MCPB
Item No.: 6
Date: 03-23-17

Brink Zone Reliability Improvements, Mandatory Referral, MR2017006

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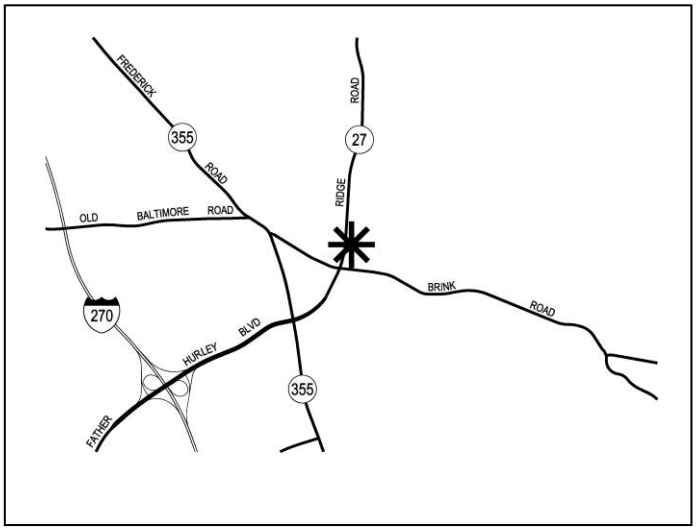
Completed: 3/10/2017

Description

Brink Zone Reliability Improvements: MR2017006

Mandatory Referral associated with a request for WSSC Facility Improvements including a new pump station, located at 21701 Ridge Road, 15.31 acres, identified as P585 and 639 on Tax Map FV-12, on the east side of Ridge Road approximately 1,000 feet north of its intersection with Brink road, AR Zone, 1994 Clarksburg Master Plan.



Staff Recommendation: Approval with Comments

Applicant: Washington Suburban Sanitary Commission (WSSC)

Filing Date: November 2, 2016
Acceptance Date: February 2, 2017

Summary

- Staff recommends approval of the Mandatory Referral with comments to be transmitted to the Washington Suburban Sanitary Commission.
- This project is located within the Clarksburg Special Protection Area (SPA). However, all regulatory reviews for environmental regulations including Environmental Guidelines, Forest Conservation, and Water Quality are being conducted by state agencies, pursuant to state law.

RECOMMENDATIONS:

Staff recommends approval of the Mandatory Referral with the following comments to be transmitted to the Washington Suburban Sanitary Commission (WSSC):

1. The current Mandatory Referral Plan shows the vault chamber (valve vault A) within the Master Plan right-of-way for Ridge Road. Therefore, Planning staff recommends WSSC move the vault chamber outside of the 150-foot right-of-way planned along Ridge Road to ensure that future conflicts between transportation infrastructure and WSSC facilities do not occur.
2. The Applicant should provide screening and/or landscaping between the proposed improvements, especially the new building, and Ridge Road (MD 27) to help preserve the Transition area and separating the onsite institutional use from future residential uses across Ridge Road (MD 27).
3. If this project was a subdivision, dedication of 75 feet of right-of-way from the centerline of Ridge Road and 50 feet of right-of-way from the centerline of Brink Road would be required for future transportation needs. If or when WSSC plans to plat this property, Planning staff would request these rights-of-way be dedicated along the frontage of the property.
4. Coordinate with Maryland State Highway Administration (SHA) District 3 Access Management staff on the additional curb cut and any potential acceleration or deceleration lanes on Ridge Road. Planning staff would prefer that the applicant use the existing curb cut for the new valve vault to minimize access points on Ridge Road if possible.
5. Ensure adequate turning radii from Ridge Road and within the property for the diesel fuel delivery trucks that will service the project site during extended power outages. Additionally, ensure adequate pavement and substructure to accommodate the weight of such vehicles on the property.

Previous Board Actions
None

Mandatory Referral Review
This proposal for the construction of a new water booster pumping station, valve vaults and piping on the site of an existing pumping station and water tank site owned by the Washington Suburban Sanitary Commission (WSSC) requires the Mandatory Referral review process under the Montgomery County Planning Department's Uniform Standards for Mandatory Referral Review. State law requires all federal, state, and local governments and public utilities to submit proposed projects for a Mandatory Referral review and approval by the Commission. The law requires the Planning Board to review and approve the proposed location, character, grade and extent of any road, park, public way or ground, public (including federal) building or structure, or public utility (whether publicly or privately owned) prior to the project being located, constructed or authorized.

INTRODUCTION

Site Description

The subject property is identified as Parcel 585 and Parcel 639 on Tax Map FV-122 and located at the intersection of Brink Road and Maryland State Highway27 (Ridge Road) in Germantown, MD, within the Clarksburg Special Protection Area (SPA).

The land use is generally suburban, with the site property surrounded by housing developments to the south and west and farmland to the north and east. The housing development project to the west was approved within the last year and included modifications to Maryland State Highway 27. The current and proposed use of the site is municipal water distribution system operations.

Figure 1: 2015 Aerial Photograph of the Vicinity

Figure 2: 2015 Aerial of the Subject Property

Project Description

This project is designed to increase the reliability of water distribution infrastructure to provide potable water to the citizens of Montgomery County. The project consists of the construction of a new Water Booster Pumping Station, valve vaults and piping on the site of an existing pumping station and water tank site owned by the Washington Suburban Sanitary Commission (WSSC). A preliminary meeting between WSSC, Mott MacDonald (MM), which managed the project for WSSC, and Montgomery County representatives was held in October of 2015.

Access to the pump station will be from the existing driveway on the eastern side of Maryland State Highway 27. A new driveway to the south of the existing one will provide access to a new valve vault. Traffic to and from the site by WSSC operations staff is projected to be minimal, as the site will not be normally occupied, with a projected frequency of several times per week up to a once per day for monitoring and maintenance purposes. During extended power outages, diesel fuel delivery trucks will visit the site, but only one or two times a week at the most depending on water demand and distribution system conditions at the time of the outage.

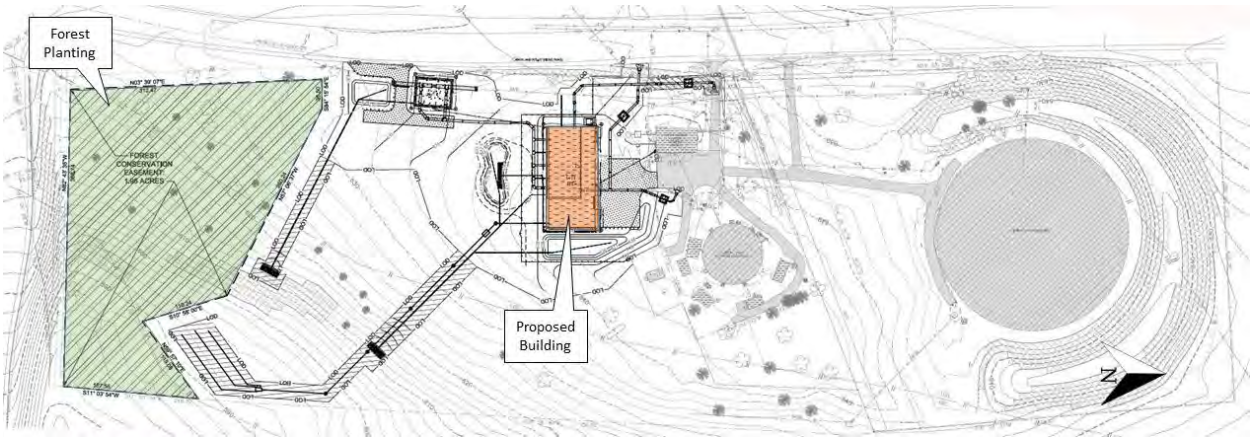


Figure 3: Site Layout

Master Plan Consistency

The project is located within the Brink Road Transition Area of the 1994 Clarksburg Master Plan. There are no specific recommendations for the Subject Property in the Master Plan; the land use table on page 77 shows this property as an institutional land use.

The Master Plan makes a general recommendation that this area should form an important transition from Germantown to Clarksburg and lies directly above the Germantown greenbelt. The project is substantially consistent with the 1994 Clarksburg Master Plan.

Neighborhood Compatibility

Building Scale and Facility Design

While most of the proposed improvements are at or below grade, the Water Booster Pumping Station is a 60-foot by 120-foot above ground structure located immediately adjacent and perpendicular to Ridge Road (MD 27). The proposed structure is approximately 7, 200 square feet and approximately 18 feet high to the roof line. The side of the building facing Ridge Road, the west elevation, has been treated architecturally with a false entrance and stone chimney to give it more of a residential character. The building placement and architectural treatments helps reduce the visible massing from Ridge Road (MD 27).

No landscaping plan was provided by the applicant and none of the submitted plans show any new plantings between the new proposed structure and Ridge Road (MD 27). Staff recommends that the Applicant provide screening landscaping between the proposed improvements, especially the new building, and Ridge Road (MD 27) to help preserve the Transition area and separating the onsite institutional use from future residential uses across Ridge Road (MD 27)

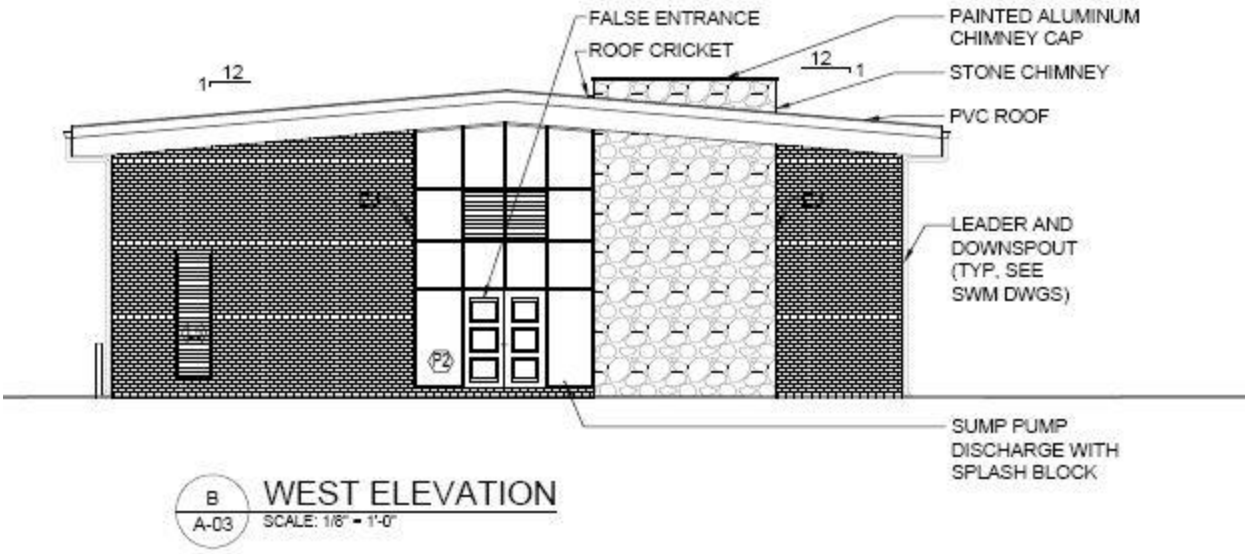


Figure 4: View from Ridge Road (MD 27)

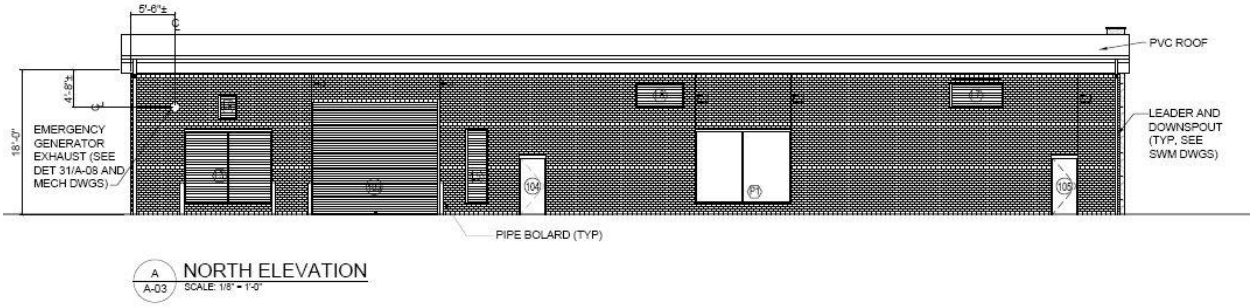


Figure 5: View from north "Front Entrance"

Master Plan of Highways and Bikeways

According to the Clarksburg Master Plan, Ridge Road (MD 27), on which the property has vehicular access, is designated as a major highway (M-29) with a recommended right-of-way of 150 feet between Brink Road and the proposed M-83. The Clarksburg Master Plan also designates Brink Road, on which the property also adjoins, as an arterial highway (A-36) with a recommended right-of-way of 100 feet. The Countywide Bikeways Functional Master Plan designates the sections of Ridge Road and Brink Road on which the property abuts as signed shared roadways (SR-39 and SR-62).

The anticipated number of regular weekday peak-hour vehicular trips during the weekday peak periods is one roundtrip (two total trips) per day for monitoring and maintenance purposes. The proposed infrastructure improvements would generate fewer than 50 peak hour person trips within the weekday peak periods; therefore, the project is exempt from the Local Area Transportation Review (LATR) requirements to conduct a traffic study. Planning staff finds the project description included in the Mandatory Referral Submission acceptable for the alternatively required transportation study exemption statement, but requests that a transportation study exemption statement be provided in future mandatory referrals that do not require a traffic study.

ENVIRONMENT

All regulatory reviews for environmental regulations including Environmental Guidelines, Forest Conservation, and Water Quality are being conducted by state agencies. State law allows for state environmental review of projects undertaken by state agencies, like WSSC.

Environmental Guidelines

The project area does not contain any environmental buffers, streams, other sensitive features. It is located in the Clarksburg Master Plan area and the Clarksburg Special Protection Area, and within the Little Seneca Creek watershed and Upper Great Seneca Creek watershed, which this site contains waters classified by the State of Maryland as Use Class I-P, III-P, IV-P waters.

Forest Conservation

The proposed project is a governmental project reviewed for forest conservation purposes by the State Department of Natural Resources under the Code of Maryland Regulations. A Forest Stand Delineation and Forest Conservation Plan has been submitted to the Maryland Department of Natural Resources in accordance with state requirements. WSSC intends to address afforestation requirements through an on-site forest easement.

Special Protection Areas (SPA) Water Quality Plan

The proposed project was reviewed for Water Quality purposes by the State Department of Environment under the Code of Maryland Regulations.

The site falls within the southeastern edge of the Clarksburg Special Protection Area (SPA). Under Section 19-63 Exemptions under Article V Water Quality Review in Special Protection Areas, the site does not meet the criteria for exemption as the cumulative land area is 15.31 acres. Under Section 19-64 Water Quality Inventory Submittal, requirements for the Water Quality Inventory and Preliminary Water Quality Plan submittals are described. It is noted that the Concept Plan to meet the state of Maryland's Stormwater Management and Erosion and Sediment Control requirements was submitted to MDE in September of 2016, and this submittal meets all requirements of the Water Quality Inventory and Preliminary Water Quality Plan submittals. Attachment C contains the completed Concept Plan submittal.

Impacts to Parkland

The closet parkland to the Subject site is south across Brink Road and southwest across the intersection of Brink Road and Ridge Road. The proposed plan shows no impacts to parkland.

COMMUNITY OUTREACH AND NOTIFICATION

No public meeting was held and no notice was sent by the Applicant. Staff responded by sending out a postcard notice to all adjoining and confronting property owners and all HOA and Civic Associations within one-mile. This notice was sent out on March 3, 2017, three weeks prior to the hearing. Staff felt this notice provided adjacent residents and all interested parties in the project area with an opportunity to review and comment on the plans.

CONCLUSION

Staff recommends that the Planning Board approves the Mandatory Referral and transmits recommendations as specified on page two of this staff report.

Attachments
Attachment A – WSSC Mandatory Referral Package
Attachment B - Architectural Elevations

Montgomery County Planning Department

Maryland-National Capital Park and Planning Commission

Mandatory Referral Submission for:

Washington Suburban Sanitary Commission

Project BP5692A14

Brink Zone Reliability Improvements

October 28, 2016

Washington Suburban Sanitary Commission

MOTT MACDONALD

I. Written Narrative

Overall summary

The purpose of this project is to increase the reliability of water distribution infrastructure to provide potable water to the citizens of Montgomery County. The project consists of the construction of a new Water Booster Pumping Station, valve vaults and piping on the site of an existing pumping station and water tank site owned by the Washington Suburban Sanitary Commission (WSSC). A preliminary meeting between WSSC, Mott MacDonald (MM) and Montgomery County representatives was held in October of 2015, and the submission requirements for this project were finalized and are reflected within this document. Those section headings with N/A in lieu of content refer to exempted section as per the meeting.

The project location is at the intersection of Brink Road and Maryland State Highway 27 in Germantown, MD. Refer to the map in Figure 1. Access to the pump station will be from the existing driveway on the eastern side of Maryland State Highway 27. A new driveway to the south of the existing one will provide access to a new valve vault. Traffic to and from the site by WSSC operations staff is projected to be minimal as the site will not be normally occupied, with a projected frequency of a few times per week up to a once per day for monitoring and maintenance purposes. During extended power outages, diesel fuel delivery trucks will visit the site, but only one or two times a week at the most depending on water demand and distribution system conditions at the time of the outage.

The land use is predominantly suburban, with the site property surrounded by housing developments to the south and west and farmland to the north and east. The housing development project to the west was constructed within the last year and included modification to Maryland State Highway 27. The current and proposed use of the site is municipal water distribution system operations.

Refer to Table 1 below regarding the size of the existing and proposed structures. Refer to Attachment 1 for civil drawings reflecting size and location of structures at the 100% design stage of completion.

Table 1 – Location and Size of Structures on Project Site

Structure	New/Existing	Dimensions (Ft.)	Purpose
Brink Pumping Station	Existing	30 x 50 (above ground)	Potable water conveyance-tank filling
Elevated Water Tank	Existing	-	Water storage – 1MG
Ground Storage Tank	Existing	240' Diameter (above ground)	Water storage– 10 MG
Brink Zone Water Pumping Station	New	60 x 125 (above ground)	Potable water conveyance-tank filling
Valve Vault A	New	35 x 45	Distribution control
Vaults B-D	New	9 x 9	Distribution control

a. Hours of Operation
   N/A

b. Conformance with County's General Plan
   N/A

c. Pedestrian and Bicycle Safety Impact Statement
   N/A

d. Typical Roadway Sections
   N/A

e. Historic Work Permit
   N/A

f. Project Schedule
   N/A

g. Common/Quasi-Public Use
   N/A

h. Funding Source
   N/A

i. Potential Impacts to Public Parkland
   N/A

j. Green Building Council Leadership (LEED) Certification
This project will not be seeking LEED certification as directed by WSSC. However, WSSC has its own design standards and guidelines for energy efficiency, and Mott MacDonald has incorporated these standards into its design. Some of the energy efficient design features include VFDs for pump control, LED lighting and minimal HVAC as the main building will normally be unoccupied. Please note that the source of the funding for the project is WSSC ratepayers.

II. General Location Map

Refer to Figure 1 and Attachment 1.

III. Site Plan

Refer to Attachment 1.

IV. Utilities and Right-of-Way Map

N/A

V. Pedestrian and Vehicular Circulation Plan

N/A

VI. Natural Resource Inventory/Forest Stand Delineation (NRI/FSD) Plan

A Forest Stand Delineation and Forest Conservation Plan has been submitted to the Maryland Department of Natural Resources in accordance with state requirements. The Commission intends to address afforestation requirements through an on-site forest easement. Refer to Attachment 2 for a copy of the submission, which is currently under review.

VII. Special Protection Area Map/Water Quality Plan

The site falls within the southeastern edge of the Clarksburg Special Protection Area (SPA). Refer to Figure 2 which shows the location of the site relative to the Clarksburg SPA. Under Section 19-63 Exemptions under Article V Water Quality Review in Special Protection Areas, the site does not meet the criteria for exemption as the cumulative land area is 15.31 acres. Under Section 19-64 Water Quality Inventory Submittal, requirements for the Water Quality Inventory and Preliminary Water Quality Plan submittals are described. It is noted that the Concept Plan to meet the state of Maryland's Stormwater Management and Erosion and Sediment Control requirements was submitted to MDE in September of 2016, and this submittal meets

all of the requirements of the Water Quality Inventory and Preliminary Water Quality Plan submittals. Refer to Attachment C for the completed Concept Plan submittal.

VIII. Preliminary Forest Conservation Plan

Refer to the response under Paragraph VI and Attachment 2.

IX. Topographic Map

N/A

X. Preliminary Stormwater Management Concept Plan

Refer to the response under Paragraph VII and Attachment 3.

XI. Landscaping and Lighting Plan

N/A

XII. Overall Concept Development Plan

N/A

XIII. Statement of Compliance with Montgomery County Noise Ordinance

Within the referenced Montgomery County Noise Ordinance, there are maximum allowable noise levels for normal operations of the site (Section 31B-5) and during construction (Section 31B-6). The project Contract Documents shall require compliance with this ordinance, and the Contractor will be obligated to comply and submit a bid in accordance with meeting same. For normal operations, since the majority of noise generating equipment is designed within enclosed structures, there is no expectation that the ordinance will be violated.

XIV. Architectural Schematics

N/A

XV. Traffic Impact Statement

N/A

Figure 1 – Project Location

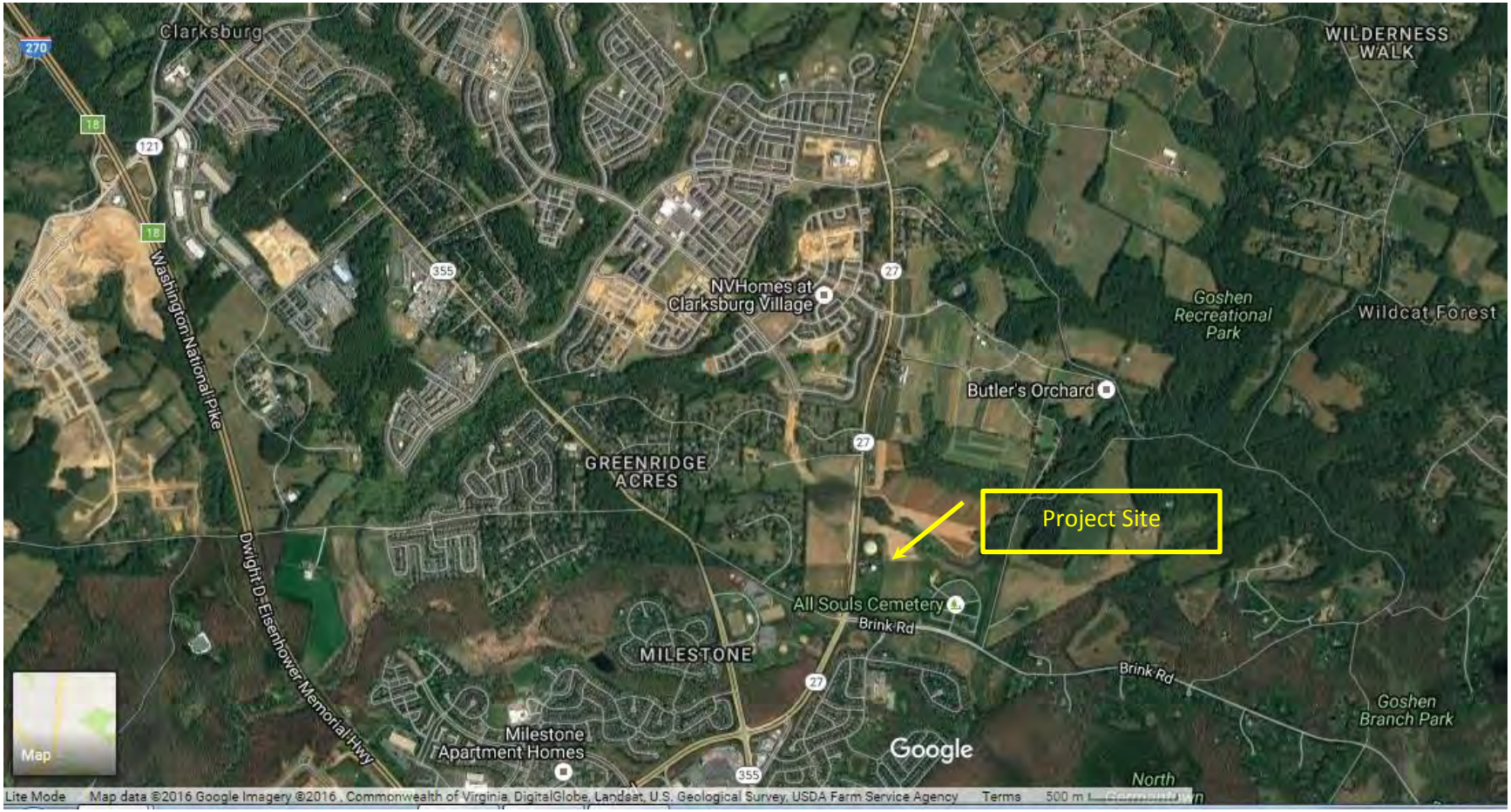
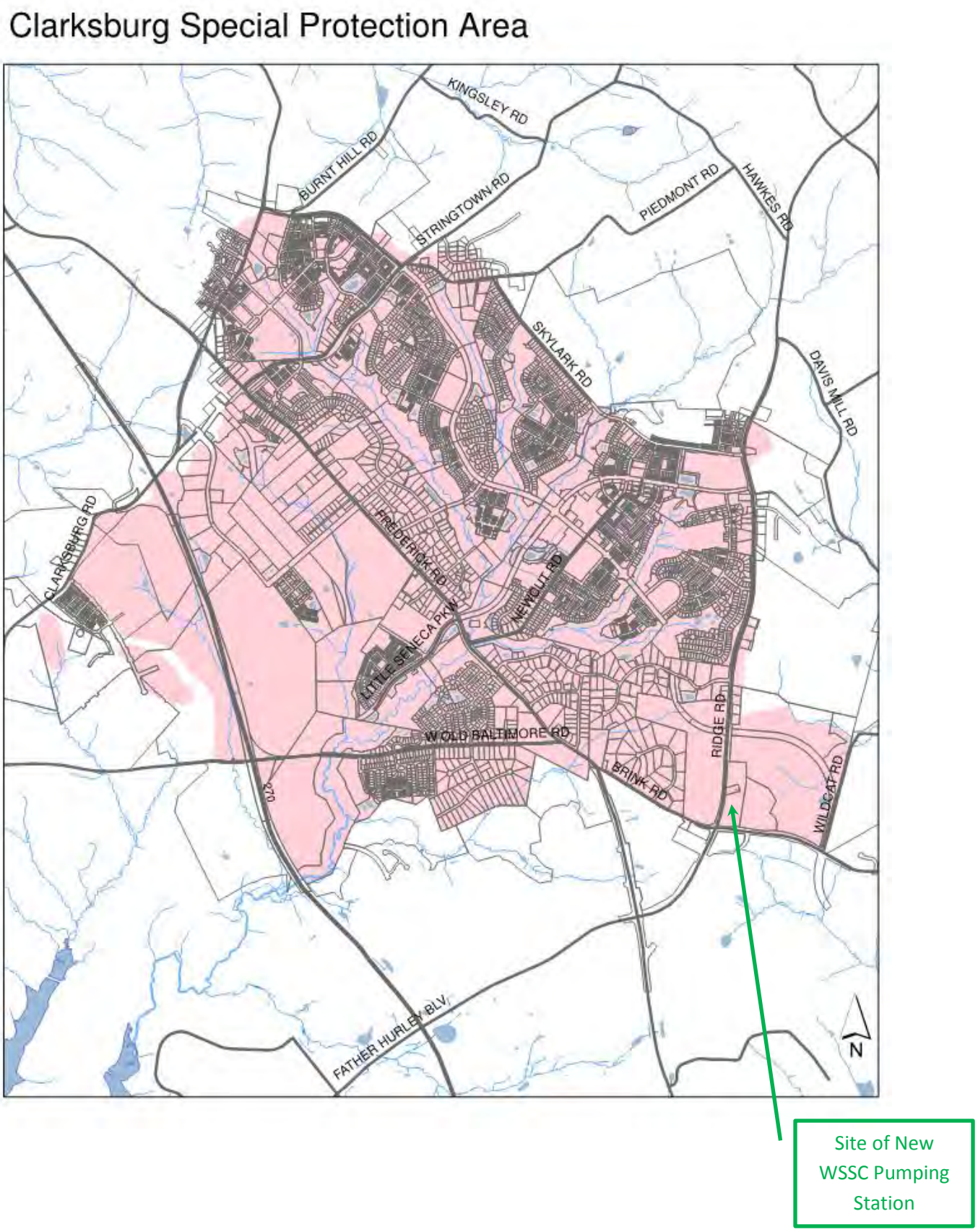


