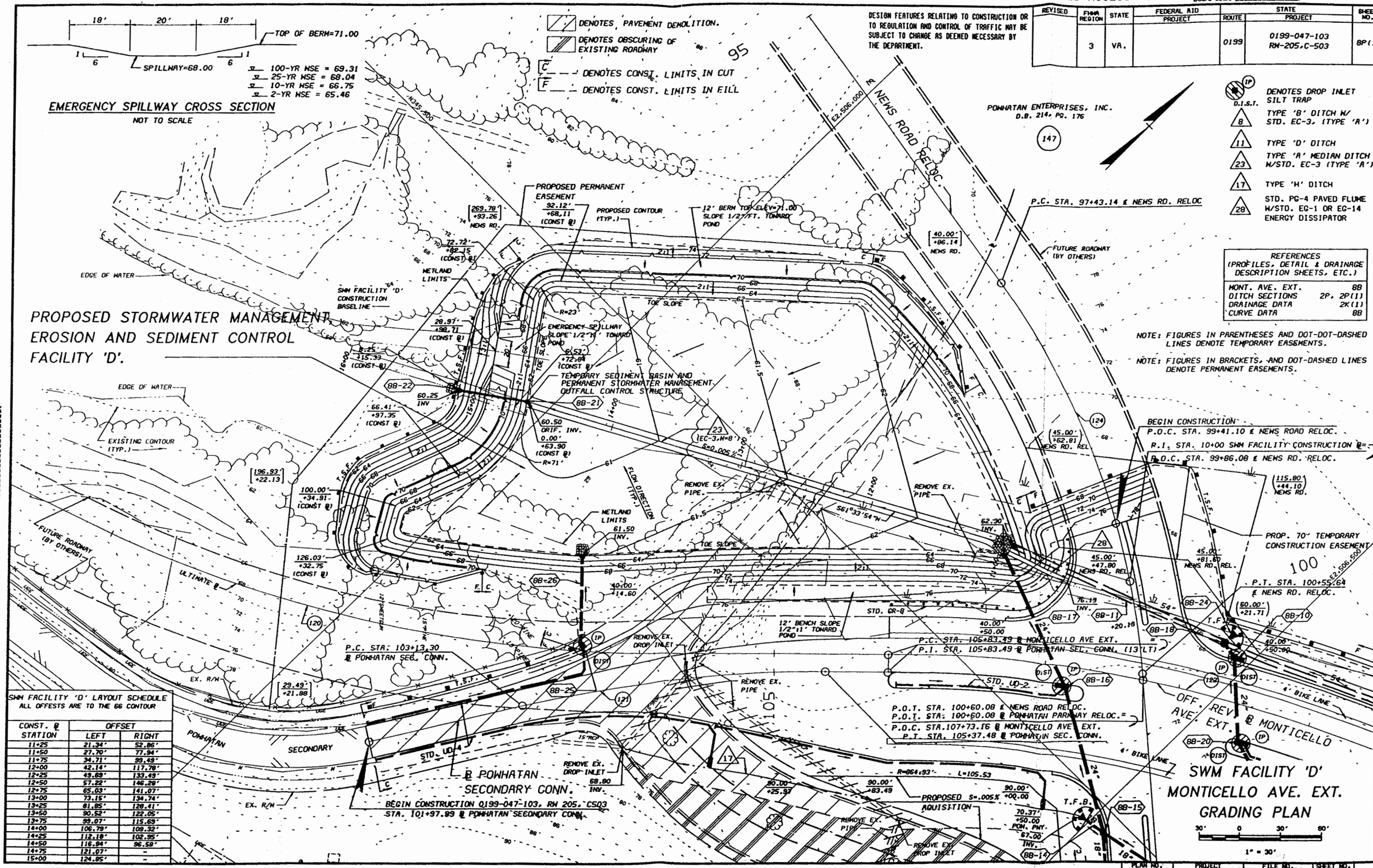
DATE	BY

PC140_POWHATAN_SECONDARY_VDOT - 021

LIMITED ACCESS HIGHWAY By Resolution of Commonwealth Transportation Board dated 10-16-86

REVISED	FHWA REGION	STATE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		0199	0199-047-103 RW-205,C-503	8P(1)

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.



DENOTES DROP INLET SILT TRAP

TYPE 'B' DITCH W/ STD. EC-3, (TYPE 'A')

TYPE 'D' DITCH

TYPE 'A' MEDIAN DITCH W/STD. EC-3 (TYPE 'A')

TYPE 'H' DITCH

STD. PG-4 PAVED FLUME W/STD. EG-1 OR EG-14 ENERGY DISSIPATOR

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)	
MONT. AVE. EXT.	8B
DITCH SECTIONS	2P, 2P(1)
DRAINAGE DATA	2K(1)
CURVE DATA	8B

NOTE: FIGURES IN PARENTHESES AND DOT-DOT-DASHED LINES DENOTE TEMPORARY EASEMENTS.

NOTE: FIGURES IN BRACKETS, AND DOT-DASHED LINES DENOTE PERMANENT EASEMENTS.

SWM FACILITY 'D' LAYOUT SCHEDULE
ALL OFFESTS ARE TO THE 66 CONTOUR

CONST. ℄ STATION	OFFSET LEFT	OFFSET RIGHT
11+25	21.34'	52.86'
11+50	27.70'	77.94'
11+75	34.71'	99.49'
12+00	42.14'	117.78'
12+25	49.69'	133.49'
12+50	57.22'	146.29'
12+75	65.03'	141.07'
13+00	73.15'	134.74'
13+25	81.85'	128.41'
13+50	90.52'	122.05'
13+75	99.07'	115.69'
14+00	106.79'	109.32'
14+25	112.18'	102.95'
14+50	116.94'	96.59'
14+75	121.07'	-
15+00	124.85'	-

SUPERVISED BY E.M. White

DESIGNED BY MMM Design Group

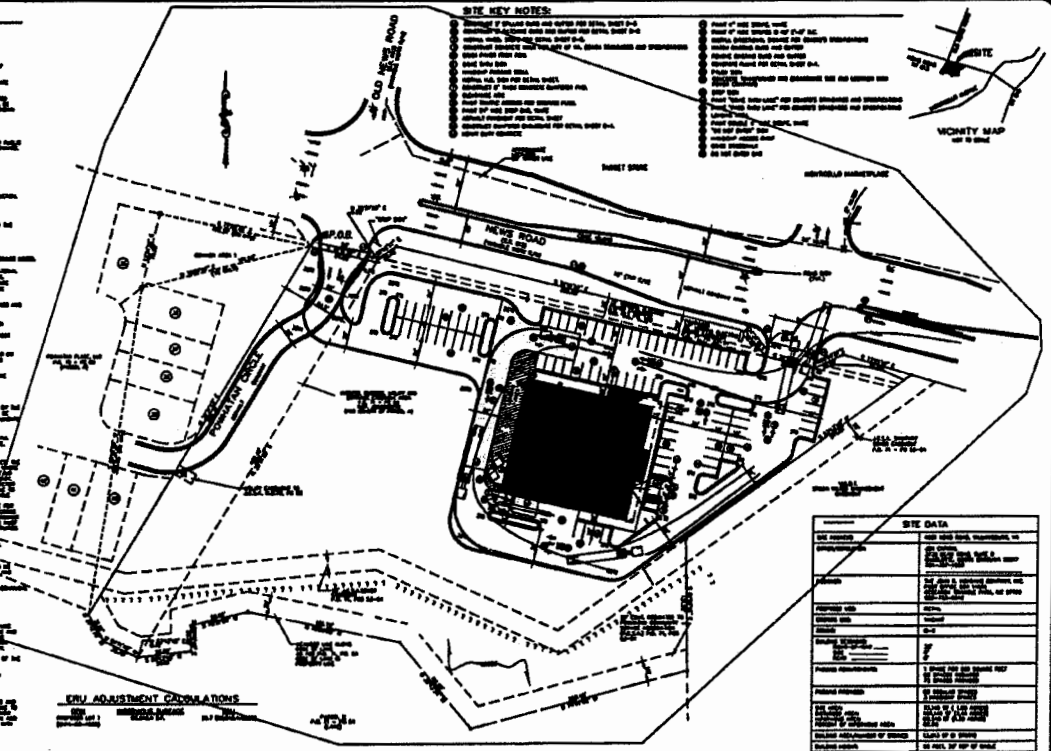
REVISED BY

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A	0199-047-103	28	8P(1)

PC140_POWHATAN_SECONDARY_VDOT - 022

GENERAL SITE NOTES:

SITE KEY NOTES:



SITE DATA

SITE ADDRESS	4501 NEWS ROAD, WILLIAMSBURG, VA
OWNER/APPLICANT	[illegible]
ENGINEER	[illegible]
PROPOSED USE	RETAIL
ZONING DIST.	[illegible]
ZONING	B-2
BUILDING SETBACKS: FRONT / SIDE / REAR	[illegible]
PARKING REQUIREMENTS	1 SPACE PER 200 SQUARE FEET OF GROSS FLOOR AREA
PARKING PROVIDED	[illegible]
SITE AREA: GROSS / NET / DISTURBED	[illegible]
BUILDING AREA/NUMBER OF STORIES	[illegible]
BUILDING HEIGHT	[illegible]
BUILDING SQUARE FOOT AVERAGE	[illegible]
SEWER	CITY OF WILLIAMSBURG
WATER	CITY OF WILLIAMSBURG
FIRE AND SERVICE	[illegible]

ERU ADJUSTMENT CALCULATIONS

DEVELOPMENT AND COMPLIANCE STANDARDS

SITE LEGEND

GRAPHIC SCALE

1 inch = 40 ft.

PRELIMINARY DESIGN - NOT ISSUED FOR CONSTRUCTION

THE JOHN R. McADAMS COMPANY, INC.

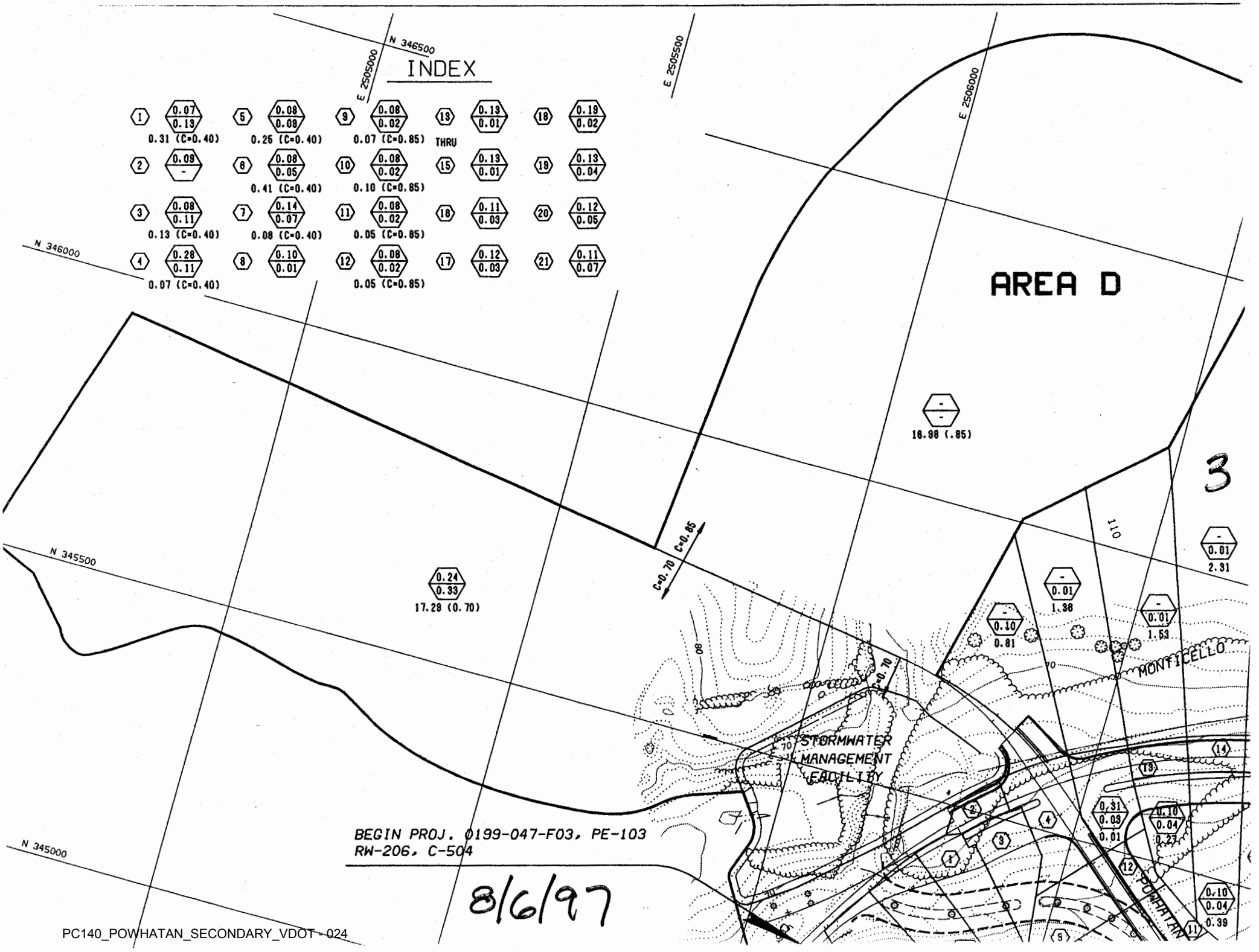
JDS CAPITAL
5700 JEAN RD. SUITE B
WILLIAMSBURG, VA 23187

ECKERD'S DRUG STORE #
4501 NEWS ROAD, WILLIAMSBURG, VA.
BERKELEY DISTRICT, JAMES CITY COUNTY, VIRGINIA

SITE PLAN

C-2

McADAMS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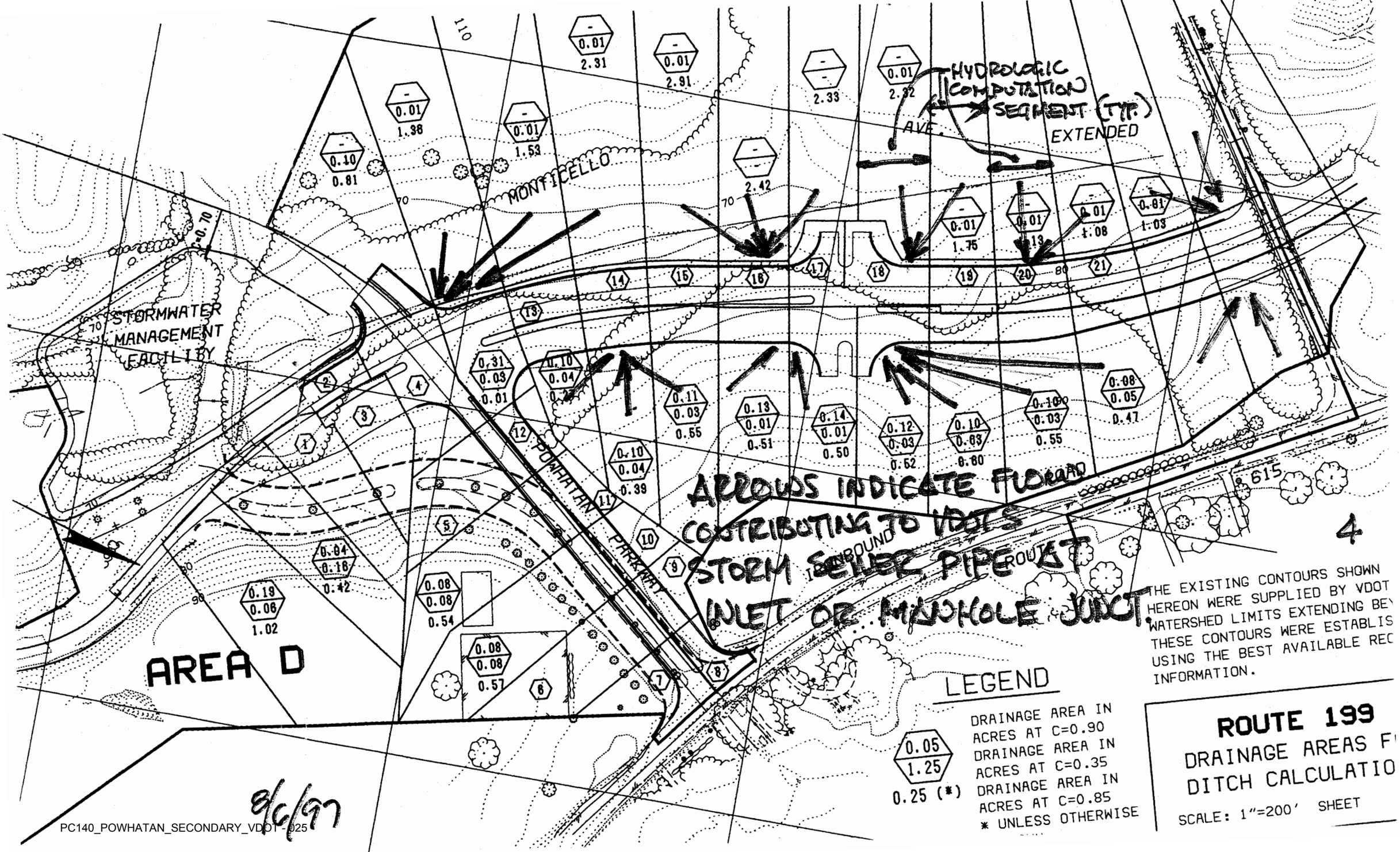
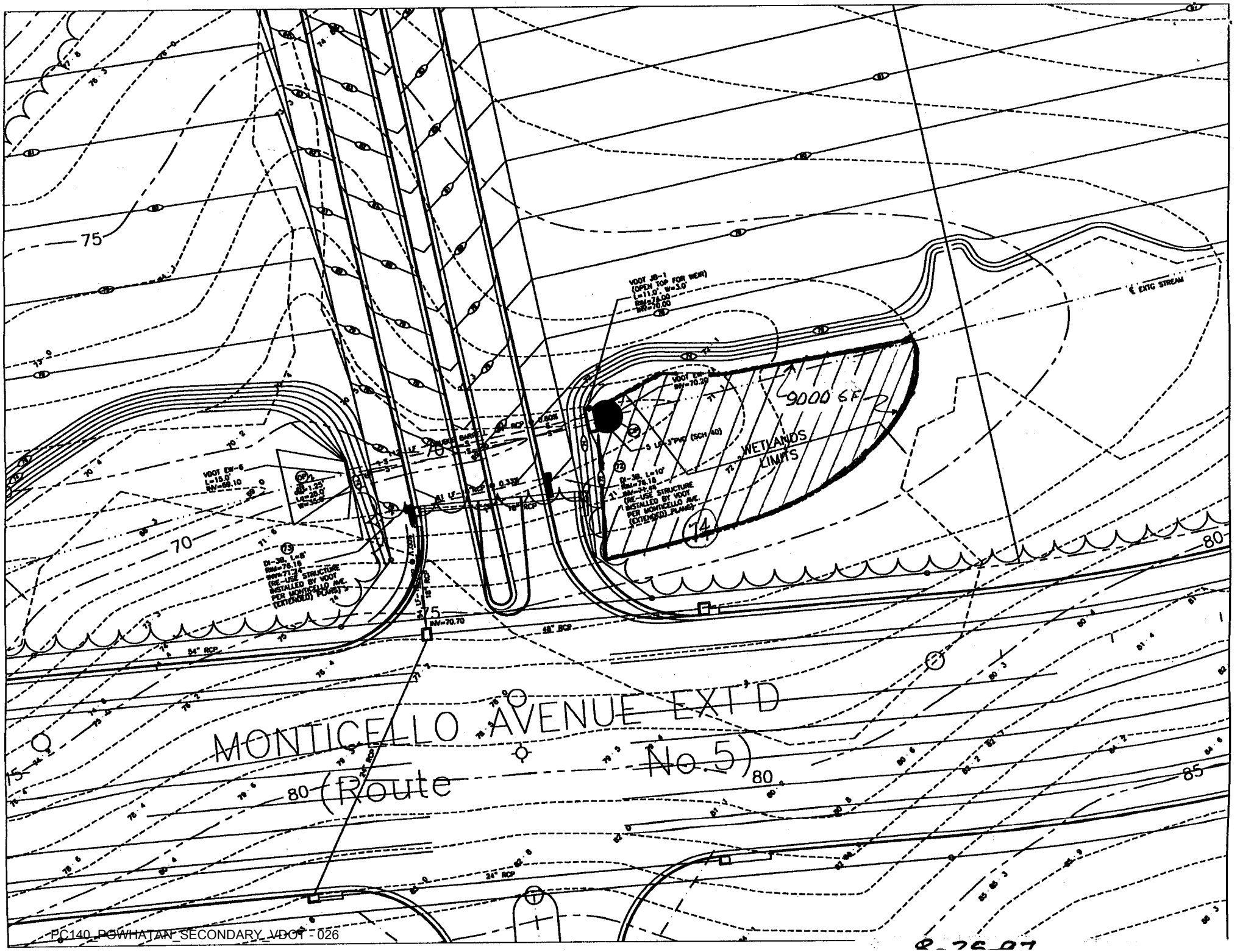
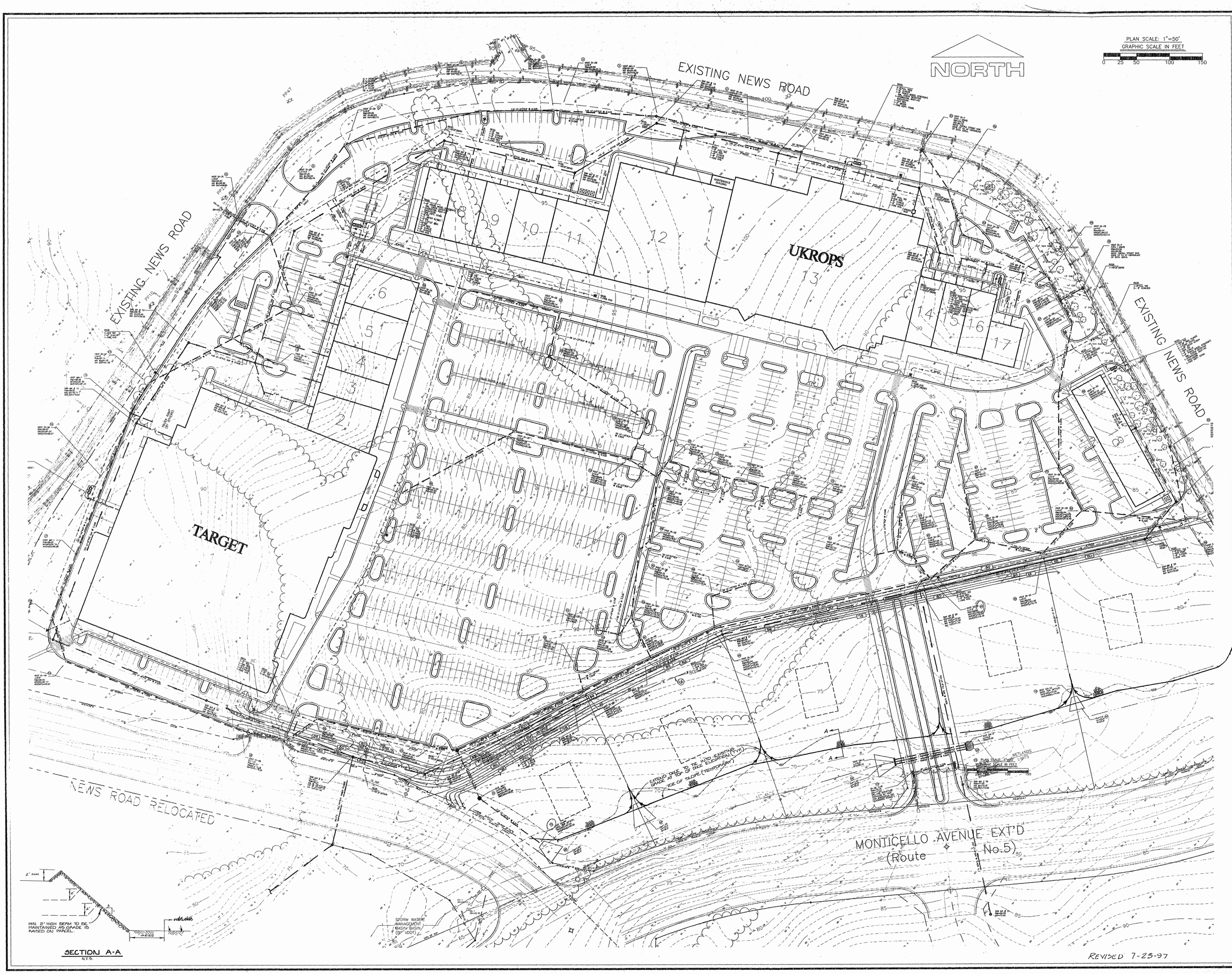
2 0.09 / -
3 0.08 / 0.11 0.13 (C=0.40)
4 0.28 / 0.11 0.07 (C=0.40)
5 0.08 / 0.08 0.26 (C=0.40)
6 0.08 / 0.05 0.41 (C=0.40)
7 0.14 / 0.07 0.08 (C=0.40)
8 0.10 / 0.01
9 0.08 / 0.02 0.07 (C=0.85)
10 0.08 / 0.02 0.10 (C=0.85)
11 0.08 / 0.02 0.05 (C=0.85)
12 0.08 / 0.02 0.05 (C=0.85)
THRU
13 0.13 / 0.01
15 0.13 / 0.01
16 0.11 / 0.03
17 0.12 / 0.03
18 0.19 / 0.02
19 0.13 / 0.04
20 0.12 / 0.05
21 0.11 / 0.07
N 346500
N 346000
N 345500
N 345000
E 2505000
E 2505500
E 2506000
AREA D
- / - 16.98 (.85)
0.24 / 0.33 17.28 (0.70)
C=0.85
C=0.70
C=0.70
- / 0.01 2.31
- / 0.01 1.38
- / 0.01 1.53
- / 0.10 0.81
0.31 / 0.03 0.01
0.10 / 0.04 0.27
0.10 / 0.04 0.39
110
MONTICELLO
POWHATAN
STORMWATER MANAGEMENT FACILITY
BEGIN PROJ. 0199-047-F03, PE-103
RW-206, C-504
3
8/6/97


HYDROLOGIC COMPUTATION SEGMENT (TYP.)
AVE. EXTENDED
MONTICELLO
STORMWATER MANAGEMENT FACILITY
POWHATAN PARKWAY
ARROWS INDICATE FLOW AND CONTRIBUTING TO VDOT'S STORM SEWER PIPE AT INLET OR MANHOLE JUNCT.
INBOUND
OUTBOUND
AREA D
615
4
8/6/97
LEGEND
0.05
1.25
0.25 (*)
DRAINAGE AREA IN ACRES AT C=0.90
DRAINAGE AREA IN ACRES AT C=0.35
DRAINAGE AREA IN ACRES AT C=0.85
* UNLESS OTHERWISE
THE EXISTING CONTOURS SHOWN HEREON WERE SUPPLIED BY VDOT WATERSHED LIMITS EXTENDING BEY THESE CONTOURS WERE ESTABLIS USING THE BEST AVAILABLE REC INFORMATION.
ROUTE 199
DRAINAGE AREAS F
DITCH CALCULATIO
SCALE: 1"=200' SHEET


MONTICELLO AVENUE EXT'D
(Route No.5)
9000 SF
WETLANDS LIMITS
℄ EXTG STREAM
VDOT JB-1
(OPEN TOP FOR WEIR)
L=11.0' W=3.0'
RIM=76.00
INV=70.00
VDOT DW-6
L=15.0'
RIM=69.10
DI-3B, L=8'
RIM=76.18
INV=71.24
(RE-USE STRUCTURE
INSTALLED BY VDOT
PER MONTICELLO AVE.
(EXTENDED) PLANS)
DI-3B, L=10'
RIM=76.18
INV=71.49
(RE-USE STRUCTURE
INSTALLED BY VDOT
PER MONTICELLO AVE.
(EXTENDED) PLANS)
INV=70.70
48" RCP
54" RCP
24" RCP
75
70
80
85



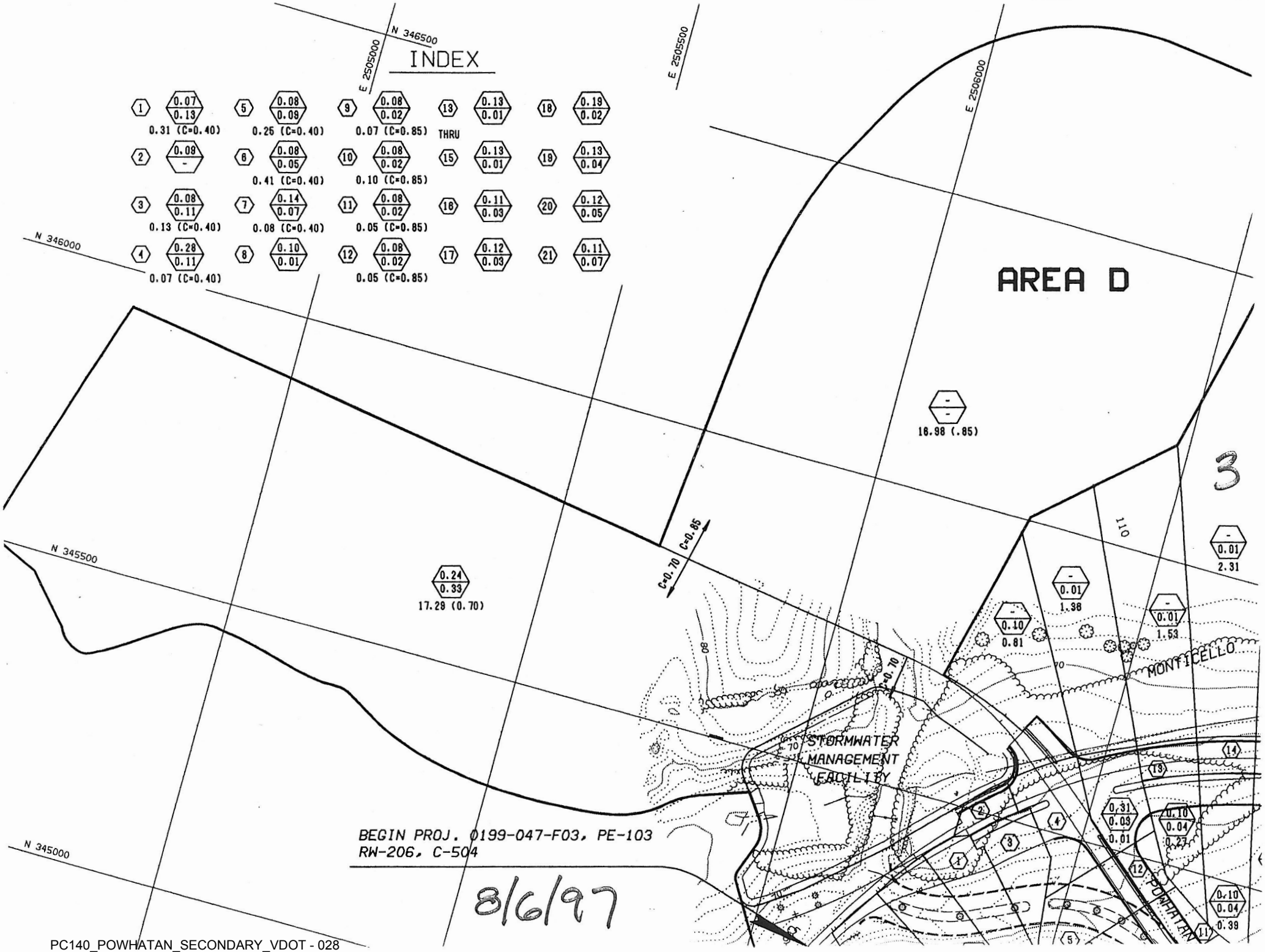
COMMONWEALTH OF VIRGINIA
STEPHEN A. ROMEO
No. 1448-B
LAND SURVEYOR

Langley and McDonald, P.C.
Engineers · Surveyors · Planners
Landscape Architects · Environmental Consultants
VIRGINIA BEACH WILLIAMSBURG

DES.	MRG
DWN.	MRG
CHK.	DEW
DATE	28-MAY-97

STORMWATER MANAGEMENT PLAN
MONTICELLO MARKETPLACE
WILLIAMSBURG, VIRGINIA
FOR
MONTICELLO MARKETPLACE ASSOCIATES L.L.C.

SHEET	OF
DISK	96046-07\LAYOUT13
PROJ. NO.	96046-07
DWG.	5925C W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11 0.08 / 0.02 0.05 (C=0.85)
12 0.08 / 0.02 0.05 (C=0.85)
THRU
13 0.13 / 0.01
15 0.13 / 0.01
16 0.11 / 0.03
17 0.12 / 0.03
18 0.19 / 0.02
19 0.13 / 0.04
20 0.12 / 0.05
21 0.11 / 0.07
N 346500
N 346000
N 345500
N 345000
E 2505000
E 2505500
E 2506000
AREA D
- / - 16.98 (.85)
0.24 / 0.33 17.29 (0.70)
C=0.85
C=0.70
- / 0.01 2.31
- / 0.01 1.38
- / 0.01 1.53
- / 0.10 0.81
0.31 / 0.03 0.01
0.10 / 0.04 0.27
0.10 / 0.04 0.39
STORMWATER MANAGEMENT FACILITY
MONTICELLO
POWHATAN
BEGIN PROJ. 0199-047-F03, PE-103
RW-206, C-504
8/6/97
3

AREA "D"

Ditch Calculations - Drainage Structures - Stormwater

Management & Temporary Sediment Basin Calculations

ROUTE 199
PROJECT 0199-047-103, RW-205, C-503

MMM DESIGN GROUP
ARCHITECTS+ENGINEERS+PLANNERS

MMM DESIGN GROUP
ARCHITECTS • ENGINEERS • PLANNERS

8/6/97

5

STORM SEWER DESIGN

Project: MONTICELLO AVENUE EXTENDED
Job #: 642903
Location PLAN SHEETS 8, 8B, & 8C

IDF-CURVE: JAMES_CITY
Computed by: KWH
Date: 03/13/97

From	To	Design Year	Area A acres	Runoff Coeff. C	C*A Incr.	C*A Accum.	Inlet Time min.	Inten. i in/hr	Flow Q cfs	Invert Elevation Up ft	Invert Elevation Down ft	Length L ft	Slope S ft/ft	n	Dia. D inch	Vel. V ft/s	Cap. Qfull cfs	Flow Time sec.	Remarks
ES	8C-15	10			8.77	8.77	20.4	4.56	39.98	75.30	75.20	32	0.0031	0.013	36	6.14	37.14	5	Q/Qfull=1.1
8C-15	8C-18	10			0.31	9.08	20.5	4.55	41.32	75.20	74.50	130	0.0054	0.013	36	7.92	48.94	16	
8C-18	8B-1	10			14.33	23.41	22.0	4.39	102.83	74.50	71.45	224	0.0136	0.013	42	14.05	117.40	16	
8B-1	8B-3	10			0.28	23.69	22.3	4.36	103.40	71.45	70.70	96	0.0078	0.013	48	11.50	126.96	8	
8B-3	8B-4	10			0.58	24.27	22.4	4.35	105.58	70.70	69.50	130	0.0092	0.013	48	12.34	138.01	11	
8B-4	8B-9	10			0.17	24.44	22.6	4.33	105.87	69.50	68.40	128	0.0086	0.013	48	12.02	133.16	11	
8B-9	8B-23	10			4.03	28.47	22.8	4.31	122.80	67.90	66.60	243	0.0053	0.013	54	10.37	143.83	23	
8B-23	8B-18	10				28.47	23.1	4.27	122.80	66.60	64.80	285	0.0063	0.013	54	11.11	156.28	26	
8B-18	8B-11	10			20.25	48.72	30.0	3.56	173.45	64.80	62.30	172	0.0145	0.013	54	16.58	237.08	10	
8B-5	8B-6	10			0.12	0.12	5.0	7.20	0.86	71.10	70.90	78	0.0026	0.013	18	2.06	5.32	38	
8B-6	8B-9	10			0.06	0.18	5.6	7.05	1.27	70.90	70.70	50	0.0040	0.013	18	2.74	6.64	18	
8B-7	8B-8	10			2.66	2.66	10.0	6.00	15.96	73.30	71.45	186	0.0099	0.013	24	7.93	22.56	23	
8B-8	8B-9	10			1.19	3.85	10.4	5.93	22.83	71.45	70.20	130	0.0096	0.013	24	8.23	22.18	16	Q/Qfull=1.0
8B-19	8B-20	10			1.56	1.56	10.0	6.00	9.36	67.45	66.45	86	0.0116	0.013	18	7.31	11.33	12	
8B-20	8B-10	10			0.50	2.06	10.2	5.97	12.29	66.45	66.16	62	0.0047	0.013	24	5.58	15.47	11	
8B-10	8B-18	10			0.05	2.11	10.4	5.93	12.52	66.16	66.10	15	0.0040	0.013	24	5.24	14.31	3	
8B-2	8B-3	10			0.46	0.46	10.0	6.00	2.76	75.25	73.20	68	0.0301	0.013	18	6.85	18.24	10	
8B-12	8B-15	10			0.56	0.56	8.0	6.48	3.63	67.55	66.75	90	0.0089	0.013	18	5.16	9.90	17	
8B-13	8B-15	10			1.07	1.07	15.0	5.12	5.48	69.65	66.75	122	0.0238	0.013	18	8.22	16.20	15	
8B-15	8B-16	10			0.59	1.66	15.2	5.09	8.46	66.25	65.00	118	0.0106	0.013	24	6.81	23.28	17	
8B-16	8B-17	10			0.12	1.78	15.5	5.06	9.01	65.00	62.30	114	0.0237	0.013	24	9.02	34.82	13	
8B-14	8B-15	10			1.17	1.17	17.1	4.90	5.73	67.00	66.75	28	0.0089	0.013	18	5.92	9.93	5	

8/6/97

6

MMM DESIGN GROUP
ARCHITECTS • ENGINEERS • PLANNERS

HYDRAULIC GRADE LINE

Project: MONTICELLO AVENUE EXTENDED
Job #: 642903
Location: PLAN SHEETS 8, 8B, & 8C

Date: 03/13/97
Computed by: KWH
Sheet Number:

Inlet	Outlet WS Elev.	Do in	Qo cfs	Lo ft	Sfo %	Hf ft	Junction Loss Vo fts	Ho ft	Qi cfs	Vi fps	QiVi	Hi ft	Ang. deg.	K	Hd ft	Ht ft	DI Y/N	1.3 Ht	SI Y/N	0.5 Ht	H ft	Inlet WS Elev.	All. WSE Elev. ft	Remarks
8B-18	66.89	54	173.45	172	0.77	1.33	16.6	1.07	122.80	11.1	1365	0.67	-	-	-	1.74	N	1.74	Y	0.87	2.20	69.09	75.25	
8B-23	69.09	54	122.80	285	0.39	1.11	11.1	0.48	122.80	10.4	1273	0.58	-	-	-	1.06	N	1.06	Y	0.53	1.64	70.73	77.77	
8B-9	70.73	54	122.80	243	0.39	0.94	10.4	0.42	105.87	12.0	1273	0.79	-	-	-	1.20	Y	1.56	Y	0.78	1.72	72.45	77.09	
8B-4	72.45	48	105.87	128	0.54	0.69	12.0	0.56	105.58	12.3	1303	0.83	-	-	-	1.39	Y	1.81	Y	0.90	1.59	74.05	78.01	
8B-3	74.05	48	105.58	130	0.54	0.70	12.3	0.59	103.40	11.5	1189	0.72	-	-	-	1.31	Y	1.70	Y	0.85	1.55	75.60	78.51	
8B-1	75.60	48	103.40	96	0.52	0.50	11.5	0.51	102.83	14.0	1444	1.07	-	-	-	1.59	Y	2.06	Y	1.03	1.53	77.13	79.10	
8C-18	77.13	42	102.83	224	1.04	2.33	14.0	0.77	41.32	7.9	327	0.34	-	-	-	1.11	Y	1.44	Y	0.72	3.05	80.17	82.03	
8C-15	80.17	36	41.32	130	0.38	0.50	7.9	0.24	39.98	6.1	245	0.20	90	0.70	0.41	0.86	Y	1.11	Y	0.56	1.05	81.23	83.47	
ES	81.23	36	39.98	32	0.36	0.11	6.1	0.15	-	-	-	-	-	-	-	0.15	N	0.15	Y	0.07	0.19	81.41	80.57	
8B-6	73.32	18	1.27	50	0.01	0.01	2.7	0.03	0.86	2.1	2	0.02	90	0.70	0.05	0.10	Y	0.13	Y	0.06	0.07	73.39	75.97	
8B-5	73.39	18	0.86	78	0.01	0.01	2.1	0.02	-	-	-	-	-	-	-	0.02	Y	0.02	Y	0.01	0.02	73.41	75.97	
8B-8	73.32	24	22.83	130	1.01	1.32	8.2	0.26	15.96	7.9	126	0.34	120	0.82	0.80	1.40	Y	1.83	Y	0.91	2.23	75.55	78.84	
8B-7	75.55	24	15.96	186	0.50	0.92	7.9	0.24	-	-	-	-	-	-	-	0.24	Y	0.32	Y	0.16	1.08	76.63	78.84	
8B-10	69.24	24	12.52	15	0.30	0.05	5.2	0.11	12.29	5.6	69	0.17	30	0.28	0.14	0.41	Y	0.54	Y	0.27	0.31	69.55	75.25	
8B-20	69.55	24	12.29	62	0.29	0.18	5.6	0.12	9.36	7.3	68	0.29	30	0.28	0.23	0.64	Y	0.84	Y	0.42	0.60	70.15	74.70	
8B-19	70.15	18	9.36	86	0.79	0.68	7.3	0.21	-	-	-	-	-	-	-	0.21	Y	0.27	Y	0.13	0.81	70.97	72.58	
8B-2	77.32	18	2.76	68	0.07	0.05	6.9	0.18	-	-	-	-	-	-	-	0.18	Y	0.24	Y	0.12	0.17	77.49	80.72	
8B-12	70.46	18	3.63	90	0.12	0.11	5.2	0.10	-	-	-	-	-	-	-	0.10	Y	0.13	Y	0.07	0.17	70.63	72.46	
8B-16	66.89	24	9.01	114	0.16	0.18	9.0	0.32	8.46	6.8	58	0.25	10	0.07	0.05	0.62	Y	0.80	Y	0.40	0.58	67.47	75.15	
8B-15	67.47	24	8.46	118	0.14	0.16	6.8	0.18	5.48	8.2	45	0.37	5	0.03	0.03	0.58	Y	0.76	Y	0.38	0.54	68.01	71.64	
8B-13	68.01	18	5.48	122	0.27	0.33	8.2	0.26	-	-	-	-	-	-	-	0.26	Y	0.34	Y	0.17	0.50	68.51	74.53	
8B-14	70.46	18	5.73	28	0.30	0.08	5.9	0.14	-	-	-	-	-	-	-	0.14	N	0.14	Y	0.07	0.15	70.61	68.85	

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Stormwater Management Calculations

MMM DESIGN GROUP
ARCHITECTS+ENGINEERS+PLANNERS

ROUTE 199
PROJECT 0199-047-103, RW-205, C-503

POND-2 Version: 5.17
S/N:

ROUTE 199 0199-047, C-503, RW-205
SWM FACILITY "D"
MONT. AVE. EXT. STA. 106+00
ELEVATION vs STORAGE TABLE

CALCULATED 02-15-1996 10:00:24
DISK FILE: C:\0642900\D .VOL

Planimeter scale: 1 inch = 1 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (sq.ft)	A1+A2+sqr(A1*A2) (sq.ft)	* Volume (cubic-ft)	Volume Sum (cubic-ft)
60.50	0.00	0	0	0	0
61.00	9,846.00	9,846	9,846	1,641	1,641
61.50	33,800.00	33,800	61,889	10,315	11,956
62.00	53,317.00	53,317	129,568	21,595	33,550
62.50	62,770.00	62,770	173,938	28,990	62,540
63.00	63,892.00	63,892	189,991	31,665	94,205
63.50	65,020.00	65,020	193,366	32,228	126,433
64.00	66,154.00	66,154	196,759	32,793	159,226
64.50	67,294.00	67,294	200,170	33,362	192,587
65.00	68,441.00	68,441	203,600	33,933	226,521
65.50	*I*	70,494	208,395	34,732	261,253
66.00	72,577.00	72,577	211,497	70,499	297,020
66.50	76,949.00	76,949	224,257	37,376	334,396
67.00	81,324.00	81,324	237,379	39,563	373,959
67.50	88,069.00	88,069	254,022	42,337	416,296
68.00	94,819.00	94,819	274,270	45,712	462,008
68.50	103,140.00	103,140	296,851	49,475	511,483
69.00	111,467.00	111,467	321,830	53,638	565,121
69.50	121,728.00	121,728	349,680	58,280	623,401
70.00	131,994.00	131,994	380,479	63,413	686,814
70.50	143,430.00	143,430	413,017	68,836	755,651
71.00	164,148.00	164,148	461,018	76,836	832,487

I ---> Interpolated area from closest two planimeter readings.

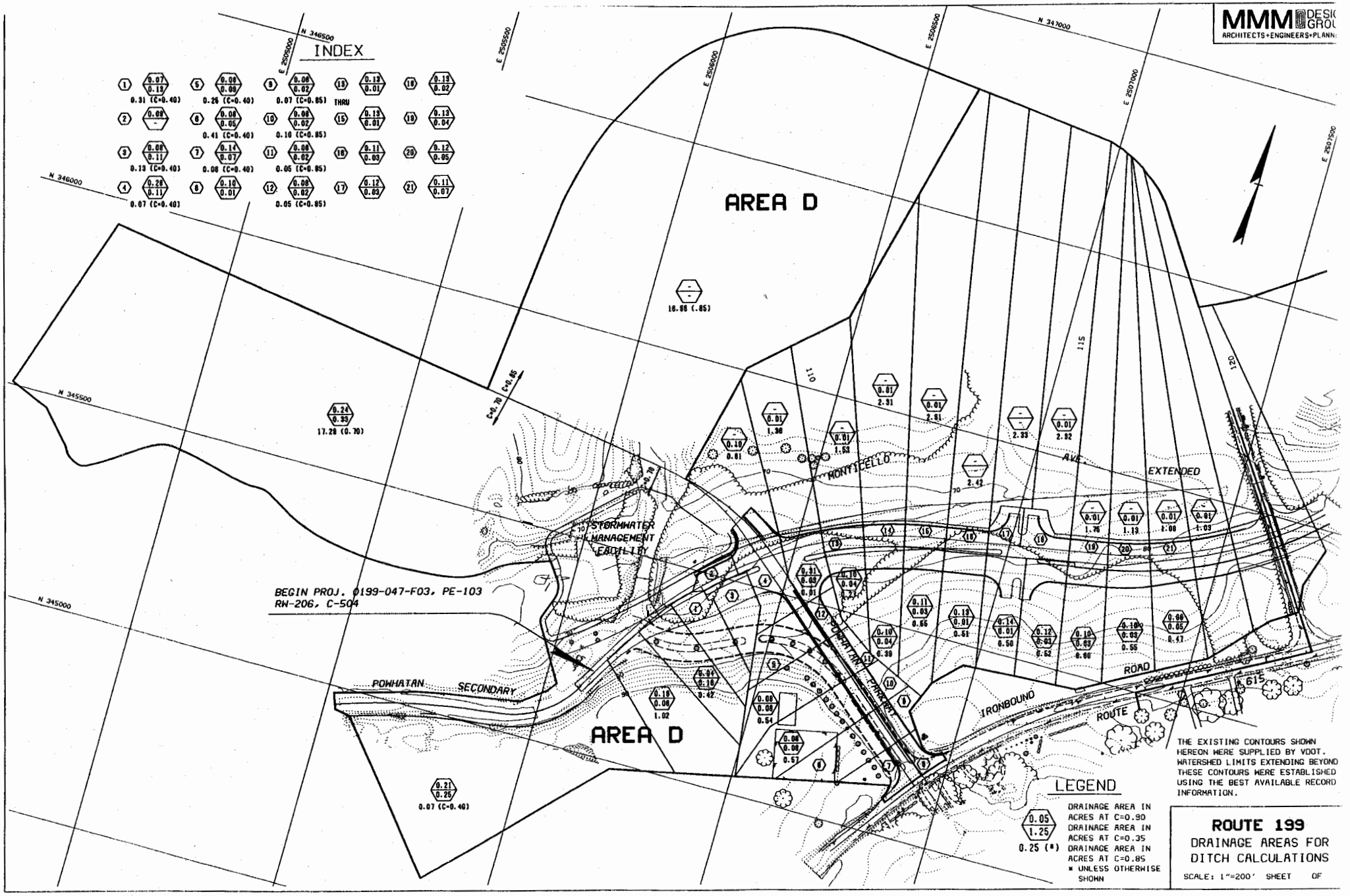
$$IA = (sq.rt(Area1) + ((Ei-E1)/(E2-E1))*(sq.rt(Area2)-sq.rt(Area1)))^2$$

where: E1, E2 = Closest two elevations with planimeter data
Ei = Elevation at which to interpolate area
Area1,Area2 = Areas computed for E1, E2, respectively
IA = Interpolated area for Ei

* Incremental volume computed by the Conic Method for Reservoir Volumes.

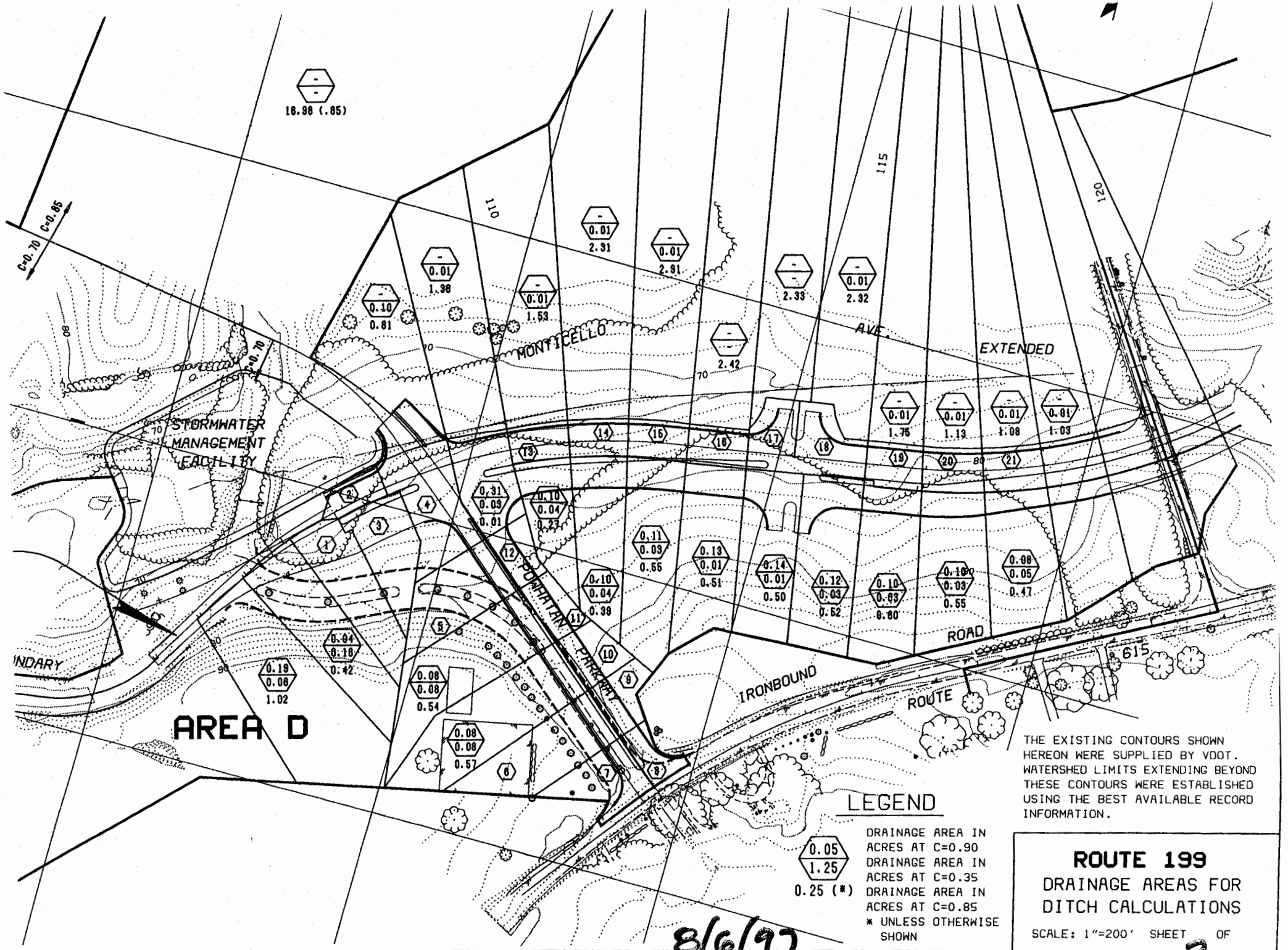
Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2


MMM DESIGN GROUP
ARCHITECTS+ENGINEERS+PLANNERS
INDEX
AREA D
AREA D
BEGIN PROJ. 0199-047-F03, PE-103
RW-206, C-504
STORMWATER MANAGEMENT FACILITY
POWHATAN SECONDARY
MONTICELLO AVE. EXTENDED
POWHATAN PARKWAY
IRONBOUND ROAD
ROUTE 615
LEGEND
DRAINAGE AREA IN ACRES AT C=0.90
DRAINAGE AREA IN ACRES AT C=0.35
DRAINAGE AREA IN ACRES AT C=0.85
* UNLESS OTHERWISE SHOWN
THE EXISTING CONTOURS SHOWN HEREON WERE SUPPLIED BY VDOT. WATERSHED LIMITS EXTENDING BEYOND THESE CONTOURS WERE ESTABLISHED USING THE BEST AVAILABLE RECORD INFORMATION.
ROUTE 199
DRAINAGE AREAS FOR DITCH CALCULATIONS
SCALE: 1"=200' SHEET OF

8/6/97

1



PC140_POWHATAN_SECONDARY_VDOT - 035

FLOW ANALYSIS FOR PRE-DEVELOPMENT AND POST-DEVELOPMENT CONDITIONS

MMM DESIGN GROUP
ARCHITECTS + ENGINEERS + PLANNERS

PROJECT: 0199-047, C-503, RW-205
IDF-CURVE: JAMES_CITY
LOCATION: SWM FACILITY "D"

DATE: 2-15-96
SHEET: ____ OF ____
USER: IZB

PRE-DEVELOPMENT CONDITION

	Subarea Surface	Area (Ac.)	C Factor	C * A
1.	Grass	119.10	0.38	45.26
2.				
3.				
	Total Area:	119.10	Total C*A:	45.26

Composite C Factor = 0.38

Time of Concentration

1730 '	Overland Flow		1.3	%	=	29.8 min
1460 '	Channel Flow	@	2.0	fps	=	12.2 min
						41.9

Peak Q for multi-year storm

Year	Area Ac.	Cf	C	Tc min	*i* in/hr	Q cfs
2	119.10	1.00	0.38	42	2.17	98.0
5	119.10	1.00	0.38	42	2.69	121.8
10	119.10	1.00	0.38	42	3.06	138.4
25	119.10	1.10	0.38	42	3.60	179.0
50	119.10	1.20	0.38	42	4.00	217.0
100	119.10	1.25	0.38	42	4.42	249.8

POST-DEVELOPMENT CONDITION

	Subarea Surface	Area (Ac.)	C Factor	C * A
1.	Combined	135.60	0.60	81.90
2.				
3.				
	Total Area:	135.60	Total C*A:	81.90

Composite C Factor = 0.60

Time of Concentration

1340 '	Overland Flow		1.3	%	=	24.1 min
2070 '	Channel Flow	@	2.5	fps	=	13.8 min
						37.9

VERSION 1.10

M:\0642900\CIVIL\RW205\D-FLOW.WB1

POND-2 Version: 5.17
S/N:

ROUTE 199 0199-047, C-503, RW-205
SWM FACILITY "D"
MONT. AVE. EXT. STA. 106+00
ELEVATION vs STORAGE TABLE

CALCULATED 02-15-1996 10:00:24
DISK FILE: C:\0642900\D .VOL

Planimeter scale: 1 inch = 1 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (sq.ft)	A1+A2+sqr(A1*A2) (sq.ft)	* Volume (cubic-ft)	Volume Sum (cubic-ft)
60.50	0.00	0	0	0	0
61.00	9,846.00	9,846	9,846	1,641	1,641
61.50	33,800.00	33,800	61,889	10,315	11,956
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63.00	63,892.00	63,892	189,991	31,665	94,205
63.50	65,020.00	65,020	193,366	32,228	126,433
64.00	66,154.00	66,154	196,759	32,793	159,226
64.50	67,294.00	67,294	200,170	33,362	192,587
65.00	68,441.00	68,441	203,600	33,933	226,521
65.50	*I*	70,494	208,395	34,732	261,253
66.00	72,577.00	72,577	211,497	70,499	297,020
66.50	76,949.00	76,949	224,257	37,376	334,396
67.00	81,324.00	81,324	237,379	39,563	373,959
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68.00	94,819.00	94,819	274,270	45,712	462,008
68.50	103,140.00	103,140	296,851	49,475	511,483
69.00	111,467.00	111,467	321,830	53,638	565,121
69.50	121,728.00	121,728	349,680	58,280	623,401
70.00	131,994.00	131,994	380,479	63,413	686,814
70.50	143,430.00	143,430	413,017	68,836	755,651
71.00	164,148.00	164,148	461,018	76,836	832,487

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$$IA = (sq.rt(Area1) + ((Ei-E1)/(E2-E1))*(sq.rt(Area2)-sq.rt(Area1)))^2$$

where: E1, E2 = Closest two elevations with planimeter data
Ei = Elevation at which to interpolate area
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* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

MMM DESIGN GROUP
ARCHITECTS + ENGINEERS + PLANNERS

DESIGN ANALYSIS

☐ BUDGET
☐ PRELIMINARY
☒ FINAL
☐ OTHER

SHEET NO: ____ OF: ____
JOB NO: 6429.00

PROJECT NAME: ROUTE 199 - SWM FACILITY "D" - RW-205
DEPARTMENT: CIVIL
SHEET NO: OF:

PROJECT PART: DRAINAGE DESIGN
COMPUTED BY: IZB
DATE: 2-15-96

SPEC. DIVISION: EROSION CONTROL & SWM
CHECKED BY:
DATE:

TEMPORARY SEDIMENT BASIN CALCULATIONS

82 Acre dist. Area for T.S. Basin

DISTURBED AREA = 82.0 ACRES

82.0 ACRES x 67 CY/ACRE 'WET STORAGE' = 5,494 CY = 148,338 CF
'DRY STORAGE' = 5,494 CY = 148,338 CF

TOTAL STORAGE = 10,988 CY = 296,676 CF

WSE FOR TOTAL STORAGE (296,676 CF): 66.00 SAY 66.00 USE 66.20

WSE FOR WET STORAGE (148,338 CF): 63.83 SAY 63.85 USE 64.35

LENGTH TO WIDTH RATIO:

L = 365' AREA OF NORMAL POND (@ WET STORAGE = 148,338 CF) = 65,777 SF

We = A/L = 65,777/365 = 180'

L/We = 365/180 = 2.02 > 2.0 ∴ NO BAFFLES REQUIRED

EMERGENCY SPILLWAY

TOP OF BERM = 71.00

DESIGN 25-YR = 179 CFS

USE 20' BOTTOM WIDTH ; 6:1 SIDE SLOPES ; INV. ELEV. = 68.00

TO ACCOMODATE PERMANENT FLOWS

MAX. 25-YR REMAINS 1' BELOW EMBANKMENT 71.00 - 1.00 = 70.00 WSE = 69.14 < 70.00 OK

DEWATERING ORIFICE (6 HOUR DRAWDOWN, MIN. 3" ORIFICE)

DRY STORAGE = 148,338 CF

$Q = 148,338/6(3600) = 6.87$ CFS

$h = 66.20 - 64.35 = 1.85'$

$A = Q/C_d\sqrt{2g(h/2)} = 6.87/0.61(64.32 \times 1.85/2)^{1/2} = 1.46'$ SF

USE (3) 3' x 0.15' & SET INVERT @ ELEV. = 64.35
(SEE COMBINED OUTLET STRUCTURE NEXT SHEET)

FRM054.E

MMM DESIGN GROUP ARCHITECTS + ENGINEERS + PLANNERS	DESIGN ANALYSIS ☐ BUDGET ☐ PRELIMINARY ☒ FINAL ☐ OTHER	SHEET NO: ___ OF: ___ JOB NO: 6429.00
PROJECT NAME: ROUTE 199 - SWM FACILITY "D" - RW-205		DEPARTMENT: CIVIL SHEET NO: OF:
PROJECT PART: DRAINAGE DESIGN		COMPUTED BY: IZB DATE: 2-15-96
SPEC. DIVISION: EROSION CONTROL & SWM		CHECKED BY: DATE:

TEMPORARY SEDIMENT BASIN CALCULATIONS (CONTINUED...)

RISER: (SEE COMBINED OUTLET STRUCTURE)

BARREL: USE 48" CONC. PIPE TO ACCOMODATE PERMANENT FLOWS

CONCENTRIC TRASH RACK & ANTI-VORTEX DEVICE: NOT REQUIRED.

ANTI-SEEP COLLARS $Y = 66.00 - 60.50 = 5.5'$; $S = 0.0105'/'$; $Z = 2:1$; $D = 4'$

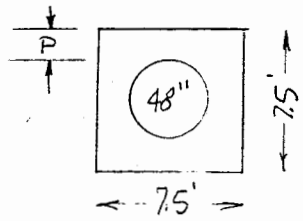
$L_S = 34'$

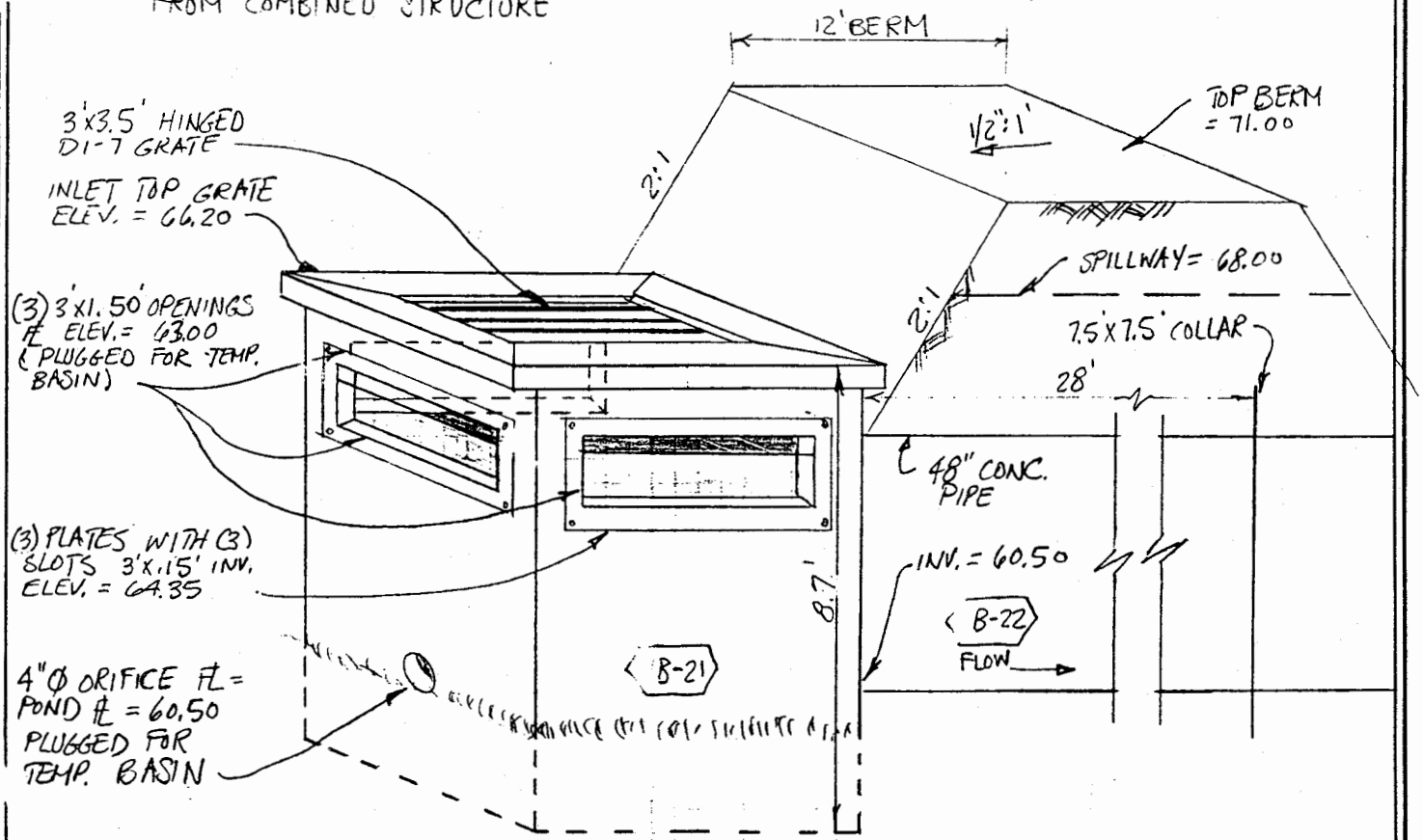
USE 1 COLLAR 7.5'x7.5'

$P = (7.5 - 4)/2 = 1.75'$

SET COLLAR @ 16P = 28'

FROM COMBINED STRUCTURE





TEMPORARY SEDIMENT BASIN & PERMANENT STORMWATER MANAGEMENT FACILITY OUTLET CONTROL STRUCTURE (SEE PLAN SHEET 2W(3))

FRM054 09

MMM DESIGN GROUP ARCHITECTS + ENGINEERS + PLANNERS	DESIGN ANALYSIS ☐ BUDGET ☐ PRELIMINARY ☒ FINAL ☐ OTHER	SHEET NO: ___ OF: ___ JOB NO: 6429.00
PROJECT NAME: ROUTE 199 - SWM FACILITY "D" - RW-205		DEPARTMENT: CIVIL SHEET NO: OF:
PROJECT PART: DRAINAGE DESIGN		COMPUTED BY: IZB DATE: 2-15-96
SPEC. DIVISION: EROSION CONTROL & SWM		CHECKED BY: DATE:

STORMWATER MANAGEMENT OUTFALL S S:

WATER QUALITY VOLUME

NET IMPERVIOUS AREA = 43.33 AC. ← Net Impervious Area for total Drainage Area

(0.5)(1/12)(43.33)(43,560) = 78,644 CF (RELEASED OVER 30 HOURS)

Q = 78,644 / 30(3600) = 0.728 CFS

WSE = 62.91 USE 63.00

CIRCULAR ORIFICE : $Q = C_d A \sqrt{2gh}$

h = 63.00 - 60.50 = 2.50'

$A = 0.728 / 0.61 (64.32 \times 2.5)^{1/2} = 0.094$ SF

$D = 2 (A/\pi)^{1/2} = 0.35' = 4.2''$ ∴ USE 4" Ø ORIFICE

EMERGENCY SPILLWAY

TOP BERM = 71.00

BOTTOM WIDTH = 20'

SIDE SLOPES = 6:1

INV. ELEV. = 66.00

(SEE COMBINED OUTLET STRUCTURE PREVIOUS SHEET)

FRM054.