Figure 2 – WSSC Pumping Station Site Within Clarksburg SPA



Attachment 1 – Civil Drawings

WASHINGTON SUBURBAN SANITARY COMMISSION

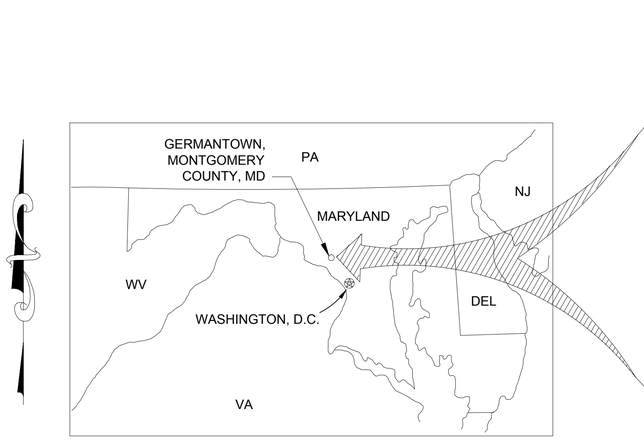
14501 SWEITZER LANE, LAUREL MARYLAND

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

CONTRACT - BP5692A14

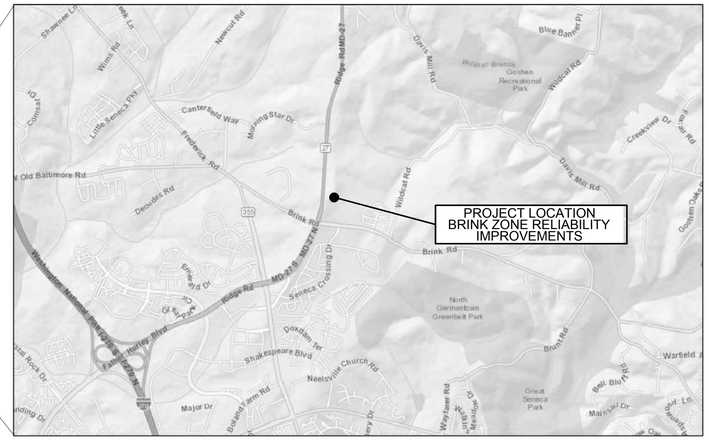
100% DESIGN

OCTOBER 2016



LOCATION MAP
N.T.S

ArcGIS Web Map



November 13, 2015
MONTGOMERY COUNTY, MD
ADC MAP PAGE; 4929

1:36,112
0 0.3 0.6 1.2 mi
0 0.5 1 2 km

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand),

Web AppBuilder for ArcGIS

VICINITY MAP

SCALE 1" : MAP UNITS

M.O.	Co.	PAGE	PAGE#	GRID	GRID#

WSSC 200' SHEET No.: 200'SHEET#

FOR LOCATION OF UTILITIES CALL 8-1-1 OR 1-800-257-7777 OR LOG ON TO www.call811.com OR www.missutility.net 48 HOURS IN ADVANCE OF ANY WORK IN THIS VICINITY

PERMIT REQUIREMENTS

MDE - WATER/SEWARAGE CONST. PERMIT	REQ'D
MDE - STORMWATER MANAGEMENT	REQ'D
MDE - EROSION & SEDIMENT CONTROL	REQ'D
MONT.CO. - BUILDING PERMIT	REQ'D
MD SHA - UTILITY PERMIT	REQ'D
MDE NPDES-GENERAL PERMIT FOR CONST. ACTIVITY	REQ'D
WSSC - PLUMBING AND GAS FITTING PERMIT	REQ'D
MONT.CO. - ELECTRICAL PERMIT	REQ'D
MONT.CO.- PUBLIC ROW PERMIT FOR UTILITY CONST.	REQ'D
MONT.CO. - GRADING PERMIT	REQ'D
MDNR - ROADSIDE TREE PERMIT	REQ'D
MDNR - FSD/FCP	REQ'D
MONT.CO. HEALTH - SEPTIC SYSTEM PERMIT	REQ'D
MNCPPC - MANDATORY REFERRAL SUBMISSION	REQ'D
*TO BE ACQUIRED BY APPLICANT	REQ'D

DATE	REVISIONS

ENGINEERING & CONSTRUCTION TEAM

DATE TEAM CHIEF

PROJECT DELIVERY GROUP

DATE GROUP LEADER

CONTRACT: BP5692A14

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.: 28215
EXPIRATION DATE: APRIL 1, 2017

100% DESIGN

1" - IF NOT ONE INCH ON THIS SHEET: ADJUST SCALES ACCORDINGLY.
VERIFY SCALE - BAR IS ONE INCH ON ORIGINAL DRAWING 0

PATH: P:\Projects\HMM\WSSC\Brink\Drawings\CAD\01 G-01.dwg
TEMPLATE LAYOUT CURRENT as of: 10/03/2013

WASHINGTON SUBURBAN SANITARY COMMISSION	THESE DOCUMENTS CONTAIN PRIVILEGED AND CONFIDENTIAL INFORMATION WHICH SHALL NOT BE REDISTRIBUTED WITHOUT PRIOR WSSC APPROVAL	MOTT MACDONALD	BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT	TITLE SHEET	G-01 NO 1 OF 117

PLOT DATE: October 14, 2016

DRAWING LIST

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6.	C-04	SITE PLAN
7.	C-05	UTILITY PLAN
8.	C-06	SEPTIC PLAN
9.	C-07	UTILITY PROFILE I
10.	C-08	UTILITY PROFILE II
11.	C-09	STAKEOUT DATA
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100% DESIGN

DATE	REVISIONS

PROFESSIONAL CERTIFICATION

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LICENSE NO.: 21042
EXPIRATION DATE: 2018-02-28

DESIGN:	MF	10/2016
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CHECKED:	BA	10/2016

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

MOTT MACDONALD

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

DRAWING INDEX

G-02

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OF 117

PATH: P:\Project\HMWWSSC\Brink\Drawings\CAD\01 G-02.dwg

VERIFY SCALE - BAR IS ONE INCH ON ORIGINAL DRAWING 0 ——— 1". IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

GENERAL NOTES

1. THE CONTRACTOR SHALL CONTACT MARYLAND STATE HIGHWAY ADMINISTRATION AT 410-545-0300 AT LEAST 48 HOURS IN ADVANCE OF STARTING CONSTRUCTION IN ROUTE 27.
2. THE CONTRACTOR SHALL CONTACT "MISS UTILITY" AT 1-800-257-7777 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO CONSTRUCTION.
3. THE CONTRACTOR SHALL MAINTAIN ROADS ON WSSC PROPERTY IN A BROOM SWEPT CONDITION AT ALL TIMES.
4. LICENSED GEOTECHNICAL ENGINEER TO PERFORM COMPACTION TESTING FOLLOWING ASTM D1666, ASTM D2922, OR ASTM D2937 AT MINIMUM RATE OF ONE (1) TEST AT EVERY LATERAL TRENCH, VALVE VAULTS, STRUCTURE AND VALVE BOX.
5. EXISTING UTILITIES, STRUCTURES AND FEATURES ARE SHOWN IN ACCORDANCE WITH INFORMATION AVAILABLE AND ARE FOR THE CONVENIENCE OF THE CONTRACTOR ONLY. THE CONTRACTOR SHALL VERIFY ALL SUCH INFORMATION TO HIS SATISFACTION PRIOR TO BEGINNING THE WORK. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EXISTING MAINS AND UTILITIES. ANY DAMAGE INCURRED SHALL BE REPAIRED IMMEDIATELY AND AT NO ADDITIONAL COST TO WSSC.
6. ALL EXISTING VALVES AND HYDRANTS SHALL BE OPERATED BY WSSC. NOTIFY WSSC AT LEAST THREE (3) DAYS IN ADVANCE OF ANY NECESSARY VALVE OPERATIONS.
7. THE CONTRACTOR IS RESPONSIBLE FOR ALL CONSTRUCTION STAKEOUT.
8. NOTIFY WSSC SEDIMENT CONTROL INSPECTOR 48 HOURS IN ADVANCE OF BEGINNING UTILITY CONSTRUCTION AT 301-206-8077
9. ALL UTILITY INSTALLATION MUST BE IN CONFORMANCE WITH THE CONDITIONS OF THE SOIL CONSERVATION DISTRICT/COUNTY/MDE APPROVED SEDIMENT CONTROL PLAN# ??, APPROVAL DATE ???, AND WITH ALL EROSION AND SEDIMENT CONTROL MEASURES CONTAINED WITHIN THIS PLAN. THE APPLICANT IS REQUIRED TO NOTIFY THE WSSC SEDIMENT CONTROL INSPECTOR OF ANY CHANGES AND MODIFICATIONS TO THE SCD/COUNTY/MDE APPROVED SEDIMENT CONTROL PLAN
10. CONTRACTOR SHALL NOTIFY PEPCO AND MISS UTILITY (1-800-757-7777) TEN (10) WORKING DAYS BEFORE STARTING CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH WSSC PROJECT MANAGEMENT FOR UTILITY LOCATION OF ALL WSSC UTILITIES IN ADDITION TO MISS UTILITY.
11. THE CONTRACTOR SHALL COMPLY WITH ALL WSSC, LOCAL, STATE AND FEDERAL REQUIREMENTS APPLICABLE TO CONSTRUCTION OF THIS PROJECT.
12. THE CONTRACTOR SHALL LIMIT THEIR WORK AREA TO AREAS DESIGNATED HEREIN AND APPROVED BY WSSC AND ENGINEER. ON-SITE STORAGE AND STAGING AREA SHALL BE DESIGNATED PRIOR TO CONSTRUCTION AND APPROVED BY WSSC AND THE ENGINEER.
13. THE CONTRACTOR SHALL FIELD VERIFY EXISTING CONDITIONS ON ALL LOCATIONS WHERE EXISTING UTILITIES ARE TO BE CROSSED OR ALTERED OR WHERE NEW CONSTRUCTION TIES INTO EXISTING FACILITIES. THE CONTRACTOR SHALL PROVIDE FITTINGS AND ADAPTERS AS REQUIRED TO AFFECT ALTERATIONS, IF ANY.
14. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EXISTING STRUCTURES, UTILITIES AND EQUIPMENT, AND TO MAINTAIN UNINTERRUPTED SERVICE OF THE EXISTING DISTRIBUTION SYSTEM. THE CONTRACTOR SHALL PROVIDE ALL TEMPORARY SUPPORTS, BRACES, SHEETING AND SHORING AS NECESSARY. ANY DAMAGES TO EXISTING STRUCTURES, UTILITIES, OR EQUIPMENT, EVEN THOSE NOT INDICATED ON THE CONTRACT DRAWINGS, RESULTING FROM THE ACTIONS OR LACK OF ACTIONS BY THE CONTRACTOR SHALL BE REPAIRED IMMEDIATELY BY THE CONTRACTOR AT HIS EXPENSE.
15. THE CONTRACTOR SHALL INCORPORATE ALL INFORMATION AND WORK REQUIRED UNDER THESE GENERAL NOTES ON THE SHOP AND WORKING DRAWINGS. ALL SUCH INFORMATION AND WORK SHALL BE SO INCORPORATED PRIOR TO THE TIME WORKING DRAWINGS ARE SUBMITTED.
16. THE CONTRACTOR SHALL PROVIDE WRITTEN NOTICE TO WSSC OF ANY WORK REQUIRING CHANGES IN OPERATING PROCEDURES A MINIMUM OF 14 DAYS IN ADVANCE OF THE REQUIRED DATE.
17. ALL COSTS ASSOCIATED WITH COMPLIANCE WITH THESE GENERAL NOTES OR ANY OTHER GENERAL NOTES INCLUDED ON OTHER DRAWINGS, SHALL BE INCLUDED IN THE VARIOUS CONTRACT ITEMS AND NO SEPARATE PAYMENT WILL BE MADE THEREFORE.
20. EXCAVATIONS TO REMAIN OPEN OVERNIGHT SHALL BE SURROUNDED BY A 6' CHAINLINK FENCE.
21. CONTRACTOR SHALL ASSUME THAT ALL VAULT AND PIPING GASKETING MATERIALS ARE ASBESTOS-CONTAINING MATERIALS (ACM). ANY DISTURBANCE OR REMOVAL OF THESE MATERIALS SHALL BE IN ACCORDANCE WITH OSHA 29 CFR 1926.1101 FOR CLASS II WORK.
24. UTILITY SEDIMENT CONTROL PERMIT IS REQUIRED. SEE ESC DRAWINGS.
25. PROVIDE 48 HOUR ADVANCED NOTIFICATION TO WSSC ENVIRONMENTAL GROUP INSPECTOR AT 301-206-8077 PRIOR TO UTILITY CONSTRUCTION. SEE ESC DRAWINGS.

WATER MAIN "A" CONNECTION NOTES

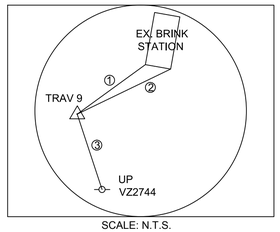
1. WSSC WILL SHUT AND DRAIN BRINK RESERVOIR AND CLOSE TWO EXISTING VALVES BETWEEN THE RESERVOIR AND TIE IN LOCATION.
2. WSSC WILL CLOSE TWO VALVES ON THE 48" MAIN SOUTH OF THE PROPOSED TIE IN LOCATION.
3. SHUT DOWN WILL NOT OCCUR UNTIL ALL 48" PIPE , 48" BALL VALVE, 30" BALL VALVES, AND ALL VAULT PIPE AND FITTINGS ARE ON SITE.
4. DRAIN AND DEMOLISH 48" MAIN AND CONSTRUCT 48" MAIN AND VALVE VENT AND ASSOCIATED PIPE AND FITTINGS.
5. PROVIDE 30" TEMPORARY BLIND FLANGES ON 30" BALL VALVE OUTLET SPOIL PIECES AND TEST NEW PIPING.
6. WSSC WILL RESTORE 48" MAIN AND RESERVOIR TO SERVICE.
7. MAXIMUM SHUT DOWN OF 48" MAIN WILL BE 90 DAYS.
8. A SECOND SHUT DOWN OF 48 HOURS WILL BE PERFORMED FOR CONNECTION OF 30" PIPE TO BALL VALVES.

SURVEY NOTES

1 REFER TO TRAVERSE CONTROL POINTS THIS SHEET.

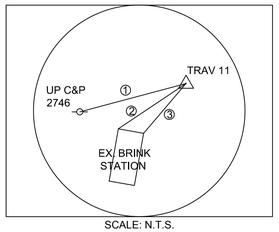
2 ALL HORIZONTAL AND VERTICAL SURVEY DATA CONTAINED HEREIN ARE REFERENCED TO THE "NAD83 (1993) HORIZONTAL DATUM AND NAVD88 VERTICAL DATUM" COORDINATE SYSTEM, AS DERIVED FROM THE FOLLOWING BENCHMARKS FROM THE PLAN ENTITLED TOPOGRAPHIC SURVEY FOR WSSC DATED MAY 04, 2015 BY NAVARRO & WRIGHT:

POINT#	NORTHING	EASTING	ELEVATION	DESCRIPTION
JV4419	563,063.73	1,244,922.60		NGS CLASSIC
JV4420	563,111.74	1,244,839.43		HORIZONTAL CONTROL
JV2279 BM			513.78	NGS VERTICAL CONTROL



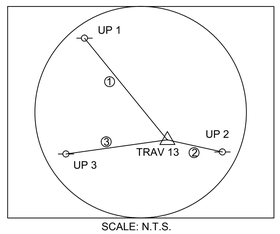
SCALE: N.T.S.

TRAVERSE POINT # 9
①152.5' TO CORNER OF BUILDING
②170.8' TO CORNER OF BUILDING
③ 79.7' TO UTILITY POLE



SCALE: N.T.S.

TRAVERSE POINT # 11
①153.3' TO UTILITY POLE
②138.3' TO CORNER OF BUILDING
③129.1' TO CORNER OF BUILDING



SCALE: N.T.S.

TRAVERSE POINT # 13
① 210.9' TO UTILITY POLE
② 28.4' TO UTILITY POLE
③ 114.1' TO UTILITY POLE

TRAVERSE CONTROL DATA

PT.	NORTHING	EASTING	ELEVATION	DESCRIPTION
9	562909.5890'	1244583.1640'	631.039'	MAG SET
11	563204.3350'	1244747.6120'	636.140'	MAG SET
13	562306.6050'	1244649.0650'	609.620'	MAG SET

LEGEND

- EXISTING TREE; DECIDUOUS, CONIFEROUS
- EXISTING UTILITY POLE
- EXISTING GUY WIRE
- EXISTING BOLLARD
- EXISTING LIGHT POLE
- EXISTING SIGN
- TRAVERSE POINT
- OHE — EXISTING OVERHEAD ELECTRIC LINE
- PROPERTY LINE
- RIGHT OF WAY LINE
- EXISTING EASEMENT
- EXISTING FENCE
- W — EXISTING WATER PIPE
- GAS — EXISTING GAS PIPE
- SD — EXISTING STORM DRAIN
- E — EXISTING UNDERGROUND ELECTRIC
- EXISTING CONCRETE
- EXISTING ASPHALT ROAD
- EXISTING BUILDING
- EXISTING WATER STRUCTURE
- PROPOSED BOLLARD
- PROPOSED SHRUBBERY
- PROPOSED FENCE
- LOD — LIMIT OF DISTURBANCE
- PROPOSED BUILDING
- PROPOSED BIORETENTION AREA
- PROPOSED ASPHALT PAVING
- PROPOSED CONCRETE

100% DESIGN

DESIGN:	MF	10/2016
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CHECKED:	BA	10/2016

PROFESSIONAL CERTIFICATION

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LICENSE NO.: ~~######~~
EXPIRATION DATE: ~~EXPIRATION DATE~~

DATE	REVISIONS

CONTRACT: BP5692A14

PATH: P:\Projects\MM\WSSC\Brink\Drawings\CAD\02 C-01 Notes, Legend, & Abbreviations.dwg

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WASHINGTON SUBURBAN SANITARY COMMISSION

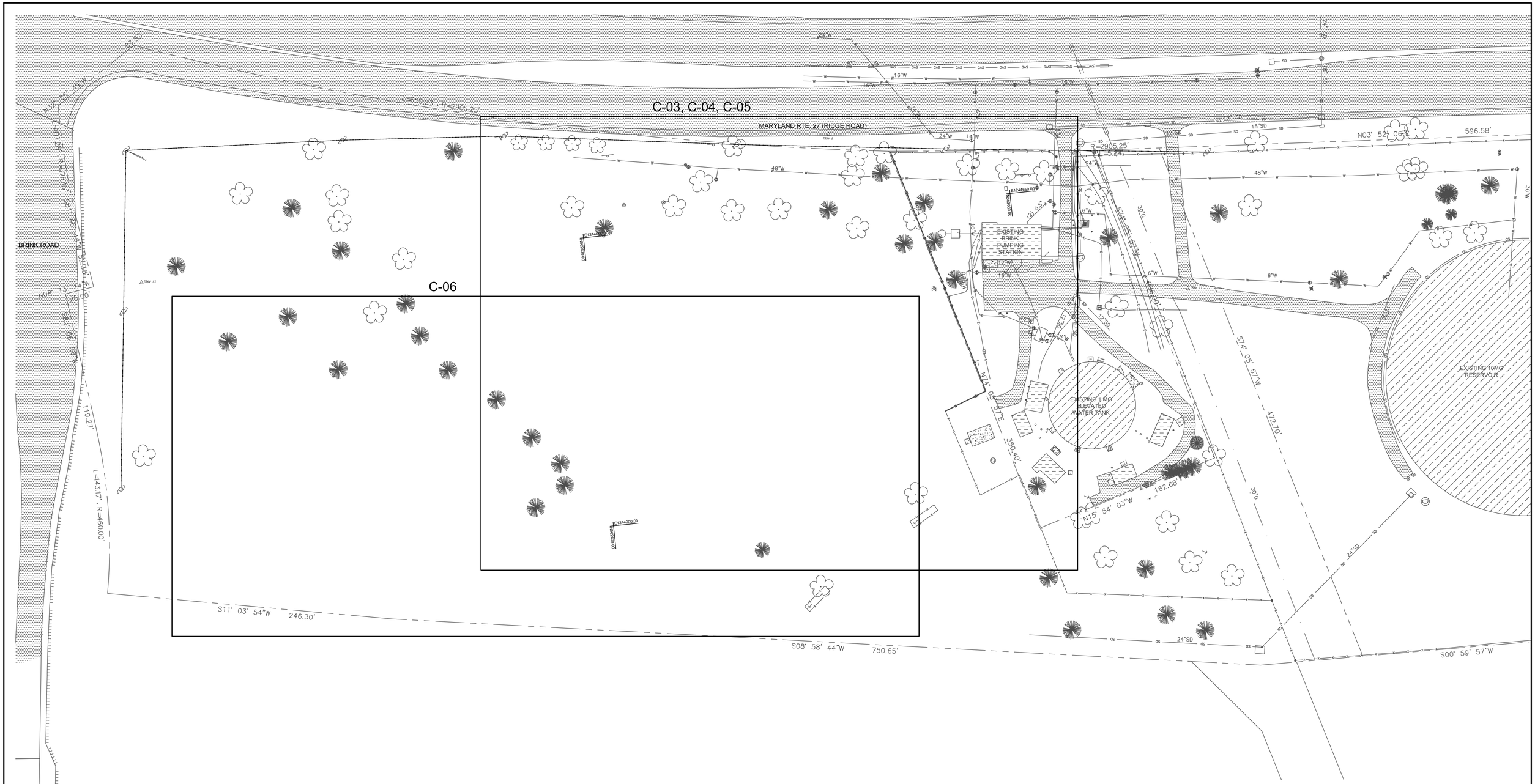
MOTT MACDONALD

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

NOTES, LEGEND, & ABBREVIATIONS

C-01

NO 3
OF 117



KEY PLAN
SCALE: 1" = 40'

GRAPHIC SCALE
0 40 80
SCALE 1" = 40'

DESIGN:	MF	10/2016
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CHECKED:	BA	10/2016

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

KEY PLAN

C-02

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OF 117

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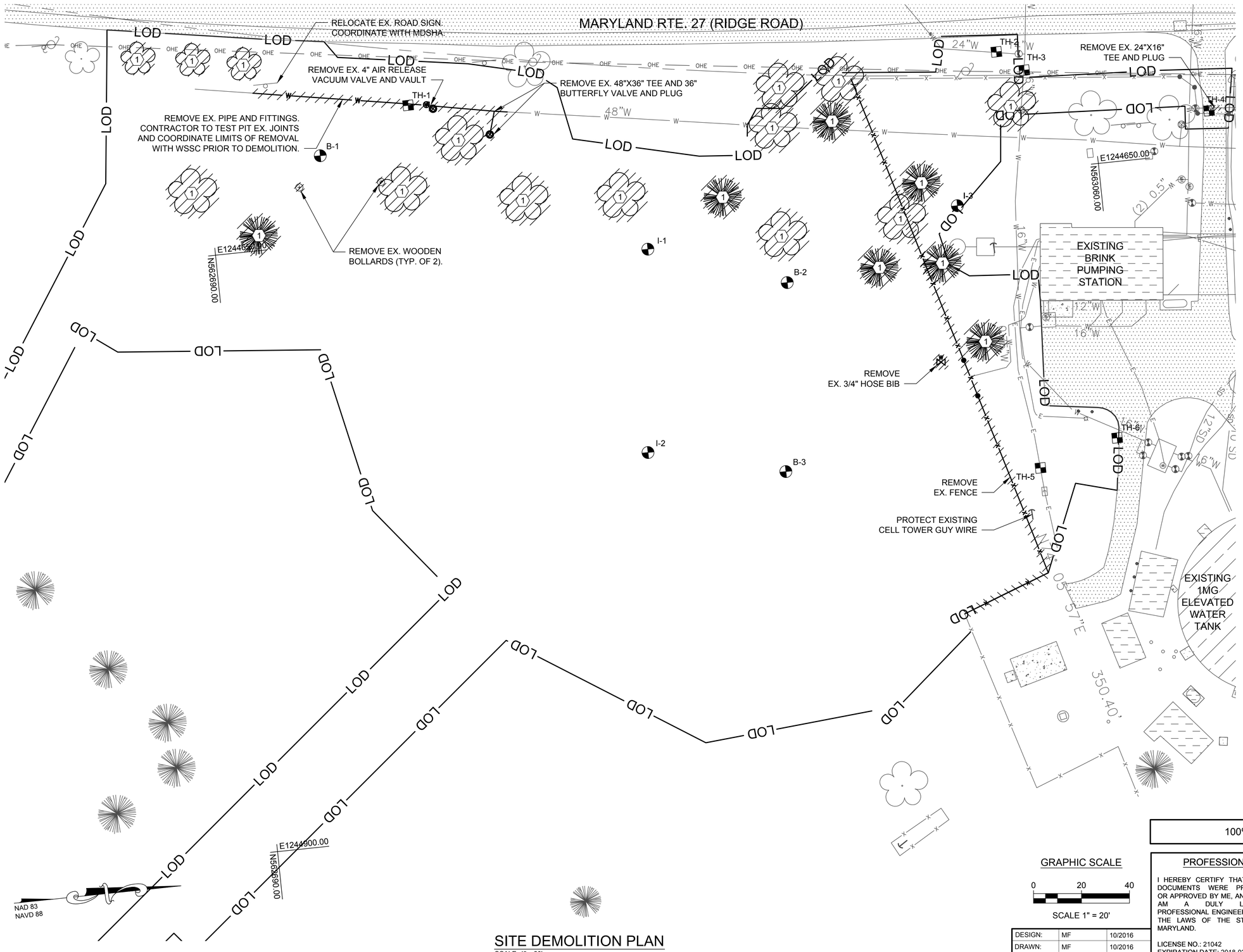

SITE DEMOLITION PLAN

SCALE: 1" = 20'

GENERAL NOTES

1. REFER TO DRAWING C-01 FOR NOTES, LEGEND, AND ABBREVIATIONS.
2. DEMOLITION SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 02220.
3. ACCESS TO THE EXISTING PUMPING STATION AND ALL BUILDING ENTRANCES BY THE COMMISSION STAFF WILL BE MAINTAINED AT ALL TIMES.
4. NOTIFY THE COMMISSION AT LEAST 10 WORKING DAYS PRIOR TO START OF WORK. CONTRACTOR SHALL SUBMIT DEMOLITION PLAN AND OBTAIN APPROVAL PRIOR TO START OF WORK.

DEMOLITION NOTES

(1) REMOVE EXISTING TREE.

100% DESIGN

GRAPHIC SCALE

0 20 40

SCALE 1" = 20'

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

DEMOLITION PLAN

C-03

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OF 117

PATH: P:\Projects\MM\WSSC\Brink\Drawings\CAD\02 C-03 Demolition Plan.dwg

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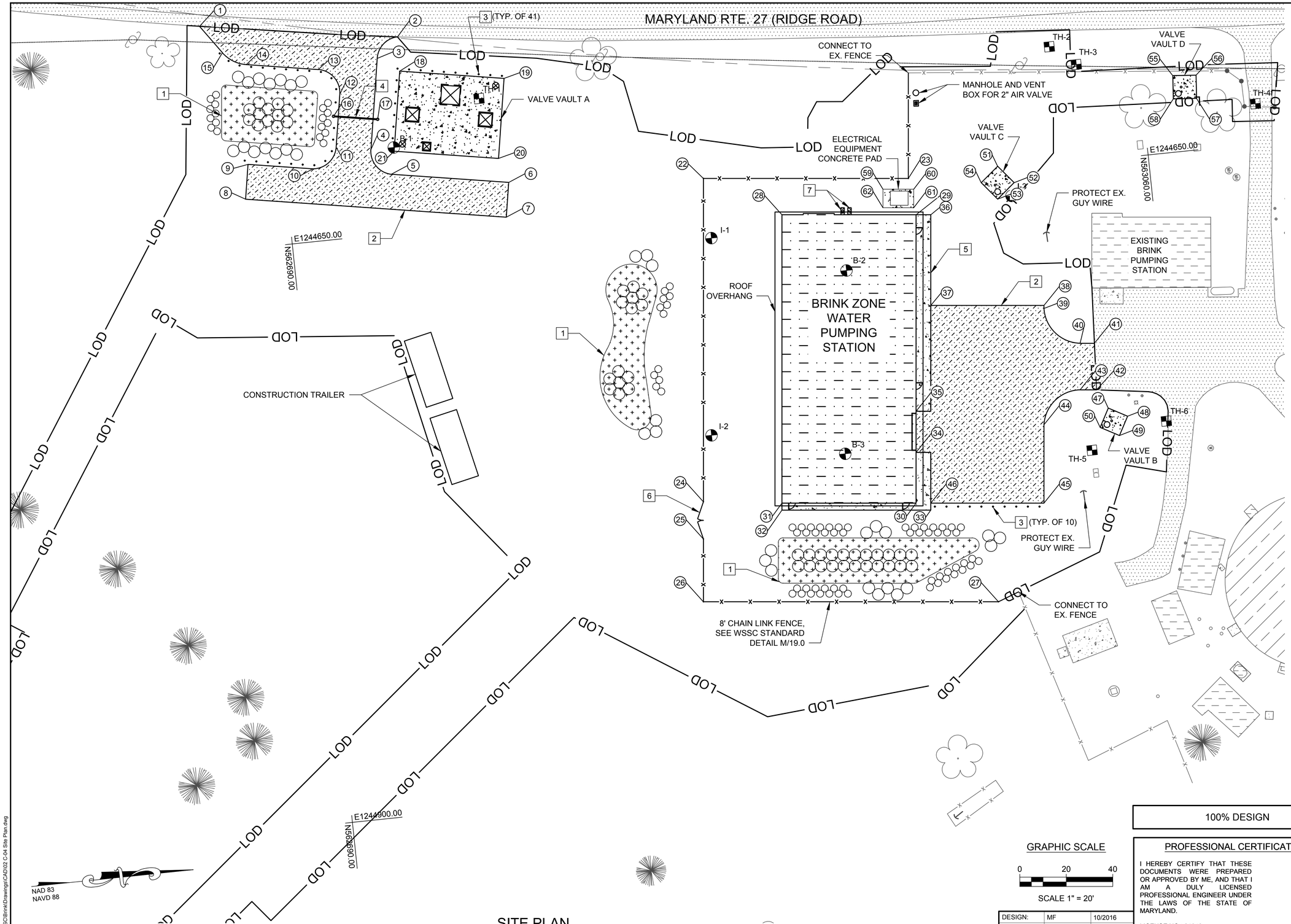

GENERAL NOTES

1. REFER TO DRAWING C-01 FOR LEGEND AND ABBREVIATIONS.
2. REFER TO DRAWING C-09 FOR STAKEOUT DATA. FOLLOW WSSC STANDARD DETAIL M/10.0 FOR CONTRACTOR'S CONSTRUCTION STAKE-OUT RECORD.
3. ALL UNPAVED AREAS WITHIN THE LOD SHALL BE RESTORED WITH GRASS SURFACE COVER IN ACCORDANCE WITH SPECIFICATIONS.
4. REFER TO ESC DRAWINGS FOR ADDITIONAL RESTORATION REQUIREMENTS.
5. CONTRACTOR TO PROTECT EXISTING CELL TOWER GUY WIRES.

DRAWING NOTES

1. MICRO-BIORETENTION BASIN, SEE SWM SHEETS
2. PAVEMENT, SEE DETAIL 2 ON C-10
3. BOLLARD, SEE DETAIL 3 ON C-10
4. ACCESS GATE, SEE WSSC STANDARD DETAIL M/11.0
5. CONCRETE SIDEWALK, SEE DETAIL 5 ON C-10
6. 16' DOUBLE SWING GATE, SEE DETAIL 6 ON C-11
7. SPLASH BLOCK FOR SUMP PUMP DISCHARGE, SEE DETAIL 2 ON M-18

SITE PLAN

SCALE: 1" = 20'

GRAPHIC SCALE

0 20 40

SCALE 1" = 20'

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MOTT MACDONALD

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

SITE PLAN

C-04

NO 6
OF 117

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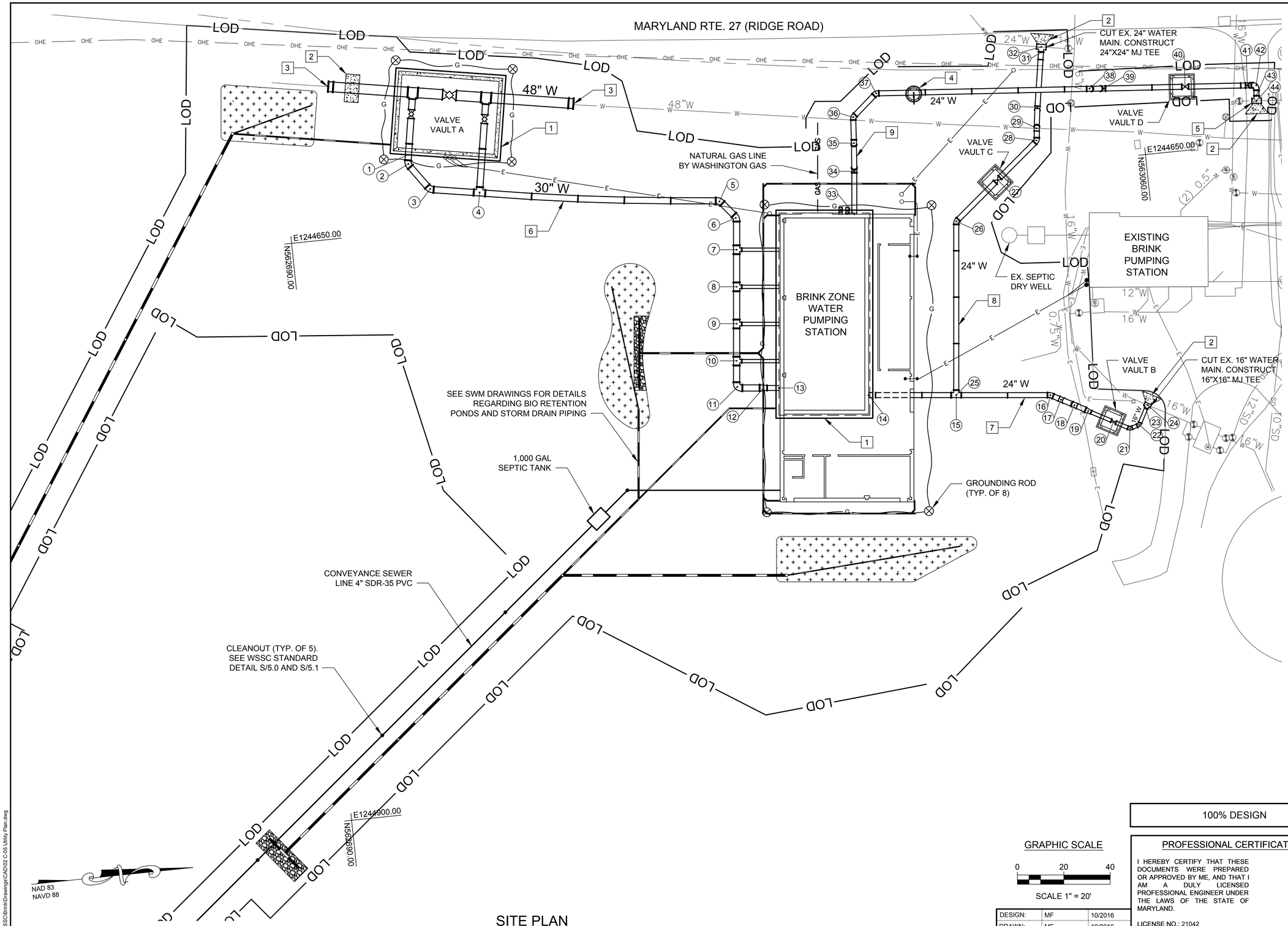

SITE PLAN

SCALE: 1" = 20'

GENERAL NOTES

1. REFER TO DRAWING C-01 FOR NOTES, LEGEND, AND ABBREVIATIONS.
2. REFER TO DRAWINGS M-12 TO M-17 FOR VALVE VAULT DRAWINGS AND PIPING DETAILS.
3. CONTRACTOR SHALL TEST PIT TO DETERMINE COORDINATES AND ELEVATIONS OF TIE-IN POINTS OF PROPOSED PIPING TO EXISTING PIPING. CONTRACTOR SHALL SUBMIT LAYOUT AND STAKEOUT PLAN FOR STRUCTURES AND NEW PIPING FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.
4. SEE DRAWINGS C-07 AND C-08 FOR PIPING PROFILES.
5. SEE DRAWING C-09 FOR STAKEOUT DATA. FOLLOW WSSC STANDARD DETAIL M/10.0 FOR CONTRACTOR'S CONSTRUCTION STAKE-OUT RECORD.
6. SEE DRAWING C-06 FOR SEPTIC SYSTEM DESIGN AND PIPING LAYOUT.
7. FOLLOW WSSC STANDARD DETAILS M/8.1A, M/8.1B, AND M/8.1C FOR PROPOSED PIPE TRENCH REQUIREMENTS.
8. FOLLOW WSSC STANDARD DETAIL M/8.3 FOR ALL PIPELINE CROSSING TRENCH DETAILS.

DRAWING NOTES

1. 6" FOUNDATION DRAIN. SEE ARCHITECTURAL DRAWINGS FOR DETAILS.
2. CONCRETE THRUST BLOCK FOR THRUST RESTRAINT. SEE WSSC STANDARD DETAILS B/1.0 AND B/1.3 AND CIVIL DETAILS FOR ADDITIONAL INFORMATION.
3. CONNECT TO EXISTING 48" WATER MAIN. SEE WSSC STANDARD DETAIL W/11.0.
4. 2" AIR VALVE IN MANHOLE. SEE WSSC STANDARD DETAIL W/2.0.
5. CUT EX. 24" WATER MAIN. CONSTRUCT 24"X24" MJ TEE. REPAIR DRIVEWAY PER WSSC STANDARD DETAIL M/5.1.
6. REFER TO PROFILE A, SHEET C-07
7. REFER TO PROFILE B, SHEET C-07
8. REFER TO PROFILE C, SHEET C-08
9. REFER TO PROFILE D, SHEET C-08

UTILITY LEGEND

- E — UNDERGROUND ELECTRIC LINE
- PVC STORM DRAIN PIPE
- BIO RETENTION POND
- G — ELECTRICAL GROUNDING SYSTEM
- GAS — NATURAL GAS PIPE

GRAPHIC SCALE

0 20 40

SCALE 1" = 20'

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

UTILITY PLAN

C-05

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OF 117

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NAD 83
NAVD 88

2'-0" WIDE ABSORPTION TRENCH
WITH 4" PVC PERFORATED DRAINAGE
PIPE (SEE TYP. SECTION THIS SHEET)

25' SETBACK FROM 25% SLOPE

PERC TEST
SITE# C

PERC TEST
SITE# D

10,000 S.F.
RESERVE
AREA

DISTRIBUTION BOX

S11° 03' 54"W 246.30'

5' SETBACK FROM PROPERTY LINE

LOD

CONVEYANCE SEWER LINE
4" SDR-35 PVC

CLEANOUT (TYP. OF 5)

1000 GAL.
STANDARD
SEPTIC TANK

I-2

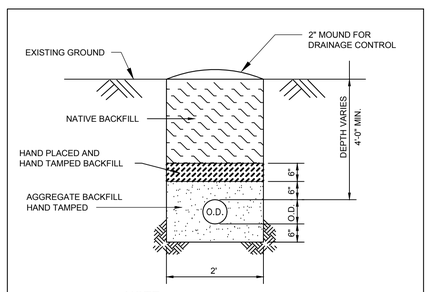
B-3

E1244900.00

N566960.00

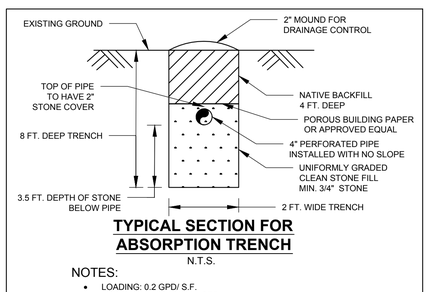
25' SETBACK
FROM 25% SLOPE

SITE PLAN
SCALE: 1" =20'



NOTE: MAINTAIN MIN. 1% PIPE SLOPE

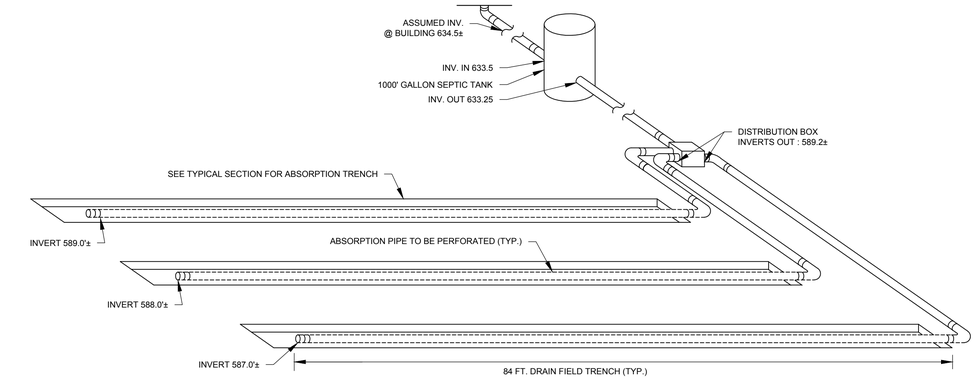
CONVEYANCE TRENCH DETAIL
- 4" SDR 35 P.V.C. SEWER PIPE
N.T.S.



TYPICAL SECTION FOR
ABSORPTION TRENCH
N.T.S.

NOTES:

- LOADING: 0.2 GPD/ S.F.
  DESIGN CAPACITY: 400 GPD
- ABSORPTIVE AREA: 400/0.2 = 2000 S.F.
  TOTAL TRENCH LENGTH: 2000 S.F./ 8F. = 250 L.F.
  PROVIDE 3 TRENCHES OF 84 L.F.
- ABSORPTION TRENCH BOTTOM AND PIPE SHOULD
  MAINTAIN LEVEL ELEVATION THROUGHOUT TRENCH.
  TRENCH ELEVATIONS WILL VARY PER TRENCH.



DRAIN FIELD
SCHEMATIC DIAGRAM
N.T.S.

SEPTIC NOTES:

1. CONTRACTOR SHALL NOTIFY MONTGOMERY COUNTY WELL & SEPTIC OFFICE AT (240) 777 6320, FOURTEEN (14) DAYS PRIOR TO START OF CONSTRUCTION.
2. SEPTIC SYSTEM COMPONENTS SHALL BE IN ACCORDANCE WITH MONTGOMERY COUNTY REGULATION NO. 28-93AM, ON-SITE WATER SYSTEMS AND ON-SITE SEWAGE DISPOSAL SYSTEMS IN MONTGOMERY COUNTY, DATED MARCH 1994 AND THE MOST CURRENT MARYLAND DEPARTMENT OF ENVIRONMENT (MDE) REQUIREMENTS.
3. THE SEPTIC TANK SHALL HAVE A MINIMUM RATED CAPACITY OF 1000 GALLONS PER DAY.
4. ALL GRAVITY SEWERS BETWEEN THE BUILDING AND THE START OF THE SEPTIC TRENCH SHALL BE 4-INCH SDR-35 PVC.
5. FINAL GRADING SHALL REDIRECT SURFACE WATER AWAY FROM SEPTIC SYSTEM COMPONENTS.
6. SEPTIC TANK PLACEMENT SHALL BE MIN. 15' FROM BUILDING AND 30' FROM SWM FACILITIES.
7. CONTRACTOR SHALL SUBMIT SEPTIC SYSTEM PLAN TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION

GRAPHIC SCALE

0 20 40

SCALE 1" = 20'

DESIGN:	BLS	07/05/16
DRAWN:	AJU	07/05/16
CHECKED:	JKO	07/05/16

100% DESIGN

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.:
EXPIRATION DATE:

DATE	REVISIONS

CONTRACT: BP5692A14

VERIFY SCALE - BAR IS ONE INCH ON ORIGINAL DRAWING 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

PATH: P:\Projects\MM\WSSC\Brink\Drawings\CAD\02 C-06 Septic Plan.dwg

WASHINGTON SUBURBAN SANITARY COMMISSION

MOTT MACDONALD

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

SEPTIC PLAN

C-06

NO 8
OF 117

Attachment 2 – Forest Conservation Submittal

Carroll Engineering, Inc.
215 Schilling Circle
Suite 102
Hunt Valley, MD 21031
Phone: 410-785-7423 Fax: 401-771-1313

LETTER OF TRANSMITTAL

DATE	10/7/2016	JOB NO.	1501.08
ATTENTION	Tod Ericson		
RE:	Brink Zone Reliablity Improvements		
	FCP Application		

TO Mr. Tod Ericson
MD DNR - MD Forest Service
2 South Bond Street
Bel Air, MD 21014

WE ARE SENDING YOU ☑ Attached ☐ Under separate cover via ____ US Mail ____ Messenger ___ Overnight the following items

☐ Shop Drawings ☐ Prints ☑ Plans ☐ Samples ☐ Specifications
☐ Copy of Letter ☐ Change Order ☑ Applications

COPIES	DATE	NO.	DESCRIPTION
1	10/6/2016		Cover Letter
2	10/4/2016		Forest Conservation Application
2	10/4/2016		Forest Conservation Worksheet
2	10/6/2016		Simplified Forest Stand Delineation
2	10/6/2016		Forest Conservation Plan
1	9/23/2016		Existing Conditions Plan and Proposed Site Plan (convenience only)
1	7/11/2016		Letters from MDNR
1	7/18/2016		Letters from MD Historical Trust

THESE ARE TRANSMITTED as checked below:

☑ For approval ☐ Approved as Submitted ☐ Resubmitted ____ copies for approval
☐ For your use ☐ Approved as Noted ☐ Submit ____ copies for distribution
☐ As requested ☐ Returned for Corrections ☐ Returned ____ corrected prints
☑ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 20____ ☐ PRINT RETURNED AFTER LOAN TO US

REMARKS:

COPY TO: Brian Aylaian, MM
Abiola Akin-Ajayi, WSSC

SIGNED: Claire Fishman

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

CARROLL ENGINEERING, INC.

October 7, 2016

Maryland Department of Natural Resources
MD Forest Service
2 South Bond Street
Bel Air, MD 21014

Attn: Mr. Tod Ericson

Re: WSSC Brink Zone Reliability Improvements - FSD / FCP
CEI Job # 1501.08

Dear Mr. Ericson:

On behalf of the Washington Suburban Sanitary Commission, I am pleased to submit the Forest Stand Delineation and Forest Conservation Calculations for the above referenced project. Enclosed with this letter are the following:

1. Two (2) copies of the Simplified Forest Stand Delineation;
2. Two (2) copies of the Forest Conservation Plan;
3. Two (2) copies of the Forest Conservation Application;
4. Two (2) copies of the Forest Conservation Worksheet;
5. One (1) copy of the current Existing Conditions Plan and Proposed Site Plan for your convenience during review;
6. Once (1) copy of each: Letter from DNR (Rare, Threatened and Endangered Species) & Letter from MD Historical Trust

This submittal is for the afforestation of 1.95 acres land located on the Brink Water Pumping Station property located at 21701 Ridge Road. This retention is required due to site improvements associated with the addition of a back-up water pumping station. This submittal represents the Forest Stand Delineation and Forest Conservation submittal in the MDNR. **Please note that prior to sending in the 30-day public notice for publication, I would appreciate receiving the preliminary approval of the Forest Conservation Plan.**

At this time we would like to offer the opportunity to meet or discuss the project, if you deem necessary. If you require additional information or documentation, or have any questions or comments, please call us at anytime at 410-785-7423. At this time we respectfully request approval of the enclosed Forest Conservation Plan.

Sincerely,
Carroll Engineering, Inc.

Claire Fishman

Claire Fishman, P.L.A., LEED Green Assoc.
Project Landscape Architect

215 Schilling Circle • Suite 102 • Hunt Valley, Maryland 21031
410.785.7423 • Fax: 410.771.1313

EFFECTIVE DECEMBER 1, 2011

FOREST CONSERVATION APPLICATION

Submit All Application Documents in Duplicate

PROJECT # BP5692A14

Project Name: Brink Zone Reliability Improvements Project
Location: 21701 RIDGE ROAD, GERMANTOWN, 20876
Description: WSSC has added a new Booster Pump Station and Valve Chamber to the Brink Zone Water Pumping station as a back-up for pump failure.
Watershed Name: Washington Metropolitan Subwatershed #: 02140208 (Seneca Creek)

County: Montgomery County Municipality: N/A

Maryland Grid Coordinate centroid: 563,029 ft North 1,244,740 ft East
North American Datum Year: NAD 83/11 NAVD 88
ADC:Year 37th edition Page 13 (Map 9) Grid J9

Tax Map # FV12 Grid# - Parcel # 0639 Block# -
Lot # - District/Account# 02/02440111
Liber 6555 Folio 0900

By signing below, the applicant certifies that he or she has the legal right to implement proposed planting, maintenance and/or a long-term protection agreement. The applicant futher certifies that the property subject to a long-term protection agreement is not otherwise protected under federal, state or local programs.

Applicant's Signature _____ Date 10-4-16

Applicant Name: Abiola Akin-Ajayi (c/o WSSC) Owner: (Y) N (circle one)
Firm Name: Washington Suburban Sanitary Commision
Address: 14501 Sweitzer Lane
City: Laurel State: MD Zip Code: 20707
Phone #: 301-206-8518

Indicate if applicant or (agent) is to be the contact (Circle)
Agent Name: Brian Aylaian
Firm Name: Mott MacDonald
Address: 11019 McCormick Rd, Suite # 260
City: Hunt Valley State: MD Zip Code: 21031
Phone #: (443) 541-5079

FOREST STAND DELINEATION INFORMATION

Total Tract Area: 14.9 Ac.
- Area within 100 year floodplain: 0 Ac.
- Area remaining in agriculture: 0 Ac.
- Other: _____ Ac. (includes critical area and impervious surfaces)

Net Tract Area: 14.90 Ac.
- Area of Existing Forest: 0 Ac.
- Area of Existing NTW forest: 0 Ac.
- Total Area in Sensitive Areas: 0 Ac.
  - Forested Stream Buffers (50 ft. wide minimum) Y/**N**
    - Buffer Area Forested: _____ Ac.
  - Steep Slopes Y/N: 1.8 Ac.
  - Threatened and Endangered Species Y/**N**

Dominant and CoDominant Forest Species: White Pine / Tree-of-Heaven

FSD Prepared by: Claire Fishman (print) (Lic. LA,) Lic. Forester, Qualified Prof. (circle)

FOREST CONSERVATION PLAN INFORMATION **PROJECT #** BP5692A14

In accordance with Maryland Annotated Code, Natural Resources Article Section 5-1607(c) and COMAR 08.19.04.03B, the applicant must submit written justification for projects that disturb the priorities for retention and protection under Section 5-1607(c) and COMAR 08.19.04.03E.

Per 5-1607(c)(2), a variance is required for disturbance to 1) rare, threatened and endangered tree, shrub or plant species, 2) trees associated with historic structures or is designated a national state or local Champion Tree, and 3) trees with 30 in dbh or 75% of the dbh of the MD State Champion Tree.

Existing Land Use Category (circle)
Residential/Commercial/Industrial/Agricultural/Resource/Mixed Use/PUD/(Institutional)
Proposed Land Use: Elevated Water Tank / Back-up Pump
Afforestation Threshold: 15% Conservation Threshold: 20%

Proposed Area of Disturbance: 13.00 Total Ac. (Total Tract minus the linear Utility Installation)
% in Sensitive Areas: 0.01 % Streams and buffer, floodplains, and steep slopes
Proposed Forest Clearing: 0 Total Ac.
in Sensitive areas: 0 Ac. Streams and buffer, floodplains, and steep slopes
in NTW: 0 Ac.
Forest Retention Onsite: 0 Ac. Offsite: 0 Ac.
in Long Term Protection: 0 Ac.

Forest Conservation Required: 1.95 Ac.
Forest Conservation Provided: 1.95 Ac.
Planting Onsite: 1.95 Ac. Offsite: 0 Ac.
Sensitive Area Planting: 0.1 Ac. (Steep Slopes)
Stream Buffer Established: length 0 (ft) width 0 (ft)
Other:
Offsite Location
County:
Tax Map: Parcel:
District/Account #:
Maryland Grid: ft. N ft. E
North American Datum Year
ADC: Year Page Grid
Subwatershed

Planting Responsibility: WSSC (WSSC does not yet know who will be performing and maintaining the Forest Conservation area as it will be added to the work roster and included in the bid package. When this information is obtained, it will be forwarded to MDNR.)
Maintenance Responsibility: WSSC
Phone:

Total Long Term Protection Acreage: 1.95 Ac.
% in Sensitive Areas: 0.1 %
Long Term Protection Agreement Type:
Fee-in-lieu Amount $: Acres:
Bond Amount $: -
Bond Type: -

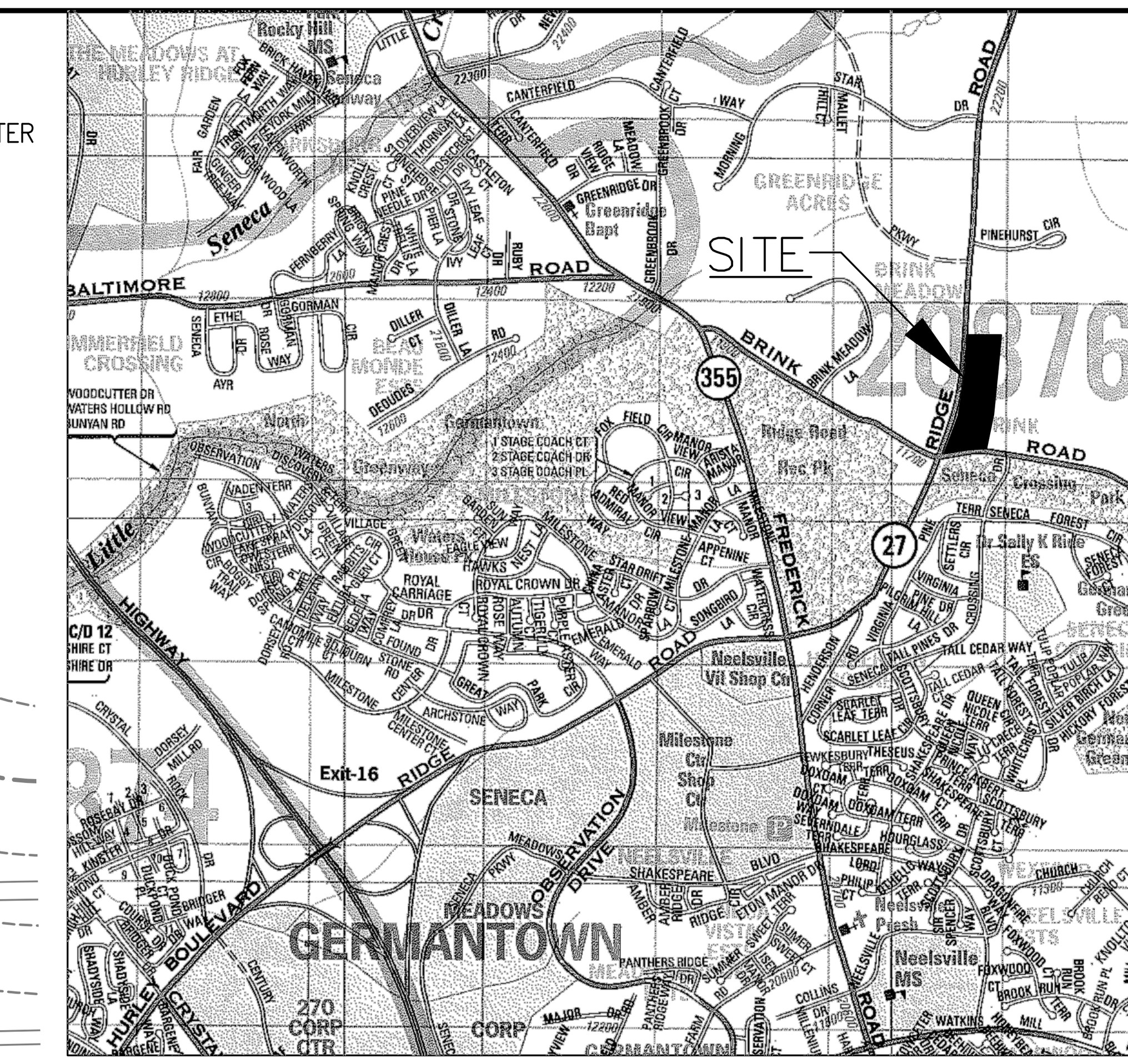
FCP Prepared by: Claire Fishman (print) (Lic.LA, Lic. Forester, Qualified Professional (circle)

Mail to the appropriate office:

Eastern Region	Central Region	Southern Region	Western Region
MD DNR Forest Service	MD DNR Forest Service	MD DNR Forest Service	MD DNR Forest Service
201 Baptist Street	2 S. Bond Street	8023 Long Hill Rd	14110 Pleasant Valley Road
Salisbury, MD 21801	Bel Air, MD 21014	Pasadena, MD 21122	Flintstone, MD 21530
(410) 543-6745	(410)836-4551	(410)360-9774	(301) 777-5591

GENERAL NOTES

1. SITE ADDRESS: 21701 RIDGE ROAD, GERMANTOWN, 20876
2. OWNER APPLICATION: WASHINGTON SUBURBAN SANITARY COMMISSION
   14501 SWEITZER LANE
   LAUREL, MD 20707
3. GROSS TRACT OF PROPERTY: 14.9 AC.
   NET TRACT OF PROPERTY: 14.9 AC.
   AREA OF LINEAR UTILITY INSTALLATION: 1.9 AC.
   AREA OF TO BE MITIGATED FOR VIA REFORESTATION 13.0 AC.
   AREA OF PROPERTY IN FOREST: 0 AC. (ALL WOODLAND AREAS WITHIN THE PROPERTY BOUNDARY ARE LESS THAN THE 10,000 SF EACH AS REQUIRED TO BE CONSIDERED "FOREST")
4. THIS SITE IS ZONED AR (AGRICULTURAL RESERVE).
5. A TOPOGRAPHIC / BOUNDARY SURVEY OF THE SITE WAS PERFORMED BY NAVARRO & WRIGHT CONSULTING ENGINEERS, INC., DATED MAY, 2015.
6. SOILS INFORMATION FOR THIS SITE WAS OBTAINED FROM USDA NRCS WEB SOIL SURVEY IN A CUSTOM SOIL RESOURCES REPORT FOR AN AREA IN INTEREST (AOI) ESTABLISHED FOR THE SUBJECT SITE ONLY AND GENERATED ON SEPTEMBER 14, 2015.
7. THIS SITE DOES NOT LIE WITHIN A 100-YEAR FLOOD PLAIN, AS SHOWN ON F.E.M.A. MAP NO. 24031C 0180 D.
8. NO WETLANDS OR REGULATED STREAMS WERE NOTED DURING THE SITE VISITS. THIS HAS BEEN VERIFIED BY MERLIN (MARYLAND'S ENVIRONMENTAL RESOURCE AND LAND INFORMATION NETWORK) ONLINE MAPS.
9. AS INDICATED BY MERLIN ONLINE MAPS AND US FISH AND WILDLIFE SERVICE'S IPaC (INFORMATION, PLANNING, AND CONSERVATION SYSTEM), THERE ARE NO RARE, THREATENED OR ENDANGERED SPECIES ON-SITE. A LETTER DATED 06/11/2016 RECEIVED FROM THE WILDLIFE AND HERITAGE DIVISION OF THE MARYLAND DEPARTMENT OF NATURAL RESOURCES (MDNR) CONFIRMS THIS.
10. NO KNOWN HISTORIC STRUCTURES, HISTORIC CEMETERIES, OR OTHER HISTORIC RESOURCES ARE LOCATED ON SITE. A LETTER DATED 06/30/2016 RECEIVED FROM THE MARYLAND HISTORICAL TRUST CONFIRMS THIS.
11. THERE IS NO KNOWN PAST OR PRESENT MANAGEMENT OF FOREST ON SITE.
12. NO SPECIMEN TREES HAVE BEEN LOCATED ON THE PROPERTY.
13. SURROUNDING LAND USES ARE AGRICULTURAL TO THE NORTH AND EAST, AND RESIDENTIAL TO THE SOUTH, ACROSS BRINK ROAD AND TO THE WEST, ACROSS RIDGE ROAD.
14. DOMINANT TREE SPECIES WITHIN THE FORESTED AREA INCLUDE WHITE PINE AND THE TREE-OF-HEAVEN.