MMM DESIGN GROUP
ARCHITECTS + ENGINEERS + PLANNERS

Project: 0199--47, C-503, RW-205
Job # : 6429.00
SWM FACILITY "D"

Date: 02/15/96
User: IZB

STORMWATER MANAGEMENT OUTFALL STRUCTURE CALCULATIONS

WSE	ORIFICE-CIRCULAR DIA.(in) 4.00 INV. EL.(ft) 60.50		WEIR-RECTANGULAR WIDTH (ft) 9.00 HEIGHT(ft) 1.50 INV. EL.(ft) 63.00			DI-7 w/ 3' X 3.5' GRATE RIM EL. (ft) 66.20			TOTAL Q W/ NON CLOGGED ORIFICE	TOTAL Q WITH CLOGGED ORIFICE	REMARKS
FEET	HEAD (ft)	Q(CFS)	HEAD (ft)	Q(CFS)		HEAD (ft)	Q(CFS)		CFS	CFS	
60.50											
61.00	0.50	0.30							0.30		
61.50	1.00	0.43							0.43		
62.00	1.50	0.52							0.52		
62.50	2.00	0.60							0.60		
63.00	2.50	0.68							0.68		
63.50	3.00	0.74	0.50	10.71					11.45	10.71	
64.00	3.50	0.80	1.00	30.30					31.10	30.30	
64.50	4.00	0.85	1.50	57.20	❖				58.05	57.20	
65.00	4.50	0.91	2.00	73.84	❖				74.75	73.84	
65.50	5.00	0.95	2.50	87.37	❖				88.32	87.37	
66.00	5.50	1.00	3.00	99.07	❖				100.07	99.07	
66.50	6.00	1.05	3.50	109.52	❖	0.30	3.98		114.55	113.51	
67.00	6.50	1.09	4.00	119.06	❖	0.80	26.66		146.95	145.73	
67.50	7.00	1.13	4.50	127.89	❖	1.30	36.90	❖	146.95	146.95	
68.00	7.50	1.17	5.00	136.15	❖	1.80	43.28	❖	146.95	146.95	
68.50	8.00	1.21	5.50	143.94	❖	2.30	48.80	❖	146.95	146.95	
69.00	8.50	1.24	6.00	151.33	❖	2.80	53.74	❖	146.95	146.95	
69.50	9.00	1.28	6.50	158.37	❖	3.30	58.25	❖	146.95	146.95	
70.00	9.50	1.32	7.00	165.11	❖	3.80	62.42	❖	146.95	146.95	
70.50	10.00	1.35	7.50	171.59	❖	4.30	66.31	❖	146.95	146.95	
71.00	10.50	1.38	8.00	177.83	❖	4.80	69.98	❖	146.95	146.95	

STORM	WSE	Qout
2YR	65.65	90.95
10 YR	66.89	138.32
25 YR	68.13	153.82
100 YR	69.34	281.83

❖ Indicates Orifice Flow

M:\0642900\CIVIL\RW205\D-OUTSWM.W

34

Outlet Structure File: D-SWM .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
ROUTE 199 0199-047, C-503, RW-205
SWM FACILITY "D"
MONT. AVE. EXT. STA. 106+00

****

***** COMPOSITE OUTFLOW SUMMARY ****

Elevation (ft)	Q (cfs)	Contributing Structures	
60.50	0.0	1	(SWM-1)
61.00	0.0	1	
61.50	0.0	1	
62.00	0.0	1	
62.50	0.0	1	
63.00	0.0	1	
63.50	10.7	1	
64.00	30.3	1	
64.50	57.2	1	
65.00	73.8	1	
65.50	87.4	1	
66.00	99.1	1	
66.50	113.5	1	
67.00	145.7	1	
67.50	146.9	1	
68.00	146.9	1 +2	(SWM-1 & SPILLWAY)
68.50	172.8	1 +2	
69.00	227.0	1 +2	
69.50	306.8	1 +2	
70.00	412.8	1 +2	
70.50	546.2	1 +2	
71.00	708.1	1 +2	

Outlet Structure File: D-SWM .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

```
**********************************
ROUTE 199  0199-047, C-503, RW-205
        SWM FACILITY "D"
   MONT. AVE. EXT. STA. 106+00

**********************************
```

Outlet Structure File: C:\0642900\D-SWM .STR
Planimeter Input File: C:\0642900\D .VOL
Rating Table Output File: C:\0642900\D-SWM .PND

Min. Elev.(ft) = 60.5 Max. Elev.(ft) = 71 Incr.(ft) = .5

Additional elevations (ft) to be included in table:
* *

```
*********************************************
              SYSTEM CONNECTIVITY
*********************************************
```

Structure	No.	Q Table		Q Table
TABLE	1		->	1 (SWM-1)
WEIR-XY	2		->	2 (SPILLWAY)

Outflow rating table summary was stored in file:
C:\0642900\D-SWM .PND

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Graphical Summary for Maximum Required Storage ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

```
*********************************************************************
*  RETURN FREQUENCY:   2 yr     |  Allowable Outflow:    98.00 cfs    *
*  'C' Adjustment: 1.000        |  Required Storage:   214,176 cu.ft. *
*-------------------------------------------------------------------*
*  Peak Inflow:  166.97 cfs       Inflow .HYD stored: D-2YR   .HYD   *
*********************************************************************
```

```
   |                Td =  46 minutes                  |  Return Freq:     2 yr
   /------- Approx. Duration for Max. Storage ------/  C adj.factor: 1.00
   |                                                  |
   |                                                  |
   |                Tc=   37.90  minutes              |
   |                I =   2.292  in/hr                |  Area (ac):   135.60
   |              . Q =  187.76  cfs                  |  Weighted C:    0.60
   |            .|.                                   |  Adjusted C:    0.60
F  |           .   .                                  |
L  |          .  |  .            Required Storage     |
O  |         .       .        .--   214,176 cu.ft.   |  Td=      46 minutes
W  |        .    |    .       |                      |  I =   2.039 in/hr
   |       .     x x x x x x x|x x x x x x x x x x x  Q =  166.97 cfs
c  |      .                   |
f  |     .    x                                       x
s  |    .                                               o   Q=   98.00 cfs
   |   .   x                                 o         |x  (Allow.Outflow)
   |  .  x                  .     o                    |
   | .  x               o    .       NOT TO SCALE      |   x
   |. x       o               .      ============      |
   |o                          .                       |       x
   `-------------------------------------------------|------------
                                                     61.66 minutes
```

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Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Graphical Summary for Maximum Required Storage ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

```
*********************************************************************
*  RETURN FREQUENCY:  10 yr     |  Allowable Outflow:   138.40 cfs    *
*  'C' Adjustment: 1.000        |  Required Storage:   304,821 cu.ft. *
*-------------------------------------------------------------------*
*  Peak Inflow:  233.09 cfs       Inflow .HYD stored: D-10YR  .HYD   *
*********************************************************************
```

```
   |                Td =  47 minutes                  |  Return Freq:    10 yr
   /------- Approx. Duration for Max. Storage ------/  C adj.factor: 1.00
   |                                                  |
   |                                                  |
   |                Tc=   37.90  minutes              |
   |                I =   3.228  in/hr                |  Area (ac):   135.60
   |              . Q =  264.40  cfs                  |  Weighted C:    0.60
   |             .|.                                  |  Adjusted C:    0.60
F  |            .   .                                 |
L  |           .  |  .            Required Storage    |
O  |          .       .        .--   304,821 cu.ft.  |  Td=      47 minutes
W  |         .    |    .       |                     |  I =   2.846 in/hr
   |        .     x x x x x x x|x x x x x x x x x x x  Q =  233.09 cfs
c  |       .                   |
f  |      .    x                                      x
s  |     .                                              o   Q=  138.40 cfs
   |    .   x                              o           |x  (Allow.Outflow)
   |   .  x                  .     o                   |
   |  .  x               o    .       NOT TO SCALE     |   x
   | .. x       o              .      ============     |
   | o                          .                      |      x
   `-----------------------------------------------------|------------
                                                      62.40 minutes
```

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Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Graphical Summary for Maximum Required Storage ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

```
*********************************************************************
*  RETURN FREQUENCY:  25 yr     |  Allowable Outflow:   179.00 cfs    *
*  'C' Adjustment: 1.100        |  Required Storage:   394,438 cu.ft. *
*-------------------------------------------------------------------*
*  Peak Inflow:  297.13 cfs       Inflow .HYD stored: D-25YR  .HYD   *
*********************************************************************
```

```
   |              Td =  48 minutes                  |  Return Freq:     25 yr
   /------- Approx. Duration for Max. Storage ------/  C adj.factor: 1.10
   |                                                |
   |                                                |
   |               Tc=   37.90  minutes             |
   |               I =   3.793  in/hr               |  Area (ac):    135.60
   |             . Q =  341.71  cfs                 |  Weighted C:     0.60
   |           .|.                                 |  Adjusted C:     0.66
F  |          .   .                                 |
L  |         .  |  .            Required Storage    |
O  |       .       .        .--   394,438 cu.ft.   |  Td=       48 minutes
W  |      .    |    .       |                      |  I =    3.298 in/hr
   |     .     x x x x x x x|x x x x x x x x x x x  Q =   297.13 cfs
c  |    .                   |
f  |   .    x                                       x
s  |  .                                               o   Q=  179.00 cfs
   |  .   x                              o           |x  (Allow.Outflow)
   |  .  x                 .     o                   |
   |  .  x              o    .      NOT TO SCALE     |   x
   | .. x       o              .     ============    |
   | o                          .                    |       x
   `-------------------------------------------------|------------
                                                     63.07 minutes
```

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Graphical Summary for Maximum Required Storage ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

```
*********************************************************************
*  RETURN FREQUENCY: 100 yr     |  Allowable Outflow:   249.80 cfs    *
*  'C' Adjustment: 1.250        |  Required Storage:   552,761 cu.ft. *
*-------------------------------------------------------------------*
*  Peak Inflow:  415.45 cfs       Inflow .HYD stored: D-100YR .HYD   *
*********************************************************************
```

```
   |              Td =  48 minutes                  |  Return Freq:   100 yr
   /------- Approx. Duration for Max. Storage ------/  C adj.factor: 1.25
   |                                                |
   |                                                |
   |                Tc=   37.90  minutes            |
   |                I =   4.654  in/hr              |  Area (ac):   135.60
   |              . Q =  476.46  cfs                |  Weighted C:    0.60
   |            .|.                                 |  Adjusted C:    0.75
F  |           .   .                                |
L  |          .  |  .            Required Storage   |
O  |         .      .        .--   552,761 cu.ft.  |  Td=      48 minutes
W  |        .    |    .      |                     |  I =   4.058 in/hr
   |       .     x x x x x x x|x x x x x x x x x x x  Q =  415.45 cfs
c  |      .                   |
f  |     .    x                                     x
s  |    .                                             o   Q=  249.80 cfs
   |   .   x                              o          |x  (Allow.Outflow)
   |  .  x                  .     o                  |
   | .  x              o    .       NOT TO SCALE     |   x
   |.. x       o              .      ============    |
   | o                         .                     |       x
   `-------------------------------------------------|------------
                                                   63.11 minutes
```

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Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

**** Modified Rational Hydrograph *****

Weighted C = 0.604 Area= 135.600 acres Tc = 37.90 minutes

Adjusted C = 0.604 Td= 46.00 min. I= 2.04 in/hr Qp= 166.97 cfs

RETURN FREQUENCY: 2 year storm Adj.factor = 1.00
Output file: D-2YR .HYD

HYDROGRAPH FOR MAXIMUM STORAGE
For the 2 Year Storm

Time Minutes	Time increment = 5.00 Minutes Time on left represents time for first Q in each row.						
2.90	12.78	34.80	56.83	78.86	100.89	122.92	144.94
37.90	166.97	166.97	158.60	136.57	114.55	92.52	70.49
72.90	48.46	26.43	4.41				

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

**** Modified Rational Hydrograph *****

Weighted C = 0.604 Area= 135.600 acres Tc = 37.90 minutes

Adjusted C = 0.604 Td= 47.00 min. I= 2.85 in/hr Qp= 233.09 cfs

RETURN FREQUENCY: 10 year storm Adj.factor = 1.00
Output file: D-10YR .HYD

HYDROGRAPH FOR MAXIMUM STORAGE
For the 10 Year Storm

Time increment = 5.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
2.90	17.84	48.59	79.34	110.09	140.84	171.59	202.34
37.90	233.09	233.09	227.56	196.81	166.06	135.31	104.55
72.90	73.80	43.05	12.30				

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

**** Modified Rational Hydrograph *****

Weighted C = 0.604 Area= 135.600 acres Tc = 37.90 minutes

Adjusted C = 0.664 Td= 48.00 min. I= 3.30 in/hr Qp= 297.13 cfs

RETURN FREQUENCY: 25 year storm Adj.factor = 1.10
Output file: D-25YR .HYD

HYDROGRAPH FOR MAXIMUM STORAGE
For the 25 Year Storm

Time increment = 5.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
2.90	22.74	61.93	101.13	140.33	179.53	218.73	257.93
37.90	297.13	297.13	297.13	258.71	219.51	180.31	141.12
72.90	101.92	62.72	23.52	0.00			

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

**** Modified Rational Hydrograph *****

Weighted C = 0.604 Area= 135.600 acres Tc = 37.90 minutes

Adjusted C = 0.755 Td= 48.00 min. I= 4.06 in/hr Qp= 415.45 cfs

RETURN FREQUENCY: 100 year storm Adj.factor = 1.25
Output file: D-100YR .HYD

HYDROGRAPH FOR MAXIMUM STORAGE
For the 100 Year Storm

Time increment = 5.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
2.90	31.79	86.60	141.41	196.22	251.02	305.83	360.64
37.90	415.45	415.45	415.45	361.74	306.93	252.12	197.31
72.90	142.50	87.69	32.89	0.00			

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 2 years
`C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
COMBINED	0.604	135.60						
			37.90	0.604	0.604	2.292	135.60	187.76

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 10 years
`C' adjustment, k = 1
Adj. 'C' = Wtd.'C' x 1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
COMBINED	0.604	135.60						
			37.90	0.604	0.604	3.228	135.60	264.40

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 25 years
`C' adjustment, k = 1.1
Adj. 'C' = Wtd.'C' x 1.1

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
COMBINED	0.604	135.60						
			37.90	0.604	0.664	3.793	135.60	341.71

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

* * * * * * SUMMARY OF RATIONAL METHOD PEAK DISCHARGES * * * * * *

Q = adj * C * I * A
Where: Q=cfs, C=Weighted Runoff Coefficient, I=in/hour, A=acres
adj = 'C' adjustment factor for each return frequency

RETURN FREQUENCY = 100 years
`C' adjustment, k = 1.25
Adj. 'C' = Wtd.'C' x 1.25

Subarea Descr.	Runoff 'C'	Area acres	Tc (min)	Wtd. 'C'	Adj. 'C'	I in/hr	Total acres	Peak Q (cfs)
COMBINED	0.604	135.60						
			37.90	0.604	0.755	4.654	135.60	476.46

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

```
*************************************************************************
*************************************************************************
*                                                                       *
*                                                                       *
*                        MODIFIED RATIONAL METHOD                       *
*          ---- Grand Summary For All Storm Frequencies ----            *
*                                                                       *
*                                                                       *
*************************************************************************
*************************************************************************
```

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

Area = 135.60 acres Tc = 37.90 minutes

Frequency (years)	Adjusted 'C'	Duration minutes	Intens. in/hr	Qpeak cfs	Allowable cfs	VOLUMES Inflow (cu.ft.)	Storage (cu.ft.)
2	0.604	46	2.039	166.97	98.00	460,842	214,176
10	0.604	47	2.846	233.09	138.40	657,326	304,821
25	0.664	48	3.298	297.13	179.00	855,722	394,438
100	0.755	48	4.058	415.45	249.80	1,196,496	552,761

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Summary for Single Storm Frequency ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

RETURN FREQUENCY: 2 yr `C' Adjustment = 1.000 Allowable Q = 98.00 cfs

Hydrograph file duration= 46.00 minutes
Hydrograph file: D-2YR .HYD Tc = 37.90 minutes

Weighted `C'	Adjusted 'C'	Duration minutes	Intens. in/hr	Areas acres	Qpeak cfs	VOLUMES Inflow (cu.ft.)	Storage (cu.ft.)
0.604	0.604	38	2.292	135.60	187.76	426,963	204,111
0.604	0.604	40	2.227	135.60	182.37	437,686	208,660
0.604	0.604	46	2.039	135.60	166.97	460,842	214,176
0.604	0.604	50	1.913	135.60	156.71	470,120	211,694
0.604	0.604	60	1.600	135.60	131.04	471,758	183,932
0.604	0.604	120	1.030	135.60	84.36	Qpeak < Qallow	

Storage Maximum

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Summary for Single Storm Frequency ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

RETURN FREQUENCY: 10 yr `C' Adjustment = 1.000 Allowable Q = 138.40 cfs

Hydrograph file duration= 47.00 minutes
Hydrograph file: D-10YR .HYD Tc = 37.90 minutes

Weighted `C'	Adjusted 'C'	Duration minutes	Intens. in/hr	Areas acres	Qpeak cfs	VOLUMES Inflow (cu.ft.)	Storage (cu.ft.)
0.604	0.604	38	3.228	135.60	264.40	601,240	286,518
0.604	0.604	40	3.140	135.60	257.17	617,216	293,776
********** Storage Maximum							
0.604	0.604	47	2.846	135.60	233.09	657,326	304,821
0.604	0.604	50	2.720	135.60	222.77	668,324	303,363
0.604	0.604	60	2.300	135.60	188.38	678,152	271,671
0.604	0.604	120	1.480	135.60	121.22	Qpeak < Qallow	

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Summary for Single Storm Frequency ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

RETURN FREQUENCY: 25 yr `C' Adjustment = 1.100 Allowable Q = 179.00 cfs

Hydrograph file duration= 48.00 minutes
Hydrograph file: D-25YR .HYD Tc = 37.90 minutes

Weighted `C'	Adjusted 'C'	Duration minutes	Intens. in/hr	Areas acres	Qpeak cfs	VOLUMES Inflow (cu.ft.)	Storage (cu.ft.)
0.604	0.664	38	3.793	135.60	341.71	777,054	370,007
0.604	0.664	40	3.690	135.60	332.44	797,860	379,537
********** Storage Maximum							
0.604	0.664	48	3.298	135.60	297.13	855,722	394,438
0.604	0.664	50	3.200	135.60	288.30	864,889	392,866
0.604	0.664	60	2.710	135.60	244.15	878,944	353,221
0.604	0.664	120	1.750	135.60	157.66	Qpeak < Qallow	

Quick TR-55 Ver.5.46 S/N:
Executed: 10:34:45 02-15-1995

MODIFIED RATIONAL METHOD
---- Summary for Single Storm Frequency ----

First peak outflow point assumed to occur at inflow recession leg.

ROUTE 199 0199-047, C-503, RW-205
S.W.M. FACILITY "D"
MONT. AVE. EXT. STA. 106+00

RETURN FREQUENCY: 100 yr `C' Adjustment = 1.250 Allowable Q = 249.80 cfs

Hydrograph file duration= 48.00 minutes
Hydrograph file: D-100YR .HYD Tc = 37.90 minutes

Weighted `C'	Adjusted 'C'	Duration minutes	Intens. in/hr	Areas acres	Qpeak cfs	VOLUMES Inflow (cu.ft.)	Storage (cu.ft.)
0.604	0.755	38	4.654	135.60	476.46	1,083,463	515,419
0.604	0.755	40	4.530	135.60	463.77	1,113,054	529,271
********** Storage Maximum							
0.604	0.755	48	4.058	135.60	415.45	1,196,496	552,761
0.604	0.755	50	3.940	135.60	403.37	1,210,108	551,385
0.604	0.755	60	3.350	135.60	342.97	1,234,679	501,016
0.604	0.755	120	2.160	135.60	221.14	Qpeak < Qallow	

POND-2 Version: 5.17 S/N:
EXECUTED: 02-15-1995 10:37:38 2 YR Return Freq: 2 years

```
*************************************
*                                   *
*  ROUTE 199  0199-047, C-503, RW-205 *
*          SWM FACILITY "D"         *
*     MONT. AVE. EXT. STA. 106+00   *
*                                   *
*                                   *
*************************************
```

Inflow Hydrograph: C:\0642900\D-2YR .HYD
Rating Table file: C:\0642900\D-SWM .PND

----INITIAL CONDITIONS----
Elevation = 60.50 ft
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)
60.50	0.0	0
61.00	0.0	1,641
61.50	0.0	11,956
62.00	0.0	33,550
62.50	0.0	62,540
63.00	0.0	94,205
63.50	10.7	126,433
64.00	30.3	159,226
64.50	57.2	192,587
65.00	73.8	226,521
65.50	87.4	261,253
66.00	99.1	297,020
66.50	113.5	334,396
67.00	145.7	373,959
67.50	146.9	416,296
68.00	146.9	462,008
68.50	172.8	511,483
69.00	227.0	565,121
69.50	306.8	623,401
70.00	412.8	686,814
70.50	546.2	755,651
71.00	708.1	832,487

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
10.9	10.9
79.7	79.7
223.7	223.7
416.9	416.9
628.1	628.1
842.9	853.6
1061.5	1091.8
1284.0	1341.2
1510.2	1584.0
1741.8	1829.2
1980.2	2079.3
2229.4	2342.9
2493.2	2638.9
2775.4	2922.3
3080.2	3227.1
3410.0	3582.8
3767.6	3994.6
4156.2	4463.0
4578.9	4991.7
5037.9	5584.1
5550.1	6258.2

Time increment (t) = 5.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-15-1995 10:37:38 2 YR Return Freq: 2 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-2YR .HYD
Outflow Hydrograph: C:\0642900\D-2SWM .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
2.9	12.78	-----	0.0	0.0	0.00	60.50
7.9	34.80	47.6	47.6	47.6	0.00	61.27
12.9	56.83	91.6	139.2	139.2	0.00	61.71
17.9	78.86	135.7	274.9	274.9	0.00	62.13
22.9	100.89	179.8	454.7	454.7	0.00	62.59
27.9	122.92	223.8	673.7	678.5	2.39	63.11
32.9	144.94	267.9	905.7	941.5	17.93	63.68
37.9	166.97	311.9	1129.8	1217.6	43.87	64.25
42.9	166.97	333.9	1332.6	1463.8	65.58	64.75
47.9	158.60	325.6	1502.4	1658.2	77.92	65.15
52.9	136.57	295.2	1626.2	1797.5	85.65	65.44
57.9	114.55	251.1	1698.1	1877.4	89.65	65.60
62.9	92.52	207.1	1723.2	1905.1	90.95	65.65
67.9	70.49	163.0	1706.1	1886.2	90.07	65.61
72.9	48.46	119.0	1650.7	1825.0	87.17	65.49
77.9	26.43	74.9	1562.3	1725.6	81.65	65.29
82.9	4.41	30.8	1444.5	1593.1	74.31	65.02
87.9	0.00	4.4	1319.8	1448.9	64.57	64.72
92.9	0.00	0.0	1210.0	1319.8	54.89	64.46
97.9	0.00	0.0	1123.9	1210.0	43.05	64.24
102.9	0.00	0.0	1056.4	1123.9	33.76	64.06
107.9	0.00	0.0	1001.6	1056.4	27.38	63.93
112.9	0.00	0.0	955.9	1001.6	22.88	63.81
117.9	0.00	0.0	917.6	955.9	19.11	63.71
122.9	0.00	0.0	885.7	917.6	15.97	63.63
127.9	0.00	0.0	859.0	885.7	13.34	63.57
132.9	0.00	0.0	836.7	859.0	11.14	63.51
137.9	0.00	0.0	816.9	836.7	9.90	63.46
142.9	0.00	0.0	799.0	816.9	8.96	63.42
147.9	0.00	0.0	782.8	799.0	8.11	63.38
152.9	0.00	0.0	768.1	782.8	7.34	63.34
157.9	0.00	0.0	754.8	768.1	6.64	63.31
162.9	0.00	0.0	742.8	754.8	6.01	63.28
167.9	0.00	0.0	731.9	742.8	5.44	63.25
172.9	0.00	0.0	722.1	731.9	4.93	63.23
177.9	0.00	0.0	713.1	722.1	4.46	63.21
182.9	0.00	0.0	705.1	713.1	4.04	63.19
187.9	0.00	0.0	697.8	705.1	3.65	63.17
192.9	0.00	0.0	691.2	697.8	3.31	63.15
197.9	0.00	0.0	685.2	691.2	2.99	63.14

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-2YR .HYD
Outflow Hydrograph: C:\0642900\D-2SWM .HYD

Starting Pond W.S. Elevation = 60.50 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 166.97 cfs
Peak Outflow = 90.95 cfs
Peak Elevation = 65.65 ft

***** Summary of Approximate Peak Storage *****

Initial Storage	=	0 cu-ft
Peak Storage From Storm	=	272,115 cu-ft
Total Storage in Pond	=	272,115 cu-ft

Warning: Inflow hydrograph truncated on left side.

POND-2 Version: 5.17 S/N:

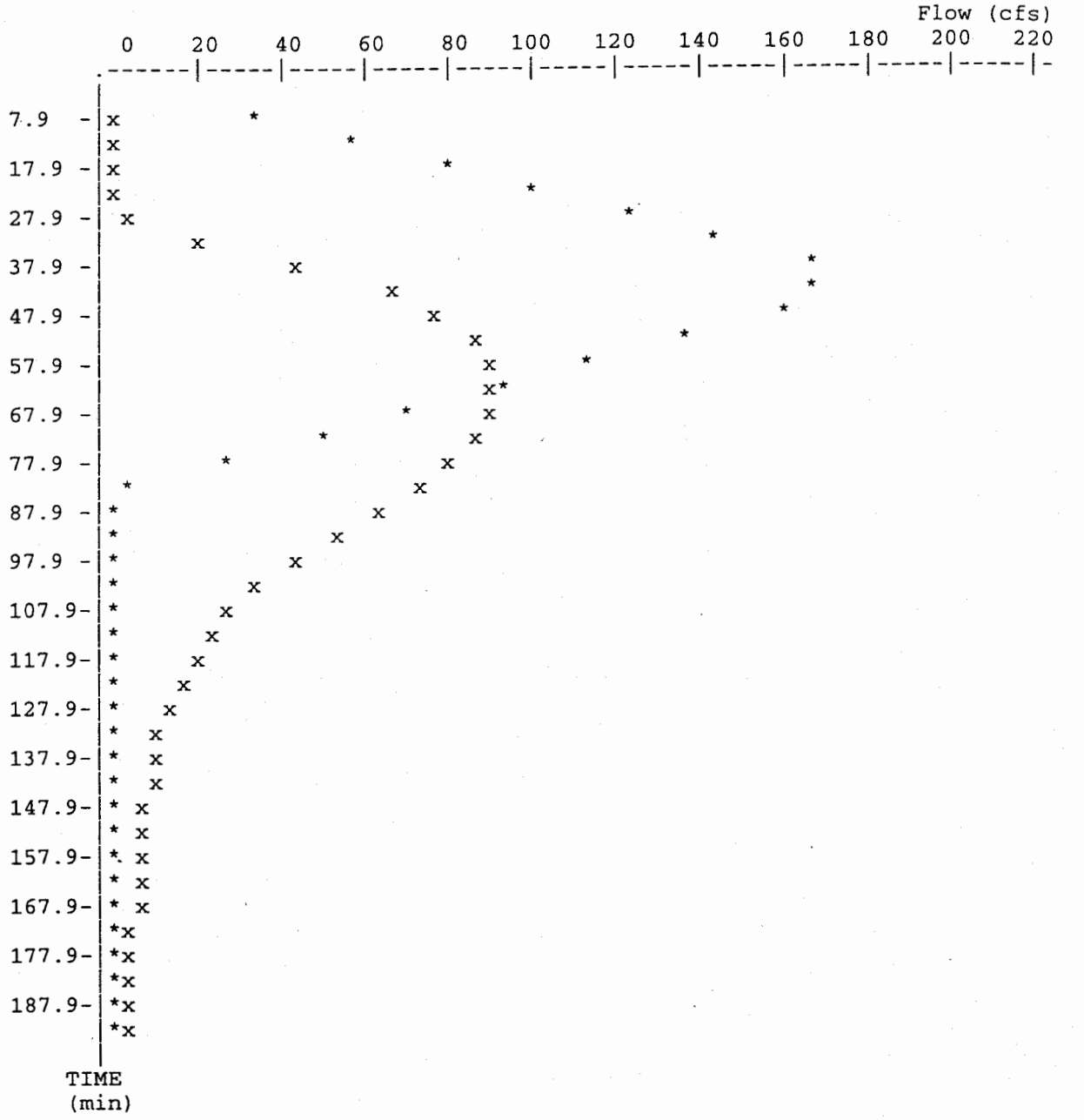
2 YR

Return Freq: 2 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-2YR .HYD
Outflow Hydrograph: C:\0642900\D-2SWM .HYD

EXECUTED: 02-15-1995
10:37:38

Peak Inflow = 166.97 cfs
Peak Outflow = 90.95 cfs
Peak Elevation = 65.65 ft



* File: C:\0642900\D-2YR .HYD Qmax = 167.0 cfs
x File: C:\0642900\D-2SWM .HYD Qmax = 90.9 cfs

EXECUTED: 02-15-1995 10:37:38 10 YR Return Freq: 10 years

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*****************************************
*                                       *
*  ROUTE 199  0199-047, C-503, RW-205   *
*            SWM FACILITY "D"           *
*      MONT. AVE. EXT. STA. 106+00      *
*                                       *
*                                       *
*****************************************
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Inflow Hydrograph: C:\0642900\D-10YR .HYD
Rating Table file: C:\0642900\D-SWM .PND

----INITIAL CONDITIONS----
Elevation = 60.50 ft
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + O (cfs)
60.50	0.0	0	0.0	0.0
61.00	0.0	1,641	10.9	10.9
61.50	0.0	11,956	79.7	79.7
62.00	0.0	33,550	223.7	223.7
62.50	0.0	62,540	416.9	416.9
63.00	0.0	94,205	628.1	628.1
63.50	10.7	126,433	842.9	853.6
64.00	30.3	159,226	1061.5	1091.8
64.50	57.2	192,587	1284.0	1341.2
65.00	73.8	226,521	1510.2	1584.0
65.50	87.4	261,253	1741.8	1829.2
66.00	99.1	297,020	1980.2	2079.3
66.50	113.5	334,396	2229.4	2342.9
67.00	145.7	373,959	2493.2	2638.9
67.50	146.9	416,296	2775.4	2922.3
68.00	146.9	462,008	3080.2	3227.1
68.50	172.8	511,483	3410.0	3582.8
69.00	227.0	565,121	3767.6	3994.6
69.50	306.8	623,401	4156.2	4463.0
70.00	412.8	686,814	4578.9	4991.7
70.50	546.2	755,651	5037.9	5584.1
71.00	708.1	832,487	5550.1	6258.2

Time increment (t) = 5.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-15-1995 10:37:38 10 YR Return Freq: 10 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-10YR .HYD
Outflow Hydrograph: C:\0642900\D-10SWM .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
2.9	17.84	-----	0.0	0.0	0.00	60.50
7.9	48.59	66.4	66.4	66.4	0.00	61.40
12.9	79.34	127.9	194.4	194.4	0.00	61.90
17.9	110.09	189.4	383.8	383.8	0.00	62.41
22.9	140.84	250.9	634.1	634.7	0.32	63.01
27.9	171.59	312.4	909.8	946.5	18.34	63.69
32.9	202.34	373.9	1181.7	1283.8	51.01	64.38
37.9	233.09	435.4	1465.9	1617.2	75.64	65.07
42.9	233.09	466.2	1747.7	1932.1	92.21	65.71
47.9	227.56	460.7	1996.0	2208.3	106.15	66.24
52.9	196.81	424.4	2176.5	2420.4	121.93	66.63
57.9	166.06	362.9	2269.6	2539.4	134.88	66.83
62.9	135.31	301.4	2294.4	2571.0	138.32	66.89
67.9	104.55	239.9	2265.6	2534.2	134.32	66.82
72.9	73.80	178.4	2195.0	2443.9	124.49	66.67
77.9	43.05	116.9	2088.2	2311.8	111.80	66.44
82.9	12.30	55.3	1938.3	2143.6	102.61	66.12
87.9	0.00	12.3	1764.5	1950.6	93.08	65.74
92.9	0.00	0.0	1596.8	1764.5	83.81	65.37
97.9	0.00	0.0	1447.8	1596.8	74.51	65.03
102.9	0.00	0.0	1318.8	1447.8	64.49	64.72
107.9	0.00	0.0	1209.3	1318.8	54.79	64.46
112.9	0.00	0.0	1123.3	1209.3	42.97	64.24
117.9	0.00	0.0	1055.9	1123.3	33.70	64.06
122.9	0.00	0.0	1001.2	1055.9	27.34	63.92
127.9	0.00	0.0	955.5	1001.2	22.85	63.81
132.9	0.00	0.0	917.4	955.5	19.09	63.71
137.9	0.00	0.0	885.5	917.4	15.95	63.63
142.9	0.00	0.0	858.8	885.5	13.32	63.57
147.9	0.00	0.0	836.6	858.8	11.13	63.51
152.9	0.00	0.0	816.8	836.6	9.89	63.46
157.9	0.00	0.0	798.9	816.8	8.95	63.42
162.9	0.00	0.0	782.7	798.9	8.10	63.38
167.9	0.00	0.0	768.0	782.7	7.34	63.34
172.9	0.00	0.0	754.7	768.0	6.64	63.31
177.9	0.00	0.0	742.7	754.7	6.01	63.28
182.9	0.00	0.0	731.8	742.7	5.44	63.25
187.9	0.00	0.0	722.0	731.8	4.92	63.23
192.9	0.00	0.0	713.1	722.0	4.46	63.21
197.9	0.00	0.0	705.0	713.1	4.03	63.19

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-10YR .HYD
Outflow Hydrograph: C:\0642900\D-10SWM .HYD

Starting Pond W.S. Elevation = 60.50 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 233.09 cfs
Peak Outflow = 138.32 cfs
Peak Elevation = 66.89 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0 cu-ft
Peak Storage From Storm = 364,888 cu-ft

Total Storage in Pond = 364,888 cu-ft

Warning: Inflow hydrograph truncated on left side.

POND-2 Version: 5.17 S/N:

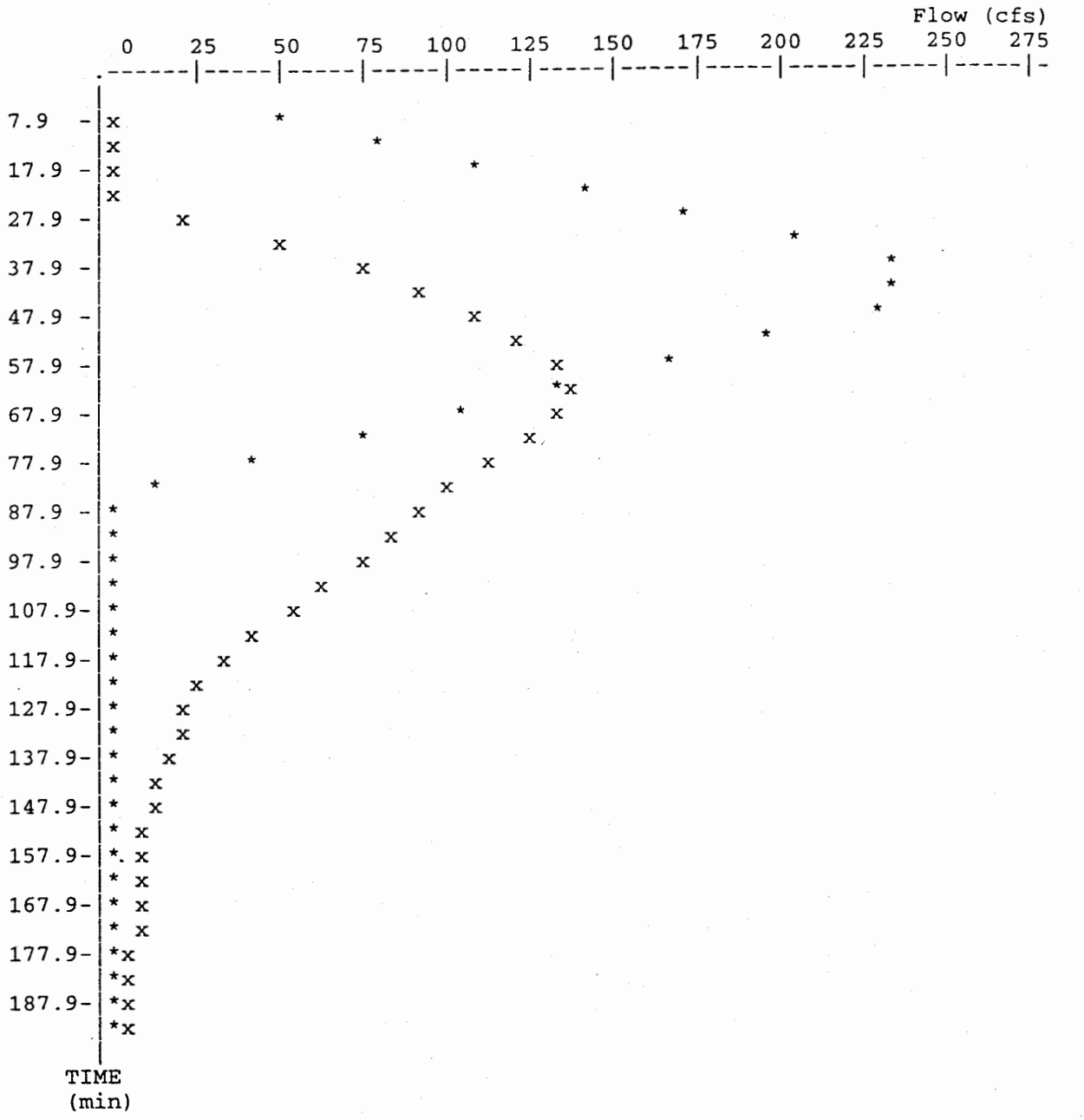
10 YR

Return Freq: 10 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-10YR .HYD
Outflow Hydrograph: C:\0642900\D-10SWM .HYD

EXECUTED: 02-15-1995
10:37:38

Peak Inflow = 233.09 cfs
Peak Outflow = 138.32 cfs
Peak Elevation = 66.89 ft



* File: C:\0642900\D-10YR .HYD Qmax = 233.1 cfs
x File: C:\0642900\D-10SWM .HYD Qmax = 138.3 cfs

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*                                       *
*  ROUTE 199  0199-047, C-503, RW-205   *
*            SWM FACILITY "D"           *
*      MONT. AVE. EXT. STA. 106+00      *
*                                       *
*                                       *
*****************************************
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Inflow Hydrograph: C:\0642900\D-25YR .HYD
Rating Table file: C:\0642900\D-SWM .PND

----INITIAL CONDITIONS----
Elevation = 60.50 ft
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)
60.50	0.0	0
61.00	0.0	1,641
61.50	0.0	11,956
62.00	0.0	33,550
62.50	0.0	62,540
63.00	0.0	94,205
63.50	10.7	126,433
64.00	30.3	159,226
64.50	57.2	192,587
65.00	73.8	226,521
65.50	87.4	261,253
66.00	99.1	297,020
66.50	113.5	334,396
67.00	145.7	373,959
67.50	146.9	416,296
68.00	146.9	462,008
68.50	172.8	511,483
69.00	227.0	565,121
69.50	306.8	623,401
70.00	412.8	686,814
70.50	546.2	755,651
71.00	708.1	832,487

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
10.9	10.9
79.7	79.7
223.7	223.7
416.9	416.9
628.1	628.1
842.9	853.6
1061.5	1091.8
1284.0	1341.2
1510.2	1584.0
1741.8	1829.2
1980.2	2079.3
2229.4	2342.9
2493.2	2638.9
2775.4	2922.3
3080.2	3227.1
3410.0	3582.8
3767.6	3994.6
4156.2	4463.0
4578.9	4991.7
5037.9	5584.1
5550.1	6258.2

Time increment (t) = 5.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-15-1995 10:37:38 25 YR Return Freq: 25 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-25YR .HYD
Outflow Hydrograph: C:\0642900\D-25SWM .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
2.9	22.74	-----	0.0	0.0	0.00	60.50
7.9	61.93	84.7	84.7	84.7	0.00	61.52
12.9	101.13	163.1	247.7	247.7	0.00	62.06
17.9	140.33	241.5	489.2	489.2	0.00	62.67
22.9	179.53	319.9	791.9	809.1	8.59	63.40
27.9	218.73	398.3	1108.3	1190.1	40.90	64.20
32.9	257.93	476.7	1437.3	1585.0	73.85	65.00
37.9	297.13	555.1	1802.3	1992.3	95.03	65.83
42.9	297.13	594.3	2157.9	2396.5	119.34	66.59
47.9	297.13	594.3	2459.8	2752.1	146.18	67.20
52.9	258.71	555.8	2721.8	3015.6	146.90	67.65
57.9	219.51	478.2	2906.2	3200.0	146.90	67.96
62.9	180.31	399.8	3000.7	3306.0	152.65	68.11
67.9	141.12	321.4	3014.5	3322.2	153.82	68.13
72.9	101.92	243.0	2959.3	3257.6	149.12	68.04
77.9	62.72	164.6	2830.2	3124.0	146.90	67.83
82.9	23.52	86.2	2622.7	2916.4	146.87	67.49
87.9	0.00	23.5	2354.7	2646.2	145.73	67.01
92.9	0.00	0.0	2125.1	2354.7	114.79	66.52
97.9	0.00	0.0	1921.9	2125.1	101.60	66.09
102.9	0.00	0.0	1738.5	1921.9	91.74	65.69
107.9	0.00	0.0	1573.7	1738.5	82.37	65.32
112.9	0.00	0.0	1427.5	1573.7	73.10	64.98
117.9	0.00	0.0	1301.3	1427.5	63.10	64.68
122.9	0.00	0.0	1195.5	1301.3	52.90	64.42
127.9	0.00	0.0	1112.5	1195.5	41.49	64.21
132.9	0.00	0.0	1047.5	1112.5	32.53	64.04
137.9	0.00	0.0	994.2	1047.5	26.65	63.91
142.9	0.00	0.0	949.7	994.2	22.26	63.80
147.9	0.00	0.0	912.4	949.7	18.60	63.70
152.9	0.00	0.0	881.4	912.4	15.54	63.62
157.9	0.00	0.0	855.4	881.4	12.98	63.56
162.9	0.00	0.0	833.7	855.4	10.85	63.50
167.9	0.00	0.0	814.2	833.7	9.76	63.46
172.9	0.00	0.0	796.5	814.2	8.83	63.41
177.9	0.00	0.0	780.6	796.5	7.99	63.37
182.9	0.00	0.0	766.1	780.6	7.23	63.34
187.9	0.00	0.0	753.0	766.1	6.55	63.31
192.9	0.00	0.0	741.1	753.0	5.93	63.28
197.9	0.00	0.0	730.4	741.1	5.36	63.25

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-25YR .HYD
Outflow Hydrograph: C:\0642900\D-25SWM .HYD

Starting Pond W.S. Elevation = 60.50 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 297.13 cfs
Peak Outflow = 153.82 cfs
Peak Elevation = 68.13 ft

***** Summary of Approximate Peak Storage *****

Initial Storage	=	0 cu-ft
Peak Storage From Storm	=	475,233 cu-ft
Total Storage in Pond	=	475,233 cu-ft

Warning: Inflow hydrograph truncated on left side.

POND-2 Version: 5.17 S/N:

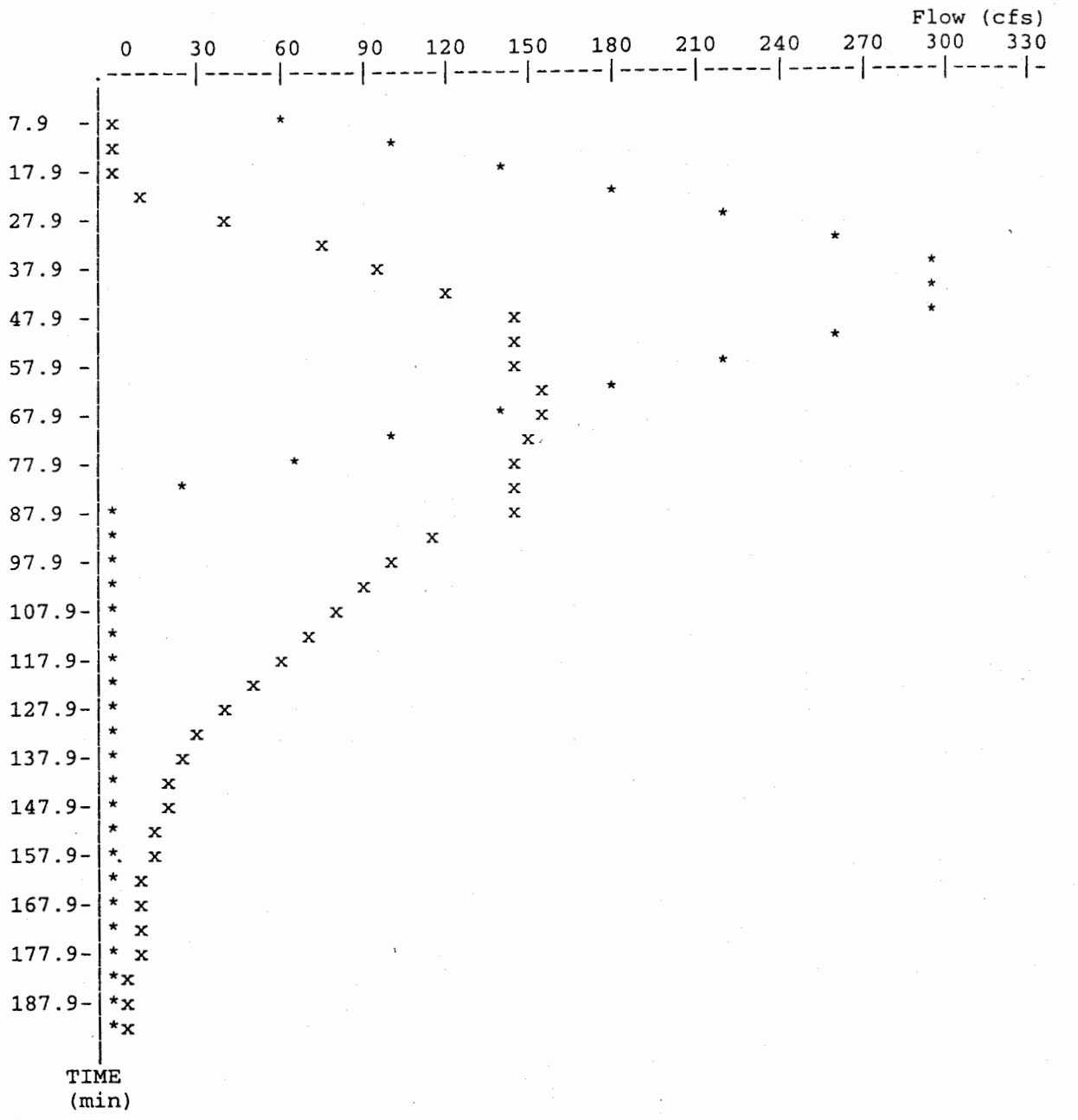
25 YR

Return Freq: 25 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-25YR .HYD
Outflow Hydrograph: C:\0642900\D-25SWM .HYD

EXECUTED: 02-15-1995
10:37:38

Peak Inflow = 297.13 cfs
Peak Outflow = 153.82 cfs
Peak Elevation = 68.13 ft



* File: C:\0642900\D-25YR .HYD Qmax = 297.1 cfs
x File: C:\0642900\D-25SWM .HYD Qmax = 153.8 cfs

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*                                       *
*  ROUTE 199  0199-047, C-503, RW-205   *
*            SWM FACILITY "D"           *
*      MONT. AVE. EXT. STA. 106+00      *
*                                       *
*                                       *
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Inflow Hydrograph: C:\0642900\D-100YR .HYD
Rating Table file: C:\0642900\D-SWM .PND

----INITIAL CONDITIONS----
Elevation = 60.50 ft
Outflow = 0.00 cfs
Storage = 0 cu-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (cu-ft)	2S/t (cfs)	2S/t + O (cfs)
60.50	0.0	0	0.0	0.0
61.00	0.0	1,641	10.9	10.9
61.50	0.0	11,956	79.7	79.7
62.00	0.0	33,550	223.7	223.7
62.50	0.0	62,540	416.9	416.9
63.00	0.0	94,205	628.1	628.1
63.50	10.7	126,433	842.9	853.6
64.00	30.3	159,226	1061.5	1091.8
64.50	57.2	192,587	1284.0	1341.2
65.00	73.8	226,521	1510.2	1584.0
65.50	87.4	261,253	1741.8	1829.2
66.00	99.1	297,020	1980.2	2079.3
66.50	113.5	334,396	2229.4	2342.9
67.00	145.7	373,959	2493.2	2638.9
67.50	146.9	416,296	2775.4	2922.3
68.00	146.9	462,008	3080.2	3227.1
68.50	172.8	511,483	3410.0	3582.8
69.00	227.0	565,121	3767.6	3994.6
69.50	306.8	623,401	4156.2	4463.0
70.00	412.8	686,814	4578.9	4991.7
70.50	546.2	755,651	5037.9	5584.1
71.00	708.1	832,487	5550.1	6258.2

Time increment (t) = 5.0 min.

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-100YR .HYD
Outflow Hydrograph: C:\0642900\D-100SWM.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
2.9	31.79	-----	0.0	0.0	0.00	60.50
7.9	86.60	118.4	118.4	118.4	0.00	61.63
12.9	141.41	228.0	346.4	346.4	0.00	62.32
17.9	196.22	337.6	678.7	684.0	2.66	63.12
22.9	251.02	447.2	1058.0	1126.0	33.98	64.07
27.9	305.83	556.9	1463.8	1614.8	75.51	65.06
32.9	360.64	666.5	1926.5	2130.3	101.89	66.10
37.9	415.45	776.1	2410.7	2702.6	145.97	67.11
42.9	415.45	830.9	2945.7	3241.6	147.96	68.02
47.9	415.45	830.9	3380.0	3776.6	198.30	68.74
52.9	361.74	777.2	3647.8	4157.2	254.69	69.17
57.9	306.93	668.7	3752.8	4316.4	281.83	69.34
62.9	252.12	559.1	3749.7	4311.8	281.05	69.34
67.9	197.31	449.4	3675.5	4199.2	261.85	69.22
72.9	142.50	339.8	3554.2	4015.3	230.52	69.02
77.9	87.69	230.2	3385.8	3784.4	199.33	68.74
82.9	32.89	120.6	3171.9	3506.3	167.23	68.39
87.9	0.00	32.9	2911.0	3204.8	146.90	67.96
92.9	0.00	0.0	2617.3	2911.0	146.85	67.48
97.9	0.00	0.0	2330.6	2617.3	143.35	66.96
102.9	0.00	0.0	2104.9	2330.6	112.83	66.48
107.9	0.00	0.0	1903.9	2104.9	100.50	66.05
112.9	0.00	0.0	1722.1	1903.9	90.90	65.65
117.9	0.00	0.0	1559.2	1722.1	81.46	65.28
122.9	0.00	0.0	1415.0	1559.2	72.10	64.95
127.9	0.00	0.0	1290.5	1415.0	62.25	64.65
132.9	0.00	0.0	1187.0	1290.5	51.73	64.40
137.9	0.00	0.0	1105.9	1187.0	40.57	64.19
142.9	0.00	0.0	1042.3	1105.9	31.82	64.03
147.9	0.00	0.0	989.8	1042.3	26.22	63.90
152.9	0.00	0.0	946.0	989.8	21.91	63.79
157.9	0.00	0.0	909.4	946.0	18.30	63.69
162.9	0.00	0.0	878.8	909.4	15.29	63.62
167.9	0.00	0.0	853.3	878.8	12.77	63.55
172.9	0.00	0.0	831.9	853.3	10.68	63.50
177.9	0.00	0.0	812.6	831.9	9.67	63.45
182.9	0.00	0.0	795.1	812.6	8.75	63.41
187.9	0.00	0.0	779.2	795.1	7.92	63.37
192.9	0.00	0.0	764.9	779.2	7.17	63.34
197.9	0.00	0.0	751.9	764.9	6.49	63.30

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-100YR .HYD
Outflow Hydrograph: C:\0642900\D-100SWM.HYD

Starting Pond W.S. Elevation = 60.50 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 415.45 cfs
Peak Outflow = 281.83 cfs
Peak Elevation = 69.34 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 0 cu-ft
Peak Storage From Storm = 605,166 cu-ft

Total Storage in Pond = 605,166 cu-ft

Warning: Inflow hydrograph truncated on left side.

POND-2 Version: 5.17 S/N:

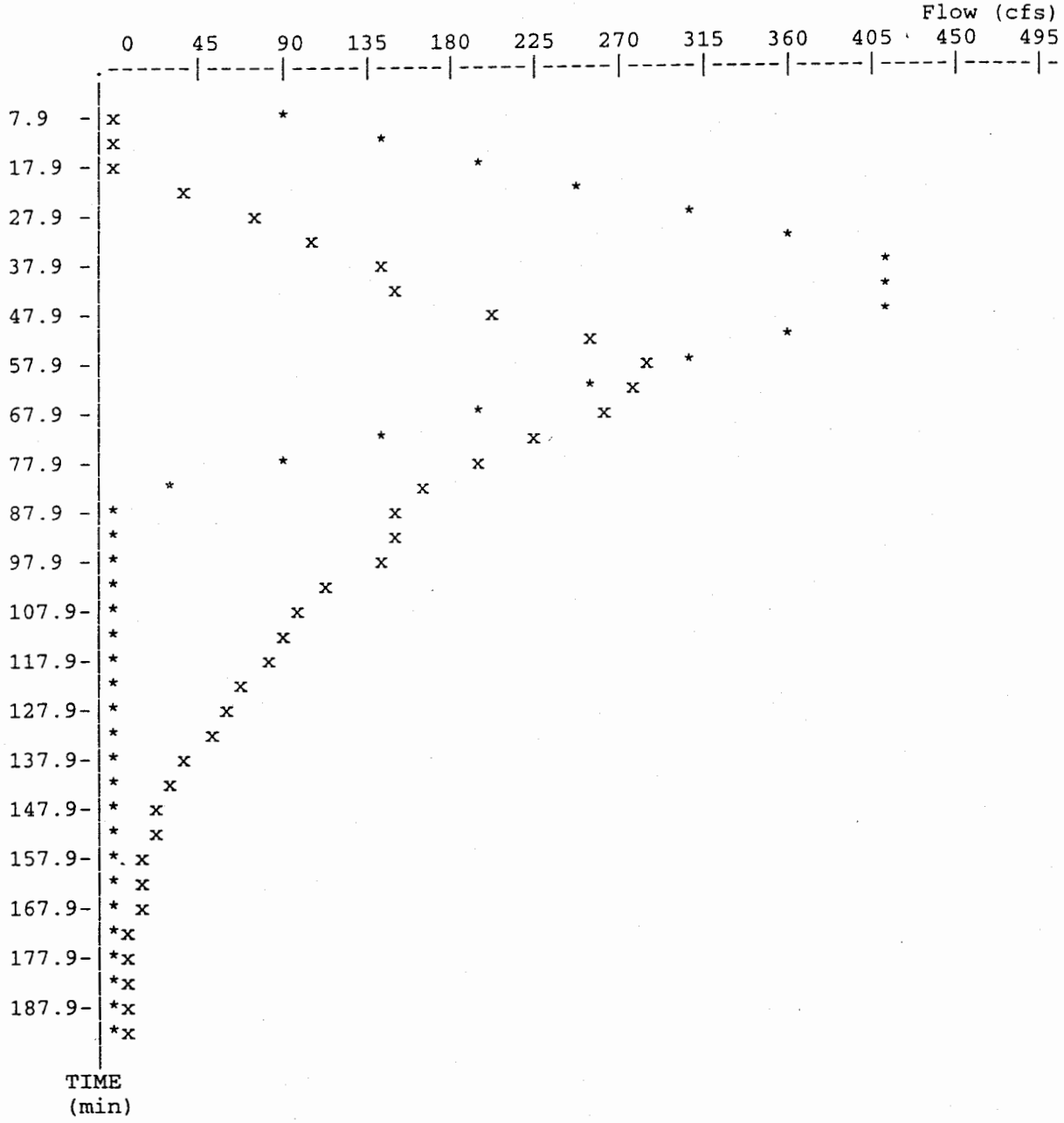
100 YR

Return Freq: 100 years

Pond File: C:\0642900\D-SWM .PND
Inflow Hydrograph: C:\0642900\D-100YR .HYD
Outflow Hydrograph: C:\0642900\D-100SWM.HYD

EXECUTED: 02-15-1995
10:37:38

Peak Inflow = 415.45 cfs
Peak Outflow = 281.83 cfs
Peak Elevation = 69.34 ft



* File: C:\0642900\D-100YR .HYD Qmax = 415.5 cfs
x File: C:\0642900\D-100SWM.HYD Qmax = 281.8 cfs

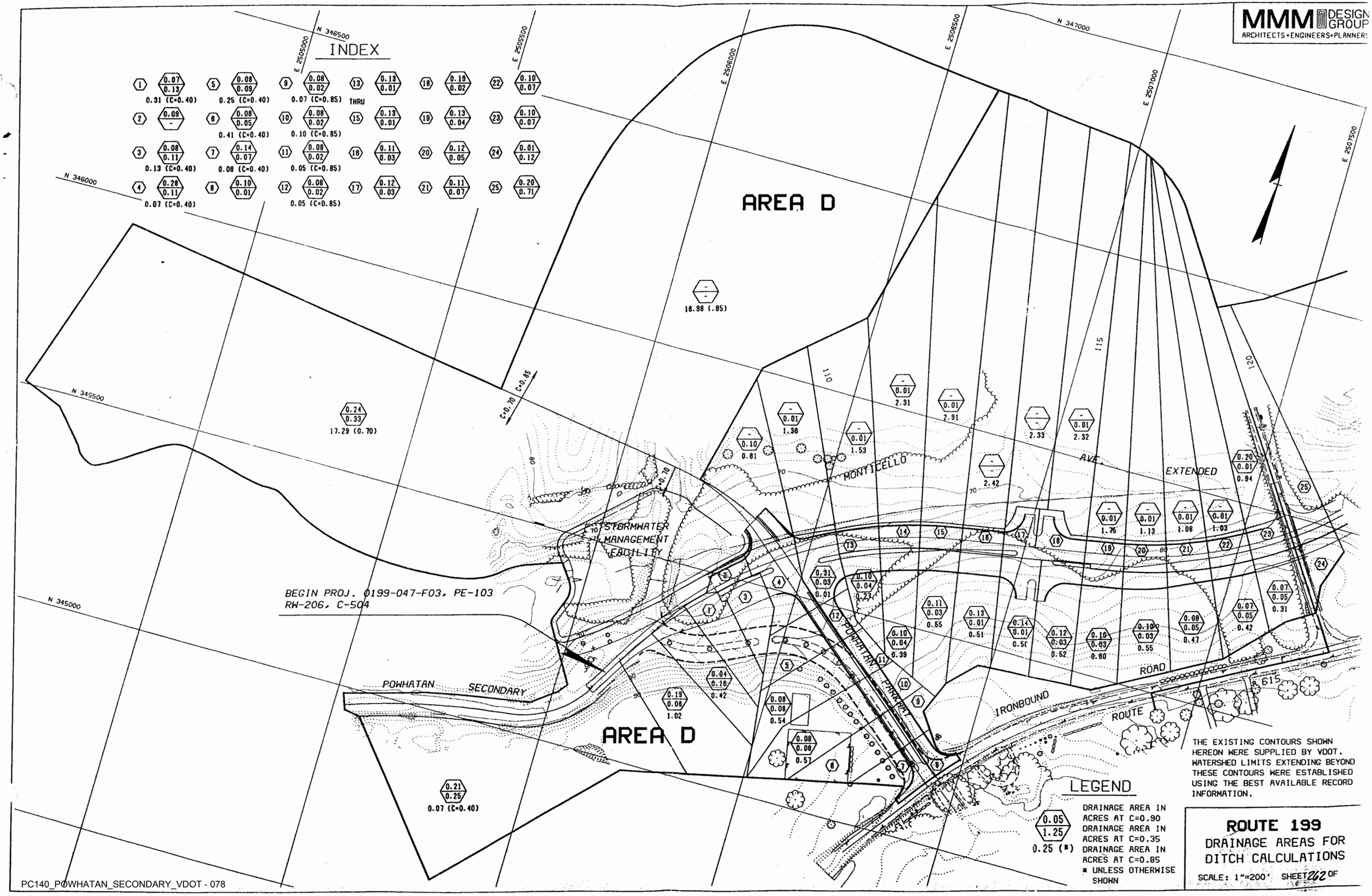
S.W.M. Facility -State owned BMP
@ upper end of Pow. Secondary
Monticello Avenue Ext. - Sta. 106+00 15 ac Pond

West of Monticello Avenue

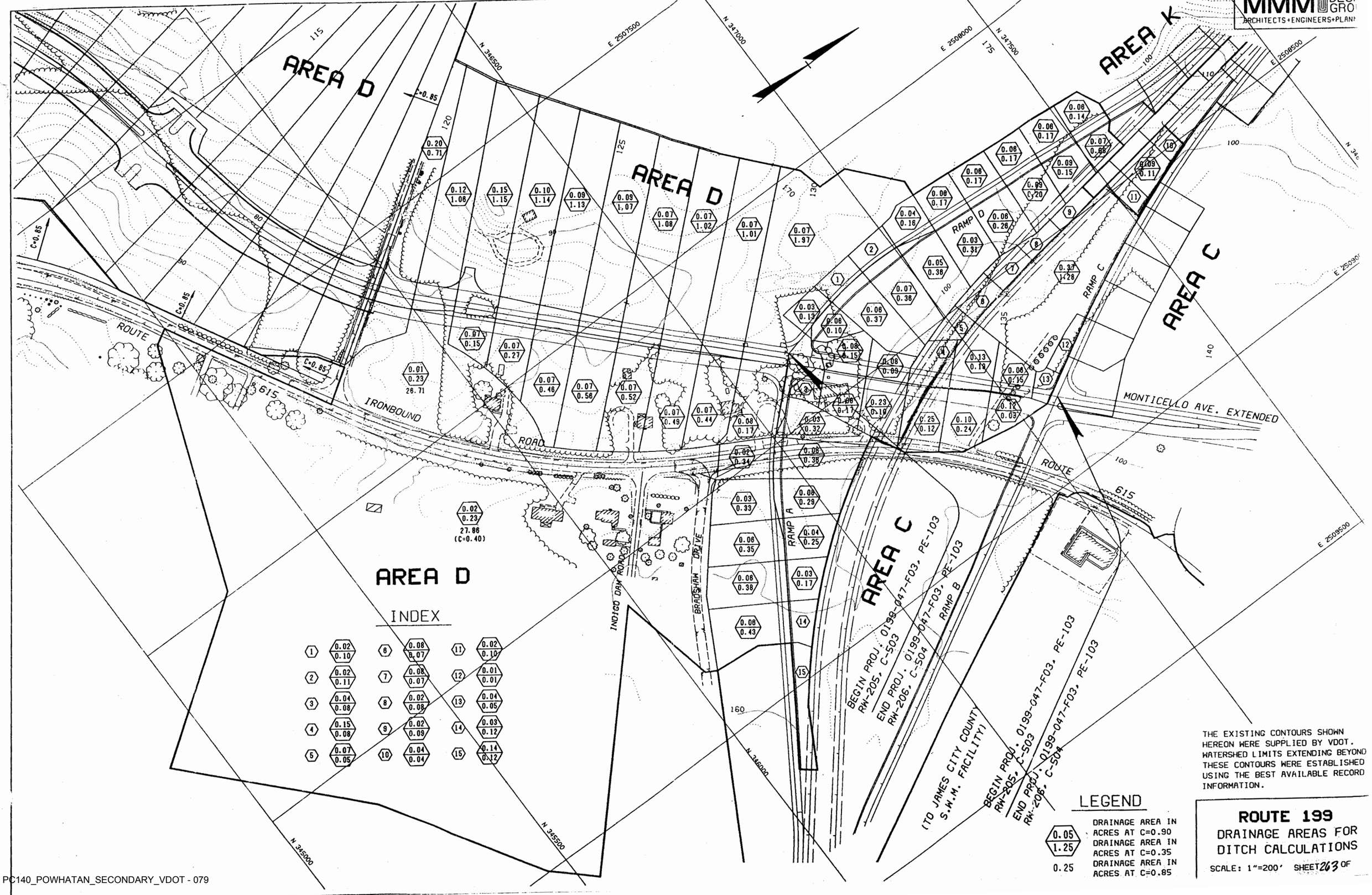
100 yr storm - 281.8 cfs post devel routed
vs 249.8 cfs pre devel

MMM DESIGN GROUP
ARCHITECTS+ENGINEERS+PLANNERS

ROUTE 199
PROJECT 0199-047-103, RW-205, C-503



DRN8B.DG SI"90.PI 03/19/96 10:30 DGB PL:.55-0.25



DRN8C.DG S: 0.PI 04/29/96 08:40 DDB PLT.SC=0.25

Hanson

Hanson Concrete Products, Inc.

Eastern Region

Roanoke, VA
540-342-6725

Richmond, VA
804-233-5471

Manasas, VA
703-361-4193

Jessup, MD
410-799-2600

Chesapeake, VA
757-485-5228

~~Kingsport Garden Club~~

~~Winnie Bryant~~

~~253-2834~~

SP-40-97
SP-63-97
SP-72-98

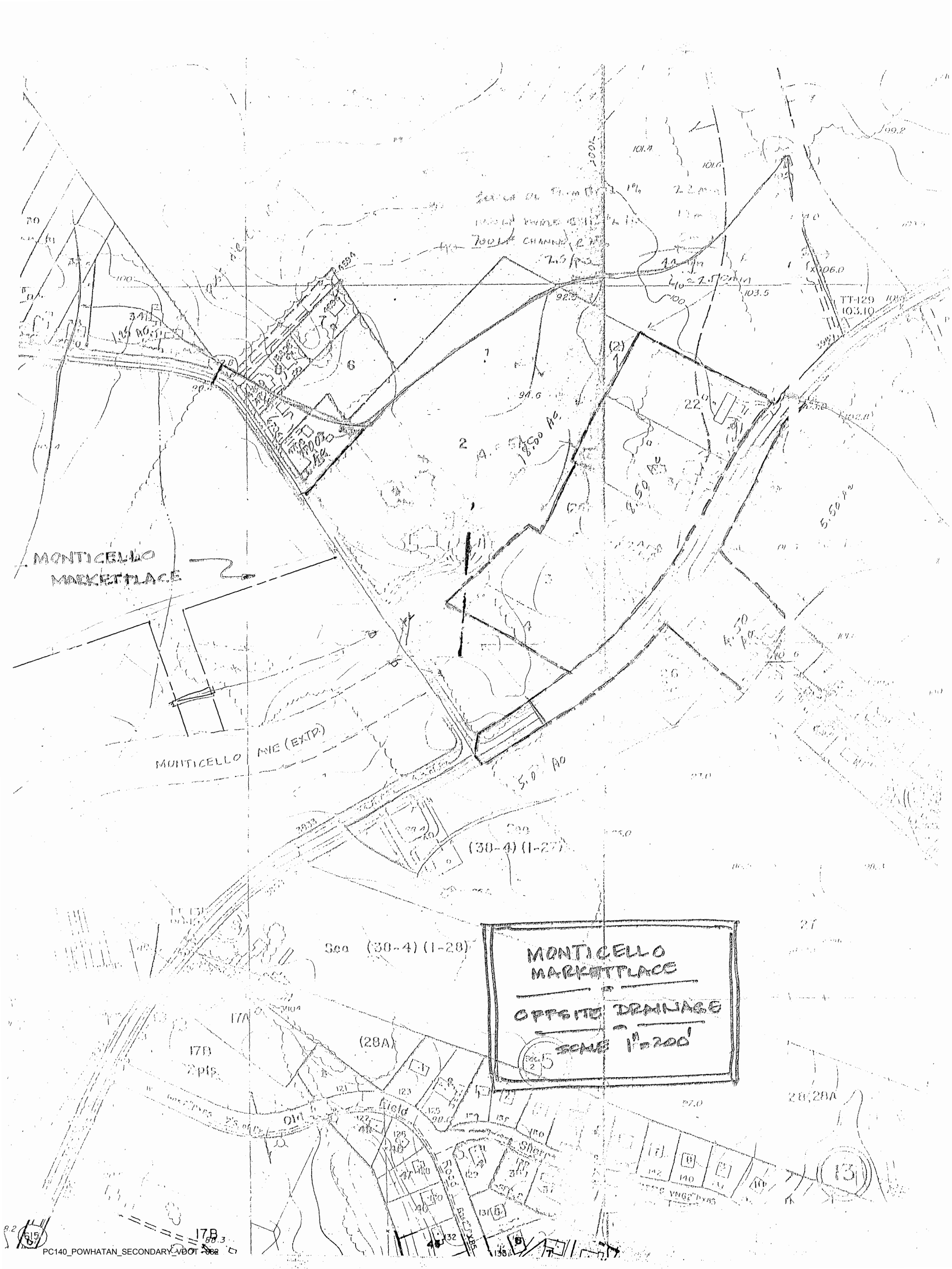
PC140 Montreillo Mktplace

intersection News Rd + Mont Ave Extended

SWM FACILITY D1

- Letter May 11 98 Ack required 1/m Agree.
- Note #18 on Sheet C10 of Apr. Plan required AB + CC of SWM FACILITY.

Q_2 = 98 cfs	~~84.36~~	90.95
Q_{10} = 138.40 cfs	~~124.22~~	138.32 cfs
Q_{100} = 249.80 cfs	~~224.14~~	281.83 cfs
		EL 69.34


MONTICELLO
MARKETPLACE
OFFSITE DRAINAGE
SCALE 1"=200'
MONTICELLO AVE (EXTD.)
(30-4) (1-27)
See (30-4) (1-28)
TT-129
103.10
Old
Field
Short
17B
2 pts.
(28A)
17A
20,28A
13
17B

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH - WILLIAMSBURG, VIRGINIA

Subject MONTICELLO MARKETPLACE

Computed By MRS Checked By

Project No. 95096-07

Client

Date 8-21-97 Sheet No.

ATTENUATION IN WETLANDS EAST OF ENTRANCE

DESCRIPTION	AREA	% IMPERV.	AREA IMP.
LARGE LOT RESIDENTIAL	12.0 Ac	15	1.80 Ac
MEDIUM DENSITY RESIDENTIAL	1.4 Ac	30	0.42 Ac
WOODS	23.8 Ac	0	0.00
FIELDS	5.3 Ac	0	0.00
OUTPARCELS	4.0 Ac	90	3.60 Ac
	46.5 Ac		5.82 Ac

% IMPERV (AVG) = 5.82/46.5 = 12.5 %

1" RUNOFF VOL. = $P(R_v)(A)/12$
= $(1")(0.05 + 0.009(12.5))(46.5)/12$
= $1(0.1625)(46.5)/12$
= 0.6297 Ac-FT
= 27,429 C.F.

1/2" RUNOFF VOL = $P(R_v)(A)/12$
= $1/2\,(0.1625)(46.5)/12$
= 0.3148 Ac-FT
= 13,715 C.F.

POND-2 Version: 5.20
S/N:

MONTICELLO MARKETPLACE
Attenuation in Wetlands East of Monticello Ave Entrance
James City County, Virginia

CALCULATED 08-21-1997 12:13:17
DISK FILE: C:\PONDPACK\96046-07\WETLND .VOL

Planimeter scale: 1 inch = 50 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (sq.ft)	A1+A2+sqr(A1*A2) (sq.ft)	* Volume (cubic-ft)	Volume Sum (cubic-ft)
70.40	0.00	0	0	0	0
71.00	0.35	875	875	175	175
72.00	1.25	3,125	5,654	1,885	2,060
73.00	2.07	5,175	12,321	4,107	6,167
74.00	4.12	10,300	22,776	7,592	13,759
75.00	7.15	17,875	41,744	13,915	27,673

$$IA = (sq.rt(Area1) + ((Ei-E1)/(E2-E1))*(sq.rt(Area2)-sq.rt(Area1)))^2$$

where: E1, E2 = Closest two elevations with planimeter data
Ei = Elevation at which to interpolate area
Area1,Area2 = Areas computed for E1, E2, respectively
IA = Interpolated area for Ei

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

File: MONT4.MRG
Project: MONTICELLO MARKETPLACE
Location: Jaames City County, Virginia
Design: M. GORDON
Date: 21-Aug-97
Rev.: 21-Aug-97

LANGLEY and McDONA
201 Packets Court
Williamsburg, Va.

ORFICE SIZE	=	4	in.
STAGE INCREMENT	=	0.23	ft.
INVERT ELEV.	=	70.40	
UPPER RANGE	=	75.00	
COEFFICIENT	=	0.6	
CONSTANT	=	0.04375	
TOTAL VOLUME	=	27,429	cf

ELEV.	HEAD	FLOW
70.40	0.00	0.00
70.63	0.23	0.20
70.86	0.46	0.28
71.09	0.69	0.35
71.32	0.92	0.40
71.55	1.15	0.45
71.78	1.38	0.49
72.01	1.61	0.53
72.24	1.84	0.57
72.47	2.07	0.60
72.70	2.30	0.64
72.93	2.53	0.67
73.16	2.76	0.70
73.39	2.99	0.73
73.62	3.22	0.75
73.85	3.45	0.78
74.08	3.68	0.81
74.31	3.91	0.83
74.54	4.14	0.85
74.77	4.37	0.88
75.00	4.60	0.90

		12.42 cfs

AVG. FLOW RATE = 0.62 cfs

DETENTION TIME = 12.27 hrs.

File: MONT4.MRG
Project: MONTICELLO MARKETPLACE
Location: Jaames City County, Virginia
Design: M. GORDON
Date: 21-Aug-97
Rev.: 21-Aug-97

LANGLEY and McDONALD, P.C.
201 Packets Court
Williamsburg, Va. 23185

ORFICE SIZE	=	3 in.
STAGE INCREMENT	=	0.18 ft.
INVERT ELEV.	=	70.40
UPPER RANGE	=	74.00
COEFFICIENT	=	0.6
CONSTANT	=	0.04375
TOTAL VOLUME	=	13,715 cf

ELEV.	HEAD	FLOW
70.40	0.00	0.00
70.58	0.18	0.10
70.76	0.36	0.14
70.94	0.54	0.17
71.12	0.72	0.20
71.30	0.90	0.22
71.48	1.08	0.25
71.66	1.26	0.27
71.84	1.44	0.28
72.02	1.62	0.30
72.20	1.80	0.32
72.38	1.98	0.33
72.56	2.16	0.35
72.74	2.34	0.36
72.92	2.52	0.38
73.10	2.70	0.39
73.28	2.88	0.40
73.46	3.06	0.41
73.64	3.24	0.43
73.82	3.42	0.44
74.00	3.60	0.45

		6.18 cfs

AVG. FLOW RATE = 0.31 cfs

DETENTION TIME = 12.33 hrs.

File: MONT4.MRG
Project: MONTICELLO MARKETPLACE
Location: Jaames City County, Virginia
Design: M. GORDON
Date: 21-Aug-97
Rev.: 21-Aug-97

LANGLEY and McDONALD, P.C.
201 Packets Court
Williamsburg, Va. 23185

ORFICE SIZE	=	2 in.
STAGE INCREMENT	=	0.18 ft.
INVERT ELEV.	=	70.40
UPPER RANGE	=	74.00
COEFFICIENT	=	0.6
CONSTANT	=	0.04375
TOTAL VOLUME	=	13,715 cf

ELEV.	HEAD	FLOW
70.40	0.00	0.00
70.58	0.18	0.04
70.76	0.36	0.06
70.94	0.54	0.08
71.12	0.72	0.09
71.30	0.90	0.10
71.48	1.08	0.11
71.66	1.26	0.12
71.84	1.44	0.13
72.02	1.62	0.13
72.20	1.80	0.14
72.38	1.98	0.15
72.56	2.16	0.15
72.74	2.34	0.16
72.92	2.52	0.17
73.10	2.70	0.17
73.28	2.88	0.18
73.46	3.06	0.18
73.64	3.24	0.19
73.82	3.42	0.19
74.00	3.60	0.20

		2.75 cfs

AVG. FLOW RATE = 0.14 cfs

DETENTION TIME = 27.74 hrs.