VICINITY MAP
SCALE: 1"=2000'

MONTGOMERY COUNTY ADC MAP PERMITTED USE No. 21009264

MDE REFERENCE #: 16-SF-0105

LEGEND

- EXISTING PROPERTY LINE
- EXISTING BUILDING
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING ASPHALT PAVING
- EXISTING FENCELINE
- EXISTING METAL POLE
- EXISTING BOLLARD
- EXISTING ELECTRIC LINE
- EXISTING GAS LINE
- EXISTING STORMDRAIN LINE
- EXISTING STORMDRAIN MANHOLE
- EXISTING UTILITY POLE
- EXISTING WATER LINE
- EXISTING WATER STRUCTURE
- EXISTING WATER VALVE
- EXISTING WATER MANHOLE
- EXISTING FIRE HYDRANT
- EXISTING SOILS
- STEEP SLOPES (25% OR GREATER)
- EXISTING TREELINE
- EXISTING DECIDUOUS TREE
- EXISTING EVERGREEN TREE
- LIMIT OF DISTURBANCE
- LINEAR UTILITY INSTALLATION PER MDE REGULATIONS

SOILS

SYM.	SOIL SYSTEM	K VALUE (WHOLE SOIL)	HYDROLIC SOIL GROUP
16B	Brinklow–Blocktown channery silt loams, 3 to 8 percent slopes	0.43	C/D
16C	Brinklow–Blocktown channery silt loams, 8 to 15 percent slopes	0.43	C/D
17B	Occoquan loam, 3 to 8 percent slopes	0.37	B

FOREST STAND DELINEATION PLAN

SCALE: 1" = 50'

0 50 100
SCALE: 1" = 50'

CARROLL ENGINEERING, INC.
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031
phone: 410-785-7423
fax: 410-771-1313
www.ceiengineering.com

DESIGN:	CMF
DRAWN:	CMF
CHECKED:	CMS

PROFESSIONAL CERTIFICATION

DATE	REVISIONS

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

THESE DOCUMENTS CONTAIN PRIVILEGED AND CONFIDENTIAL INFORMATION WHICH SHALL NOT BE REDISTRIBUTED WITHOUT PRIOR WSSC APPROVAL

Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

FOREST STAND DELINEATION PLAN

FSD-01

NO

OF

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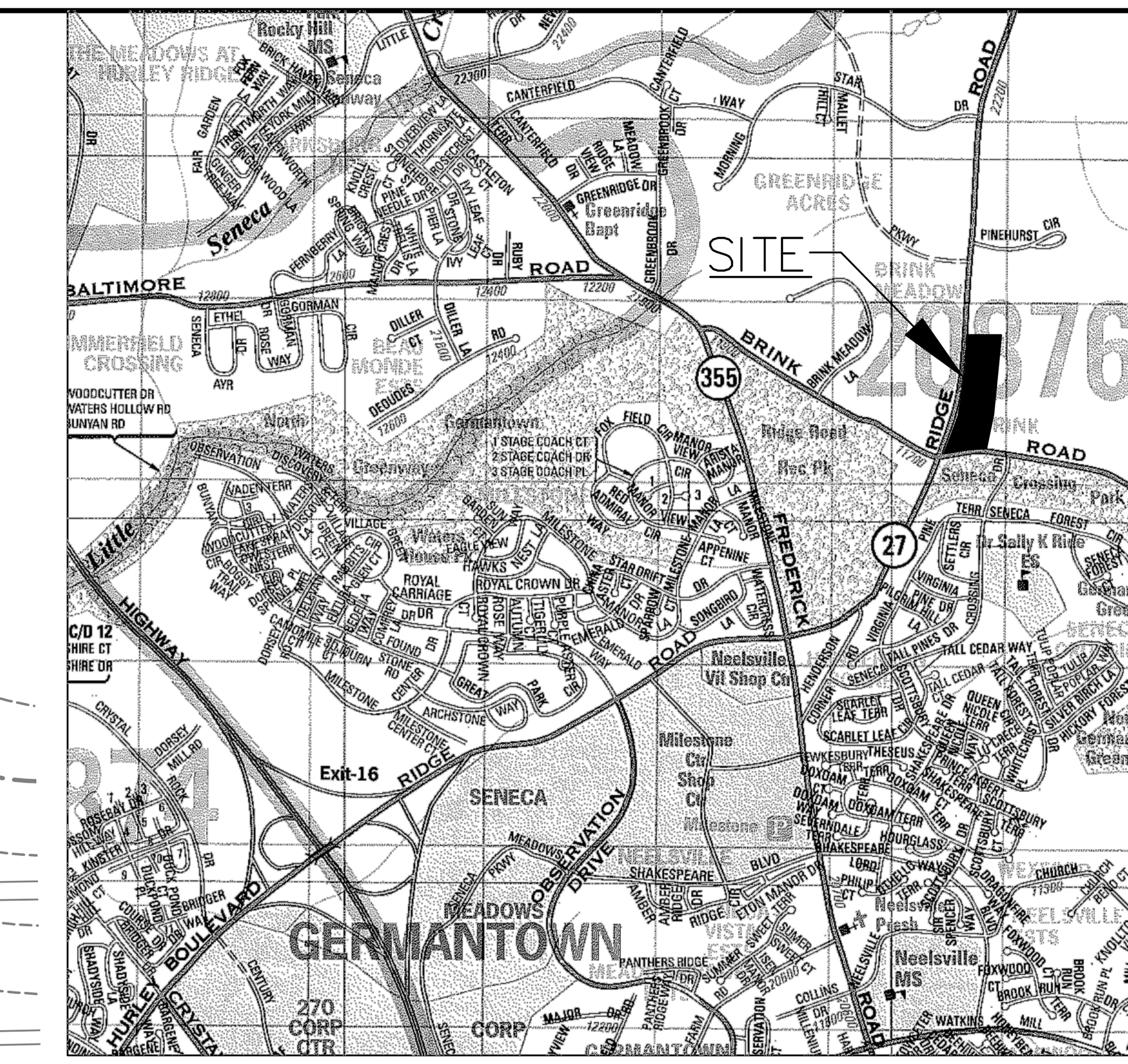

VICINITY MAP
SCALE: 1"=2000'

MONTGOMERY COUNTY ADC MAP
PERMITTED USE No. 21009264

MDE REFERENCE #: 16-SF-0105

LEGEND

EXISTING PROPERTY LINE	EXISTING WATER STRUCTURE
EXISTING BUILDING	EXISTING WATER VALVE
EXISTING MAJOR CONTOUR	EXISTING WATER MANHOLE
EXISTING MINOR CONTOUR	EXISTING FIRE HYDRANT
EXISTING ASPHALT PAVING	EXISTING SOILS
EXISTING FENCELINE	STEEP SLOPES (25% OR GREATER)
EXISTING METAL POLE	EXISTING TREELINE
EXISTING BOLLARD	EXISTING DECIDUOUS TREE
EXISTING ELECTRIC LINE	EXISTING EVERGREEN TREE
EXISTING GAS LINE	LIMIT OF DISTURBANCE
EXISTING STORMDRAIN LINE	LINEAR UTILITY INSTALLATION
EXISTING STORMDRAIN MANHOLE	
EXISTING UTILITY POLE	
EXISTING WATER LINE	

FOREST CONSERVATION EASEMENT

FOREST CONSERVATION PLAN

SCALE: 1" = 50'

SCALE: 1" = 50'

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Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

FOREST CONSERVATION PLAN

FCP-01

NO

OF

Forest Conservation Worksheet 2.2

Net Tract Area			
A.	Total Tract Area	A =	13.00
B.	Deductions	B =	0.00
C.	Net Tract Area	C =	13.00
Land Use Category			
	Input the number "1" under the appropriate land use zoning, and limit to only one entry		
	ARA 0, MDR 0, IDA 1, HDR 0, MPD 0, CIA 0		
D.	Afforestation Threshold (Net Tract Area x 15%)	D =	1.95
E.	Conservation Threshold (Net Tract Area x 20%)	E =	2.60
Existing Forest Cover			
F.	Existing Forest Cover within the Net Tract Area	F =	0.00
G.	Area of Forest Above Conservation Threshold	G =	0.00
Break Even Point			
H.	Break Even Point	H =	0.00
I.	Forest Clearing Permitted Without Mitigation	I =	0.00
Proposed Forest Clearing			
J.	Total Area of Forest to be Cleared	J =	0.00
K.	Total Area of Forest to be Retained	K =	0.00
Planting Requirements			
L.	Reforestation for Clearing Above the Conservation Threshold	L =	0.00
M.	Reforestation for Clearing Below the Conservation Threshold	M =	0.00
N.	Credit for Retention above the Conservation Threshold	N =	0.00
P.	Total Reforestation Required	P =	0.00
Q.	Total Afforestation Required	Q =	1.95
R.	Total Planting Requirement	R =	1.95

FOREST CONSERVATION AREA MANAGEMENT NOTES

REMOVAL OF HAZARDOUS TREES OR HAZARDOUS LIMBS BY DEVELOPERS OR BUILDERS

THE DEVELOPER AND/OR BUILDER IS RESPONSIBLE FOR THE COMPLETE PRESERVATION OF ALL FORESTED AREAS SHOWN ON THE APPROVED PLAN TO REMAIN UNDISTURBED. ONLY TREES OR PARTS THEREOF NOT SHOWN ON THIS PLAN AND DESIGNATED BY THE STATE OF MARYLAND AS DEAD, DYING OR HAZARDOUS MAY BE REMOVED. BRUSH / SCRUB VEGETATION AREA OUTSIDE THE EXISTING WOODED AREA TO BE CLEARED PRIOR TO REFORESTATION / AFFORESTATION PLANTINGS.

1. A TREE IS CONSIDERED HAZARDOUS IF A CONDITION IS PRESENT WHICH LEADS A LICENSED ARBORIST OR A LICENSED TREE EXPERT TO BELIEVE THAT THE TREE OR PORTION OF THE TREE HAD A POTENTIAL TO FALL AND STRIKE A STRUCTURE, PARKING AREA, OR OTHER HIGH USE AREA AND RESULT IN INJURY OR PROPERTY DAMAGE.
2. IF A HAZARDOUS CONDITION MAY BE ALLEVIATED BY CORRECTIVE PRUNING, THE LICENSED ARBORIST OR A LICENSED TREE EXPERT MAY PROCEED WITHOUT FURTHER AUTHORIZATION. THE PRUNING MUST BE DONE IN ACCORDANCE WITH THE LATEST EDITION OF THE ANSI A-300 PRUNING STANDARDS ("TREE, SHRUB AND OTHER WOODY PLANT MAINTENANCE – STANDARD PRACTICES").
3. CORRECTIVE MEASURES REQUIRING THE REMOVAL OF HAZARDOUS TREES OR PORTIONS THEREOF SHALL REQUIRE AUTHORIZATION BY THE BUILDING OR GRADING INSPECTOR IF THERE IS A VALID GRADING OR BUILDING PERMIT FOR THE SUBJECT LOTS OR PARCELS ON WHICH THE TREES ARE LOCATED. ONLY AFTER APPROVAL OF THE APPROPRIATE INSPECTOR MAY THE TREE BE CUT BY CHAINSAW TO NEAR THE EXISTING GROUND LEVEL. THE STUMP MAY NOT BE REMOVED OR COVERED WITH SOIL, MULCH OR OTHER MATERIALS THAT WOULD INHIBIT SPROUTING.
4. DEBRIS FROM THE TREE REMOVAL OR PRUNING THAT OCCURS WITHIN 35 FEET OF THE WOODLAND EDGE MAY BE REMOVED AND PROPERLY DISPOSED OF BY RECYCLING, CHIPPING OR OTHER ACCEPTABLE METHODS. ALL DEBRIS THAT IS MORE THAN 35 FEET FROM THE WOODLAND EDGE SHALL BE CUT-UP TO ALLOW CONTACT WITH THE GROUND THUS ENCOURAGING DECOMPOSITION. THE SMALLER MATERIALS SHALL BE PLACED INTO BRUSH PILES THAT WILL SERVE AS WILDLIFE HABITAT.

SITE STOCKING

THE MINIMUM STANDARDS FOR STOCKING ARE AS FOLLOWS:
- 200 CANOPY SPECIES PER ACRE WITH APPROXIMATE SPACING OF 15' X 15'
- 350 UNDERSTORY SPECIES PER ACRE WITH APPROXIMATE SPACING OF 12' X 12'

SURVIVABILITY REQUIREMENTS AFTER SECOND GROWING SEASON ARE:
- 85% FOR CANOPY SPECIES (170 PER ACRE)
- 75% FOR UNDERSTORY SPECIES (260 PER ACRE)

PLANTING SHALL BE DONE IN A MIXED AND RANDOM PATTERN USING METHODS SIMILAR TO THOSE SHOWN IN "RANDOM PLANTING LAYOUT" DETAIL

EXPLANATION OF PRIORITY

THE FOREST CONSERVATION REQUIREMENT WILL BE MET THROUGH ON-SITE REFORESTATION OF 1.95 ACRES.

LONG TERM PROTECTION

LONG TERM PROTECTION WILL BE PROVIDED FOR FOREST CONSERVATION AREAS. THIS WILL BE ACCOMPLISHED BY PROVIDING COVENANTS, DEED RESTRICTIONS OR CONSERVATION EASEMENTS ON THE RECORD PLAT. THE PLAT RESTRICTIONS ARE BINDING AND WILL BE RECORDED IN THE LAND RECORDS FOR THE PROPERTY

NO DUMPING OF TRASH OR OTHER MATERIALS WITHIN THE FOREST CONSERVATION AREA WILL BE PERMITTED.

PLANT SCHEDULE

Quantity	Scientific/Common Name	Size	Root	Comments/Spacing
Canopy (Shade) Trees				
70	Acer rubrum / Red Maple	7 Gal.	Cont.	15' offsets
70	Quercus palustris / Pin Oak	7 Gal.	Cont.	15' offsets
70	Robinia pseudoacacia / Black Locust	7 Gal.	Cont.	15' offsets
Understory (Ornamental) Trees				
85	Cercis canadensis / Eastern Redbud	3 Gal.	Cont.	12' offsets
85	Fagus grandifolia / American Beech	3 Gal.	Cont.	12' offsets
85	Ilex opaca / American Holly (1 male per 8 female)	3 Gal.	Cont.	12' offsets
85	Magnolia virginiana / Sweetbay Magnolia	3 Gal.	Cont.	12' offsets

AREA TO BE PLANTED (SEE FCP-01 FOR SPECIFIC LOCATION)

TWO-YEAR MAINTENANCE AND MONITORING AGREEMENT

FIRST YEAR

WATERING:
- REFORESTATION AREAS SHALL BE WATERED FROM MAY THROUGH SEPTEMBER, AT A RATE OF ONCE EVERY TWO WEEKS, AND AT A VOLUME OF 1" OF WATER WITHIN EACH INDIVIDUAL PLANTING FIELD.
- FROM OCTOBER THROUGH APRIL, REFORESTATION AREAS SHALL BE WATER ONLY DURING TIMES OF SEVERE DROUGHT.

FERTILIZING:
- REFORESTATION AREA SHALL NOT BE FERTILIZED DURING THE FIRST GROWING SEASON.

COMPETING VEGETATION:
- COMPETING VEGETATION SHALL BE CONTROLLED BY MANUAL OR MECHANICAL MEANS DURING THE FIRST GROWING SEASON.
- MULCH SHOULD BE PRESENTED AT A 2"-4" HEIGHT FROM INITIAL PLANTING.

PRUNING:
- ONLY DEAD AND DISEASED BRANCHES SHALL BE PRUNED DURING THE FIRST GROWING SEASON.

INSPECTIONS:
- AT THE BEGINNING OF EACH GROWING SEASON (BI-ANNUAL), LICENSED FORESTER OR LICENSED TREE EXPERT SHALL CONDUCT A HEALTH AND MORTALITY INSPECTION.
- AN INSPECTION REPORT ADDRESSING HEALTH ISSUES, RECOMMENDED TREATMENTS AND ALSO INCLUDING A MORTALITY AND REPLANTING TABLE SHALL BE PREPARED BY THE INSPECTOR AND SENT TO THE STATE WITHIN 30 DAYS OF EACH INSPECTION.
- THE SECOND INSPECTION SHALL INCLUDE FERTILIZATION SPECIFICATIONS FOR THE FOLLOWING YEAR.

REPLANTING:
- REPLANTING SPECIFICATIONS REQUIRE RESTOCKING IF MORALITY FALLS BELOW THE SURVIVABILITY RATE OF THE ORIGINAL PLANTED STOCK.

SECOND YEAR

WATERING:
- REFORESTATION AREAS SHALL BE WATERED FROM MAY THROUGH SEPTEMBER, AT A RATE OF ONCE EVERY TWO WEEKS, AND AT A VOLUME OF 1" OF WATER WITHIN EACH INDIVIDUAL PLANTING FIELD.
- FROM OCTOBER THROUGH APRIL, REFORESTATION AREAS SHALL BE WATER ONLY DURING TIMES OF SEVERE DROUGHT.

FERTILIZING:
- THE ENTIRE PLANTING FIELD SHALL BE FERTILIZED AT A RATE SPECIFIED BY THE INSPECTION REPORT.

COMPETING VEGETATION:
- COMPETING VEGETATION SHALL BE CONTROLLED BY MANUAL OR MECHANICAL MEANS DURING THE SECOND GROWING SEASON.

MULCH:
- EXISTING MULCH SHALL BE RACKED TO REMOVE MATTING.
- ADDITIONAL MULCH TO A 2"-4" HEIGHT SHALL BE ADDED AS NECESSARY.

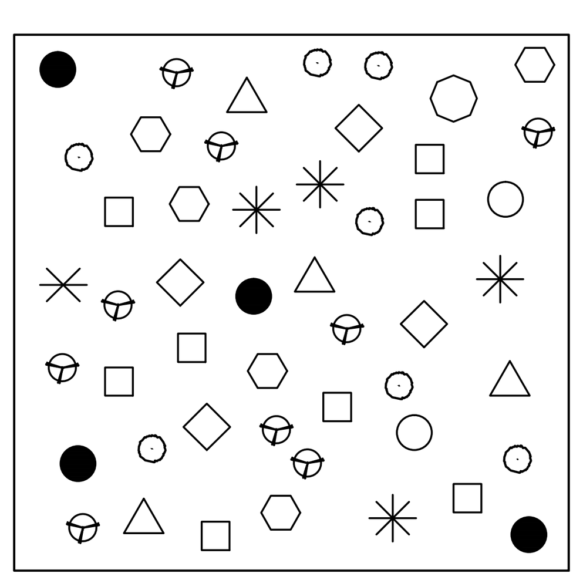
PRUNING:
- DEAD AND DISEASED BRANCHES SHALL BE PRUNED.

INSPECTIONS:
- AT THE BEGINNING OF EACH GROWING SEASON (BI-ANNUAL), LICENSED FORESTER OR LICENSED TREE EXPERT SHALL CONDUCT A HEALTH AND MORTALITY INSPECTION.
- AN INSPECTION REPORT ADDRESSING HEALTH ISSUES, RECOMMENDED TREATMENTS AND ALSO INCLUDING A MORTALITY AND REPLANTING TABLE SHALL BE PREPARED BY THE INSPECTOR AND SENT TO THE STATE WITHIN 30 DAYS OF EACH INSPECTION.

REPLANTING:
- BASED UPON THE FINAL MORTALITY REPORT, ANY RESTOCKING OF THE REFORESTED / AFFORESTATION AREA SHALL BY CONDUCTED FOLLOWING THE SECOND GROWING SEASON.
- REPLANTING SPECIFICATIONS REQUIRE RESTOCKING IF MORALITY FALLS BELOW THE SURVIVABILITY RATE OF THE ORIGINAL PLANTED STOCK.

SEQUENTIAL TIMETABLE

1. FIELD LOCATION OF CONSERVATION BOUNDARY AS SHOWN ON FCP.
2. FIELD LOCATION OF PROPOSED L.O.D. AND CONSERVATION OF FCP PER ANY DISAGREEMENT BETWEEN THE CONSERVATION BOUNDARY AND THE L.O.D.
3. FIELD ADJUSTMENT FOREST CONSERVATION AREA AND STAKE AND FLAG THE EDGES OF THE FOREST CONSERVATION AREA.
4. OBTAINMENT OF FINAL FCP APPROVAL FROM THE STATE.
5. SEDIMENT CONTROL AND TREE PROTECTION DEVICES SHALL BE INSTALLED IN ACCORDANCE WITH THE GENERAL CONSTRUCTION PLANS, EROSION AND SEDIMENT CONTROL PLANS AND THE FOREST CONSERVATION PLAN. SEE SITE, ESC, AND FCP PLANS.
6. NOTIFICATION TO STATE FOR INSPECTION OF INSTALLED DEVICES.
7. CONSTRUCTION BEGINS.
8. CONSTRUCTION ENDS.
9. NOTIFICATION TO STATE OF COMPLETION OF CONSTRUCTION FOR INSPECTION.



1. PLANT MATERIAL TO BE PLACED IN RANDOM DISTRIBUTION PATTERN, TAKING CARE NOT TO PLANT MORE THAN 3 OF THE SAME SPECIES OR SIZE IN SUCCESSION.
2. SEE PLANT SCHEDULE FOR PLANT SPECIES, SIZES AND QUANTITIES.
3. THIS DETAIL PROVIDES A HYPOTHETICAL GRAPHIC DEPICTION OF A PROPOSED LAYOUT FOR APPROX. 10 TREE SPECIES. IT IS NOT MEANT TO BE FOLLOWED EXACTLY. THE PURPOSE IS TO ACHIEVE THE APPEARANCE OF RANDOM SPACING.

RANDOM PLANTING LAYOUT

NOT TO SCALE

PLANTING SPECIFICATIONS

- NO SOIL AMENDMENTS SHALL BE USED. BACKFILL WITH NATIVE SOIL
- ONLY PLANTING FIELDS 3-5 TIMES THE DIAMETER OF THE ROOT BALL SHALL BE DISTURBED.
- MANUAL PLANTING METHODS SHALL BE EMPLOYED FOR ALL SPECIES (SEE CONTAINER GROWN AND B&B PLANTING TECHNIQUES DETAIL)
- CONTAINERIZED TREES SHALL BE CHECKED FOR WRAPPED OR KINKED ROOTS, AND SHALL BE REPLACED IF PRESENT.
- AN AREA 2" THICK AND COVERING THE ENTIRE PLANTING FIELD SHALL BE MULCHED.
- PLANTING SEASON SCHEDULE SHALL BE IN ACCORDANCE WITH THE "AMERICAN STANDARDS FOR NURSERY STOCK" AS PREPARED BY THE AMERICAN ASSOCIATION OF NURSERYMEN.
- PLANTING SHOULD OCCUR WITHIN 24 HOURS OF DELIVERY OF PLANT MATERIAL TO SITE. PLANT MATERIAL LEFT UNPLANTED FOR MORE THAN 24 HOURS SHOULD BE PROTECTED FROM DIRECT SUN AND WEATHER AND KEPT MOIST UNTIL PLANTED.
- FULLY BIODEGRADABLE TREE SHELTERS (TUBES) AND ASSOCIATED WOODEN STAKES SHALL BE INSTALLED AFTER EACH TREE IS PLANTED AND SHALL REMAIN IN PLACE FOR A MINIMUM OF TWO YEARS. IF A TREE SHELTER IS DAMAGED OR REMOVED DURING THE MAINTENANCE PERIOD, A REPLACEMENT TREE TUBE SHALL BE PROVIDED. ALL TREE TUBES SHALL BE REMOVED AT THE END OF THE TWO-YEAR MAINTENANCE PERIOD.

PROTECTION OF REFORESTATION & AFFORESTATION AREAS BY DEVELOPERS OR BUILDERS

IF PLANTING CANNOT OCCUR DUE TO PLANTING CONDITIONS, THE DEVELOPER OR PROPERTY OWNER SHALL INSTALL FENCING AND/OR SIGNAGE IN ACCORDANCE WITH THE APPROVED FOREST CONSERVATION PLAN. PLANTING SHALL THEN BE ACCOMPLISHED DURING THE NEXT PLANTING SEASON.

FOREST CONSERVATION CONSTRUCTION AND REFORESTATION FENCING AND SIGNAGE SHALL REMAIN IN PLACE IN ACCORDANCE WITH THE FOREST CONSERVATION PLAN OR UNTIL THE TREES HAVE GROWN SUFFICIENTLY TO HAVE CROWN CLOSURE.