Culvert Designer/Analyzer Report
WETLANDS CULVERT

Analysis Component			
Storm Event	Design	Discharge	39.79 cfs

Peak Discharge Method: Rational			
Design Return Period	10 year	Check Return Period	50 year
Design Peak Discharge	39.79 cfs	Check Peak Discharge	52.47 cfs
Total Area	46.50 acres	Time of Concentration	52.00 min

Sub-watershed	Area (acres)	C
1	12.00	0.30
2	1.40	0.40
3	23.80	0.25
4	5.30	0.25
5	4.00	0.90

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-24 inch Circular	39.79 cfs	72.93 ft	7.38 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
WETLANDS CULVERT

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	72.93	ft	Discharge	39.79	cfs
Inlet Control HW Elev	72.93	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev	72.87	ft	Control Type	Inlet Control	
Headwater Depth/ Height	1.46				

Grades					
Upstream Invert	70.00	ft	Downstream Invert	69.10	ft
Length	112.00	ft	Constructed Slope	0.008036	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.60	ft
Slope Type	Mild		Normal Depth	1.61	ft
Flow Regime	Subcritical		Critical Depth	1.60	ft
Velocity Downstream	7.38	ft/s	Critical Slope	0.008076	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev	72.87	ft	Upstream Velocity Head	0.84	ft
Ke	0.50		Entrance Loss	0.42	ft

Inlet Control Properties					
Inlet Control HW Elev	72.93	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	6.3	ft^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Designer/Analyzer Report
WETLANDS CULVERT

Analysis Component			
Storm Event	Check	Discharge	52.47 cfs

Peak Discharge Method: Rational			
Design Return Period	10 year	Check Return Period	50 year
Design Peak Discharge	39.79 cfs	Check Peak Discharge	52.47 cfs
Total Area	46.50 acres	Time of Concentration	52.00 min

Sub-watershed	Area (acres)	C
1	12.00	0.30
2	1.40	0.40
3	23.80	0.25
4	5.30	0.25
5	4.00	0.90

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev	Velocity
Culvert-1	2-24 inch Circular	39.79 cfs	72.93 ft	7.38 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
WETLANDS CULVERT

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	72.93 ft	Discharge	39.79 cfs
Inlet Control HW Elev	72.93 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev	72.87 ft	Control Type	Inlet Control
Headwater Depth/ Height	1.46		

Grades			
Upstream Invert	70.00 ft	Downstream Invert	69.10 ft
Length	112.00 ft	Constructed Slope	0.008036 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.60 ft
Slope Type	Mild	Normal Depth	1.61 ft
Flow Regime	Subcritical	Critical Depth	1.60 ft
Velocity Downstream	7.38 ft/s	Critical Slope	0.008076 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev	72.87 ft	Upstream Velocity Head	0.84 ft
Ke	0.50	Entrance Loss	0.42 ft

Inlet Control Properties			
Inlet Control HW Elev	72.93 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	6.3 ft^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

FILE: MONT1A.XLS
Project: MONTICELLO MARKETPLACE SHOPPING CENTER
Location: James City County, Virginia
Design: M. Gordon
Date: 5/28/97
Revision: 8/22/97
Yr. Storm: 10 Yr.
N Value: 0.013

LANGLEY and McDONALD, P.C.
201 Packets Court
Williamsburg, Virginia 23185

STORM SEWER DESIGN COMPUTATIONS

FROM PT.	TO PT.	DRAIN. AREA	RUN-OFF COEFF.	C x A INCR.	C x A ACCUM.	INLET TIME	RAIN FALL	RUNOFF "Q" INCR.	RUNOFF "Q" ACCUM.	INVERT ELEV UP	INVERT ELEV LOW	LENGTH	SLOPE	PIPE DIAM.	VELOCITY	CAPACITY	FLOW TIME	FLOW RATIO	VELOCITY RATIO	REMARKS
		acres	"C"			min.	in/hr	cfs	cfs			ft.	ft./ft.	inches	ft./sec.	cfs	min.	Qp/Qf	Vp/Vf	
		[E]	[E]			[E]				[E]		[E]		[E]						
1	2	0.80	0.90	0.72	0.72	10.00	5.93	4.27	4.27	85.03	84.89	82	0.0017	18	2.42	4.27	0.57	1.00	1.00	
2	3	0.73 2.23	0.90	0.66	1.38	10.57	5.83	3.83	8.03	84.64	84.27	145	0.0026	21	3.34	8.03	0.72	1.00	1.00	
3	4	0.70	0.90	0.63	2.01	11.29	5.71	3.60	11.46	84.17	83.80	145	0.0026	24	3.65	11.46	0.66	1.00	1.00	
4	5	0.63	0.90	0.57	2.57	11.95	5.61	3.18	14.43	83.70	83.65	12	0.0041	24	4.59	14.43	0.04	1.00	1.00	
5	6	0.62	0.90	0.56	3.13	12.00	5.60	3.12	17.54	83.55	83.19	110	0.0032	27	4.41	17.54	0.42	1.00	1.00	
6	7	0.47	0.90	0.42	3.56	12.41	5.54	2.34	19.68	83.09	82.61	210	0.0023	30	4.01	19.68	0.87	1.00	1.00	
7	8	0.39	0.90	0.35	3.91	13.28	5.41	1.90	21.11	82.51	82.32	72	0.0027	30	4.30	21.11	0.28	1.00	1.00	
8	10	0.43	0.90	0.39	4.29	13.56	5.37	2.08	23.03	82.22	82.09	106	0.0012	36	3.26	23.03	0.54	1.00	1.00	
9	10	0.50	0.90	0.45	0.45	10.00	5.93	2.67	2.67	88.80	84.35	53	0.0839	15	10.06	18.64	0.09	0.14	0.66	
10	11	0.40	0.90	0.36	5.10	14.11	5.29	1.90	26.99	81.99	81.81	112	0.0016	36	3.82	26.99	0.49	1.00	1.00	
11	13	0.57	0.90	0.51	5.62	14.59	5.22	2.68	29.32	81.71	81.51	102	0.0019	36	4.15	29.32	0.41	1.00	1.00	
12	13	1.03	0.90	0.93	0.93	10.00	5.93	5.50	5.50	83.75	83.21	74	0.0073	15	4.48	5.50	0.28	1.00	1.00	
13	14	0.05	0.90	0.05	6.59	15.00	5.17	0.23	34.04	81.41	81.24	145	0.0011	42	3.54	34.04	0.68	1.00	1.00	
14	15	0.19	0.90	0.17	6.76	15.69	5.08	0.87	34.32	81.14	81.08	53	0.0012	42	3.57	34.32	0.25	1.00	1.00	
15	16	0.10	0.90	0.09	6.85	15.93	5.05	0.45	34.56	80.98	80.85	106	0.0012	42	3.59	34.56	0.49	1.00	1.00	
16	17	1.94	0.90	1.75	8.60	16.43	4.98	8.70	42.84	80.75	80.54	121	0.0018	42	4.45	42.84	0.45	1.00	1.00	
17	18	1.12	0.90	1.01	9.60	16.88	4.93	4.97	47.33	80.44	80.21	102	0.0022	42	4.92	47.33	0.35	1.00	1.00	
18	19	0.36	0.90	0.32	9.93	17.22	4.89	1.58	48.52	80.11	79.95	68	0.0023	42	5.04	48.52	0.22	1.00	1.00	
19	20	0.24	0.90	0.22	10.14	17.45	4.86	1.05	49.30	79.85	76.40	286	0.0121	42	11.03	110.50	0.43	0.45	0.96	
20	21	0.67	0.90	0.60	10.75	17.88	4.81	2.90	51.70	76.30	76.12	68	0.0026	42	5.37	51.70	0.21	1.00	1.00	
21	22	0.17	0.90	0.15	10.90	18.09	4.79	0.73	52.17	76.02	75.86	57	0.0027	42	5.42	52.17	0.18	1.00	1.00	
22	23	0.16	0.90	0.14	11.04	18.27	4.77	0.69	52.64	73.76	71.55	185	0.0120	42	11.20	110.00	0.28	0.48	0.98	
51	52	1.44	0.55	0.79	0.79	16.00	5.04	3.99	3.99	90.75	84.96	68	0.0852	15	11.48	18.78	0.10	0.21	0.75	
52	53	1.32	0.90	1.19	1.98	16.10	5.03	5.97	9.95	84.86	84.72	72	0.0019	24	3.17	9.95	0.38	1.00	1.00	
53	54	0.42	0.90	0.38	2.36	16.48	4.98	1.88	11.74	84.62	84.23	142	0.0027	24	3.74	11.74	0.63	1.00	1.00	
54	56	0.23	0.90	0.21	2.57	17.11	4.90	1.01	12.57	84.13	84.00	42	0.0031	24	4.00	12.57	0.17	1.00	1.00	

FILE: MONT1A.XLS
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Revision: 8/22/97
Yr. Storm: 10 Yr.
N Value: 0.013

FROM PT.	TO PT.	DRAIN. AREA	RUN-OFF COEFF.	C x A INCR.	C x A ACCUM.	INLET TIME	RAIN FALL	RUNOFF "Q" INCR.	RUNOFF "Q" ACCUM.	INVERT ELEV UP	INVERT ELEV LOW	LENGTH	SLOPE	PIPE DIAM.	VELOCITY	CAPACITY	FLOW TIME	FLOW RATIO	VELOCITY RATIO	REMARKS
		acres	"C"			min.	in/hr	cfs	cfs			ft.	ft./ft.	inches	ft./sec.	cfs	min.	Qp/Qf	Vp/Vf	
		[E]	[E]			[E]				[E]		[E]		[E]						
55	56	0.10	0.90	0.09	0.09	10.00	5.93	0.53	0.53	90.00	86.00	38	0.1053	15	5.87	20.88	0.11	0.03	0.35	
56	57	0.03	0.90	0.03	2.68	17.29	4.88	0.13	13.09	83.90	83.72	38	0.0050	24	5.69	15.90	0.11	0.82	1.13	ROOF TO MH-1
57	58	0.31	0.90	0.28	2.96	17.40	4.87	1.36	14.41	83.62	83.38	106	0.0022	27	4.21	14.45	0.42	1.00	1.16	
58	71	0.27	0.90	0.24	3.20	17.82	4.82	1.17	15.44	83.28	82.99	116	0.0025	27	3.88	15.44	0.50	1.00	1.00	
71	61	0.17	0.90	0.15	3.36	18.31	4.76	0.73	15.98	82.89	82.78	72	0.0015	30	3.26	15.98	0.37	1.00	1.00	
59	60	0.47	0.90	0.42	0.42	10.00	5.93	2.51	2.51	85.30	81.03	115	0.0371	15	7.43	12.40	0.26	0.20	0.74	
60	61	0.20	0.90	0.18	0.60	10.26	5.88	1.06	3.55	80.03	79.55	158	0.0030	15	2.89	3.55	0.91	1.00	1.00	
61	69	0.17	0.90	0.15	4.11	18.68	4.72	0.72	19.41	79.45	79.25	87	0.0022	30	3.95	19.41	0.37	1.00	1.00	
69	68	0.38	0.90	0.34	4.46	19.05	4.68	1.60	20.85	79.15	78.88	104	0.0026	30	4.25	20.85	0.41	1.00	1.00	
67	68	0.41	0.90	0.37	0.37	10.00	5.93	2.19	2.19	84.71	84.33	81	0.0047	12	3.54	2.43	0.38	0.90	1.15	
68	66	0.28	0.90	0.25	5.08	19.46	4.64	1.17	23.53	78.78	77.31	90	0.0164	30	10.25	52.40	0.15	0.45	0.96	
62	64	0.30	0.90	0.27	0.27	10.00	5.93	1.60	1.60	84.25	83.31	87	0.0108	12	4.46	3.68	0.32	0.44	0.95	
63	64	0.20	0.90	0.18	0.18	10.00	5.93	1.07	1.07	83.41	83.31	34	0.0029	12	2.50	1.93	0.23	0.55	1.02	
64	65	0.18	0.90	0.16	0.61	10.32	5.87	0.95	3.59	83.21	83.13	27	0.0031	15	2.93	3.59	0.15	1.00	1.00	
65	66	0.18	0.90	0.16	0.77	10.48	5.85	0.95	4.53	82.13	80.18	40	0.0487	15	9.97	14.20	0.07	0.32	0.86	
66	46	0.09	0.90	0.08	5.93	19.60	4.62	0.37	27.40	76.00	74.50	336	0.0045	30	5.58	27.40	1.00	1.00	1.00	
44	45	0.07	0.90	0.06	0.06	10.00	5.93	0.37	0.37	81.28	80.04	69	0.0180	12	3.10	4.76	0.37	0.08	0.51	
45	46	0.09	0.90	0.08	0.14	10.37	5.87	0.48	0.84	79.04	76.64	49	0.0490	12	5.90	7.85	0.14	0.11	0.59	
46	47	0.63	0.90	0.57	6.64	20.61	4.52	2.56	30.00	74.40	70.80	106	0.0340	30	14.18	75.48	0.12	0.40	0.92	
26	27	0.17	0.90	0.15	0.15	10.11	5.91	0.90	0.90	85.88	85.14	210	0.0035	12	2.55	2.10	1.37	0.43	0.95	
27	28	0.46	0.90	0.41	0.57	11.48	5.68	2.35	3.22	85.04	84.88	66	0.0025	15	2.62	3.22	0.42	1.00	1.00	
28	29	1.05	0.90	0.95	1.51	11.90	5.61	5.31	8.49	84.78	81.68	178	0.0174	15	6.92	8.49	0.43	1.00	1.00	
29	32	0.30	0.90	0.27	1.78	12.33	5.55	1.50	9.89	81.58	81.02	63	0.0089	18	5.59	9.89	0.19	1.00	1.00	
30	31	0.04	0.90	0.04	0.04	5.00	6.96	0.25	0.25	84.59	81.70	192	0.0150	12	2.55	4.35	1.26	0.06	0.46	
31	32	0.22	0.90	0.20	0.23	12.52	5.52	1.09	1.29	81.60	81.03	179	0.0032	12	2.70	2.00	1.10	0.65	1.06	
32	38	0.16	0.90	0.14	2.16	13.62	5.36	0.77	11.57	80.92	80.66	49	0.0054	21	4.81	11.57	0.17	1.00	1.00	
33	34	0.17	0.90	0.15	0.15	10.00	5.93	0.91	0.91	83.84	83.51	60	0.0055	12	2.95	2.62	0.34	0.35	0.88	
34	35	0.29	0.90	0.26	0.41	10.34	5.87	1.53	2.43	83.41	83.11	60	0.0050	12	3.68	2.50	0.27	0.97	1.16	
35	38	0.27	0.90	0.24	0.66	10.61	5.82	1.42	3.83	83.01	82.32	60	0.0116	12	4.87	3.83	0.21	1.00	1.00	
36	37	0.25	0.90	0.23	0.88	10.82	5.79	1.30	5.11	82.22	81.88	51	0.0065	15	4.91	5.20	0.17	0.98	1.16	
37	38	0.36	0.90	0.32	1.21	10.99	5.76	1.87	6.95	81.78	81.43	30	0.0117	15	5.66	6.95	0.09	1.00	1.00	
38	39	0.28	0.90	0.25	3.62	13.79	5.33	1.34	19.30	80.56	78.57	98	0.0203	27	10.54	44.00	0.15	0.44	0.95	

FILE: MONT1A.XLS
Date: 5/28/97
Revision: 8/22/97
Yr. Storm: 10 Yr.
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FROM PT.	TO PT.	DRAIN. AREA	RUN-OFF COEFF.	C x A INCR.	C x A ACCUM.	INLET TIME	RAIN FALL	RUNOFF "Q" INCR.	RUNOFF "Q" ACCUM.	INVERT ELEV UP	INVERT ELEV LOW	LENGTH	SLOPE	PIPE DIAM.	VELOCITY	CAPACITY	FLOW TIME	FLOW RATIO	VELOCITY RATIO	REMARKS
		acres	"C"			min.	in/hr	cfs	cfs			ft.	ft./ft.	inches	ft./sec.	cfs	min.	Qp/Qf	Vp/Vf	
		[E]	[E]			[E]				[E]		[E]		[E]						
39	40	0.24	0.90	0.22	3.83	13.94	5.31	1.15	20.36	78.47	78.38	20	0.0043	27	5.12	20.36	0.07	1.00	1.00	
40	43	0.16	0.90	0.14	3.98	14.01	5.30	0.76	21.09	78.28	76.18	100	0.0211	30	10.78	59.45	0.15	0.35	0.89	
41	42	1.27	0.90	1.14	1.14	10.00	5.93	6.78	6.78	78.00	77.08	34	0.0271	15	9.13	10.60	0.06	0.64	1.06	
42	43	0.47	0.90	0.42	1.57	10.06	5.92	2.50	9.27	76.98	76.87	32	0.0034	21	3.85	9.27	0.14	1.00	1.00	
43	47	0.34	0.90	0.31	5.85	14.16	5.28	1.62	30.89	76.08	73.87	69	0.0319	30	14.08	73.15	0.08	0.42	0.95	
47	48	0.70	0.90	0.63	13.12	20.73	4.50	2.84	59.09	70.30	70.23	8	0.0079	36	8.36	59.09	0.02	1.00	1.00	
48	49	0.89	0.90	0.80	13.92	20.75	4.50	3.61	62.68	69.73	69.34	102	0.0039	42	6.51	62.68	0.26	1.00	1.00	
25	49	0.44	0.90	0.40	0.40	10.00	5.93	2.35	2.35	77.87	77.19	38	0.0180	12	6.02	4.76	0.11	0.49	0.99	
49	24	0.67	0.90	0.60	14.92	21.01	4.48	2.70	66.79	69.24	68.80	100	0.0044	42	6.94	66.79	0.24	1.00	1.00	
24	23	0.67	0.90	0.60	15.53	21.25	4.45	2.68	69.12	68.70	68.03	140	0.0047	42	7.18	69.12	0.32	1.00	1.00	
23	5-5	0.28	0.90	0.25	26.82	21.57	4.42	1.11	118.55	63.49	62.95	80	0.0068	48	9.43	118.55	0.14	1.00	1.00	SITE PIPE TO VDOT STRUCTURE 5-5
5-3	5-5	0.20	0.90	0.18	0.18	5.00	7.20	1.30	1.30	78.37	78.03	105	0.0032	15	2.65	3.66	0.66	0.35	0.89	PIPE FROM VDOT CALCS
5-5	5-6	MH-1	0.90	0.00	27.00	21.57	4.42	0.00	119.34	62.85	62.57	76	0.0037	54	7.50	119.34	0.17	1.00	1.00	DEL. VDOT 36" RCP FOR 48" RCP
5-2	5-6	0.32	0.90	0.29	2.14	9.83	6.22	1.79	13.22	77.85	76.00	265	0.0070	21	5.50	13.22	0.80	1.00	1.00	PIPE FROM VDOT CALCS
5-6	5-12	0.25	0.90	0.23	27.41	21.74	4.40	0.99	120.69	62.47	62.30	44	0.0038	54	7.59	120.69	0.10	1.00	1.00	NEW 48" OUTFALL - DEL. VDOT 36"RCP

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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 1

Drainage Calculations for - Large 15 ac Pond on which Pow Secondary Road is located

Powhatan Secondary South Extension and Powhatan Cluster Homes

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3. SCS Hydrograph and Storage Routing (Computer generated) (2 yr Freq.)	15-22	
4. SCS Hydrograph and Storage Routing - Standpipe operating - Computer Generated (100 yr Freq.)	23-32	
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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 1a

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11. Sta 16+65 Private Road - Culvert Design	48-49
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Subject: Pagan Method of Storage Routing for Exist Dam
Computed By: WCS Checked By: NHM

Project No. 7841
Client
Date 4/2/87 Sheet No. 2

TOTAL AREA DRAINING TO DAM = 121 AC. (BASIN "A")

PRE-DEV. "C" 0.53

POST-DEV. "C" 0.65

PRE-DEV. T_c =

1000' OVERLAND FLOW GRASS SURF.

Δ ELEV = 20'

T_c = 7 MIN X 2 = 14 MIN.

2400' IN NAT. BASIN - WELL DEF. CHANNEL

Δ ELEV = 26'

T_c = 18 MIN.

Σ T_c = 14 + 18 = 32 MIN.

POST DEV. T_c

ON SITE THRU COMM AREA L=1800'

ASSUME WITH PIPING AVG. VEL = 5'/SEC.

TIME = $\frac{(1800-5)}{60}$ = 6 MIN.

OFF SITE T_c = 14 MIN. (SEE ABOVE)

TOTAL T_c = 14 + 6 = 20 MIN.

PRE-DEV. Q_2

$Q = CAi$

$Q = (.53)(121)(2.5)$

$Q = 160.3$ CFS

POST DEV. Q_2

$Q = CAi$ 75

$Q = (.65)(121)(3.5)$

$Q = 275.3$ CFS (224)

590 CFS Not including lake

Weighted "C_x" Computations (Post Development)

	AC.	C	=
Commercial	37.2	.8	29.76
Townhomes	18.3	.6	10.98
ROW	6.4	.7	4.48
Recreational	11.4	.45	5.13
Apartments (EX)	1.7	.4	.68
" (Future)	2.3	.7	1.61
Offsite	25.0	.4	10.00
Church	3.5	.5	1.75
Lake	15.0	.9	13.50
			77.89

$\frac{77.89}{121} = .64$

Project No.
Client
Date
Sheet No. 3

Subject Inflow Hydrograph based on Peak Flow
Computed By
Checked By

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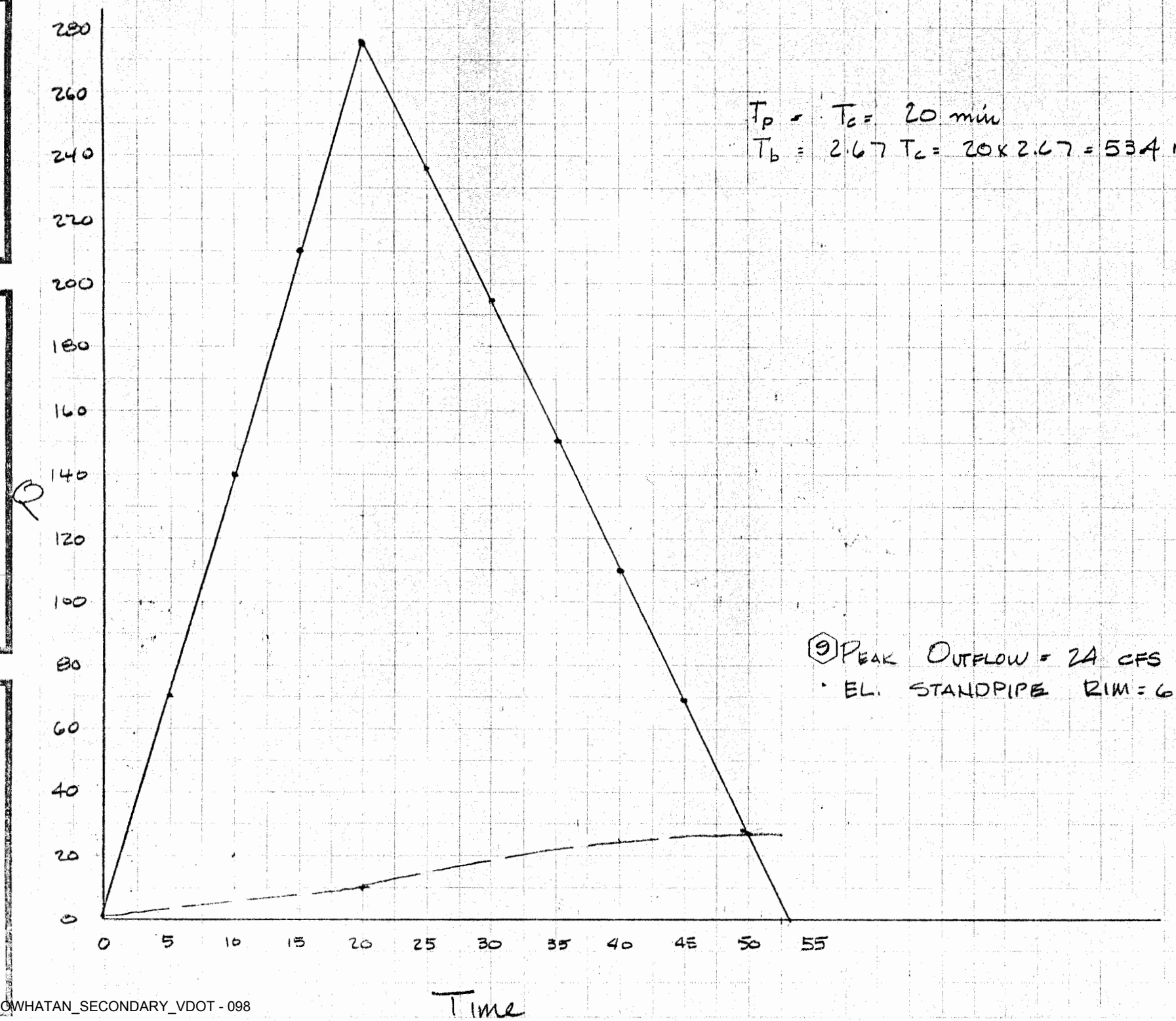

$T_p = T_c = 20$ min

$T_b = 2.67\ T_c = 20 \times 2.67 = 53.4$ min

(9) PEAK OUTFLOW = 24 CFS

EL. STANDPIPE RIM = 60.34

Project No. ____ Client ____ Date ____ Sheet No. 4

Subject ____ Computed By ____ Checked By ____

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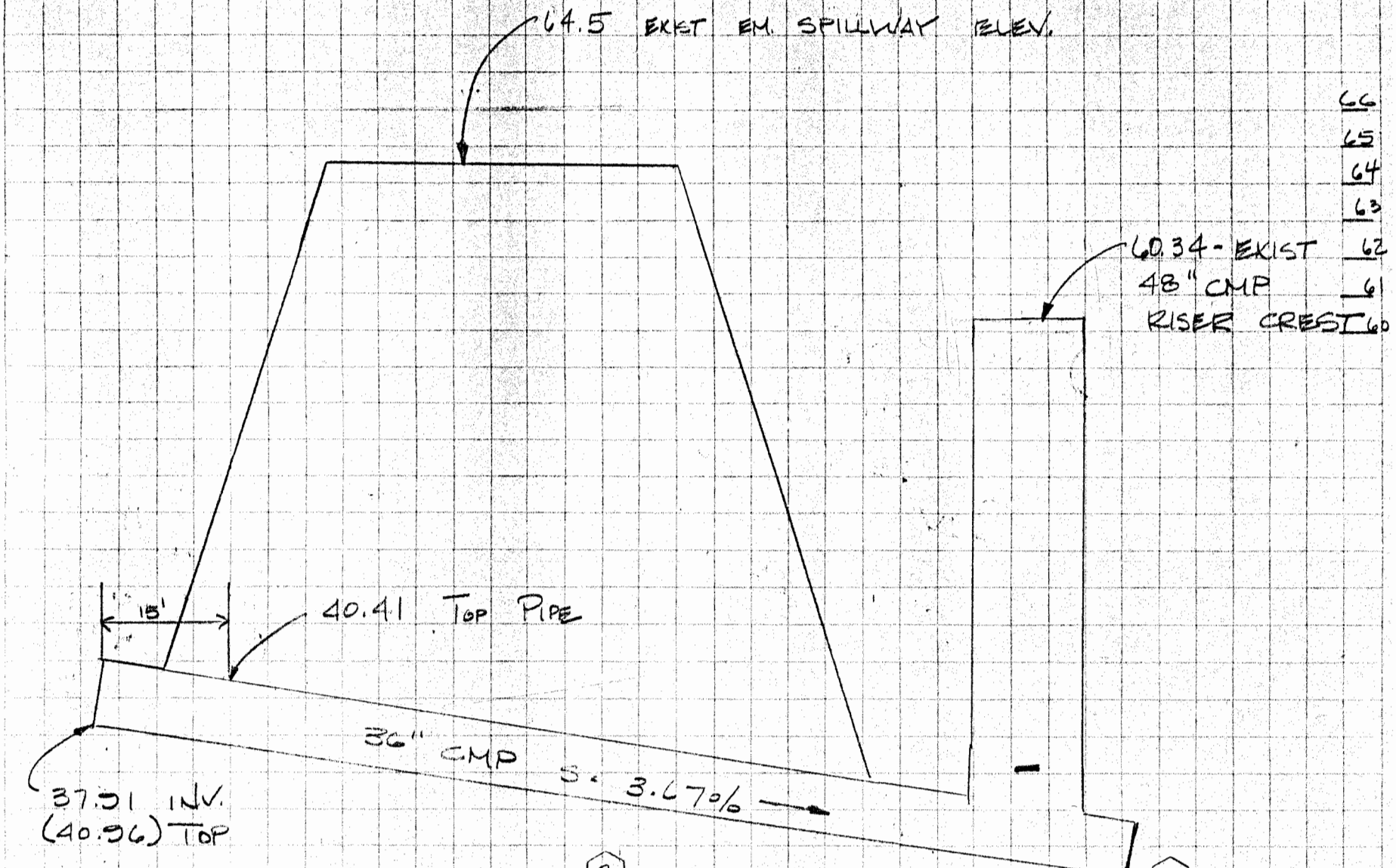
(2) BASED ON RISER INFLOW COMPUTATIONS
(3) BASED ON STORAGE BASIN COMPUTATIONS



ELEVATION	(2) OUTFLOW "O" (CFS)	(3) STORAGE (CU. FT.)
60.34	0	0
62.00	77	1,154,032
63.00	100	2,710,032
64.00	120	4,266,032
64.50		

1,932,032

Project No.
Client
Date
Sheet No. 15

Subject
Computed By
Checked By

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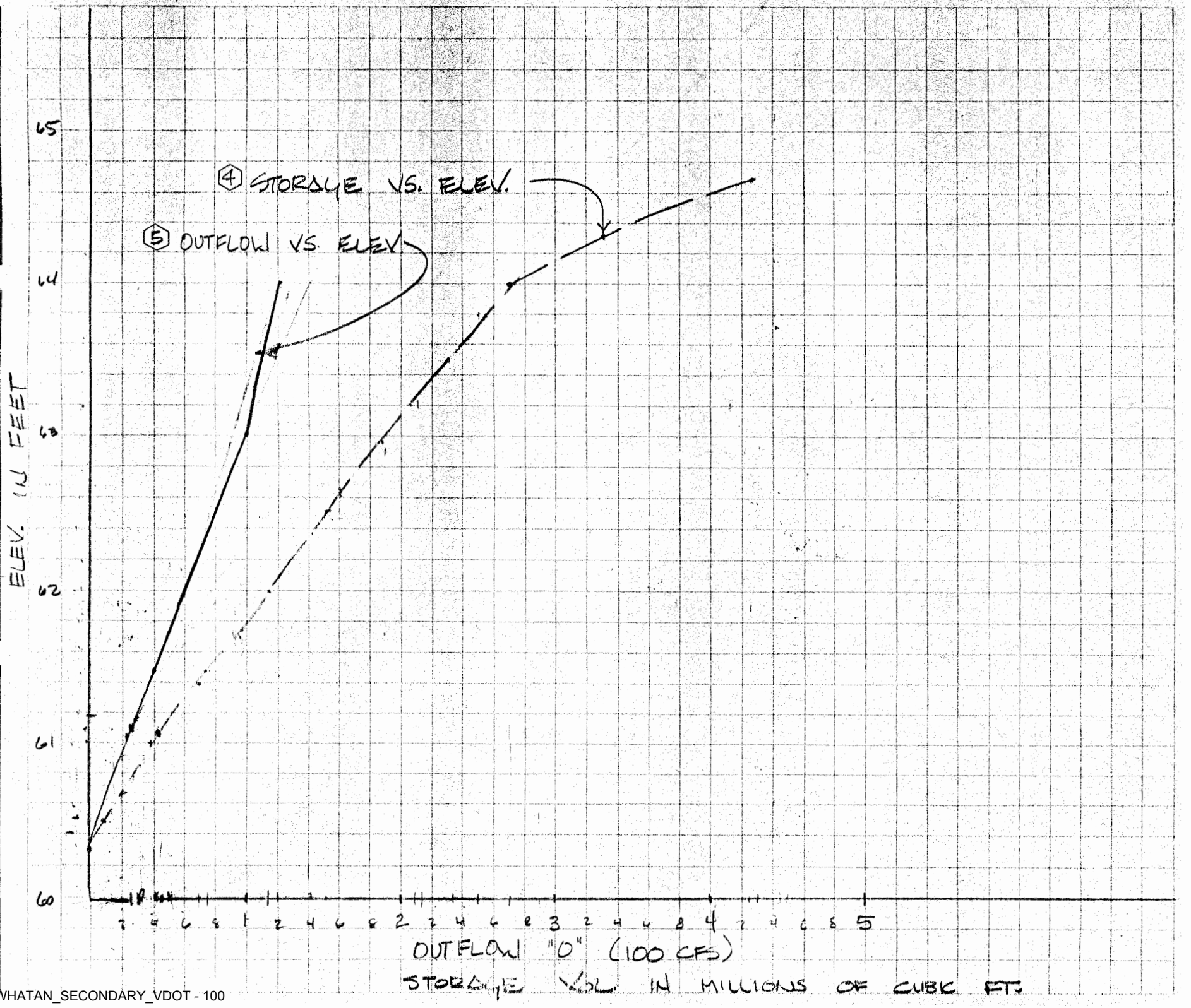

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Subject _____

Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 6

(6) CALCULATING 2S/t + "O" BASED ON Δt = 5 MIN = 300 SEC

(1) OUTFLOW "O"	(2) "S" (CU.FT.)	(3) 2S/t	(4) 2S/t + "O"
0	0	0	0
20	320,000	2133	2153
40	500,000	3333	3373
60	950,000	6333	6393
80	1200,000	8000	8080
100	1,400,000	9333	9433
120	1,600,000	10,667	10,787
140	1,850,000	12,333	12,473
160	2,050,000	13667	13,827
180	2,300,000	15333	15513
200	2,550,000	17,000	17,200
220	2,700,000	18,000	18,220
240	3,300,000	22,200	22,440
260	4,000,000	26,667	26,927

(8) ROUTING PROCEDURE

(1) TIME (MIN)	(2) INFLOW "I" (CFS)	(3) 2S/t - "O" (CFS)	(4) 2S/t + "O" (CFS)	(5) OUTFLOW (CFS)
0	0	0	0	0
5	70	68.7	70	.63
10	140	273.7	278.7	2.5
15	210	611.7	623.7	6
20	275	1076.7	1096.7	10
25	235	1556.7	1586.7	15
30	195	1950.7	1986.7	18
35	150	2250.7	2295.7	~~22.5~~ 21.1
40	110	2468.7	2510.7	~~25~~ 22.5
45	70	2585.7	2648.7	~~27.5~~ 23.7
50	27	2626.7	2682.7	28 24.
55	0	2629	2653.7	27.5 24.
60	0	2583	2629	23
65	0		2583	22.5
70	0			

PEAK OUTFLOW = ~~28~~ 24 CFS

2S/t = ~~2682.7~~ 2654.7 - ~~28~~ 24 = ~~2654.7~~ 2630.7

2S = 2630.7 × 300 = ~~398,205~~ 789,210

S = 394,105

FROM (4) ELEV. = 61.0

FROM (5) ELEV. = 61.2

Project No.
Client
Date
Sheet No. 7

Subject
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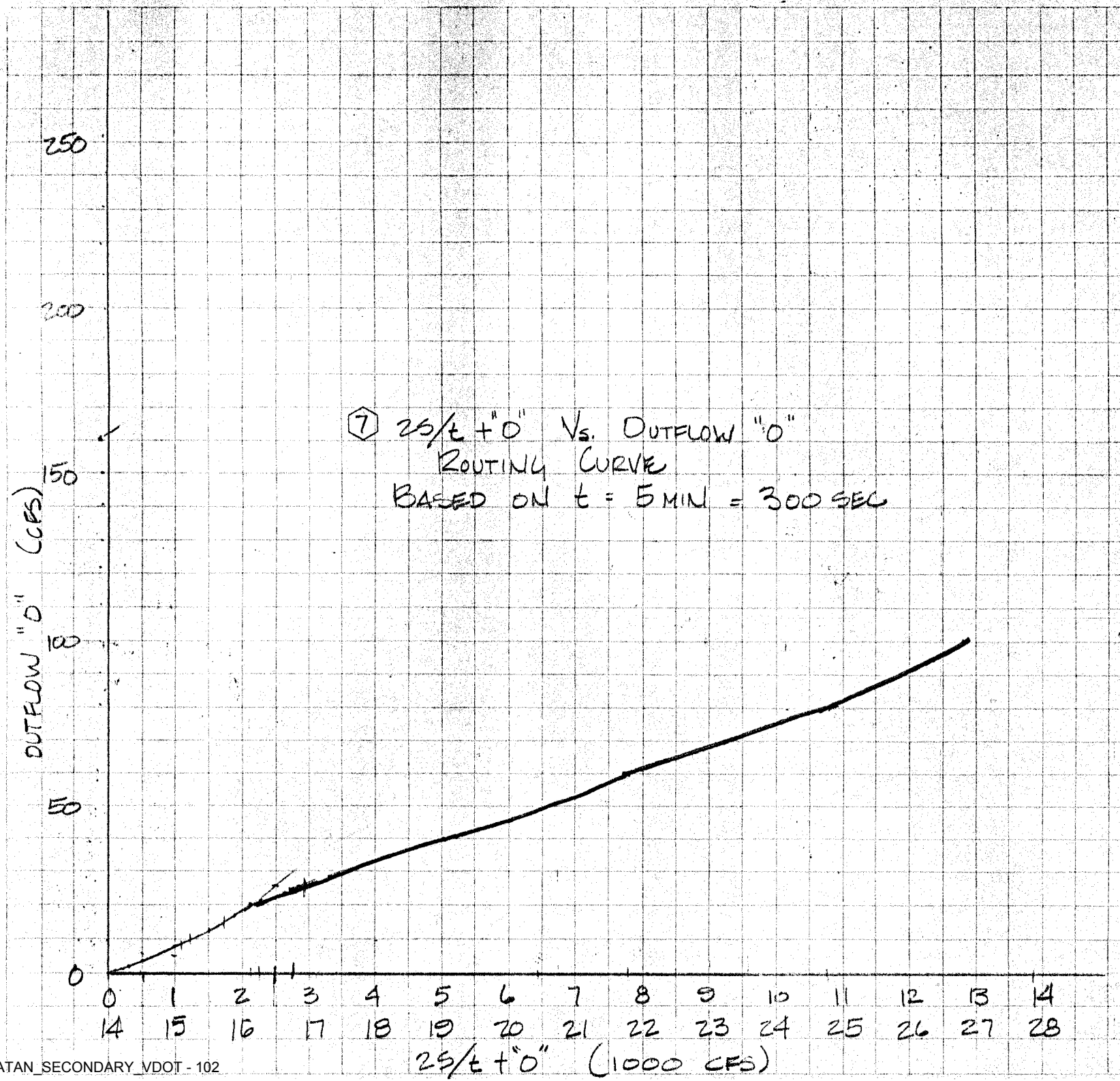

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Subject _____

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Project No. _____
Client _____
Date _____ Sheet No. 8

Using previous basin parameters check to see if outflow "O" and storage "S" will be increased or decreased when a storm having a duration of 60 min. occurrs.

For duration = 60 min ; I_2 = 1.6 in/hr.
Q_2 = .65 x 121 x 1.6 = 126 CFS

Δt = 10 min

$T_p = T_c$ = 20 min
Duration = 60 min
T_b = Duration + 1.67 T_p = 60 + (1.67 x 20) = 93 min

ELEV.	OUTFLOW (CFS)	STORAGE "S" (Cu Ft.)
60.34	0	0
62.00	65.2	1,154,032
64.00	99.3	2,710,032

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Subject _____
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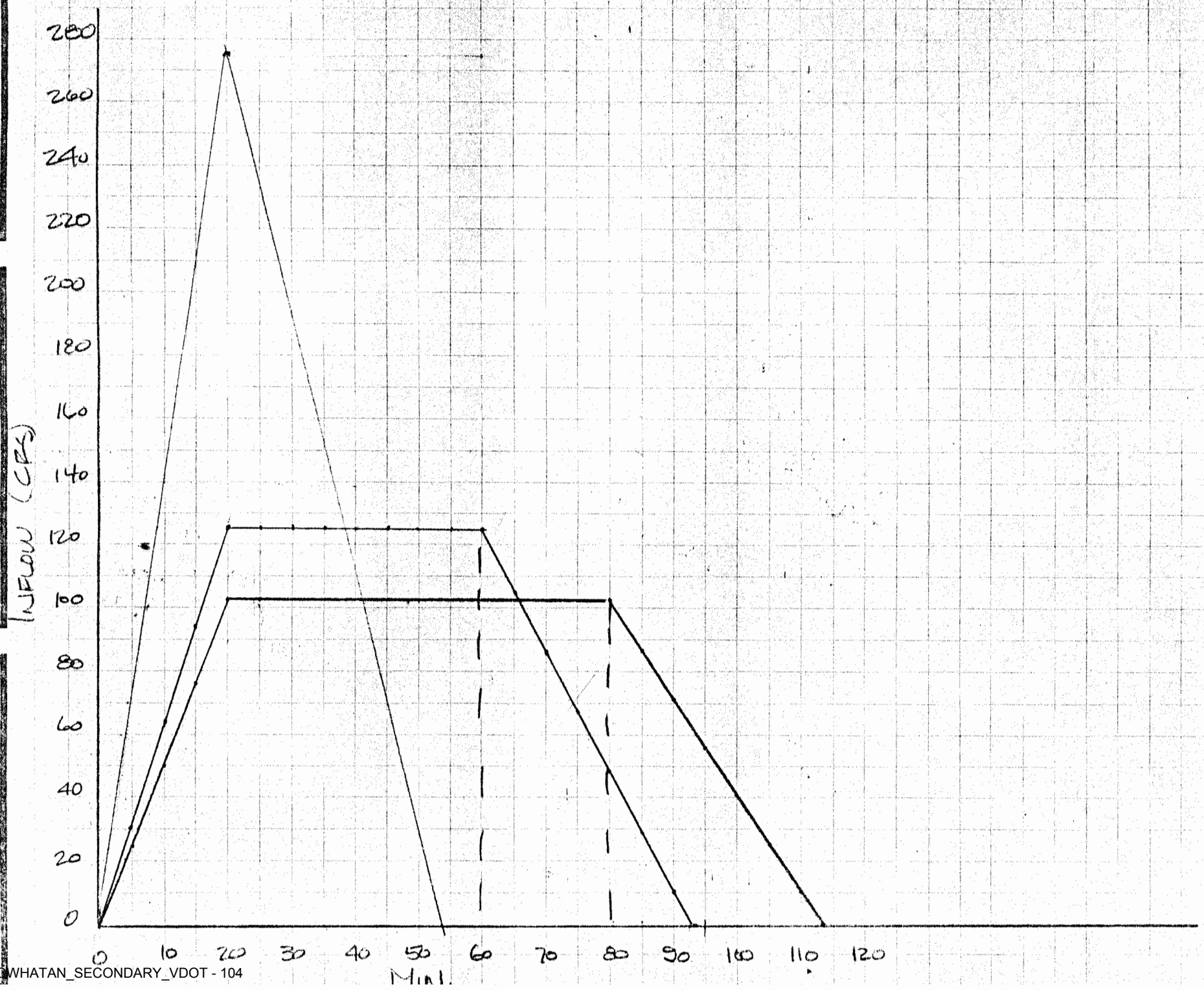
Project No. _____
Client _____
Date _____ Sheet No. 9



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Subject _____

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Project No. _____
Client _____
Date _____ Sheet No. 10

1 TIME (MIN)	2 INFLOW "I" (CFS)	3 2S/t - "O" (CFS)	4 2S/t + "O" (CFS)	5 OUTFLOW (CFS)
0	0	0	0	0
5	30	29.5	30	.25
10	65	122	124.5	1.25
15	95	277	282	2.5
20	125	487	497	5
25	125	723	737	7
30	125	955	973	9
35	125	1183	1205	11
40	125	1407	1433	13
45	125	1627	1657	15
50	125	1842	1877	17.5
55	125	2054	2092	19
60	125	2259	2304	22.5
65	105	2439	2489	25
70	87	2576	2631	27.5
75	67	2672	2730	29
80	48	2727	2787	30
85	30	2743	2805	31
90	10	2723	2783	30
95	0	2665	2733	29

+ ↑ t →

← Peak outflow = 31 CFS

2S/t = 2805 - 31
= 2774
2S = 2774 x 300
= 832,200
S = 416,100
EL = 61.15
EL = 61.1

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Subject _____

Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 11

Using previous basin parameters check to see if outflow "O" and storage "S" will be increased or decreased when a storm having a duration of 80 min occurs.

For duration = 80 min, I_2 = 1.3 in/hr.
Δt = 5 min $\quad O_2 = (.65)(121)(1.3) = 102$ cfs
$T_p = T_c$ = 20 min
Duration = 80 min
T_b = Duration + 1.67 T_p = 80 + (1.67 x 20) = 113.40 min

1 TIME (MIN)	2 INFLOW "I" (CFS)	3 2S/t - "O" (CFS)	4 2S/t + "O" (CFS)	5 OUTFLOW CFS
0	0	0	0	0
5	25	24.5	25	.25
10	50	97.0	99.5	1.25
15	75	218	222	2.0
20	102	387.5	395	3.75
25	102	581.3	591.5	5.1
30	102	770.3	785.3	7.5
35	102	956.8	974.3	8.75
40	102	1138.8	1160.8	11.0
45	102	1317.8	1342.8	12.5
50	102	1493.8	1521.8	14.0
55	102	1665.8	1697.8	16.0
60	102	1834.8	1869.8	17.5
65	102	2001	2038.8	19.0
70	102	2165	2205	20.0
75	102	2327	2369	21.1
80	102	2486	2531	22.5
85	87	2628	2675	23.7
90	72	2738	2786	24.5
95	57	2817	2867	25
100	40	2863	2913	25.1 — Peak
105	25	2878	2928	25.1
110	10	2868	2913	25.1
113	0		2873	25

Peak outflow = 25.1 cfs
2S/t = 2928 - 25.1 = 2903
2S = 2903 x 300 = 870,870
S = 435,435
EL = 61.1

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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
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SCS Curvilinear Hydrograph

$T_c = 1/3$ hours
$A = 121$ ac $= .1891$ mi^2

Calculate: Lag time $(L) = .6(T_c)$
Duration $(D) = 2/9(L)$ of the one inch excess precipitation
Peak Time $(T_p) = 5(D)$
Total Time $(T) = 5(T_p)$
Peak Q $(q_p) = \frac{484A}{T_p}$

$L = (.6)(.33) = .20$ hrs
$D = 2/9(.2) = .44$ hrs
$T_p = 5(.44) = .22$ hrs
$T = 1.11$ hrs
$q_p = \frac{484(.1891)}{.22} = 416$ CFS

SCS Triangular Hydrograph

$L = .6T_c = .20$ hours (.3)
$D = .4L = .08$ hours (.12)
$T_p = 3D = .24$ hours (.36)
$T = 8D = .64$ hours (.96)
$q_p = \frac{484A}{T_p} = 381$ CFS (254)

1	2	3	4
t (hrs)	t/T_p	q/q_p	q(cfs)
0	0	0	0
.08	1/3	1/3	126
.16	2/3	2/3	254
.24	1	1	381
.32	4/3	.8	305
.40	5/3	.6	229
.48	2	.4	152
.56	7/3	.2	76
.64	8/3	0	0

Project No.
Client
Date
Sheet No. 13

Subject
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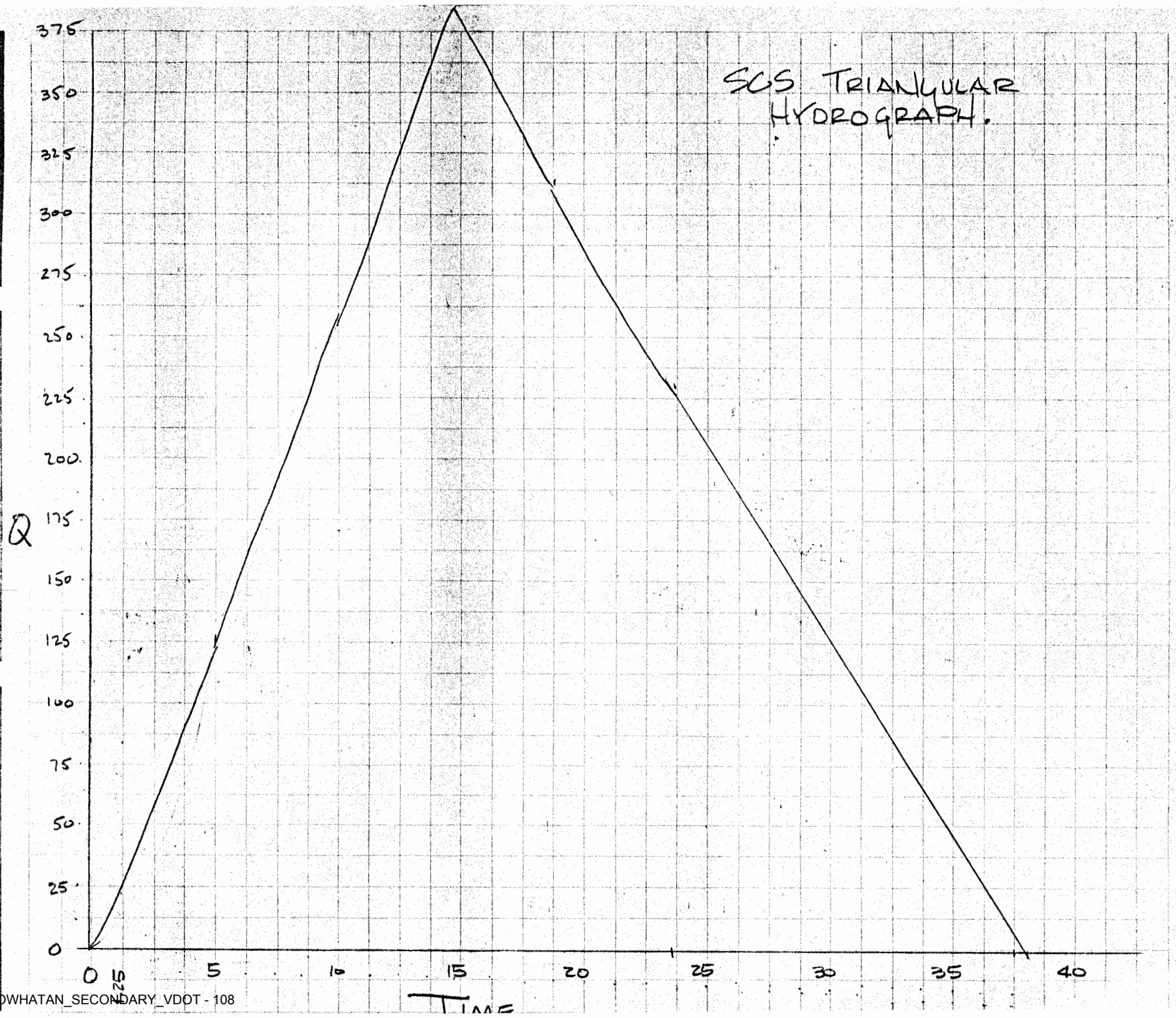

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Subject: Powhatan 15 Acre La

Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 14

Routing procedure using SCS Triangular Hydrograph

1	2	3	4	5
TIME (MIN)	INFLOW CFS	2S/t - "O" CFS	2S/t + "O" CFS	OUTFLOW CFS
0	0	0	0	0
5	125	122.5	125	1.25
10	255	492.5	502	5
15	381	1108.5	1128.5	10
20	305	1760.5	1794.5	17
25	229	2254.5	2294.5	20
30	152	2589.5	2635.5	23
35	76	2767.5	2817.5	25
40	0	2793.5	2843.5	25
45	0		2793.5	24
50				
55				
60				

Σ PEAK "O" = 25

2S/t = 2843.5 - 25
= 2818.5
2S = 845,550
S = 422,775

(5) EL = 61.1
(4) EL = 61.1

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WILLIAMSBURG, VIRGINIA
4/06/87

HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION 15 AC LAKE
BASIN DISCHARGES INTO POWHATAN CREEK

BASIN AREA	=	121.00	ACRES
BASIN CURVE NUMBER	=	89.00	
24-HOUR PRECIPITATION	=	3.75	INCHES
AVERAGE BASIN SLOPE	=	3.3	%
HYDRAULIC LENGTH	=	3300.0	FEET
BASIN LAG	=	.30	HOURS

HYDROGRAPH RUNOFF VALUES
2 YEAR STORM FREQUENCY

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
2.00	0.0	2.50	0.0	3.00	0.0	3.50	0.0
4.00	0.0	4.50	0.0	5.00	0.0	5.50	0.0
6.00	.3	6.50	.7	7.00	1.2	7.50	1.7
8.00	2.1	8.50	3.0	9.00	3.9	9.50	5.0
10.00	6.4	10.50	8.9	11.00	13.2	11.50	22.1
12.00	132.3	12.50	153.6	13.00	48.5	13.50	26.4
14.00	19.4	14.50	14.4	15.00	12.7	15.50	12.5
16.00	12.5	16.50	9.3	17.00	7.7	17.50	7.6
18.00	7.6	18.50	7.6	19.00	7.6	19.50	7.5
20.00	7.5	20.50	6.0	21.00	5.2	21.50	5.1
22.00	5.1	22.50	5.1	23.00	5.1	23.50	5.1
24.00	4.8	24.50	.7	25.00	.1	25.50	0.0
26.00	0.0	26.50	0.0	27.00	0.0	27.50	0.0

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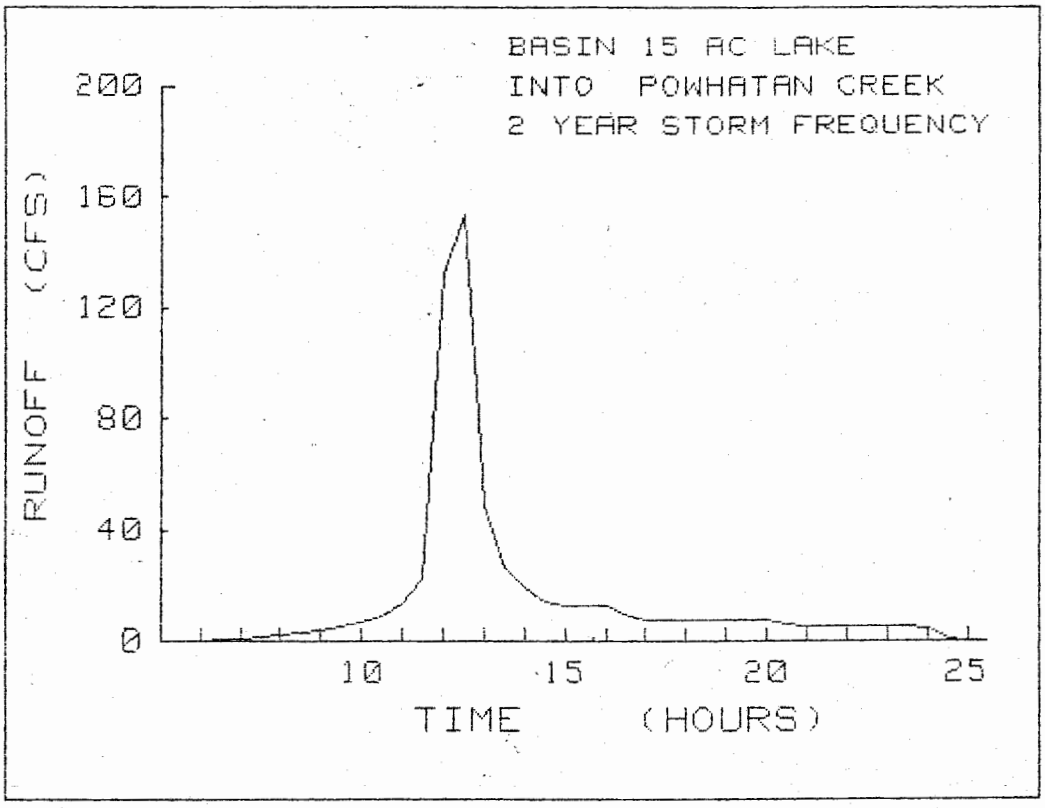

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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER 15 ACRE LAKE

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
60.3		653400.0		0.0	0.00
	1.7		1154032.0		
62.0		737000.0		1154032.0	77.00
	1.0		757500.0		
63.0		778000.0		1911532.0	100.00
	1.0		798500.0		
64.0		819000.0		2710032.0	140.00

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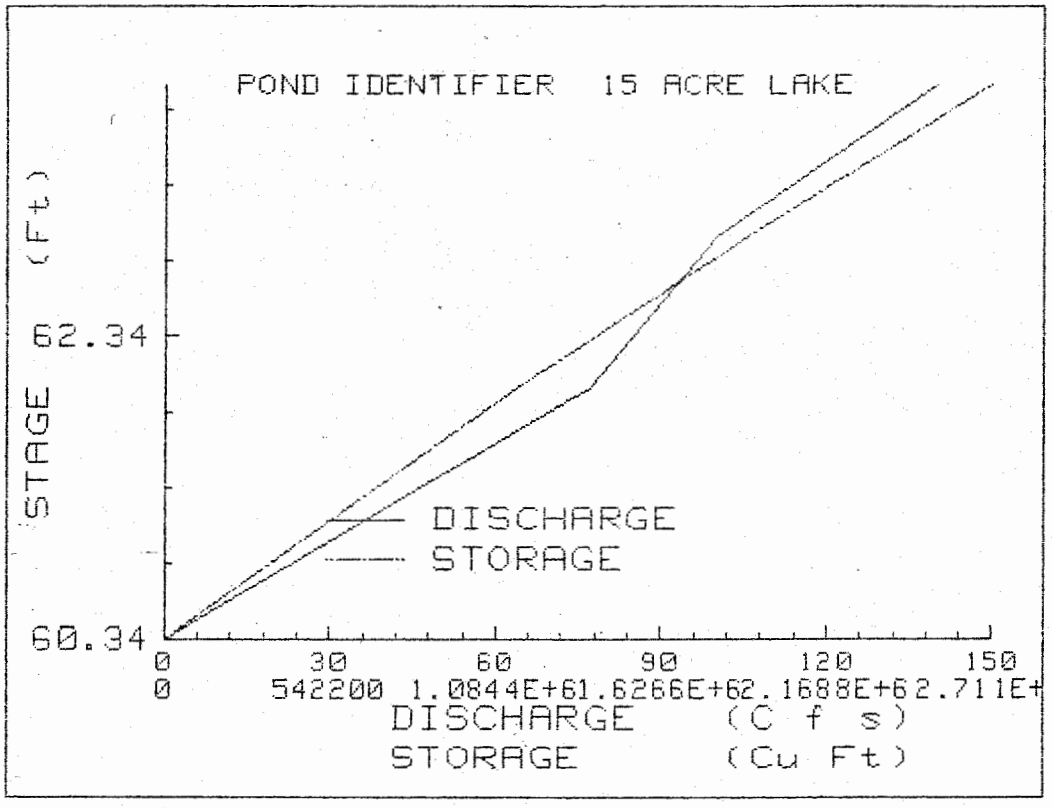
HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER 15 ACRE LAKE

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
60.3	0.0	0.0	0.0
62.0	1154032.0	77.0	1359.3
63.0	1911532.0	100.0	2223.9
64.0	2710032.0	140.0	3151.1

HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION



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HYDROLOGIC REPORT FOR
POWHATAN SECONDARY SOUTH EXTENSION
HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 ACRE LAKE
2 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
6.00	0.0	.3	0.0	0.0	.3	0.0	.3
6.50	.3	.7	.3	0.0	1.3	.1	1.2
7.00	.7	1.2	1.2	.1	3.1	.2	2.9
7.50	1.2	1.7	2.9	.2	5.7	.3	5.3
8.00	1.7	2.1	5.3	.3	8.7	.5	8.2
8.50	2.1	3.0	8.2	.5	12.8	.7	12.1
9.00	3.0	3.9	12.1	.7	18.3	1.0	17.2
9.50	3.9	5.0	17.2	1.0	25.1	1.4	23.6
10.00	5.0	6.4	23.6	1.4	33.7	1.9	31.8
10.50	6.4	8.9	31.8	1.9	45.2	2.6	42.6
11.00	8.9	13.2	42.6	2.6	62.1	3.5	58.6
11.50	13.2	22.1	58.6	3.5	90.3	5.1	85.1
12.00	22.1	132.3	85.1	5.1	234.4	13.3	221.1
12.50	132.3	153.6	221.1	13.3	493.7	28.0	465.8
13.00	153.6	48.5	465.8	28.0	639.9	36.2	603.6
13.50	48.5	26.4	603.6	36.2	642.3	36.4	605.9
14.00	26.4	19.4	605.9	36.4	615.4	34.9	580.5
14.50	19.4	14.4	580.5	34.9	579.4	32.8	546.6
15.00	14.4	12.7	546.6	32.8	540.8	30.6	510.2
15.50	12.7	12.5	510.2	30.6	504.7	28.6	476.1
16.00	12.5	12.5	476.1	28.6	472.6	26.8	445.9
16.50	12.5	9.3	445.9	26.8	440.9	25.0	416.0
17.00	9.3	7.7	416.0	25.0	408.0	23.1	384.9
17.50	7.7	7.6	384.9	23.1	377.1	21.4	355.7
18.00	7.6	7.6	355.7	21.4	349.5	19.8	329.7
18.50	7.6	7.6	329.7	19.8	325.1	18.4	306.7
19.00	7.6	7.6	306.7	18.4	303.4	17.2	286.2
19.50	7.6	7.5	286.2	17.2	284.1	16.1	268.0
20.00	7.5	7.5	268.0	16.1	267.0	15.1	251.9
20.50	7.5	6.0	251.9	15.1	250.3	14.2	236.1
21.00	6.0	5.2	236.1	14.2	233.1	13.2	219.9
21.50	5.2	5.1	219.9	13.2	216.9	12.3	204.6
22.00	5.1	5.1	204.6	12.3	202.5	11.5	191.1
22.50	5.1	5.1	191.1	11.5	189.8	10.8	179.0
23.00	5.1	5.1	179.0	10.8	178.4	10.1	168.3
23.50	5.1	5.1	168.3	10.1	168.3	9.5	158.8
24.00	5.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 ACRE LAKE
2 YEAR STORM FREQUENCY (CONT'D)

24.50	4.8	.7	150.2	9.0	146.7	8.3	138.4
25.00	.7	.1	138.4	8.3	130.8	7.4	123.4
25.50	.1	0.0	123.4	7.4	116.1	6.6	109.5
26.00	0.0	0.0	109.5	6.6	102.9	5.8	97.1
26.50	0.0	0.0	97.1	5.8	91.2	5.2	86.1
27.00	0.0	0.0	86.1	5.2	80.9	4.6	76.3
27.50	0.0	0.0	76.3	4.6	71.7	4.1	67.7
28.00	0.0	0.0	67.7	4.1	63.6	3.6	60.0
28.50	0.0	0.0	60.0	3.6	56.4	3.2	53.2
29.00	0.0	0.0	53.2	3.2	50.0	2.8	47.2
29.50	0.0	0.0	47.2	2.8	44.3	2.5	41.8
30.00	0.0	0.0	41.8	2.5	39.3	2.2	37.1
30.50	0.0	0.0	37.1	2.2	34.9	2.0	32.9
31.00	0.0	0.0	32.9	2.0	30.9	1.8	29.2
31.50	0.0	0.0	29.2	1.8	27.4	1.6	25.9
32.00	0.0	0.0	25.9	1.6	24.3	1.4	22.9
32.50	0.0	0.0	22.9	1.4	21.6	1.2	20.3
33.00	0.0	0.0	20.3	1.2	19.1	1.1	18.0
33.50	0.0	0.0	18.0	1.1	16.9	1.0	16.0
34.00	0.0	0.0	16.0	1.0	15.0	.9	14.2
34.50	0.0	0.0	14.2	.9	13.3	.8	12.6
35.00	0.0	0.0	12.6	.8	11.8	.7	11.1
35.50	0.0	0.0	11.1	.7	10.5	.6	9.9
36.00	0.0	0.0	9.9	.6	9.3	.5	8.8
36.50	0.0	0.0	8.8	.5	8.2	.5	7.8
37.00	0.0	0.0	7.8	.5	7.3	.4	6.9
37.50	0.0	0.0	6.9	.4	6.5	.4	6.1
38.00	0.0	0.0	6.1	.4	5.7	.3	5.4
38.50	0.0	0.0	5.4	.3	5.1	.3	4.8
39.00	0.0	0.0	4.8	.3	4.5	.3	4.3
39.50	0.0	0.0	4.3	.3	4.0	.2	3.8
40.00	0.0	0.0	3.8	.2	3.5	.2	3.3
40.50	0.0	0.0	3.3	.2	3.1	.2	3.0
41.00	0.0	0.0	3.0	.2	2.8	.2	2.6
41.50	0.0	0.0	2.6	.2	2.5	.1	2.3
42.00	0.0	0.0	2.3	.1	2.2	.1	2.1
42.50	0.0	0.0	2.1	.1	1.9	.1	1.8
43.00	0.0	0.0	1.8	.1	1.7	.1	1.6
43.50	0.0	0.0	1.6	.1	1.5	.1	1.4
44.00	0.0	0.0	1.4	.1	1.4	.1	1.3

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WILLIAMSBURG, VIRGINIA
4/06/87

HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 ACRE LAKE
2 YEAR STORM FREQUENCY (CONT'D)

44.50	0.0	0.0	1.3	.1	1.2	.1	1.1
45.00	0.0	0.0	1.1	.1	1.1	.1	1.0
45.50	0.0	0.0	1.0	.1	.9	.1	.9
46.00	0.0	0.0	.9	.1	.8	0.0	.8

MAXIMUM OUTFLOW = 36.4 C.F.S.
MAXIMUM STORAGE = 545348.1 CU FT.
MAXIMUM ELEVATION = 61.1 FEET

LANGLEY & McDONALD, P.C.
WILLIAMSBURG, VIRGINIA
4/28/87

HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION 15 AC LAKE
BASIN DISCHARGES INTO POWHATAN CREEK

BASIN AREA	=	121.00	ACRES
BASIN CURVE NUMBER	=	89.00	
24-HOUR PRECIPITATION	=	8.50	INCHES
AVERAGE BASIN SLOPE	=	3.3	%
HYDRAULIC LENGTH	=	3300.0	FEET
BASIN LAG	=	.30	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY
W/ STANDPIPE OPERATING

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
0.00	0.0	.50	0.0	1.00	0.0	1.50	0.0
2.00	0.0	2.50	0.0	3.00	.2	3.50	1.1
4.00	2.1	4.50	3.5	5.00	4.8	5.50	5.9
6.00	6.8	6.50	8.8	7.00	10.5	7.50	11.4
8.00	12.2	8.50	16.0	9.00	18.5	9.50	21.9
10.00	26.2	10.50	33.6	11.00	46.5	11.50	72.5
12.00	375.6	12.50	397.3	13.00	121.4	13.50	65.0
14.00	47.5	14.50	35.0	15.00	30.8	15.50	30.4
16.00	30.4	16.50	22.6	17.00	18.6	17.50	18.3
18.00	18.3	18.50	18.3	19.00	18.3	19.50	18.3
20.00	18.3	20.50	14.4	21.00	12.4	21.50	12.2
22.00	12.2	22.50	12.2	23.00	12.2	23.50	12.2
24.00	11.6	24.50	1.7	25.00	.1	25.50	0.0
26.00	0.0	26.50	0.0	27.00	0.0	27.50	0.0

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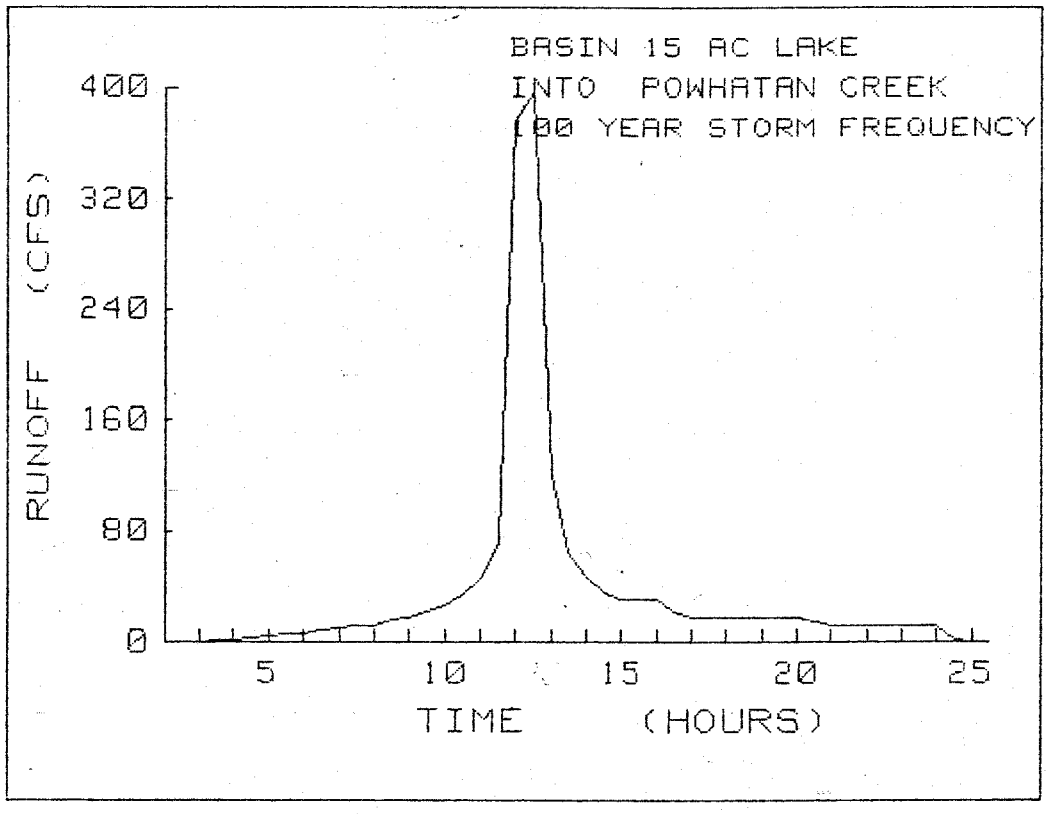
HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION



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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER 15 AC LAKE

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
60.3		653400.0		0.0	0.00
	1.7		1181840.0		
62.0		737000.0		1181840.0	77.00
	1.0		757500.0		
63.0		778000.0		1939340.0	100.00

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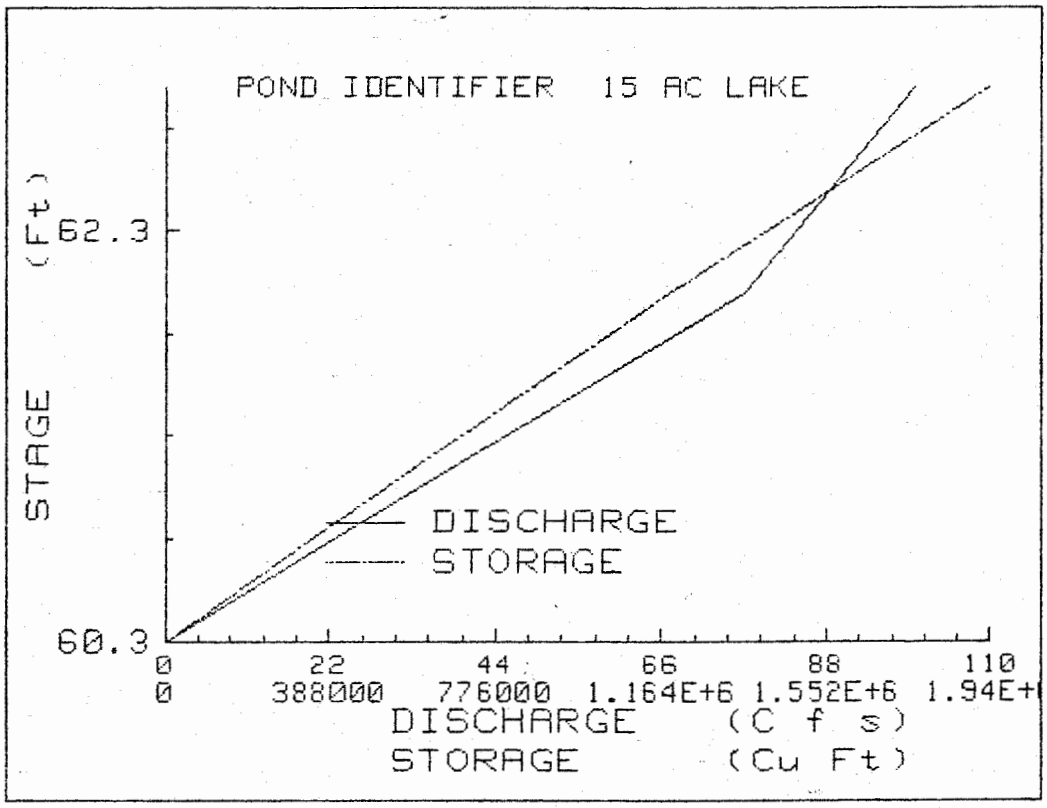
HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER 15 AC LAKE

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
60.3	0.0	0.0	0.0
62.0	1181840.0	77.0	1390.2
63.0	1939340.0	100.0	2254.8

HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION



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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	O1	2S2/T +O2	O2	2S2/T
3.00	0.0	.2	0.0	0.0	.2	0.0	.2
3.50	.2	1.1	.2	0.0	1.5	.1	1.4
4.00	1.1	2.1	1.4	.1	4.5	.3	4.3
4.50	2.1	3.5	4.3	.3	9.6	.5	9.1
5.00	3.5	4.8	9.1	.5	16.9	.9	15.9
5.50	4.8	5.9	15.9	.9	25.7	1.4	24.3
6.00	5.9	6.8	24.3	1.4	35.5	2.0	33.5
6.50	6.8	8.8	33.5	2.0	47.1	2.6	44.5
7.00	8.8	10.5	44.5	2.6	61.2	3.4	57.8
7.50	10.5	11.4	57.8	3.4	76.3	4.2	72.1
8.00	11.4	12.2	72.1	4.2	91.5	5.1	86.4
8.50	12.2	16.0	86.4	5.1	109.6	6.1	103.5
9.00	16.0	18.5	103.5	6.1	131.9	7.3	124.5
9.50	18.5	21.9	124.5	7.3	157.6	8.7	148.9
10.00	21.9	26.2	148.9	8.7	188.3	10.4	177.8
10.50	26.2	33.6	177.8	10.4	227.2	12.6	214.6
11.00	33.6	46.5	214.6	12.6	282.2	15.6	266.5
11.50	46.5	72.5	266.5	15.6	369.8	20.5	349.3
12.00	72.5	375.6	349.3	20.5	777.0	43.0	733.9
12.50	375.6	397.3	733.9	43.0	1463.9	79.0	1384.9
13.00	397.3	121.4	1384.9	79.0	1824.6	88.6	1736.1
13.50	121.4	65.0	1736.1	88.6	1833.8	88.8	1745.0
14.00	65.0	47.5	1745.0	88.8	1768.6	87.1	1681.6
14.50	47.5	35.0	1681.6	87.1	1677.0	84.6	1592.4
15.00	35.0	30.8	1592.4	84.6	1573.5	81.9	1491.7
15.50	30.8	30.4	1491.7	81.9	1471.0	79.2	1391.9
16.00	30.4	30.4	1391.9	79.2	1373.6	76.1	1297.5
16.50	30.4	22.6	1297.5	76.1	1274.4	70.6	1203.8
17.00	22.6	18.6	1203.8	70.6	1174.5	65.1	1109.4
17.50	18.6	18.3	1109.4	65.1	1081.3	59.9	1021.4
18.00	18.3	18.3	1021.4	59.9	998.2	55.3	942.9
18.50	18.3	18.3	942.9	55.3	924.2	51.2	873.0
19.00	18.3	18.3	873.0	51.2	858.4	47.5	810.8
19.50	18.3	18.3	810.8	47.5	799.8	44.3	755.5
20.00	18.3	18.3	755.5	44.3	747.0	41.4	706.3

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21.00	14.4	12.4	658.9	38.6	647.1	35.8	611.2

LANGLEY & McDONALD, P.C.
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HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