REFORESTATION AREAS SHALL NOT BE MOWED, HOWEVER THE MANAGEMENT OF COMPETING VEGETATION AROUND INDIVIDUAL TREES IS ACCEPTABLE.

POST-CONSTRUCTION MEASURES

POST CONSTRUCTION PHASE:

THE FOLLOWING MEASURES SHALL BE TAKEN:

1. CORRECTIVE MEASURES IF DAMAGES OCCURRED DUE TO NEGLIGENCE:
   A. STRESS REDUCTION
   B. REMOVAL OF DEAD OR DYING TREES. THIS MAY BE DONE ONLY IF TREES POSE AN IMMEDIATE SAFETY HAZARD.
2. REMOVAL OF TEMPORARY STRUCTURES:
   A. NO BURIAL OF DISCARDED MATERIALS WILL OCCUR ON-SITE WITHIN THE CONSERVATION AREA.
   B. NO OPEN BURNING WITHIN 100 FEET OF A WOODED AREA
   C. ALL TEMPORARY FOREST PROTECTION STRUCTURES WILL BE REMOVED UPON FINAL INSPECTION APPROVAL.

MDE REFERENCE #: 16-SF-0105

DATE	REVISIONS

PROFESSIONAL CERTIFICATION

CARROLL ENGINEERING, INC.
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031
phone: 410-785-7423
fax: 410-771-1313
www.ceiengineering.com

DESIGN:	CMF
DRAWN:	CMF
CHECKED:	CMS

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

Hatch Mott MacDonald

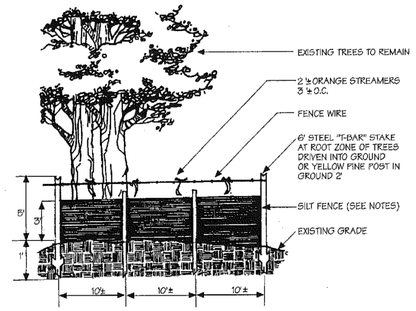
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

FOREST CONSERVATION NOTES AND DETAILS

FCP-02

NO

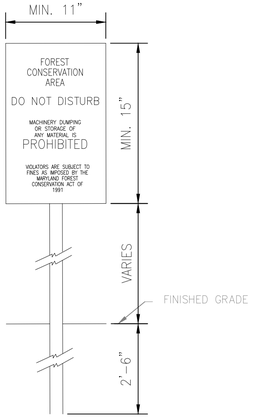
OF



NOTES:
1. SILT FENCE TO BE INSTALLED PER APPROVED MDE DETAIL.
2. THE BOUNDARIES OF THE LIMITS OF DISTURBANCE SHOULD BE STAKED AND FLAGGED PRIOR TO ERECTING THE PROTECTIVE DEVICE.
3. SEE SHEET ESC-01 FOR LOCATION FOR TREE PROTECTION FENCE.
4. ANCHOR POSTS SHOULD BE PLACED TO AVOID ROOT DAMAGE PROTECTIVE SIGNAGE MAY ALSO BE USED.
5. DEVICE SHOULD BE MAINTAINED THROUGHOUT CONSTRUCTION.
6. LOCATE FENCE OUTSIDE CRITICAL ROOT ZONE WHERE POSSIBLE.

SILT FENCE AND TREE PROTECTION FENCE DETAIL

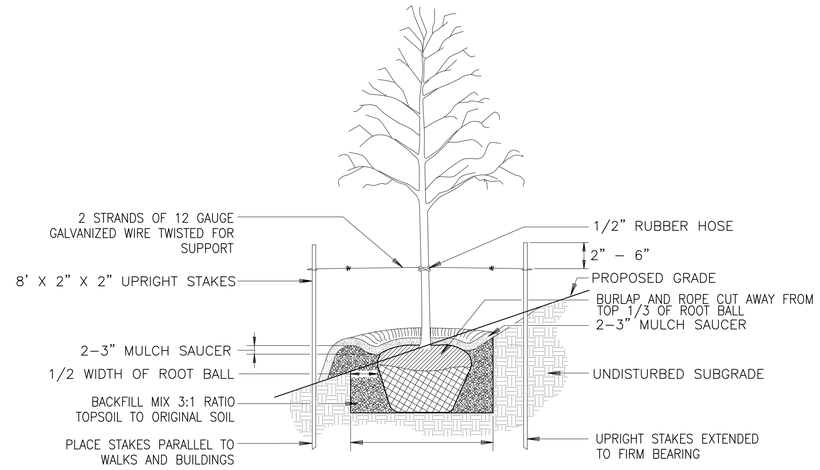
NOT TO SCALE



NOTES:
1. BOTTOM OF SIGNS TO BE HIGHER THAN TOP OF TREE PROTECTION FENCE.
2. SIGNS TO BE PLACED APPROXIMATELY 50 FEET APART AND AT EVERY CORNER OF THE EASEMENT AREA.
3. CONDITIONS ON SITE AFFECTING VISIBILITY MAY WARRANT PLACING SIGNS CLOSER OR FARTHER APART.
4. ATTACHMENT OF SIGNS TO TREES IS PROHIBITED.

FOREST CONSERVATION AREA CONSTRUCTION SIGN

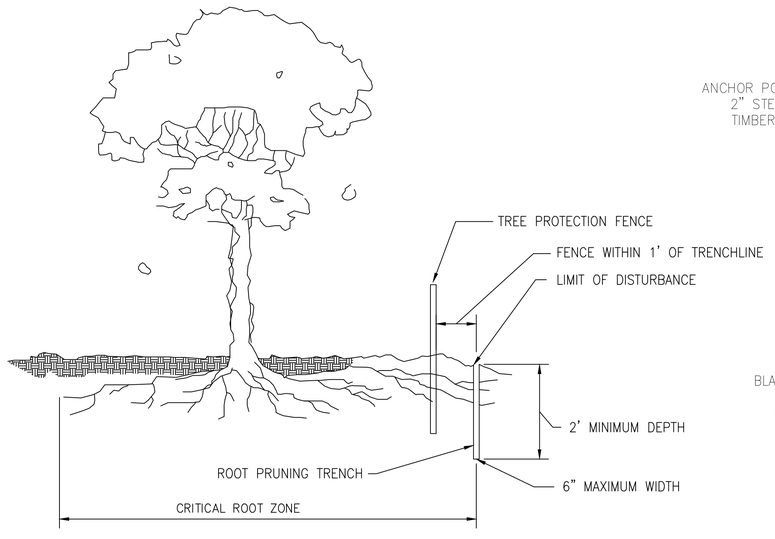
NOT TO SCALE



SLOPE TREE PLANTING DETAIL

B & B / CONT.

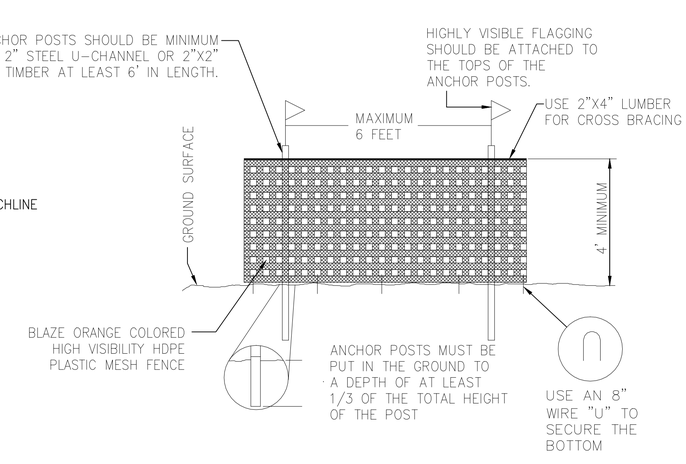
NOT TO SCALE



NOTES:
1. RETENTION AREAS TO BE ESTABLISHED AS PART OF THE FOREST CONSERVATION PLAN REVIEW PROCESS.
2. BOUNDARIES OF RETENTION AREAS TO BE STAKED, FLAGGED AND/OR FENCED PRIOR TO TRENCHING.
3. EXACT LOCATION OF TRENCH SHOULD BE IDENTIFIED.
4. TRENCH SHOULD BE IMMEDIATELY BACKFILLED WITH SOIL REMOVED OR OTHER HIGH ORGANIC SOIL.
5. ROOTS SHOULD BE CLEANLY CUT USING VIBRATORY KNIFE OR OTHER ACCEPTABLE EQUIPMENT.

ROOT PRUNING DETAIL

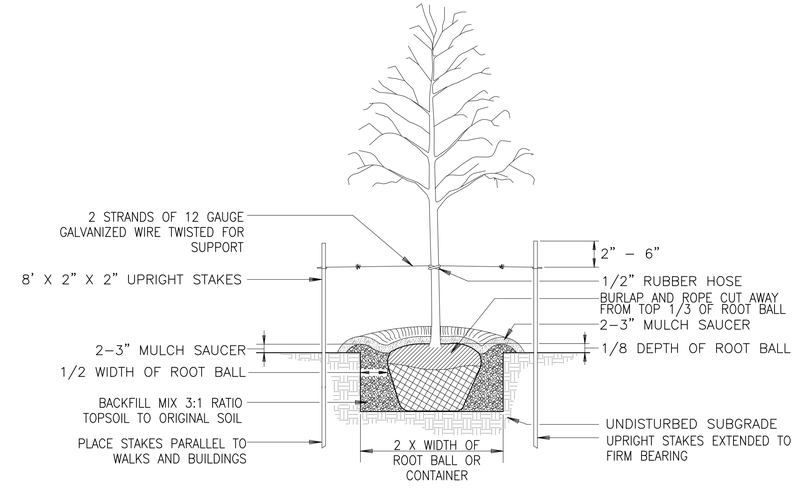
NOT TO SCALE



NOTES:
1. FOREST PROTECTION DEVICE ONLY.
2. THE BOUNDARIES OF THE LIMITS OF DISTURBANCE SHOULD BE STAKED AND FLAGGED PRIOR TO ERECTING THE PROTECTIVE DEVICE.
3. SEE SHEET ESC-01 FOR LOCATION FOR TREE PROTECTION FENCE.
4. ANCHOR POSTS SHOULD BE PLACED TO AVOID ROOT DAMAGE. PROTECTIVE SIGNAGE MAY ALSO BE USED.
5. FENCING MATERIAL SHOULD BE FASTENED SECURELY TO THE ANCHOR POSTS, CROSS BRACING, AND GROUND.
6. DEVICE SHOULD BE MAINTAINED THROUGHOUT CONSTRUCTION.

TREE PROTECTION FENCE: MESH FENCE DETAIL

NOT TO SCALE



DECIDUOUS TREE PLANTING DETAIL

B & B / CONT.

NOT TO SCALE

MDE REFERENCE #: 16-SF-0105

DATE	REVISIONS

CARROLL ENGINEERING, INC.
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PROFESSIONAL CERTIFICATION

DESIGN:	CMF	
DRAWN:	CMF	
CHECKED:	CMS	

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

FOREST CONSERVATION NOTES AND DETAILS

FCP-03

NO OF

Attachment 3 – Stormwater Management and Erosion & Sediment Control Concept Plan Submittal

MARYLAND DEPARTMENT OF THE ENVIRONMENT
Water Management Administration • Sediment and Stormwater Plan Review Division
1800 Washington Boulevard • Baltimore, MD 21230
(410) 537-3543 • 1-800-633-6101 • http://www.mde.state.md.us

STORMWATER MANAGEMENT WAIVER APPLICATION

OWNER: Washington Sanitary Suburban Commission MDE NO.: MDE Permit No.: 16-SF-0105

ADDRESS: 21701 Ridge Road, Gaithersburg, MD 20876 PROJECT NO.:

LOCATION/POI: Within the Seneca Creek Watershed. POI located to the southeast of the site, within the adjoining property to the east of the subject property.

CONSULTANT: Carroll Engineering, Inc. (215 Schilling Circle, Suite 102, Hunt Valley, MD 21031)

DESCRIPTION: 718 l.f. of linear utility installation not included in the drainage area study within the project's SWM study.

I/We, the Owner/Owners hereby request a stormwater management waiver be granted for the above referenced project in accordance with the following Section of the Stormwater Management Guidelines for State and Federal Projects:

X	3.3.A.	Contract plans and provisions, stormwater management report.
____	3.3.B.1.a.	Contract plans and provisions, stormwater management report.
____	3.3.B.1.b.	Contract plans and provisions, stormwater management report.*
____	3.3.B.1.c.	Contract plans and provisions, stormwater management report.*
____	3.3.B.2.a.	Contract plans and provisions, stormwater management report.
____	3.3.B.2.b.	Contract plans and provisions, stormwater management report.*
____	3.3.B.2.c.	Contract plans and provisions, stormwater management report.*
____	3.3.B.3.a.	Contract plans and provisions, stormwater management report.*
____	3.3.B.3.b.	Contract plans and provisions, stormwater management report.*
____	3.3.B.4.	Contract plans and provisions, stormwater management report.*

*Evidence of stable outfall with adequate capacity (e.g., video, photos, statement): _____

Other evidence submitted: SWM-2 (IART Exhibit), SWM-3 (ESD & BMP Exhibit) and SWM Study

ABIOLA AKIN-AJAYI _____ 9-26-16

Name of Owner or authorized representative — Signature — Date

____ Approved ____ Denied/Reason _____

By _____ _____

Sediment and Stormwater Plan Review Engineer — Date

Submit to:
Maryland Department of the Environment
Water Management Administration
Sediment and Stormwater Plan Review Division
1800 Washington Boulevard
Baltimore, MD 21230

If a project involves a waiver request for more than one (1) drainage area, a Stormwater Management Waiver Application is required for each point of investigation (POI).

MDE/WMA/PER.058

MARYLAND DEPARTMENT OF THE ENVIRONMENT
Water Management Administration ● Sediment and Stormwater Plan Review Division
1800 Washington Boulevard ● Baltimore, MD 21230
(410) 537-3543 ● 1-800-633-6101 ● http://www.mde.state.md.us

STORMWATER MANAGEMENT WAIVER APPLICATION

OWNER: Washington Sanitary Suburban Commission MDE NO.: MDE Permit No.: 16-SF-0105

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____ 3.3.B.1.a. Contract plans and provisions, stormwater management report.

____ 3.3.B.1.b. Contract plans and provisions, stormwater management report.*

____ 3.3.B.1.c. Contract plans and provisions, stormwater management report.*

____ 3.3.B.2.a. Contract plans and provisions, stormwater management report.

____ 3.3.B.2.b. Contract plans and provisions, stormwater management report.*

____ 3.3.B.2.c. Contract plans and provisions, stormwater management report.*

____ 3.3.B.3.a. Contract plans and provisions, stormwater management report.*

____ 3.3.B.3.b. Contract plans and provisions, stormwater management report.*

____ 3.3.B.4. Contract plans and provisions, stormwater management report.*

*Evidence of stable outfall with adequate capacity (e.g., video, photos, statement): _____

Other evidence submitted: SWM-2 (IART Exhibit), SWM-3 (ESD & BMP Exhibit) and SWM Study

FORTHCOMING

Name of Owner or authorized representative	Signature	Date

____ Approved ____ Denied/Reason _____

By _____ _____
Sediment and Stormwater Plan Review Engineer Date

Submit to:
Maryland Department of the Environment
Water Management Administration
Sediment and Stormwater Plan Review Division
1800 Washington Boulevard
Baltimore, MD 21230

If a project involves a waiver request for more than one (1) drainage area, a Stormwater Management Waiver Application is required for each point of investigation (POI).

MDE/WMA/PER.O58

Brink Zone Reliability Improvements Project

CONCEPTUAL STORMWATER MANAGEMENT REPORT

MDE Permit No.: 16-SF-0105

Prepared by:

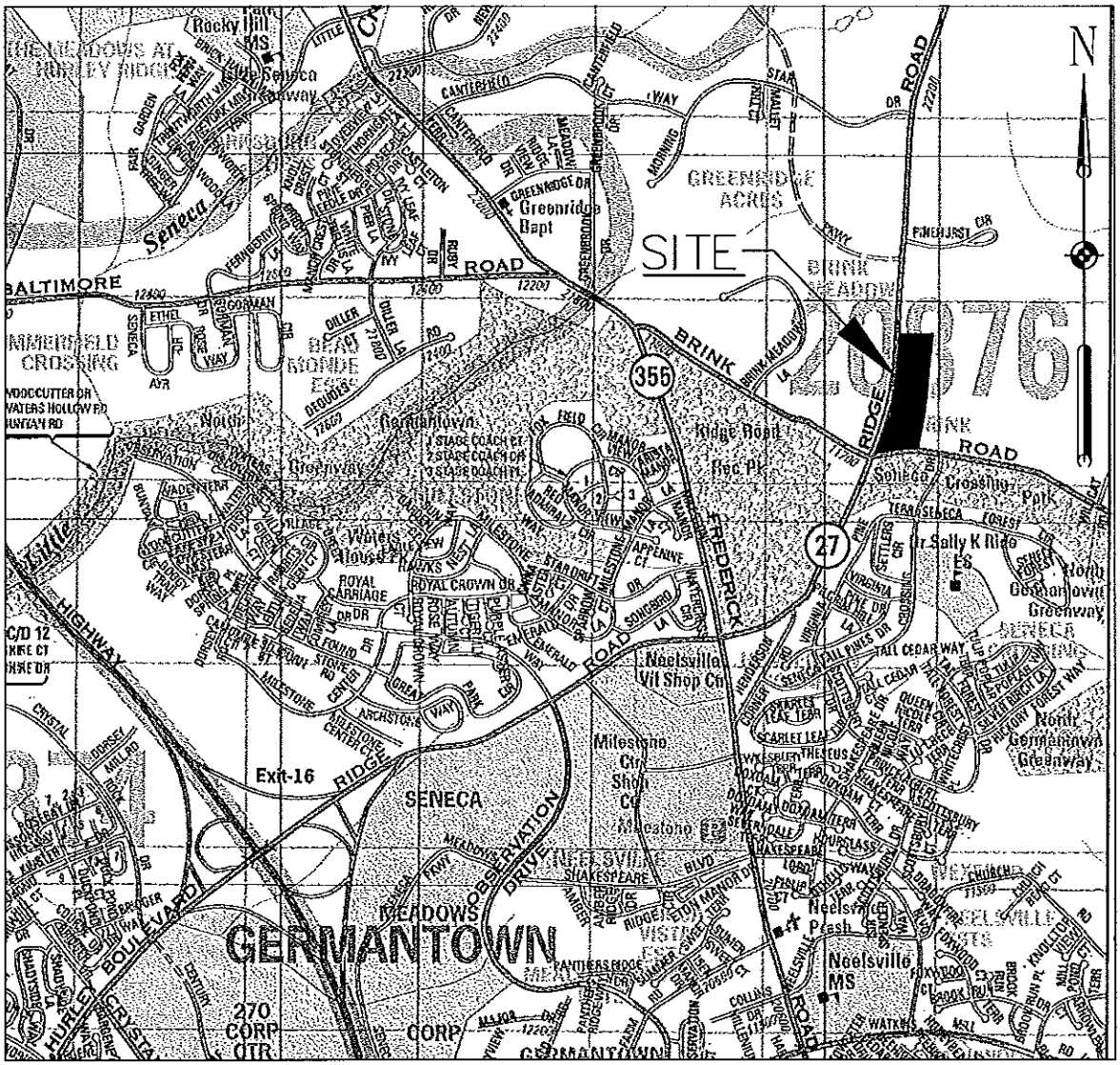
Carroll Engineering, Inc.
215 Schilling Circle
Suite 102
Hunt Valley, Maryland 21031
(410) 785-7423

WSSC Contract No: BP5692A14
CEI Project No.: 1501.08

September 2016

"Professional Certification" I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland Maryland, License No. 14446 Expiration Date: 05-25-2017"

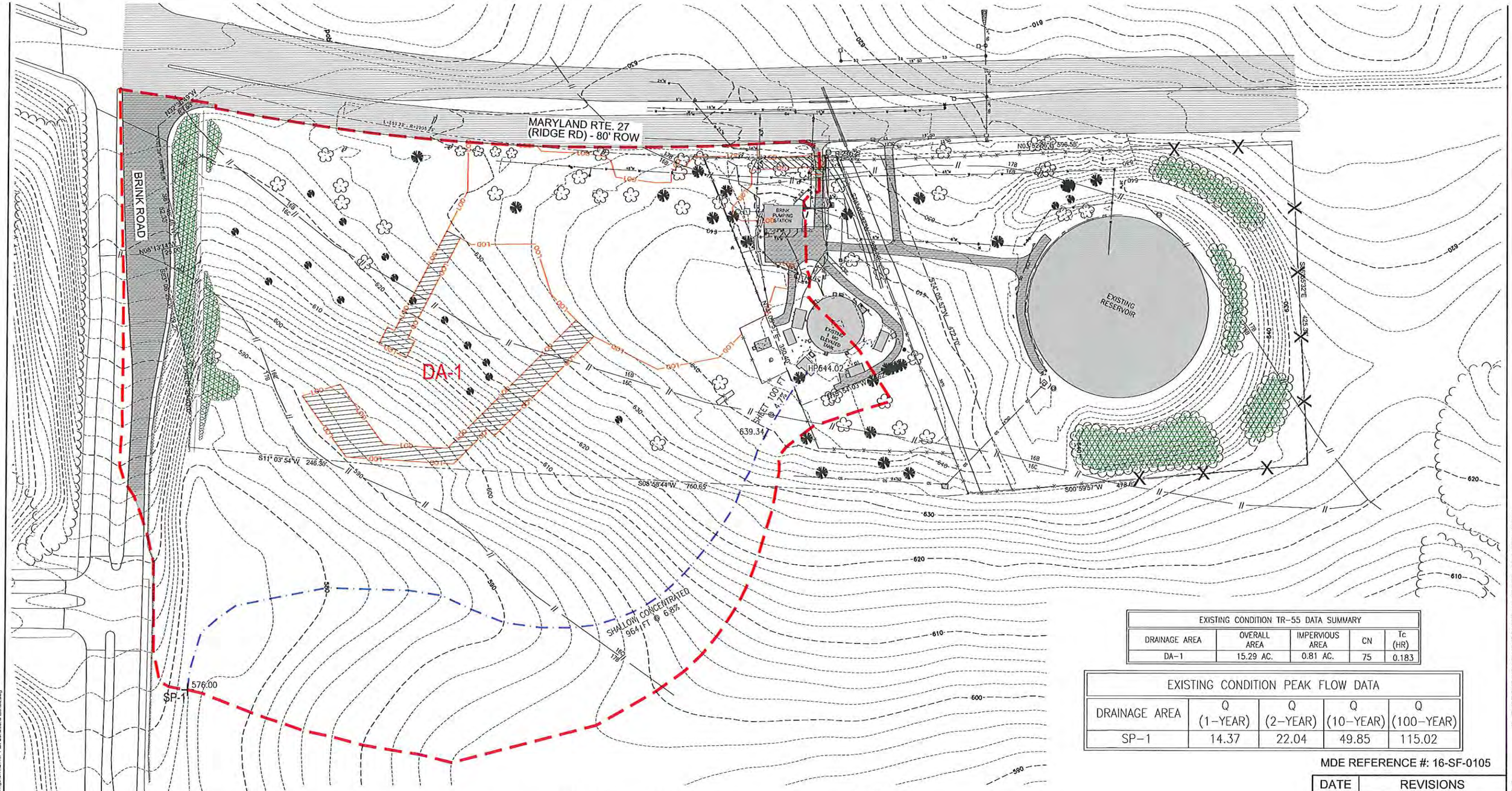
Table of Contents



VICINITY MAP

SCALE: 1"=2000'

MONTGOMERY COUNTY ADC MAP
PERMITTED USE No. 21009264



SOIL TYPES		
SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
17B	OCCOQUAN LOAM	B

STORMWATER MANAGEMENT - EXISTING CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH
- LOD — LIMIT OF DISTURBANCE (LOD)
- LINEAR LIMIT OF DISTURBANCE
- --640-- INDEX CONTOURS
- INTERMEDIATE CONTOURS

EXISTING CONDITION TR-55 DATA SUMMARY				
DRAINAGE AREA	OVERALL AREA	IMPERVIOUS AREA	CN	Tc (HR)
DA-1	15.29 AC.	0.81 AC.	75	0.183

EXISTING CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1-YEAR)	Q (2-YEAR)	Q (10-YEAR)	Q (100-YEAR)
SP-1	14.37	22.04	49.85	115.02

MDE REFERENCE #: 16-SF-0105

CARROLL ENGINEERING INC
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031
phone 410-785-7403
fax 410-771-1313
www.carolleng.com

DESIGN:	CMF
DRAWN:	CMF
CHECKED:	CMS

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.: 14446
EXPIRATION DATE: 05/25/2017

DATE	REVISIONS

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

Hatch Mott MacDonald

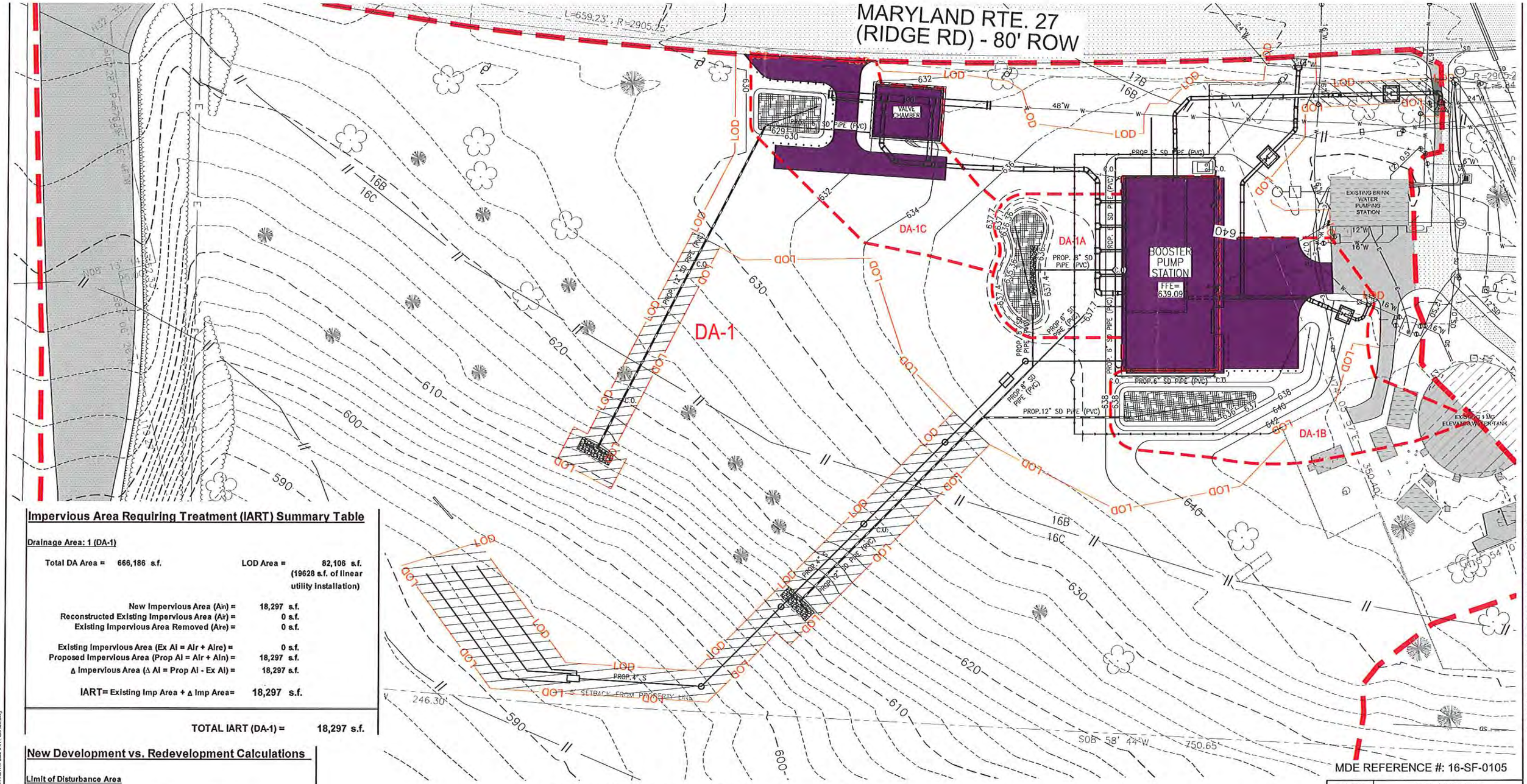
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT EXISTING CONDITIONS EXHIBIT

SWM-1

NO 1
OF 4

TM: P:\2015\15011\06.00 WSSC Brink Zone Reliability Improvements\Drawings\Civil\SWM-1-Ex Conditions Exhibit.dwg



MDE REFERENCE #: 16-SF-0105

Impervious Area Requiring Treatment (IART) Summary Table

Drainage Area: 1 (DA-1)

Total DA Area =	666,186 s.f.	LOD Area =	82,106 s.f. (19628 s.f. of linear utility installation)
New Impervious Area (Ain) =	18,297 s.f.		
Reconstructed Existing Impervious Area (Air) =	0 s.f.		
Existing Impervious Area Removed (Aire) =	0 s.f.		
Existing Impervious Area (Ex AI = Air + Aire) =	0 s.f.		
Proposed Impervious Area (Prop AI = Air + Ain) =	18,297 s.f.		
Δ Impervious Area (Δ AI = Prop AI - Ex AI) =	18,297 s.f.		
IART= Existing Imp Area + Δ Imp Area=	18,297 s.f.		

TOTAL IART (DA-1) = 18,297 s.f.

New Development vs. Redevelopment Calculations

Limit of Disturbance Area

Total LOD Area = 82,106 s.f.

Existing Impervious Area In LOD = 0
Existing Percent Impervious = 0 %

Existing % Impervious < 40% - New Development Condition

0 30 60
SCALE: 1" = 30'

SOIL TYPES		
SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
17B	OCCOQUAN LOAM	B

STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

LEGEND

- EXISTING UNDISTURBED IMPERVIOUS AREA
- RECONSTRUCTED IMPERVIOUS AREA
- NEW IMPERVIOUS AREA
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB-DRAINAGE AREA DELINEATION

100% DESIGN

Kimball Engineering, Inc.
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031
phone: 410-785-7433
fax: 410-771-1313
www.kimballengineering.com

DESIGN:	CMF	
DRAWN:	CMF	
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PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.: 14446
EXPIRATION DATE: 05/25/2017

DATE	REVISIONS

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

Hatch Mott MacDonald

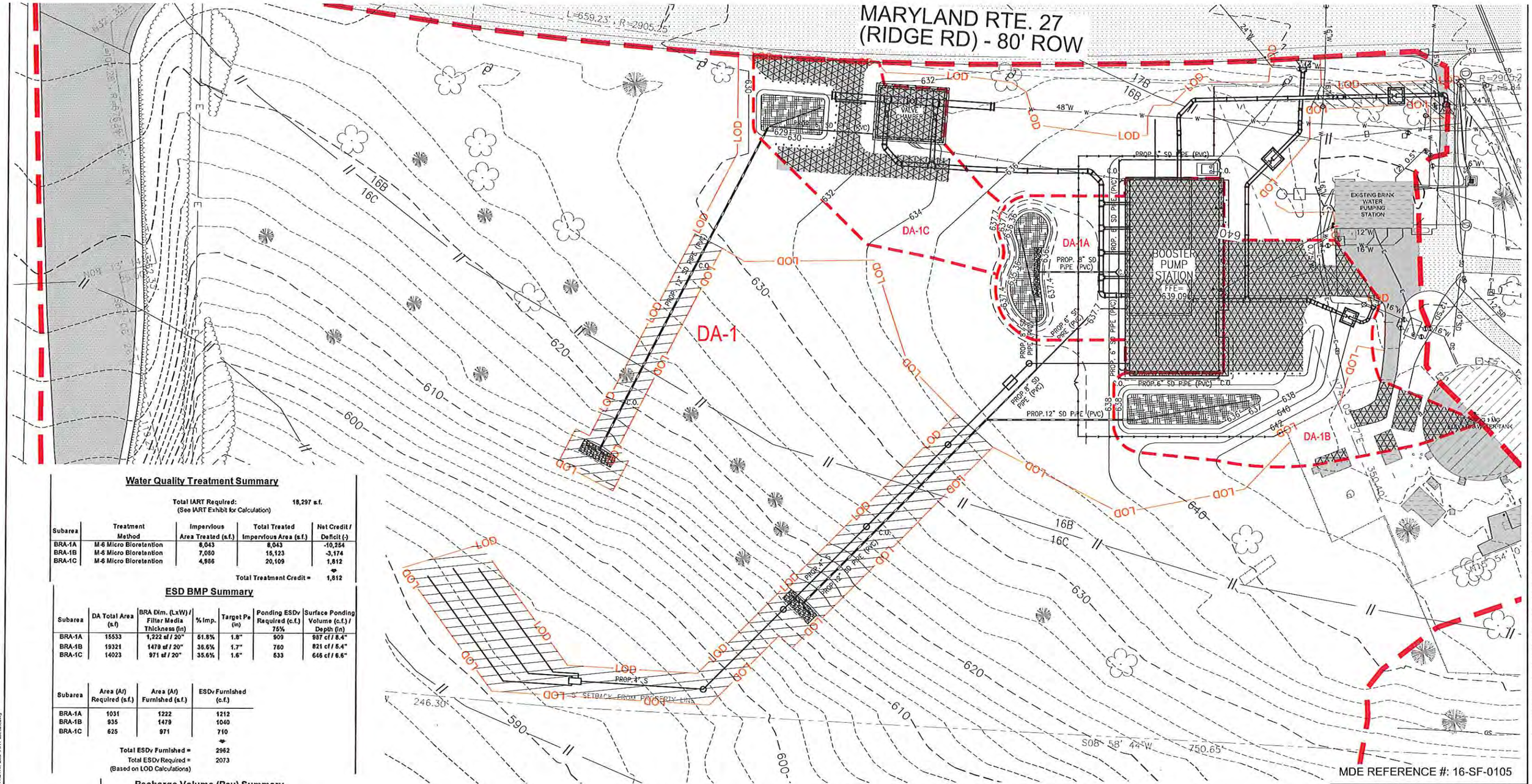
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT IART EXHIBIT

SWM-2

NO 2
OF 4

TM: P:\2015\01\01.08.00 WSSC Brink Zone Reliability Improvements\Drawings\Civil\SWM-2&3-IART Exhibit.dwg



Water Quality Treatment Summary

Total IART Required: 18,297 s.f.
(See IART Exhibit for Calculation)

Subarea	Treatment Method	Impervious Area Treated (s.f.)	Total Treated Impervious Area (s.f.)	Net Credit / Deficit (-)
BRA-1A	M-6 Micro Bioretention	8,043	8,043	-10,254
BRA-1B	M-6 Micro Bioretention	7,080	15,123	-3,174
BRA-1C	M-6 Micro Bioretention	4,986	20,109	1,812
			Total Treatment Credit =	1,812

ESD BMP Summary

Subarea	DA Total Area (s.f)	BRA Dim. (LxW) / Filter Media Thickness (in)	% Imp.	Target Pe (in)	Ponding ESDv Required (c.f.) 75%	Surface Ponding Volume (c.f.) / Depth (in)
BRA-1A	15533	1,222 sf / 20"	51.8%	1.8"	909	987 cf / 8.4"
BRA-1B	19321	1479 sf / 20"	36.6%	1.7"	760	821 cf / 8.4"
BRA-1C	14023	971 sf / 20"	35.6%	1.6"	633	646 cf / 8.6"

Subarea	Area (Af) Required (s.f.)	Area (Af) Furnished (s.f.)	ESDv Furnished (c.f.)
BRA-1A	1031	1222	1212
BRA-1B	935	1479	1040
BRA-1C	625	971	710
		Total ESDv Furnished =	2962
		Total ESDv Required =	2073
		(Based on LOD Calculations)	

Recharge Volume (Rev) Summary

Subarea	Treatment Method	Rev Furnished (c.f.)
BRA-1A	M-6 Micro Bioretention	489
BRA-1B	M-6 Micro Bioretention	592
BRA-1C	M-6 Micro Bioretention	388
	Total Rev Furnished =	1081
	Total Rev Required =	226
	(Based on LOD Calculations)	

0 30 60
SCALE: 1" = 30'

SOIL TYPES		
SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
17B	OCCOQUAN LOAM	B

STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

LEGEND

- IMPERVIOUS AREA
- TREATED IMPERVIOUS AREA
- PROPOSED MICRO-BIORETENTION AREA
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB-DRAINAGE AREA DELINEATION

MDE REFERENCE #: 16-SF-0105

100% DESIGN

CARROLL ENGINEERING, INC.
215 Schilling Circle, Suite 100
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PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.: 14446
EXPIRATION DATE: 05/25/2017

DESIGN:	CMF
DRAWN:	CMF
CHECKED:	CMS

DATE	REVISIONS

CONTRACT: BP5692A14

WASHINGTON SUBURBAN SANITARY COMMISSION

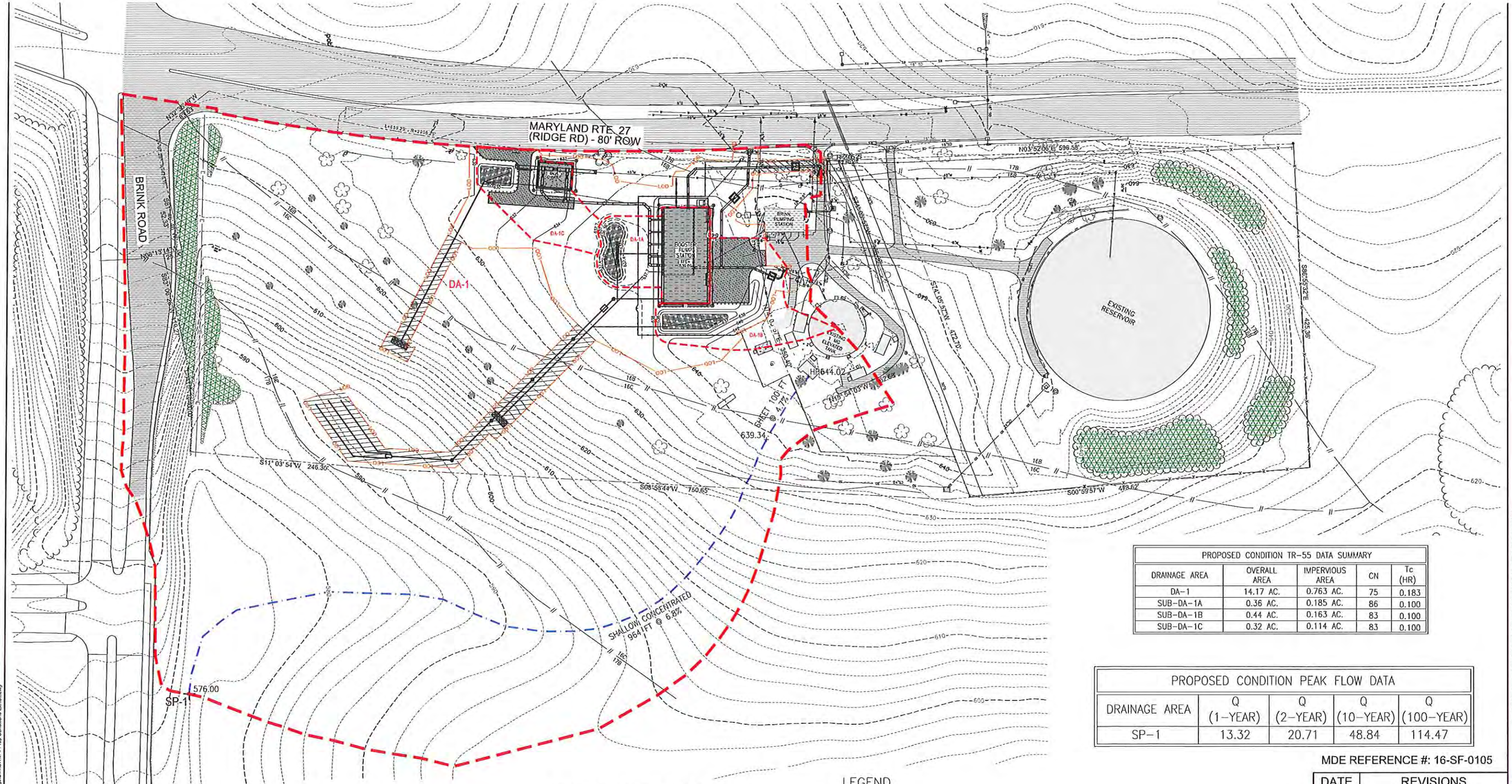
Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT ESD-BMP EXHIBIT

SWM-3

NO 3
OF 4



PROPOSED CONDITION TR-55 DATA SUMMARY				
DRAINAGE AREA	OVERALL AREA	IMPERVIOUS AREA	CN	Tc (HR)
DA-1	14.17 AC.	0.763 AC.	75	0.183
SUB-DA-1A	0.36 AC.	0.185 AC.	86	0.100
SUB-DA-1B	0.44 AC.	0.163 AC.	83	0.100
SUB-DA-1C	0.32 AC.	0.114 AC.	83	0.100

PROPOSED CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1-YEAR)	Q (2-YEAR)	Q (10-YEAR)	Q (100-YEAR)
SP-1	13.32	20.71	48.84	114.47

MDE REFERENCE #: 16-SF-0105

SOIL TYPES		
SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW-BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW-BLOCKTOWN CHANNERY SILT LOAM	C
17B	OCCOQUAN LOAM	B

STORMWATER MANAGEMENT - PROPOSED CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- PROPOSED CONDITIONS IMPERVIOUS AREA
- PROPOSED STORM DRAIN LINE
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB-DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH

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WASHINGTON SUBURBAN SANITARY COMMISSION

Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT PROPOSED CONDITIONS EXHIBIT

SWM-4

NO 4
OF 4

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT
21701 Ridge Road,
Gaithersburg, MD 20876

STORMWATER MANAGEMENT DESIGN NARRATIVE
September 2016

I. PROJECT DESCRIPTION

This Washington Suburban Sanitary Commission (WSSC) Brink Zone Reliability Improvements Project includes the construction of a new 13 MGD booster Water Pump Station (WPS) with associated infrastructure as well as new valve vault located on the southern portion of the property. The construction consists of the booster Water Pumping Station enclosure, a one story building with a basement level for booster pump location, a paved access pad and parking area, utility piping and appurtenances, and two (2) SWM micro-bioretention facilities.

The overall WSSC property is bound by agricultural farmland to the north and east, by Brink Road to the south and by Ridge Road (MD Route 27) to the west. The overall WSSC property contains approximately 14.93-acres of land that is located as shown on the Montgomery County ADC Map 4929, Grids B6 and B7, located on the easterly side of Ridge Road in Germantown, Maryland. The project site's overall limit of disturbance consists of approximately 2.34-acres. Of the 2.34-acres of disturbance, approximately 0.46 acres is associated with linear utility installation and will therefore not be included in the SWM calculations.

II. EXISTING CONDITIONS

The overall project area is currently consists of two (2) storage tanks, the existing Brink Pumping Station, access drives and parking, and accessory utility buildings. One storage tank, better known as the Brink Elevated Water Tank (EWT), is an elevated water tower and is located northeast of the proposed project, while the other storage tank is a reservoir tank at grade located closer to the northern boundary of the site. The Brink EWT receives its water supply from the existing Neelsville WPS through a 7,000 foot, 24-inch water main. WSSC has determined that a new booster WPS on the Brink facility site will ensure the effective delivery of water to the Brink EWS and other dependent zones if ever there is a disruption to the service, while also allowing for regular repair and maintenance to be performed.

The majority of the topography within the project area drains away from a high point centrally located beneath the existing EWT. The topography drains away from the high point listed above in all directions, with two low points of the property located on the western edge of the site, in between the two water storage tanks, and at the southeast corner of the site. A crescent shaped berm surrounds the northern portion of the reservoir tank. Currently, stormwater draining to Ridge Road runs either to the north or south depending on where along the roadway the stormwater leaves the site. A more significant portion of the runoff from the site drains to the east and southeast into an open field used for agriculture. A small portion of the site drains to the northern edge of the site, eventually directing the stormwater into the swale lining Ridge Road. It is assumed that the storm water runoff draining from the interior of the crescent, toward the reservoir tank is intercepted by a storm drain inlet on the

southeast side of the tank and then travels through an existing storm water conveyance pipe which exits the site at the southeasterly corner of the property, where the majority of the overland flow eventually ends up.

The slopes ranges from relatively flat to steep, with slopes as shallow as 1.5% toward the center of the site, to slopes with as steep as approximately 40% gradient on the side of the berm discussed above. Within the project limits (Limit of Disturbance) the maximum slope is approximately 38% and located adjacent to Ridge Road. The area within the project limits contains no streams, springs, wetlands, buffers, or highly erodible soils. There are small portions of wooded areas on the northern and eastern portion of the site, however no woodland is within the overall drainage area being studied. The site is not located in a floodplain nor is it in the Chesapeake Bay Critical Area.

Runoff from the project limits is conveyed to one (1) locations identified as a Study Point (SP), as there is only a single overall drainage area. Study point #1 (SP-1) is located just southeast of the site where the majority of site runoff from the southern portion of the property drains to. This study point also receives runoff from an offsite area associated with the neighboring agricultural field to the east of the property.

Soils within the study point drainage area are classified as Brinklow-Blocktown channery silt loams (16B), 3 to 8 percent slopes, Brinklow-Blocktown channery silt loams (16C), 8 to 15 percent slopes, and Occoquan loam (17B), 3 to 8 percent slopes. The Brinklow-Blocktown channery silt loams soils are classified as Hydrologic Soils Group C while and the Occoquan loam is classified as Hydrologic Soils Group B. WSSC owns, operates and maintains the water, and storm drain infrastructure on site.

III. PROPOSED CONSTRUCTION

The site improvements include the addition of a new 13 MGD booster Water Pump Station (WPS) building and associated piping and appurtenances, a proposed control valve chamber vault, associated piping and appurtenances, a proposed access drive and truck turning area for access to the pump station, and a proposed septic drainage field. The pump station shall include horizontal split case pumps, VFD, SCADA, electrical panels, a generator, header piping, branch piping and valves, and a magnetic flow meter and air valve. A water utility connection to the existing water lines on the western edge of the property will be constructed and used for the emergency water intake during the time of maintenance and repair to the existing EWT.

Three (3) proposed M-6 Micro-bioretention facilities are located so as to intercept runoff from the existing reservoir tank, the proposed booster pump station and the proposed valve chamber and surrounding drives and provide water quality treatment for the associated impervious area. Site designs have minimized impacts to existing forested area. Existing forest located on the project site both surrounds the northern portion of the existing water reservoir and is situated on top of an existing berm as well as provides a buffer between the southern portion of the site and Brink Road. This forest will be undisturbed. The majority of the existing trees within the limit of disturbance will be demolished in order to allow for construction of the booster pump and the associated utilities.

Overflow from the bio-retention ponds discharges as overland flow downstream from each pond location. Inverts and outfall elevations have been calculated and it has been determined that the slope from invert out of the outfall located within each pond to the outfall invert shall be between 0.9 and 5.0%.

In addition to the main area of disturbance, three areas of linear utility installation are proposed. One shall encompass the connection of the proposed water lines to an existing water main on the western side of the property which will be constructed and used for the emergency water intake during the time of maintenance and repair to the existing EWT, one shall encompass the connection of one of the micro-bioretention ponds to an outfall level spreader located southeast of the major disturbance and one shall encompass both the connection of remaining micro-bioretention ponds to the an outfall level spread as well as a sanitary line which leave to a septic drainage field on the southeast corner of the overall property. Being a linear utility installation isolated from the site, the limit of disturbance for this work is not included in the SWM calculations, but is included in the Erosion and Sediment Control design work.

V. METHODOLOGY

The stormwater management designs and review are being performed using the typically three (3) step process as outlined by the current Maryland Department of Environment regulations. This study represents the conceptual phase in that process.

This stormwater management study was conducted to evaluate the proposed condition for stormwater quantity attenuation to each study point (SP) to existing condition runoff rates, utilizing storm water quality treatment for new and reconstructed impervious areas. These evaluations use methods outlined in the Stormwater Management Act of 2007. The project area is evaluated for feasibly utilizing Environmental Site Design (ESD) techniques to the Maximum Extent Practicable (MEP) to provide treatment for impervious areas. The Impervious Area Requiring Treatment (IART) is calculated for each drainage area and for the project area as a whole. The existing condition impervious area coverage within the limits of disturbance is less than 40%, therefore the IART is calculated as new development thus providing treatment for 100% of the reconstructed and new impervious areas within the limits of disturbance. No credit is applied for impervious areas removed. The impervious areas, both existing or proposed, treated by an ESD-BMP practice (micro-bioretention facility) is tabulated as a credit towards the IART treatment goal.

The required Environmental Site Design volumes (ESDv) and recharge volume for the overall limit of disturbance as well as the ESDv required for the ESD-BMP micro-bioretention drainage areas have been calculated. The furnished ESDv for the ESD-BMP exceeds the required ESDv for both the micro-bioretention drainage areas and for the LOD as a whole. In addition, the furnished recharge volume, based on a minimum of 12-inches of #57 stone below the lowest invert of the underdrain, has been calculated to demonstrate that the recharge volume furnished exceeds the recharge volume required. The ESD-BMP micro-bioretention facilities, as designed for their respective drainage subarea, have been sized using the Target Pe value, therefore, channel protection volume (Cpv) requirements have been satisfied.

Using methodology outlined by the Soil Conservation Service Publication on Hydrology for Small Watersheds, Technical Release 55 (TR55), land use curve numbers and times of concentration have been calculated for the existing condition (see Exhibit SWM-1 and Appendix A) and for the proposed condition subareas (see Exhibit SWM-4 and the Appendix C). The TR55 methodology was also used to determine the land use curve numbers for the drainage subareas to the individual ESD-BMPs. A minimum time of concentration of six (6) minutes was used for each of the ESD-BMP subareas.

The TR-55 output for the existing and proposed conditions have been hydraulically routed to the Study Points to determine the peak discharge rates for the 1-year, 2-year, 10-year, and 100-year storm events. As shown by the calculations, the proposed condition runoff rates (peak flow conditions) are less than the existing condition runoff rates for the 1-year, 2-year, 10-year, and 100-year storm events. The hydraulic routing through the micro-bioretention facilities was performed utilizing TR-20 methodology with Hydraflow software.

The TR-55 calculated land use curve number for the M-6 Micro-bioretention ESD-BMP drainage subareas are hydraulically routed through the micro-bioretention facilities to determine the 10-year and 100-year water surface elevations within the micro-bioretention facility. The hydraulic routing was performed utilizing TR-20 methodology with Hydraflow software.

Erosion and sediment control (ESC) and stormwater management (SWM) designs seek to protect the existing natural features. Vegetative cover will be installed to protect slopes and grades from erosion. Erosion control measure will be employed at all inlets receiving runoff from disturbed areas. The intent of the design is to ensure that the implemented measures meet the requirements for protection of the surrounding environment.

VI. EROSION & SEDIMENT CONTROL

Erosion & Sediment Control Plans have been prepared per the "Maryland Standards and Specifications for Soil Erosion and Sediment Control". The intent of the design is to protect downstream natural features from erosion, capture sediment on-site, and meet applicable guidelines and requirements.

The designs include individual control devices such as Stabilized Construction Entrances, Silt and Super Silt Fences, Inlet Protections, and other measures as needed. The area of the linear utility installation on the site is performed using linear utility installation methods and has been protected by Super Silt Fencing located as required to prevent sedimentation from running outside of the LOD.

VII. STORMWATER MANAGEMENT

The disturbed site is entirely in one drainage areas (DA-1). DA-1 contains just over half of the property as well as a small portion of the adjoining agricultural land to the east. This drainage area was analyzed to determine runoff patterns and drainage subareas for the

proposed condition. The drainage areas were investigated for the feasibility of employing ESD-BMP practices and non-structural practices for: IART credit, to provide groundwater recharge, and provide water quality treatment for runoff. The ESD-BMP micro-bioretention practices are designed to furnish treatment for the site improvements. The on-site soils are classified as Hydrologic Soils Groups B and C. A site geotechnical investigation shall be performed to determine that ground water elevations at the micro-bioretention facilities are acceptable. The Summary Tables furnished summarize the proposed condition drainage areas, the IART requirements, the ESD-BMP drainage subareas, the employed treatment practices, impervious area being treated, ESDv requirements and ESDv furnished for the respective ESD-BMP micro-bioretention facilities, recharge volume, and the existing and proposed condition 1-year, 2-year, 10-yr, and 100-year storm peak discharge summaries to Study Point #1 (SP-1).

The total area of disturbance associated with this project is approximately 2.34-acres, although only 1.88 acres has been mitigated for. An NPDES application is required to be submitted to MDE. Water quality treatment for stormwater runoff for new and reconstructed impervious areas is furnished through three (3) M-6 Micro-bioretention facilities. The following appendices include data summary tables and calculations for sizing the micro-bioretention facilities in accordance to Chapter 5. As noted above, by furnishing ESD to the MEP for the IART goal, Channel Protection Volume (Cpv) has been satisfied.

Water quantity attenuation is furnished so that the post-developed condition runoff rates are less than or equal to the pre-developed condition runoff rates for the 1-year, 2-year,10-year, and 100-year storm events to SP-1. Volume associated with the micro-bioretention areas provides the required volume to achieve the attenuation. The following table summarizes the peak runoff rates for the 1-year, 2-year, 10-year, and 100-year storm events:

Existing Condition Peak Discharge Summary				
SP	1-year	2-year	10-year	100-year
1	14.37	22.04	49.85	115.02

Proposed Condition Peak Discharge Summary				
SP	1-year	2-year	10-year	100-year
1	13.32	20.71	48.84	114.47

VIII. CONCLUSION

As demonstrated by the above narrative as well as the attached tables & calculations, the site designs meet the stormwater management requirements for IART treatment, ESD to the MEP for new and reconstructed impervious areas, peak discharge attenuation to existing condition runoff rates for the 1-year, 2-year, 10-year, and 100-year storm events, groundwater recharge volume requirements, and ESD volumes. Erosion and Sediment

Control designs are provided in accordance with MDE requirements and regulations to prevent the escape of sediment laden runoff.

SUMMARY TABLES

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

New Development vs. Redevelopment Calculations

Limit of Disturbance Area

Total LOD Area = 82,106 s.f.

Existing Impervious Area In LOD = 0
Existing Percent Impervious = 0 %

Existing % Impervious < 40% - New Development Condition

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Impervious Area Requiring Treatment (IART) Summary Table

Drainage Area: 1 (DA-1)

Total DA Area =	**666,186 s.f.**	**LOD Area =**	**82,106 s.f. (19628 s.f. of linear utility installation)**
New Impervious Area (A_{in}) =		**18,297 s.f.**	
Reconstructed Existing Impervious Area (A_{ir}) =		**0 s.f.**	
Existing Impervious Area Removed (A_{ire}) =		**0 s.f.**	
Existing Impervious Area (Ex Ai = Air + Aire) =		**0 s.f.**	
Proposed Impervious Area (Prop Ai = Air + Ain) =		**18,297 s.f.**	
Δ Impervious Area (Δ Ai = Prop Ai - Ex Ai) =		**18,297 s.f.**	
IART= Existing Imp Area + Δ Imp Area=		**18,297 s.f.**	

TOTAL IART (DA-1) = 18,297 s.f.

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Water Quality Treatment Summary

Total IART Required: **18,297 s.f.**
(See IART Exhibit for Calculation)

Subarea	Treatment Method	Impervious Area Treated (s.f.)	Total Treated Impervious Area (s.f.)	Net Credit / Deficit (-)
BRA-1A	M-6 Micro Bioretention	8,043	8,043	-10,254
BRA-1B	M-6 Micro Bioretention	7,080	15,123	-3,174
BRA-1C	M-6 Micro Bioretention	4,986	20,109	1,812
			Total Treatment Credit =	**1,812**

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

ESD BMP Summary

Subarea	DA Total Area (s.f)	BRA Dim. (LxW) / Filter Media Thickness (in)	% Imp.	Target P_e (in)	Ponding ESDv Required (c.f.) 75%	Surface Ponding Volume (c.f.) / Depth (in)
BRA-1A	15533	1,222 sf / 20"	51.8%	1.8"	909	987 cf / 8.4"
BRA-1B	19321	1479 sf / 20"	36.6%	1.7"	780	821 cf / 5.4"
BRA-1C	14023	971 sf / 20"	35.6%	1.6"	533	646 cf / 6.6"

Subarea	Area (A_f) Required (s.f.)	Area (A_f) Furnished (s.f.)	ESDv Furnished (c.f.)
BRA-1A	1031	1222	1212
BRA-1B	935	1479	1040
BRA-1C	625	971	710
		Total ESDv Furnished =	2962
		Total ESDv Required = (Based on LOD Calculations)	2073

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Recharge Volume (Rev) Summary

Subarea	Treatment Method	Rev Furnished (c.f.)
BRA-1A	**M-6 Micro Bioretention**	**489**
BRA-1B	**M-6 Micro Bioretention**	**592**
BRA-1C	**M-6 Micro Bioretention**	**388**
	Total Rev Furnished =	**1081**
	Total Rev Required =	226
	(Based on LOD Calculations)	

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	14.37	22.04	-------	-------	49.85	-------	-------	115.02	DA-1

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	13.32	20.43	-------	-------	46.20	-------	-------	106.59	DA-1
2	SCS Runoff	------	0.789	1.055	-------	-------	1.918	-------	-------	3.709	DA-1A
3	SCS Runoff	------	0.827	1.133	-------	-------	2.168	-------	-------	4.363	DA-1B
4	SCS Runoff	------	0.602	0.824	-------	-------	1.577	-------	-------	3.173	DA-1C
5	Reservoir	2	0.032	0.130	-------	-------	0.920	-------	-------	1.479	BRA-1A
6	Reservoir	3	0.000	0.022	-------	-------	0.631	-------	-------	3.631	BRA-1B
7	Reservoir	4	0.049	0.283	-------	-------	1.444	-------	-------	3.051	BRA-1C
8	Combine	1, 5, 6, 7	13.32	20.71	-------	-------	48.84	-------	-------	114.47	SP-1

APPENDIX - A

Existing Condition TR55 Data and Report

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Ex. Conditions TR-55 Data

DA-1 (Drains to Study Point #1: SP-1)
Total Area = 666186 s.f. (15.29 Ac.)