21.50	12.4	12.2	611.2	35.8	600.0	33.2	566.8
22.00	12.2	12.2	566.8	33.2	558.0	30.9	527.1
22.50	12.2	12.2	527.1	30.9	520.7	28.8	491.8
23.00	12.2	12.2	491.8	28.8	487.4	27.0	460.4
23.50	12.2	12.2	460.4	27.0	457.8	25.4	432.5
24.00	12.2	11.6	432.5	25.4	430.9	23.9	407.0
24.50	11.6	1.7	407.0	23.9	396.4	22.0	374.5
25.00	1.7	.1	374.5	22.0	354.3	19.6	334.7
25.50	.1	0.0	334.7	19.6	315.2	17.5	297.7
26.00	0.0	0.0	297.7	17.5	280.3	15.5	264.7
26.50	0.0	0.0	264.7	15.5	249.2	13.8	235.4
27.00	0.0	0.0	235.4	13.8	221.6	12.3	209.3
27.50	0.0	0.0	209.3	12.3	197.1	10.9	186.1
28.00	0.0	0.0	186.1	10.9	175.2	9.7	165.5
28.50	0.0	0.0	165.5	9.7	155.8	8.6	147.2
29.00	0.0	0.0	147.2	8.6	138.6	7.7	130.9
29.50	0.0	0.0	130.9	7.7	123.2	6.8	116.4
30.00	0.0	0.0	116.4	6.8	109.6	6.1	103.5
30.50	0.0	0.0	103.5	6.1	97.4	5.4	92.0
31.00	0.0	0.0	92.0	5.4	86.6	4.8	81.8
31.50	0.0	0.0	81.8	4.8	77.0	4.3	72.8
32.00	0.0	0.0	72.8	4.3	68.5	3.8	64.7
32.50	0.0	0.0	64.7	3.8	60.9	3.4	57.5
33.00	0.0	0.0	57.5	3.4	54.2	3.0	51.2
33.50	0.0	0.0	51.2	3.0	48.2	2.7	45.5
34.00	0.0	0.0	45.5	2.7	42.8	2.4	40.5
34.50	0.0	0.0	40.5	2.4	38.1	2.1	36.0
35.00	0.0	0.0	36.0	2.1	33.9	1.9	32.0
35.50	0.0	0.0	32.0	1.9	30.1	1.7	28.4
36.00	0.0	0.0	28.4	1.7	26.8	1.5	25.3
36.50	0.0	0.0	25.3	1.5	23.8	1.3	22.5
37.00	0.0	0.0	22.5	1.3	21.2	1.2	20.0
37.50	0.0	0.0	20.0	1.2	18.8	1.0	17.8
38.00	0.0	0.0	17.8	1.0	16.7	.9	15.8
38.50	0.0	0.0	15.8	.9	14.9	.8	14.1
39.00	0.0	0.0	14.1	.8	13.2	.7	12.5
39.50	0.0	0.0	12.5	.7	11.8	.7	11.1
40.00	0.0	0.0	11.1	.7	10.5	.6	9.9
40.50	0.0	0.0	9.9	.6	9.3	.5	8.8
41.00	0.0	0.0	8.8	.5	8.3	.5	7.8

LANGLEY & McDONALD, P.C.
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HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

41.50	0.0	0.0	7.8	.5	7.4	.4	7.0
42.00	0.0	0.0	7.0	.4	6.5	.4	6.2
42.50	0.0	0.0	6.2	.4	5.8	.3	5.5
43.00	0.0	0.0	5.5	.3	5.2	.3	4.9
43.50	0.0	0.0	4.9	.3	4.6	.3	4.3
44.00	0.0	0.0	4.3	.3	4.1	.2	3.9
44.50	0.0	0.0	3.9	.2	3.6	.2	3.4
45.00	0.0	0.0	3.4	.2	3.2	.2	3.1
45.50	0.0	0.0	3.1	.2	2.9	.2	2.7
46.00	0.0	0.0	2.7	.2	2.6	.1	2.4
46.50	0.0	0.0	2.4	.1	2.3	.1	2.1
47.00	0.0	0.0	2.1	.1	2.0	.1	1.9
47.50	0.0	0.0	1.9	.1	1.8	.1	1.7
48.00	0.0	0.0	1.7	.1	1.6	.1	1.5
48.50	0.0	0.0	1.5	.1	1.4	.1	1.3
49.00	0.0	0.0	1.3	.1	1.3	.1	1.2
49.50	0.0	0.0	1.2	.1	1.1	.1	1.1
50.00	0.0	0.0	1.1	.1	1.0	.1	.9
50.50	0.0	0.0	.9	.1	.9	0.0	.8

MAXIMUM OUTFLOW = 88.8 C.F.S.
MAXIMUM STORAGE = 1570511.9 CU FT.
MAXIMUM ELEVATION = 62.5 FEET

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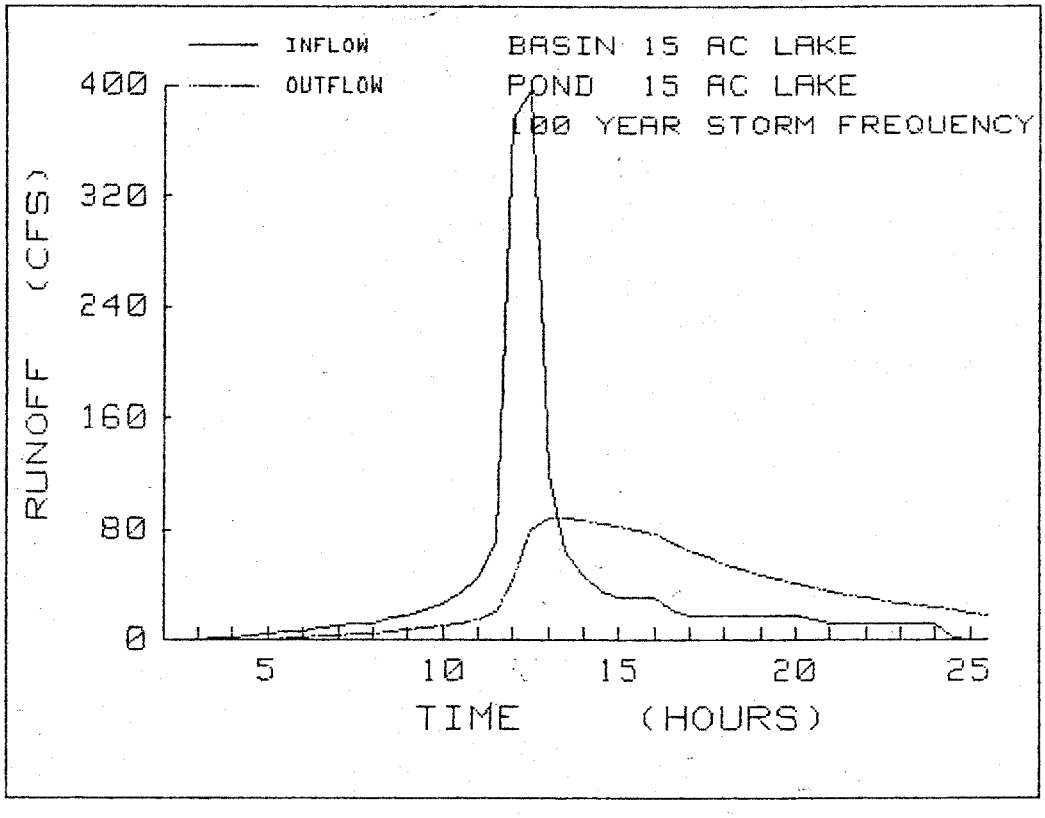
HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION



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4/28/87

HYDROLOGIC REPORT FOR

POWHATAN SECONDARY SOUTH EXTENSION

S. C. S. HYDROGRAPH

BASIN IDENTIFICATION 15 AC. LAKE
BASIN DISCHARGES INTO POWHATAN CREEK

BASIN AREA	=	121.00	ACRES
BASIN CURVE NUMBER	=	89.00	
24-HOUR PRECIPITATION	=	8.50	INCHES
AVERAGE BASIN SLOPE	=	3.3	%
HYDRAULIC LENGTH	=	3300.0	FEET
BASIN LAG	=	.30	HOURS

HYDROGRAPH RUNOFF VALUES
100 YEAR STORM FREQUENCY
STAND PIPE NOT OPERATING - EM. SPILLWAY OPERATING

TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.	TIME HOUR	RUNOFF C.F.S.
0.00	0.0	.50	0.0	1.00	0.0	1.50	0.0
2.00	0.0	2.50	0.0	3.00	.2	3.50	1.1
4.00	2.1	4.50	3.5	5.00	4.8	5.50	5.9
6.00	6.8	6.50	8.8	7.00	10.5	7.50	11.4
8.00	12.2	8.50	16.0	9.00	18.5	9.50	21.9
10.00	26.2	10.50	33.6	11.00	46.5	11.50	72.5
12.00	375.6	12.50	397.3	13.00	121.4	13.50	65.0
14.00	47.5	14.50	35.0	15.00	30.8	15.50	30.4
16.00	30.4	16.50	22.6	17.00	18.6	17.50	18.3
18.00	18.3	18.50	18.3	19.00	18.3	19.50	18.3
20.00	18.3	20.50	14.4	21.00	12.4	21.50	12.2
22.00	12.2	22.50	12.2	23.00	12.2	23.50	12.2
24.00	11.6	24.50	1.7	25.00	.1	25.50	0.0
26.00	0.0	26.50	0.0	27.00	0.0	27.50	0.0

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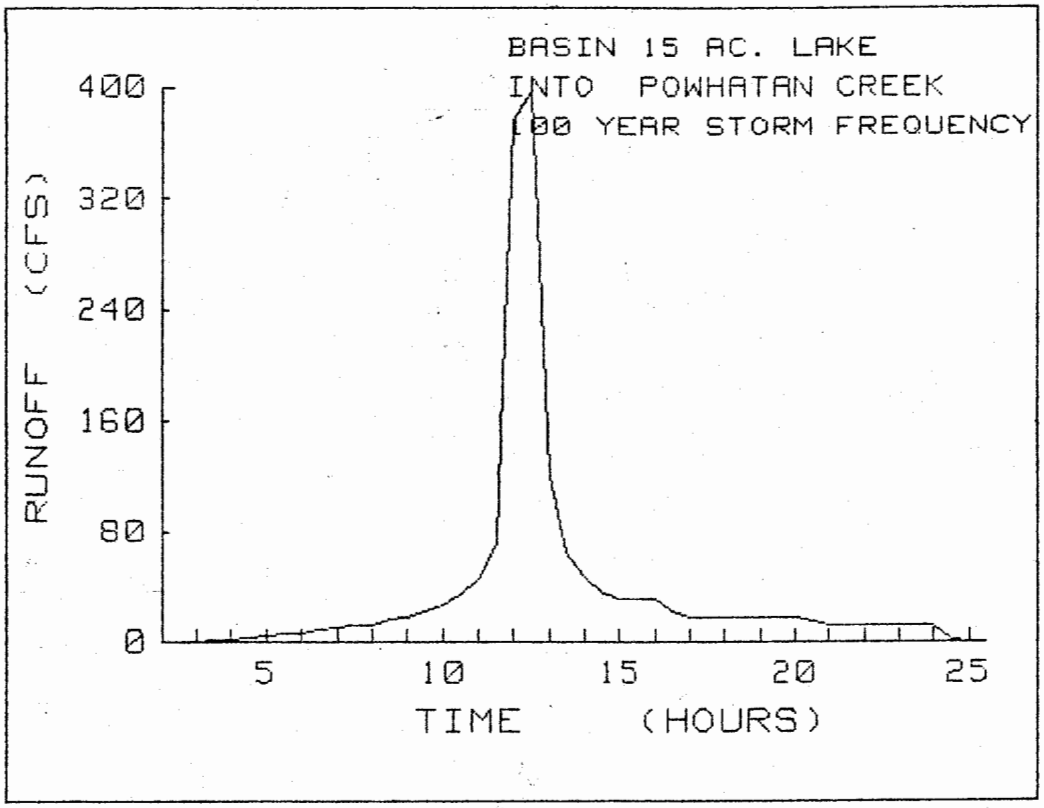

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4/28/87

HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

POND DEPTH VS STORAGE PROVIDED

POND IDENTIFIER 15 AC LAKE

ELEV feet	DEPTH feet	AREA sq.ft.	VOLUME cu.ft.	SUM VOL cu.ft.	OUTFLOW c.f.s.
60.3		653400.0		0.0	0.00
	1.7		1181840.0		
62.0		737000.0		1181840.0	0.00
	1.0		757500.0		
63.0		778000.0		1939340.0	0.00
	1.0		798500.0		
64.0		819000.0		2737840.0	0.00
	.6		491400.0		
64.6		819000.0		3229240.0	8.10
	.1		81900.0		
64.7		819000.0		3311140.0	22.92

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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

STAGE, STORAGE & DISCHARGE

POND IDENTIFIER 15 AC LAKE

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
60.3	0.0	0.0	0.0
62.0	1181840.0	0.0	1313.2
63.0	1939340.0	0.0	2154.8
64.0	2737840.0	0.0	3042.0
64.6	3229240.0	8.1	3596.1
64.7	3311140.0	22.9	3702.0

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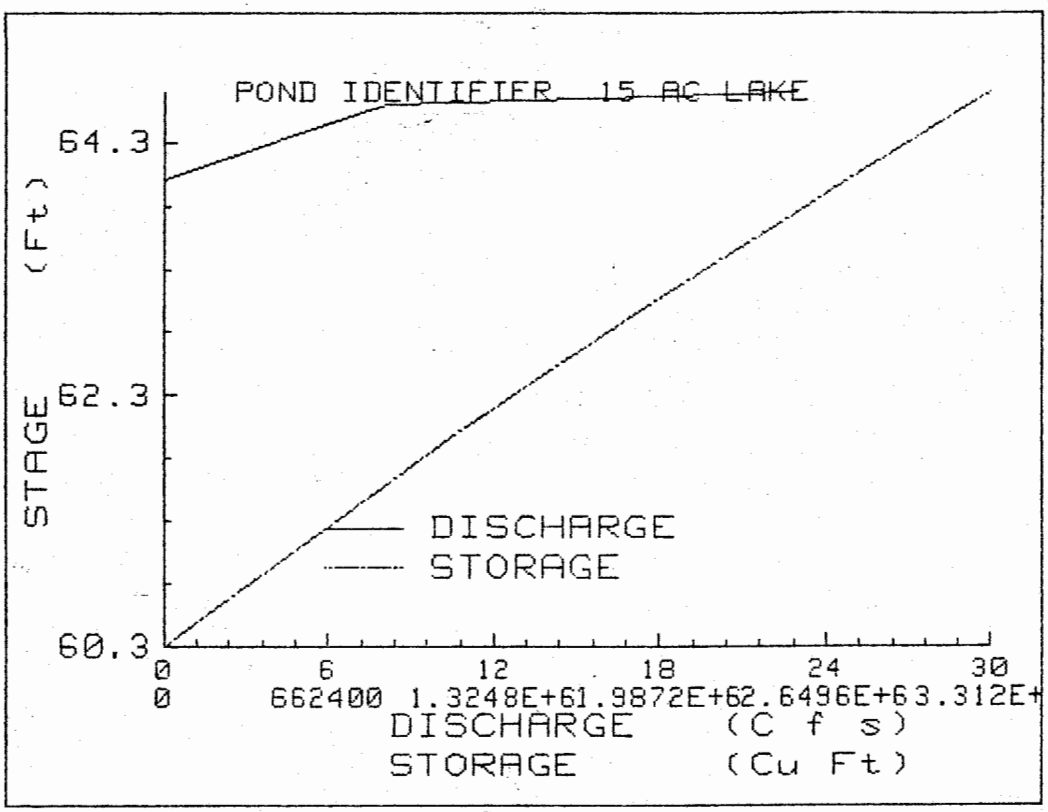

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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

HYDROGRAPH RESERVOIR ROUTING

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY

T	I1	I2	2S1/T	01	2S2/T +02	02	2S2/T
3.00	0.0	.2	0.0	0.0	.2	0.0	.2
3.50	.2	1.1	.2	0.0	1.5	0.0	1.5
4.00	1.1	2.1	1.5	0.0	4.7	0.0	4.7
4.50	2.1	3.5	4.7	0.0	10.3	0.0	10.3
5.00	3.5	4.8	10.3	0.0	18.6	0.0	18.6
5.50	4.8	5.9	18.6	0.0	29.3	0.0	29.3
6.00	5.9	6.8	29.3	0.0	41.9	0.0	41.9
6.50	6.8	8.8	41.9	0.0	57.5	0.0	57.5
7.00	8.8	10.5	57.5	0.0	76.8	0.0	76.8
7.50	10.5	11.4	76.8	0.0	98.7	0.0	98.7
8.00	11.4	12.2	98.7	0.0	122.4	0.0	122.4
8.50	12.2	16.0	122.4	0.0	150.6	0.0	150.6
9.00	16.0	18.5	150.6	0.0	185.0	0.0	185.0
9.50	18.5	21.9	185.0	0.0	225.4	0.0	225.4
10.00	21.9	26.2	225.4	0.0	273.4	0.0	273.4
10.50	26.2	33.6	273.4	0.0	333.3	0.0	333.3
11.00	33.6	46.5	333.3	0.0	413.4	0.0	413.4
11.50	46.5	72.5	413.4	0.0	532.3	0.0	532.3
12.00	72.5	375.6	532.3	0.0	980.4	0.0	980.4
12.50	375.6	397.3	980.4	0.0	1753.4	0.0	1753.4
13.00	397.3	121.4	1753.4	0.0	2272.0	0.0	2272.0
13.50	121.4	65.0	2272.0	0.0	2458.4	0.0	2458.4
14.00	65.0	47.5	2458.4	0.0	2570.8	0.0	2570.8
14.50	47.5	35.0	2570.8	0.0	2653.3	0.0	2653.3
15.00	35.0	30.8	2653.3	0.0	2719.1	0.0	2719.1
15.50	30.8	30.4	2719.1	0.0	2780.3	0.0	2780.3
16.00	30.4	30.4	2780.3	0.0	2841.2	0.0	2841.2
16.50	30.4	22.6	2841.2	0.0	2894.2	0.0	2894.2
17.00	22.6	18.6	2894.2	0.0	2935.4	0.0	2935.4
17.50	18.6	18.3	2935.4	0.0	2972.4	0.0	2972.4
18.00	18.3	18.3	2972.4	0.0	3009.0	0.0	3009.0
18.50	18.3	18.3	3009.0	0.0	3045.6	.1	3045.5
19.00	18.3	18.3	3045.5	.1	3082.1	.6	3081.5
19.50	18.3	18.3	3081.5	.6	3117.5	1.1	3116.3
20.00	18.3	18.3	3116.3	1.1	3151.8	1.6	3150.2
20.50	18.3	14.4	3150.2	1.6	3181.2	2.0	3179.2

21.00	14.4	12.4	3179.2	2.0	3203.9	2.4	3201.6

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4/28/87

HYDROLOGIC REPORT FOR
POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

21.50	12.4	12.2	3201.6	2.4	3223.8	2.7	3221.2
22.00	12.2	12.2	3221.2	2.7	3243.0	2.9	3240.1
22.50	12.2	12.2	3240.1	2.9	3261.6	3.2	3258.4
23.00	12.2	12.2	3258.4	3.2	3279.6	3.5	3276.1
23.50	12.2	12.2	3276.1	3.5	3297.0	3.7	3293.3
24.00	12.2	11.6	3293.3	3.7	3313.4	4.0	3309.4
24.50	11.6	1.7	3309.4	4.0	3318.7	4.0	3314.6
25.00	1.7	.1	3314.6	4.0	3312.4	4.0	3308.5
25.50	.1	0.0	3308.5	4.0	3304.6	3.8	3300.8
26.00	0.0	0.0	3300.8	3.8	3297.0	3.7	3293.2
26.50	0.0	0.0	3293.2	3.7	3289.5	3.6	3285.9
27.00	0.0	0.0	3285.9	3.6	3282.3	3.5	3278.8
27.50	0.0	0.0	3278.8	3.5	3275.2	3.4	3271.8
28.00	0.0	0.0	3271.8	3.4	3268.4	3.3	3265.1
28.50	0.0	0.0	3265.1	3.3	3261.8	3.2	3258.6
29.00	0.0	0.0	3258.6	3.2	3255.4	3.1	3252.3
29.50	0.0	0.0	3252.3	3.1	3249.1	3.0	3246.1
30.00	0.0	0.0	3246.1	3.0	3243.1	2.9	3240.2
30.50	0.0	0.0	3240.2	2.9	3237.2	2.9	3234.4
31.00	0.0	0.0	3234.4	2.9	3231.5	2.8	3228.7
31.50	0.0	0.0	3228.7	2.8	3226.0	2.7	3223.3
32.00	0.0	0.0	3223.3	2.7	3220.6	2.6	3218.0
32.50	0.0	0.0	3218.0	2.6	3215.4	2.5	3212.8
33.00	0.0	0.0	3212.8	2.5	3210.3	2.5	3207.8
33.50	0.0	0.0	3207.8	2.5	3205.4	2.4	3203.0
34.00	0.0	0.0	3203.0	2.4	3200.6	2.3	3198.3
34.50	0.0	0.0	3198.3	2.3	3196.0	2.3	3193.7
35.00	0.0	0.0	3193.7	2.3	3191.5	2.2	3189.3
35.50	0.0	0.0	3189.3	2.2	3187.1	2.1	3185.0
36.00	0.0	0.0	3185.0	2.1	3182.9	2.1	3180.8
36.50	0.0	0.0	3180.8	2.1	3178.7	2.0	3176.7
37.00	0.0	0.0	3176.7	2.0	3174.7	1.9	3172.8
37.50	0.0	0.0	3172.8	1.9	3170.9	1.9	3169.0
38.00	0.0	0.0	3169.0	1.9	3167.1	1.8	3165.3
38.50	0.0	0.0	3165.3	1.8	3163.4	1.8	3161.7
39.00	0.0	0.0	3161.7	1.8	3159.9	1.7	3158.2
39.50	0.0	0.0	3158.2	1.7	3156.5	1.7	3154.8
40.00	0.0	0.0	3154.8	1.7	3153.1	1.6	3151.5
40.50	0.0	0.0	3151.5	1.6	3149.9	1.6	3148.3
41.00	0.0	0.0	3148.3	1.6	3146.7	1.5	3145.2

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HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

41.50	0.0	0.0	3145.2	1.5	3143.6	1.5	3142.2
42.00	0.0	0.0	3142.2	1.5	3140.7	1.4	3139.2
42.50	0.0	0.0	3139.2	1.4	3137.8	1.4	3136.4
43.00	0.0	0.0	3136.4	1.4	3135.0	1.4	3133.6
43.50	0.0	0.0	3133.6	1.4	3132.3	1.3	3131.0
44.00	0.0	0.0	3131.0	1.3	3129.6	1.3	3128.4
44.50	0.0	0.0	3128.4	1.3	3127.1	1.2	3125.8
45.00	0.0	0.0	3125.8	1.2	3124.6	1.2	3123.4
45.50	0.0	0.0	3123.4	1.2	3122.2	1.2	3121.0
46.00	0.0	0.0	3121.0	1.2	3119.8	1.1	3118.7
46.50	0.0	0.0	3118.7	1.1	3117.6	1.1	3116.5
47.00	0.0	0.0	3116.5	1.1	3115.4	1.1	3114.3
47.50	0.0	0.0	3114.3	1.1	3113.2	1.0	3112.2
48.00	0.0	0.0	3112.2	1.0	3111.1	1.0	3110.1
48.50	0.0	0.0	3110.1	1.0	3109.1	1.0	3108.1
49.00	0.0	0.0	3108.1	1.0	3107.1	1.0	3106.2
49.50	0.0	0.0	3106.2	1.0	3105.2	.9	3104.3
50.00	0.0	0.0	3104.3	.9	3103.4	.9	3102.5
50.50	0.0	0.0	3102.5	.9	3101.6	.9	3100.7
51.00	0.0	0.0	3100.7	.9	3099.9	.8	3099.0
51.50	0.0	0.0	3099.0	.8	3098.2	.8	3097.4
52.00	0.0	0.0	3097.4	.8	3096.5	.8	3095.7
52.50	0.0	0.0	3095.7	.8	3094.9	.8	3094.2
53.00	0.0	0.0	3094.2	.8	3093.4	.8	3092.6
53.50	0.0	0.0	3092.6	.8	3091.9	.7	3091.2
54.00	0.0	0.0	3091.2	.7	3090.4	.7	3089.7
54.50	0.0	0.0	3089.7	.7	3089.0	.7	3088.3
55.00	0.0	0.0	3088.3	.7	3087.6	.7	3087.0
55.50	0.0	0.0	3087.0	.7	3086.3	.6	3085.7
56.00	0.0	0.0	3085.7	.6	3085.0	.6	3084.4
56.50	0.0	0.0	3084.4	.6	3083.8	.6	3083.2
57.00	0.0	0.0	3083.2	.6	3082.5	.6	3081.9
57.50	0.0	0.0	3081.9	.6	3081.4	.6	3080.8
58.00	0.0	0.0	3080.8	.6	3080.2	.6	3079.7
58.50	0.0	0.0	3079.7	.6	3079.1	.5	3078.6
59.00	0.0	0.0	3078.6	.5	3078.0	.5	3077.5
59.50	0.0	0.0	3077.5	.5	3077.0	.5	3076.4
60.00	0.0	0.0	3076.4	.5	3075.9	.5	3075.4
60.50	0.0	0.0	3075.4	.5	3074.9	.5	3074.5
61.00	0.0	0.0	3074.5	.5	3074.0	.5	3073.5

HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

61.50	0.0	0.0	3073.5	.5	3073.1	.5	3072.6
62.00	0.0	0.0	3072.6	.5	3072.1	.4	3071.7
62.50	0.0	0.0	3071.7	.4	3071.3	.4	3070.8
63.00	0.0	0.0	3070.8	.4	3070.4	.4	3070.0
63.50	0.0	0.0	3070.0	.4	3069.6	.4	3069.2
64.00	0.0	0.0	3069.2	.4	3068.8	.4	3068.4
64.50	0.0	0.0	3068.4	.4	3068.0	.4	3067.6
65.00	0.0	0.0	3067.6	.4	3067.2	.4	3066.9
65.50	0.0	0.0	3066.9	.4	3066.5	.4	3066.1
66.00	0.0	0.0	3066.1	.4	3065.8	.3	3065.4
66.50	0.0	0.0	3065.4	.3	3065.1	.3	3064.8
67.00	0.0	0.0	3064.8	.3	3064.4	.3	3064.1
67.50	0.0	0.0	3064.1	.3	3063.8	.3	3063.4
68.00	0.0	0.0	3063.4	.3	3063.1	.3	3062.8
68.50	0.0	0.0	3062.8	.3	3062.5	.3	3062.2
69.00	0.0	0.0	3062.2	.3	3061.9	.3	3061.6
69.50	0.0	0.0	3061.6	.3	3061.3	.3	3061.0
70.00	0.0	0.0	3061.0	.3	3060.8	.3	3060.5
70.50	0.0	0.0	3060.5	.3	3060.2	.3	3060.0
71.00	0.0	0.0	3060.0	.3	3059.7	.3	3059.4
71.50	0.0	0.0	3059.4	.3	3059.2	.3	3058.9
72.00	0.0	0.0	3058.9	.3	3058.7	.2	3058.4
72.50	0.0	0.0	3058.4	.2	3058.2	.2	3057.9
73.00	0.0	0.0	3057.9	.2	3057.7	.2	3057.5
73.50	0.0	0.0	3057.5	.2	3057.3	.2	3057.0
74.00	0.0	0.0	3057.0	.2	3056.8	.2	3056.6
74.50	0.0	0.0	3056.6	.2	3056.4	.2	3056.2
75.00	0.0	0.0	3056.2	.2	3056.0	.2	3055.8
75.50	0.0	0.0	3055.8	.2	3055.6	.2	3055.4
76.00	0.0	0.0	3055.4	.2	3055.2	.2	3055.0
76.50	0.0	0.0	3055.0	.2	3054.8	.2	3054.6
77.00	0.0	0.0	3054.6	.2	3054.4	.2	3054.2
77.50	0.0	0.0	3054.2	.2	3054.0	.2	3053.9
78.00	0.0	0.0	3053.9	.2	3053.7	.2	3053.5
78.50	0.0	0.0	3053.5	.2	3053.4	.2	3053.2
79.00	0.0	0.0	3053.2	.2	3053.0	.2	3052.9
79.50	0.0	0.0	3052.9	.2	3052.7	.2	3052.5
80.00	0.0	0.0	3052.5	.2	3052.4	.2	3052.2
80.50	0.0	0.0	3052.2	.2	3052.1	.1	3051.9
81.00	0.0	0.0	3051.9	.1	3051.8	.1	3051.6

HYDROLOGIC REPORT FOR
POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

81.50	0.0	0.0	3051.6	.1	3051.5	.1	3051.4
82.00	0.0	0.0	3051.4	.1	3051.2	.1	3051.1
82.50	0.0	0.0	3051.1	.1	3051.0	.1	3050.8
83.00	0.0	0.0	3050.8	.1	3050.7	.1	3050.6
83.50	0.0	0.0	3050.6	.1	3050.4	.1	3050.3
84.00	0.0	0.0	3050.3	.1	3050.2	.1	3050.1
84.50	0.0	0.0	3050.1	.1	3050.0	.1	3049.8
85.00	0.0	0.0	3049.8	.1	3049.7	.1	3049.6
85.50	0.0	0.0	3049.6	.1	3049.5	.1	3049.4
86.00	0.0	0.0	3049.4	.1	3049.3	.1	3049.2
86.50	0.0	0.0	3049.2	.1	3049.1	.1	3049.0
87.00	0.0	0.0	3049.0	.1	3048.9	.1	3048.8
87.50	0.0	0.0	3048.8	.1	3048.7	.1	3048.6
88.00	0.0	0.0	3048.6	.1	3048.5	.1	3048.4
88.50	0.0	0.0	3048.4	.1	3048.3	.1	3048.2
89.00	0.0	0.0	3048.2	.1	3048.1	.1	3048.0
89.50	0.0	0.0	3048.0	.1	3047.9	.1	3047.8
90.00	0.0	0.0	3047.8	.1	3047.8	.1	3047.7
90.50	0.0	0.0	3047.7	.1	3047.6	.1	3047.5
91.00	0.0	0.0	3047.5	.1	3047.4	.1	3047.4
91.50	0.0	0.0	3047.4	.1	3047.3	.1	3047.2
92.00	0.0	0.0	3047.2	.1	3047.1	.1	3047.0
92.50	0.0	0.0	3047.0	.1	3047.0	.1	3046.9
93.00	0.0	0.0	3046.9	.1	3046.8	.1	3046.8
93.50	0.0	0.0	3046.8	.1	3046.7	.1	3046.6
94.00	0.0	0.0	3046.6	.1	3046.6	.1	3046.5
94.50	0.0	0.0	3046.5	.1	3046.4	.1	3046.4
95.00	0.0	0.0	3046.4	.1	3046.3	.1	3046.2
95.50	0.0	0.0	3046.2	.1	3046.2	.1	3046.1
96.00	0.0	0.0	3046.1	.1	3046.0	.1	3046.0
96.50	0.0	0.0	3046.0	.1	3045.9	.1	3045.9
97.00	0.0	0.0	3045.9	.1	3045.8	.1	3045.8
97.50	0.0	0.0	3045.8	.1	3045.7	.1	3045.7
98.00	0.0	0.0	3045.7	.1	3045.6	.1	3045.5
98.50	0.0	0.0	3045.5	.1	3045.5	.1	3045.4
99.00	0.0	0.0	3045.4	.1	3045.4	0.0	3045.3

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4/28/87

HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION

BASIN IDENTIFIER 15 AC. LAKE
POND IDENTIFIER 15 AC LAKE
100 YEAR STORM FREQUENCY (CONT'D)

MAXIMUM OUTFLOW = 4.0 C.F.S.
MAXIMUM STORAGE = 2983175.9 CU FT.
MAXIMUM ELEVATION = 64.3 FEET

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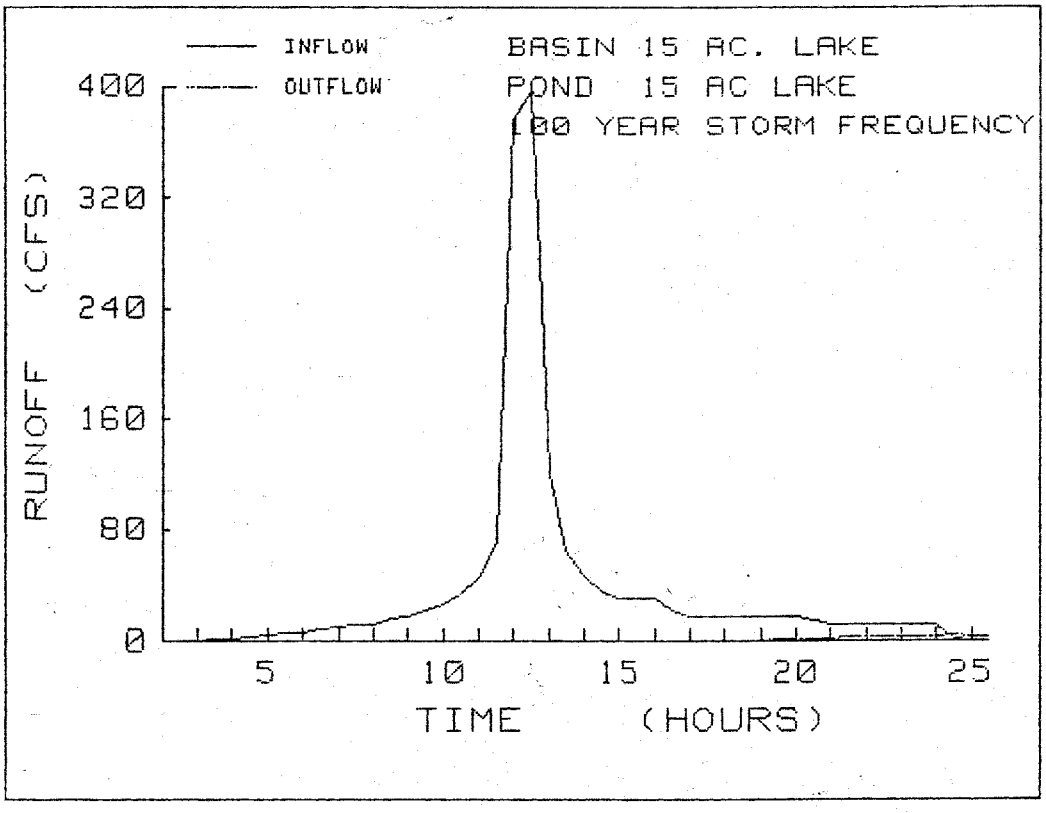
HYDROLOGIC REPORT FOR POWHATAN SECONDARY SOUTH EXTENSION



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TRAPEZOIDAL BROAD CRESTED WEIR

BOTTOM WIDTH = 80.00 FEET
SIDE ANGLE = 9.00 DEGREES

ELEV. (FT.)	FLOW (CFS)
64.50	0.00
64.60	8.10
64.70	22.92
64.80	42.11
64.90	64.84
65.00	90.63
65.10	119.15
65.20	150.17
65.30	183.50
65.40	219.00
65.50	256.53
65.60	296.01
65.70	337.33
65.80	380.42
65.90	425.22
66.00	471.65
66.10	519.68
66.20	569.24
66.30	620.30
66.40	672.81

FORMULA USED Q = 4.8*H^1.5*(0.667*W+0.533*HEAD*TAN (A))

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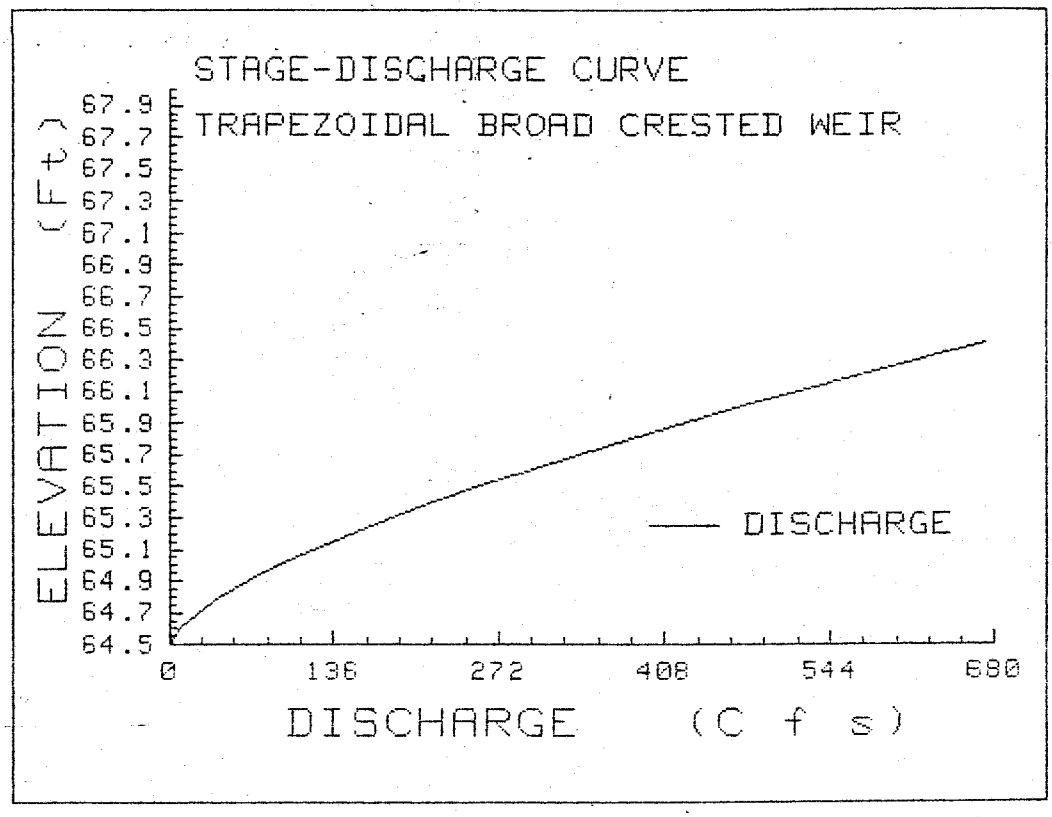

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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 34

Peak Discharge Method – Pre-Development

Step 1: A = 1.21 ACRES
Hydraulic Length = 3300'
Average Slope = 3.25%

Step 2: Soil Groups

		(permeability)	(runoff)
15E	.15	moderately permeable	fast runoff
5	.10	slow	" "
10C	.15	moderate	" "
15D	.15	moderate	" "
8B	.15	moderate slow	slow runoff
14C	.05	moderate	fast runoff
14B	.05	moderate	medium
18B	.15	moderate	medium
11C	.05	slow	fast

Use soil Group C

Calculate Curve No. (CN)

Cultivated Land	48%	x 83	=	3984
Wood or Forest	9%	x 73	=	657
Residential (1ac. Lots)	21%	x 79	=	1659
Streets and Roads	5%	x 98	=	490
Lake	12%	x 98		1176
Recreational	5%	x 79		395
	100%			8361 ∴ CN: 84

Step 3: Determine runoff depth & volume
a. Rainfall depth for 2 year storm in J.C.C.
= 3.75 inches
b. Runoff depth = 2.1
c. Runoff volume for site =
$2.1 \text{ in} \times \left(\frac{121 \text{ ac}}{12 \text{ in/ft}}\right) = 21.2 \text{ acre/ft}$

Step 4: Determine peak discharge rate adjusted for watershed shape
a. Equiv. drain. area = 100 acreas

b. Equiv. peak discharge =
75 cfs/in x 2.1 = 158 cfs

c. Actual peak discharge =

$$158 \text{ cfs} \times \left(\frac{121}{100}\right) = 191. \text{ cfs}$$

Step 5: Adust peak discharge for percent impervious area and percent hychaulic length modified.

a. Impervious factor – 1.06
b. Hydraulic length factor = 1.08
c. Q_{mod} = 191 cfs x 1.06 x 1.08
= 219 cfs

Step 6 : Adjust peak discharge based on watershed slope
Adust. factor = .90
219 x .90 = 197 cfs

Step 7 : Adjust peak discharge for ponding area
.80 at upper

197 x .80 = 158 CFS

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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 36

Peak Discharge Method - Post Development

1. A = 121 AC.
   HL = 3300'
   Av. S = 3.25%

2. Soil use group C

Calculate Curve No. (CN)

Commercial / Industrial	31% x 91 =	2821	72% imper.
Residential	20% x 90 =	1800	65% imper
"	21% x 79 =	1659	
Streets & Roads	7% x 98 =	686	100% imper.
Recreational	9% x 79 =	711	
Lake	12% x 98 =	1176	100% imper.
	100	8853	54% imper.

$\frac{8853}{100} = 89 = CN$

3. a. Rainfall depth = 3.75 in
   b. Runoff depth = 2.55 in
   c. Runoff Volume for site
   $2.55 \times \frac{121}{12} = 25.7$ acre/ft

4. Determine peak discharge rate adjusted for watershed shape
   a. equiv. drain area = 100 acres
   b. " peak discharge =
   83 cfs/in x 2.55 = 212 CFS
   c. actual peak discharge =
   $212 \times \frac{121}{100} = 257$ CFS

5. Adust for impervious area and mod. hyd length
   a. Impervious factor = 1.2
   b. Hyd. length factor = 1.08
   c. 257 x 1.2 x 1.08 = 333 CFS

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Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 37

6. Slope adjustment = .90
333 x .9 = 300 CFS

7. Pond adjustment:
.80 at upper end
300 x .8 = 240 CFS

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Subject: Powhatan Secondary South Extension
Computed By: WKS Checked By:

Project No. 7841
Client: Beamer Bros.
Date: Sheet No. 38

Basin A, (To size pipe culvert at Sta. 27+00)

$A = 4.7$ AC
$C_w = .60$
$CA = 2.8$
$I_{10} = 4.5$ in/hr.
$Q_{10} = 12.7$ CFS
$I_2 = 3.4$

Weighted "C"

Ex. Apts.	1.7 AC	x .40	=	.68
Future Apts	2.3 AC	x .70	=	1.61
Pavement	.4 AC	x .9	=	.36
Shoulder/Ditch	.3 AC	x .5	=	.15
				2.80

Overland Flow Time
$L = 200'$
$S = 3\%$
$C = .4$
$T_c = 14$ min

Channel Flow Time
$L = 900'$
$\Delta EL = 20'$
$T_c = 6$ min

$\Sigma T_c = 20$ min

Capacity of 24" RCP @ 0.577% = 17.1 CFS

Basin A_2 (To check channel adequacy for outfall channel @ Sta. 27+00)

$A = 1.2$ AC
$C = .48$
$CA = .58$

Weighted "C."

Pavement	.37	x .9	=	.28
Shoulder/Ditch	.56	x .5	=	.28
Landscape	.07	x .3	=	.02
				.58 ÷ 1.2 =

$\Sigma CA\ (A_1 + A_2) = 3.38$
$I_{10} = 4.5$ in/hr
$Q_{10} = 15.2$ CFS

Max depth of flow in channel = 0.9'
Velocity = 3.0 FPS Allowable for grass lined channel

LD-269
Rev 3-83

Project POWHATAN SECONDARY SOUTH EXTENSION

Plan Sheet No. 10 Designer WCS

Rev. Date _____ Date _____

Sheet 39 of _____

HYDROLOGICAL DATA:

D.A. = _____ AC.

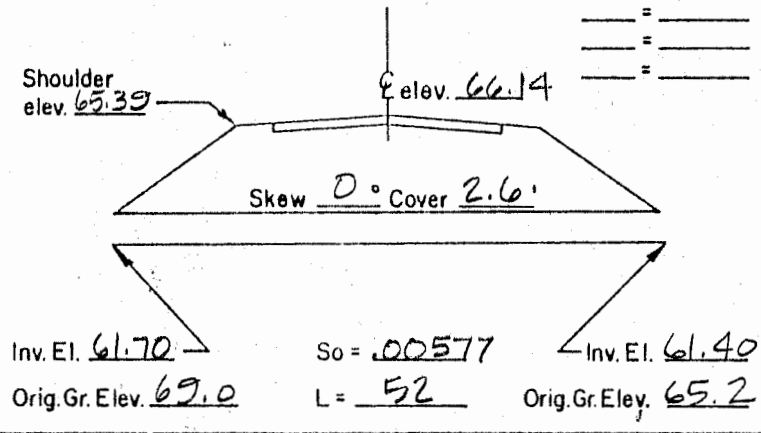
AHW Controls

100 yr. Flood plain _____ elev. _____
Design AHW depth _____ elev. _____
Structures _____ elev. _____

STATION: 27+00

freq.	TW elev.
10	.83

2.8 FPS



DISCHARGES USED

Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS

RISK ASSESSMENT

ADT _____

Detours Available _____, Length _____
Overtopping Stage _____
Flood Plain Management _____
Criteria and Significant Impact _____

CULVERT TYPE & SIZE	Q	Q/B	HEADWATER COMPUTATIONS: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL Ke	dc	(dc+D)/2	ho	H	LSo	HW	CONT. HW. ELEV.	OUTLET VELOCITY C.M.	OUTLET VELOCITY Smooth	End Treat.	COMMENTS
24" RCP	13	N/A	.95	1.9	.5	1.25	1.63	1.63	1.63 + .55 = 2.18		2.18	64.18		4.8	ES-1	

Design Flood Exceed. Prob. _____ Elev. _____
Overtop Flood Exceed. Prob. _____ Elev. _____
Base Flood 1% Exceed. Prob. _____ Elev. _____

SUMMARY & RECOMMENDATIONS:

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH - WILLIAMSBURG, VIRGINIA

Subject: Powhatan Secondary South Extension
Computed By: WCS Checked By:

Project No. 7841
Client: Beamer Bros.
Date: Sheet No. 40

Basin B_1 (To size pipe culvert at Sta. 41+50)

$A = 10.5$ Ac.
$C_w = .43$
$I_{10} = 5$ in/hr
$Q_{10} = 22.6$ CFS
$CA = 4.55$

Weighted "C"

Pavement & Bldgs	= 2.0 AC x .9	=	1.8
Shoulder & Ditch	= 1.0 AC x .5	=	.5
Woods & Lawn	= 7.5 AC x .3	=	2.25
			4.55

Overland Flow Time
$L = 300'$
$S = 6.0\%$
$C = .45$
$T_c = 12.5$ min

Channel Time
$L = 450'$
$\Delta EL = 13.5$
$T_c = 3$ min

$\Sigma T_c = 15.5$ min

Capacity of 36" RCP culvert @ 3% = 115 CFS

Basin B_2 (To check capacity of PG-5; b = 2'; d = 1'; S = 8%)

$A = .58$
$C = .6$
$CA = 0.35$

$\Sigma CA = 4.9$
$I_{10} = 5$ in/hr
$Q_{10} = 25.5$ CFS

Max. depth = 0.61
" Velocity = 16 FPS EG-1 required

LD-269
Rev 3-83

Project POWHATAN SECONDARY SOUTH EXTENSION.

Plan Sheet No. 10 Designer WCS

Rev. Date _____ Date _____

Sheet 41 of _____

HYDROLOGICAL DATA:

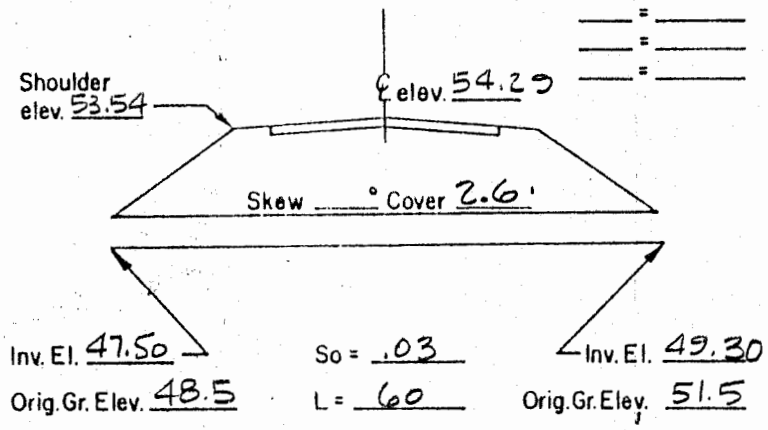
D.A. = _____ AC.

AHW Controls

STATION: 41+50

100 yr. Flood plain _____ elev. _____
Design AHW depth _____ elev. _____
Structures _____ elev. _____

freq.		TW elev.
10	=	.5
	=	
	=	
	=	
	=	



DISCHARGES USED

Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS

RISK ASSESSMENT

ADT _____

Detours Available _____, Length _____
Overtopping Stage _____
Flood Plain Management _____
Criteria and Significant Impact _____

CULVERT TYPE & SIZE	Q	Q/B	HEADWATER COMPUTATIONS: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL Ke	dc	(dc+D)/2	ho	H	LSo	HW	CONT. HW. ELEV.	OUTLET VELOCITY C.M.	OUTLET VELOCITY Smooth	End Treat.	COMMENTS
36" RCP	24	N/A	.76	2.3	.5	1.6	2.3	2.3	2.3 + .3 = 2.6		2.6	52.22		11	ES-1	

Design Flood Exceed. Prob. _____ Elev. _____
Overtop Flood Exceed. Prob. _____ Elev. _____
Base Flood 1% Exceed. Prob. _____ Elev. _____

SUMMARY & RECOMMENDATIONS:

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

Computed by WCS Date
Checked by NHM Date

Project Powhatan Cluster Homes

Basin# 1 Location Sta. 41+50 at Toe of Slope

Total Area draining to basin, 16.0 Acres.

BASIN VOLUME DESIGN

1. Min. required vol. = 67 cu. yds. x 16.0 ac. drainage = 1072 cu.yds.
2. Vol. of basin = 273 cu.yds.
3. Excavated 810 cu. yds. to obtain required capacity.
   Min. vol. before cleanout = 27 cu. yds. x 16.0 ac. drainage = 432 cu.yds.
   Elevation corresponding to scheduled time to clean out 37.8
   Distance below top of riser 2.2'

BASIN SHAPE

4. L/W_e = 2.8 Baffles needed? No x, Yes ____; show location on site plan.

DESIGN OF SPILLWAYS

Runoff

5. Q_{10} = 32 cfs (see chapter 5).

Pipe Spillway (Q_p)

6. Min. pipe spillway capacity, Q_p = 0.2 x 16 ac. drainage = 3.2 cfs.
   Note: If there is no emergency spillway, then req'd $Q_p = Q_{10}$ = N/A cfs.
7. Riser: Diam. 12 inches; Height 4 ft.; h = 0.8 ft.
8. H = 5 ft. Barrel length = 125 ft.
9. Barrel: Diam. 12 inches;
10. Trash Rack: Diam. 18 inches; A = 6 inches.

Emergency Spillway Design

11. Emergency Spillway Flow, $Q_e = Q_{10} - Q_p$ = 32 - 3.2 cfs.
12. Width 12 ft. H_p 1.0 ft.
    Entrance channel slope (3:1) 33 %
    Exit channel slope 3 %

ANTI-SEEP COLLAR DESIGN (IF REQUIRED)

13. y = 4.8 ft.; z = 3 : 1; pipe slope = 0016%, L_s = 33.8 ft.
    # of collars = 2 Dimensions = 2.8' x 2.8'

DESIGN ELEVATIONS

14. Riser Crest = 40 Design High Water = 42.0
    Em. Spwy. Crest = 41.0 Top of Dam = 43.0

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS · PLANNERS · SURVEYORS
VIRGINIA BEACH · WILLIAMSBURG, VIRGINIA

Subject: Drainage Area For Sediment Basin
Computed By: WCS Checked By: MHM

Project No. 78-41
Client: Beamer
Date: Sheet No. 43

Basin B (B_1, B_2, B_3)

$A = 16$ AC
$C_w = .44$
$CA = 7.1$
$I_{10} = 4.5$ in/hr
$Q_{10} = 32$ CFS

AREA IN LOTS = 1.14 @ .4 = .456
AREA IN LOTS = 3.5 @ .35 = 1.225
" IN BLDG/PVMT = 3.0 @ .9 = 2.70
" IN SHOULDER/DITCH = 1.0 @ .5 = 0.50
" IN WOODS/LAWN = 7.36 @ .3 = 2.208
7.089 ÷ 16 = .44

(Principal spillway)

Time of Concentration

Overland Flow Time
$L = 400'$
$S = 7\%$
$C = .3$
$T_c = 18$ min

Channel Flow Time (Road) (Kirpich)
$L = 400$
$\Delta EL = 8'$
$T_c = 3.5$ min $\times .2 = .7$ min

Channel Flow Time (ravine) (kirpich
$L = 150'$
$\Delta EL = 7'$
$T_c = 1.25$ min

TOTAL = 20 min
$I_{10} = 4.5$ in/hr

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH • WILLIAMSBURG, VIRGINIA

Subject _____
Computed By _____ Checked By _____

Project No. _____
Client _____
Date _____ Sheet No. 44

I. Basin Volume 67 x 16 = 1072 c.y.

Sediment Basin Volume Calculations, (After excavation)

EL.	Area #	Volume cy
40	9250	
		324
39	8250	
		287
38	7250	
		250
37	6250	
		213
36	5250	
		11
35.9	500	
		1085 = TOTAL VOLUME

II Basin Shape

A. $W_e = A/L$ $\frac{L}{W_e}$ = Length to Width ratio

$A = 8000$ SF. $= 150/53 = 2.8:1$

$L = 150'$

$\therefore W_e = 53.3$ (Note: second point of inflow < 30% of total)

III. Basin will have an emergency spillway

IV. EL. of crest of principal spillway for the required volume = 40

V. EL. of design high water = 42
EL. of top of dam = 43

VI. $Q_p = 32$ cfs

VII Principal Spillway design

A. $Q_p = .2 \times 16$ ac = 3.2 cfs
B. N/A
C. Plate 1.26g ; h = 1'
D. Plate 1.26h ; Smallest riser = 12" ; h = .8'
E. H = 5' ; L = 125' ;
F. Table 1.26e ; Smallest barrel = 12"

PC140_POWHATAN SECONDARY_VBOL_162

PROJECT POWHATAN CLUSTER
JOB NO. 78-41
DATE 8-12-86 SHEET 1 OF 2
DESIGN FORMULA Q=CRIA FREQ. 10 YR

STORM SEWER DESIGN COMPUTATIONS

COMPUTED BY EDZ CHECKED BY WG

LANGLEY AND McDONALD
ENGINEERS·PLANNERS·SURVEYORS
VIRGINIA BEACH, VIRGINIA

LOCATION STREET	LOCATION POINT	AREA ACRES "A"	RUNOFF COEF. "C"	"A" x "C" INCRE.	"A" x "C" ACCUM.	INLET TIME MIN.	RAIN INTEN. INCH	RUNOFF Q CFS	PIPE (DITCH) SIZE	CAPACITY CFS	VELO. FT./SEC.	LENGTH FEET	SLOPE FT/FT	FALL FT.	INVERT ELEV. UP	INVERT ELEV. DOWN	REMARKS
AREA	A	.3	.6	.18		5	7.1	1.3	DITCH d=0.4'	1.3	2.8		.08				
	A	2.9	.4	1.16	1.34	15	5.1	6.8	15"	10.7	8.8	68	.0279				
AREA	B	—	—	.038	.038	5	7.1	0.63	12"	7.5	9	24	.0419				
				.019	.057	5	7.1	0.85	12"	7.5	9	24	.0419				
				.183	.24	5	7.1	3.12	12"	3.2	4	32	.008				3 cfs no siphon needed
AREA	C	—	—	.36	.36	6	6.9	2.48	12"	2.55	3.1	32	.005				<3 cfs no siphon needed
AREA	D	—	—	.248	.248	5	7.1	1.76	12"	8.8	10.1	24	.06				
	E	—	—	.10	.348	5	7.1	2.47	12"	8.8	10.1	24	.06				
	F	—	—	.115	.463	6	6.9	3.19	12"	8.8	10.1	24	.06				
	G	—	—	.139	.602	6	6.9	4.15									
	G1	—	—	.422	1.024												
	G2	—	—	.164	1.19	8	6.5	7.72	15"	11	8.5	68	.0275				
AREA	H	—	—	.06	.06	5	7.1	0.43	12"	6.3	7.6	48	.03				

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH • WILLIAMSBURG, VIRGINIA

Subject: Powhatan Cluster Homes
Computed By: WCS Checked By:

Project No.
Client:
Date: Sheet No.

Ditch Velocities By Area Designation on Cluster Homes Drainage Area Map.

A. 2.8 FPS d = .4'
B. 1.5 FPS d = .75'
C. 1.5 FPS d = .75'
D. 1.9 FPS d = .55'
E. 2.1 FPS d = .63'
F. 2.2 FPS d = .68'
G. 3.7 FPS d = .61
G_2 2.9 FPS d = .94'

Langley and McDonald
A PROFESSIONAL CORPORATION
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH • WILLIAMSBURG, VIRGINIA

Subject: Powhatan Cluster Homes
Computed By: WCS Checked By:

Project No. 7841
Client: Beamer Bros.
Date: Sheet No. 48

Area "C," (See Cluster Homes Drainage area map)
(To check capacity of 15" RCP)

$A = .85$ ac
$C = .42$
$CA = .36$
$I_{10} = 6.9$
$Q_{10} = 2.5$ CFS

Capacity of 15" RCP @ 0.5% = 4.6 CFS

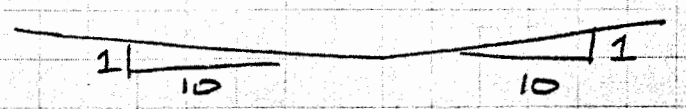
Area "C" To check capacity of Stormwater Conveyance Channel.

$A = 2.1$ ac
$C = .49$
$CA = 1.03$

Bldg/Pvmt .5 ac x .9 = .45
Ditch/Grass @ 3:1 .5 ac x .5 = .25
Lawn & Woods 1.1 ac x .3 = .33
1.03

$\Sigma CA = 1.4$
$I_2 = 5.5$
$Q_2 = 7.6$ CFS

Given: grass lined channel w/ ENKAMAT
$S = 7\%$
$n = .05$



Max depth = 0.5'
" velocity = 3 FPS
Wetted Perimeter = 10'

LD-269
Rev 3-83

Project POWHATAN CLUSTER HOMES

Plan Sheet No. 2 Designer WCS

Rev. Date _____ Date _____

Sheet 49 of _____

HYDROLOGICAL DATA:

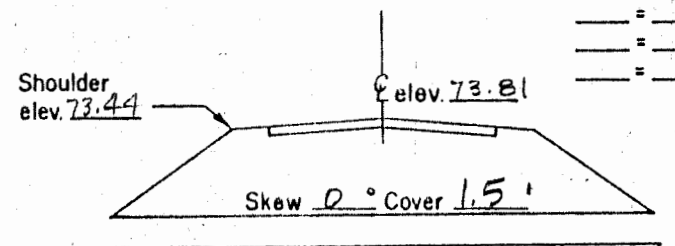
D.A. = _____ AC.

AHW Controls

STATION: 16+65

100 yr. Flood plain _____ elev. _____
Design AHW depth _____ elev. _____
Structures _____ elev. _____

freq. TWelev.
10 = .25' (2.0 FPS)



Inv. El. 70.74 So = .005 Inv. El. 70.92
Orig. Gr. Elev. 71.8 L = 36 Orig. Gr. Elev. 74.0

DISCHARGES USED

Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS
Q ____ = _____ CFS

RISK ASSESSMENT ADT _____

Detours Available _____, Length _____
Overtopping Stage _____
Flood Plain Management _____
Criteria and Significant Impact _____

CULVERT TYPE & SIZE	Q	Q/B	HEADWATER COMPUTATIONS: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL Ke	dc	(dc+D)/2	ho	H	L·So	HW	CONT. HW. ELEV.	OUTLET VELOCITY C.M.	OUTLET VELOCITY Smooth	End Treat.	COMMENTS
15" RCP	2.5	N/A	.72	.9	.5	.62	.94	.94	.95 + .07 1.02		1.02	71.94		4.2	ES-1	

Design Flood Exceed. Prob. _____ Elev. _____
Overtop Flood Exceed. Prob. _____ Elev. _____
Base Flood 1% Exceed. Prob. _____ Elev. _____

SUMMARY & RECOMMENDATIONS:

Langley and McDonald
ENGINEERS • PLANNERS • SURVEYORS
VIRGINIA BEACH • WILLIAMSBURG • VIRGINIA

Subject: Powhatan Cluster Homes
Computed By: ____ Checked By: ____

Project No. ____
Client ____
Date ____ Sheet No. 50

[Cluster Homes]

Area "B1" (see drainage area map Scale 1" = 50') (To calculate capacity of 15" RCP)

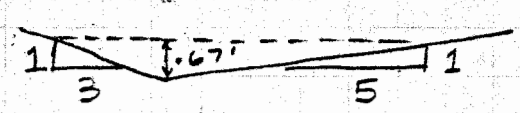
$A = 1.3$ AC
$C_W = .48$
$CA = .63$
$I_{10} = 7.1$ in/hr.
$Q_{10} = 4.5$ CFS

Capacity of 15" RCP @ 1.0% = 6.4 CFS

Area "B." To calculate adequacy of Stormwater Conveyance Channel.

$A = 1.6$
$C = .55$
$I_2 = 5.7$ in/hr.
$Q_2 = 5$ CFS

Given grass lined (VEE DITCH) channel with 3:1 & 5:1 sideslopes; $S = 4.0\%$; $n = .05$



Max. depth = 0.67'
" velocity = 2.8 FPS
WP = 5.5'

Rev 3-83

22 (5-18)

Project POWHATAN CLUSTER HOMES

Plan Sheet No. ____ Designer WCS

Rev. Date ____ Date ____

Sheet 57 of ____

HYDROLOGICAL DATA:

D.A. = ____ AC.

AHW Controls

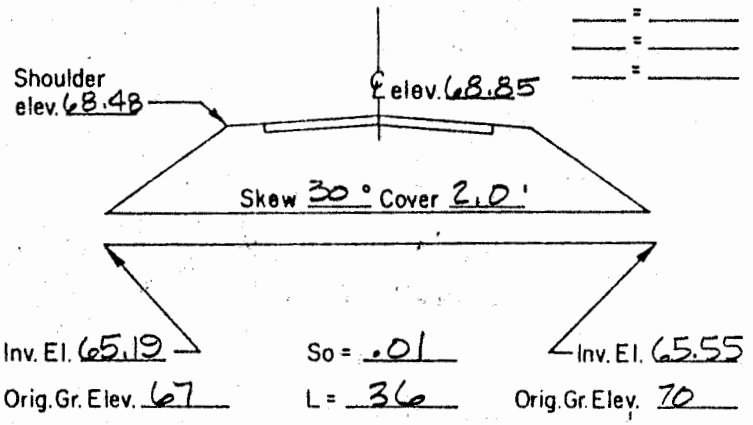
STATION: 20+25

100 yr. Flood plain ____ elev. ____

Design AHW depth ____ elev. ____

Structures ____ elev. ____

freq.	TW elev.
10	.6



DISCHARGES USED

Q ____ = ____ CFS

Q ____ = ____ CFS

Q ____ = ____ CFS

Q ____ = ____ CFS

Q ____ = ____ CFS

RISK ASSESSMENT

ADT ____

Detours Available ____, Length ____

Overtopping Stage ____

Flood Plain Management ____

Criteria and Significant Impact ____

CULVERT TYPE & SIZE	Q	Q/B	HEADWATER COMPUTATIONS: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL Ke	dc	(dc+D)/2	ho	H	LSo	HW	CONT. HW. ELEV.	OUTLET VELOCITY C.M.	OUTLET VELOCITY Smooth	End Treat.	COMMENTS
15" RCP	4.5	N/A	1.2	1.5	.5	.8	1.03	1.03	1.03 .4 1.43		1.43	66.98			ES-1	

Design Flood Exceed. Prob. ____ Elev. ____

Overtop Flood Exceed. Prob. ____ Elev. ____

Base Flood 1% Exceed. Prob. ____ Elev. ____

SUMMARY & RECOMMENDATIONS:

(Rev. 1/85)

Scott Thomas

From: Scott Thomas
Sent: Thursday, August 21, 2003 11:06 AM
To: 'Hicks, Michael'
Subject: RE: Eckerd's @ News Road, Williamsburg

Future Eckerd Site.

piping.5.JPG (43 KB) piping.7.JPG (44 KB) piping.8.JPG (44 KB) piping.9.JPG (43 KB)

The facility of which you refer to is wet pond BMP known as SWM Facility D (Area D) which was constructed as part of the Monticello Avenue Extension. County BMP ID Code assigned to this facility is PC 140. It also serves as quasi regional BMP for the Monticello Marketplace and Marketplace Shoppes. It was constructed by VDOT under state project Route 0199, 0199-047-103, RW-205, C-503 (Mark White, Project Manager).

Based on information that I have in our asbuilt files, it was designed by MMM Design Group , 229 West Bute Street, Norfolk, Va. 23510. It serves a drainage area of 135.6 acres and attenuates the 2- and 10-year storm. It appears your site was included in the overall anticipated postdevelopment drainage basin subarea to be conveyed to the pond. A map I have in file shows a subarea along the south side of News Road 17.29 (ie. West of the basin) of C=0.70.

I will alert you however that this basin just recently failed and was repaired (some photos attached). VDOT and the property owner of record (Powhatan Enterprises) were involved in the repair. The County was not heavily involved with meetings and actual repair activities.

Photo 5 was seepage occurring along the barrel prior to failure. Photos 7, 8 and 9 were after the actual failure. The facility is now repaired.

Scott J. Thomas, P.E.
James City County
Environmental Division

Visit: http://www.james-city.va.us/resources/devmgmt/div_devmgmt_environ.html
and
www.protectedwithpride.org

-----Original Message-----
From: Hicks, Michael [mailto:hicks@johnrmcadams.com]
Sent: Wednesday, August 20, 2003 4:31 PM
To: Scott Thomas
Cc: Clark, Amos
Subject: Eckerd's @ News Road, Williamsburg

Scott,

thanks for your help this morning. This is a pdf of the Site Plan for the Eckerd's I talked to you about this morning across the street from Target. Do you know anything about the stormwater feature to the east of our site (not shown on the plan but is over there). Can we drain into this and then go into the lake. Not sure what this is sized at and such and who on earth designed this. Check will be in Joan's hand tommorrow morning. Thanks for sending out the BMP Manual today.

<<0258_001.pdf>>

Thanks,

Michael Hicks
The John R. McAdams Company

2905 Meridian Pkwy.
Durham, NC 27709
919-361-5000 ext 297 (Office)
1-800-733-5646 ext 297 (Toll Free)
919-361-2269 (Fax)
919-417-0217 (cell)
702-995-8110 (e-fax)

Scott Thomas

From: Hicks, Michael [hicks@johnrmcadams.com]
Sent: Wednesday, August 20, 2003 4:31 PM
To: Scott Thomas
Cc: Clark, Amos
Subject: Eckerd's @ News Road, Williamsburg

0258_001.pdf (101 KB)

Scott,

thanks for your help this morning. This is a pdf of the Site Plan for the Eckerd's I talked to you about this morning across the street from Target. Do you know anything about the stormwater feature to the east of our site (not shown on the plan but is over there). Can we drain into this and then go into the lake. Not sure what this is sized at and such and who on earth designed this. Check will be in Joan's hand tommorrow morning. Thanks for sending out the BMP Manual today.

<<0258_001.pdf>>

Thanks,

Michael Hicks
The John R. McAdams Company
2905 Meridian Pkwy.
Durham, NC 27709
919-361-5000 ext 297 (Office)
1-800-733-5646 ext 297 (Toll Free)
919-361-2269 (Fax)
919-417-0217 (cell)
702-995-8110 (e-fax)

ADDRESS!

ENVIRONMENTAL – STORMWATER TRANSMITTAL

PROTECTING RESOURCES PRIDE IN DELICATE ENVIRONMENTS

James City County Jamestown 1607

COUNTY PLAN NO: _____

BMP ID CODE: PC 140 BMP FOR MONTICELLO MARKETPLACE AT CORNER NEWS RD + MONTICELLO AVE.

WATERSHED: POWHATAN

☐ **ENTIRE RECORD FILE**

☐ **ASBUILTS**

☐ **CONSTRUCTION CERTIFICATION**

☐ **COMPUTATIONS**

☒ **OTHER:** Found this correspondence relative to this BMP. Please put in the record file for PC 140.

NAME: Scott J. Thomas

SIGNATURE: Scott J. Thomas

DATE: 12/16/08

S.L. NUSBAUM Realty Co.
9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

June 7, 2006

RECEIVED
DEVELOPMENT MANAGEMENT

James W. Brewer
Residency Administrator
Virginia Department of Transportation
Williamsburg Residency
4451 Ironbound Road
Williamsburg, VA 23188

Re: BMP Located Between Monticello Marketplace and Powhatan Secondary, James City County, Virginia - Your Letter of July 19, 2005

Dear Mr. Brewer:

Reference is made to your letter of July 19, 2005, a copy of which is attached, regarding the referenced BMP and my ongoing effort to bring this matter to a close with VDOT and James City County.

Once again, the current Letter of Credit in effect with Wachovia Bank will be expiring in September. As I indicated in our past meeting, there should be no need to extend it any further with the construction of Monticello Marketplace and Marketplace Shoppes being completed for some time. You should have ample information in your file from my prior correspondence with your office and the County on this matter. I would appreciate any update you can provide me on any discussions or meetings you may have had with John Horne and/or Darryl Cook since our meeting last year.

With regard to the Inspection/Maintenance Agreement, I will once again bring this to Lawrence Beamer's attention to see if we can move forward with this document if he feels the prior issues that were of concern to him with VDOT and the County have been addressed.

In the meantime, if you should have any questions or comments, please feel free to contact me. I look forward to your response.

Sincerely,

James M Gresock

James M. Gresock
Senior Vice President

RECEIVED
JUN - 8 2006
DEVELOPMENT MANAGEMENT

JMG:lds

Enclosure - as noted

cc Alan Nusbaum
Lawrence Beamer
Darryl Cook
John Horne

COMMONWEALTH of VIRGINIA

GREGORY A. WHIRLEY
ACTING COMMISSIONER

DEPARTMENT OF TRANSPORTATION
1700 NORTH MAIN STREET
SUFFOLK, VA 23434

July 19, 2005

James M. Gresock
Senior Vice President
S. L. NUSBAUM REALTY COMPANY
9211 Forest Hill Avenue, Suite 110
Richmond, Virginia 23235

Re: BMP Located Between Monticello Marketplace and Powhatan Secondary,
James City County, Virginia

Dear Mr. Gresock:

This is in reference to your letter received in this office concerning the BMP located between Monticello Marketplace and Powhatan Secondary in James City County.

We have previously performed some work that was indicated in Mr. Cook's letter that I received on May 25, 2005. The only items that are left, to my knowledge to be performed, is the mowing operation on the dam. I will set up a meeting with Mr. John Horne and Mr. Darrel Cook next week to review any other work they feel need further attention, then another meeting will be arranged with all respective parties to bring this matter to a conclusion.

If additional information is desired, please give me a call at (757) 253-4832.

Sincerely,

J. W. Brewer
Residency Administrator

cc: Mr. John Horne
Mr. Darrel Cook

S.L. NUSBAUM Realty Co.
9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

May 2, 2000

Powhatan Enterprises, Inc.
Attn: Lawrence F. Beamer, President
13441 Warwick Boulevard
Newport News, Virginia 23602

Re: James City County BMP Maintenance Agreement

Dear Lawrence,

This is to advise you that I had a recent call from Darryl Cook regarding the status of the referenced BMP Maintenance Agreement. At this time, Darryl is concerned about the appearance of algae in the pond as well as related concerns on the adjacent lakes.

As you may recall, we discussed this matter in detail last year and brought the BMP matter to VDOT's attention per my letter of February 22, 1999 to Quinton Elliott, a copy of which is attached, which addresses the need for VDOT to provide the necessary treatment for the pond, including repairs, prior to Powhatan Enterprises taking over the maintenance of the facility. I believe this was followed up with subsequent phone calls to Quinton, but as far as I know, VDOT has not contacted us regarding this matter.

By copy of this letter, I am requesting Quinton to evaluate the situation so we can address Darryl's concerns as expeditiously as possible.

I assume you have retained the Declaration of Covenants - Inspections/Maintenance of Drainage System Agreement that needs to be put in place once we have resolved the questions of VDOT's obligations.

I will be conferring with Darryl Cook further on this matter and, if there is need for a meeting with the various parties, I will advise you and Quinton accordingly. If you have any questions, please advise.

Sincerely,

James M. Gresock

James M. Gresock
Senior Vice President
Director of Development

RECEIVED VDOT

MAY 12 2000

WILLIAMSBURG RESIDENCY

JMG:lds

cc Alan Nusbaum
Darryl Cook
Quinton Elliott

S.L. NUSBAUM Realty Co.
9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

February 22, 1999

Mr. Quinton Elliott
Resident Engineer
Virginia Department of Transportation
Post Office Box HD
Williamsburg, Virginia 23817

Re: Monticello Marketplace Shopping Center - James City County BMP Maintenance Agreement

Dear Quinton,

For your review and input, please find enclosed a copy of my letter to Lawrence Beamer dated November 30, 1998, together with a Declaration of Covenants - Inspections/Maintenance of Drainage System Agreement to be executed by Powhatan Enterprises, Inc. per the Deed of Easement between Powhatan Enterprises and Monticello Marketplace Associates, a copy of which is also attached.

In discussing this matter recently with Lawrence Beamer, it is our understanding that Powhatan Enterprises would take over the repair and maintenance of the BMP subsequent to VDOT providing any necessary treatment of the pond, including repairs. This is based on VDOT's use of the pond for their construction work on News Road and Monticello Avenue extension as their designated storm water management facility, as discussed and agreed upon at the time the various right of way dedications were made with VDOT and related County agreements.

With the completion of VDOT's roadwork and the Shopping Center, James City County is requesting completion of the Maintenance Agreement and its implementation. Please review this matter with the appropriate VDOT departments and let me know when you would expect to turn over the pond to Powhatan Enterprises for its future maintenance, as I need to keep the County informed on the status of this matter.

If you have any questions or need to meet to further discuss same, please advise as I can make myself readily available.

Sincerely,

James M. Gresock

James M. Gresock
Senior Vice President
Director of Development

JMG:lds
cc Alan Nusbaum
Rob Dewey, Esquire
Lawrence Beamer
Darryl Cook

FILE- MONTICELLO MKT.

S.L. NUSBAUM Realty Co.

9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

Via Airborne Express

November 30, 1998

Powhatan Enterprises, Inc.
Attn: Lawrence F. Beamer, President
13441 Warwick Boulevard
Newport News, Virginia 23602

DEC 1998 RECEIVED ENVIRONMENTAL DIVISION

Re: Monticello Marketplace Shopping Center
James City County BMP Maintenance Agreement

Dear Lawrence,

With the opening of Monticello Marketplace Shopping Center in October, the James City County staff wants to complete the necessary paperwork on our project at this time. Accordingly, I enclose a Declaration of Covenants-Inspections/Maintenance of Drainage System Agreement that needs to be executed by Powhatan Enterprises, Inc.

This agreement covers the obligation of Powhatan Enterprises, as the owner of the property on which the BMP facility is located, to maintain the system and allow the County to inspect the same, etc. This is the County's standard form, and based on what we have seen in other jurisdictions, a very reasonable one.

As you will recall, the Deed of Easement between Powhatan Enterprises and Monticello Marketplace Associates, a copy of which is attached, provides that Powhatan Enterprises will repair and maintain the BMP located within the Drainage Easement Area and related facilities at its own expense, subject to our paying a proportionate share of the reasonable costs incurred.

Please sign the Declaration in the space provided on Page 3, and have your signature acknowledged before a notary public. Once this is completed, please return the Declaration to my attention to forward to the appropriate County staff.

Please call me if you have any questions regarding this Agreement. Thank you for your assistance, and best wishes during the holiday season.

Sincerely,

James M Gresock

James M. Gresock
Senior Vice President
Director of Development

JMG:lds
cc Rob Dewey, Esquire/Willcox & Savage
Alan Nusbaum/S.L. Nusbaum
Darryl Cook/Environmental Department, James City Co. (with enclosure)

DEVELOPMENT MANAGEMENT

101-E MOUNTS BAY ROAD, P.O. BOX 8784, WILLIAMSBURG, VIRGINIA 23187-8784
(757) 253-6671 Fax: (757) 253-6850 E-MAIL: devtman@james-city.va.us

CODE COMPLIANCE
(757) 253-6626
codecomp@james-city.va.us

ENVIRONMENTAL DIVISION
(757) 253-6670
environ@james-city.va.us

PLANNING
(757) 253-6685
planning@james-city.va.us

COUNTY ENGINEER
(757) 253-6678

INTEGRATED PEST MANAGEMENT
(757) 253-2620

May 11, 1998

Mr. James Gresock
S.L. Nusbaum Realty Co.
9211 Forest Hill Avenue, Suite 110
Richmond, VA 23235

RE: Monticello Marketplace Shopping Center

Dear Mr. Gresock:

Enclosed for your use is the Declaration of Covenants, Inspection/Maintenance of Drainage System form that needs to be executed to guarantee long-term maintenance of the Best Management Practice (BMP) that controls the runoff from your project site. The Agreement needs to be completed and notarized and returned to this office for recordation.

In addition, I also want to discuss the issue of the clarity of the water in the pond that is immediately downstream of the BMP facility. The County has received numerous complaints about the turbidity in the pond that has resulted from the construction of the shopping center and the Virginia Department of Transportation (VDOT) work on News Road and the Monticello Extension. In our opinion and in the opinion of the Department of Game and Inland Fisheries (DGIF) this should only be a short-term problem and that as the shopping center site and road work becomes completed and stabilized with vegetation and pavement, the turbidity should decrease and the clarity of the water increase. However, in the event that this does not occur naturally, I would request that your firm either alone or in conjunction with VDOT treat the pond to remove the turbidity. DGIF has recommended treating the surface of the water with lime to improve its clarity. This was tried as a test on the BMP/sediment basin and an improvement in water clarity was noticed until the recent heavy rains caused another increase in turbidity.

I would appreciate hearing from you on the issue of turbidity removal in the near future. Please contact me at 253-6673 if you have any questions.

Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

Powhatan Community Services Assn (PCSA)
P.O. Box 5004
Williamsburg, VA 23188-5004

Memorandum of Meeting November 8, 2005

Subject: Long-Term Maintenance of BMP (Detention Pond) at Corner of News Rd & Monticello Avenue

Undersigned participated this date in a meeting with John Horne and Darryl Cook (representing JCC Development Management & Environmental Control); Jim Brewer (VDOT Regional Administrator); James Gresock (S.L. Nusbaum Realty Co. representing management of Monticello Marketplace); and Lawrence Beamer (Developer of *Powhatan Secondary*).

After preliminary discussion and "exchange of positions" (which included the fact that by prior agreement or law that VDOT and JCC have no financial responsibility for contribution towards long-term maintenance of the BMP despite being major contributors), the following appears to be the *road map* as regards responsibility for the BMP:

- Within certain pre-stated parameters [not identified herein], Lawrence Beamer will ultimately take possession of the BMP. Concurrently, James City County will undertake a project to install plantings along News Rd to screen the BMP from view of those driving by on News Rd.

- If desired by Lawrence Beamer and the ultimate owner/occupant of the commercial property that borders the west side of the BMP, the pond *may* be allowed to have a small depth of water that would cover the bottom and enable operation of a fountain for "beautification" purposes (of value only to the owner/occupant of said commercial property). All costs associated with this effort, both initial and long-term maintenance of the fountain, would be the responsibility of the commercial property owner/occupant.

- Reluctantly, it is acknowledged that the ownership of the BMP would eventually transfer from the Developer of *Powhatan Secondary* to our homeowners association (***PCSA***) ..... but with a well-defined agreement that all costs associated with maintenance and repair of the BMP would be assessed to three contributors, those being the owners of MONTICELLO MARKETPLACE & MARKETPLACE SHOPPES; small portion of WINDSORMEADE MARKETPLACE; and potentially the commercial property adjacent to the BMP that was to be occupied by Eckerd Drug Stores. Those costs would include but not be limited to periodic mowing/trimming of the sides of the dam, any maintenance of the BMP required by JCC, and any repair of the BMP "structures" (including any portion of the dam itself) that may become necessary.

PHILLIP SMEAD
Resident

John Horne

From: Jim Gresock [jgresock@slnusbaum.com]
Sent: Wednesday, November 09, 2005 11:22 AM
To: Phil Smead
Cc: MacKenzie, Doug; Beamer, Jonathon; Beamer, Lawrence; Chapman, John; Malarkey, Madeline and Pat; Puterbaugh, Kirk; Shumaker, Patricia; John Horne; Jones, CJ
Subject: RE: Memorandum of Meeting

No problem I agree

From: Phil Smead [mailto:philsmead@cox.net]
Sent: Wednesday, November 09, 2005 11:18 AM
To: Jim Gresock
Cc: MacKenzie, Doug; Beamer, Jonathon; Beamer, Lawrence; Chapman, John; Malarkey, Madeline and Pat; Puterbaugh, Kirk; Shumaker, Patricia; Horne, John; Jones, CJ
Subject: Re: Memorandum of Meeting

I take no issue with your statement, other than to assert that prior to transition of the BMP from Powhatan Enterprises to PCSA, the Developer must have whatever study is required to define the "sharing" accomplished, and then prepare an agreement between himself and ***PCSA*** that provides absolute clarity that 100% of maintenance/repair costs are passed on to the contributors of stormwater to the BMP.

> ----- Original Message -----
> **From:** Jim Gresock
> **To:** Phil Smead ; Horne, John ; MacKenzie, Doug ; Beamer, Jonathon ; Beamer, Lawrence ; Chapman, John ; Malarkey, Madeline and Pat ; Puterbaugh, Kirk ; Shumaker, Patricia
> **Cc:** Jones, CJ
> **Sent:** Wednesday, November 09, 2005 9:50 AM
> **Subject:** RE: Memorandum of Meeting
>
> Phil,
> I am in agreement with your memo except for the third item.Agreements are already in place or drafted for implementation that you should review if you haven't already.Specifically,there is a Deed of Easement dated 9/04/1996 by and between Powhatan Enterprises,Inc. and Monticello Marketplace Associates Associates LLC invoving a sewer easement and drainage easement.The drainage easement involves the BMP and setsforth various rights and responsibilities.In addition a Declaration of Covenants Inspection/Maintenance of Drainage System using the County's document format was drafted but not finalized because of the disputes addressed at our meeting between Lawrence Beamer,County and VDOT. A remedy to the dispute appears to be forthcoming which would lead to completion of this agreement.
> Finally,the contributors to the BMP who are to be assessed needs to be verified by an engineer acceptable to all parties as stated in aforementioned Deed of Easement.Monticello Marketplace & Marketplace Shoppes are contributors but it is not clear if Windsormeade Marketplace is.I will assist in the clarification of this matter since I am involved in all three projects.The Eckerd Drug Store site is also a contributor and perhaps some other tracts of land that require further investigation.
>
> ---
>
> **From:** Phil Smead [mailto:philsmead@cox.net]
> **Sent:** Tuesday, November 08, 2005 9:38 PM
> **To:** Horne, John; MacKenzie, Doug; Beamer, Jonathon; Beamer, Lawrence; Chapman, John; Malarkey, Madeline and Pat; Puterbaugh, Kirk; Shumaker, Patricia; Jim Gresock
> **Cc:** Jones, CJ
> **Subject:** Memorandum of Meeting

The attached summarizes my understanding of the meeting held 8 Nov 05 to address long-term maintenance responsibility for the BMP adjacent to the Monticello Marketplace

---

NOTICE: This e-mail message (including all attachments transmitted with it, if any) is intended solely for the use of the addressee and may contain legally privileged and confidential information. If you are not the person to whom this e-mail is addressed, or an employee or agent responsible for delivering this message to the person to whom it is addressed, you are hereby notified that any dissemination, distribution, copying, or other use of this message or its attachments is strictly prohibited.

If you have received this e-mail in error, please notify the sender immediately by e-mail reply, then please delete this e-mail, together with any attachments to it, from your computer.

If this message contains a proposal for sale or lease, the terms therein shall not be binding upon either party until such time as a contract or lease agreement has been fully-executed.

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Scott Thomas

From: Darryl Cook
Sent: Monday, October 03, 2005 10:48 AM
To: John Horne
Cc: Scott Thomas
Subject: RE: Monticello BMP

We have completed the review of the BMP and the work they did to get it in an acceptable condtion. It is ready for the next step with Lawrence, VDOT and Jim Gresock.

-----Original Message-----
From: Brewer, Jim (Williamsburg) [mailto:Jim.Brewer@VDOT.Virginia.gov]
Sent: Tuesday, September 20, 2005 2:05 PM
To: John Horne; Darryl Cook
Subject: Monticello BMP

John and Darryl

I believe that we have completed everything that was required on the pond.
What is the next step to resolve this issue, so that we can both get it off
our plates.

Thanks

Jim Brewer
Residency Administrator
Williamsburg Residency
(757) 253-5140
Fax (757) 253-5148

Scott Thomas

From: Scott Thomas
Sent: Monday, October 03, 2005 11:04 AM
To: Darryl Cook
Subject: RE: Monticello BMP

For record purposes, I inspected the BMP on Friday September 30th. All repairs made by VDOT per our punchlist appeared adequately addressed and there were no further issues from my end.

Scott J. Thomas, P.E.
James City County
Environmental Division

-----Original Message-----
From: Darryl Cook
Sent: Tuesday, September 20, 2005 2:53 PM
To: 'Brewer, Jim (Williamsburg)'; John Horne
Cc: Scott Thomas
Subject: RE: Monticello BMP

I have looked at it and you addressed the issues that we discussed on our last site visit. As Scott has also looked at it but has not seen the latest repairs, I would like him to look at it as well. I'll have an answer on the pond condition by the end of the week. Then it would seem to be time to approach Mr. Beamer and say it is ready to go - that it meets County stnds.

-----Original Message-----
From: Brewer, Jim (Williamsburg) [mailto:Jim.Brewer@VDOT.Virginia.gov]
Sent: Tuesday, September 20, 2005 2:05 PM
To: John Horne; Darryl Cook
Subject: Monticello BMP

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our plates.

Thanks

Jim Brewer
Residency Administrator
Williamsburg Residency
(757) 253-5140
Fax (757) 253-5148

Langley and McDonald Transmittal

ENGINEERS•PLANNERS•SURVEYORS

5544 Greenwich Road
☐ Virginia Beach, Virginia 23462
(804) 473-2000

☒ 201 Packets Court
Williamsburg, Virginia 23185
(804) 253-2975

Project: MONTICELLO MARKETPLACE

To: DARRYL COOK
ENVIRONMENTAL DIVISION
JAMES CITY COUNTY

From: DOUG WHITE

Date: AUG 28, 1997

Reply requested: ☒ Yes ☐ No

Reply to: DOUG WHITE

We are sending you:
☒ Attached
☐ Under separate cover via:

☐ Prints
☐ Copy of letter
☐ Plans
☐ Specifications
☐ Shop drawings
☐ CALCULATIONS

Transmitted as checked below:
☐ For your use
☒ As requested
☐ For review and comment
☒ For approval
☐ Return for correction
☐ Approved as noted
☐ Approved
☐

PC140

Copies	Date	No.	Description
1	8-6-97		DITCH CALCS, DRAINAGE STRUCTURES, STORMWATER MANAGEMENT + TEMPORARY SEDIMENT BASIN CALCULATIONS BY MMM DESIGN GROUP.

Remarks: FOR INCLUSION IN STORMWATER MANAGEMENT SUBMITTAL OF 8-25-97 FOR MONTICELLO MARKETPLACE.

DARRYL: YOUR EARLIEST POSSIBLE REVIEW WOULD BE MUCH APPRECIATED.

DOUG,

Copies
1. File: 96046-7
2.
3.
4.

Enclosures
☐
☐
☐
☐

Langley and McDonald

By: [signature]

If enclosures are not as noted, kindly notify us at once.

#4

MMM DESIGN GROUP
ARCHITECTS + ENGINEERS + PLANNERS

229 WEST BUTE STREET
P.O. BOX 269
NORFOLK, VIRGINIA 23510
(804) 623-1641
FAX (804) 623-5809

VIA
FEDERAL EXPRESS

LETTER OF TRANSMITTAL

DATE: 3-26-97	JOB NO. 6429.05
RE: ROUTE 199	
SWM FACILITY 'D'	
JOINT USE VDOT & POWHATAN	
SECONDARY DEVELOPMENT	

TO LANGLEY & McDONALD
201 PACKETS COURT
WILLIAMSBURG VA 23185

ATTENTION: DOUG WHITE

GENTLEMEN:

WE ARE SENDING YOU ☑ Attached ☐ Under separate cover via _____ the following items:

- ☐ Shop drawings
- ☐ Copy of letter
- ☐ Prints
- ☐ Change order
- ☐ Plans
- ☐ Sepias
- ☐ Samples
- ☐ Specifications
- ☑ DESIGN COMPS

COPIES	DATE	DRAWING NO.	DESCRIPTION
1			STM. SWR & SWM FACILITY DESIGN COMPS
			FOR SWM "D" AT POWHATAN PARKWAY
			AND MONTICELLO AVE. EXT.

THESE ARE TRANSMITTED as checked below:

- ☐ For approval
- ☑ For your use
- ☐ As requested
- ☐ FOR BIDS DUE _____ 19____
- ☐ Returned for corrections
- ☐ Approved as submitted
- ☐ Approved as noted
- ☐ For review and comment
- ☐ Per Owner's request
- ☐ Prints returned after loan to us

REMARKS PER AUTHORIZATION FROM MARK WHITE, VDOT PROJECT MGR.

PLEASE CALL IF YOU HAVE ANY QUESTIONS

COPY TO
FILE

VERY TRULY YOURS
MMM DESIGN GROUP

BY

FILE · MONT. Mktplace

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
PO BOX HD
WILLIAMSBURG, 23187-3608

MAY 2000
RECEIVED
ENVIRONMENTAL DIVISION

CHARLES D. NOTTINGHAM
COMMISSIONER

QUINTIN D. ELLIOTT
RESIDENT ENGINEER

May 15, 2000

Route: 199
Project: 0199-047-F03,C503,D611-613
FHWA: STP-199-5(003)
Location: James City Co.

S. L. Nusbaum Realty Co.
9211 Forest Hill Avenue, Suite 110
Richmond, VA 23235

Attn: Mr. James M. Gresock

Ref: Algae Storm Water Management Basin

Dear Mr. Gresock:

This is concerning your letter dated May 2, 2000 concerning the appearance of algae in the SWM Basin. We have discussed this with Mr. Lawrence Beamer and we are at the present time having our contractor, Jack L. Massie purchase Grass Carp to control the algae. The carp will be placed in our SWM Basin on a trial period to evaluate the vegetation control. If this is successful we will then discuss with Mr. Beamer the purchase of Carp for the larger lake. These Carp are being purchased through the Virginia Game and Inland Fisheries and will be permitted to the Department.

Should you need additional information on this matter, please call at 757-253-4862.

Sincerely,

Quintin Elliott
Resident Engineer

By: Jimmy I. Hamrick
Assistant Resident Engineer

JIH/lja
Attachment
Xc: ✓Mr. Darryl Cook, James City Co. w/attachment
Mr. Lawrence Beamer, Powhatan Enterprises, w/attachment
Ms. Jane Wimbush w/attachment
Mr. Joe Parker w/attachment
File w/attachment

WE KEEP VIRGINIA MOVING

S.L. NUSBAUM Realty Co.
9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

May 2, 2000

Powhatan Enterprises, Inc.
Attn: Lawrence F. Beamer, President
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Newport News, Virginia 23602

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Sincerely,

James M. Gresock

James M. Gresock
Senior Vice President
Director of Development

RECEIVED VDOT

MAY 1 2 2000

WILLIAMSBURG RESIDENCY

JMG:lds

cc Alan Nusbaum
Darryl Cook
Quinton Elliott

FILE- Monticello Mkt'place

S.L. NUSBAUM Realty Co.

9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

FEB 1999 RECEIVED ENVIRONMENTAL DIVISION

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Mr. Quinton Elliott
Resident Engineer
Virginia Department of Transportation
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If you have any questions or need to meet to further discuss same, please advise as I can make myself readily available.

Sincerely,

James M. Gresock

James M. Gresock
Senior Vice President
Director of Development

JMG:lds
cc Alan Nusbaum
Rob Dewey, Esquire
Lawrence Beamer
Darryl Cook

DEVELOPMENT MANAGEMENT

101-E MOUNTS BAY ROAD, P.O. BOX 8784, WILLIAMSBURG, VIRGINIA 23187-8784
(757) 253-6671 Fax: (757) 253-6850 E-MAIL: devtman@james-city.va.us

CODE COMPLIANCE
(757) 253-6626
codecomp@james-city.va.us

ENVIRONMENTAL DIVISION
(757) 253-6670
environ@james-city.va.us

PLANNING
(757) 253-6685
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COUNTY ENGINEER
(757) 253-6678

INTEGRATED PEST MANAGEMENT
(757) 253-2620

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9211 Forest Hill Avenue, Suite 110
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Sincerely,

Darryl E Cook

Darryl E. Cook, P.E.
Environmental Director

FILE- MONTICELLO MKT.

S.L. NUSBAUM Realty Co.

9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

Via Airborne Express

November 30, 1998

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Attn: Lawrence F. Beamer, President
13441 Warwick Boulevard
Newport News, Virginia 23602

DEC 1998
RECEIVED
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Dear Lawrence,

With the opening of Monticello Marketplace Shopping Center in October, the James City County staff wants to complete the necessary paperwork on our project at this time. Accordingly, I enclose a Declaration of Covenants-Inspections/Maintenance of Drainage System Agreement that needs to be executed by Powhatan Enterprises, Inc.

This agreement covers the obligation of Powhatan Enterprises, as the owner of the property on which the BMP facility is located, to maintain the system and allow the County to inspect the same, etc. This is the County's standard form, and based on what we have seen in other jurisdictions, a very reasonable one.

As you will recall, the Deed of Easement between Powhatan Enterprises and Monticello Marketplace Associates, a copy of which is attached, provides that Powhatan Enterprises will repair and maintain the BMP located within the Drainage Easement Area and related facilities at its own expense, subject to our paying a proportionate share of the reasonable costs incurred.

Please sign the Declaration in the space provided on Page 3, and have your signature acknowledged before a notary public. Once this is completed, please return the Declaration to my attention to forward to the appropriate County staff.

Please call me if you have any questions regarding this Agreement. Thank you for your assistance, and best wishes during the holiday season.

Sincerely,

James M Gresock

James M. Gresock
Senior Vice President
Director of Development

JMG:lds
cc Rob Dewey, Esquire/Willcox & Savage
Alan Nusbaum/S.L. Nusbaum
Darryl Cook/Environmental Department, James City Co. (with enclosure)

Date Record Created:

Created By:

WS_BMPNO: PC140

PRINTED ON
Thursday, March 04, 2010
4:11:39 PM

WATERSHED	PC
BMP ID NO	140
PLAN NO	SP-40-97
TAX PARCEL	
PIN NO	3830100032
CONSTRUCTION DATE	
PROJECT NAME	VDOT BMP at Monticello-Private Dam
FACILITY LOCATION	SW Intx of News Road & Mont Ave Ext
CITY-STATE	Williamsburg, Va. 23185
CURRENT OWNER	
OWNER ADDRESS	
OWNER ADDRESS 2	
CITY-STATE-ZIP CODE	
OWNER PHONE	
MAINT AGREEMENT	Yes
EMERG ACTION PLAN	No

MAINTENANCE PLAN	No
SITE AREA acre	
LAND USE	Retail & Roadway
old BMP TYP	Wet Pond
JCC BMP CODE	A2 Wet Pond
POINT VALUE	
SVC DRAIN AREA acres	135.6
SERVICE AREA DESCRI	Monticello Marketplace & VDOT Roads
IMPERV AREA acres	43.33
RECV STREAM	UT of Powhatan Creek
EXT DET-WQ-CTRL	Yes
WTR QUAL VOL acre-ft	1.8
CHAN PROT CTRL	No
CHAN PROT VOL acre-ft	0
SW/FLOOD CONTROL	Yes
GEOTECH REPORT	No

CTRL STRUC DESC	VDOT DI-7
CTRL STRUC SIZE inches	3' x 3.5'
OTLT BARRL DESC	RCP Barrel
OTLT BARRL SIZE inch	48
EMERG SPILLWAY	Yes
DESIGN HW ELEV	69.34
PERM POOL ELEV	63.00
2-YR OUTFLOW cfs	90.95
10-YR OUTFLOW cfs	138.32
REC DRAWING	No
CONSTR CERTIF	No
LAST INSP DATE	
Inspected by:	
INTERNAL RATING	
MISC/COMMENTS	SWMF "D". Shared Maint Facility VDOT/Developer.

Get Last BMP No | Return to Menu | Print Record

Additional Comments:

MMM DESIGN GROUP
ARCHITECTS + ENGINEERS + PLANNERS

STEVE W. LOWRY
SENIOR CIVIL ENGINEER

229 WEST BUTE STREET ■ NORFOLK, VIRGINIA 23510
POST OFFICE BOX 269 ■ NORFOLK, VIRGINIA 23501
PHONE (804) 623-1641 ■ FAX (804) 623-5809
e-mail to...mmm@infi.net

Pat Menichino

From: Scott Thomas
Sent: Tuesday, July 23, 2013 2:33 PM
To: Pat Menichino
Cc: Joseph Buchite; Greg Johnson; Bill Cain
Subject: Martins Fuel; SP-2-11

I got your voicemail and talked with staff. The manufactured BMP oil/water separator device was pretreatment installed to treat incidental runoff or should a spill occur beneath the fuel canopy only. This was from a pollution prevention plan aspect which is typical of what we ask for on fuel/gas stations, whether through conditions or proffers if an SUP or rezoning; or as a pretreatment device if a byright plan. This site itself was not subject to water quality under the County's 10-point system. The Powhatan Secondary master stormwater management plan and PC-140 is the facility which provides compliance. Therefore, in these situations we would not assign it a BMP #.

The asbuilts and file forwarded were for a storm system only.

add to PC140

Scott J. Thomas, P.E.
Director of Engineering and Resource Protection

James City County VIRGINIA Jamestown 1607

101-E Mounts Bay Road
Williamsburg, VA 23185
P: 757-253-6639
F: 757-259-4032
jamescitycountyva.gov

TRANSMITTAL SHEET

ENGINEERING & RESOURCE PROTECTION → STORMWATER

Project: **Martin's Fuel Facility**

County Plan No.: **SP-002-2011**

Assigned BMP No.: **None storm pipe only**

BMP Type:

Information Enclosed:

X Record Drawings (Asbuilts)

X Construction Certification

X Computations

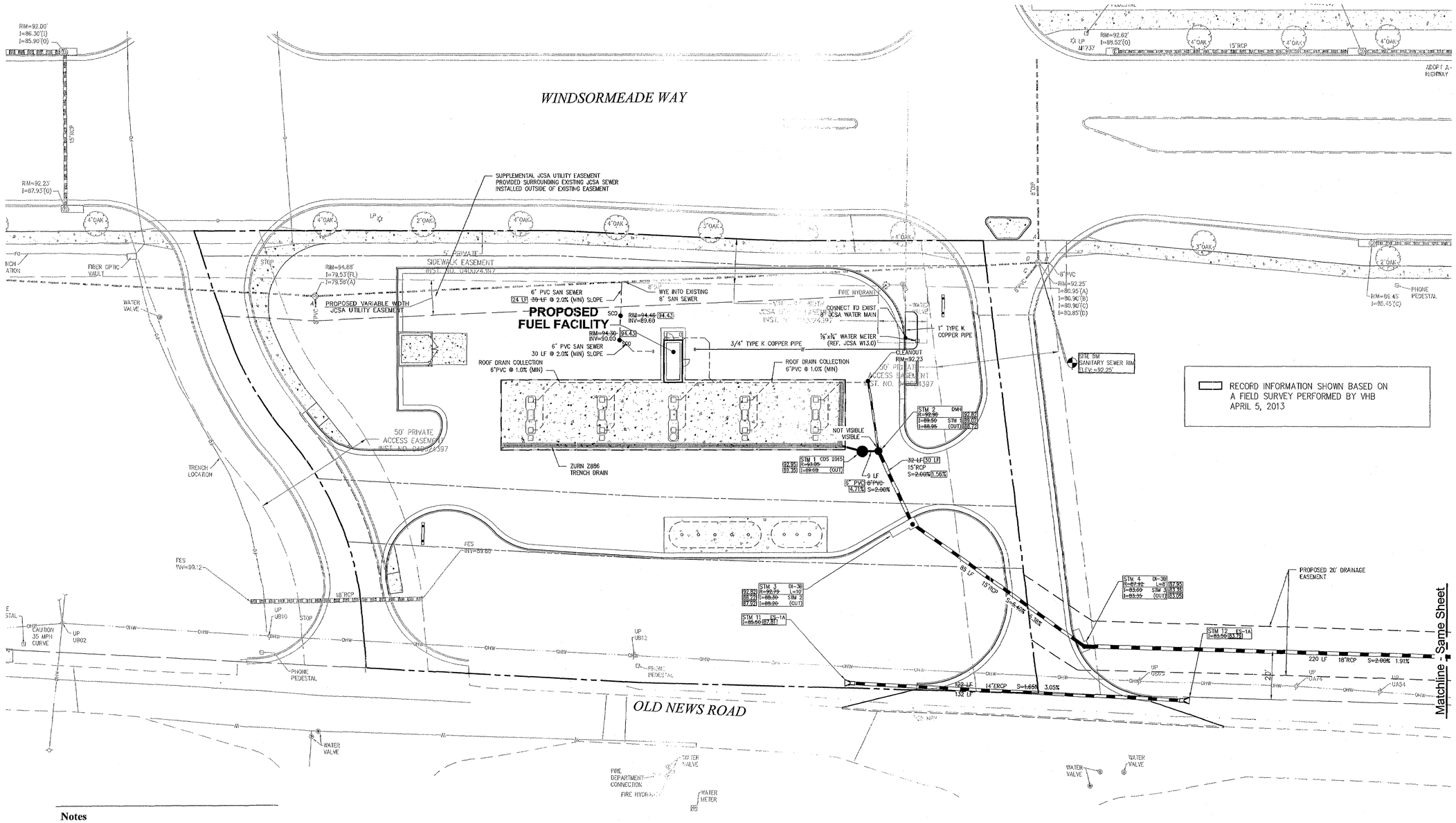
□ Other :

Name: **Gregory B. Johnson**

Date: 7/11/13

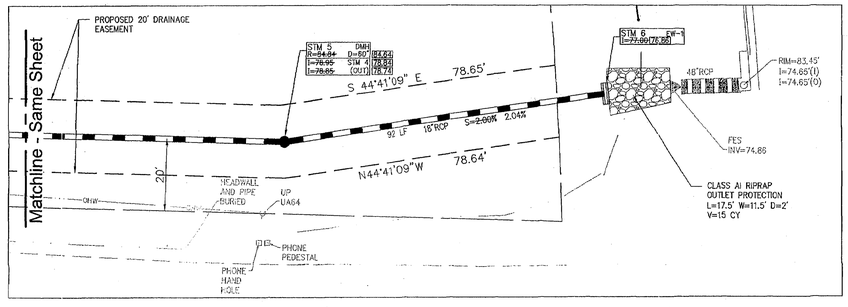
Signature:

\\VARIDATA\PROJECTS\33205.00\CAD\SR\PLANSET\3320500-W-AB



Notes

1. EASEMENTS DENOTED AS "JCSA UTILITY EASEMENTS" ARE FOR THE EXCLUSIVE USE OF THE JAMES CITY SERVICE AUTHORITY AND THE PROPERTY OWNER. OTHER UTILITY SERVICE PROVIDERS DESIRING TO USE THESE EASEMENTS WITH THE EXCEPTION OF PERPENDICULAR UTILITY CROSSINGS MUST OBTAIN AUTHORIZATION FOR ACCESS AND USE FROM JCSA AND THE PROPERTY OWNER. ADDITIONALLY, JCSA SHALL NOT BE HELD RESPONSIBLE FOR ANY DAMAGE TO IMPROVEMENTS WITHIN THIS EASEMENT, FROM ANY CAUSE.
2. HORIZONTAL DATUM BASED ON GPS LOCALIZATION USING JAMES CITY COUNTY GEODETIC MONUMENTS: 310, 313, 315, 316, 317, 318, 324, AND 325.
3. VERTICAL DATUM BASED ON RECORD PLANS PREPARED BY AES TITLED "WINDSORMEADE WAY ROADWAY/UTILITIES PLAN AND PROFILE STA. 10+75± TO STA. 17+00, DATED MAY 2, 2002.



RECORD DRAWING

I HEREBY CERTIFY TO THE BEST OF MY KNOWLEDGE AND BELIEF THAT THIS RECORD DRAWING REPRESENTS THE ACTUAL CONDITION OF THE STORMWATER MANAGEMENT/BMP FACILITY. THE FACILITY APPEARS TO CONFORM WITH THE PROVISIONS OF THE APPROVED DESIGN PLAN, SPECIFICATIONS AND STORMWATER MANAGEMENT PLAN, EXCEPT AS SPECIFICALLY NOTED.

COMMONWEALTH OF VIRGINIA
4/17/13
STEPHEN A. ROMEO
Lic. No. 1448-B
LAND SURVEYOR

Environmental Division
MAY 20 2013
RECEIVED

VHB
Vanasse Hangen Brustlin, Inc.
Transportation
Land Development
Environmental Services
351 McLaws Circle, Suite 3
Williamsburg, Virginia 23185
757.220.0500 • FAX 757.220.8544

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Carlisle, PA 17013

N

20 0 20 40
SCALE IN FEET

No.	Revision	Date	Apprvd.

Designed by	Drawn by AJL	Checked by AJL	
CAD checked by SAR		Approved by SAR	
Scale 1"=20'		Date April 17, 2013	

Project Title
Martin's Fuel Facility
Store #6402
JCC-SP-0002-2011
4820 Monticello Avenue
Williamsburg, Virginia

Issued for
Keystone Petroleum Equipment, Ltd.

Drawing Title
Utility As-built Plan

Drawing Number
R-1

Sheet 1 of 1

Project Number
33724.00

3320500-W-AB.DWG

COPY

COUNTY OF JAMES CITY, VIRGINIA

DECLARATION OF COVENANTS
INSPECTION/MAINTENANCE OF DRAINAGE SYSTEM

Please type or print legibly in black ink. Covenantor(s) should submit this form to the JCC Environmental Division, 101-E Mounts Bay Road, Williamsburg, VA 23185.

THIS DECLARATION OF COVENANTS, made this 15th day of April, 20 11, between SLN Casey Associates, L.L.C., and all successors in interest, ("COVENANTOR(S)"), owner(s) of the following property:

Parcel Identification Number(s): 3831800003A & 3831800003B
Legal Description(s): L-3A and L-3B of CC Casey Limited Co parcels 1-5 (WindsorMeade Marketplace)

Project or Subdivision Name: Martin's Fuel Facility, Store #6402
Document/Instrument No(s): 040024401
or Deed Book _____, Page No. _____,
and the County of James City, Virginia ("COUNTY.")

WITNESSETH:

I (We), the COVENANTOR(S), with full authority to execute deeds, mortgages, other covenants, and all rights, titles and interests in the property described above, do hereby covenant with the COUNTY as follows:

1. The COVENANTOR(S) shall provide maintenance for the drainage system including any runoff control facilities, conveyance systems and associated easements, hereinafter referred to as the "SYSTEM," located on and serving the above-described property to ensure that the SYSTEM is and remains in proper working condition in accordance with approved design standards, and with the law and applicable executive regulations. The SYSTEM shall not include any elements located within any Virginia Department of Transportation rights-of-way.

2. If necessary, the COVENANTOR(S) shall levy regular or special assessments against all present or subsequent owners of property served by the SYSTEM to ensure that the SYSTEM is properly maintained.

3. The COVENANTOR(S) shall provide and maintain perpetual access from public right-of-ways to the SYSTEM for the COUNTY, its agent and its contractor.

4. The COVENANTOR(S) shall grant the COUNTY, its agent and its contractor a right of entry to the SYSTEM for the purpose of inspecting, monitoring, operating, installing, constructing, reconstructing, maintaining or repairing the SYSTEM.

5. If, after reasonable notice by the COUNTY, the COVENANTOR(S) shall fail to maintain the SYSTEM in accordance with the approved design standards and with the law and applicable executive regulations, the COUNTY may perform all necessary repair or maintenance work, and the COUNTY may assess the COVENANTOR(S) and/or all property served by the SYSTEM for the cost of the work and any applicable penalties.

Prepared by (Name, Address & Phone):
James M. Gresock, Senior Vice President
S.L. Nusbaum Realty Co.
9211 Forest Hill Ave., #110, Richmond, VA 23235
(804)320-7600 Extension 1312

Return to:
JCC Attorney's Office
101-C Mount's Bay Road
Williamsburg, VA 23185
(757) 253-6612

Instrument # 110009118
recorded on 4-25-11

6. The COVENANTOR(S) shall indemnify and save the COUNTY harmless from any and all claims for damages to persons or property arising from the installation, construction, maintenance, repair, operation or use of the SYSTEM.

7. The COVENANTOR(s) shall promptly notify the COUNTY when the COVENANTOR(S) legally transfers any of the COVENANTOR(S) responsibilities for the SYSTEM. The COVENANTOR(S) shall supply the COUNTY with a copy of any document of transfer, executed by both parties.

8. The covenants contained herein shall run with the land and shall bind the COVENANTOR(S) and the COVENANTOR(S)' heirs, executors, administrators, successors and assignees, and shall bind all present and subsequent owners of property served by the SYSTEM.

9. This COVENANT shall be recorded in the County Land Records.

IN WITNESS WHEREOF, the COVENANTOR(S) has executed this DECLARATION OF COVENANTS as of the date first above written.

COVENANTOR(S)
SLN CASEY ASSOCIATES, L.L.C.
a Virginia limited liability company
BY: SLN Williamsburg Associates, L.L.C.
a Virginia limited liability company, Manager
BY: S.L. Nusbaum Realty Co.,
a Virginia corporation, Manager
BY: James M Gresock (SEAL)
James M. Gresock
Senior Vice President

ACKNOWLEDGMENT

COMMONWEALTH OF VIRGINIA
CITY/COUNTY OF Richmond, to wit:

I hereby certify that on this 15th day of April, 20 11, before the subscribed, a Notary Public for the Commonwealth of Virginia, personally appeared James M. Gresock and did acknowledge the foregoing instrument to be his/her Act.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal this 15th day of April, 20 11.

[SEAL]

DONNA M. JAMES
COMMONWEALTH OF VIRGINIA
REGISTRATION NO. 146836
MY COMM. EXPIRES: 07/31/2014
NOTARY PUBLIC

Donna M James
Notary Public

Notary Registration Number: 146836

My Commission expires: 7/31/14

Approved as to form:

Alan Lusman
County Attorney

Drainage1_pre_doc
(Revised 3-8-11)

James City County Environmental Division
Stormwater Management/BMP Record Drawing and Construction Certification Review Tracking Form

Project Name: MARTINS Fuel Facility
County Plan No.: SP-002-2011
Stormwater Management Facility: STORM PIPE - MANUFACTURED PRE TREATMENT
BMP Phase #: ☐ I ☐ II ☐ III
☒ Information Package Received. Date/By: 5/20/13
☒ Completeness Check:
- ☒ Record Drawing Date/By: 4/17/2013 Stephen A. Romeo
- ☒ Construction Certification Date/By: 4/17/2013 Scott Chapman
- ☒ RD/CC Standard Forms (Required for all BMPs after Feb 1st 2001Only)
- ☐ Insp/Maint Agreement # / Date:
- ☒ BMP Maintenance Plan Location: NA
- ☐ Other:

☐ Standard E&SC Note on Approved Plan Requiring RD/CC or County comment in plan review
- ☐ Yes ☐ No Location:

☒ Assign **County BMP ID Code #**: Code: NA
☒ Preliminary Input/Log into Division's "As-Built Tracking Log"
☒ Add Location to GIS Map. Obtain basic site information (GPIN, Owner, Address, etc.)
☒ Preliminary Log into Access Database (BMP ID #, Plan No., GPIN, Project Name, etc.)
☐ Active Project File Review (correspondence, H&H, design computations, etc.).
☒ Initial As-Built File setup (File label, folder, copy plan/details/design information, etc.).
☒ Inspector Check of RD/CC (forward to Inspector using transmittal for cursory review).
☒ Pre-Inspection Drawing Review of Approved Plan (Quick look prior to Field Inspection).
☒ Final Inspection (FI) Performed Date:
☒ Record Drawing (RD) Review Date:
☒ Construction Certification (CC) Review Date:
☒ Actions:
- ☒ No comments.
- ☐ Comments. Letter Forwarded. Date:
- ☐ Record Drawing (RD)
- ☐ Construction Certification (CC)
- ☐ Construction-Related (CR)
- ☐ Site Issues (SI)
- ☐ Other :

☐ Second Submission:
☐ Reinspection (if necessary):
☒ Acceptable for SWM Purposes (RD/CC/CR/Other). Ok to proceed with bond release.
☒ Complete "Surety Request Form".
☐ Check/Clean active file of any remaining material and finish "As-Built" file.
☐ Add to County BMP Inventory/Inspection schedule (Phase I, II or III).
☐ Copy Final Inspection Report into County BMP Inspection Program file.
☐ Obtain Digital Photographs of BMP and save into County BMP Inventory.
☐ Request mylar/reproducible from As-Built plan preparer.
☐ Complete "As-built Tracking Log".
☐ Last check of BMP Access Database (County BMP Inventory).
☐ Add BMP to JCC Hydrology & Hydraulic database (optional).
☐ Add BMP to Municipal BMP list (if a County-owned facility)
☐ Add BMP to PRIDE BMP ratings database.

Final Sign-Off

Inspector: Gary B Johnson Date:

Chief Engineer: Date: 7/2/13

*** See separate checklist, if needed.

Environmental Division
MAY 20 2013
RECEIVED

Stormwater Management/BMP Facilities Record Drawing and Construction Certification Forms

(Note: In accordance with the requirements of the Chesapeake Bay Preservation Ordinance, Chapter 23, Section 23-10(4), BMP's shall be designed and constructed in accordance with the manual entitled James City County Guidelines for Design and Construction of Stormwater Management BMP's. Erosion and sediment control policy and approved plans generally require that at the completion of the project and prior to release of surety, an "as-built" plan prepared by a registered Professional Engineer or Certified Land Surveyor must be provided for the drainage system for the project, including any Best Management Practice (BMP) facilities. In addition, for BMP facilities involving the construction of an impounding structure or dam embankment, certification is required by a Professional Engineer who has inspected the structure during its construction. Currently there are over 20 water quality type BMP's accepted by the County.)

Section 1 - Site Information:

Project Name: Martin's Fuel Facility, Store #6402
Structure/BMP Name: n/a
Project Location: 4820 Monticello Avenue
BMP Location: on site south of fuel pad
County Plan No.: SP-002-2011

Project Type:
- ☐ Residential
- ☑ Commercial
- ☐ Institutional
- ☐ Public
- ☐ Other _____
- ☑ Business
- ☐ Office
- ☐ Industrial
- ☐ Roadway

Tax Map/Parcel No.: 3831800003B
BMP ID Code (if known): _____
Zoning District: MU Mixed Use District
Land Use: _____
Site Area (sf or acres): 1.2037

Brief Description of Stormwater Management/BMP Facility:
CDS 2015 Hydrodynamic Separator used as an oil/water separator. Unit collects water from the the fuel area concrete pad through a trench drain system.

Nearest Visible Landmark to SWM/BMP Facility: Martin's Fuel Facility

Nearest Vertical Ground Control (if known):

☐ JCC Geodetic Ground Control ☐ USGS ☐ Temporary ☐ Arbitrary ☐ Other

Station Number or Name: _____
Datum or Reference Elevation: _____
Control Description: _____
Control Location from Subject Facility: _____

Section 2 - Stormwater Management/BMP Facility Construction Information:

Pre-Construction Meeting Held for Construction of SWM/BMP Facility: ☐ Yes ☐ No ☑ Unknown
Approx. Construction Start Date for SWM/BMP Facility: May 2011
Facility Monitored by County Representative during Construction: ☐ Yes ☐ No ☑ Unknown
Name of Site Work Contractor Who Constructed Facility: Keystone Petroleum Equipment, Inc.
Name of Professional Firm Who Routinely Monitored Construction: Froehling & Robertson, Inc.
Date of Completion for SWM/BMP Facility: June 2011
Date of Record Drawing/Construction Certification Submittal: April 17, 2013

(Note: Record Drawing and Construction Certifications are required within thirty (30) days of the completion of Stormwater Management and/or BMP facility construction. Record Drawings and Construction Certifications must be reviewed and approved by the James City County Engineering and Resource Protection Division prior to final inspection, acceptance and bond or surety release.)

Section 3 - Owner/Designer/Contractor Information:

Owner/Developer: *(Note: Site Owner or Applicant responsible for development of the project.)*

Name: S.L. Nusbaum Co.
Mailing Address: 9211 Forest Hill Avenue, Suite 110
Richmond, VA 23235
Business Phone: 804-320-7600 Fax: 804-330-8924
Contact Person: James Gresock Title: Vice President

Design Professional: *(Note: Professional Engineer or Certified Land Surveyor responsible for the design and preparation of plans and specifications for the Stormwater Management / BMP facility.)*

Firm Name: Vanasse Hangen Brustlin
Mailing Address: 351 McClaws Circle, Suite 3
Williamsburg, VA 23185
Business Phone: 757-220-0500
Fax: 757-220-8544
Responsible Plan Preparer: Scott Chapman
Title: Senior Project Manager
Plan Name: Martin's Fuel Facility, Store #6402
Firm's Project No. 33205.00
Plan Date: April 7, 2011
Sheet No.'s Applicable to SWM/BMP Facility: C5.01 / C7.01 / _____ / _____ / _____

BMP Contractor: *(Note: Site Work Contractor directly responsible for construction of the Stormwater Management/BMP facility.)*

Firm Name: Advanced Fueling Systems
Mailing Address: 9998 Lickinghole Road
Ashland, VA 23005
Business Phone: 804-798-2900

Fax: 804-798-2940
Contact Person: Linnie Hiter
Site Foreman/Supervisor: Bruce Cox
Specialty Subcontractors and Purpose (for BMP Construction Only): _____

Section 4 - Professional Certifications:

Certifying Professionals: *(Note: A Registered Professional Engineer or Certified Land Surveyor is responsible for preparation of a Record Drawing, sometimes referred to as an As-Built plan, for the drainage system for the project including any Stormwater Management/BMP Facilities. A Registered Professional Engineer is responsible for the inspection, monitoring and certification of Stormwater Management / BMP facilities during its construction.)*

Record Drawing and Construction Certifications for Stormwater Management/BMP Facilities

Record Drawing Certification

Firm Name: Vanasse Hangen Brustlin
Mailing Address: 351 McLaws Circle, Ste 3
Williamburg, VA 23185
Business Phone: 804-757-0500
Fax: 757-220-8544
Name: Steve Romeo
Title: Principle, Land Surveyor
Signature: _____
Date: 4-17-13

I hereby certify to the best of my knowledge and belief that this record drawing represents the actual condition of the Stormwater Management/BMP facility. The facility appears to conform to the provisions of the approved design plan, specifications design, and stormwater management plan, except as specifically noted.

COMMONWEALTH OF VIRGINIA
4/17/13
STEPHEN A. ROMEO
Lic. No. 1448-B
LAND SURVEYOR

_____(Seal)

Virginia Registered Professional Engineer or Certified Land Surveyor

Construction Certification

Firm Name: Vanasse Hangen Brustlin
Mailing Address: 115 S. 15th Street, Suite 200
Richmond, VA 23219
Business Phone: 804-343-7100
Fax: 804-343-1713
Name: Scott Chapman
Title: Senior Project Manager
Signature: _____
Date: 4-17-13

I hereby certify to the best of my knowledge and belief that this Stormwater Management/BMP facility was monitored and constructed in accordance with the provisions of the approved plan, specifications, and stormwater management plan, except as specifically noted.

COMMONWEALTH OF VIRGINIA
RAYMOND SCOTT CHAPMAN
Lic. No. 033557
PROFESSIONAL ENGINEER

_____(Seal)

Virginia Registered Professional Engineer

Section 5 - Record Drawing and Construction Certification Requirements and Instructions:

☑ Pre-Construction Meeting - Provides an opportunity to review SWM/BMP facility construction, maintenance and operation plans and addresses any questions regarding construction and/or monitoring of the structure. The design engineer, certifying professionals (if different), Owner/Applicant, Contractor and County representative(s) are encouraged to attend the preconstruction meeting. Advanced notice to the Engineering and Resource Protection Division is requested. Usually, this requirement can be met simultaneously with Erosion and Sediment Control preconstruction meetings held for the project.

☑ A fully completed ***STORMWATER MANAGEMENT / BMP FACILITIES, RECORD DRAWING and CONSTRUCTION CERTIFICATION FORM*** and ***RECORD DRAWING CHECKLIST***. All applicable sections shall be completed in their entirety and certification statements signed and sealed by the registered professional responsible for individual record drawing and/or construction certification.

☑ The Record Drawing shall be prepared by a Registered Professional Engineer or Certified Land Surveyor for the drainage system of the project including any Best Management Practices.

☐ Construction Certification - Construction of Stormwater Management / BMP facilities which contain impoundments, embankments and related engineered appurtenances including subgrade preparation, compacted soils, structural fills, liners, geosynthetics, filters, seepage controls, cutoffs, toe drains, hydraulic flow control structures, etc. shall be visually observed and monitored by a Registered Professional Engineer or his/her authorized representative. The Engineer must certify that the structure, embankment and associated appurtenances were built in accordance with the approved design plan, specifications and stormwater management plan and standard accepted construction practice and shall submit a written certification and/or drawings to the Engineering and Resource Protection Division as required. Soil and compaction test reports, concrete test reports, inspection reports, logs and other required construction material or installation documentation may be required by the Engineering and Resource Protection Division to substantiate the certification, if specifically requested. The Engineer shall have the authority and responsibility to make minor changes to the approved plan, in coordination with the assigned County inspector, in order to compensate for unsafe or unusual conditions encountered during construction such as those related to bedrock, soils, groundwater, topography, etc. as long as changes do not adversely affect the integrity of the structure(s). Major changes to the approved design plan or structure must be reviewed and approved by the original design professional and the James City County Environmental Division.

☐ Record Drawing and Construction Certifications are required within **thirty (30) days** of the completion of Stormwater Management / BMP facility construction. Submittals must be reviewed and accepted by James City County Engineering and Resource Protection Division prior to final inspection, acceptance and bond/surety release.

Dual Purpose Facilities - Completion of construction also includes an interim stage for Stormwater Management / BMP facilities which serve dual purpose as temporary sediment basins during construction and as permanent stormwater management / BMP facilities following construction, once development and stabilization are substantially complete. For these dual purpose facilities, construction certification is required once the temporary sediment basin phase of construction is complete. Final record drawing and construction certification of additional permanent components is required once permanent facility construction is complete.

Interim Construction Certification is required for those dual purpose embankment-type facilities that are generally ten (10) feet or greater in dam height (*) and may not be converted, modified or begin function as a permanent SWM / BMP structure for a period generally ranging from six (6) to eighteen (18) months or more from issuance of a Land Disturbance permit for construction.

Interim or final record drawing and construction certifications are not required for temporary sediment basins which are designed and constructed in accordance with current minimum standards and specifications for temporary sediment basins per the Virginia Erosion and Sediment Control Handbook (VESCH); have a temporary service life of less than eighteen (18) months; and will be removed completely once associated disturbed areas are stabilized, unless a distinct hazard to the public's health, safety and welfare is determined by the Engineering and Resource Protection Division due to the size or presence of the structure or due to evidence of improper construction.

(*Note: Dam Height as referenced above is generally defined as the vertical distance from the natural bed of the stream or waterway at the downstream toe of the embankment to the top of the embankment structure in accordance with 4VAC50-20-30, Virginia Impoundment Structure Regulations and the Virginia Dam Safety Program.)

☑ Record Drawings shall provide, at a minimum, all information as shown within these requirements and the attached **RECORD DRAWING CHECKLIST** specific to the type of SWM/BMP facility being constructed. Other additional record data may be formally requested by the James City County Engineering and Resource Protection Division. *(Note: Refer to the current edition of the James City County Guidelines for Design and Construction of Stormwater Management BMP's manual for a complete list of acceptable BMP's. Currently there are over 20 acceptable water quality type BMP's accepted by the County.)*

☑ Record Drawings shall consist of blue/black line prints and a reproducible (mylar, sepia, diazo, etc.) set of the approved stormwater management plan including applicable plan views, profiles, sections, details, maintenance plans, etc. as related to the subject SWM / BMP facility. The set shall indicate **"RECORD DRAWING "** in large text in the lower right hand corner of each sheet with record elevations, dimensions and data drawn in a clearly annotated format and/or boxed beside design values. Approved design plan values, dimensions and data shall not be removed or erased. Drawing sheet revision blocks shall be modified as required to indicate record drawing status. Elevations to the nearest 0.1' are sufficiently accurate except where higher accuracy is needed to show positive drainage. Certification statements as shown in Section 4 of the Record Drawing and Construction Certification Form, ***or similar forms thereof***, and professional signatures and seals, with dates matching that of the record drawing status in the revision or title block, are also required on all associated record drawing plans, prints or reproducibles.

☑ Submission Requirements - Initial and subsequent submissions for review shall consist of a minimum of one (1) blue/black line set for record drawings and one copy of the construction certification documents with appropriate transmittal. Under certain circumstances, it is understood that the record drawing and construction certification submissions may be performed by different professional firms. Therefore, record drawing submission may be in advance of construction certification or vice versa. Upon approval and prior to release of bond/surety, final submission shall include one (1) reproducible set of the record drawings, one (1) blue/black line set of the record drawings and one (1) copy of the construction certification. Also for current and/or future incorporation into the County BMP database and GIS system,

it is requested that the record drawings also be submitted to the Engineering and Resource Protection Division on a diskette or CD-ROM in an acceptable electronic file format such as *.dxf, *.dwg, etc. or in a standard scanned and readable format. The electronic file requirement can be discussed and coordinated with Engineering and Resource Protection Division staff at the time of final submission.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

I. Methods and Presentation: *(Required for all Stormwater Management/BMP facilities.)*

XX 1. All constructed facilities meet approved design plans, unless otherwise shown. Record information or deviations from approved design plan shown in clearly annotated format and/or boxed beside design values.

N/A 2. Elevations to the nearest 0.1' unless higher accuracy is needed to show positive drainage.

XX 3. All plan sheets labeled with "RECORD DRAWING" in large text in lower right hand corner. (Approved County Plan Number and BMP ID Code can be included if known).

XX 4. All plan sheet revision blocks modified to indicate date and record drawing status.

XX 5. All plan sheets have certification statements and certifying professional's signature and seal.

II. Minimum Standards: *(Required for all Stormwater Management / BMP facilities, as applicable.)*

XX 1. All requirements of Section I (Methods and Presentation) apply to this section.

XX 2. Plan Views: Show general location, arrangement and dimensions. Location and alignment shall generally match approved design plans.

N/A 3. Profile or elevations along top or berm of the facility. At a minimum, elevations are required at each end, at intervals not to exceed 50 feet and where low spots may be present. Top of embankment or berm elevations must be no less than design elevation plus any settlement allowances.

N/A 4. Top widths, berm widths, and embankment side slopes.

N/A 5. Show length, width and depth of facility or grading, contours or spot elevations as required to verify permanent pool and design storage volumes were met or were reasonably close to the approved design. Evaluation of as-built grading, contours, spot elevations, or cross-sections, may be necessary by the professional to ensure approved design configurations, depths and volumes were closely maintained. If grading or elevations are significantly different from the approved plan, the Engineering and Resource Protection Division shall be contacted immediately to determine whether the variation is acceptable or whether further evidence will be required. Facilities which do not closely resemble approved plan grades, elevations or configurations may require regrading by the Contractor; check volumetric computations; and/or a check hydraulic routing to ensure approved design water surface elevations, discharges or freeboard were closely maintained.

N/A 6. Cross-section of the embankment through the principal spillway or outlet barrel. Must extend at least 100 ft. downstream of the pipe outlet or to recorded site property line, whichever is closer. Proper correlation is required between principal spillway (control structure) crest, emergency spillway crest, orifice, and weirs and the top of the dam or facility. All elevations and dimensions must reasonably match the design plan or be sequentially relative to each other and the facility must reflect the required design storage volume(s) and/or design depth.

N/A 7. Profile or elevations along the entire centerline of the emergency spillway. Emergency spillway may be steeper, but no flatter or narrower than design.

N/A 8. Elevation of the principal spillway crest or outlet crest of the structure.

N/A 9. Primary control structure (riser) diameter or dimensions, height, type of material and base size. Indicate provisions for access that are present such as steps, ladders, etc.

N/A 10. Dimensions, locations and elevations of outlet orifices, weirs, slots and drains.

N/A 11. Type and size of anti-vortex and trash rack device. Height, diameter, dimensions, bar spacings (if applicable) and elevations relative to the principal spillway crest. Indicate if lockable hatch is present or not.

N/A 12. Type, location, size, and number of anti-seep collars or documentation of other methods utilized for seepage control. **May need to obtain this information during construction.**

N/A 13. Top of impervious core embankment, core trench limits and elevation of cut-off trench bottom. **May need to obtain this information during construction.**

N/A 14. Elevation of the principal spillway barrel (outlet pipe) inlet and outlet invert.

N/A 15. Outlet barrel diameter, length, slope, type, and thickness class of material and type of flared end sections, headwall or endwall.

N/A 16. Outfall protection dimension, type and depth of rock and if underlain filter fabric is present.

N/A 17. BMP interior and periphery landscaping zones conform with arrangements and requirements of the approved design plan.

XX 18. Maintenance plan taken from approved design plan transposed onto record drawing set.

N/A 19. Fencing location and type, if applicable to facility.

N/A 20. BMP vicinity properly cleaned of stockpiles and construction debris.

N/A 21. No visual signs of erosion or channel degradation immediately downstream of facility.

XX 22. Any other information formally requested by the Environmental Division specific to the constructed SWM/BMP facility.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

III. Group A - Wet Ponds *(Includes A-1 Small Wet Ponds; A-2 Wet Ponds; A-3 Wet Ext Det Ponds.)*

N/A A1. All requirements of Section II, Minimum Standards, apply to Group A facilities.

N/A A2. Principal spillway consists of reinforced concrete pipe with O-Ring gaskets for watertight joint construction.

N/A 3. Sediment forebays or pretreatment devices provided at inlets to pond. Generally 4 to 6 ft. deep.

N/A A4. Access for maintenance and equipment is provided to the forebay(s). Access corridors are at least 12 ft. wide, have a maximum slope of 15 percent and are adequately stabilized to withstand heavy equipment or vehicle use.

N/A A5. Adequate fixed vertical sediment depth markers installed in the forebay(s) for future sediment monitoring purposes.

N/A A6. Pond liner (if required) provided. Either clay liners, polyliners, bentonite liners or use of chemical soil additives based on requirements of the approved plan.

N/A A7. Minimum 6 percent slope safety bench extending a minimum of 15 feet outward from normal pool edge and/or an aquatic bench extending a minimum of 10 feet inward from the normal shoreline with a maximum depth of 12 inches below the normal pool elevation, if applicable, per the approved design plans. (Note: Safety benches may be waived if pond side slopes are no steeper than 4H:1V).

N/A A8. No trees are present within a zone 15 feet around the embankment toe and 25 feet from the principal spillway structure.

N/A A9. Wet permanent pool, typically 3 to 6 feet deep, is provided and maintains level within facility.

N/A A10. Low flow orifice has a non-clogging mechanism.

N/A A11. A pond drain pipe with valve was provided.

N/A A12. Pond side slopes are not steeper than 3H:1V, unless approved plan allowed for steeper slope.

N/A A13. End walls above barrels (outlet pipe) greater than 48 inch in diameter are fenced to prevent a fall hazard.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

IV. Group B – Wetlands *(Includes B-1 Shallow Marsh; B-2 Ext Det Shallow Wetlands; B-3 Pond Wetland System and B-4 Pocket Wetland)*

N/A B1. Same requirements as Group A Wet Ponds.

N/A B2. Minimum 2:1 length to width flow path provided across the facility.

N/A B3. Micropool provided at or around outlet from BMP (generally 3 to 6 ft. deep).

N/A B4. Wetland type landscaping provided in accordance with approved plan. Includes correct pondscaping zones, plant species, planting arrangements, wetland beds, etc. Wetland plants include 5 to 7 emergent wetland species. Individual plants at 18 inches on center in clumps.

N/A B5. Adequate wetland buffer provided (Typically 25 ft. outward from maximum design water surface elevation and 15 ft. setback to structures).

N/A B6. No more than one-half (½) of the wetland surface area is planted.

N/A B7. Topsoil or wetland mulch provided to support vigorous growth of wetland plants.

N/A B8. Planting zones staked or flagged in field and locations subsequently established by appropriate field surveying methods for record drawing presentation.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

V. Group C - Infiltration Practices *(Includes C-1 Infiltration Trench; C-2 Infiltration Trench; C-3 Infiltration Basin; and C-4 Infiltration Basin)*

N/A C1. All requirements of Section II, Minimum Standards, apply to Group C facilities as applicable.

N/A C2. Facility is not located on fill slopes or on natural ground in excess of six (6) percent.

N/A C3. Pretreatment devices provided prior to entry into the infiltration facility. Acceptable pretreatment devices include sediment forebays, sediment basins, sediment traps, sump pits or inlets, grass channels, plunge pools or other acceptable measures.

N/A C4. Three (3) or more of the following pretreatment devices provided to protect long term integrity of structure: grass channel; grass filter strip; bottom sand layer; upper filter fabric layer; use of washed bank run gravel aggregate.

N/A C5. Sides of infiltration practice lined with filter fabric.

N/A C6. Facility was not used for erosion and sediment control purposes and sediment was prevented from entering the facility to the greatest extent possible during construction.

N/A C7. Stabilization and acceptable vegetative cover established over contributing drainage area prior to conveyance of stormwater to the facility.

N/A C8. Minimum one hundred (100) foot separation horizontally from any known water supply well and minimum one hundred (100) foot separation upslope from any building.

N/A C9. Minimum twenty-five (25) foot separation down gradient from any structure.

N/A C10. Stormwater outfalls provided for overflow associated with larger design storms.

N/A C11. No visual signs of erosion or channel degradation immediately downstream of facility.

N/A C12. Facility does not currently cause any apparent surface or subsurface water problems to downgrade properties.

N/A C13. Observation well provided.

N/A C14. Adequate, direct access provided to the facility for future maintenance, operation and inspection.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

VI. Group D - Filtering Systems *(Includes D-1 Bioretention Cells; D-2 Surface Sand Filters; D-3 Underground Sand Filters; D-4 Perimeter Sand Filters; D-5 Organic Filters; and D-6 Pocket Sand Filters)*

N/A D1. All requirements of Section II, Minimum Standards, apply to Group D facilities.

N/A D2. Sediment pretreatment devices provided.

N/A D3. For D-1 BMPs (Bioretention Cells), pretreatment consisting of a grass filter strip below level spreader (deflector); a gravel diaphragm; and mulch and planting soil layers were provided.

N/A D4. For D-1 BMPs (Bioretention Cells), plantings consist of native plant species; vegetation provided was based on zones of hydric tolerances; trees and understory of shrubs and herbaceous materials were provided; woody vegetation is absent from inflow locations; and trees are located around facility perimeter.

N/A D5. Facility was not used for erosion and sediment control purposes and sediment was prevented from entering the facility to the greatest extent possible during construction.

N/A D6. No visible signs of accumulated silt/sediment were present in the facility following construction or alternately, accumulated silt/sediment was properly removed.

N/A D7. Filtering system is off-line from storm drainage conveyance system.

N/A D8. Overflow outlet has adequate erosion protection.

N/A D9. Deflector, diversion, flow splitter or regulator structure provided to divert the water quality volume to the filtering structure.

N/A D10. Minimum four (4) inch perforated underdrain provided in a clean aggregate envelope layer beneath the facility.

N/A D11. Minimum fifty (50) foot separation from any slope fifteen (15) percent or greater. Minimum one hundred (100) foot separation horizontally from any known water supply well. Minimum one hundred (100) foot separation upslope and twenty-five (25) foot separation downslope from any building.

N/A D12. Stabilization and acceptable vegetative cover established over contributing drainage area prior to conveyance of stormwater to the facility.

N/A D13. No visual signs of erosion or channel degradation immediately downstream of facility.

N/A D14. Adequate, direct access provided to the pretreatment area and/or filter bed for future maintenance.

STORMWATER MANAGEMENT/BMP FACILITIES
AS-BUILT PLAN CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

VII. Group E - Open Channel Systems *(Includes E-1 Wet Swales (Check Dams); E-2 Dry Swales; and E-3 Biofilters)*

N/A E1. All requirements of Section II, Minimum Standards, apply to Group E facilities as applicable.

N/A E2. Open channel system has constructed longitudinal slope of less than four (4) percent.

N/A E3. No visual signs of erosion in the open channel system's soil and/or vegetative cover.

N/A E4. Open channel side slopes are no steeper than 2H:1V at any location. Preferred channel sideslope is 3H:1V or flatter.

N/A E5. No visual signs of ponding are present at any location in the open channel system, except at rock check dam locations for E-1 systems (Wet Swales).

N/A E6. For E-2 BMPs (Dry Swales), an underdrain system was provided.

N/A E7. Treated timber or rock check dams provided as pretreatment devices for the open channel system.

N/A E8. Gravel diaphragm provided in areas where lateral sheet flow from impervious surfaces are directly connected to the open channel system.

N/A E9. Grass cover/stabilization in the open channel system appears adaptable to the specific soils and hydric conditions for the site and along the channel system.

N/A E10. Open channel system areas with grass covers higher than four (4) to six (6) inches were properly mowed.

N/A E11. Facility was not used for erosion and sediment control purposes and sediment was prevented from entering the facility to the greatest extent possible during construction.

N/A E12. No visible signs of accumulated silt/sediment were present in the facility following construction or alternately, accumulated silt/sediment was properly removed and no adverse affects to the function of the facility are anticipated.

N/A E13. For E-3 BMPs (Biofilters), the bottom width is six (6) feet maximum at any location.

N/A E14. For E-3 BMPs (Biofilters), sideslopes are 3H:1V maximum at any location.

N/A E15. For E-3 BMPs (Biofilters), the constructed channel slope is less than or equal to three (3) percent at any location.

N/A E16. For E-3 BMPs (Biofilters), the constructed grass channel is approximately equivalent to the constructed roadway length.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

VIII. Group F - Extended Dry Detention *(Includes F-1 Timber Walls; and F-2 Dry Extended Detention with Forebay)*

N/A F1. All requirements of Section II, Minimum Standards, apply to Group F facilities.

N/A F2. Basin bottom has positive slope and drainage from all basin inflow points to the riser (or outflow) location.

N/A F3. Timber wall BMP used in intermittent stream only. (ie. Prohibited in perennial streams.)

N/A F4. Forebay provided approximately 20 ft. upstream of the facility. Forebays generally 4 to 6 feet in depth.

N/A F5. A reverse slope pipe, vertical stand pipe or mini-barrel and riser was provided to prevent clogging.

N/A F6. Principal spillway and outlet barrel provided consisting of reinforced concrete pipe with O-Ring gaskets for watertight joint construction.

N/A F7. Mini-barrel and riser, if used, contains a removable trash rack to reduce clogging.

N/A F8. Low flow orifice, if used, has a minimum diameter of three (3) inches or two (2) inches if internal orifice control was utilized and a small, cage type external trash rack.

N/A F9. Timbers properly reinforced or concrete footing provided if soil conditions were prohibitive.

N/A F10. Timber wall cross members extended to a minimum depth of two (2) feet below ground elevation.

N/A F11. Protection against erosion and scour from the low flow orifice and weir-flow trajectory provided.

N/A F12. Stilling basin or standard outlet protection provided at principal spillway outlet.

N/A F13. Adequate, direct access provided to the facility. Access corridor to facility is at least ten (10) feet wide; slope is less than twenty (20) percent and appropriate stabilization provided for equipment and vehicle use. Access extends to forebay, standpipe and timber wall, as applicable.

N/A F14. No visual signs of undercutting of timber walls or clogging of the low orifice were present.

N/A F15. No visual signs of erosion or channel degradation immediately downstream of facility.

N/A F16. No visible signs of accumulated silt/sediment were present in the facility following construction or alternately, accumulated silt/sediment was properly removed and no adverse affects to the function of the facility are anticipated.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

IX. Group G - Open Spaces *(Includes All Open Space Types G-1; G-2; and G-3)*

N/A G1. All requirements of Section II, Minimum Standards, apply to Group G facilities as applicable.

N/A G2. Constructed impervious areas appear to conform with locations indicated on the approved plan and appear less than sixty (60) percent impervious in accordance with the requirements of the James City County Chesapeake Bay Preservation Ordinance.

N/A G3. Dedicated open space areas are in undisturbed common areas, conservation easements or are protected by other enforceable instruments that ensure perpetual protection.

N/A G4. Provisions included to clearly specify how the natural vegetated areas utilized as dedicated open space will be managed and field identified (marked).

N/A G5. Adequate protection measures were implemented during construction to protect the defined dedicated open space areas.

N/A G6. Dedicated open space areas were not disturbed during construction (ie. cleared, grubbed or graded).

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

(Key for Checklist is as follows: XX Acceptable N/A Not Applicable Inc Incomplete)

X. Storm Drainage Systems (Associated with BMP's Only)

(Includes all incidental stormwater drainage conveyance systems associated with SWM/BMP facilities such as onsite or offsite storm drains, open channels, inlets, manholes, junctions, outlet protections, deflectors, etc. These facilities are external to the treatment function of, but are directly associated with drainage to and/or from a constructed SWM/BMP facility. The intent of this portion of the certification is to accurately identify the type and quantity of inflow or outflow points associated with the facility for future reference. The Professional may use his/her own discretion to determine inclusive facilities to meet the intent of this section. As a general rule, storm drainage systems would include incidental facilities to the nearest access structure upslope or downslope from the normal physical limits of the facility or 800 feet of storm drainage conveyance system length, whichever is less.)

XX SD1. All requirements of Section II, Minimum Standards, apply to Storm Drainage Systems.

XX SD2. Horizontal location of all pipe and structures relative to the SWM/BMP facility.

XX SD3. Type, top elevation and invert elevation of all access type structures (inlets, manholes, etc.).

XX SD4. Material type, size or diameter, class, invert elevations, lengths and slopes for all pipe segments.

XX SD5. Class, length, width and depth of riprap and outlet protections or dimensions of special energy dissipation structures.

XI. Other Systems *(Includes any non-typical, specialty, manufactured or innovative stormwater management/BMP practices or systems generally accepted for use as or in conjunction with other acceptable stormwater management/BMP practices. Requires evidence of prior satisfactory industry use and prior Environmental Division approval, waiver or exception.)*

N/A O1. All requirements of Section II, Minimum Standards, apply to this section.

N/A O2. Certification criteria to be determined on a case-by-case basis by the Engineering and Resource Protection Division specific to the proposed SWM/BMP facility.

STORMWATER MANAGEMENT/BMP FACILITIES
RECORD DRAWING CHECKLIST

XII. **References** *(The James City County Record Drawing and Construction Certification Forms and Checklists for Stormwater Management/BMP facilities were developed using the following sources and references.)*

- [ ] Baltimore County, Maryland Soil Conservation District, As-Built Stormwater Management Pond Checklist.
- [x] James City County, Virginia, Guidelines for Design and Construction of Stormwater Management BMP's (October 1999).
- [x] James City County, Virginia, Stormwater Detention/Retention Basin Design Checklist and Erosion and Sediment Control and Stormwater Management Design Plan Checklists.
- [x] James City County Stormwater Policy Framework, Final Report of the James City County BMP Policy Project, October 1998, The Center for Watershed Protection.
- [ ] Prince Georges County, Maryland, As-Built Requirements Retention or Detention Pond/Basin.
- [ ] Prince William County, Virginia, Stormwater Management Fact Sheet.
- [ ] Stafford County, Virginia, As-Built Plan Checklist.
- [ ] Stormwater Management Design Manual, NRCS Maryland Code No. 378, Pond Standards and Specifications.
- [ ] USEPA/Watershed Management Institute, Stormwater Management Inspection Forms.
- [ ] Virginia Impounding Structure Regulations (Dam Safety), Department of Conservation & Recreation, 1997.
- [ ] Virginia Erosion and Sediment Control Handbook, Third Edition 1992, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation.
- [ ] Virginia Stormwater Management Handbook, 1999 edition, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation.

Environmental Division

APR 25 2011

RECEIVED

TRANSMITTAL

DATE: **April 22, 2011**

TO: County Attorney's Office-Attention to Mr. Adam Kinsman
Environmental Division

FROM: Jose Ribeiro, Senior Planner

SUBJECT: SP-0002-2011, Martin's Fuel Facility

Store #6402
Parcel 3B

ITEMS ATTACHED: **Declaration of private drainage easement***

Thank you for your review,
José-Ricardo Linhares Ribeiro
JCC Planner

*The Environmental Division has requested the applicant to provide drainage easements for all proposed storm water conveyance system located outside the property and not within the street rights-of-way.

Declaration of private drainage easement between Parcels 3A + 3B is approved by the Engineering + Resource Protection Division.

05-04-11

Environmental Division

APR 25 2011

Prepared by and return to Robert L. Dewey
Willcox & Savage, P.C.
440 Monticello Ave., Ste. 2200
Norfolk, VA 23510

JCC Tax ID#s 3831800003A
3831800003B

RECEIVED

DECLARATION OF PRIVATE DRAINAGE EASEMENT

(WindsorMeade Marketplace Shopping Center – Parcel 3A)

THIS DECLARATION OF PRIVATE DRAINAGE EASEMENT is made as of the 21st day of April, 2011, by SLN CASEY ASSOCIATES, L.L.C., a Virginia limited liability company ("Grantor"), grantor and grantee for purposes of indexing.

RECITALS

A. Grantor is the owner of Parcel 3A and Parcel 3B as more particularly described on Exhibit A to this Declaration. Parcel 3A and Parcel 3B are each part of WindsorMeade Marketplace Shopping Center located in James City County, Virginia.

B. In connection with the contemplated development of Parcel 3B, Grantor desires to create a perpetual, non-exclusive utility easement over a portion of Parcel 3A for Drainage Facilities as more particularly described below.

DECLARATION

For and in consideration of the sum of Ten Dollars ($10.00) cash in hand paid and other good and valuable consideration, the receipt and sufficiency of which are acknowledged, Grantor declares as follows:

1. Drainage Easement.

(a) Grantor hereby declares, creates and constitutes a perpetual, non-exclusive private utility easement (the "Drainage Easement") in, under, upon, through and beneath the portion of Parcel 3A (the "Easement Area") designated as "20' Drainage Easement 0.150 Acres 6,520 sq. ft." on the Plat entitled "Drainage Easement on Land Owned by SLN Casey Associates, L.L.C.," prepared by VHB dated March 24, 2011, and attached to this Declaration as Exhibit B.

(b) The Drainage Easement shall be appurtenant to and shall run with the land as between Parcel 3A as the servient tenement and Parcel 3B as the dominant tenement and shall be binding upon and inure to the benefit of the successors and assigns of Grantor and any person claiming by, through or under Grantor or its successors and assigns as the owner of Parcel 3A and/or Parcel 3B, respectively. Nothing in this Declaration is intended to created, nor shall the Drainage Easement as so created, be deemed as creating any rights in or for the benefit of the general public in all or any portion of Parcel 3A and/or Parcel 3B.

2. Use of Drainage Easement.

(a) The Parcel 3B Owner shall have the non-exclusive right to use the Drainage Easement for installation, construction, alteration, operation and maintenance of a private stormwater drainage line and associated facilities to serve Parcel 3B (collectively the "Drainage Facilities"). The Parcel 3B Owner shall have the right to connect the Drainage Facilities with the associated drainage facilities installed on Parcel 3B.

(b) The Parcel 3A Owner shall also have the non-exclusive right to use the Drainage Facilities for stormwater drainage on Parcel 3A and shall have the right to connect and tie-in associated drainage facilities on Parcel 3A to the Drainage Facilities serving Parcel 3B for that purpose. The Parcel 3A Owner shall perform such work in a good and workmanlike manner and shall be responsible for any repairs resulting therefrom.

3. Access. The Parcel 3B Owner shall have access to the Easement Area by means of existing roads and drives located on Parcel 3A (and if none so exist, other reasonable means of access thereto), and, if reasonably required given the nature and scope of the work involved, the Parcel 3B Owner shall be permitted to work in an area (not to exceed 10 feet in width) immediately adjacent to the Easement Area for the purposes of installing, maintaining and repairing the Drainage Facilities, to the extent that such adjacent areas have not been improved with buildings or other permanent structures.