HSG-B (17B) =	**8,795 s.f.**
Landscape (Good):	8,374 s.f.
Impervious Area:	421 s.f.
HSG-C (16B / 16C) =	**657,391 s.f.**
Landscape (Good):	622,522 s.f.
Impervious Area:	34,869 s.f.

Tc Data:

Sheet Flow:	100 ft	@	4.68%	-	Grass
Shallow Concentrated Flow:	964 ft	@	6.57%	-	Unpaved

CFishman

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
DA-1	15.29	0.183	75		

Total Area: 15.29 (ac)

CFishman

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
DA-1							
SHEET	100	0.0468	0.150				0.118
SHALLOW	964	0.0657	0.050				0.065
						Time of Concentration	.183

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
DA-1	Open space; grass cover > 75% (good)	B	.193	61
	Open space; grass cover > 75% (good)	C	14.295	74
	Paved parking lots, roofs, driveways	B	.01	98
	Paved parking lots, roofs, driveways	C	.796	98
	Total Area / Weighted Curve Number		15.29	75

APPENDIX - B

Existing Condition Hydroflow 1-year, 2-year, 10-year, and 100-year Peak Flow Calculations

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	14.37	22.04	-------	-------	49.85	-------	-------	115.02	DA-1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	14.37	2	722	39,596	------	------	------	DA-1

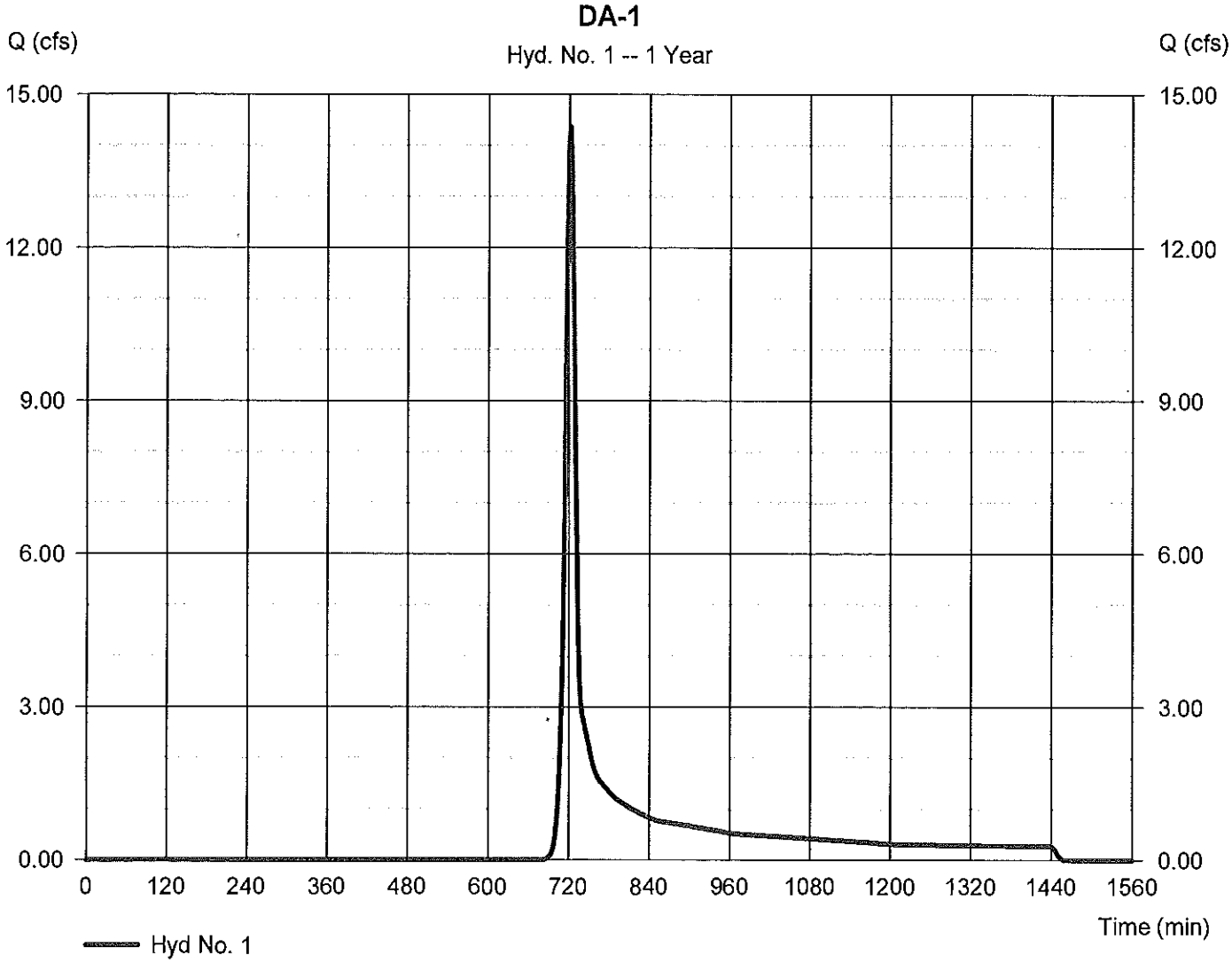
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 14.37 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 39,596 cuft
Drainage area	= 15.290 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	22.04	2	722	58,770	------	------	------	DA-1

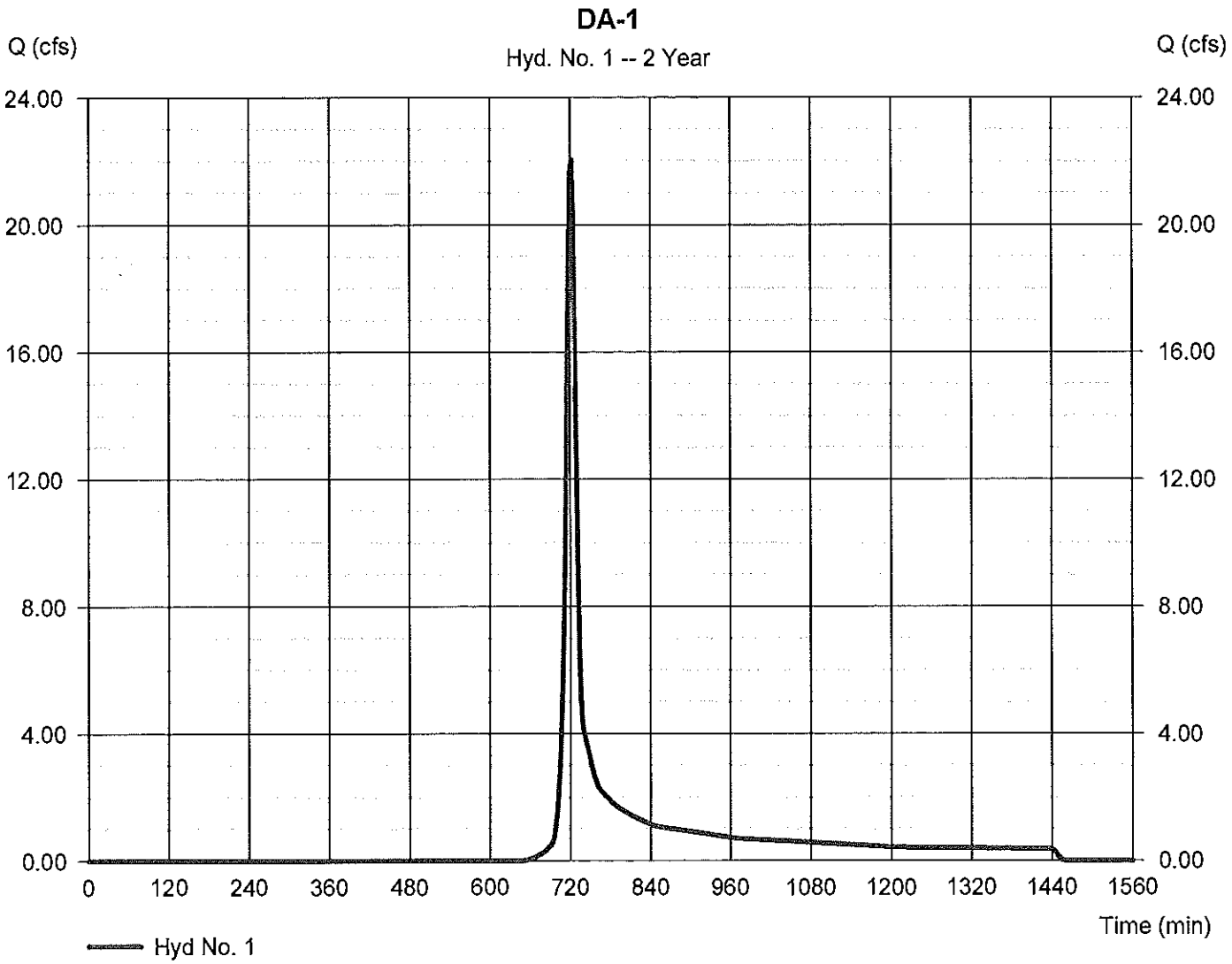
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 22.04 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 58,770 cuft
Drainage area	= 15.290 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	49.85	2	720	129,591	------	------	------	DA-1

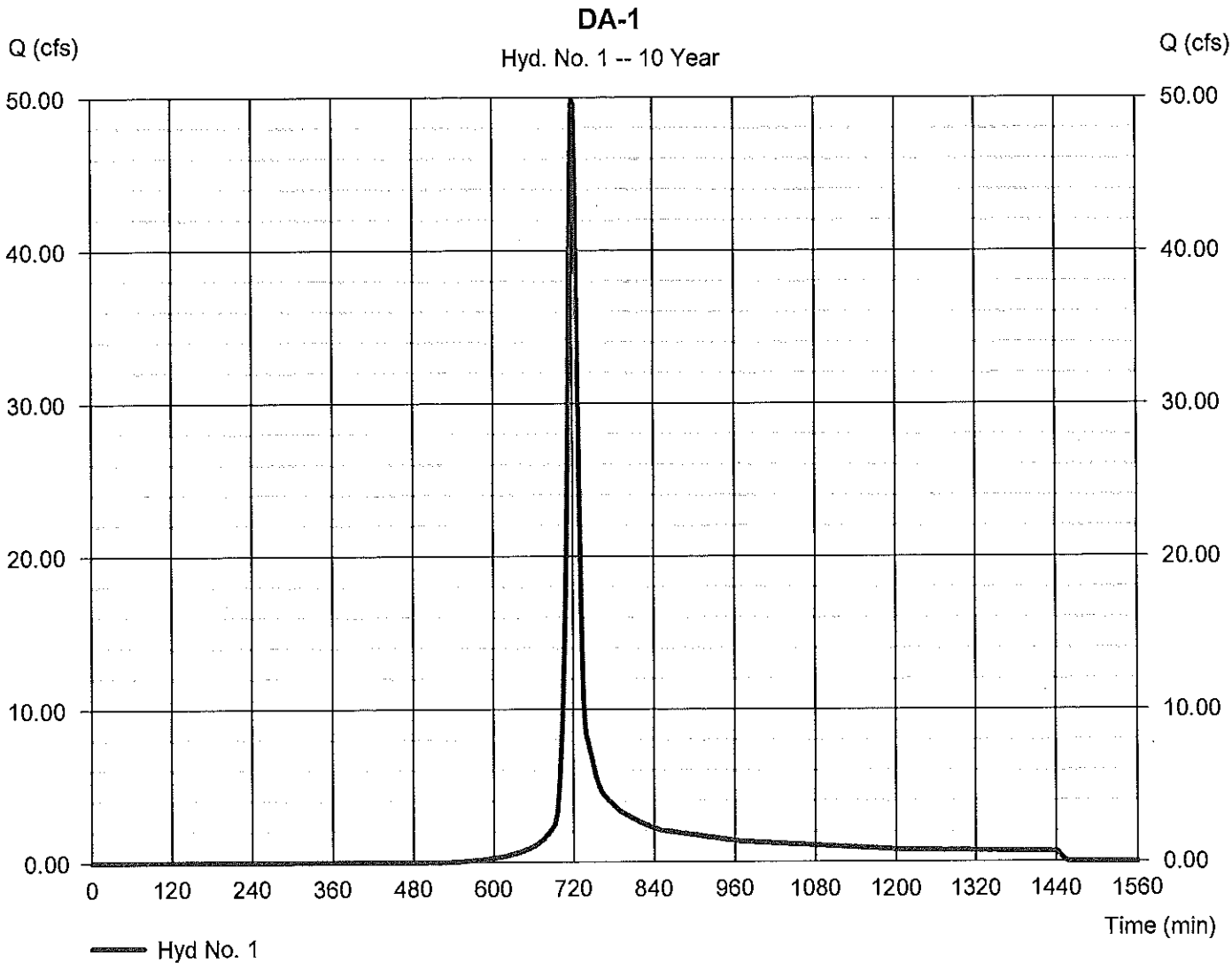
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 49.85 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 129,591 cuft
Drainage area	= 15.290 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	115.02	2	720	300,477	------	------	------	DA-1

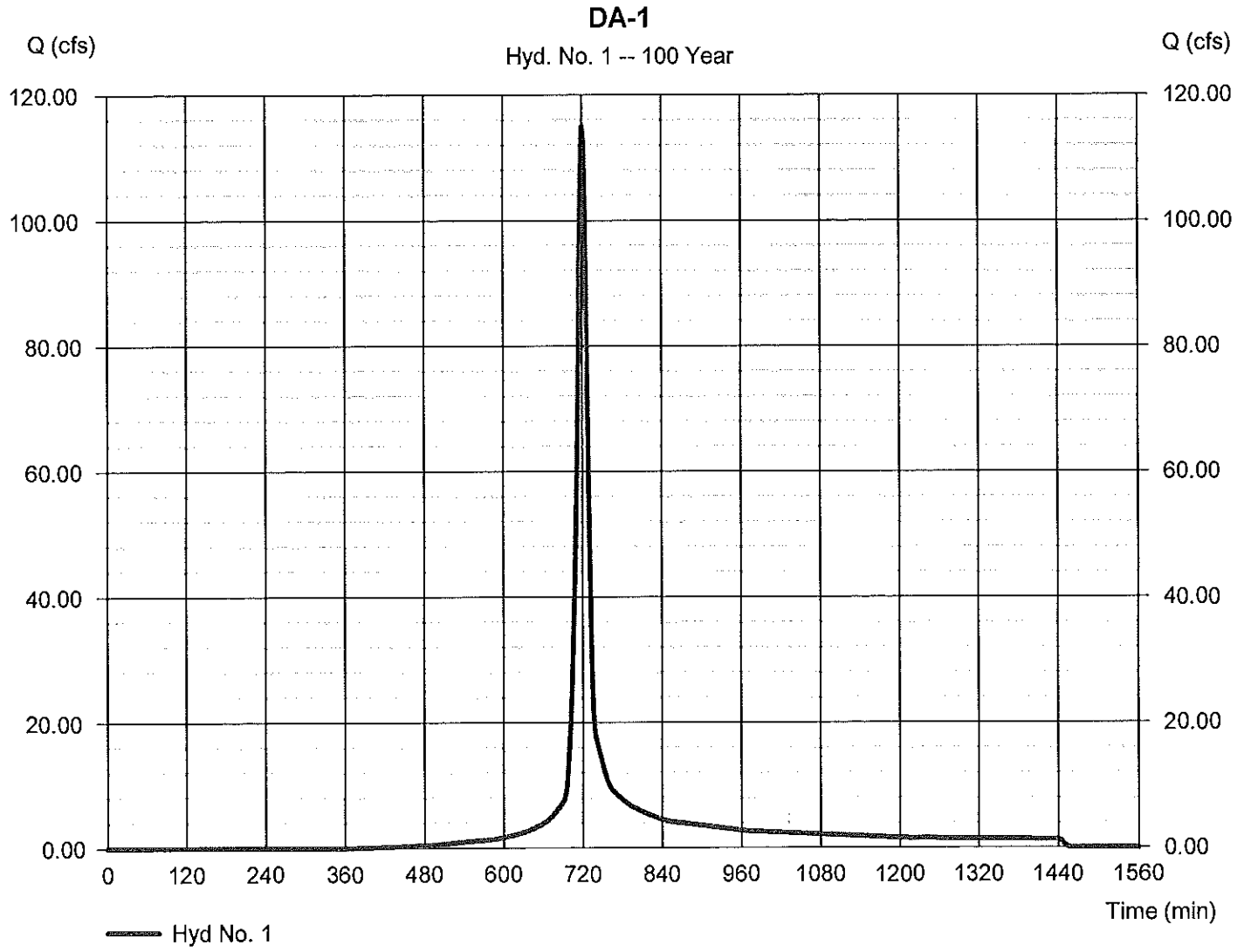
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 115.02 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 300,477 cuft
Drainage area	= 15.290 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



APPENDIX - C

Proposed Condition TR55 Data and Report

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Prop. Conditions TR-55 Data

DA-1 (Drains to Study Point #1: SP-1)
Total Area = 666186 s.f. (15.29 Ac.)

HSG-B (17B) =	**8,795 s.f.**
Landscape (Good):	8,374 s.f.
Impervious Area:	421 s.f.
HSG-C (16B / 16C) =	**652,391 s.f.**
Landscape (Good):	599,093 s.f.
Impervious Area:	53,298 s.f.

Tc Data:

Sheet Flow:	100 ft	@	4.68%	- Grass
Shallow Concentrated Flow:	964 ft	@	6.57%	- Unpaved

Sub-DA-1A (Drains to BRA-1A / Study Point #1 - SP-1)
Total Area = 15,533 s.f. (0.36 Ac.)

HSG-C (16B) =	**15,533 s.f.**
Landscape (Good):	7,490 s.f.
Impervious Area:	8,043 s.f.

Tc Data: 6 Minutes (assumed minimum)

Sub-DA-1B (Drains to BRA-1B / Study Point #1 - SP-1)
Total Area = 19321 s.f. (0.44 Ac.)

HSG-C (16B) =	**19,321 s.f.**
Landscape (Good):	12,241 s.f.
Impervious Area:	7,080 s.f.

Tc Data: 6 Minutes (assumed minimum)

(Continued on following sheets)

Sub-DA-1c (Drains to BRA-1C / Study Point #1 - SP-1)

Total Area = 14023 s.f. (0.32 Ac.)

HSG-C (16B) =	**14,023** s.f.
Landscape (Good):	9,037 s.f.
Impervious Area:	4,986 s.f.

Tc Data: 6 Minutes (assumed minimum)

WinTR-55 Current Data Description

--- Identification Data ---

User: CFishman
Project: Brink Zone
SubTitle: Reliability Improvements Project
State: Maryland
County: Montgomery NOAA_C
Filename: P:\2015\1501.08.00 WSSC Brink Zone Reliability Improvements\Design\Civil\SWM\2016.09.02

Date: 9/21/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
DA-1		Outlet	14.17	75	0.183
DA-1A		Outlet	0.36	86	0.100
DA-1B		Outlet	0.44	83	0.100
DA-1C		Outlet	0.32	83	0.100

Total area: 15.29 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.1	3.99	4.77	5.97	7.03	8.23	2.57

Storm Data Source: Montgomery NOAA_C County, MD (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

CFishman

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.1	3.99	4.77	5.97	7.03	8.23	2.57

Storm Data Source: Montgomery NOAA_C County, MD (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
DA-1	14.17	0.183	75	Outlet	
DA-1A	.36	0.100	86	Outlet	
DA-1B	.44	0.100	83	Outlet	
DA-1C	.32	0.100	83	Outlet	

Total Area: 15.29 (ac)

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
DA-1							
SHEET	100	0.0470	0.150				0.118
SHALLOW	964	0.0657	0.050				0.065
						Time of Concentration	0.183
DA-1A							
User-provided							0.100
						Time of Concentration	0.100
DA-1B							
User-provided							0.100
						Time of Concentration	0.100
DA-1C							
User-provided							0.100
						Time of Concentration	0.100

CFishman

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
DA-1	Open space; grass cover > 75%	(good)	B	.193	61
	Open space; grass cover > 75%	(good)	C	13.215	74
	Paved parking lots, roofs, driveways		B	.01	98
	Paved parking lots, roofs, driveways		C	.753	98
	Total Area / Weighted Curve Number			14.17	75
DA-1A	Open space; grass cover > 75%	(good)	C	.172	74
	Paved parking lots, roofs, driveways		C	.185	98
	Total Area / Weighted Curve Number			.36	86
DA-1B	Open space; grass cover > 75%	(good)	C	.281	74
	Paved parking lots, roofs, driveways		C	.163	98
	Total Area / Weighted Curve Number			.44	83
DA-1C	Open space; grass cover > 75%	(good)	C	.207	74
	Paved parking lots, roofs, driveways		C	.114	98
	Total Area / Weighted Curve Number			.32	83

APPENDIX - D

Proposed Condition Hydroflow 1-year, 2-year, 10-year, and 100-year Peak Flow Calculations

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	13.32	20.43	-------	-------	46.20	-------	-------	106.59	DA-1
2	SCS Runoff	------	0.789	1.055	-------	-------	1.918	-------	-------	3.709	DA-1A
3	SCS Runoff	------	0.827	1.133	-------	-------	2.168	-------	-------	4.363	DA-1B
4	SCS Runoff	------	0.602	0.824	-------	-------	1.577	-------	-------	3.173	DA-1C
5	Reservoir	2	0.032	0.130	-------	-------	0.920	-------	-------	1.479	BRA-1A
6	Reservoir	3	0.000	0.022	-------	-------	0.631	-------	-------	3.631	BRA-1B
7	Reservoir	4	0.049	0.283	-------	-------	1.444	-------	-------	3.051	BRA-1C
8	Combine	1, 5, 6, 7	13.32	20.71	-------	-------	48.84	-------	-------	114.47	SP-1

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 09 / 22 / 2016

Pond No. 1 - BRA-1A

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 635.36 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	635.36	1,222	0	0
0.64	636.00	1,554	888	888
1.00	636.36	1,753	595	1,484
2.04	637.40	2,358	2,138	3,621

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 631.66	0.00	0.00	0.00
Length (ft)	= 38.00	0.00	0.00	0.00
Slope (%)	= 4.89	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 2.10	0.00	0.00	0.00
Crest El. (ft)	= 636.06	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	635.36	0.00	---	---	---	0.00	---	---	---	---	---	0.000
0.64	888	636.00	3.08 ic	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,484	636.36	3.08 ic	---	---	---	0.81 ic	---	---	---	---	---	0.812
2.04	3,621	637.40	3.08 ic	---	---	---	1.72 ic	---	---	---	---	---	1.716

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 09 / 22 / 2016

Pond No. 2 - BRA-1B

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 636.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	636.00	1,479	0	0
1.00	637.00	2,170	1,825	1,825
2.00	638.00	3,624	2,897	4,722

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 632.20	0.00	0.00	0.00
Length (ft)	= 95.00	0.00	0.00	0.00
Slope (%)	= 4.87	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.93	0.00	0.00	0.00
Crest El. (ft)	= 637.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	636.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,825	637.00	6.87 ic	---	---	---	0.00	---	---	---	---	---	0.000
2.00	4,722	638.00	6.87 ic	---	---	---	5.19 ic	---	---	---	---	---	5.190

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Pond No. 3 - BRA-1C

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 629.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	629.00	971	0	0
1.00	630.00	1,377	1,174	1,174

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 614.15	0.00	0.00	0.00
Length (ft)	= 245.00	0.00	0.00	0.00
Slope (%)	= 0.90	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.93	0.00	0.00	0.00
Crest El. (ft)	= 629.55	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	629.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,174	630.00	8.38 oc	---	---	---	3.95	---	---	---	---	---	3.951

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	13.32	2	722	36,695	------	------	------	DA-1
2	SCS Runoff	0.789	2	716	1,594	------	------	------	DA-1A
3	SCS Runoff	0.827	2	718	1,661	------	------	------	DA-1B
4	SCS Runoff	0.602	2	718	1,208	------	------	------	DA-1C
5	Reservoir	0.032	2	812	639	2	636.08	1,029	BRA-1A
6	Reservoir	0.000	2	n/a	0	3	636.91	1,661	BRA-1B
7	Reservoir	0.049	2	752	620	4	629.53	627	BRA-1C
8	Combine	13.32	2	722	37,955	1, 5, 6, 7	------	------	SP-1

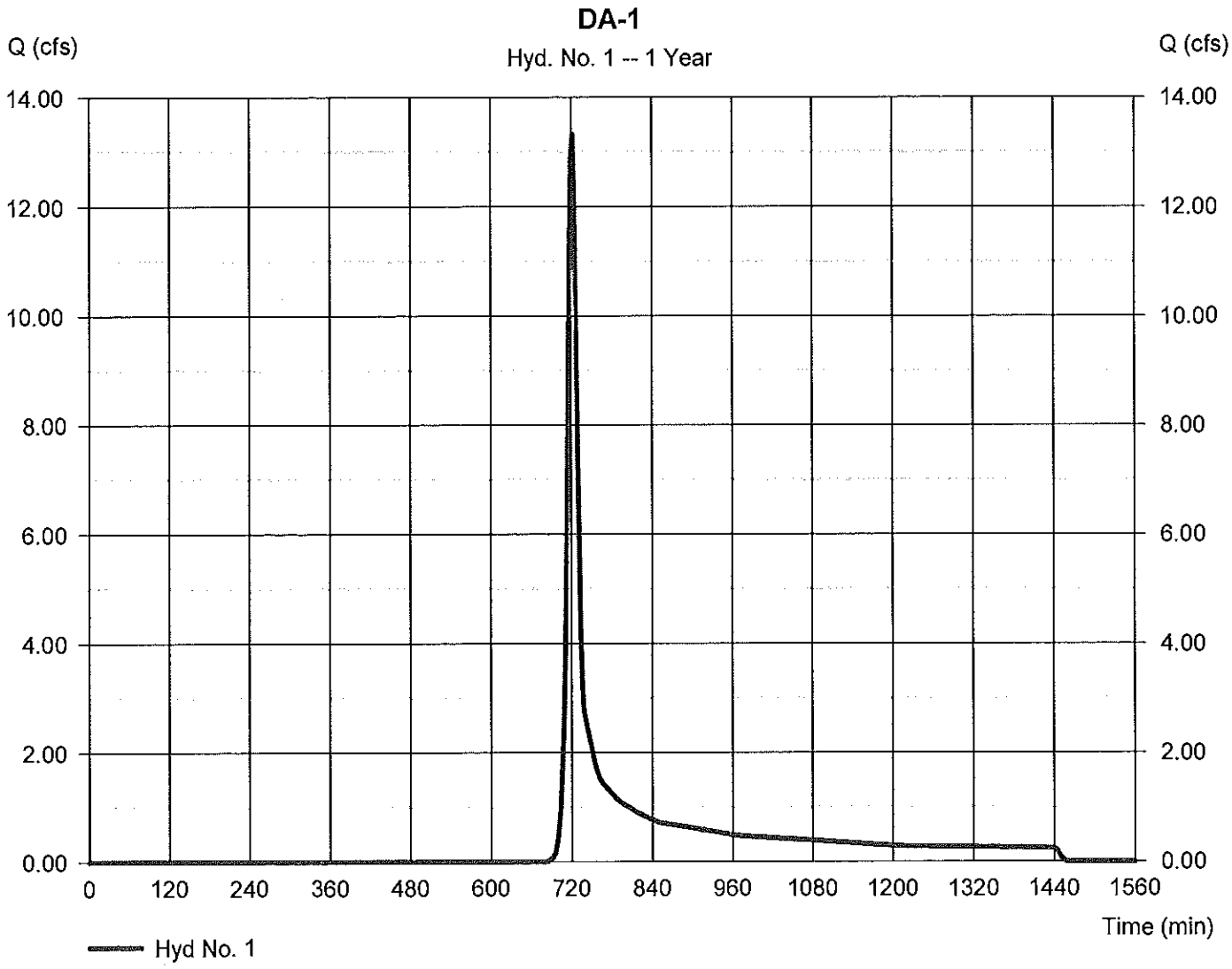
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 13.32 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 36,695 cuft
Drainage area	= 14.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