4. Improvements to Parcel 3A. The owner of Parcel 3A (the "Parcel 3A Owner") shall have the right to landscape, grade, pave and curb the Easement Area, erect signs within the Easement Area, park and transport vehicles over, upon or cross the Easement Area and otherwise use the Easement Area for such other purposes as the Parcel 3A Owner may desire, provided that such uses are not inconsistent with and do not interfere with the use and enjoyment of the Drainage Easement. The Parcel 3A Owner shall not construct any buildings or other permanent structures (other than signs, paving and curbing) within the Easement Area.

5. Maintenance. Unless otherwise agreed by the Parcel 3A Owner and the Parcel 3B Owner, the Parcel 3A Owner shall, at its own cost and expense, maintain the Drainage Facilities that are located from time to time in the Easement Area in good repair and condition. If the Parcel 3A Owner shall fail to do so, the Parcel 3B Owner shall have the right to perform such maintenance or repair itself. As a condition of exercising self-help, the Parcel 3B Owner shall give written notice to the Parcel 3A Owner and a ten (10) business day cure period. If the Parcel 3B Owner does exercise self-help, the Parcel 3B Owner shall be entitled to recover its costs and expenses incurred in performing such maintenance and repair obligations, together with reasonable attorney's fees incurred in the collection of such amounts, if the Parcel 3A Owner does not reimburse same within ten (10) business days after receipt of an invoice therefor.

6. Limitations on Easement. The Drainage Easement is an easement for buried drainage pipe and related Drainage Facilities only, and no facilities or equipment shall be installed by the Parcel 3B Owner on the surface of the Easement Area except for Drainage Facilities expressly approved by the Parcel 3A Owner. Furthermore, the surface of the Easement Area shall not be otherwise used or disturbed except when reasonably necessary for the installation, maintenance and repair of the Drainage Facilities.

7. Notices. Any notices to be given pursuant to this Declaration to the Parcel 3A Owner or the Parcel 3B Owner shall be sent by certified mail, return receipt requested, or by Federal Express or other reputable delivery service to the address of such owner as listed for real estate tax billing purposes in James City County or such other address as designated in writing by such Owner. Any such notice shall be effective upon delivery to the specified address (or such Owner's refusal to accept delivery).

8. Modifications. The Drainage Easement and the terms and conditions of this Declaration may not be modified, released, rescinded or waived except by written instrument in recordable form executed by the Parcel 3A Owner and the Parcel 3B Owner.

9. Successors and Assigns. This Declaration shall be binding upon and inure to the benefit of the Parcel 3A Owner and the Parcel 3B Owner and their respective successors and assigns.

Remainder of Page Intentionally Left Blank

WITNESS the following signature and seal:

SLN CASEY ASSOCIATES, L.L.C.
a Virginia limited liability company

By: SLN Williamsburg Associates, L.L.C., a Virginia limited liability company, Manager

By: S. L. Nusbaum Realty Co., a Virginia corporation, Manager

By: James M Gresock (SEAL)
James M. Gresock
Senior Vice President

COMMONWEALTH OF VIRGINIA

CITY OF RICHMOND, to wit:

The foregoing Declaration of Private Drainage Easement was acknowledged before me this 21st day of April, 2011 by James M. Gresock, as Senior Vice President of S. L. Nusbaum Realty Co., a Virginia corporation, Manager of SLN Williamsburg Associates, L.L.C., a Virginia limited liability company, which in turn is Manager of SLN Casey Associates, L.L.C., a Virginia limited liability company, on behalf of the company.

Donna M James
Notary Public

My commission expires: 7/31/14 Registration No. 146836

[AFFIX SEAL]

DONNA M. JAMES
COMMONWEALTH OF VIRGINIA
REGISTRATION NO. 146836
MY COMM. EXPIRES 07/31/2014
NOTARY PUBLIC

I-1030098.1
04/21/2011

EXHIBIT A

ALL those certain lots, pieces or parcels of land lying and being in Berkeley District, James City County, Virginia, being known, numbered and designated as Parcel 3A and Parcel 3B as shown on a certain plat prepared by AES Consulting Engineers dated 1/15/04, last revised 7/27/04 entitled "Plat of Subdivision and Lot Line Extinguishment Parcels 1 through 5, Being the Property of C.C. Casey Limited Company, Berkeley District, James City County, Virginia" recorded in the Clerk's Office of the Circuit Court of James City County, Virginia, as Instrument No. 040024397.

Environmental Division
APR 25 2011
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CONTECH®
ENGINEERED SOLUTIONS

744 Greenwing Drive
Chesapeake, VA. 23323
Mobile: (757) 478-4782
Fax: (757) 485-5846
www.contech-cpi.com

Scott Chapman, PE
VHB
115 South 15th Street, Suite 200
Richmond, VA 23219-4209

May 28th, 2013

RE: CDS Online Inspection Letter for **Martin's Fuel Facility at Windsormeade.**

The purpose of this letter is to document for VHB and James City County that the CDS unit for the project was designed in accordance with VADCR regulations and installed in conformance to the project site plans.

The CDS unit was designed using the TR-20 hydrograph method for the first 0.50" of runoff over the impervious area. To treat the calculated water quality flow of 0.14 cfs, the CDS2015-4 was selected. This unit can treat up to 0.70 cfs before internal bypass. Additionally, Contech has inspected the unit and confirmed that the CDS was installed in conformance to the project drawings.

The configurations of the CDS inlet and outlet pipes are acceptable. The system appears to be constructible and is located in order to facilitate maintenance activities. We recommend biannual inspections for hydrodynamic separators. Removal of trash, oil and debris will be required in accordance with Contech's CDS Design, Operation and Maintenance guide. Actual maintenance interval will vary by site.

During the site inspection of the structure, I noted that the outlet pipe was built as a 6" PVC instead of 15" RCP per our Contract Drawings... I could not see the inlet pipe without entering the confined space. This as-built structure will perform per plan if the water quality flow is 0.7 cfs and the Peak Flow Rate is 1 cfs as shown in our CONTRACT drawing.

But it appears that the invert of the 6" PVC is commensurate with the designed invert of ~88.94.... 3'-8" (3.67') from rim down to top crown of 6" PVC + 0.5' I.D. = ~4.17' approximates the DESIGNED rim to invert dimension of 4'-1 1/4" per our CONTRACT drawing.

In summary, the system is expected to operate in accordance with Contech's design intent.

Please feel free to contact me directly with any questions.

VERY TRULY YOURS,

Brad
Bradley W. Vanderwarker, P.E.
Project Consultant
Contech Engineered Solutions LLC
Mob: 757-478-4782 Fax: 757-485-5846
bvanderwarker@conteches.com

S.L. NUSBAUM Realty Co.
9211 Forest Hill Avenue, Suite 110 • Richmond, Virginia 23235 • (804) 320-7600 • FAX (804) 330-8924

April 1, 2011

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Mr. Joseph LaCagnina
Director, Real Estate
Giant Food Stores, LLC
A Division of Ahold USA Retail
1149 Harrisburg Pike
P.O. Box 249
Carlisle, PA 17013

RE: **Martin's Fuel Center**
WindsorMeade Marketplace Shopping Center
James City County, Virginia

Dear Joe,

Pursuant to Paragraph 7.6 and 7.7 of the Deed of Ground Lease currently being completed between SLN Casey Associates, LLC, ("Landlord") and Giant Food Stores, LLC ("Tenant"), Landlord grants Tenant permission to install an underground storm-water drainage pipe and associated facilities under and on a portion of Landlord's Parcel 3A to provide storm-water drainage from Tenant's adjacent leased Parcel 3B, as more specifically described in the aforementioned Deed of Ground Lease, per the plans approved by Landlord and James City County.

Tenant shall construct the storm-water drainage system in a good and workmanlike manner and in compliance with all applicable governmental requirements.

Sincerely,

SLN CASEY ASSOCIATES, L.L.C.
By: SLN Williamsburg Associates, LLC, Manager

By: S.L. Nusbaum Realty Co., Manager

James M Gresock

James M. Gresock
Senior Vice President

JMG/kms

CONTECH®
CONSTRUCTION PRODUCTS INC.

SP-2-11

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs. Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs. The pollutant removal capacity of the CDS system has been proven in lab and field testing.

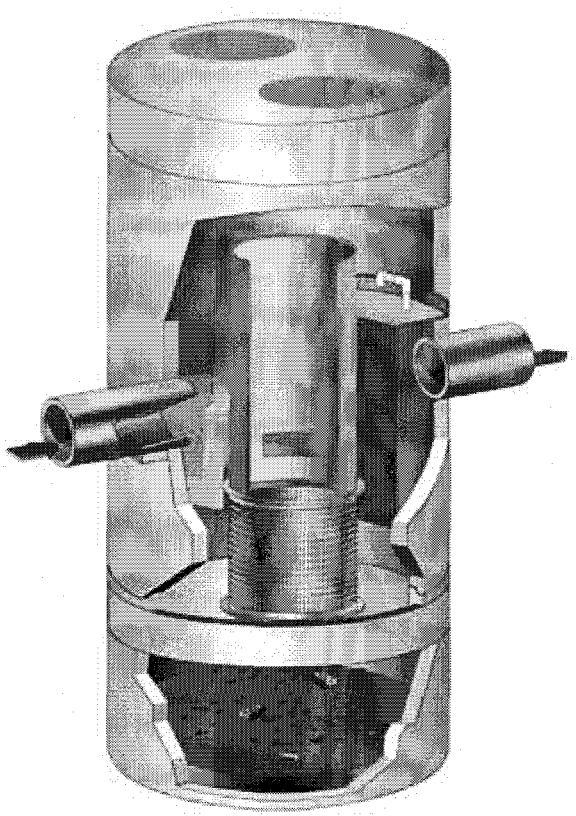
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall MethodTM and Probabalistic Method are used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125-microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75-microns (μm).

Water Quality Flow Rate Method

In many cases, regulations require that a specific flow rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval (i.e. the six-month storm) or a water quality depth (i.e. 1/2-inch of rainfall).

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the treatment flow rate around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and reduces the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore they are variable based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to

calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabalistic Rational Method

The Probabalistic Rational Method is a sizing program CONTECH developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic rational method is an extension of the rational method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (i.e.: 2-year storm event). Under this method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus helping to prevent re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

CDS hydraulic capacity is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. As needed, the crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulics.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS unit (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This full-scale CDS unit was evaluated under controlled laboratory conditions of pumped influent and the controlled addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSD) of the test materials were analyzed using standard method "Gradation ASTM D-422 with Hydrometer" by a certified laboratory. UF Sediment is a mixture of three different U.S. Silica Sand products referred as: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (uniform coefficient Cu averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003). The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

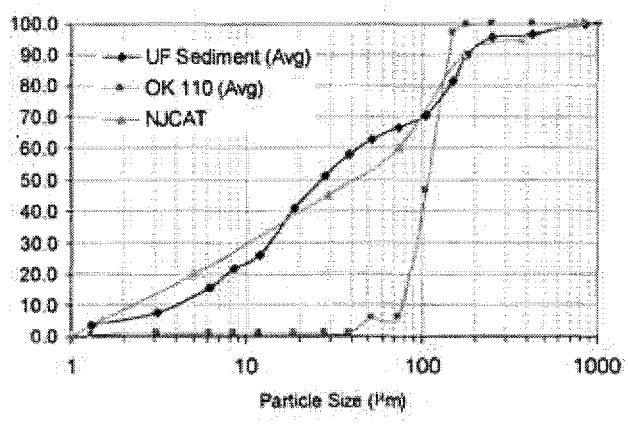


Figure 1. Particle size distributions for the test materials, as compared to the NJCAT/NJDEP theoretical distribution.

Tests were conducted to quantify the CDS unit (1.1 cfs (31.3-L/s) design capacity) performance at various flow rates, ranging from 1% up to 125% of the design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC – ASTM Standard Method D3977-97) and particle size distribution analysis.

Results and Modeling

Based on the testing data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve for the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation assuming sandy-silt type of inorganic components of SSC. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand).

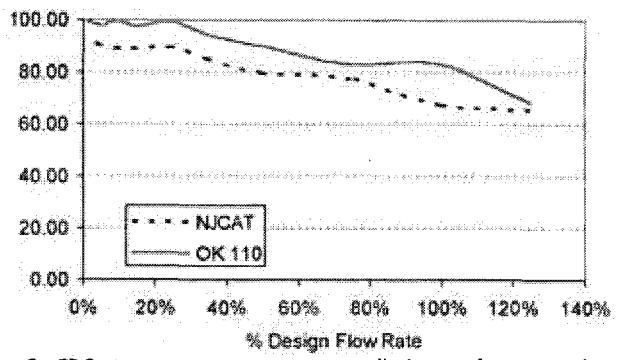


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (WADOE, 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). Supported by the laboratory data, the model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at 100% of design flow rate, for this particle size distribution (d50 = 125 μm).

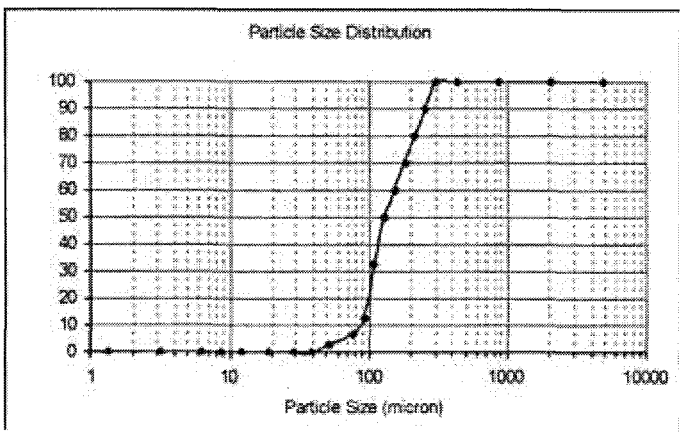


Figure 3. PSD with d50 = 125 microns, used to model performance for Ecology submittal.

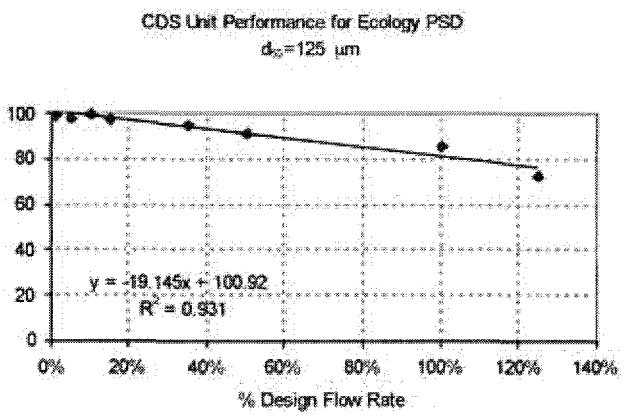


Figure 4. Modeled performance for CDS unit with 2400 microns screen, using Ecology PSD.

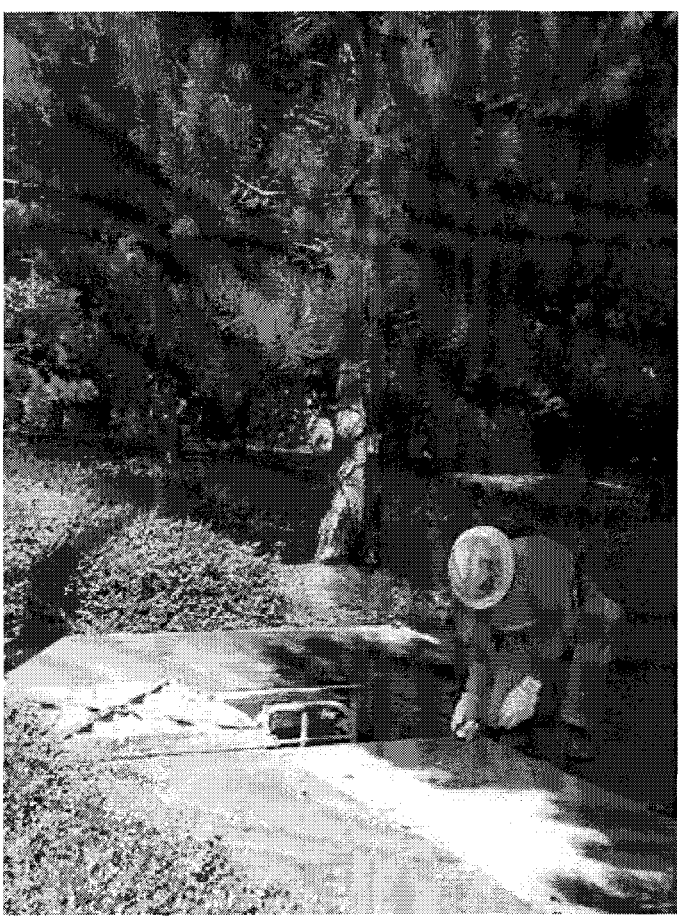
Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, e.g., unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help insure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Additionally, installations should be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions to inlet and/or separation screen. The inspection should also identify evidence of vector infestation and accumulations of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If sorbent material is used for enhanced removal of hydrocarbons, then the level of discoloration of the sorbent material should also



be identified during inspection. It is useful and often required as part of a permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (screen/cylinder) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained behind the screen. For units possessing a sizable depth below grade (depth to pipe), a single manhole access point would allow both sump cleanout and access behind the screen.

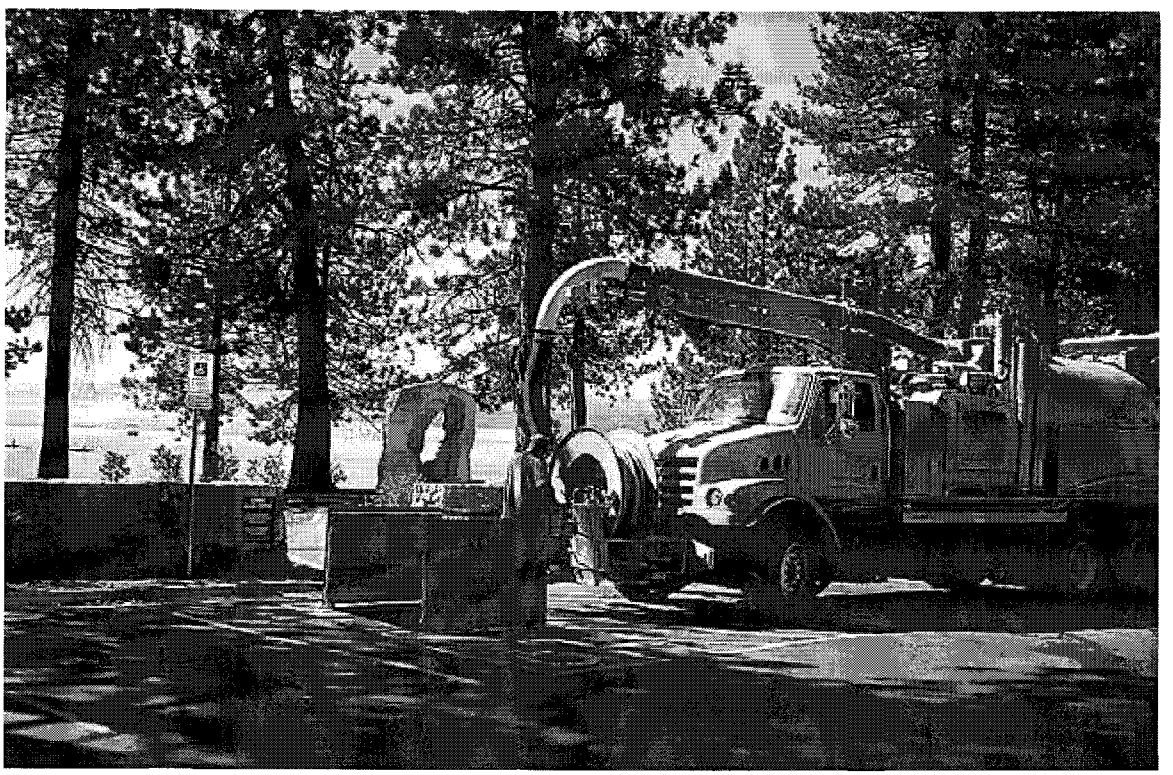
The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine if the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of the CDS systems should be done during dry weather conditions when no flow is entering the system. Cleanout of the CDS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should be pumped out also if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash can be netted out if you wish to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. Confined Space Entry procedures need to be followed. Disposal of all material removed from the CDS system should be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.



CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	yd3	m3
CDS2015-4	4	1.2	3.0	0.9	0.5	0.4
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.

CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than eighteen inches the system should be cleaned out. **Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

7

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

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CONTECH STORMWATER SOLUTIONS

Parameter Brief

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Planning Department

The CDS® Unit for Removal of Oil and Grease

The CDS system is a hydrodynamic separator which uses patented continuous deflective separation (CDS) technology to separate and trap debris, sediment and oil and grease from stormwater runoff. Indirect screening allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls separate captured solids and minimize resuspension of previously captured pollutants.

Oil and grease (O&G) are commonly found in stormwater runoff from automobiles and associated anthropogenic activities. O&G appear in many different forms in stormwater runoff: free, dissolved, emulsified, and attached to sediments. Total Petroleum Hydrocarbons (TPH) is the usual analytical measure of fuels, oil and grease (O&G) for stormwater. Typically the concentrations of TPH associated with runoff from streets and parking lots range from 2.7 to 27 mg/l (FHWA, 1996). The Oregon Association of Clean Water Agencies (ACWA) reports O&G levels for runoff from different land uses for the period of 1991 – 1996, as shown in Table 1.

Table 1. O&G levels from different land uses.

Land Use	Median (mg/L)	Range (mg/L)
Residential	1.2	ND - 12.6
Commercial	2.4	ND – 18
Industrial	2.0	ND – 107.6 (12 mg/l next highest)
Mixed	1.0	ND –28

CDS units can be equipped with a conventional oil baffle to capture and retain oil, grease, and other TPH pollutant as they are transported through the storm drain system during wet weather (stormwater) and dry weather (spills) flows. In addition, CDS units with the addition of oil sorbents can ensure the permanent removal of the free oil and grease from stormwater runoff. Laboratory investigations into the CDS unit's removal of oils and greases are summarized below.

Laboratory Studies – CDS Unit at Portland State University, 2003

In 2003, Slominski and Wells at Portland State University conducted tests on a CDS Model 20_20 unit equipped with a 2400 micron screen and oil baffle. Tests were conducted at 25, 50 and 75 percent of the unit's hydraulic capacity (500 gpm) for the removal of used motor oil with influent concentrations of 10, 25 and 50 mg/L. A summary of the test is shown in Table 2 (Slominski and Wells, 2003).

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Table 2. Summary of oil and grease tests (Slominski and Wells, 2003).

Flow Rate (gpm)	Influent Conc. (mg/L)	Average Effluent Conc. (mg/L)	Removal Efficiency (%)
125	7.2	3.5	51
125	18.3	1.5	92
125	46.2	3.5	92
250	9.9	2	80
250	22.8	5	78
250	45.6	7.5	84
375	10.5	7.5	29
375	21.9	16	27
375	46.9	27	42

Laboratory Studies – CDS Unit Oil Spill Test at Portland State University, 2003

In addition to the regular capture test performed to measure the removal of free oil and grease from stormwater, Slominski and Wells (2003) also performed an oil spill test. The unit performed extremely well in the oil spill test, with the peak oil concentration in the effluent occurring right as the addition of oil to the unit stopped. This showed a capture rate of more than 99.75% of the oil dumped into the unit (82,000 mg/L). This demonstrates that a CDS unit would be a very effective means of containing an oil spill. An oil storage capacity chart for the CDS unit is available on request.

Laboratory Study – CDS Unit with Sorbents at University of California, Los Angeles (UCLA)

Studies by Stenstrom and Lau (1998) at UCLA demonstrated that the CDS unit with sorbents can achieve 80 to 90 percent removal of oil and grease at influent concentrations ranging from 13.6 mg/L to 41.1 mg/L. Test results showed that the effluent oil and grease concentrations were less than 10 mg/L.

A series of nine laboratory experiments were performed on a CDS unit (Model PMSU20_15) to determine its ability to remove free oil and grease using sorbents (Stenstrom and Lau, 1998). One control experiment was performed without sorbents. The focus of this study was to evaluate the effectiveness of various sorbent materials to control the typically low concentrations of free oil and grease found in urban stormwater runoff when applied within the separation chamber of a CDS unit. The conventional oil baffle was not installed within the CDS unit during this evaluation. The sorbents were allowed to float on the surface of the separation chamber of the CDS device. Different amounts of each sorbent were used because of the varying properties of the sorbents (density and surface area).

Tests were performed using a 2400-micron screen over 30 minutes at 125 gpm (approximately 40% of the CDS unit's nominal flow capacity). Used motor oil (Specific Gravity = 0.86) was introduced into the feed of the CDS at approximately 25 mg/L, which is generally the upper limit of oil and grease concentrations found in stormwater runoff. Oil and grease were measured at various times (influent/effluent) to determine the removal efficiency. Background oil and grease was measured as well as oil and grease released from the sorbents after the influent oil and grease was reduced to zero.

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Five commercially available sorbents were evaluated. Two sorbents were found particularly effective and they are:

- OARS™ (AbTech Industries, 4110N. Scottsdale Rd., Suite 235, Scottsdale, AZ 85251)
- Rubberizer™ (Haz-Mat Response Technologies, Inc., 4626 Santa Fe Street, San Diego, CA 92109)

Results from the sorbent laboratory study (Stenstrom and Lau, 1998) are shown in Table 3.

Table 3. Performance of Oil and Grease Removal of CDS Units.

Test No.	Sorbent Type	Sorbent Mass (g)	Influent (mg/L)	Effluent (mg/L)	Percent Removal	Flow (gpm)
2	OARS	2600	19.6	2.7	86	125
3	OARS	2600	24.0	4.3	82	190
4	OARS	2600	30.7	1.7	94	75
5	OARS	2600	21.0	3.5	83	125
6	Rubberizer	1030	27.2	3.9	86	125

Effluent concentration of oil using the OARS™ sorbent was less than 1.0 mg/L. Effluent concentration of oil using the Rubberizer™ sorbent was 1.96 mg/L.

References:

Federal Highway Association. (1996). Evaluation and Management of Highway Runoff Water Quality. Publication No. FHWA-PD-96-032.

Slominski and Wells. (2003). Oil and Grease Removal using Continuous Deflection Separation with and Oil Baffle. Portland, Oregon: Author.

Stenstrom, M. K. and Sim-Lin Lau. (1998). Oil and Grease Removal by Floating Sorbent in a CDS Device. Los Angeles.

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NJCAT TECHNOLOGY VERIFICATION

CDS TECHNOLOGIES INC.

JUNE 2003

Manufactured
BMP SP-2-11

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1. Introduction

1.1 NJCAT Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization,
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated,
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state, and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program) NJDEP and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies the net beneficial environmental effect of the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter in reciprocal environmental technology agreements concerning the evaluation and verification protocols with the United States Environmental Protection Agency, other local required or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the energy and environment technology verification program.

1.2 Technology Verification Report

In December, 2002, CDS Technologies Inc. (CDS Technologies), 16360 Monterey Road, Morgan Hill, CA 95037 submitted a formal request for participation in the NJCAT Technology Verification Program. The technology proposed – Continuous Deflective Separation (CDS) – features a patented non-blocking, indirect screening technique developed in Australia in 1992, described in greater detail later in this report, designed to remove gross pollutants from stormwater runoff. Through research and field application, the technology has been refined to capture total suspended solids (TSS), sediments, oils and greases, and trash and debris (including floatables, neutrally buoyant, and negatively buoyant debris). The request after pre-screening by NJCAT staff personnel (in accordance with the technology assessment guidelines) was accepted into the verification program. This verification report covers the evaluation based upon the performance claims of the vendor CDS Technologies (see Section 4). The verification report differs from typical NJCAT verification reports in that final verification of the CDS technology (and subsequent NJDEP certification of the technology) awaits completed field testing that meets the full requirements of the Technology Acceptance and Reciprocity Partnership (TARP) – Stormwater Best Management Practice Tier II Protocol for Interstate Reciprocity for stormwater treatment technology. This verification report is intended to evaluate CDS Technologies initial performance claims for the technology based primarily on carefully conducted laboratory studies along with several field studies. These claims are expected to be modified and expanded following completion of the TARP required field testing.

Several meetings were held with the vendor and a number of telephone discussions and email exchanges were conducted to solicit relevant materials and to refine specific claims. The evaluation is based on literature, third party reports and conference proceedings provided by CDS Technologies.

1.3 Technology Description

1.3.1 Technology Status: general description including elements of innovation/uniqueness/competitive advantage.

In 1990 Congress established deadlines and priorities for EPA to require permits for discharges of stormwater that is not mixed or contaminated with household or industrial wastewater. Phase I regulations established that a NPDES (National Pollutant Discharge Elimination System) permit is required for stormwater discharge from municipalities with a separate storm sewer system that serves a population greater than 100,000 and certain defined industrial activities. To receive a NPDES permit, the municipality or specific industry has to develop a stormwater management plan and identify Best Management Practices for stormwater treatment and discharge. Best Management Practices (BMPs) are measures, systems, processes or controls that reduce pollutants at the source to prevent the pollution of stormwater runoff discharge from the site. Phase II stormwater discharges include all discharges composed entirely of stormwater, except those specifically classified as Phase I discharge.

The nature of pollutants emanating from differing land use are very diverse. CDS Technologies has developed a technology for separating and retaining gross solids under rapid flow conditions

using the mechanism of continuous deflective separation (CDS). This new technology overcomes many of the current problems encountered in conventional gross pollutant traps using trash racks where significant blockage of the trap can occur leading to a reduction in trapping efficiency and hydraulic performance of the drainage system. The continuous deflective separation mechanism is also different from the mechanism of typical hydrodynamic separators used in combined sewer overflow management and is expected to be more efficient in removing gross solids, especially during rapid flow conditions.

The Continuous Deflective Separation Mechanism

General

The mechanism by which the CDS technology separates and retains gross pollutant is by first diverting flow and associated pollutants in a stormwater or combined sewer drainage system away from the main flow stream of the pipe or channel into a pollutant separation and containment chamber. The separation and containment chamber consist of a containment sump in the lower section and an upper separation section. Gross pollutants are separated within the chamber using a perforated plate allowing the filtered water to pass through to a volute return system and thence to the outlet pipe. The water and associated pollutant contained within the separation chamber are kept in continuous motion by the energy generated by the incoming flow. This has the effect of preventing the separation plate from being blocked by the gross solids separated from the inflow. The heavier solids ultimately settle into the containment sump. Figure 1 is a schematic representation of the solid separation mechanism of the CDS technology.

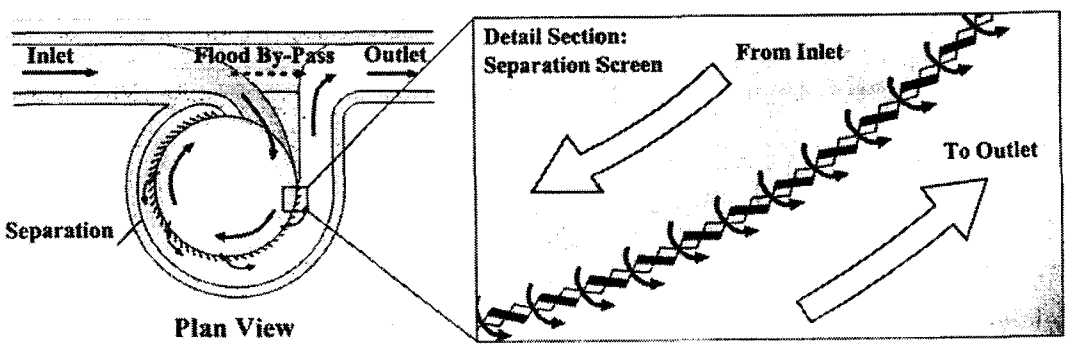

Figure 1 Schematic Representation of the CDS System

The diversion of the stormwater and associated pollutants into a separation chamber overcomes problems associated with the direct filtration systems of conventional gross pollutant traps. The present design of the CDS system utilizes a simple solid diversion unit to divert flows into the separation chamber. The diversion unit is designed to divert all flows into the separation chamber as long as water levels are below the crest level of the diversion unit. As water levels

exceed the crest of the diversion unit, some flows would by-pass the CDS system. The crest level of the diversion unit may be adjusted to suit individual installations.

The solid separation system consists of a large expanded stainless steel plate which acts as a filter screen with an outer volute outlet passage. The perforations in the separation screen are typically elongated in shape and are aligned with the longer axis in the vertical direction. The size of the elliptical holes can be specified according to performance requirements and typical width of the short axis ranges from 2.4 mm to 4.7 mm. The separation screen is installed in the unit such that the leading edge of each perforation extends into the flow within the containment chamber, essentially presenting a closed face to the direction of flow of solids and liquid.

Operating Mechanism

The essential operational function of the CDS unit is to ensure that the separation screen remains free from blocking by trapped material as the volume of pollutant trapped increases. The screen surface area is of the order of 40-45 times the pipe inlet area. Measurement of screen perforations indicates that the orifice area in the direction perpendicular to the plate is approximately 20% of the total plate area. The radial flow velocity through the screen is thus an order of magnitude less than the pipe inlet velocity. Gross solids are prevented from blocking the separation screen using the significantly higher tangential flow velocity compared to the radial velocity throughout the surface of the separation screen. The flow direction in the outer volute outlet system is opposite to that of the circular motion in the separation chamber.

Measurements of surface velocities indicated that tangential velocity decreases along the separation screen as well as with depth and decreases from the screen to the center of the separation chamber (Wong and Wooton, 1995). The radial velocity distribution is a direct reflection of the distribution of flow through the separation screen. Different inlet conditions can influence distribution of flow through the separation screen and optimization of the CDS unit configuration has been conducted to promote a radial velocity distribution which is consistent with the distribution of tangential velocities along the separation screen. Thus the ratio of tangential to radial velocities is maintained at a high level throughout the surface of the separation screen with both velocities decreasing with increasing distance from the inlet.

Gross Solids Separation

Solids entering the separation chamber can either be floating or settleable materials with those solids which are larger than the aperture size of the separation screen being prevented from passing through the screen. The trapped material is kept in motion within the separation chamber by the design of the unit which maintains the ratio of tangential to radial velocities necessary to promote the non-blocking mechanism throughout the surface of the separation screen. The settleable material ultimately settles into the containment sump. The floating material that enters the CDS unit (including organic matter which over time absorbs water and eventually sinks, e.g. leaf litter) remains within the separation chamber and circulates at the water surface until the water level drops and inflow ceases. The action of the inflow jet, the shaping of the screen and centrifugal effects tend to concentrate this floating material towards the center of the chamber away from the screen.

Fine Solids Separation

For solids which are smaller than the aperture size of the separation screen, trapping efficiency will be affected by the ability of the unit in keeping these solids away from the separation screen as they progressively settle into the containment chamber. The trajectory of these fine particles within the separation chamber is defined by the combined effect of fluid velocity within the chamber and the settling velocity of the particles. The likelihood for very fine particles to flow through the separation screen is higher than coarser particles owing to the trajectory of the former being more exposed to the separation screen. Both particle size and its settling velocity have a direct influence on the trapping efficiency of these particles by the CDS unit.

Oil and Grease Removal

Oil and grease and other total petroleum hydrocarbons (TPHs) are primary water quality constituents of concern from many catchment areas, such as parking areas and highways. CDS units are equipped with a conventional oil baffle to capture and retain oil and grease and TPH pollutants as they are transported through the storm drain system during dry weather (gross spills) and wet weather flows. CDS units provide a minimum gross oil storage volume from 47 gallons (Model PMSU20_15_4) to 1320 gallons (Model PSW100_100). The CDS units are also capable of receiving and retaining the addition of oil sorbents within their separation chambers. The addition of sorbents is a unique enhancement capability, enabling increased oil and grease capture efficiencies beyond that obtainable by conventional oil baffle systems. The addition of sorbents is not a requirement for CDS units to control oil and grease from stormwater.

1.3.2 Specific Applicability

A unique advantage of the CDS Technology is the ability to treat a wide range of flows which allows large drainage basins to be treated by a few strategically located facilities, thereby reducing overall life cycle costs of the treatment system. In addition to reducing the capital and maintenance costs, the CDS units require a very small amount of real estate, saving a valuable resource for other uses.

CDS Technologies stormwater treatment systems treat the stormwater runoff from:

- Retail, Commercial, Industrial and Residential Developments
- Inter-modal Transportation Facilities
- Solid Waste Management Facilities and Transfer Stations
- Pre-Treatment to Wetlands and Detention, and Retention Ponds
- Pretreatment/Screening of Storm Water Pump Stations
- Combined Sewage Overflows

1.3.3 Range of Contaminant Characteristics

CDS units have been shown to capture a wide range of pollutants of concern. These include: trash and debris (including floatables, neutrally buoyant, and negatively buoyant debris); total suspended solids; sediments; and oil and grease.

1.3.4 Range of Site Characteristics

There are three (3) types of configurations that CDS units are available in to meet the hydraulic and water quality needs of large and small projects. These treatment configurations can have either an internal or external bypass. Figure 2 provides an illustration of a typical offline CDS unit.

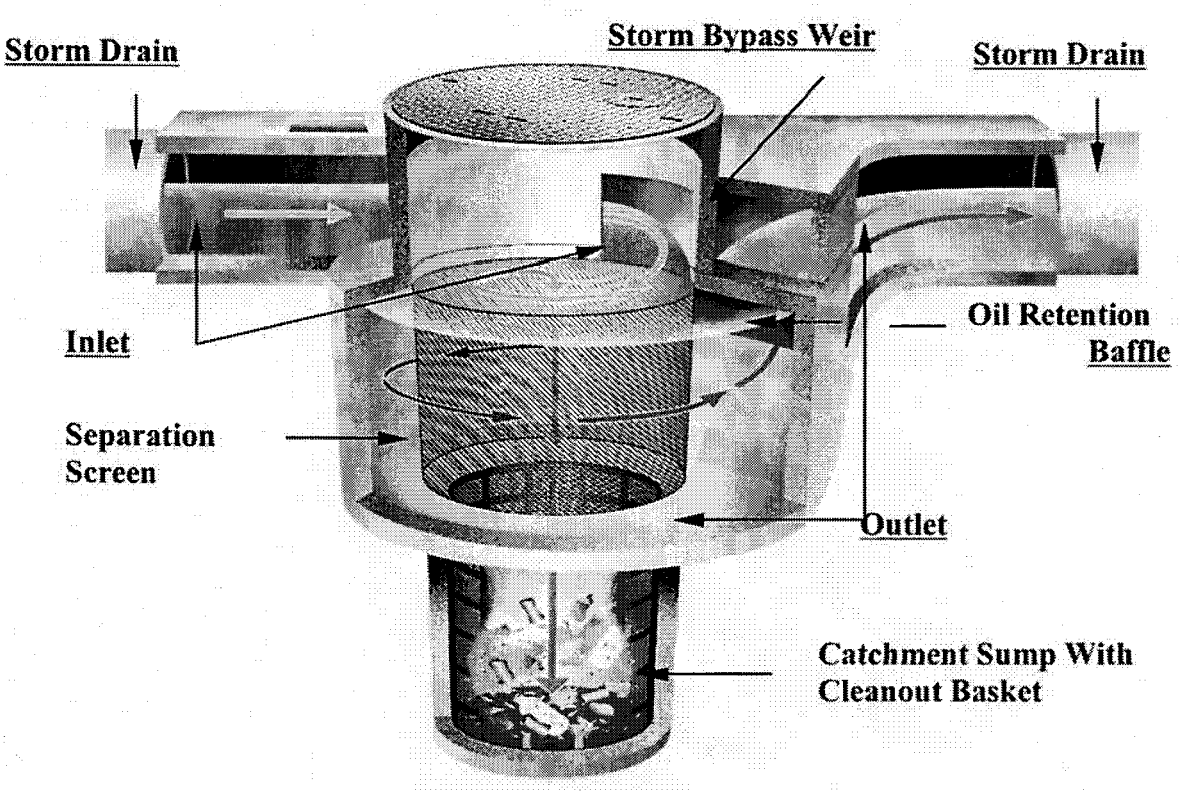

Figure 2 Schematic of an Off-Line CDS Unit

Off-line CDS units are available as cast-in-place or as precast reinforced concrete modules. Cast-in-place units are presently designed and available to treat up to 300 cfs (135,000 GPM). Precast modules are available for treatment flow applications up to 64 cfs (28,700 GPM). The diversion weir box structure can be designed to accommodate multiple inlet pipes and by-pass very large flood flows. Smaller, pre-manufactured in-line CDS units are sized to process typical drainage flows of 0.7-3 cfs (300 - 1350 GPM) from new and existing urban developments. The CDS unit can be placed within new, or retrofitted into existing, stormwater collection systems. Its small footprint takes little space and requires no supporting infrastructure. These smaller units are ideal for treating runoff from large parking lots and vehicle maintenance yards. Drop-in pre-manufactured CDS units, are designed to process flows of 0.7 cubic foot per second or less and are ideal for small drainage areas such as small parking lots.

With the installation of a CDS unit on an existing pipeline or open channel, the hydraulic characteristics of the drainage system will be altered by the introduction of additional energy loss components. The CDS unit diverts all flows in the drainage system below the level of the diversion unit into the separation chamber and under such conditions additional head loss can be significant. The height of the diversion unit is determined by careful consideration of the physical and hydraulic characteristics of the drainage system in the vicinity of the CDS installation. During high flow conditions, some of the flow would by-pass the CDS unit by flowing over the diversion unit. The energy loss attributed to the CDS unit becomes influenced by the hydraulic characteristics of the crest of the diversion weir under such conditions.
In a closed conduit drainage system, flow conditions during periods when the entire flow is diverted to the CDS unit is often that of open channel flow (or referred to as non-pressurized flow). During by-pass operation, flow conditions in the system are often that of pressurized closed conduit flow. Head loss measurements under non-pressurized open channel flow and pressurized closed conduit flow conditions have been conducted to derive the head loss coefficient for the full range of flow conditions encountered by the CDS unit. This enables accurate hydraulic design.

1.3.5 Material Overview, Handling and Safety

Access to the CDS unit is typically achieved through two manhole access covers – one allows inspection and cleanout of the separation chamber (screen/cylinder) and sump and another allows inspection and cleanout of sediment captured and retained behind the screen. The PSW and PSWC off-line models have an additional access cover over the weir of the diversion vault. For units possessing a sizable depth below grade (depth to pipe), a single manhole access point allows both sump cleanout and access behind the screen.

The CDS unit is a confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the unit to perform maintenance or inspection procedures. Inspections of the internal components can, in most cases, be accomplished through observations from the ground surface. CDS Technologies recommends that CDS units should be cleaned using either a vacuum truck or a boom truck to lift a basket from the sump or a combination of both types of equipment.

To date the material cleaned out of the CDS units has not been determined as hazardous waste. It is possible that there may be some specific land use activities that create contaminated solids, which will be captured in the CDS unit. Such material would have to be handled and disposed of in accordance with hazardous waste management requirements. The sorbent material used to increase the oil and grease capture efficiency through solidifying organic liquids (oil and grease) is an inert non-hazardous material. Once used to solidify oil and grease this non-leaching sorbent is presently acceptable at an appropriately classified landfill or incinerated.

1.4 Project Description

This project included the evaluation of assembled reports, conference proceedings, company manuals, literature and a CD, and laboratory testing reports to verify that CDS units meet the performance claims of CDS Technologies.

1.5 Key Contacts

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2. Evaluation of the Applicant

2.1 Corporate History

The CDS business started in Australia in 1994 with five employees to sell the company's patented CDS (Continuous Deflective Separation) products. CDS Technologies Limited is a publicly listed company (CDX) on the Australian Stock Exchanger (listed in 1997).

CDX has successfully grown out of its original Australian market, to the extent that its major divisions are now in the US and the UK.

CDS Technologies, Inc. was incorporated as a business in the State of Delaware in September 1996. Entry into the US market required significant capital investment and time to build the business from scratch. After five years of operation, CDS has approximately 20% of the US stormwater market.

When CDX made its move into the US, it was thought that the main opportunities were in the Combined Sewer Overflow (CSO) market. It was considered that changes to regulations and increased public funding would deliver opportunities in this CSO market for CDS technology. The changes in regulations and increased public funding have still not occurred.

CDX quickly changed its focus to the stormwater market, mainly related to housing developments and land development. The initial drive was the stormwater markets in California and Florida. From 1999, it was decided to expand sales to further areas of the US. One of the keys to the rapid growth in market share was the move to direct sales.

By 2002, a ten-office network had been established distributed around the country. The US activities moved into profit in 2002 after five years of capital investment. The introduction of minimum performance criteria for stormwater by the EPA has assisted CDX in its growth.

2.2 Organization and Management

CDS Technologies, Inc.'s principal office is located at 16360 S. Monterey Road, Suite 250, Morgan Hill, CA 95037, with Bob Howard as its President, Barry Febey, as its Vice President – Finance, and Walt Stein, as its Vice President – Project Development. Jim Heist, Vice President – New Product Development, is located at CDS Technologies, Inc., 105 Springbrook Place, Cary, NC 27511. Nine (9) regional offices are distributed as follows: California (2), Florida, Georgia, Illinois, Kentucky, Maryland, Massachusetts and Oregon. The Mid-Atlantic regional manager is Thomas Mullen. Currently, CDS Technologies has 36 staff employed by the US company.

2.3 Operating Experience with respect to the Proposed Technology

CDS Technologies has had extensive experience in the installation of this technology that expands five (5) years in the United States and over seven (7) years in Australia. To date, over 2,500 CDS stormwater units, including CSO units, have been installed worldwide, with approximately 1,300 units throughout the United States and Canada. The CDS technology has receive numerous awards in Australia. Two are notable. **The 1999 Engineering Excellence Award** – These awards are conducted bi-annually by the Institute of Engineers Australia. The CDS technology was chosen from over 100 entries for the Award which sets the benchmark for professional engineering in Australia. **The 1998 Banksia Environmental Award** – The Banksia Environmental Awards are Australia's most prestigious and comprehensive national environmental awards. They were established by the Banksia Environmental Foundation to recognize companies and individuals developing solutions to the environmental problems in Australia. CDS technology was recognized in the "Innovation" category.

2.4 Patents

The CDS technology was granted a United States patent (Patent Number: 5,788,848) – Apparatus and Methods for Separating Solids from Flowing Liquids or Gases, on August 4, 1998.

2.5 Technical Resources, Staff and Capital Equipment

CDS Technologies provides full engineering services for the design and installation of its products. CDS Technologies engineering staff includes eleven (11) professional engineers and five (5) engineers in training. Expertise includes chemical, civil, hydraulic and mechanical engineering.

The manufacture of the CDS components is outsourced. CDS currently employs one US manufacturer for the screen assembly, two manufacturers for fiberglass inlets and outlets and a number of manufacturers for concrete products. CDS Technologies has no significant capital equipment other than formwork to manufacture the larger pre-cast concrete products. The capital equipment used to install CDS products is owned by the contractors or municipalities who install these products.

3. Treatment System Description

Continuous deflective separation stormwater treatment units are designed to remove gross pollutants, including sediments, from stormwater using a non-blocking, indirect screening technique. Each unit has two basic components: 1) an upper separation chamber, and 2) a lower chamber that serves as a containment sump for pollutants that are removed from stormwater.

Figure 2 displayed a simple schematic of an off-line CDS unit. Stormwater routed into the separation chamber is kept in motion by the force of the incoming flow. This water movement and the deflective characteristics of the screen prevents the separation screen from being blocked by gross solids while at the same time allowing the screen to act as a filter to remove pollutants.

Hydrodynamic separators are flow-through structures that use the energy of the flowing water to remove sediments and other pollutants. CDS units are considered hydrodynamic separators. CDS units are configured to promote a radial velocity distribution which is consistent with the distribution of tangential velocities along the separation screen. Heavier solids that enter the separation chamber are subsequently trapped and eventually settle into the containment sump. The off-line design of the CDS unit and diversion or bypass weir do not allow removed materials back into the flow stream during peak flows.

There are three (3) types of configurations that CDS units are available in to meet the hydraulic and water quality needs of large and small projects (Sec. 1.3.4). CDS units have the ability to treat a wide range of flows.

4. Technical Performance Claims

Claim 1 - CDS units effect solids separation using a cylindrical screen that prevents blockage through the use of significantly higher tangential flow velocities compared to radial velocities throughout the surface of the separation screen and facilitated by the unique physical nature of the CDS expanded metal screen.

Claim 2 - CDS units have a 100% trapping efficiency for gross pollutants (defined as solids greater in size than the aperture size of the screen, i.e., 2400 or 4700 microns), including floatables and neutrally buoyant material (which is unique to devices with a physical barrier such as a CDS screen), for flow rates up to the capacity of the unit.

Claim 3 - A 300 GPM CDS unit (Model PMSU20_15) with a 2400 micron screen opening has been shown to have a TSS removal efficiency of 87.5% with 95% confidence limits of 88% and 87% respectively when operated at 50% of flow capacity, and a TSS removal efficiency of 68.5% with 95% confidence limits of 70% and 67% respectively when operated at 100% of flow capacity, using a fine sand and high influent TSS loadings in laboratory studies using simulated stormwater.

Claim 4 - A 500 GPM CDS unit (Model PMSU20_20) with a 2400 micron screen opening has been shown to have a TSS removal efficiency of 83% with 95% confidence limits of 83.5% and 82.5% respectively when operated at 40% of flow capacity, and a TSS removal efficiency of

56% with 95% confidence limits of 57% and 55% respectively when operated at 100% of flow capacity, using a fine sand in laboratory studies and high influent TSS loadings using simulated stormwater.

Claim 5 - CDS units are equipped with an oil baffle and can capture oil spills to the oil baffle's capacity.

Claim 6 - A 300 GPM CDS unit (Model PMSU20_15) with a 2400 micron screen opening removed 83-86% of free oil (sp.gr.=0.86) using sorbents (OARS™ and Rubberizer™) when operated at 40% of flow capacity in laboratory studies using simulated stormwater.

5. Technical System Performance

CDS units have been tested numerous times in the laboratory and applied at over 2,500 locations in the field. These installations have ranged from mid-size parking lots to eight (8) lane highways to over 100 acre drainage areas, with flow capacities ranging from 290 GPM to 144,500 GPM. Several of these installations have been the subject of monitoring and assessments studies which have been documented in various reports. The above provides the foundation upon which CDS Technologies claims are evaluated.

5.1 CDS Unit Case Studies and Laboratory Studies

Four (4) case studies are presented below. The case studies are intended to provide the reader with a perspective on the range of CDS applications and provide insight into the performance of CDS units in the field. As such these studies complement and expand CDS unit performance measured in the laboratory. These descriptions give a history of the site, the specific objectives for the project, and the time and duration of the project. In addition, CDS Technologies has contracted for significant laboratory testing to assess CDS unit performance.

Case Study 1 – Coburg, Melbourne, Australia

The performance of a 13,500 GPM CDS unit (Model PSW100_60) was tested in a 50 hectare inner-Melbourne catchment. A feature of the project was the range of parties (e.g., universities, water utility, commonwealth EPA, CDS Technologies) involved in the project. (Allison et al., 1998)

The CDS unit was installed in Coburg, Victoria, at the junction of two streets adjacent to a main drain. The 50 hectare catchment area was approximately 35% commercial and 65% residential land-use, with 192 road entrances to the drainage system. Management practices in the catchment included street sweeping, pit cleaning, and litter officers.

The CDS unit was monitored to provide estimates of:

- the trapping efficiency of the CDS device (for gross pollutants)[1];
- the flow capacity of the CDS device and head losses through the system;
- the types and amounts of material being transported by the stormwater system;
- the potential nutrient contribution of organic gross pollutants to receiving waters;
- any water quality changes to the stormwater caused by the CDS device, and
- the cleaning requirements for the device during typical operating conditions.

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[1] Gross pollutants were defined in this study as material retained by a 4700 micron screen, which was the size of the CDS screen.

The construction of the CDS unit took about 12 weeks; however, the majority of the construction was carried out while keeping the existing stormwater system in operation. Trapping efficiency for gross pollutants was monitored during a 12 month period. Clean-out data was collected over a three month monitoring period (13 May – 2 August, 1996) and involved 13 runoff events.

Case Study 2 – Coburg, Melbourne, Australia

An earlier study investigated the performance of a CDS unit (Allison, et al., 1998) and estimated litter and gross pollutant loads from a suburban catchment in Coburg, Melbourne. However, the trapping performance for material less than 4.7 mm was not estimated. Removal of this fine material is regarded as a secondary benefit of this gross pollutant trap. Over a 22-month period (May 1996 to February 1998), 15 storms were monitored and dry weather samples were taken at least every two weeks.

Case Study 3 – Brevard County, Florida

In July, 1997, Brevard County's Stormwater Utility Program installed a 4050 GPM CDS unit (Model PSW50_42) with a 4700 micron screen opening along a ditch at the north end of Brentwood Drive, north of Cocoa and close to the Indian River. This was the first United States installation of the CDS technology. Over an 18-month period 5 storm events (4/20/98, 5/1/98, 7/7/98, 1/3/99, 3/15/99) were monitored for 6 parameters: pH, TSS, BOD, COD, turbidity and total phosphorous. In addition, sediment samples were collected and tested for 61 parameters. (Strynchuck et al., 1999)

Stormwater sedimentation is a primary source of pollutant to the Indian River Lagoon in Brevard County, Florida. The Indian River Lagoon is an estuary of national significance and is part of the National Estuary Program. Pollutants targeted in the Lagoon by the State of Florida are suspended solids, phosphorous, and nitrogen. Suspended solids and turbidity reduce sunlight penetration in the Lagoon which negatively impacts sea grass growth. Phosphorous and nitrogen are nutrients which promote algae growth and reduce oxygen levels in the Lagoon.

Case Study 4 – Issaquah, Washington

The City of Issaquah, Washington, installed two CDS stormwater treatment units to provide water quality treatment for urban stormwater runoff in 2000. One unit (Model PSW30_28, identical to PSWC30_30) with a 2400 micron screen and a 1350 GPM nominal maximum flow rate capacity is located on NW Birch Place, treats stormwater from a 45-acre area (approximately 52% is covered by impervious surfaces) with mixed commercial and residential land uses, and discharges into Issaquah Creek.

The installation and operation of these CDS units was funded in part through a grant from the Washington Department of Ecology (Ecology). As a component of the grant scope of work issued by Ecology, a 10-month monitoring program was implemented to evaluate the performance of the CDS unit located on NW Birch Place. The specific goals of this monitoring program were twofold: 1) estimate the pollutant removal efficiency of the CDS unit, and

2) evaluate the actual hydrologic performance of the unit in relation to design expectations. (Herrera Environmental Consultants, 2002)

To evaluate potential seasonal influences on the performance of the CDS unit, stormwater sampling activities were performed over three distinct monitoring periods: summer (September 2000), fall (October – December 2000), and winter/spring (February – June 2001). One storm was sampled during the summer monitoring period to capture pollutants in stormwater following an extended dry period. Four storms were sampled in the fall to determine if leaf litter accumulation and decomposition within the CDS unit had any effect on system performance. Eight storms were sampled in the winter/spring monitoring period to provide a more generalized assessment of system performance. Sampling of sump material was also conducted on January 4, 2001 and July 2, 2002 to correspond with the end of the fall and winter/spring monitoring periods, respectively.

Laboratory Studies

Particle Removal

CDS Technologies contracted with Portland State University to conduct particle removal testing on CDS units (Slominski et al., 2002). Laboratory testing was conducted on two CDS units: Model PMSU20_15 and Model PMSU20_20. PMSU20_15 has a nominal maximum flow rate capacity of 300 GPM, while PMSU20_20 has a 500 GPM nominal maximum flow rate capacity. Two PMSU20_15 units with 2400 and 4700 micron screen openings were tested. The PMSU20_20 unit had a 2400 micron screen opening. Two different types of sand were used for the tests: a fine sand (F-110) and a coarser sand (#17 silica).

The CDS units were tested at different flow rates for each type of sand. For the PMSU20_20 unit flow rates of 200 GPM, 300 GPM, 400 GPM and 500 GPM were tested. For the PMSU20_15 unit flow rates of 150 GPM, 200 GPM, 250 GPM, and 300 GPM were tested. At each flow rate three trials were performed; a mean average of these results was then taken to determine an approximate capture rate for the CDS unit.

A standard sample size consisting of 5 kg of sand was used for each trial. The sand was poured into the inlet pipe about 2 feet before it entered the CDS unit. The sand was added continuously over a twenty-second interval. This type of loading was chosen for efficiency, since previous testing of the CDS unit had shown no difference between this type of loading and pouring in a well-mixed solution over a longer time period (Schwartz and Wells, 1999). The resulting TSS loadings tested were extremely high (26,400 mg/l at 150 gpm, 7900 mg/l at 500 gpm), well above what one would encounter in the field. Trials were run for a length of time equal to the residence time of the system times 1.5 to make sure there was proper circulation time.

The water from the outlet pipe flowed into another pipe with six plankton nets connected to the outlets. Attached to the plankton nets were plastic canisters that also had openings covered with this same plankton net material. The plankton nets had a mesh opening of 80 microns, which retained all but the smallest particles.

The capture rate for the CDS unit was calculated by measuring the mass captured by the plankton nets and subtracting that from what was put into the inlet (Schwartz and Wells; 1999). After the residence time had passed, the pump was shut off and flow through the system was allowed to stop. The plankton nets were then rinsed to flush any remaining residual particles into the canisters below. The canisters were then opened and poured out into a dish. The sand

was then dried in an oven set at 175° F until all of the water had been evaporated from the sample.

Once the sample was determined to be dry, a sieve analysis was performed so that the sand could be categorized into different particle sizes and the effectiveness of the CDS unit could be analyzed. The capture rate of the CDS unit was calculated by subtracting the sand mass removed from the nets from the mass placed in the inlet.

The sand used in this study was purchased from La Grande industrial supply in Portland, Oregon. The particle size distribution was analyzed for each bag of sand purchased. The distributions for the F-110 particles differed between the PMSU20_15 tests and the PMSU20_20 tests. This was due to La Grande receiving a new shipment from their supplier during the transitional period between the two unit sizes. A total of ten distributions were completed for the #17 silica and the F-110 sand used for the PMSU20_15 tests. Six distributions were taken for the F-110 sand used for the PMSU20_20 tests. The mean average of these distributions were calculated giving percent composition of each particle size distribution. This percentage was then multiplied by the 5 kg sample size used in each trial, giving a mass distribution grams for each sample. With these data, a capture rate for each particle size could be tabulated as well as an overall rate for the unit.

Table 1 – Distribution of Sand in Five (5) Kg

Particle Size	F-110 Sand PMSU20_15 Tests	F-110 Sand PMSU20_20 Tests	#17 Silica All tests
Range (microns)	Mass (g) for a 5kg weight	Mass (g) for a 5kg weight	Mass (g) for a 5kg weight
>600	0.1	0.0	7.9
425-600	1.5	1.6	348.8
297-425	35.4	286.5	2985.5
215-297	322.9	1354.0	1163.4
150-215	2453.5	2689.7	449.5
75-150	2036.6	612.9	44.7
<75	150.1	55.4	0.2

Fine Particle Removal

Portland State University (Howard, 2003), as part of its continuing evaluation of CDS unit performance for sediment control, conducted fine sand removal tests on the previously tested Model PMSU20_20.

The source of the parent material is Sil-Co-Sil 106 silica sand as produced by the US Silica Company in the Ottowa, IL plant. The material contains more than 80% of its graduation passing the 50 micron sieve. Repeated washing and decanting of the fines from this parent material produced the "test" material. Starting with two batches each of 150 pounds of parent material, the washing/decanting process produced 36 pounds for Batch 1 material and 40 pounds for Batch 2 material. Batch 1 material had 78.6% of the total < 75 microns; Batch 2 had 74.6% of the total < 75 microns.

The laboratory test system was reconfigured to facilitate feed rate control, eliminate the need to recirculate the test water during a discrete test, and improve the CDS outlet for best sediment control. Specifically, feed control was achieved using constant feed peristaltic pumps, while a slurry tank equipped with a high energy variable speed mixer and recirculating peristaltic pumps was added to assure the larger (> 50 microns) particles would not separate from the mixed solution. Eliminating the need to recirculate the water was accomplished by adding 5-550 gallon tanks. The CDS oil baffle was removed and replaced with a skimming weir set at three inches above the outlet invert.

Slurry was prepared for each test run. This was done by utilizing the constant feed rate of the peristaltic pumps, coupled with the CDS run flow rate, and batched to hit a 200 milligram per liter sediment loading. The actual feed rate was determined after each run, when the actual CDS flow rate was determined.

Tests were run for incremental flow rates of about 25 gpm, from 25 gpm, or 5% of the CDS unit's capacity to 250 gpm, or 50% of the unit's capacity. In addition, runs were carried out at 340 gpm, and 500 gpm to establish adequate efficiency data points to allow extension of the removal efficiencies beyond 500 gpm, the pump's limiting capacity.

Three grab samples were collected for each run, with the exception of the 500 gpm run, where it was only possible to achieve two samples due to the influent pump starting to cavitate when the third sample was to be taken. The samples were packaged and sent overnight to Spectrex Corporation in Redwood City, CA, where the samples were subjected to a particle size analysis.

Oil and Grease Removal

CDS units are equipped with a conventional oil baffle to capture and retain oil and grease and TPH pollutants as they are transported through the storm drain system during dry weather (gross spills) and wet weather flows. CDS units with the addition of oil sorbents can ensure the permanent removal of the free oil and grease from the stormwater runoff.

A series of nine (9) laboratory experiments were performed on a CDS unit (Model PMSU20_15) to determine its ability to remove free oil and grease using sorbents. (Stenstrom and Lau, 1998).

One control experiment was performed without a sorbent. The focus of this study was to evaluate the effectiveness of various sorbent material to control the typically low concentrations of free oil and grease found in urban stormwater runoff when applied within the separation chamber of a CDS unit. The conventional oil baffle was not installed within the CDS unit during this evaluation. The sorbents were allowed to float on the surface of the separation chamber of the CDS device. The CDS unit was not modified to accept the sorbents. Different amounts of each sorbent were used because of the varying properties of the sorbents (density and surface area).

Tests were performed using a 2400-micron screen over 30 minutes at 125 GPM (approximately 40% of the CDS unit's nominal flow capacity). Used motor oil (sp.gr. = 0.86) was introduced into the feed of the CDS at approximately 25 mg/L, which is generally the upper limit of oil and grease concentrations found in stormwaters. Oil and grease were measured at various times (influent/effluent) to determine the removal efficiency. Background oil and grease was measured as well as oil and grease released from the sorbents after the influent oil and grease was reduced to zero.

Prior to the beginning of each test, the freeboard of the CDS unit was wiped clean and a small amount of new sorbent was used to remove any oil that remained from the previous test. This sorbent was removed prior to the beginning of the test. A weighed amount of test sorbent was then dumped into the separation chamber of the CDS unit. Sorbents were removed using a large fine mesh sieve.

Five sorbents were evaluated. They were obtained from the manufacturers or from dealers in the Los Angeles area. Most are marketed for oil spill cleanup. These materials are called "sorbents" as opposed to "adsorbers" or "absorbers" because both absorption and adsorption mechanisms are present. Two sorbents were particularly effective. These are discussed as follows:

- **OARS.** OARS™ (AbTech Industries, 4110N. Scottsdale Rd., Suite 235, Scottsdale, AZ 85251) is a "rubber" type of sorbent. It can be manufactured in any desired size fraction. The material is sintered into larger particles from smaller particles. The material used in this study (bulk storage density = 0.22 g/ml) was originally intended for use in catch basin inserts, and is somewhat larger than optimal for this application. The manufacturer generally believes that the removal mechanism is absorption. Of the sorbents evaluated in this study, the AbTech sorbent is most similar to the Rubberizer sorbent. The material is denser than the other sorbents and tends to wet better in the separation chamber of the CDS device.

- **Rubberizer.** Rubberizer™ is a sorbent that is marketed by Haz-Mat Response Technologies, Inc. (4626 Santa Fe Street, San Diego, CA 92109) as a clean up sorbent for various types of solvents, oils and fuels. It is composed of a mixture of hydrocarbon polymers and additives. It can be purchased as a particle, used in this test (bulk storage density = 0.26 g/ml) or water gel or assembled into pillows and booms. It is similar to the touch as the OARS sorbent.

The sorbers tested all had different bulk densities, specific surface areas and costs. It was not possible to create an equivalent mass of each sorbent on any common basis. Therefore the

experiments were conducted with sufficient sorbent to cover the top of the CDS unit. When these sorbents are used to clean up spills they are exposed to either pure oil or very concentrated mixtures of oil and water. Under these circumstances, they will sorb many times their weight. For the applications investigated in this report, they sorb much less because they are only exposed to very dilute mixtures of oil and water.

5.2 Verification Procedures

CDS Technologies has applied CDS units at over 2500 locations worldwide. Three (3) full flow commercial installations have been evaluated independently and the findings well documented in reports. QA/QC procedures appear to be consistent with accepted practice. In addition, three (3) independent laboratory studies were conducted at two United States universities to assess particle, and oil and grease, removal efficiencies. Consequently, sufficient information exists to support verification of the claims submitted by CDS Technologies.

Claim 1 - CDS unit's effect solids separation using a cylindrical screen that prevents blockage through the use of significantly higher tangential flow velocities compared to radial velocities throughout the surface of the separation screen and facilitated by the unique physical nature of the CDS expanded metal screen.

As described in Section 1.3.1, the essential operational function of the CDS unit is to ensure that the separation screen remains free from blocking by trapped material as the volume of pollutant trapped increases. This is accomplished by several means.

- Particles are subject to a tangential drag force caused by the tangential flow around the chamber (screen). This force is resisted by a friction force on the particle as it is swept along the screen. Particles are kept in motion because the tangential drag force is larger than the friction force.

- The radial flow velocity through the screen is an order of magnitude less than the pipe-inlet velocity.

- The separation screen is installed in the unit such that the leading edge of each perforation extends into the flow within the containment chamber, thus deflecting solids away from the screen. The solid deflective segments (Figure 1) on the screen essentially present a closed face to the direction of the flow of liquid within the separation chamber. Behind each defective segment there is an opening to permit flow of liquid and particles smaller than the opening.

To date, blockage of screens with 2400 micron and 4700 micron screen openings has been minimal. Earlier CDS units employed 1200 micron screen openings. Blockage occurred in several of these units.

- San Francisco, CA (1998). A Model PSW30_30 blocked during a dry start (no water in the CDS). The first loading storm transported several cubic feet of pine needles on a low

flow. The needles lodged in the 1200 micron screen and prevented the proper flow to develop. It has worked well since.

- Monterey, CA (1999). A CDS Fiberglass 30_30 unit experienced blockage during start up. The installation was subject to significant tidal influence. The 1200 micron screen was replaced with a 2400 micron screen and the inlet area to screen area changed to improve the washing energy to deal with the tidal conditions. The unit has worked successfully since the changes were made.

- Florida (1999 & 2000). A PSW100_60 unit in Orlando blocked in late 1999. A similar instance occurred in Venice, Florida in early 2000. In both cases the 1200 micron screen was replaced and the units have functioned well since.

Due to problems with the 1200 micron screen, this screen is no longer used by CDS Technologies.

Two instances of blockage have occurred with the larger 2400 and 4700 micron screen openings.

- Orlando, FL (2001). An interesting blockage occurred in a large PSW100_100 unit equipped with a 4700 micron screen. The unit has a dry weather flow and drains a 500 acre urban area that is heavily vegetated with deciduous trees. Neutrally buoyant solids can build to the point that a unit can no longer rotate effectively. CDS Technologies concluded that the high deciduous load was doing just that in this unit. The inlet area to screen area was modified to add more rotating energy; this solved the problem.

- Issaquah, WA (2002). On two occasions (2/2/2001 and 3/13/2001) the CDS unit (2400 micron screen) was bypassed due to a system blockage. The blockage was caused by a biofilm that accumulated on the separation screen. CDS Technologies indicated that this is the first and only biofilm blockage that they have experienced. While it is unclear what precipitated the biofilm growth on the separation screen, it is likely related to stagnant, standing water conditions that persist within the unit between storms. The northwest was experiencing a drought during this period. These stagnant conditions may have allowed anoxic conditions to develop within the sump that, in turn, cause nutrients present within the sump solids to be mobilized. These nutrients may have subsequently stimulated the biofilm growth on the separation screen. Problems related to biofilm growth on the separation screen were not observed in the second Issaquah CDS unit, where there is a small but constant flow of water through the system at all times. The unit continues to function properly today.

The blockage issues with the 2400 and 4700 micron screens have been minimal in light of the 1200^{+} units installed in the United States.

Claim 2 - CDS units have a 100% trapping efficiency for gross pollutants (defined as solids greater in size than the aperture size of the screen, i.e., 2400 or 4700 microns), including

floatables and neutrally buoyant material (which is unique to devices with a physical barrier such as a CDS screen), for flow rates up to the capacity of the unit.

Solids entering the separation chamber can either be floating or settleable materials with those solids which are larger than the aperture size of the separation screen being prevented from passing through the screen. By definition, gross pollutants can not pass through the CDS screen unless these solids breakup in the unit. The settleable material ultimately settles into the containment sump. The floating material that enters the CDS unit (including organic matter which over time absorbs water and eventually sinks, e.g., leaf litter) remains within the separation chamber and circulates at the water surface until the water level drops and inflow ceases.

If the flow rate exceeds the capacity of the CDS unit or the unit becomes blocked, the flow will bypass the unit along with the accompanying gross pollutants. Field tests in Australia (Allison et al., 1998) indicated that less than 1% of stormwater by-passed the unit during 12 months of monitoring. Therefore, the trapping efficiency of the CDS unit was estimated to be approximately 99% during this period. The Issaquah, WA study (Herrera Environmental Consultants, 2002) reported that even with the two biofilm blockages, the CDS unit treated 90 percent of the total runoff volume during the period covered by the study. Therefore the annual trapping efficiency is expected to be less than 100%.

Claim 3 - A 300 GPM CDS unit (Model PMSU20_15) with a 2400 micron screen opening has been shown to have a TSS removal efficiency of 87.5% with 95% confidence limits of 88% and 87% respectively when operated at 50% of flow capacity, and a TSS removal efficiency of 68.5% with 95% confidence limits of 70% and 67% respectively when operated at 100% of flow capacity, using a fine sand and high influent TSS loadings in laboratory studies using simulated stormwater.

The PMSU20_15 unit with a 2400 micron screen opening was tested at flow rates of 150 GPM, 200 GPM, 250 GPM, and 300 GPM at Portland State University. Three trials were performed at each flow rate; a mean average of these results was then taken to determine an approximate capture rate for the CDS unit. Standard deviation (%) was also reported. Results are shown in Table 2.

Table 2 – Percent Removal for the PMSU20_15 Unit with a 2400 Micron Screen with F-110 Sand (Slominksi et al., 2002)

Range (microns)	150 GPM (50% Capacity, TSS = 26,400 mg/l)		300 GPM (100% Capacity, TSS = 13,200 mg/l)	
	% Captured	S.D. of Capture (%)	% Captured	S.D. of Capture (%)
> 600	100.0	0.00	100.0	0.00
425 – 600	95.6	3.85	93.3	0.00
297 – 425	99.6	0.16	96.7	1.61
215 – 297	99.7	0.04	94.5	1.77
150 – 215	88.0	0.98	68.4	6.03
75 – 150	85.1	1.84	64.2	8.42
< 75	83.2	3.21	60.3	12.88
ALL	87.5	0.37	68.3	1.91

The capture rate for the CDS unit was calculated by measuring the mass captured by the plankton nets and subtracting that from what was put into the inlet. Since the plankton nets had a mesh opening of 80 microns, the reported capture efficiency of particles < 75 microns is questionable, as these smaller particles may have passed through the nets rather than being captured in the unit. Since only 3 % of the sand was < 75 microns, even if all the < 75 micron sand were lost through the nets, rather than captured as reported, the overall removal rate for all particles would only be a few percent lower. The excellent repeatability of the experiments is shown by the small standard deviation.

The same CDS unit, with a 4700 micron screen opening, was similarly tested, i.e., same sand and flow rates. The overall particle removal efficiency was only slightly affected by the larger screen opening. At 150 GPM, overall removal efficiency was 86.45% (1.4% S.D.) and at 300 GPM the overall removal efficiency was 63.47% (0.94 % S.D.).

Field Studies

Case Study 2 – Coburg, Melbourne, Australia

Over the 22 month study, 15 storms were monitored. A line of best fit of TSS concentration entering and leaving the CDS unit during these storm events was plotted. The line of best fit had a slope 0.28 and intercepted the 45° line (i.e., inflow concentration is the same as outflow concentration) at approximately 38 mg/L indicating, statistically, a mean increase in TSS concentration when inflow concentrations fall below this value.

The plot indicated that the CDS unit is relatively effective in reducing TSS for concentrations above approximately 75 mg/L. The reduction in TSS during periods of inflow concentrations less than 75 mg/L were erratic, with some instances of higher TSS concentration at the outflow than the inflow. The slope for the fitted line indicated a TSS removal efficiency of 60 to 70% for TSS concentrations above 200 mg/L.

Case Study 3 – Brevard County, Florida

Five (5) storm events were monitored over an 18-month period. Storm event #5 was the only event in which all equipment operated correctly and accurate flow rates were measured. Unfortunately flow rates during this storm event were extremely low, 0.005 cfs (2.2 GPM). This flow rate was only 0.045% of the unit's capacity. An average TSS removal efficiency of 55% was recorded.

Case Study 4 – Issaquah, Washington

The Model PSW30_28 CDS unit had a nominal maximum flow capacity of 3.0 cfs (1350 GPM). The maximum discharge rate effectively treated by the CDS unit before activation of the system by-pass was estimated to be 2.8 cfs. In general, the hydrologic performance of the CDS unit was found to meet design expectations.

Influent TSS concentration in this study ranged from 8 to 276 mg/L, with a median value of 31 mg/L. Similarly, effluent TSS concentrations ranged from 8 to 252 mg/L, with a median value of 31 mg/L. In general, TSS concentrations in this study were low in comparison to data from national studies of stormwater pollutant concentrations. For example, the average TSS concentration from nationwide stormwater data compiled by the U.S. EPA was approximately 5 times higher than the median values reported for this study (Horner et al., 1994).

Results showed that there was no significant decrease in effluent TSS concentrations relative to influent concentrations. Effluent TSS concentrations were typically higher than influent concentrations. For example, effluent TSS concentrations were found to exceed influent concentrations in 68 percent of the sample pairs evaluated in this study. However, the difference between influent and effluent concentrations was relatively small (5.2 mg/L). For all periods monitored TSS concentration in the effluent was 8.3% higher than TSS concentration in the influent. In addition, instantaneous pollutant removal estimates also suggest that the CDS unit frequently exported total phosphorous during this study. These findings may be a result of biological decomposition of leaves and other organic material trapped in the unit for prolonged periods of time.

There is some evidence to support the concept that stormwater contains background pollutant concentrations that cannot be further reduced through stormwater treatment (Schueler, 2000). These irreducible concentrations exist because internal processes within the treatment system inevitably return some pollutants to the stormwater or, in some cases, there is an inherent limitation associated with the particular removal pathway used by the treatment system. Studies suggest that stormwater TSS concentrations ranging from 20 to 40 mg/L are irreducible (Schueler, 2000). Similarly, in the CDS unit performance study conducted by Walker et al. (1999), TSS could not effectively be reduced below 75 mg/L.

Particle size analyses (conducted by Soil Control Laboratory) on two samples collected during a June 11 event showed that over 60 percent of solids present in the influent stormwater were smaller than 63 micron. Additional analyses to examine the particle size distribution of solids smaller than 31 micron showed that the influent stormwater contained mainly silt and, to a lesser

extent, clay sized particles. Separate analyses performed by Portland State University (PSU) using a different methodology showed that the average particle size of solids present in the influent stormwater was approximately 34 micron. Particle count data from PSU confirmed that the influent stormwater contained mainly silt and clay sized particles.

Claim 4 - A 500 GPM CDS unit (Model PMSU20_20) with a 2400 micron screen opening has been shown to have a TSS removal efficiency of 83% with 95% confidence limits of 83.5% and 82.5% respectively when operated at 40% of flow capacity, and a TSS removal efficiency of 56% with 95% confidence limits of 57% and 55% respectively when operated at 100% of flow capacity, using a fine sand and high influent TSS loadings in laboratory studies using simulated stormwater.

The PMSU20_20 unit with a 2400 micron screen opening was tested at flow rates of 200 GPM, 300 GPM, 400 GPM and 500 GPM at Portland State University. The fine sand for these tests had significantly less small particles (< 150 microns) than that used in the PMSU20_15 tests (Table 1). Again three trials were performed at each flow rate. Results are shown in Table 3.

Table 3 – Percent Removal for the PMSU20_20 Unit with a 2400 Micron Screen with F-110 Sand (Slominski et al., 2002)

Range (microns)	200 GPM (40% Capacity, TSS = 19,800 mg/l)		500 GPM (100% Capacity, TSS = 7,900 mg/l)	
	% Captured	S.D. of Capture (%)	% Captured	S.D. of Capture (%)
> 600	100.0	0.00	100.0	0.00
425 – 600	97.9	3.61	75.0	12.50
297 – 425	99.9	0.00	96.8	3.51
215 – 297	98.5	0.34	63.5	9.75
150 – 215	84.3	4.53	52.1	5.87
75 – 150	40.7	16.99	39.8	19.73
< 75	35.0	1.46	57.4	14.81
All	83.2	0.54	56.3	1.97

The repeatability of the tests on this larger unit was less than on the 300 GPM unit. Further, the smaller quantity of < 150 micron particles resulted in larger standard deviations for removal of these particles.

Because of questions raised regarding capture of < 75 micron particles in the 80 micron aperture plankton nets, a series of tests was run at Portland State University using fine sand (Wells and Slominski, 2003). Results are shown in Table 4.

Table 4 – Percent Removal for the PMSU20_20 Unit with a 2400 Micron Screen with Fine Sand (Howard, 2003)

Actual Flow Rate GPM	< 75 micron Capture - %	Overall Capture - %
30.7	90.0	89.7
116.9	87.9	85.2
203.8	76.9	81.9
339	76.4	69.8
493	90	83.9

The results of the laboratory testing demonstrate that the CDS device does capture < 75 micron particles. These results are generally better than those shown in the most recent Portland State study (Slominski et al., 2002) This is attributed to the fact that a sediment control outlet baffle was deployed in lieu of the oil baffle used in the recent Portland State study, and the utilization of particle counting to actually determine the effluent particle size distribution and mass.

Of interest in the results is the disparity between the overall capture and the capture of the < 75 micron particles. The overall capture rate should be higher. The authors attribute this disparity in results to the particle counting method deployed, since other explanations were considered unlikely.

Since limited test runs and samples were done, inadequate data exists to do a statistical evaluation of the data. It does appear that the general trend of performance is that capture deteriorates with increased flow rates, and that the capture of the sub 75 micron particles is above 70% through the flow rates tested.

The results shown for the 493 GPM flow rate is inconsistent with the other data. Overall trending performance would be best analyzed by ignoring this data point.

Claim 5 - CDS units are equipped with an oil baffle and can capture oil spills to the oil baffle's capacity.

As discussed earlier, CDS units are equipped with a conventional oil baffle to capture and retain oil and grease and TPHs up to the capacity of the unit (gross oil storage volume varies from unit to unit, ranging from 47 gallons to 1,320 gallons). This design feature enables CDS units to capture oil spills during dry weather to the capacity of the unit's oil baffle.

During normal wet weather flows, the oil baffle system will remove some fraction of the free oil and grease from the stormwater runoff. The City of Redmond, Washington installed CDS units as a pretreatment system upstream from a coalescing plate interceptor (CPI) oil/water separator system treating the stormwater runoff from a 184-acre downtown catchment area. This catchment area consists of mixed land uses of residential, retail and commercial. The City of Redmond reported that the maintenance effort on the CPI oil/separator located immediately

downstream of the CDS units was greatly reduced. Further, the amount of oil collected in the CPI oil/water separator was also reduced (Franklin, 2003).

Claim 6 - A 300 GPM CDS unit (Model PMSU20_15) with a 2400 micron screen opening removed 83-86% of free oil (sp.gr.=0.86) using sorbents (OARS™ and Rubberizer™) when operated at 40% of flow capacity in laboratory studies using simulated storm water.

Results from the sorbent laboratory study (Stenstrom and Lau, 1998) are shown below in Table 5.

Table 5 – Oil and Grease Removal

Test No.	Sorbent Type	Sorbent Mass(g)	Influent (mg/L)	Effluent (mg/L)	Percent Removal	Flow (gpm)
2	OARS	2600	19.6	2.7	86	125
3	OARS	2600	24.0	4.3	82	190
4	OARS	2600	30.7	1.7	94	75
5	OARS[1]	2600	21.0	3.5	83	125
6	Rubberizer	1030	27.2	3.9	86	125

Test 5 was conducted for 125 minutes to saturate the sorbent (unsuccessful – the sorbent was not saturated). All other tests lasted 30 minutes.

The more dense sorbents (OARS™ and Rubberizer™) generally had greater efficiencies than the lighter sorbents (such as Xsorb and Sponge Rok). This is because the lighter sorbents float on top of the water and have less contact with influent water and oil and grease. In some cases, there was poor mixing of the sorbents with the influent. The OARS™ and Rubberizer™ sorbents floated just below the fluid surface and had much better circulation patterns.

The sorbents generally retained the sorbed oil and grease. Effluent concentration of oil for the OARS™ sorbent was less than 1.0 mg/L. Effluent concentration of oil for the Rubberizer™ sorbent was higher (1.96 mg/L). This may have resulted from the higher mass of removed oil and grease per unit mass of sorbent (approximately three times higher).

5.3 Cleanout and Maintenance

Cleanout

The frequency of cleaning the CDS unit will depend upon the generation of trash, debris and sediments. Cleanout and preventive maintenance schedules should be determined based on operating experience unless precise pollutant loadings have been determined. The unit should be periodically inspected to determine the amount of accumulated pollutants and to ensure that the cleanout frequency is adequate to handle the predicted pollutant load being processed by the CDS unit.

Access to the CDS unit is typically achieved through two manhole access covers – one allows inspection and cleanout of the separation chamber (screen/cylinder) and sump and another allows inspection and cleanout of sediment captured and retained behind the screen. The PSW and PSWC off-line models have an additional access cover over the weir of the diversion vault. For units possessing a sizable depth below grade (depth to pipe), a single manhole access point would allow both sump cleanout and access behind the screen.

During the rainfall season, the unit should be inspected at least once every 30 days. The floatables should be removed and the sump cleaned when the sump is 75-85% full. If floatables accumulate more rapidly than the settleable solids, the floatables should be removed using a vactor truck or dip net before the layer thickness exceeds one to two feet.

Cleanout of the CDS unit at the end of rainfall season is recommended because of the nature of pollutants collected and the potential for odor generation from the decomposition of material collected and retained. This end of season cleanout will assist in preventing the discharge of pore water from the CDS unit during summer months.

A vactor truck is recommended for cleanout of the CDS unit and can be easily accomplished in less than 30-40 minutes for most installations. Standard vactor operations should be employed in the cleanout of the CDS unit. Disposal of material from the CDS unit should be in accordance with the local municipality's requirements. Disposal of the decant material to a POTW is recommended. Field decanting to the storm drainage system is <u>not</u> recommended. Solids can be disposed of in a similar fashion as those materials collected from street sweeping operations and catch-basin cleanouts.

Maintenance

It is recommended that the CDS unit be pumped down at lease once a year and a thorough inspection of the separation chamber (inlet/cylinder and separation screen) and oil baffle performed. The unit's internal components should be inspected for any signs of damage or any loosening of the bolts used to fasten the various components to the manhole structure and to each other. Ideally, the screen should be power washed for the inspection. If any of the internal components are damaged or if any fasteners appear to be damaged or missing, CDS Technologies can make arrangements to have the damaged items repaired or replaced.

The screen assembly is fabricated from Type 316 stainless steel and fastened with Type 316 stainless steel fasteners that are easily removed and/or replaced with conventional hand tools. The damaged screen assembly can be replaced with the new screen assembly placed in the same orientation as the one that was removed.

The CDS unit is a confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the unit to perform maintenance or inspection procedures. Inspections of the internal components can, in most cases, be accomplished through observations from the ground surface.

6. Technical Evaluation Analysis

6.1 Verification of Performance Claims

Based on the evaluation of the results from laboratory studies and field data, sufficient data is available to support CDS Technologies Claims 1, 2, 3, 4, 5 and 6.

6.2 Limitations

Annual gross pollutant trapping efficiency is a function of the fraction of the total stormwater flow that by-passes the CDS unit. Hence it is essential that CDS units be hydraulically designed correctly for the site. The field studies reviewed indicates minimal by-pass occurrences, consequently CDS units appear to have a high annual gross pollutant trapping efficiency.

High neutrally buoyant pollutant loadings have been shown to effect fluid rotation within the chamber, leading to screen blockage.

Field data indicate a much lower TSS removal efficiency than measured in the laboratory with fine sand in simulated stormwater. The reasons for this are not clear, but can be attributed to many factors including: resuspension and entrainment of particles in the sump; the decrease in particle removal efficiency for small particles (e.g., silt and clay); and an inability to remove TSS below a background concentration level (75 mg/L). Hence care must be taken when extrapolating laboratory performance to expected field performance, i.e., other sediment particle size distributions, TSS loadings.

Clean outs should be scheduled based on the pollutant loading to the CDS unit to optimize performance and ensure proper operation of the unit. Excessive pollutant loadings in the containment sump and separation chamber will reduce unit performance.

CDS units can export total phosphorus, particularly during the fall. This decrease in system performance may be related to the relatively large amounts of leaf litter that accumulates in the sump of the unit during the fall. Measured pollutant removal efficiencies may show a decrease (eventually showing a negative removal efficiency, i.e., an increase in total phosphorous exiting the unit) if anoxic conditions and decomposition within the sump cause stable forms of phosphorus stored in the leaf litter to become more soluble and subsequently enter the effluent stream.

The CDS unit design incorporates standing water in the separation chamber and containment sump which can be a breeding site for mosquitoes.

7. Net Environmental Benefit

The New Jersey Department of Environmental Protection (NJDEP or Department) encourages the development of innovative environmental technologies (IET) and has established a performance partnership between their verification/certification process and NJCAT's third party independent technology verification program. The Department in the IET data and technology

verification/certification process will work with any New Jersey-based company that can demonstrate a net beneficial effect (NBE) irrespective of the operational status, class or stage of an IET. The NBE is calculated as a mass balance of the IET in terms of its inputs of raw materials, water and energy use and its outputs of air emissions, wastewater discharges, and solid waste residues. Overall the IET should demonstrate a significant reduction of the impacts to the environment when compared to baseline conditions for the same or equivalent inputs and outputs.

Once CDS units have been recommended and verified for interim use within the State of New Jersey, CDS Technologies will then proceed to install and monitor systems in the field for the purpose of achieving goals set by the Tier II Protocol and final certification. At that time a net environmental benefit evaluation will be completed. However, it should be noted that the CDS technology requires no input of raw material other than sorbent material used to increase oil and grease capture efficiency, has no moving parts, and therefore, uses no water or energy.

8. References

Allison, R.A., Walker, T.A., Chiew, F.H.S., O'Neill, I.C. and McMahon (1998). From Roads to Rivers – Gross Pollutant Removal from Urban Waterways. Report 98/6. Cooperative Research Centre for Catchment Hydrology, Department of Civil Engineering, Monash University, Victoria, Australia.

Franklin, R. (2003) Letter to Walter Stein, P.E., Vice-president CDS Technologies, dated April 3, 2003.

Franklin Herrera Environmental Consultants (2002). Issaquah Stormwater Treatment Continuous Deflective Separation – Performance Monitoring Report. Centennial Clean Water Fund Grant Number G9900236. Prepared for the City of Issaquah, WA.

Horner, R., Skupien, J., Livingston, E., and Shaver, H.E. (1994). Fundamentals of Urban Runoff Management: Technical and Institutional Issues. Produced by the Terrene Institute, Washington, D.C., in cooperation with the U.S. Environmental Protection Agency.

Howard, R. (2003), under the direction of Wells, S.A. and Slominski, S. (2003). Continuous Deflective Separation Fine Sediment Control – Study Update, Department of Civil Engineering, Portland State University, Portland, Oregon.

Schueler, T. (2000). Irreducible Pollutant Concentrations Discharged from Urban Stormwater Treatment Practices. Technical note #75 from Watershed Protection Techniques 2 (2): 369-372.

Schwarz, T. and Wells, S. (1999). Stormwater Particle Remov al Using a Cross-Flow Filtration and Sedimentation Device, Technical Report EWR-5-99, Department of Civil Engineering, Portland State University, Portland, Oregon.

Slominski, S., Wells, S.A., and Berger, C.J. (2002). Particle Removal using Continuous Deflection Separation, Department of Civil Engineering, Portland State University, Portland, Oregon.

Stenstrom, M.K. and Lau, S.L. (1998). Oil and Grease Removal by Floating Sorbent in a CDS Device, Civil and Environmental Engineering Department, University of California, Los Angeles, CA.

Strynchuck, J., Royal, J. and England, G. (1999). The Use of a CDS Unit for Sediment Control in Brevard County. Brevard County Surface Water Improvement, Viera, Florida.

Walker, T.A., Allison, R.A., Wong, T.H.F. and Wooton, R.M. (1999). Removal of Suspended Solids and Associated Pollutants by a CDS Gross Pollutant Trap. Report 99/2. Cooperative Research Centre for Catchment Hydrology, Department of Civil Engineering, Monash University, Victoria, Australia.

Wong, T.H.F. & Wootton R.M., 1995, An Innovative Gross Pollutant Trap for Stormwater Treatment, in the Proc. Of the 2nd Int. Sym. On Urban Stormwater Management, NCP 95/03, Vol. 2, pp. 407-412.

NJCAT TECHNOLOGY VERIFICATION

ADDENDUM REPORT

HIGH EFFICIENCY CONTINUOUS DEFLECTIVE SEPARATORS

CDS TECHNOLOGIES INC.

DECEMBER 2004

2. Introduction

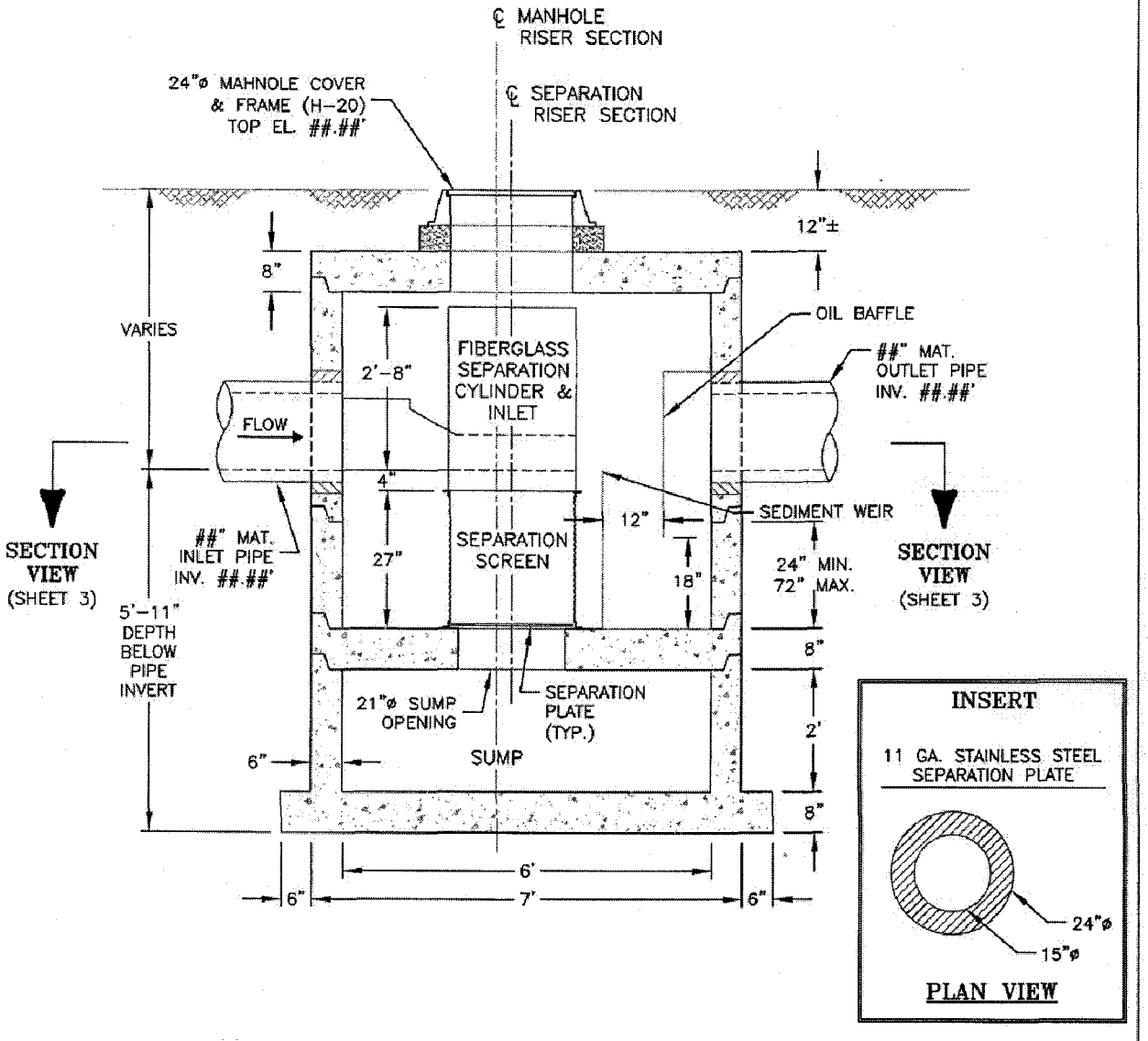
NJCAT published a Technology Verification Report on CDS Technologies Inc. (CDS Technologies) stormwater treatment technology using the mechanism of continuous deflective separation (CDS) in June 2003. The New Jersey Department of Environmental Protection (NJDEP) considered the sediment particle size distribution (PSD) and influent total suspended solids (TSS) loadings used in the laboratory studies to develop the TSS removal efficiency claims (Claims 3 and 4) not to be relevant to New Jersey stormwater particulate loading conditions and decided that they would not grant interim certification to CDS Technologies based on the NJCAT Verification Report[1].

CDS continues to make product improvements to achieve greater capture of particulates. When the CDS separator maintains good tangential velocity on the screen very little solids of any size get through. It is only when the tangential velocity decreases, or the flow velocity through the screen is substantially higher than the average velocity across the whole screen, that excessive loss of solids occurs. Increasing the ratio of the diameter of the manhole, to that of the screen, prevents short-circuiting from the area of the screen nearest the outlet. This minimizes excessive flow through the screen. Excessive screen velocities are especially detrimental to solids loss when they occur down in the lower part of the screen, where the tangential velocity has deteriorated. Consequently, the oil containment baffle was hurting particle capture efficiency because it forced all of the flow to enter the outlet area at an elevation in the lower third of the screen. Hence baffling to force the flow into the outlet at a higher elevation on the screen helps removal efficiency, because more flow goes through the screen in the upper regions where the tangential velocity is higher.

CDS wishes to retain their oil baffling capability, so they modified their original design to use a double baffle. It looks like a U, with the outer baffle (oil baffle), where the water enters, at an elevation 1/3 down on the screen, and the inner baffle (sediment weir) extending over the height of the separation screen. The diameter of the manhole has also been increased by 1 foot so that there is more separation between the screen and the inlet to the double baffle. CDS units employing this new design are designated High Efficiency Continuous Deflective Separators. CDS, recognizing that New Jersey is developing into a market that requires protection of its water resources through the verified removal of a very fine gradation of particles, will only provide its high efficiency particle removal efficiency CDS screening product in this market. All stormwater units sold in New Jersey will be one of these high efficiency units configured with a sediment weir. A New Jersey specific CDS Technical Manual having plan and profile drawings of commercial high efficiency particle removal CDS units with sedimentation weirs has been developed. Figure 1 shows the double baffle system for CDS Model PMSU20_20_6 (1.1 cfs, 493 gpm).

Figure 1

ELEVATION VIEW



CDS MODEL PMSU20_20_6, 1.1 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

(RIGHT-HANDED CONFIGURATION)

CDS TECHNOLOGIES™	PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 2.5'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	2
		APPROV.		

307 N. Bridge Street, Suite 3, Elkton, Maryland 21921 (410) 620-0933 www.cdstech.com

CDS Technologies has submitted a new performance claim for a high efficiency CDS unit based on previously submitted data[2] to NJCAT that more closely matches the PSD and influent loadings contained in the NJDEP Total Suspended Solids Laboratory Testing Procedures[3]. The objective of this Addendum Report is to evaluate this new performance claim based on this previously submitted data.

3. Technical Performance Claim

Claim – A 500 GPM (1.1cfs) unit (Model PMSU20_20_5) with a 2400 micron screen opening and a reconfigured outlet for best sediment control, operating with an average influent TSS concentration of 184 mg/L and zero initial sediment loading, has been shown to have a total mass TSS removal efficiency of 73.7% (per NJDEP treatment efficiency calculation methodology) for silica sand particles < 100 microns (d_{50} particle size of 63 microns) in laboratory studies using simulated stormwater.

4. Technical System Performance

3.1 Laboratory Study

Background

Portland State University (PSU), in its continuing evaluation of the CDS performance for sediment control, performed extensive testing that was aimed at determining the ability to control sub-100 micron particles[2].

Producing a suitable material to represent the fine particle gradation that needed evaluation was the first challenge. The source of the parent material is the Sil-Co-Sil 106 silica sand produced by the US Silica Company. The material originated at the Ottowa, IL plant. It is specified as a product suitable for BMP testing by the State of Washington, Department of Ecology. The base material used in the PSU testing was developed by repeated washing and decanting of the fines from the parent material to achieve the ultimate test gradation. The resulting sub-100 micron particle size distribution is shown in Table 1. The d_{50} particle size is 63 microns.

Table 1 – Sub-100 Micron Particle Size Distribution

Particle Size Micron (μm)	Percent (%)	Cumulative (%)
< 10	1.5	1.5
10-45	5.25	6.75
45-53	13.3	20.05
53-75	56.55	76.6
75-100	22.4	99.0

The second issue that needed to be managed was to reconfigure the laboratory to facilitate feed rate control, eliminate the need to re-circulate the test water during a discrete test, and reconfigure the CDS outlet for best sediment control. Feed control was achieved through using constant feed peristaltic pumps manufactured by Anko Products, Inc. and a slurry tank that was equipped with a high energy variable speed mixer Model #850 manufactured by Arrow Engineering Company and re-circulating peristaltic pumps to assure the larger (>50-μm) particles would not separate from the mixed solution.

Eliminating the need to re-circulate the water was accomplished by adding five (5) 550-gallon (gal) tanks. This, along with the existing storage in the laboratory created 1650-gal of source water and 1650-gal capacity to hold the CDS effluent (Figure 2). The CDS oil baffle was flipped over to behave as a sediment weir.

Slurry was prepared for each test run. This was done by utilizing the constant feed rate of the peristaltic pumps, coupled with the CDS run flow rate, and batched to hit a 200 milligram per liter (mg/L) sediment loading. The actual feed rate was determined after each run, when the actual CDS flow rate was determined.

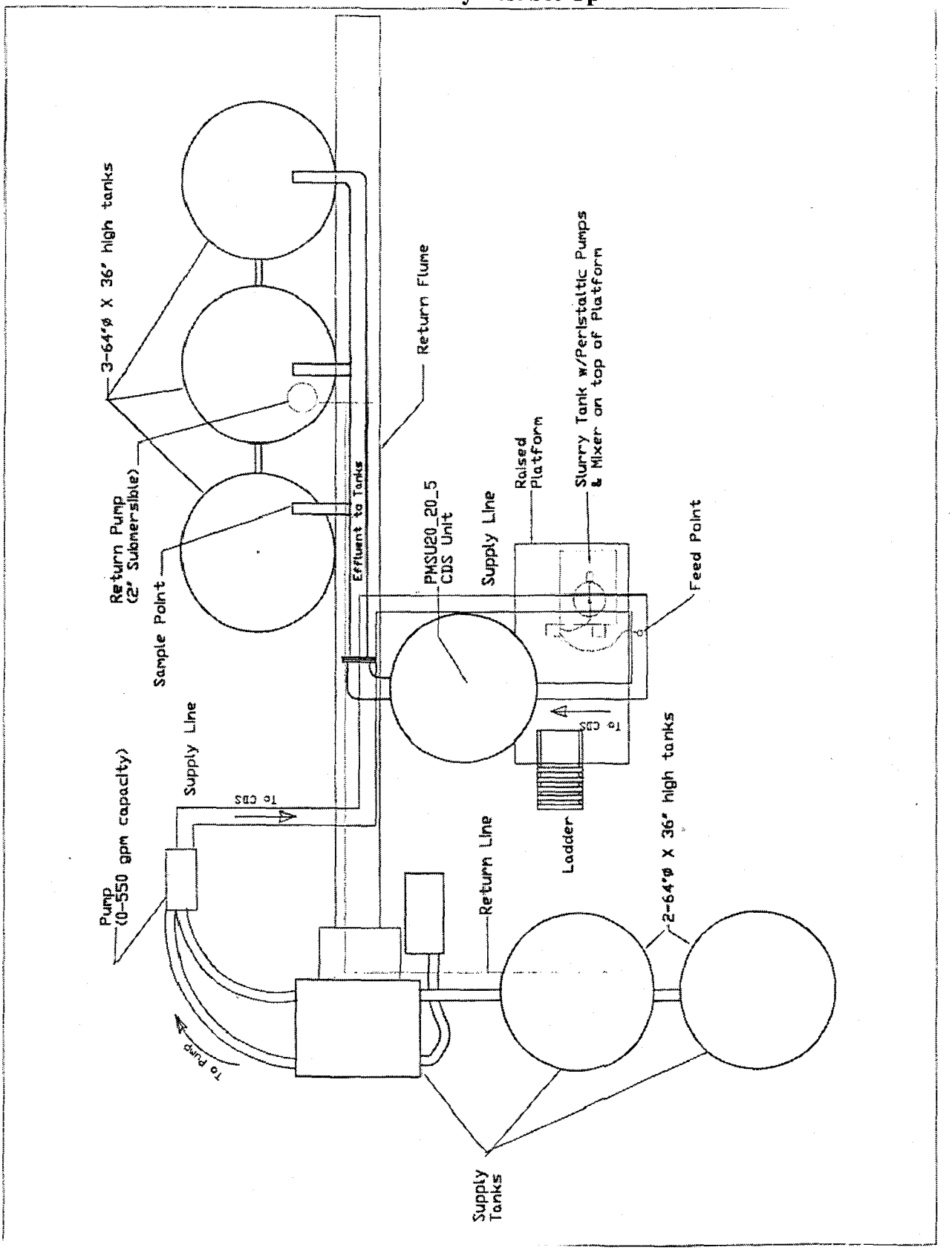
The volume of water and solids required for each run was determined and measured on a triple beam laboratory scale. The dry material was mixed with approximately two liters of water, in two one-liter sample bottles. These were shaken thoroughly and allowed to hydrate until they were used.

Test Procedure

Tests were run for incremental flow rates of about 25 gallon per minute (gpm) or 5% of the CDS unit's capacity to 250-gpm, or 50% of the unit's capacity. In addition, runs were carried out at flow rates of approximately 340-gpm and 500-gpm to establish TSS removal efficiencies at or near the unit's treatment operating capacity.

For each flow rate, the pump was set to the approximate flow using a digital magnetic flow meter. Once this was set, the pump was switched off. Water in the effluent side of the CDS unit was pumped to influent storage using a 75-gpm submersible pump. The depth in the effluent tanks was measured and was used later in the volumetric calculations to determine precise flow rates for each test run.

Figure 2
Laboratory Test Set-Up



The slurry water was measured out and added to the slurry tank, with two liters reserved for rinsing the sediment concentrate containers. The variable speed mixer was started, the re-circulating pumps were started, the sediment concentrate was added, and the containers rinsed and emptied into the slurry tank.

The influent pump and the slurry feed pumps were started simultaneously, along with a stopwatch. The system was operated through 1 & 1/3 active CDS volume turnover before the first 250-milliliter grab sample was taken. The second grab sample was taken at 1 & 2/3 turnover, with the final sample taken at just beyond 2 complete volume turnovers. The system was shut down, with the stopwatch measuring the total run time. The effluent tanks were allowed to settle for about 20-minutes, the depth measured, and then the water was returned to the influent side of the CDS unit. It is possible that some of the smallest particles may not have settled out during this time and were returned to the influent tanks. If so, the removal efficiencies reported would be conservative. Once this was done, the procedure set out above was repeated until all tests were run.

Three grab samples were collected for each run, with exception of the 500-gpm run, where it was only possible to achieve two samples due to the influent pump starting to cavitate toward the point when the third sample was to be taken. The samples were packaged and sent overnight to Spectrex Corporation, a certified laboratory, in Redwood City, CA. where the samples were subjected to a particle size analysis.

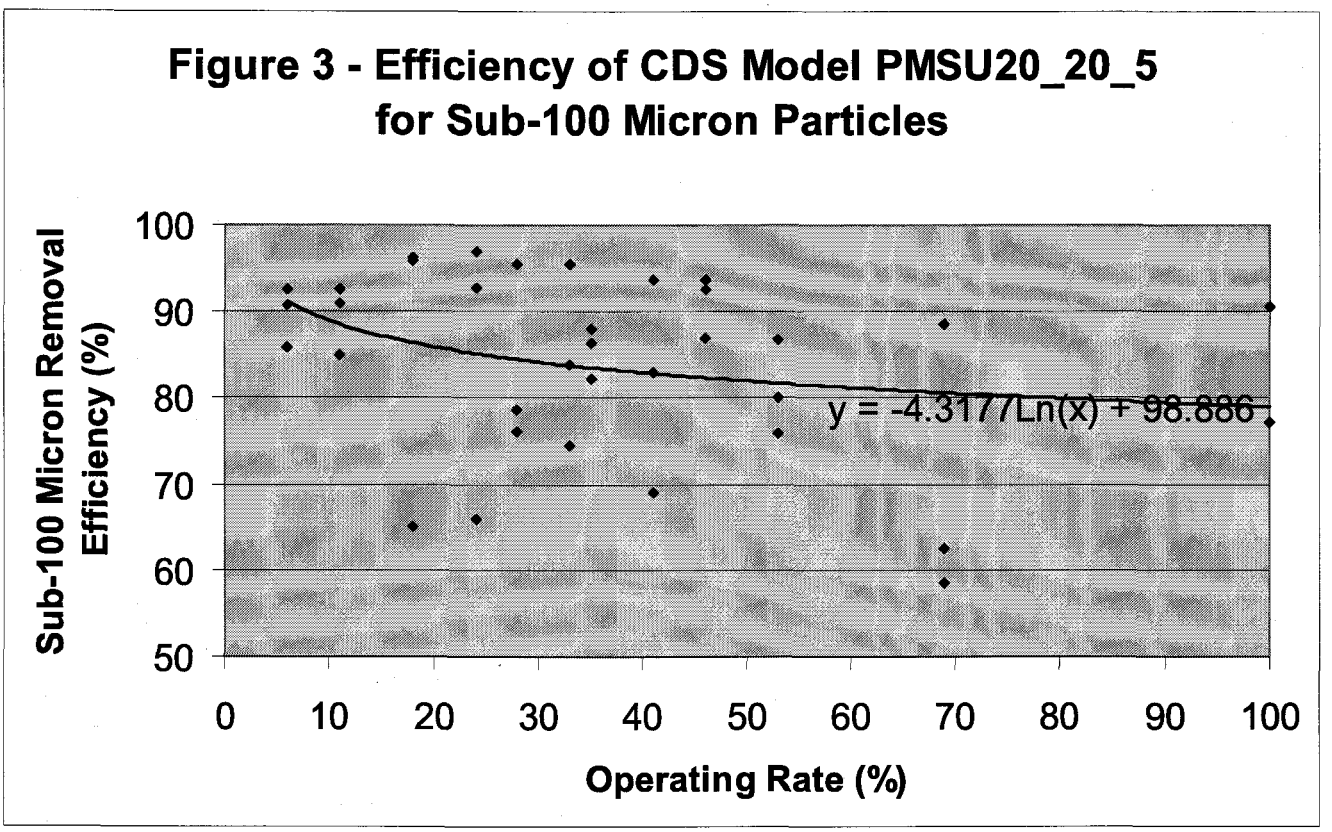
4. Results

Spectrex Corporation subjected the 35 grab samples collected from the 12 test conditions to an extensive particle size analysis to determine the sub-100 micron effluent concentration (mg/L) in each sample as shown in Table 2. (Spectrex first performed a particle number count in one micron increments and then calculated the mass in each particle size range.). The loading in the slurry tank was selected to achieve a TSS influent concentration of 200 mg/L. Actual influent TSS concentrations were determined at the end of each test run based on the actual recorded, verified flow rate into the CDS unit (Table 2). Influent concentrations varied from 160.4 mg/L to 202.9 mg/L, with an average influent concentration of 184 mg/L. The sub-100 micron particle removal efficiencies for each of the 35 grab samples was calculated from these data and are shown in Table 2 and graphically in Figure 3.

Figure 3 shows a wide scatter in the data. This is possibly a consequence of the particle counting method deployed especially for the resulting low effluent concentrations. This is not a science that follows a standard method and each provider of this technique has developed and perfected their processes for determining the results. The method is expensive, but was selected due to its ability to accurately discern the particle sizes in the samples in a timely manner. Moreover, as expected, the results indicate a decreasing TSS removal efficiency with increasing operating rate. The deployment of a sediment control baffle in lieu of the oil baffle used in the earlier Portland State University study improved the TSS removal efficiency substantially over that verified in the earlier NJCAT verification report[1].

Table 2 CDS Model PMSU20_20_5 Sub-100 Micron Particle Removal Efficiency

Flowrate (gpm)	Operating Rate (%)	Sub-100 micron Influent Concentration (mg/L)	Sub-100 micron Effluent Concentration (mg/L)	Sub-100 micron Removal Efficiency (%)
30.7	6	160.4	12.0	92.5
30.7	6	160.4	14.97	90.7
30.7	6	160.4	22.55	85.9
53.7	11	182.9	13.46	92.6
53.7	11	182.9	27.67	84.9
53.7	11	182.9	16.51	91.0
89.6	18	164.7	6.25	96.2
89.6	18	164.7	57.5	65.1
89.6	18	164.7	6.73	95.9
116.9	24	168.4	57.33	66.0
116.9	24	168.4	12.12	92.8
116.9	24	168.4	5.19	96.9
136.8	28	179.9	42.99	76.1
136.8	28	179.9	38.45	78.6
136.8	28	179.9	8.35	95.4
162.1	33	182	8.17	95.5
162.1	33	182	29.41	83.8
162.1	33	182	46.33	74.5
172	35	200	27.27	86.4
172	35	200	35.45	82.3
172	35	200	24.0	88.0
203.8	41	193.1	59.69	69.1
203.8	41	193.1	32.92	83.0
203.8	41	193.1	12.4	93.6
228.4	46	193.8	14.31	92.6
228.4	46	193.8	12.21	93.7
228.4	46	193.8	25.23	87.0
259.1	53	190	25.32	86.7
259.1	53	190	45.72	75.9
259.1	53	190	37.78	80.1
339	69	202.9	84.24	58.5
339	69	202.9	76.14	62.5
339	69	202.9	23.31	88.5
493	100	199.9	19.07	90.5
493	100	199.9	45.82	77.1



The weighting factors contained in the NJDEP Total Suspended Solids Laboratory Procedures[3] document were applied to the test results to generate the weighted average removal efficiency as shown in Table 3. Since no tests were run at flow rates higher than the treatment operating rate, it was decided to give no credit for TSS removal at 125% of the operating rate. This was deemed the most conservative approach.

Table 3 NJDEP Weighted TSS Removal Efficiency for CDS Model PMSU20_20_5

Treatment Operating Rate (%)	NJDEP Weight Factor	CDS TSS Removal Efficiency[1] (%)	NJDEP Weighted Average Removal Efficiency (%)
25	0.25	85.0	21.2
50	0.30	82.0	24.6
75	0.20	80.2	16.0
100	0.15	79.0	11.9
125	0.10	NA	-
Total			**73.7**

[1]Removal Efficiency = -4.3177ln (operating rate) + 98.886

5. Technical Evaluation Analysis

5.1 Verification of Performance Claim

Based on the evaluation of the results from the Portland State University sub-100 micron particle testing studies, sufficient data is available to support the CDS Technologies Claim: A 500 GPM unit (Model PMSU20_20_5) with a 2400 micron screen opening and a reconfigured outlet for best sediment control, operating with an average influent TSS concentration of 184 mg/L and zero initial sediment loading, has been shown to have a total mass TSS removal efficiency of 73.7% (per NJDEP treatment efficiency calculation methodology) for silica sand particles < 100 microns (d_{50} particle size of 63 microns) in laboratory studies using simulated stormwater.

5.2 Limitations

CDS Technologies Inc. offers a range of stormwater treatment systems designed to treat stormwater runoff. Treatment performance requirements vary throughout the country. New Jersey requires protection of its water resources through the verified removal of a fine gradation of particles. CDS Technologies has developed high efficiency continuous deflective separators configured with a sediment weir. These are the only CDS units which are capable of meeting or exceeding the verified performance claim. Since the high efficiency CDS units contain a double baffle and an increased manhole diameter, the commercial high efficiency particle removal CDS units' performance should exceed the performance demonstrated in the reconfigured unit tested at Portland State University. Only high efficiency CDS units should be approved in New Jersey. A New Jersey specific CDS Technical Manual having plan and profile drawings of commercial high efficiency CDS units with sedimentation weirs has been developed exclusively for use in New Jersey.

6. References

1. CDS Technologies, Inc. – NJCAT Technology Verification Report, June 2003.

2. Howard, R. (2003), under the direction of Wells, S.A. and Slominski, S., Continuous Deflective Separation Fine Sediment Control – Study Update, Department of Civil Engineering, Portland State University, Portland, Oregon.

5. Patel, M. (2004) Total Suspended Solids Laboratory Testing Procedures, dated December 23, 2003, New Jersey Department of Environmental Protection, Office of Innovative Technology and Market Development.

Stormwater Management Engineering Report

Environmental Division
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Martin's Fuel Facility Store #6402

December 22, 2010

Vanasse Hangen Brustlin, Inc. (VHB, Inc.)
351 McLaws Circle, Suite 3
Williamsburg, Virginia 23185
757.220.0500 Fax 757.220.8544

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- Drainage Area Maps (DA-1 through DA-2)
- APPENDIX A: Hydraulic Calculations
- APPENDIX B: Geotechnical Report

Stormwater Management Engineering Report

Martin's Fuel Facility
Store #6402

Stormwater Management Design Narrative

Martin's Fuel Facility (Store #6402)
Stormwater Management Design Narrative

Project Description
The project involves the proposed development of approximately 1.20 acres on Windsormeade Way across from Windsormeade Marketcenter. The site is located roughly 500 feet north of the intersection of Windsormeade Way and Monticello Avenue. Proposed improvements include construction of a new automobile refueling station with associated parking, drive aisles, sidewalks, site utilities, landscaping and stormwater management enhancements.

Stormwater Quality
The site falls within the planned service area of an existing 10-point BMP (PC-140, PC-141). Hence, no additional BMPs are required to meet the county's 10-point regulations. However, a hydrodynamic fuel-water separator structure has been provided to protect receiving systems from pollution due to fuel spills on the fueling pad.

Stormwater Quantity
Runoff from the proposed development will sheet flow to surface inlets including trench drains around the fueling pad and curb inlets. Runoff will then flow through a proposed closed pipe system parallel to Old News Road before discharging into the existing ditch alongside Monticello Avenue where it will enter the existing Monticello Avenue drainage system. No onsite detention of stormwater runoff is required as the receiving system has adequate excess capacity to support the proposed flows. Detention of peak flows from the site will be provided by the existing 10-point BMP at the intersection of Monticello Avenue and News Road (PC-140, PC-141). Hydraulic calculations for the proposed on-site pipe system are included in Appendix A, along with copies of the original calculations for the Monticello Avenue system to verify adequacy.

Existing Site Conditions
The existing site is currently undeveloped. When Windsormeade Marketcenter was constructed, the subject site and adjacent empty sites were cleared, graded, and prepared for future development as outparcel lots. The existing site is almost entirely open grass field with sparse vegetation.

Adjacent Areas
The project area is bounded on the northeast by Windsormeade Way and on the southwest by Old News Road. The site lies approximately 500 feet northwest of the intersection of Monticello Avenue and Windsormeade Way.

Off-site Areas
Construction of the proposed storm drainage system and proposed roadway connection between Old News Road and Windsormeade Way will require land disturbance on the adjacent parcel (the parcel lying between the project parcel and Monticello Avenue). Both parcels are owned by SL Nusbaum Realty Company. Spoils and debris will be removed from the site and will be disposed of at properly permitted and approved facilities.

Critical Areas

Existing slopes within the project area are relatively flat with the exception of the earthen berm along Old News Road which has slopes of approximately 4:1. All disturbed slopes shall be properly stabilized in accordance with the methods set forth in the Virginia Erosion and Sediment Control Handbook, latest edition.

Soils

Subsurface explorations were conducted by Froehling & Robertson, Inc. (F&R) in Fall 2010. A copy of the full geotechnical report is included as Appendix B.

Erosion and Sediment Control Measures

Unless otherwise indicated, waived, or approved by a variance, all vegetative and structural erosion and sediment control practices shall be constructed and maintained according to minimum standards and specifications of the Virginia Erosion and Sediment Control Handbook, 1992 edition. The following practices apply to this project:

Sequencing

Activities shall be sequenced to the maximum practical extent in order to minimize the area disturbed at any given time.

Silt Fence Barrier

Silt fence sediment barriers will be installed around the perimeter of disturbed areas to filter sediment-laden runoff from sheet flow and shallow concentrated flows. Additionally, silt fence shall be installed around all stockpiles.

Inlet Protection

Inlet protection devices shall be installed on existing and proposed drainage structures as shown on the plan. Inlet protection devices provide filtration of sediment-laden runoff to prevent the conveyance of sediment into the storm sewer system.

Temporary Construction Entrance

A temporary construction entrance shall be installed as shown on the plan.

Permanent Seeding

All disturbed areas shall be stabilized with permanent seeding immediately following finish grading. Seeding shall be in accordance with standard & specification 3.32 of the handbook. Seeded areas shall be mulched in accordance with standard & specification 3.35 of the handbook.

Sediment Trap

Sediment laden construction runoff shall be directed towards sediment traps, as shown on the plans, to the extent possible. Sediment traps detain construction runoff and prevent the associated sedimentation from being conveyed offsite.

Management Strategies

1. Operations shall be phased to minimize the overall area that is not stabilized at a given time.

2. Erosion and sediment control measures will be installed as a first step in any land disturbing operations.
3. Temporary seeding or other stabilization will follow immediately after grading.
4. Areas that are not to be disturbed will be clearly marked by flags, signs, etc.
5. The "responsible land disturber" designated for this project shall be responsible for the installation and maintenance of all erosion and sediment control measures.
6. After adequate stabilization is achieved, the temporary erosion and sediment controls measures will be cleaned up and removed.

Maintenance Of Controls

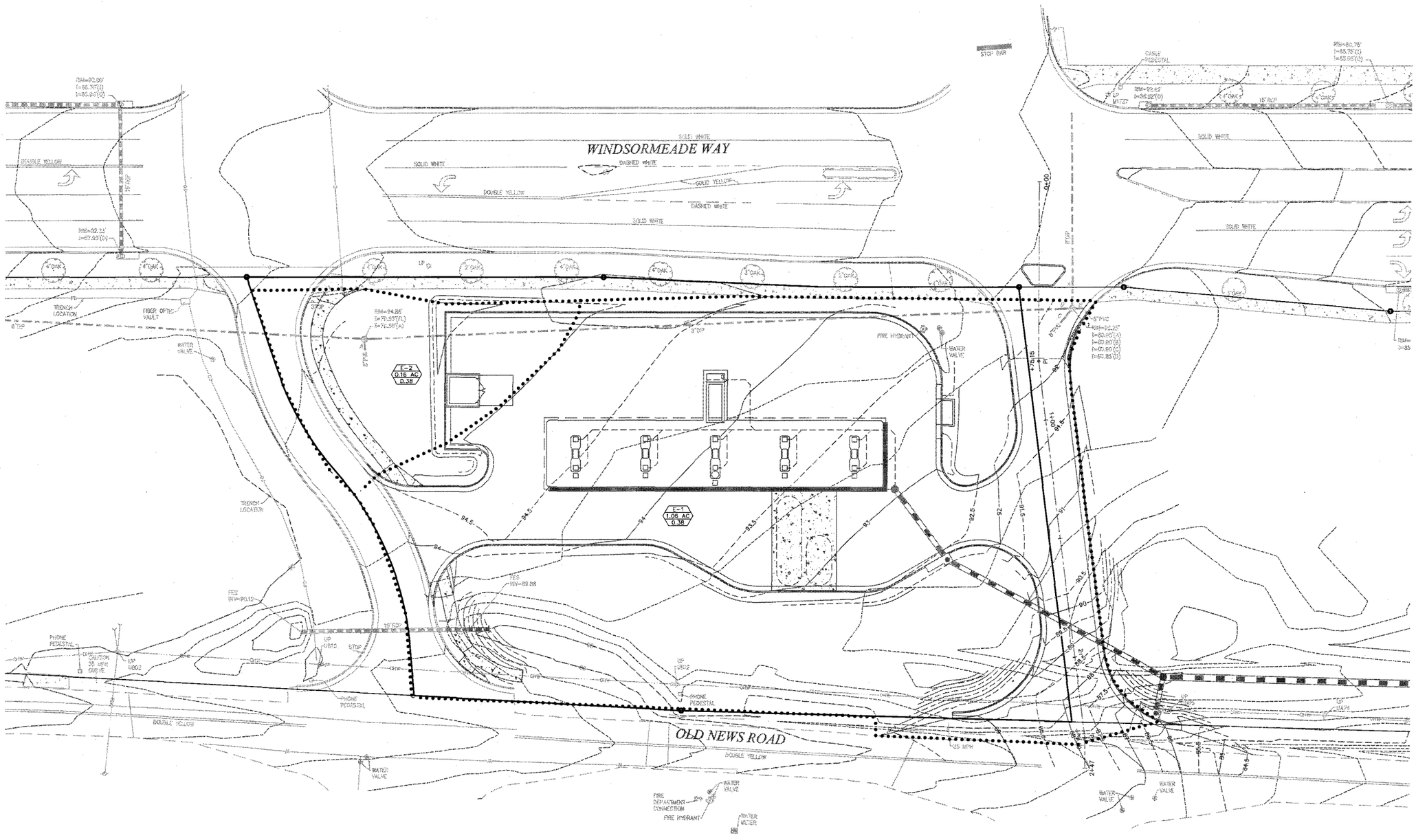
In general all erosion and sediment control measures will be checked daily and after each significant rainfall. The following items will be checked in particular:

1. The silt fence barriers will be checked regularly for undermining or deterioration of the fabric. Sediment shall be removed when the level of sediment deposition reaches half way to the top of the barrier.
2. Inlet protection devices shall be checked regularly and shall be cleaned or replaced if clogging or excessive ponding is observed.
3. The seeded areas will be checked regularly to ensure that a good stand of grass is maintained. Areas should be fertilized and re-seeded as needed.

Stormwater Management Engineering Report

Martin's Fuel Facility
Store #6402

Drainage Area Maps (DA-1 through DA-2)



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DRAINAGE AREA LABEL

DA#
AREA
C

20 0 20 40
SCALE IN FEET

No.	Revision	Date	Apprvd.

Designed by	Drawn by	Checked by
CAD checked by	Approved by	
Scale 1"=20'	Date December 22, 2010	

Project Title
Martin's Fuel Facility
Store #6402

4820 Monticello Avenue
Williamsburg, Virginia

Issued for
Site Plan Review

Not Approved for Construction

Drawing Title
Drainage Area Map
Existing

Drawing Number
DA-1

Sheet 1 of 1

Project Number
33205.00

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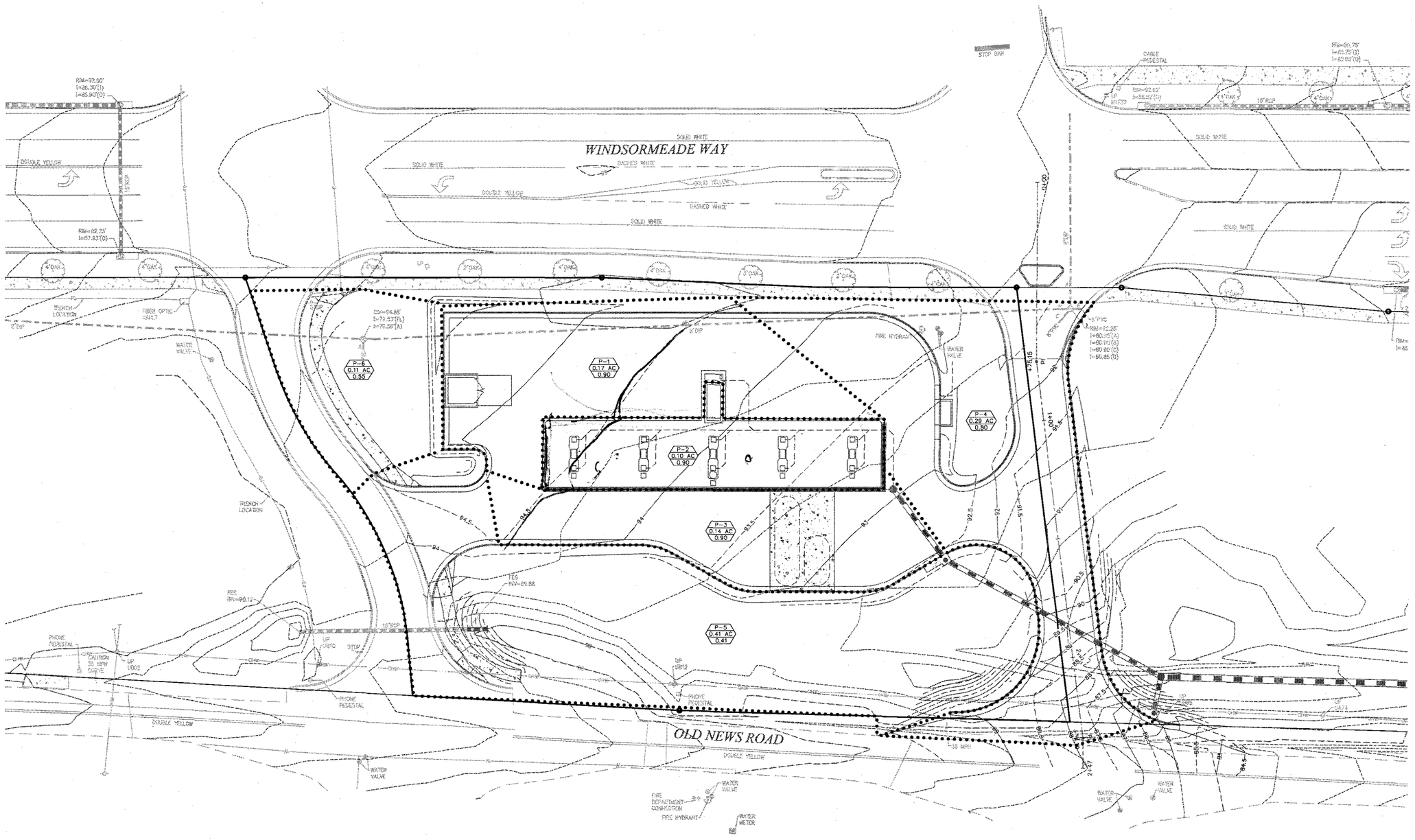

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DRAINAGE AREA LABEL

DA#
AREA
C

20 0 20 40
SCALE IN FEET

No.	Revision	Date	Appvd.

Designed by	Drawn by	Checked by
CAD checked by	Approved by	
Scale 1"=20'	Date December 22, 2010	

Project Title
Martin's Fuel Facility
Store #6402

4820 Monticello Avenue
Williamsburg, Virginia

Issued for
Site Plan Review

Not Approved for Construction

Drawing Title
Drainage Area Map
Proposed

Drawing Number
DA-2

Sheet 2 of

Project Number
33205.00

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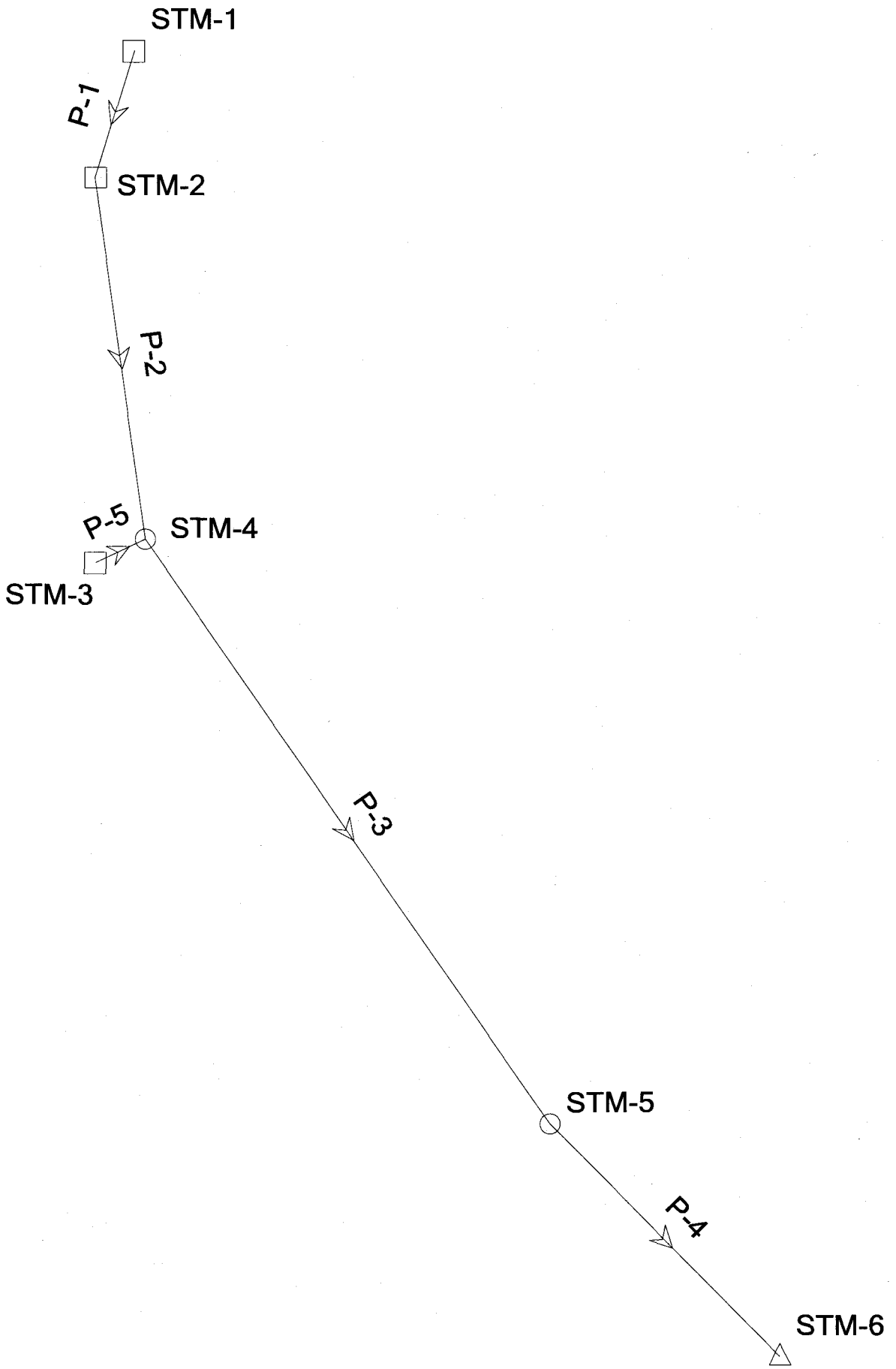
Stormwater Management Engineering Report

Martin's Fuel Facility
Store #6402

APPENDIX A: Hydraulic Calculations

Scenario: Base



Seperates
is for ~~ca~~
capacity of 1.1

in first 6
month need
to be checked
twice.

Scenario: Base

Node Report

Label	Area (acres)	Inlet C	Inlet CA (acres)	External CA (acres)	System CA (acres)	Time of Concentration (min)	External Time of Concentration (min)	Upstream Time Of Concentration (min)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Ground Elevation (ft)	Rim Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
STM-1	0.27	0.90	0.24	0.00	0.24	5.00	0.00	0.00	5.00	7.11	1.74	93.05	93.05	89.50	89.46
STM-2	0.14	0.90	0.13	0.00	0.37	5.00	0.00	5.11	5.11	7.08	2.63	92.79	92.79	88.94	88.85
STM-3	0.29	0.80	0.23	0.00	0.23	5.00	0.00	0.00	5.00	7.11	1.66	86.59	86.59	82.41	82.38
STM-4					0.60				5.29	7.03	4.26	90.38	90.38	82.33	82.24
STM-5					0.60				5.83	6.89	4.18	84.84	84.84	80.35	80.31
STM-6					0.60				6.04	6.84	4.14	82.00	82.00	80.17	80.17

Scenario: Base

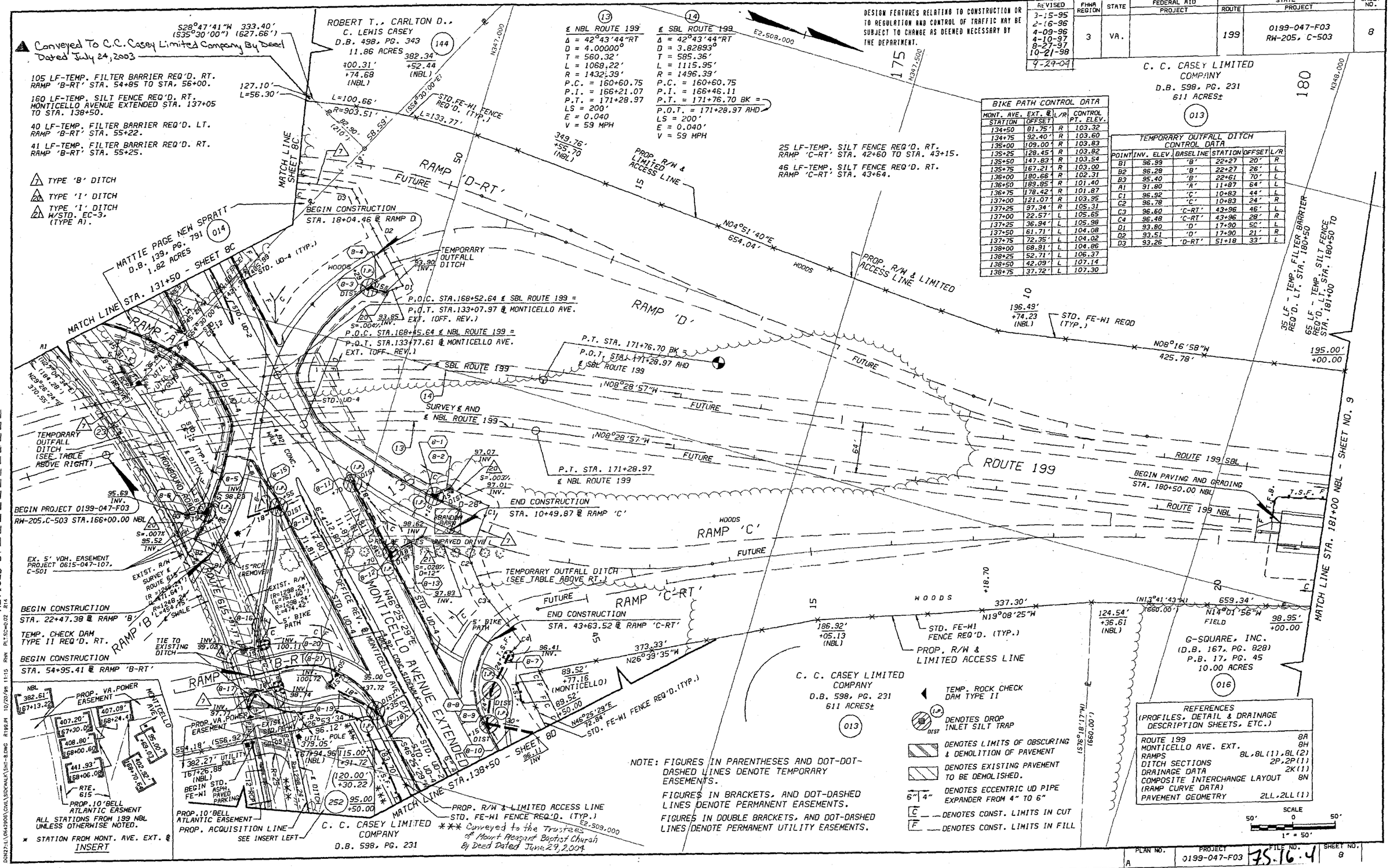
Pipe Report

Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Full Capacity (cfs)	Flow / Full Capacity (%)	Average Velocity (ft/s)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	STM-1	STM-2	0.27	0.90	0.24	0.24	7.11	1.74	37.00	0.017297	15 inch	0.013	8.50	20.5	5.44	89.46	88.94
P-2	STM-2	STM-4	0.14	0.90	0.13	0.37	7.08	2.63	102.00	0.065196	15 inch	0.013	16.49	16.0	9.84	88.85	82.33
P-5	STM-3	STM-4	0.29	0.80	0.23	0.23	7.11	1.66	16.00	0.020000	15 inch	0.013	9.14	18.2	5.66	82.38	82.33
P-3	STM-4	STM-5	N/A	N/A	N/A	0.60	7.03	4.26	200.00	0.012500	18 inch	0.013	11.74	36.3	6.12	82.24	80.35
P-4	STM-5	STM-6	N/A	N/A	N/A	0.60	6.89	4.18	92.00	0.020109	18 inch	0.013	14.89	28.0	7.23	80.31	80.17

LIMITED ACCESS HIGHWAY By Resolution of Commonwealth Transportation Board dated 10-16-86

REVISED	FHWA REGION	STATE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3-15-95 2-16-96 4-09-96 4-10-97 8-27-97 10-21-98 9-29-04	3	VA.		199	0199-047-F03 RW-205, C-503	8

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.



BIKE PATH CONTROL DATA

MONT. AVE. EXT. ℄ STATION	OFFSET	L/R	CONTROL PT. ELEV.
134+50	81.75'	R	103.32
134+75	92.40'	R	103.60
135+00	109.00'	R	103.83
135+25	128.45'	R	103.82
135+50	147.83'	R	103.54
135+75	167.21'	R	103.00
136+00	180.66'	R	102.31
136+50	189.95'	R	101.40
136+75	178.42'	R	101.87
137+00	121.07'	R	103.95
137+25	97.34'	R	105.31
137+00	22.57'	L	105.65
137+25	36.94'	L	105.98
137+50	61.71'	L	104.08
137+75	72.35'	L	104.02
138+00	68.91'	L	104.86
138+25	52.71'	L	106.37
138+50	42.09'	L	107.14
138+75	37.72'	L	107.30

TEMPORARY OUTFALL DITCH CONTROL DATA

POINT	INV. ELEV.	BASELINE	STATION	OFFSET	L/R
B1	96.99	'B'	22+27	20'	R
B2	96.28	'B'	22+27	26'	L
B3	95.40	'B'	22+61	70'	L
A1	91.80	'A'	11+87	64'	L
C1	96.92	'C'	10+83	44'	L
C2	96.78	'C'	10+83	24'	R
C3	96.60	'C-RT'	43+96	46'	L
C4	96.48	'C-RT'	43+96	28'	R
D1	93.80	'D'	17+90	50'	L
D2	93.51	'D'	17+90	21'	R
D3	93.26	'D-RT'	51+18	33'	L

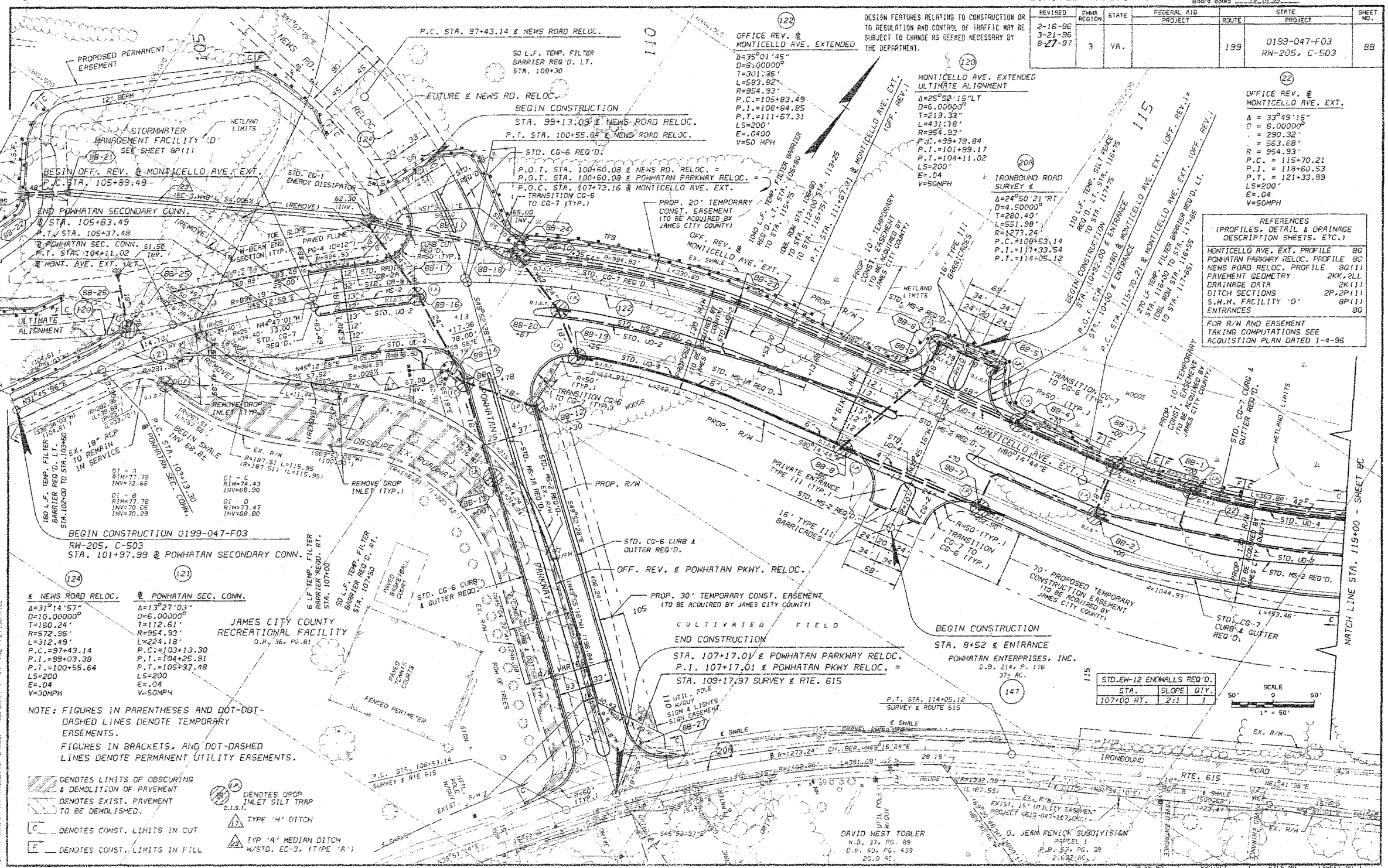
REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)

ROUTE 199	8A
MONTICELLO AVE. EXT.	8H
RAMPS	8L, 8L(1), 8L(2)
DITCH SECTIONS	2P, 2P(1)
DRAINAGE DATA	2K(1)
COMPOSITE INTERCHANGE LAYOUT (RAMP CURVE DATA)	8N
PAVEMENT GEOMETRY	2LL, 2LL(1)

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A	0199-047-F03	75.16.4	8

LIMITED ACCESS HIGHWAY By Resolution of Commonwealth Transportation Board dated 10-16-96

REVISED	FHWA REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
2-16-96 3-21-96 8-27-97	3	VA.		199	0199-047-F03 RW-205, C-503	8B



℄ NEWS ROAD RELOC.	℄ POWHATAN SEC. CONN.
Δ=31°14'57"	Δ=13°27'03"
D=10.00000°	D=6.00000°
T=160.24'	T=112.61'
R=572.96'	R=954.93'
L=312.49'	L=224.18'
P.C.=97+43.14	P.C.=103+13.30
P.I.=99+03.38	P.I.=104+25.91
P.T.=100+55.64	P.T.=105+37.48
LS=200	LS=200
E=.04	E=.04
V=30MPH	V=50MPH

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A	0199-047-F03	75-16-4	8B

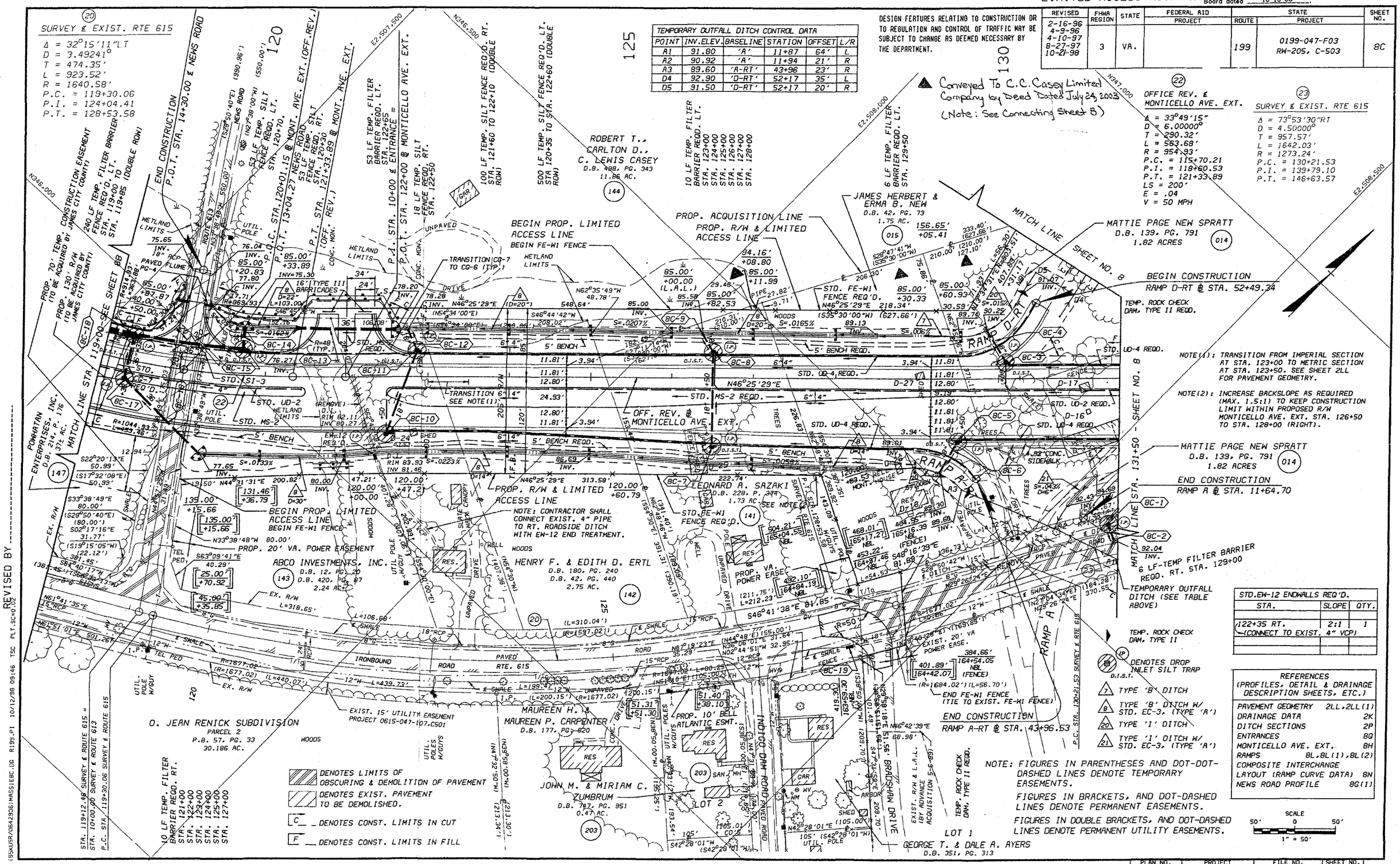
DESIGNED BY MMM Date on 6/30/97
REVISED BY

LIMITED ACCESS HIGHWAY By Resolution of Commonwealth Transportation Board dated 10-16-86

REVISED	FHWA REGION	STATE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
2-16-96 4-9-96 4-10-97 8-27-97 10-21-98	3	VA.		199	0199-047-F03 RW-205, C-503	8C

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.

TEMPORARY OUTFALL DITCH CONTROL DATA					
POINT	INV.ELEV.	BASELINE	STATION	OFFSET	L/R
A1	91.80	'A'	11+87	64'	L
A2	90.92	'A'	11+94	21'	R
A3	89.60	'A-RT'	43+96	23'	R
D4	92.90	'D-RT'	52+17	35'	L
D5	91.50	'D-RT'	52+17	20'	R



STD.EW-12 ENDWALLS REQ'D.		
STA.	SLOPE	QTY.
122+35 RT. (CONNECT TO EXIST. 4" VCP)	2:1	1

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)	
PAVEMENT GEOMETRY	2LL,2LL(1)
DRAINAGE DATA	2K
DITCH SECTIONS	2P
ENTRANCES	8Q
MONTICELLO AVE. EXT.	8H
RAMPS	8L,8L(1),8L(2)
COMPOSITE INTERCHANGE LAYOUT (RAMP CURVE DATA)	8N
NEWS ROAD PROFILE	8G(1)

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A	0199-047-F03	75.16.4	8C

DESIGNED BY MMM Design Group
REVISED BY

8/6/97

6

MMM DESIGN GROUP

ARCHITECTS + ENGINEERS + PLANNERS

HYDRAULIC GRADE LINE

Project: MONTICELLO AVENUE EXTENDED
Job #: 642903
Location: PLAN SHEETS 8, 8B, & 8C

Date: 03/13/97
Computed by: KWH
Sheet Number:

Inlet	Outlet WS Elev.	Do in	Qo cfs	Lo ft	Sfo %	Hf ft	Junction Loss Vo fts	Ho ft	Qi cfs	Vi fps	QiVi	Hi ft	Ang. deg.	K	Hd ft	Ht ft	DI Y/N	1.3 Ht	SI Y/N	0.5 Ht	H ft	Inlet WS Elev.	All. WSE Elev. ft	Remarks
8B-18	66.89	54	173.45	172	0.77	1.33	16.6	1.07	122.80	11.1	1365	0.67	-	-	-	1.74	N	1.74	Y	0.87	2.20	69.09	75.25	
8B-23	69.09	54	122.80	285	0.39	1.11	11.1	0.48	122.80	10.4	1273	0.58	-	-	-	1.06	N	1.06	Y	0.53	1.64	70.73	77.77	
8B-9	70.73	54	122.80	243	0.39	0.94	10.4	0.42	105.87	12.0	1273	0.79	-	-	-	1.20	Y	1.56	Y	0.78	1.72	72.45	77.09	
8B-4	72.45	48	105.87	128	0.54	0.69	12.0	0.56	105.58	12.3	1303	0.83	-	-	-	1.39	Y	1.81	Y	0.90	1.59	74.05	78.01	
8B-3	74.05	48	105.58	130	0.54	0.70	12.3	0.59	103.40	11.5	1189	0.72	-	-	-	1.31	Y	1.70	Y	0.85	1.55	75.60	78.51	
8B-1	75.60	48	103.40	96	0.52	0.50	11.5	0.51	102.83	14.0	1444	1.07	-	-	-	1.59	Y	2.06	Y	1.03	1.53	77.13	79.10	
8C-18	77.13	42	102.83	224	1.04	2.33	14.0	0.77	41.32	7.9	327	0.34	-	-	-	1.11	Y	1.44	Y	0.72	3.05	80.17	82.03	
8C-15	80.17	36	41.32	130	0.38	0.50	7.9	0.24	39.98	6.1	245	0.20	90	0.70	0.41	0.86	Y	1.11	Y	0.56	1.05	81.23	83.47	
ES	81.23	36	39.98	32	0.36	0.11	6.1	0.15	-	-	-	-	-	-	-	0.15	N	0.15	Y	0.07	0.19	81.41	80.57	
8B-6	73.32	18	1.27	50	0.01	0.01	2.7	0.03	0.86	2.1	2	0.02	90	0.70	0.05	0.10	Y	0.13	Y	0.06	0.07	73.39	75.97	
8B-5	73.39	18	0.86	78	0.01	0.01	2.1	0.02	-	-	-	-	-	-	-	0.02	Y	0.02	Y	0.01	0.02	73.41	75.97	
8B-8	73.32	24	22.83	130	1.01	1.32	8.2	0.26	15.96	7.9	126	0.34	120	0.82	0.80	1.40	Y	1.83	Y	0.91	2.23	75.55	78.84	
8B-7	75.55	24	15.96	186	0.50	0.92	7.9	0.24	-	-	-	-	-	-	-	0.24	Y	0.32	Y	0.16	1.08	76.63	78.84	
8B-10	69.24	24	12.52	15	0.30	0.05	5.2	0.11	12.29	5.6	69	0.17	30	0.28	0.14	0.41	Y	0.54	Y	0.27	0.31	69.55	75.25	
8B-20	69.55	24	12.29	62	0.29	0.18	5.6	0.12	9.36	7.3	68	0.29	30	0.28	0.23	0.64	Y	0.84	Y	0.42	0.60	70.15	74.70	
8B-19	70.15	18	9.36	86	0.79	0.68	7.3	0.21	-	-	-	-	-	-	-	0.21	Y	0.27	Y	0.13	0.81	70.97	72.58	
8B-2	77.32	18	2.76	68	0.07	0.05	6.9	0.18	-	-	-	-	-	-	-	0.18	Y	0.24	Y	0.12	0.17	77.49	80.72	
8B-12	70.46	18	3.63	90	0.12	0.11	5.2	0.10	-	-	-	-	-	-	-	0.10	Y	0.13	Y	0.07	0.17	70.63	72.46	
8B-16	66.89	24	9.01	114	0.16	0.18	9.0	0.32	8.46	6.8	58	0.25	10	0.07	0.05	0.62	Y	0.80	Y	0.40	0.58	67.47	75.15	
8B-15	67.47	24	8.46	118	0.14	0.16	6.8	0.18	5.48	8.2	45	0.37	5	0.03	0.03	0.58	Y	0.76	Y	0.38	0.54	68.01	71.64	
8B-13	68.01	18	5.48	122	0.27	0.33	8.2	0.26	-	-	-	-	-	-	-	0.26	Y	0.34	Y	0.17	0.50	68.51	74.53	
8B-14	70.46	18	5.73	28	0.30	0.08	5.9	0.14	-	-	-	-	-	-	-	0.14	N	0.14	Y	0.07	0.15	70.61	68.85	

STORM V1.1

M:\0642903\CIVIL\QPW\JAN97\QPWD-STRM2.WB2

8/6/97

5

MMM DESIGN GROUP
ARCHITECTS • ENGINEERS • PLANNERS

STORM SEWER DESIGN

Project: MONTICELLO AVENUE EXTENDED
Job #: 642903
Location PLAN SHEETS 8, 8B, & 8C

IDF-CURVE: JAMES_CITY
Computed by: KWH
Date: 03/13/97

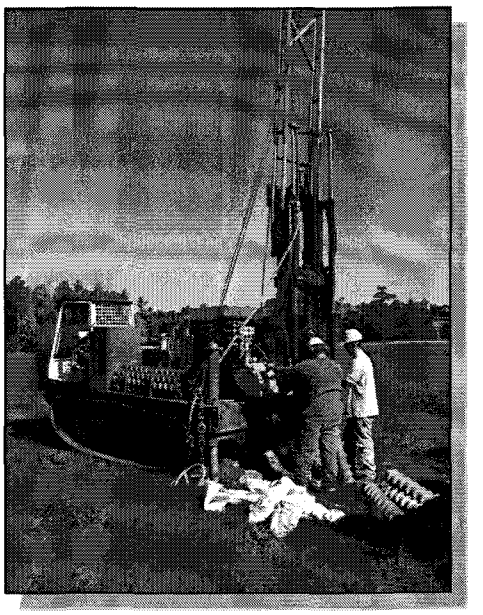
From	To	Design Year	Area A acres	Runoff Coeff. C	C*A Incr.	C*A Accum.	Inlet Time min.	Inten. i in/hr	Flow Q cfs	Invert Elevation Up ft	Invert Elevation Down ft	Length L ft	Slope S ft/ft	n	Dia. D inch	Vel. V ft/s	Cap. Qfull cfs	Flow Time sec.	Remarks
ES	8C-15	10			8.77	8.77	20.4	4.56	39.98	75.30	75.20	32	0.0031	0.013	36	6.14	37.14	5	Q/Qfull=1.1
8C-15	8C-18	10			0.31	9.08	20.5	4.55	41.32	75.20	74.50	130	0.0054	0.013	36	7.92	48.94	16	
8C-18	8B-1	10			14.33	23.41	22.0	4.39	102.83	74.50	71.45	224	0.0136	0.013	42	14.05	117.40	16	
8B-1	8B-3	10			0.28	23.69	22.3	4.36	103.40	71.45	70.70	96	0.0078	0.013	48	11.50	126.96	8	
8B-3	8B-4	10			0.58	24.27	22.4	4.35	105.58	70.70	69.50	130	0.0092	0.013	48	12.34	138.01	11	
8B-4	8B-9	10			0.17	24.44	22.6	4.33	105.87	69.50	68.40	128	0.0086	0.013	48	12.02	133.16	11	
8B-9	8B-23	10			4.03	28.47	22.8	4.31	122.80	67.90	66.60	243	0.0053	0.013	54	10.37	143.83	23	
8B-23	8B-18	10				28.47	23.1	4.27	122.80	66.60	64.80	285	0.0063	0.013	54	11.11	156.28	26	
8B-18	8B-11	10			20.25	48.72	30.0	3.56	173.45	64.80	62.30	172	0.0145	0.013	54	16.58	237.08	10	
8B-5	8B-6	10			0.12	0.12	5.0	7.20	0.86	71.10	70.90	78	0.0026	0.013	18	2.06	5.32	38	
8B-6	8B-9	10			0.06	0.18	5.6	7.05	1.27	70.90	70.70	50	0.0040	0.013	18	2.74	6.64	18	
8B-7	8B-8	10			2.66	2.66	10.0	6.00	15.96	73.30	71.45	186	0.0099	0.013	24	7.93	22.56	23	
8B-8	8B-9	10			1.19	3.85	10.4	5.93	22.83	71.45	70.20	130	0.0096	0.013	24	8.23	22.18	16	Q/Qfull=1.0
8B-19	8B-20	10			1.56	1.56	10.0	6.00	9.36	67.45	66.45	86	0.0116	0.013	18	7.31	11.33	12	
8B-20	8B-10	10			0.50	2.06	10.2	5.97	12.29	66.45	66.16	62	0.0047	0.013	24	5.58	15.47	11	
8B-10	8B-18	10			0.05	2.11	10.4	5.93	12.52	66.16	66.10	15	0.0040	0.013	24	5.24	14.31	3	
8B-2	8B-3	10			0.46	0.46	10.0	6.00	2.76	75.25	73.20	68	0.0301	0.013	18	6.85	18.24	10	
8B-12	8B-15	10			0.56	0.56	8.0	6.48	3.63	67.55	66.75	90	0.0089	0.013	18	5.16	9.90	17	
8B-13	8B-15	10			1.07	1.07	15.0	5.12	5.48	69.65	66.75	122	0.0238	0.013	18	8.22	16.20	15	
8B-15	8B-16	10			0.59	1.66	15.2	5.09	8.46	66.25	65.00	118	0.0106	0.013	24	6.81	23.28	17	
8B-16	8B-17	10			0.12	1.78	15.5	5.06	9.01	65.00	62.30	114	0.0237	0.013	24	9.02	34.82	13	
8B-14	8B-15	10			1.17	1.17	17.1	4.90	5.73	67.00	66.75	28	0.0089	0.013	18	5.92	9.93	5	

Martin's Fuel Facility
Store #6402

APPENDIX B: Geotechnical Report

FROEHLING & ROBERTSON, INC.

Martin's Fueling Facility - Williamsburg



Prepared for:

Vanasse Hangen Brustlin, Inc.
115 South 15th Street, Suite 200
Richmond, Virginia 23219-4209
F&R Record No. 60M-0685

Prepared By:

FROEHLING & ROBERTSON, INC.
3015 Dumbarton Road
Richmond, Virginia 23228
Phone: 804.264.2701
Fax: 804.264.7862

SINCE 1881

FROEHLING & ROBERTSON, INC.
Engineering • Environmental • Geotechnical

3015 Dumbarton Road
Richmond, Virginia 23228-5831 I USA
T 804.264.2701 I F 804.264.7862

F&R Project No. 60M-0685 December 9, 2010

Vanasse Hangen Brustlin, Inc.
115 South 15th Street, Suite 200
Richmond, VA 23219-4209

Attention: Scott Chapman, P.E.

Reference: Report of Subsurface Exploration Program and Geotechnical Engineering Analysis
Martin's Fueling Facility - Williamsburg
James City County, Virginia

Dear Mr. Chapman:

The purpose of this report is to present the results of the subsurface exploration program, laboratory testing, and geotechnical engineering analyses undertaken by Froehling & Robertson, Inc. (F&R) in connection with the above referenced project. This work was performed in general accordance with our proposal No. 1160-142Gr1, dated November 3, 2010. The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents our evaluation, conclusions, and recommendations.

We have enjoyed working with you on this project, and we are prepared to assist you with the recommended quality assurance monitoring and testing services during construction. Please contact us if you have questions regarding this report or if we may be of further service.

Sincerely,
FROEHLING & ROBERTSON, INC.

COMMONWEALTH OF VIRGINIA
CLYDE A. SIMMONS, III
Lic. No. 037906
12/9/10
PROFESSIONAL ENGINEER

Caleb M. Lange, E.I.T.
Geotechnical Engineering Staff

Clyde A. Simmons III, P.E.
Senior Geotechnical Engineer

F:\PROJECTS M60\60M-0685 (VHB-Martin's Fueling Facility Williamsburg)\60M-0685 Report.doc

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ASFE Information about Geotechnical Reports
Site Vicinity Map (Drawing No. 1)

APPENDIX B
Boring Location Plan (Drawing No. 2)
Boring Logs (B-1 through B-6)
Soil Classification Chart
Key to Boring Log Soil Classification

APPENDIX C
Moisture-Density Relationship Curves (1 page)
California Bearing Ratio Test (1 page)

1.0 INTRODUCTION

1.1 Project Information

The proposed fueling facility is located between Old News Road and Windsormeade Way, James City County, Virginia, as shown on the Site Vicinity Map (Drawing No. 1). Project information was provided by Scott Chapman, P.E., of Vanasse Hangen Brustlin, Inc., which included the project location and a site plan with proposed boring locations. The proposed project consists of constructing a fueling facility on a vacant lot. The fueling facility will included underground fuel storage tanks, a CMU attendants booth, a canopy, and accompanying rigid and flexible pavements.

Structural loads were not available at the time of this report but for our analysis we assumed a light canopy structure with maximum column loads of 30 kips and maximum wall loads of 3 kips per linear foot. Traffic loading is not expected to exceed 75,000 ESALs. While grading information was not provided, considering the relatively level site, cuts and fills of 5 feet or less are anticipated. A BMP infiltration basin is planned along the west side of the site.

1.2 Scope of Work

The purposes of our involvement on the geotechnical portion of this project were: 1) to provide general descriptions of the subsurface soil conditions at the locations explored, 2) to provide foundation recommendations, and 3) to comment on geotechnical aspects of the proposed development. To accomplish the above objectives, we undertook the following scope of services:

1. Visited the site to observe existing surface conditions and features and to mark boring locations;
2. Coordinated utility clearance with Miss Utility;
3. Reviewed readily available geologic and subsurface information relative to the project site;
4. Executed a subsurface exploration program consisting of six soil test borings drilled to depths ranging from 15 to 30 feet;
5. Installed two Environmental Monitoring Wells;
6. Performed three field infiltration tests to assist with the sites BMP design;

7. Performed laboratory testing on recovered soil samples to ascertain characteristic soil properties for use in design of foundation and pavements;

8. Evaluated the findings of the test borings relative to foundations, pavements, and earthwork considerations; and

9. Prepared this written report summarizing our work on the project, providing general descriptions of the encountered subsurface conditions, drainage considerations, and discussing geotechnical related aspects of foundations, and pavement construction.

Our scope of services did not include a survey of boring locations, quantity estimates, delineation of wetlands, environmental testing or analysis of the installed Monitoring Wells, and/or preparation of plans or specifications.

2.0 SUBSURFACE EXPLORATION PROCEDURES

The exploration program was performed on November 1, through November 5, 2010 and consisted of six soil test borings designated B-1 through B-6. Soil test borings B-1, B-2, and B-3 were drilled to depths of 30 feet each while borings B-4, B-5, and B-6 were drilled to depths of 15 feet each. All borings, B-1 through B-6, were performed within the confines of the proposed development. F&R personnel performed the borings at the approximate locations as provided to us by Mr. Chapman by measuring from existing features. The approximate locations of the borings are shown on the attached Boring Location Plan (Drawing No. 2). In consideration of the methods used in their determination, the boring locations shown on the attached Boring Location Plan should be considered approximate.

The soil test borings were performed in accordance with generally accepted practice using an track-mounted CME-55 rotary drill rig equipped with an automatic hammer. Hollow-stem augers were advanced to pre-selected depths, the center plug was removed, and representative soil samples were recovered with a standard split-spoon sampler (1 3/8 in. ID, 2 in. OD) in general accordance with ASTM D 1586, the Standard Penetration Test. For these tests, a weight of 140 pounds was freely dropped from a height of 30 inches to drive the split-spoon sampler into the soil. The number of blows required to drive the split-spoon sampler three consecutive 6-inch increments was recorded, and the blows of the last two increments were summed to obtain the

Standard Penetration Resistance (N-value). The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils.

Prior to demobilization, the boreholes were backfilled with auger cuttings (soil). Periodic observation of the backfilled borings should be performed as the boring backfill could settle over time resulting in subsidence of the surface cuttings.

Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory. In the laboratory, the soil samples were evaluated by a member of our engineering staff in general accordance with techniques outlined in the visual-manual identification procedure (ASTM D 2488). The soil descriptions and classifications discussed in this report and shown on the attached Boring Logs are based on visual observation and should be considered approximate. A copy of the boring logs is provided and classification procedures are further explained in Appendix B.

Field infiltration testing was conducted in three test holes located along the west side of the site. Due to the unknown depth of the proposed BMP basin, the test hole was drilled to 40 inches below existing site grades and cased with 5 inch diameter solid PVC pipe. The cased borehole was soaked with water to a depth of about 2 feet for 24 hours. After this presoaking period water was added as necessary to the cased borehole and water level readings were taken approximately every hour for 4 hours, and the infiltration rate is reported as last reading of the test (inches per hour).

Split-spoon soil samples recovered on this project will be stored at F&R's office for a period of 60 days. After 60 days, the samples will be discarded unless prior notification is provided to us in writing.

3.0 SUBSURFACE CONDITIONS

3.1 Site Description

The site is located east of Monticello Marketplace in between the parallel roads of Windsormeade Way and Old News Road in James City County, Virginia. There is a swale approximately 4 feet deep which lies along Old News Road on the west side of the site. A berm borders the south portion of the swale and reaches an approximate height of 3 feet. A small detention pond is located at the southwest corner of the site. It appears to be consistently wet and has cattails and similar vegetation. A gas line traverses the south portion of the site, and a manhole was located in

the northeast corner of the site. According to the provided site plan, existing site grades range from approximately EL 95 in the northeast corner to EL 88 in the southwest corner.

3.2 Regional Geology

Available geologic references report that the project site lies within the western part of the Coastal Plain physiographic province of Virginia. Locally, the project site is underlain by Pliocene Sand and Gravel. The topography of the Coastal Plain is a terraced landscape that stair-steps down to the coast and to the major rivers. The risers (scarps) are former shorelines and the treads (flat parts) are emergent bay and river bottoms. The higher, older plains in the western part of the Coastal Plain are more dissected by stream erosion than the lower, younger terrace treads. It is commonly held that this landscape was formed over the last few million years as sea level rose and fell in response to the repeated melting and growth of large continental glaciers and as the Coastal Plain slowly uplifted.

According to the 1993 Geological Map of Virginia, the project site is located specifically over the Moorings unit of Oaks and Coch which is an upper Pliocene deposit. This deposit typically consists of white, light-gray, and grayish-yellow quartzose SAND and gray to grayish-brown Clayey SILT and Silty CLAY. This deposit constitutes a discontinuous linear body along and just west of the Surry scarp; depositional surfaces range in altitiude from 130 feet along slightly higher, ridge-like topography at the scarp to about 110 feet west of scarp. Eastern facies of this unit are unfossiliferous, massive to cross-laminated, moderately well-sorted, fine sand believed to have been deposited in beach and near-shore environments. The upper part of the fine sand facies interfingers westward with massive, bioturbated clay and silt deposited in a lagoon or shallow bay. This deposit can be as thick as 30 feet.

3.3 General Subsurface Conditions

The subsurface conditions discussed in the following paragraphs and those shown on the attached Boring Logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between different soil strata are usually less distinct than those shown on the attached Boring Logs. Although the individual soil test boring is representative of the subsurface conditions at the boring location on the date shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific soil test borings is shown on the attached Boring Logs in Appendix B.

3.4 Surficial Soils

Surficial Soils were encountered in all borings to approximate depths ranging from 6 to 12 inches below the existing ground surface. Surficial Soil is typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components and is generally unsuitable for engineering purposes. F&R has not performed any laboratory testing to determine the organic content or other horticultural properties of the observed Surficial Soil materials. Therefore, the term Surficial Soil is not intended to indicate a suitability for landscaping and/or other purposes. The Surficial Soil depths provided in this report are based on driller observations and should be considered approximate. We note that the transition from Surficial Soil to underlying materials may be gradual, and therefore the observation and measurement of Surficial Soil depths is subjective. Actual Surficial Soil depths should be expected to vary across the site especially in areas of root ball systems from trees and the mulched play area.

3.5 Fill Soils

Fill may be any material that has been transported and deposited by man. Materials described as fill or possible fill were encountered in borings B-1, B-2, B-4, B-5, and B-6 to depths ranging from approximately 3 to 5 feet below existing site grades. Sampled fill materials were generally described as Sandy Lean CLAY (CL) and Clayey SAND (SC). Standard penetration resistances (N-values) in the fill soils ranged from 6 to 18 blows per foot (bpf).

3.6 Alluvial Soils

Alluvial Soils were encountered under the Surficial Soils and Fill Soils to the individual boring termination depths noted on the Boring Logs. These alluvial soils were generally described as Sandy Lean CLAY (CL), Sandy Fat CLAY (CH), Silty SAND (SM), and SAND with varying amounts of Silt and Clay (SC-SM). Standard penetration resistances (N-values) in the fine-grained soils (CLAYs) ranged from 3 to 19 bpf indicated these soils are soft to very stiff in consistency. The N-values in the coarse-grained soils (SANDs) ranged from 3 to 18 bpf indicating a very loose to medium dense relative density. In general, higher N-values were recorded in the upper 10 feet of the soils profile, with N-values typically between 3 and 7 below that depth.

3.7 Subsurface Water

The test borings were monitored during and after drilling operations to obtain short-term subsurface water information. The subsurface water data, obtained during our subsurface exploration, have been summarized in the following table:

Boring	Depth of Boring (Feet)	Subsurface Water Depth While Drilling (Feet)	Subsurface Water Depth After Removal of Augers (Feet)	Cave-in Depth (Feet)
B – 1	30	18.5	20	22
B – 2	30	18	Not Reported	Not Reported
B – 3	30	18.5	Not Reported	Not Reported
B – 4	15	Not Encountered	Not Observed	13
B – 5	15	14	Not Observed	13
B – 6	15	Not Encountered	Not Observed	12
Test – 1	3.5	Not Encountered	Not Observed	3.5
Test – 2	3.5	Not Encountered	Not Observed	3.5
Test – 3	3.5	Not Encountered	Not Observed	3.5

It should be noted that the location of the subsurface water table could vary by several feet because of seasonal fluctuations in precipitation, evaporation, surface water runoff, local topography, and other factors not immediately apparent at the time of this exploration. Normally, the highest subsurface water levels occur in the late winter and spring and lowest levels occur in the late summer and fall. It should be noted that borehole cave-in often indicates wet and unstable conditions.

3.8 Laboratory Testing Program

Representative soil samples were subjected to Water Content, #200 Sieve Wash, and Atterberg Limits testing to substantiate the visual classifications and assist with the estimation of the soils' pertinent engineering properties. Classification procedures are further explained in Appendix B. The results of our laboratory testing are included in the following table:

Boring No.	Sample Depth (Feet)	Natural Water Content (%)	Liquid Limit/ Plasticity Index	#200 Sieve Wash	USCS Class.
B – 1	3.5 – 5.0	25.9	59/33	66.0	CH
B – 3	3.5 – 5.0	26.7	53/26	67.6	CH
B – 5	0.0 – 5.0	19.3	37/18	56.9	CL

Boring No.	Sample Depth (Feet)	Natural Water Content (%)	Liquid Limit/ Plasticity Index	#200 Sieve Wash	USCS Class.
B – 6	3.5 – 5.0	25.6	53/30	57.7	CH

In addition to the testing listed above, moisture-density relationship testing using the Modified Proctor method and California Bearing Ratio (CBR) testing was performed on the bulk sample from boring B-5 for use in pavement design recommendations. The results of our laboratory testing are included in the table below:

Boring No.	Sample Depth (Feet)	Maximum Dry Density (pcf)	Optimum Water Content (%)	CBR @ 0.1 inch (soaked)	USCS Class.
B – 5	0.0 – 5.0	113.6	14.5	28.2	CL

3.9 Field Infiltration Testing

As part of our services, we performed three field infiltration tests along the west side of the site. Our testing was performed in general accordance with Appendix E of the James City County BMP Manual as provided by Barry E. Moses, P.E., Senior Stormwater Engineer with James City County. The results of our field testing are shown in the table below:

Test No.	Depth	Soil Type	Final Infiltration Rate
1	3.5 feet	CH	0.25 in/hr
2	3.5 feet	CH	0.35 in/hr
3	3.5 feet	CH	0.55 in/hr

4.0 DESIGN RECOMMENDATIONS

4.1 General

The following recommendations are based on our observations at the site, interpretation of the field and laboratory data obtained during this exploration, provided structural characteristics, and our experience with similar subsurface conditions and projects. The design team should realize that although individual soil test borings are representative of the subsurface conditions at the

boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Soil penetration data have been used to estimate the quality of the existing overburden soils at the proposed site. Subsurface conditions in unexplored locations may vary from those encountered. If structure dimensions, location, or elevation are changed, we request that we be advised so that we may re-evaluate our recommendations.

Determination of an appropriate foundation system for a given structure is dependent on the structural loads, soil conditions, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations with regard to both allowable bearing pressure and compressibility of the underlying soils. In addition, since the method of construction greatly affects the materials intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction.

4.2 Foundations

Based on the results of our exploration, we recommend that the building be supported on a shallow foundation system such as spread footings. Footings should be founded on suitable undisturbed alluvial soils or on compacted structural fill (Engineered Fill). Existing fill materials which are not considered suitable for foundation support were encountered in each boring except B-3 and extended up to 5 feet below existing site grades. Therefore, the footings should be lowered to bear on firm natural soil, or the fill materials below the footings should be undercut and replaced with lean concrete or compacted fill.

The footings may be designed for an allowable bearing pressure of 2,500 psf. Minimum footing widths of 24 inches and 36 inches should be maintained for continuous (wall type) spread footings and square (column type) spread footings, respectively. Footings should have a minimum embedment depth of at least 36 inches below final exterior grade for shrink-swell soil considerations.

We recommend that foundations be designed to resist uplift forces on the canopy. To aid with this design, we have included the following estimated soil parameters for frictional resistance, passive earth pressure coefficient, and moist soil unit weight.

- Coefficient of friction value of 0.32 between the concrete bottom of footings and underlying alluvial subgrade.
- Passive earth pressure coefficient of 2.5. Please note that significant movement is required to develop the passive pressure. Therefore, the total calculated passive pressure should be reduced by one-half to two-thirds for design purposes.
- Moist soil unit weight of 115 pounds per cubic foot (pcf).

During construction of the facility, an experienced geotechnical engineer or his/her representative should be on site to confirm that the in-situ bearing condition at the bottom of each footing excavation is adequate for the design bearing pressure recommended in this report.

4.3 Settlement

Based on the boring data and assumed structural information, we estimate that foundation settlements will be less than 1 inch with differential settlement of up to one-half the estimated total settlement. The magnitude of differential settlements will be influenced by the variation in excavation requirements across the building footprint, the distribution of loads, and the variability of underlying soils.

Our settlement analysis was performed on the basis of assumed structural loading and excavation requirements discussed in the project information section of this report. Actual settlements experienced by the structure and the time required for these soils to settle will be influenced by undetected variations in subsurface conditions, final grading plans, and the quality of fill placement and foundation construction.

4.4 Ground Floor Slab

Ground floor slabs may be designed as a slab-on-grade supported by alluvial soils, newly placed controlled fill, or approved existing fill material. Any loose/soft or otherwise unsuitable materials should be remediated as judged necessary by the Geotechnical Engineer. We recommend that the slab-on-grade be underlain by 4-inches of well-compacted granular materials, which should conform to an open graded aggregate (such as VDOT No. 57 Stone). This granular material provides a capillary break between the subgrade and slab-on-grade; while also providing a uniform bearing surface. A vapor retarder should be used beneath ground floor slabs that will be covered by tile, wood, carpet, impermeable floor coatings, and/or if other moisture-sensitive equipment or materials will be in contact with the floor. However, the use of vapor retarders may result in

excessive curling of floor slabs during curing. We refer the floor slab designer to ACI 302.1R-96, Sections 4.1.5 and 11.11, for further discussion on vapor retarders, curling, and the means to minimize concrete shrinkage and curling.

Proper jointing of the ground floor slab is also essential to minimize cracking. ACI suggests that unreinforced, plain concrete slabs may be jointed at spacings of 24 to 36 times the slab thickness, up to a maximum spacing of 18 feet. Floor slab construction should incorporate isolation joints along bearing walls and around column locations to allow minor movements to occur without damage. Utility or other construction excavations in the prepared floor subgrade should be backfilled to a controlled fill criteria to provide uniform floor support.

Structural analyses and design of floor slab foundation may require the use of a vertical modulus of subgrade reaction (k). We note that typical practice for slab-on-grade and pavement design is to provide a "k" value based on published correlation with soil types and California Bearing Ratio (CBR) test values. Such correlations are based on empirical data from plate load tests. The plate load test sufficiently models typical floor and wheel loads that exert stresses on the order of 3 to 5 feet. Based on published correlations, we estimate that a design modulus of subgrade reaction (k) = 150 pci is appropriate for floor slab design calculations, provided that the recommended 4-inch subbase is utilized.

4.5 Pavement Recommendations

We understand that asphaltic concrete pavement is planned for the at-grade parking areas, driveways, and aprons on the site. We anticipate that the parking areas will service primarily automobile traffic, while the driveways will have delivery truck and trash truck traffic, along with automobile traffic. Therefore, two pavement sections have been designed based on different loading conditions: standard-duty traffic (automobile traffic only) and medium-duty traffic (delivery and trash truck traffic).

CBR testing was completed on a bulk sample taken from boring B-5 at a depth of 0 to 5 feet below the existing ground surface. The sample was classified as a Sandy Lean CLAY (CL) according to the USCS, with a soaked CBR value of 28.2 at 0.1 inches penetration. In our experience, this value is higher than typical values for similar soils in the area. In order to account for this, and for some variability of the subgrade soils, a Design CBR value of 10 has been used for our analyses. The CBR value of the actual subgrade materials used should be verified prior to the construction of any pavements.

The following design values were used for our analysis:

Standard duty traffic loading	75,000 equivalent single axle loads (ESAL)
Medium duty traffic loading	200,000 ESAL
Design life	20 years
Reliability	75 %
Overall Standard Deviation	0.49
Initial serviceability	4.0
Terminal serviceability	2.0

Our design analysis was based on methodology from the American Association of State Highway and Transportation Officials' (AASHTO) *Guide of Design of Pavement Structures*, 1993. Based on the assumptions and methodologies presented above, we recommend the following pavement sections:

Pavement Section		MEDIUM	Standard
Layer	VDOT Specification (SUPERPAVE)	Thickness (inches)	Thickness (inches)
Surface Course	Asphalt Concrete (SM-9.5A)	1.5	2.0
Intermediate Course	Asphalt Concrete (IM-19)	2.0	---
Subbase Course	Type I Crushed Aggregate (No. 21A or No. 21B)	6.0	6.0

Our pavement recommendations are based on pavements being supported on soils similar to the soils we tested. Fill materials underlying pavements should be placed in accordance with the controlled fill and pavement subgrade recommendations contained in this report. In addition, all pavement subgrades should be evaluated by a geotechnical engineer prior to basestone placement. If excessive subgrade movement is observed (pumping/rutting), appropriate improvements such as undercutting and/or in-place stabilization will be required at that time.

It is recommended that the approaches, loading and unloading areas, main turnaround areas and other areas subjected to excessive starting and stopping motion, be supported with concrete pavement. For pavements restricted to light duty traffic and where excessive starting and stopping motions are anticipated, we recommend the pavement be constructed of 4 inch thick concrete. For pavements subject to heavy duty traffic with excessive starting and stopping motions, we recommend that the pavement be constructed of 6 inch thick concrete.

The aggregate subbase course should be placed, compacted, and tested in accordance with the requirements of Section 309 of Virginia Department of Transportation *Road and Bridge Specifications*, January 1994 (VDOT Specifications).

We recommend that the asphaltic concrete base course and surface course be placed and compacted in general accordance with the requirements of VDOT Specifications Section 315. In addition, acceptable compaction should be defined as a test section density within the range of 98% to 102% of the maximum density determined on a density control strip constructed by an approved roller at the start of paving operations for the course mix. The size of test sections should be determined based on field observations made by experienced testing personnel. A minimum of five density tests should be performed in each test section and the results averaged. In addition to the average required compaction recommended above, VDOT specs require no individual test should be below 95% of the control strip value.

4.6 Infiltration Considerations

Typically, in Virginia, the infiltration potential of the soils is evaluated using the Virginia Department of Conservation and Recreation (DCR) Standard General Infiltration Practices. According to DCR requirements, infiltration is only permissible where infiltration rates exceed 0.52 inches per hour, and groundwater or an impermeable layer is not located within 2 to 4 feet of the planned bottom of the facility. The infiltration rate can be determined from field testing and estimated empirically from the USDA soil classification. Infiltration is generally not acceptable in fill soils.

Infiltration tests were conducted at the approximate locations as indicated on the attached Boring Location Plan (Drawing No. 2). The tested infiltration rates are generally below the minimum infiltration rate of 0.52 inches per hour, and therefore, infiltration practices are not considered suitable at the locations and elevation tested.

4.7 Seismic Site Classification

The following Seismic Site Class Definition was established per Section 1613.5.2 of the 2009 International Building Code (IBC). Our scope of services did not include a seismic conditions survey to determine site-specific shear wave velocity information. IBC 2009 provides a methodology for interpretation of Standard Penetration Test resistance values (N-values) to determine a Site Class Definition. This method requires averaging N-values over the top 100 feet of the subsurface

profile. We note that the soil test boring for this project was extended to a maximum depth of 30 feet below the existing site grade.

The available subsurface data from our exploration indicates N-values of 3 to 19 bpf. Based on the N-values in the upper 30 feet of the site, our knowledge of the area, and in general accordance with Section 1613.5.2 of the 2009 IBC, a Site Classification "E" should be used for further evaluations relative to earthquake load design.

We note that the above provided Site Classification is based on information available at the time this report was written. Should this classification be so onerous to the project cost that further study is warranted, we can perform a site-specific geo-physical survey to attain sufficient detail to refine the project's Seismic Site Class Definition. This additional testing would be beyond the currently authorized scope of services for this project.

5.0 CONSTRUCTION RECOMMENDATIONS

5.1 Site Preparation

Before proceeding with construction, any utilities, surficial soils and other deleterious non-soil materials (if any) should be stripped or removed from the proposed construction area. Attention should be given to these areas to ensure all unsuitable material is removed prior to continuing with construction. During the stripping operations, positive surface drainage should be maintained to prevent the accumulation of water. Existing underground utilities should be re-routed to locations a minimum of 10 feet outside of any proposed structure footings.

After stripping, areas intended to support foundations, floor slabs, pavements, and new fill should be carefully evaluated by a geotechnical engineer. At that time, the subgrade should be proofrolled with a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight under the observation of the geotechnical engineer. Proofrolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. The proofrolling observation is an opportunity for the geotechnical engineer to locate inconsistencies intermediate of our boring locations in the existing subgrade, especially near existing utilities where fill may exist and where slab support or new fill placement is proposed. The existing fill materials can be left in place for pavement and slab support provided that they are stable during proofrolling.

Particular attention should be given to any utility trenches within or in proximity to proposed footings. For obvious reasons, existing underground utility trenches were avoided in our drilling program. Our experience is that utility trenches are sometimes backfilled with very little compactive effort. Where utility lines are removed, the trench subgrade should be verified by an F&R representative prior to backfilling in accordance with the controlled structural fill recommendations provided in this report.

5.2 Construction Drainage

Subsurface water for the purposes of this report is defined as water encountered below the existing ground surface. Based on the subsurface water data obtained during our exploration program, we do not generally anticipate that subsurface water will be encountered during anticipated earthwork or shallow foundation excavations for the proposed building at the site. However, the contractor should be prepared to dewater should water levels vary from those encountered during the drilling program. Fluctuations in subsurface water levels and soil moisture can be anticipated with changes in precipitation, runoff, and season.

An important aspect to consider during development of this site is surface water control. During the initiation of grading operations, we recommend that the grading contractor take those steps necessary to enhance surface flow and promote rapid clearing of rainfall and runoff water following rain events. It should be incumbent on the contractor to maintain favorable site drainage during construction to reduce deterioration of otherwise stable subgrades.

An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should minimize the possibility of the subgrade materials becoming saturated over a long time. Based upon the results of the soil test borings, the groundwater table should not significantly affect the performance of pavements; however, surface runoff water that is trapped during construction on the exposed subgrade soils could create localized deterioration of the soil's bearing capacity. Standing water that may develop on the surface of the pavement may be reduced by:

- adequate design (surface graded to control runoff to desired locations - catch basins, drain inlets, gutters, etc.);

- adequate compaction of each lift of pavement section component material (to minimize localized settlements that result in ponding);
- accurate grading of each lift of pavement section component material (to achieve the desired design grades);
- installing temporary weep holes in drainage structures, construction of drainage swales and diversion ditches and proper backfill and grading behind curbs to minimize water intrusion from behind the curbs.

5.3 Excavations

It is anticipated that general dewatering during construction of shallow footing excavations can be easily achieved using diversion ditches and localized sump pumps. It should be incumbent on the contractor to provide dewatering by appropriate methods.

With regard to underground fuel tank installation, subsurface water levels were observed at depths of 14 feet below existing grade. Based on information from Mr. Chapman, it is expected that the underground fuel tanks will be installed approximately 10 below finished grade. Therefore, pending final grades and seasonal fluctuations of the water levels, subsurface water may necessitate dewatering methods or could have an adverse impact on installation/construction. During periods of heavy precipitation or wet seasonal conditions, we anticipate that the site can be adequately dewatered using sump pit and pumping operations. Below grade excavations should extend to no closer than 24 inches above the water level before dewatering measures are initiated. Otherwise, subgrade and excavation sidewall destabilization will occur. If the dewatering operations are insufficient, significant difficulties could be experienced in constructing the project foundations.

The sump pit and pumping operations can consist of French drains constructed at or below the proposed subgrade elevation, which are connected to temporary sump pits. The French drains may consist of a 1-foot by 2-foot minimum trench filled with No. 57 stone or equivalent. The French drains should be sloped to drain to a temporary sump pit. The sump pits may consist of 55-gallon drums, which have been perforated to accept water inflow from the French drains and surrounding soils. The sump pits should be placed several feet below the proposed subgrade elevation. Temporary pumps must be placed in the sump pits to remove the water, which will accumulate.

5.4 Foundation/Floor Slab Construction

All foundation subgrades should be observed, evaluated, and verified for the design bearing pressure by the geotechnical engineer after excavation and prior to reinforcement steel placement. If low consistency soils are encountered during foundation construction, localized undercutting and/or in-place stabilization of foundation subgrades will be required. The actual need for, and extent of, undercutting should be based on field observations made by the geotechnical engineer or his/her representative at the time of construction.

Excavations for footings should be made in such a way as to provide bearing surfaces that are firm and free of loose, soft, wet, or otherwise disturbed soils. Foundation concrete should not be placed on frozen or saturated subgrades. If such materials are allowed to remain below foundations, settlements will increase. Foundation excavations should be concreted as soon as practical after they are excavated. If an excavation is left open for an extended period, a thin mat of lean concrete should be placed over the bottom to minimize damage to the bearing surface from weather or construction activities. Water should not be allowed to pond in any excavation.

In a dry and undisturbed state, the subgrade soils at the site will provide suitable subgrade support for fill placement and construction operations. However, when wet, the soil can degrade quickly either with or without disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations to help maintain the stability of the soil. Attempting site work during adverse seasonal conditions will have significant effect on the site work budget, as substantially more undercutting will be required. Ideally, earthwork should be performed during the summer or early fall (typically drier and warmer months).

During construction, care should be exercised to protect existing buildings from damage resulting from construction activity and equipment.

5.5 Controlled Structural Fill

Based on the boring data, the Lean CLAY (CL) or more granular soils may be used as controlled fill. The Fat CLAY (CH) materials are not recommended for use as fill. The CH soils were typically encountered at depths of more than 3.5 feet except at boring B-3 where they were encountered below the surficial soil. Controlled structural fill may be constructed using an off-site borrow having a classification of CL, ML, SC, SM, or better as defined by the USCS. Other materials may be suitable for use as general controlled structural fill materials and should be individually evaluated by the geotechnical engineer. Controlled structural fill should be free of boulders, organic matter,

debris, or other deleterious materials and should have a maximum particle size no greater than 3 inches.

We recommend that structural fill be compacted to at least 95 percent of the Standard Proctor (ASTM D 698 or AASHTO T 99) maximum dry density. Fill materials should be placed in horizontal lifts with maximum height of 8 inches loose measure. New fill should be adequately keyed into stripped and scarified subgrade soils. During fill operations, positive surface drainage should be maintained to prevent the accumulation of water. In confined areas such as utility trenches, portable compaction equipment and thin lifts of 3 to 4 inches may be required to achieve specified degrees of compaction.

In general, we recommend that the moisture content of approved fill soils be maintained within three percentage points of the optimum moisture content as determined from the Standard Proctor density test. Due to the nature of the on-site CLAYs and the natural Water Contents obtained from our laboratory tests, we anticipate that drying of the soils prior to construction will be needed. The bulk sample from boring B-5 was nearly 5 percentage points above the optimum moisture content.

Generally, we do not anticipate significant problems controlling moistures within approved fill during periods of dry weather, but moisture control may be difficult during winter months or extended periods of rain. We recommend that the contractor have equipment on site during earthwork for both drying and wetting of fill soils. Attempts to work the soils when wet can be expected to result in deterioration of otherwise suitable soil conditions or of previously placed and properly compacted fill.

Where construction traffic or weather has disturbed the subgrade, the upper 8 inches of soils intended for structural support should be scarified and re-compacted. Each lift of fill should be tested to confirm that the recommended degree of compaction is attained. In confined areas, a greater frequency may be required.

6.0 CONTINUATION OF SERVICES

We recommend that Froehling & Robertson, Inc. (F&R) be given the opportunity to review the proposed building and foundation plans, grading plans, and project specifications when construction documents approach completion. This review evaluates whether the recommendations and comments provided herein have been understood and properly

implemented. We also recommend that F&R be retained for professional and construction materials testing services during construction of the project. Our continued involvement on the project helps provide continuity for proper implementation of the recommendations discussed herein. These services are not part of the currently authorized scope of services.

7.0 LIMITATIONS

This report has been prepared for the exclusive use of Vanasse Hangen Brustlin, Inc., or their agent, for specific application to the proposed Martin's Fueling Facility in James City County, Virginia, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our recommendations are based on design information furnished and generally accepted geotechnical engineering practices. The recommendations do not reflect variations in subsurface conditions that could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork and foundation construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications or recommendations.

In the event that changes are made in the design or location of the proposed addition, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid. This report contains 18 pages of text and the attached appendices.

APPENDIX A

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes — even minor ones — and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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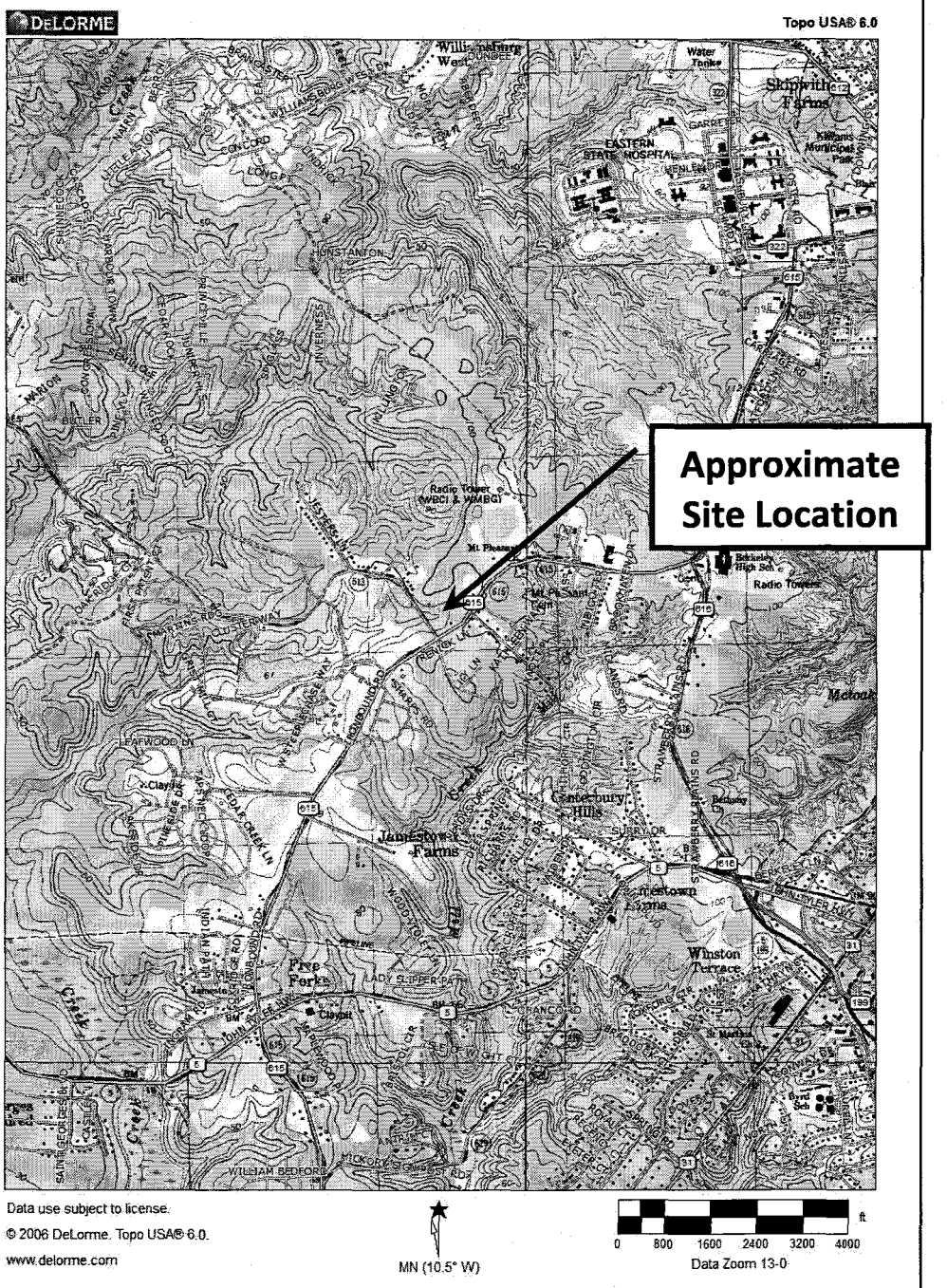


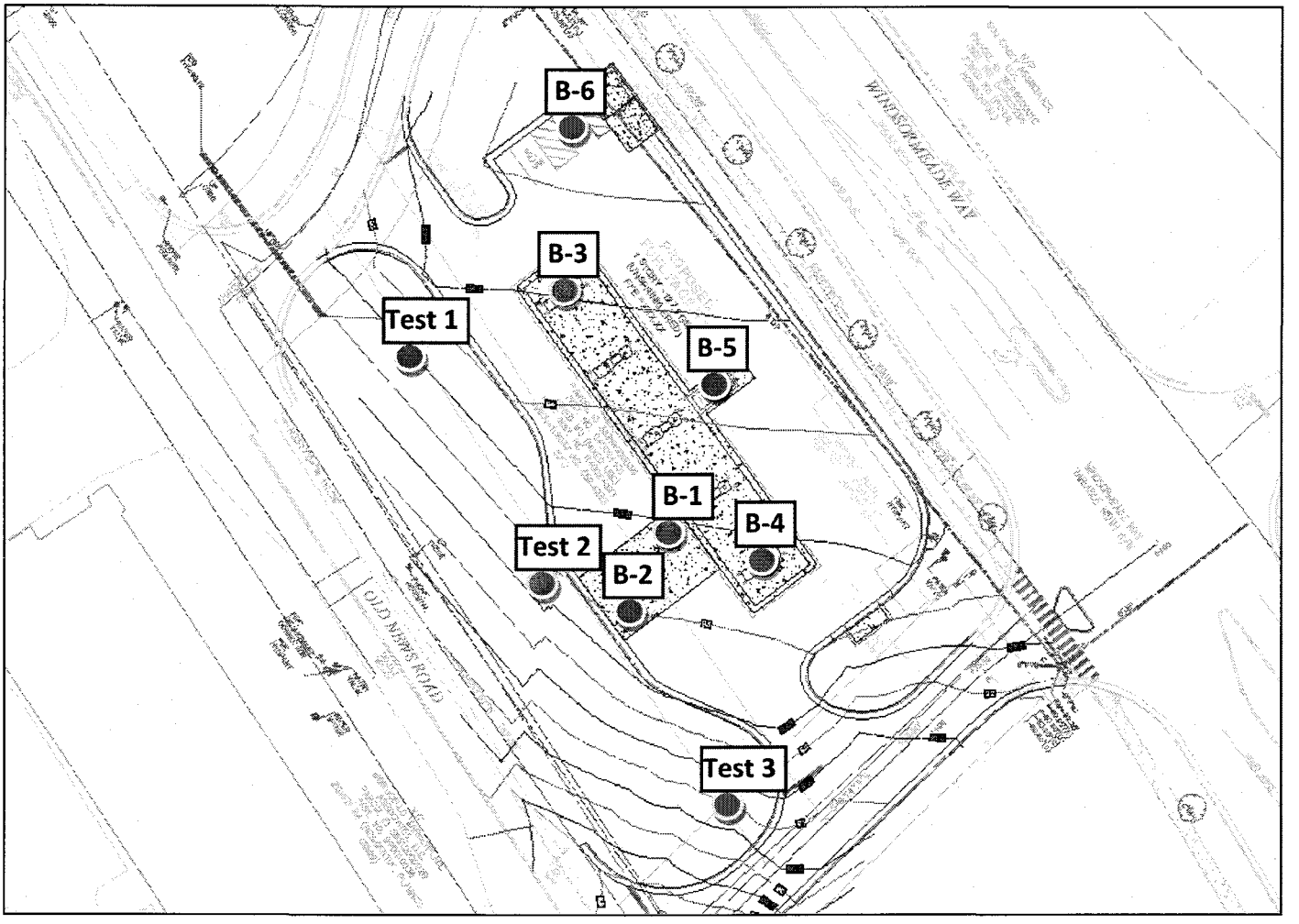
FROEHLING & ROBERTSON, INC
ENGINEERING • ENVIRONMENTAL • GEOTECHNICAL

DATE: December 2010	
SOURCE: DeLorme	
DRAWN: N/A	F&R # 60M-0685

Site Vicinity Map
Martin's Fueling Facility – Williamsburg
James City County, Virginia

Drawing No.
1

APPENDIX B



- Approximate Boring Location
- Approximate Infiltration Test Location

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DATE: December 2010	
SOURCE: VHB, Inc.	
SCALE: N/A	F&R # 60M-0685

Boring Location Plan
Martin's Fueling Facility – Williamsburg
James City County, Virginia

Drawing No.
2

BORING LOG

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FROEHLING & ROBERTSON, INC.
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Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-1** **(1 of 1)** Total Depth **30.0'** Elev: **93.0 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 2-1/4" ID** Started: **11/5/10** Completed: **11/5/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
92.3	0.7	8 inches of Surficial Soil	4-5-6	0.0	11	Groundwater was encountered at 18.5 feet during drilling
		FILL: Siff, Yellowish-Brown to Olive Brown, Sandy Lean CLAY, with trace Organic Material and Gravel - Moist (CL-FILL)	4-5-8	1.5	13	
89.5	3.5	**ALLUVIUM:** Stiff to Very Stiff, Yellowish-Brown to Reddish-Brown, Sandy Fat CLAY, with trace Roots - Moist (CH)	4-5-5	3.0 3.5	10	Groundwater was observed at 20 feet upon removal of auger
			5-7-12	5.0 6.0	19	Cave-in depth at 22 feet
85.5	7.5	Medium Dense to Very Loose, Dark Red and Yellow, Silty Fine SAND, with trace Clay - Moist (SM)	4-7-9	7.5 8.5	16	Driller used automatic hammer to perform SPT
			3-3-3	10.0 13.5	6	
			1-1-3	15.0 18.5	4	
			2-2-3	20.0 23.5	5	
68.0	25.0	Soft, Reddish-Yellow, Sandy Fat CLAY - Moist (CH)	1-1-3	25.0 28.5	4	
63.0	30.0	Boring terminated at 30 feet Boring backfilled upon completion		30.0		

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

FROEHLING & ROBERTSON, INC.
Engineering • Environmental • Geotechnical

Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-2** **(1 of 1)** Total Depth **30.0'** Elev: **92.3 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 4-1/4" ID** Started: **11/1/10** Completed: **11/1/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
91.8	0.5	6 inches if Surficial Soil	3-5-7	0.0		
		FILL: Stiff to Firm, Yellowish-Brown, Sandy Lean CLAY, with trace Organic Material - Moist (CL-FILL)	3-3-3	1.5	12	Groundwater was encountered at 18 feet during drilling
				3.0	6	
			2-2-3	3.5		Groundwater was not reported upon removal of auger
87.3	5.0	**ALLUVIUM:** Medium Dense to Loose, Reddish-Brown, Silty Fine SAND - Moist (SM)		5.0	5	
			2-3-9	6.0		Cave-in depth was not reported
				7.5	12	
			3-4-7	8.5		Driller used automatic hammer to perform SPT
				10.0	11	Driller Installed Environmental Monitoring Well
			2-3-3	13.5		
				15.0	6	
			1-3-2	18.5		
				20.0	5	
			1-3-4	23.5		
67.3	25.0	Loose, Reddish-Brown, Silty Fine to Medium SAND, with trace Clay - Moist (SC-SM)		25.0	7	
			3-2-5	28.5		
62.3	30.0			30.0	7	
		Boring terminated at 30 feet Environmental Monitoring Well Installed				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

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FROEHLING & ROBERTSON, INC.
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Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-3** **(1 of 1)** Total Depth **30.0'** Elev: **94.2 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 4-1/4" ID** Started: **11/1/10** Completed: **11/5/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
		12 inches of Surficial Soil	4-3-4	0.0		
93.2	1.0	**ALLUVIUM:** Very Stiff to Firm, Yellowish-Brown to Yellowish-Red, Sandy Fat CLAY - Moist (CH)	10-8-11	1.5	7	Groundwater was encountered at 18.5 feet during drilling
			3-6-8	3.0 3.5	19	Groundwater was not reported upon removal of auger
			4-6-6	5.0 6.0	14	Cave-in depth was not reported
			2-4-5	7.5 8.5	12	Driller used automatic hammer to perform SPT
				10.0	9	Driller Installed Environmental Monitoring Well
			2-3-3	13.5		
79.2	15.0	Loose, Yellow, Silty Fine SAND, with trace Clay - Wet (SM)		15.0	6	
			2-3-2	18.5		
74.2	20.0	Soft, Yellow, Sandy Fat CLAY - Moist (CH)		20.0	5	
			1-1-2	23.5		
69.2	25.0	Very Loose, Yellowish-Brown, Silty Fine to Coarse SAND, with little Clay - Moist (SC-SM)		25.0	3	
			1-1-2	28.5		
64.2	30.0			30.0	3	
		Boring terminated at 30 feet Environmental Monitoring Well Installed				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

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Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-4** **(1 of 1)** Total Depth **15.0'** Elev: **93.1 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 2-1/4" ID** Started: **11/5/10** Completed: **11/5/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
92.4	0.7	8 inches of Surficial Soil	4-5-5	0.0		
		FILL: Stiff, Yellowish-Brown to Brown, Sandy Lean CLAY, with trace Gravel and Organic Material - Moist (CL-FILL)	7-7-8	1.5	10	Groundwater was not encountered during drilling
				3.0	15	
89.1	4.0	**ALLUVIUM:** Medium Dense, Olive Yellow, Silty Fine SAND, with little Clay - Moist (SC-SM)	2-7-11	3.5		Groundwater was not observed upon removal of auger
				5.0	18	
			5-7-10	6.0		Cave-in depth was 13 feet
				7.5	17	
			6-7-8	8.5		Driller used automatic hammer to perform SPT
83.1	10.0	Very Loose, Reddish-Brown, Silty Fine SAND - Moist (SM)		10.0	15	
			2-2-2	13.5		
78.1	15.0			15.0	4	

Boring terminated at 15 feet
Boring backfilled upon completion

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

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Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-5** **(1 of 1)** Total Depth **15.0'** Elev: **94.2 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 2-1/4" ID** Started: **11/5/10** Completed: **11/5/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
93.5	0.7	8 inches of Surficial Soil	3-5-13	0.0	18	Groundwater was encountered at 14 feet during drilling
		FILL: Very Stiff to Stiff, Brown to Yellowish-Brown, Sandy Lean CLAY, with trace Organic Material and Silt - Moist (CL-FILL)	7-7-8	1.5	15	
91.2	3.0		6-7-8	3.0 3.5	15	Groundwater was not observed upon removal of auger
		ALLUVIUM: Stiff, Yellowish-Brown to Reddish-Brown, Sandy Lean CLAY, with little Silt - Moist (CL)	4-6-8	5.0 6.0	14	Cave-in depth was 13 feet
88.2	6.0	Medium Dense, Yellowish-Brown to Reddish-Brown, Clayey Fine SAND, with little Silt - Moist (SC-SM)	3-5-6	7.5 8.5 10.0	11	Driller used automatic hammer to perform SPT
80.7	13.5	Very Loose, Yellowish-Brown, Silty Fine SAND - Wet (SM)	2-2-1	13.5 15.0	3	
79.2	15.0	Boring terminated at 15 feet Boring backfilled upon completion				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

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FROEHLING & ROBERTSON, INC.
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Report No.: **60M-0685** Date: **November 2010**

Client: **Vanasse Hangen Brustlin, Inc.**

Project: **Martin's Fueling Facility-Williamsburg, James City County, Virginia**

Boring No.: **B-6** **(1 of 1)** Total Depth **15.0'** Elev: **95.0 ±** Location: **See Boring Location Plan**

Type of Boring: **HSA 2-1/4" ID** Started: **11/5/10** Completed: **11/5/10** Driller: **Drew**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
		12 inches of Surficial Soil	2-4-4	0.0		
94.0	1.0	**FILL:** Firm to Stiff, Yellowish-Brown, Sandy Lean CLAY, with trace Organic Material and Silt - Moist (CL-FILL)	4-4-5	1.5	8	Groundwater was not encountered during drilling
				3.0	9	
91.5	3.5	**ALLUVIUM:** Firm to Stiff, Reddish-Brown to Yellow, Sandy Fat CLAY, with little Silt - Moist (CH)	3-2-6	3.5	8	Groundwater was not observed upon removal of auger
				5.0		
			8-4-8	6.0	12	Cave-in depth was 12 feet
				7.5		
			2-3-3	8.5	6	Driller used automatic hammer to perform SPT
				10.0		
			2-3-4	13.5	7	
80.0	15.0	Boring terminated at 15 feet Boring backfilled upon completion		15.0		

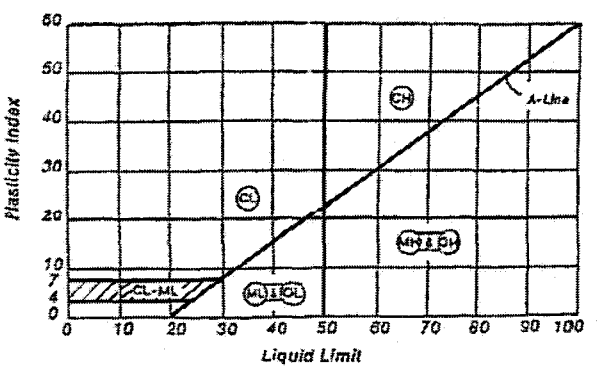
*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

SOIL CLASSIFICATION CHART - Adapted from ASTM D 2487

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SM, SC: Less than 5% pass No. 200 sieve	$C_u = D_{60}/D_{10}$ Greater than 4; $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	More than 12% pass No. 200 sieve: Borderline Classification requiring use of dual symbols	Atterberg limits plot below "A" line and plasticity index greater than 4	Atterberg limits ploting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line and plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	5% to 12% pass No. 200 sieve:	$C_u = D_{60}/D_{10}$ Greater than 6; $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line and plasticity index less than 4	Atterberg limits ploting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line and plasticity index greater than 7	
FINE-GRAINED SOILS 50% or more passes No. 200 sieve*	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	SILTS AND CLAYS Liquid limit GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
Highly Organic Soils			PT	Peat, muck and other highly organic soils			

PLASTICITY CHART

For classification of fine-grained soils and fine fraction of coarse-grained soils.
Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
Equation of A-line: PI = 0.73 (LL - 20)



*Based on the material passing the 3-in. (75-mm) sieve.

KEY TO BORING LOG SOIL CLASSIFICATIONS

Particle Size and Proportion

Verbal descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size Descriptive Terms		Proportion/ Descriptive Terms		
Soil Component	**Particle Size**	**Component**	**Term**	**Percentage**
Boulder	> 12 inch	Major	Uppercase Letters (e.g., SAND, CLAY)	> 50%
Cobble	3 - 12 inch			
Gravel-Coarse	3/4 - 3 inch			
-Fine	#4 - 3/4 inch	Secondary	Adjective (e.g., sandy, clayey)	20%-50%
Sand-Coarse	#10 - #4			
-Medium	#40 - #10			
-Fine	#200 - #40	Minor	Some	15%-25%
Silt (non-cohesive)	< #200		Little	5%-15%
Clay (cohesive)	< #200		Trace	0%-5%

Notes: 1. Particle size is designated by U.S. Standard Sieve Sizes.
2. Because of the small size of the split-spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.

Density or Consistency

The standard penetration resistance values (N-values) are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

DENSITY		CONSISTENCY	
Term	**N-Value**	**Term**	**N-Value**
Very Loose	0 - 4	Very Soft	0 - 1
Loose	5 - 10	Soft	2 - 4
Medium-Dense	11 - 30	Firm	5 - 8
Dense	31 - 50	Stiff	9 - 15
Very Dense	> 50	Very Stiff	16 - 30
		Hard	> 30

Notes: 1. The N-value is the number of blows of a 140 lb. hammer freely falling 30 inches required to drive a standard split spoon sampler (2.0 in. O.D., 1 3/8 in I.D.) 12 inches into the soil after properly seating the sampler six inches.

2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.

rev. Dec 2001

APPENDIX C

COMPACTION TEST REPORT

Curve No.: 1

Project No.: 60M-0685 **Date:** 11-10-10

Project: Martin's Fueling Facility - Williamsburg

Client: Vanasse Hangen Brustlin, Inc.

Location: James City County

Sample Number: B-5 [Control **Depth:** 0-5'

Remarks: N/A

MATERIAL DESCRIPTION

Description: Brown Sandy Lean CLAY [B-5]

Classifications - **USCS:** CL **AASHTO:**

Nat. Moist. = 19.3 %

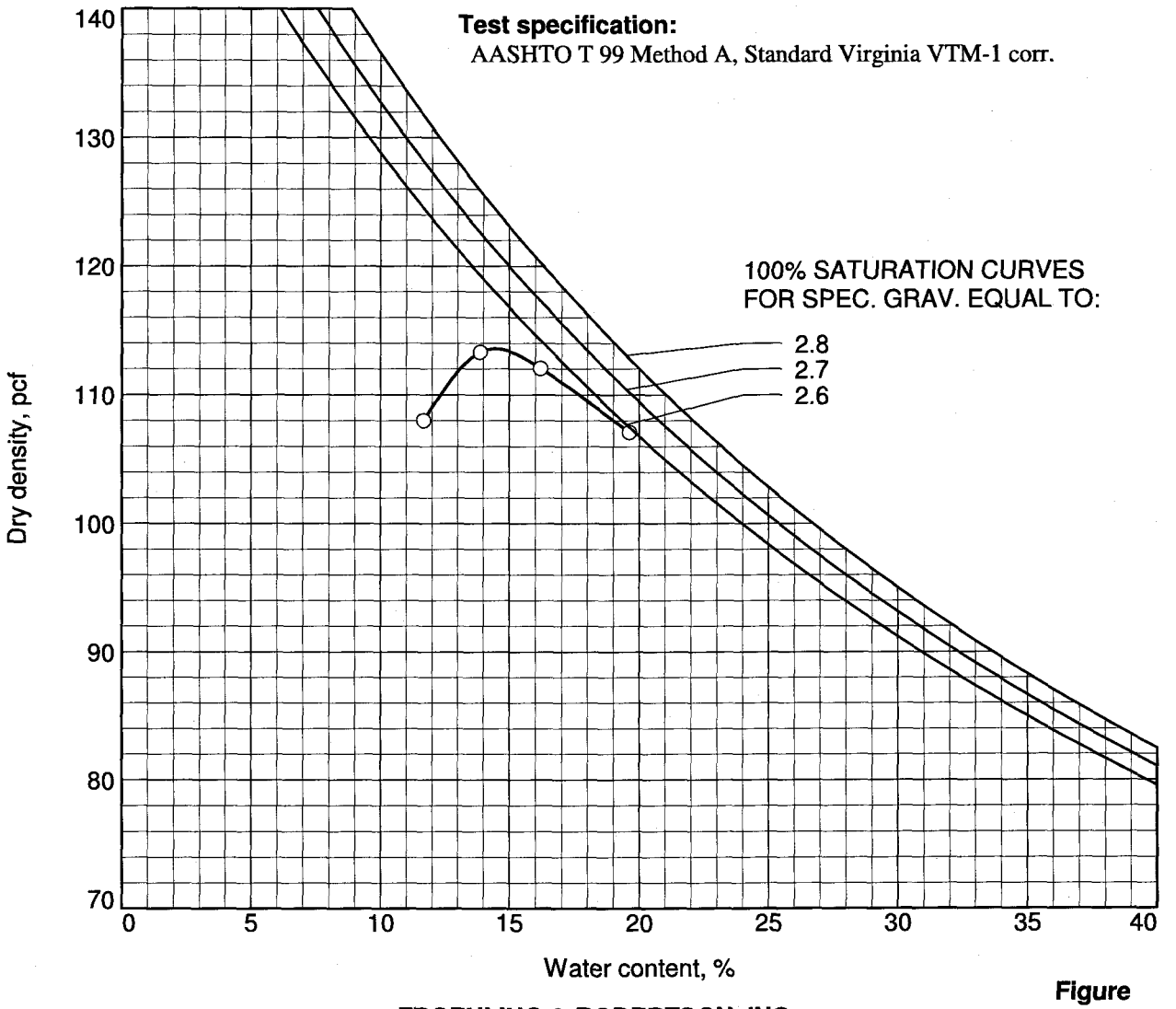
Liquid Limit = 37

Sp.G. =

Plasticity Index = 18

% < No.200 = 56.9 %

TEST RESULTS
Maximum dry density = 113.6 pcf
Optimum moisture = 14.5 %



Figure

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SINCE 1881

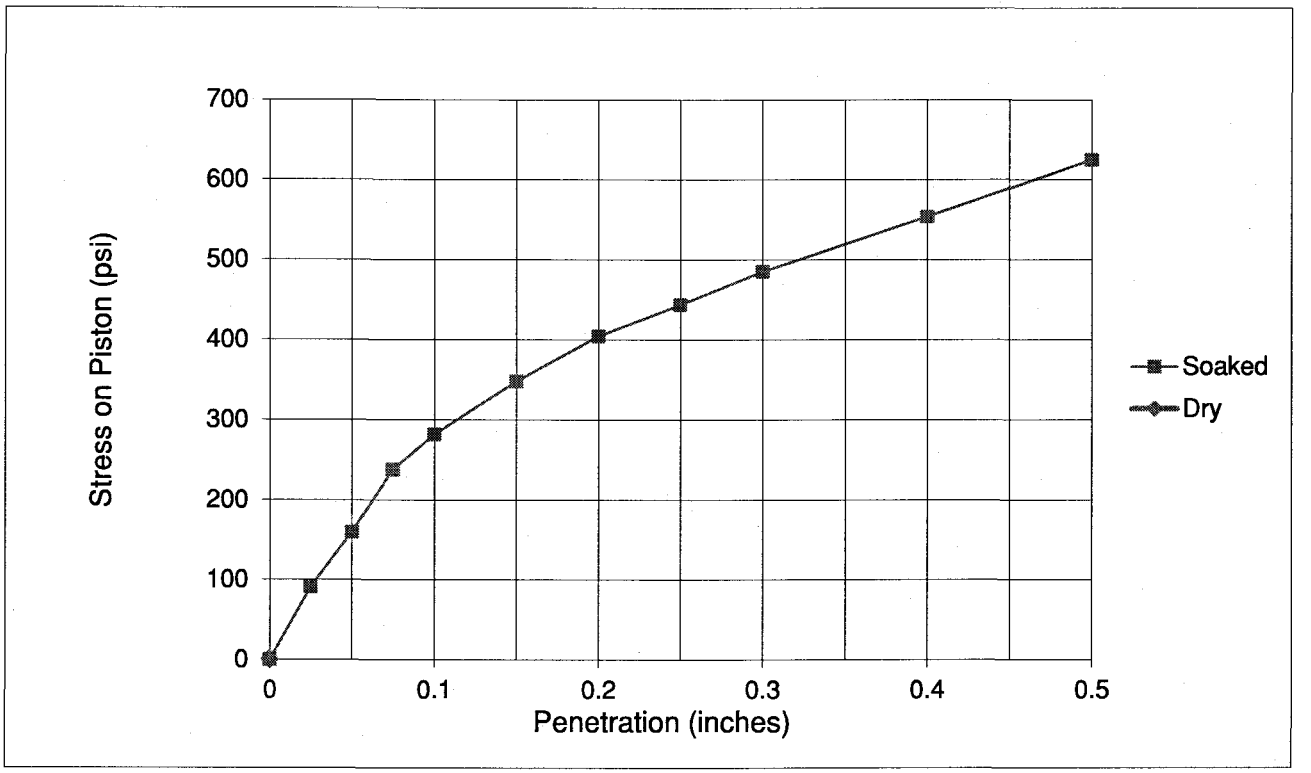
FROEHLING & ROBERTSON, INC.

Engineering Environmental Geotechnical

3015 Dumbarton Road
Richmond, Virginia 23228-5831 I USA
T 804.264.2701 I F 804.264.7862

California Bearing Ratio

Project No.:	60M-0685	Test Date:	11/16/2010
Client:	Vanasse Hangen Brustlin, Inc.	Tested By:	C.M.
Project:	Martin's Fueling Facility - Williamsburg	Compaction method: AASHTO T 193	
Location:	James City County, Virginia	X	Soaked CBR
		X	65 BLOWS



CBR @ 0.1 in. penetration (dry):	#N/A
CBR @ 0.1 in. penetration (wet):	28.2
Swell (%):	0.1
Dry Density Before Soaking (pcf):	113.6
Dry Density After Soaking (pcf):	115.2
Retained on 3/4 inch sieve (%):	0.0
Surcharge Weight (pounds):	10.0
Moisture Content Before Soaking (%):	14.5%
Moisture Content After Soak, Top in. (%):	16.9%
Moisture Content After Soak, Ave. (%):	14.3%

Maximum Dry Density (pcf):	113.6
Optimum Moisture Content (%):	14.5

Visual Description:

Brown Sandy Lean CLAY

F&R Lab No.: 113542

Source: B - 5

RECEIVED
JAN 2011
Planning Department