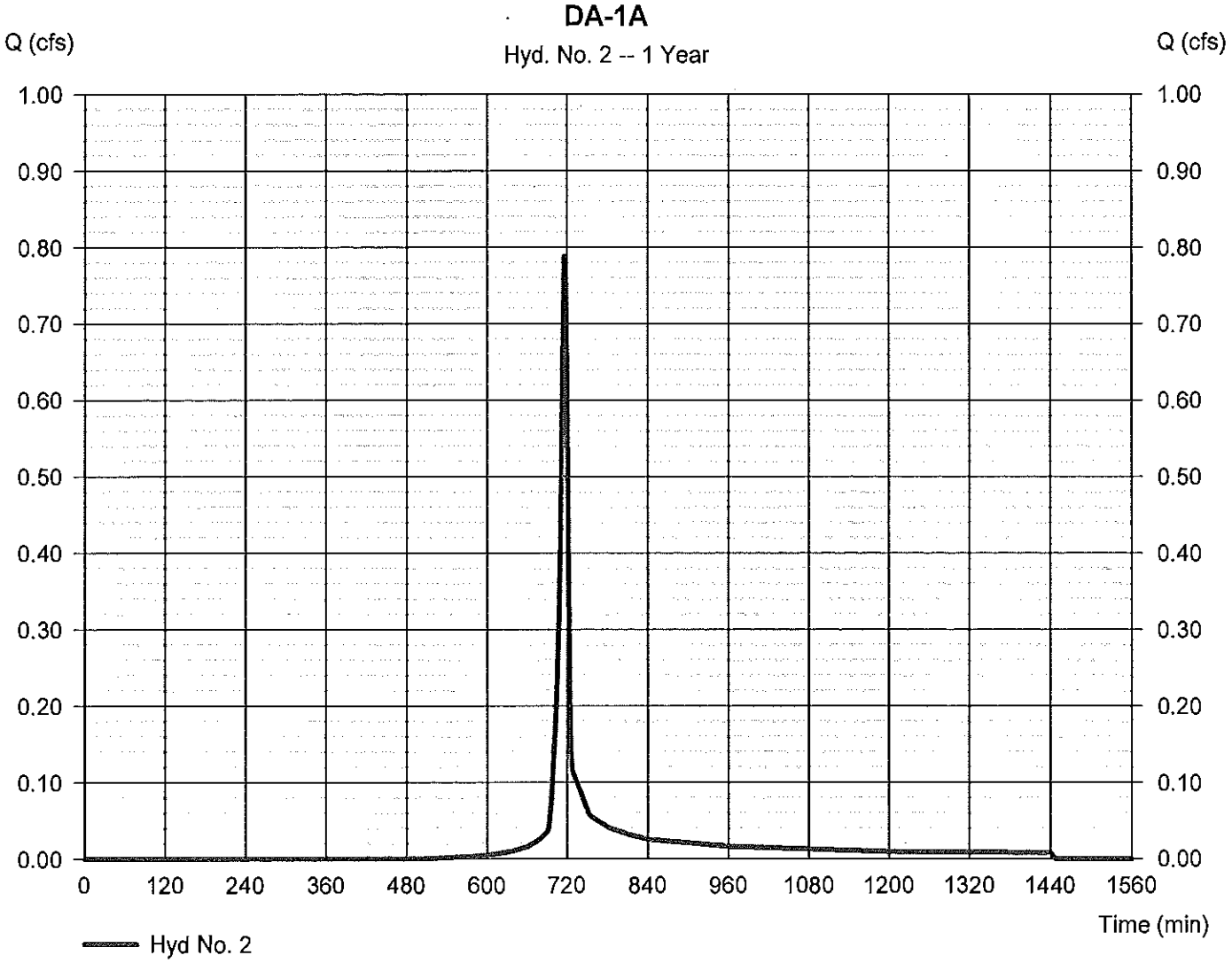
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 0.789 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,594 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



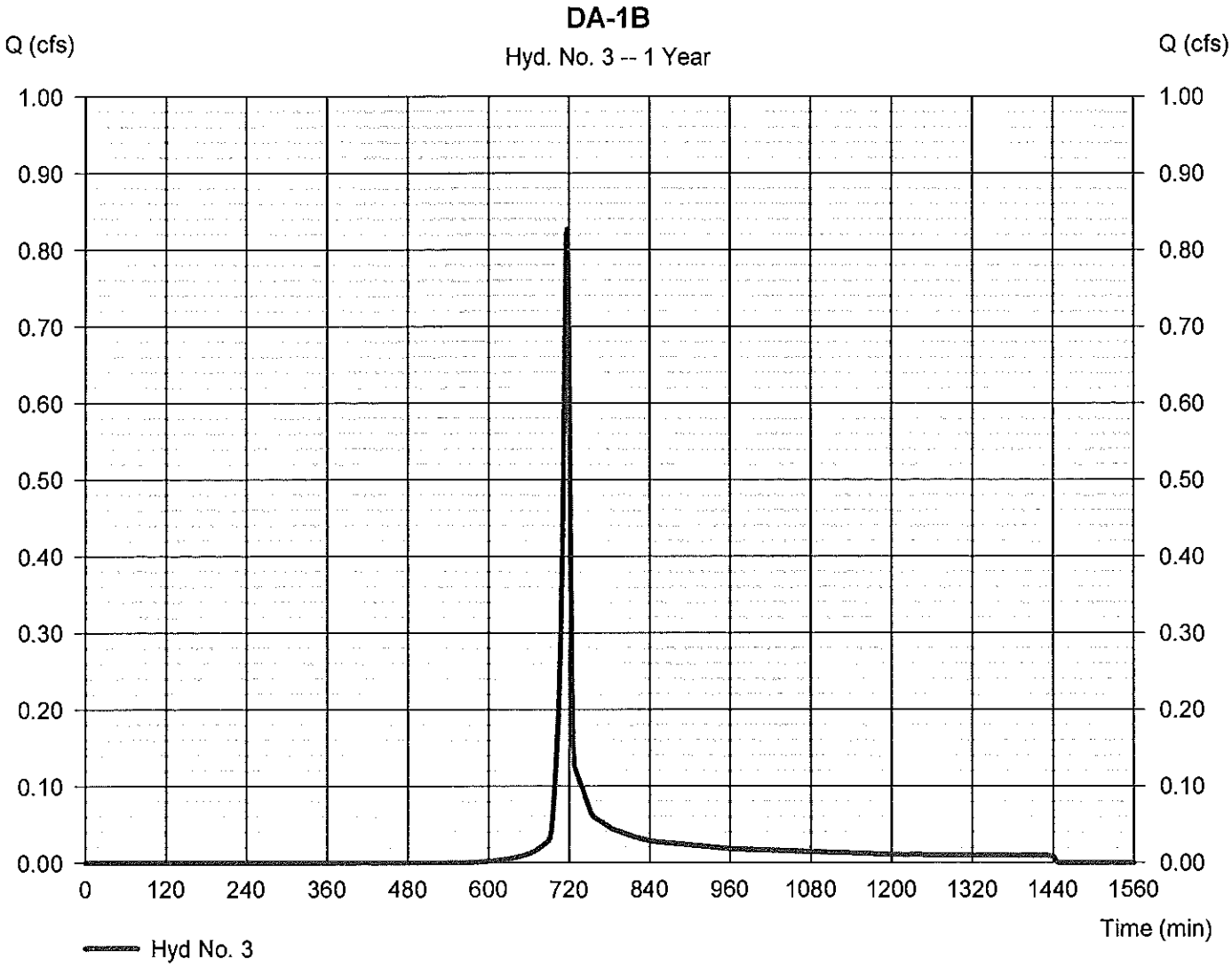
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.827 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,661 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



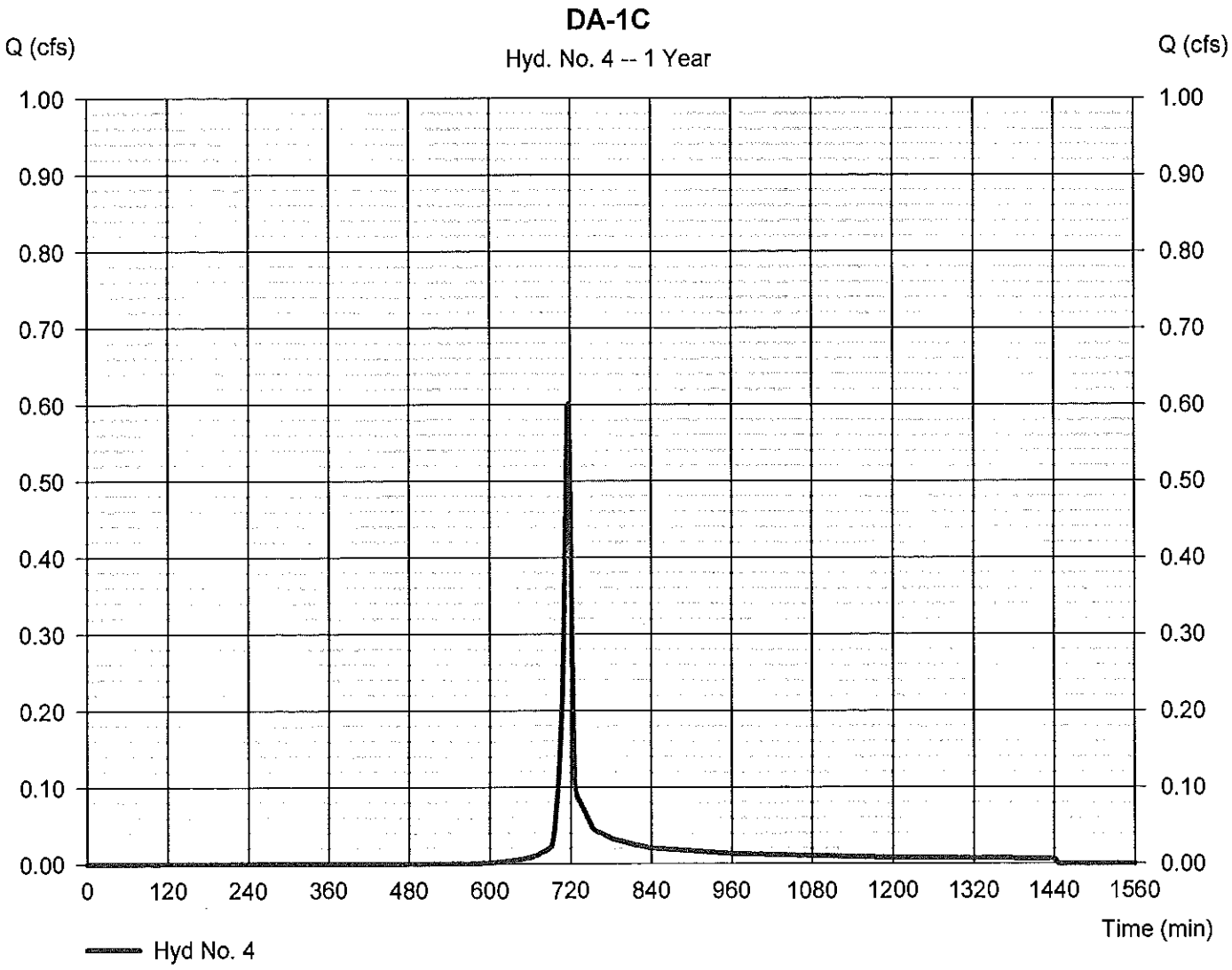
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 0.602 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,208 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

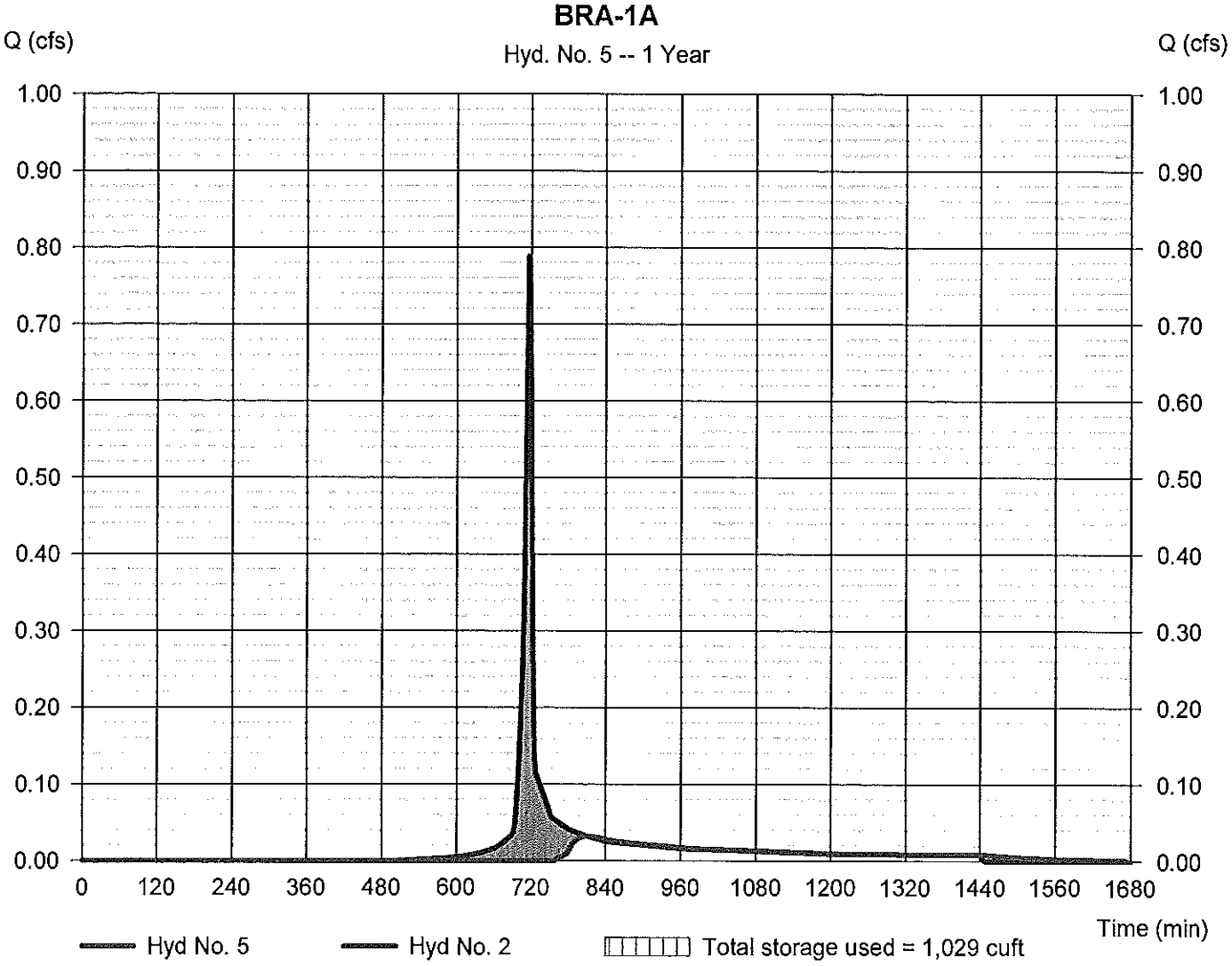
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.032 cfs
Storm frequency	= 1 yrs	Time to peak	= 812 min
Time interval	= 2 min	Hyd. volume	= 639 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.08 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,029 cuft

Storage Indication method used.



Hydrograph Report

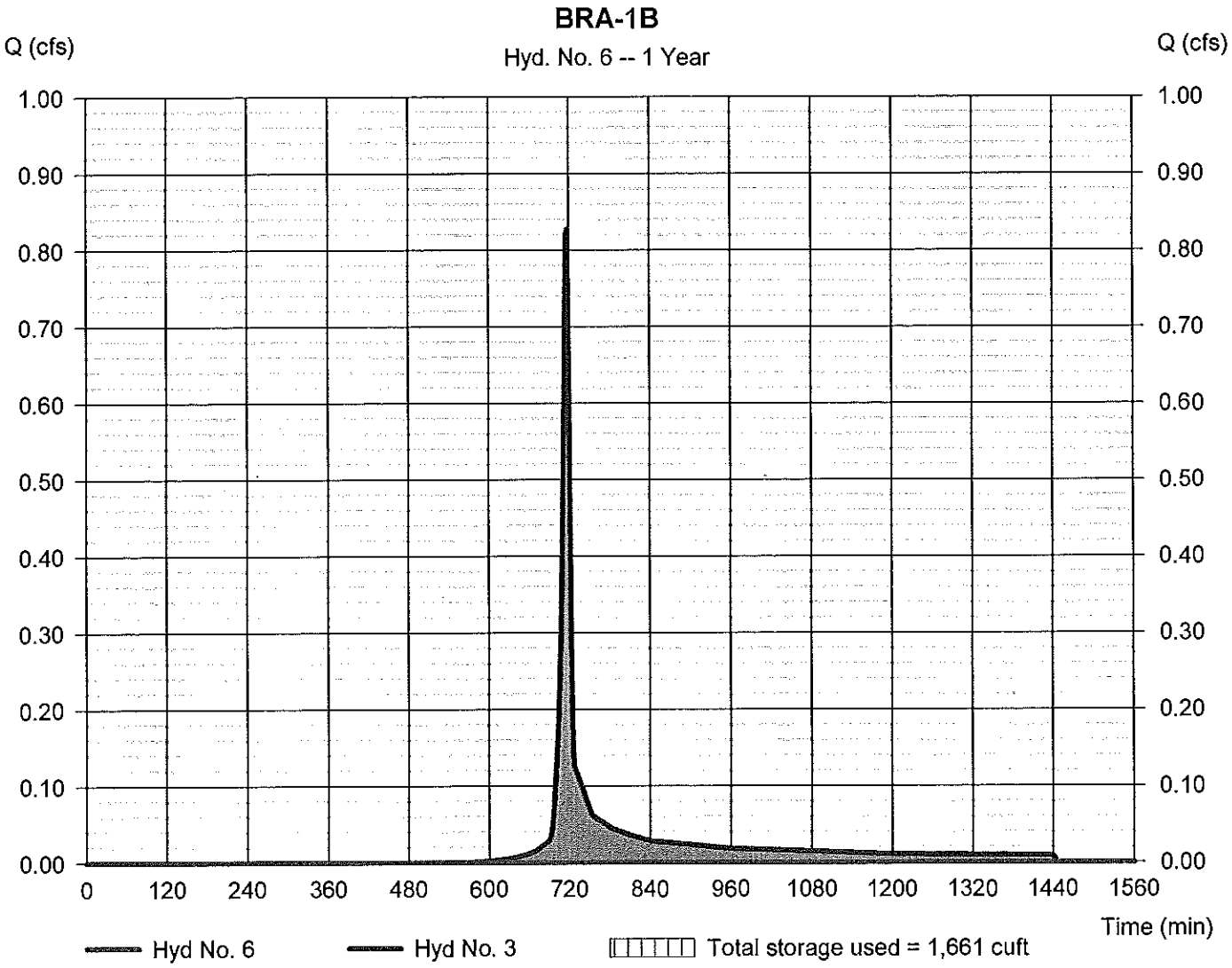
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 1 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 636.91 ft
Reservoir name	= BRA-1B	Max. Storage	= 1,661 cuft

Storage Indication method used.



Hydrograph Report

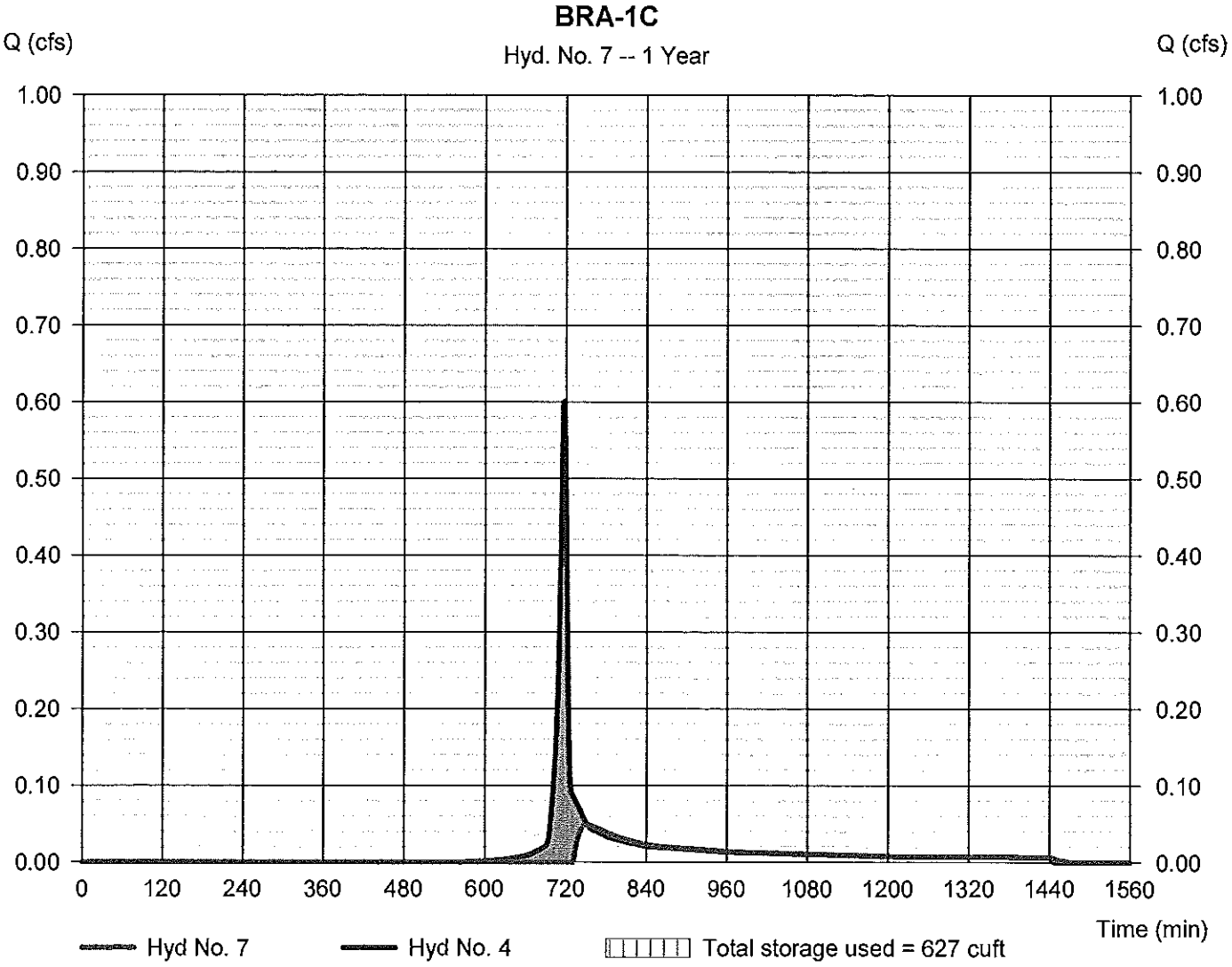
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 0.049 cfs
Storm frequency	= 1 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 620 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.53 ft
Reservoir name	= BRA-1C	Max. Storage	= 627 cuft

Storage Indication method used.



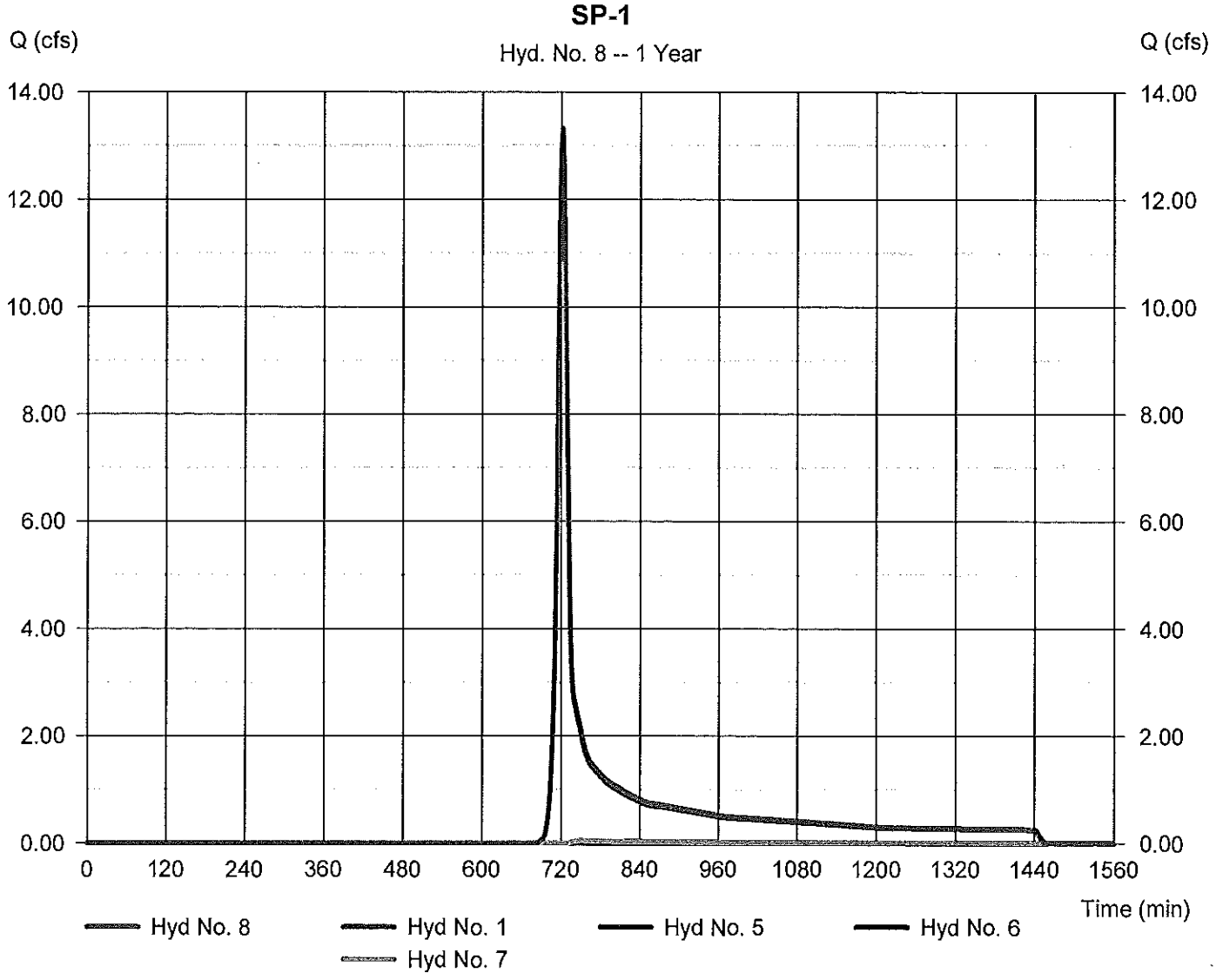
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 8

SP-1

Hydrograph type	= Combine	Peak discharge	= 13.32 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 37,955 cuft
Inflow hyds.	= 1, 5, 6, 7	Contrib. drain. area	= 14.170 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	20.43	2	722	54,465	------	------	------	DA-1
2	SCS Runoff	1.055	2	716	2,142	------	------	------	DA-1A
3	SCS Runoff	1.133	2	716	2,287	------	------	------	DA-1B
4	SCS Runoff	0.824	2	716	1,663	------	------	------	DA-1C
5	Reservoir	0.130	2	734	1,188	2	636.13	1,102	BRA-1A
6	Reservoir	0.022	2	996	462	3	637.01	1,840	BRA-1B
7	Reservoir	0.283	2	724	1,076	4	629.62	731	BRA-1C
8	Combine	20.71	2	722	57,191	1, 5, 6, 7	------	------	SP-1

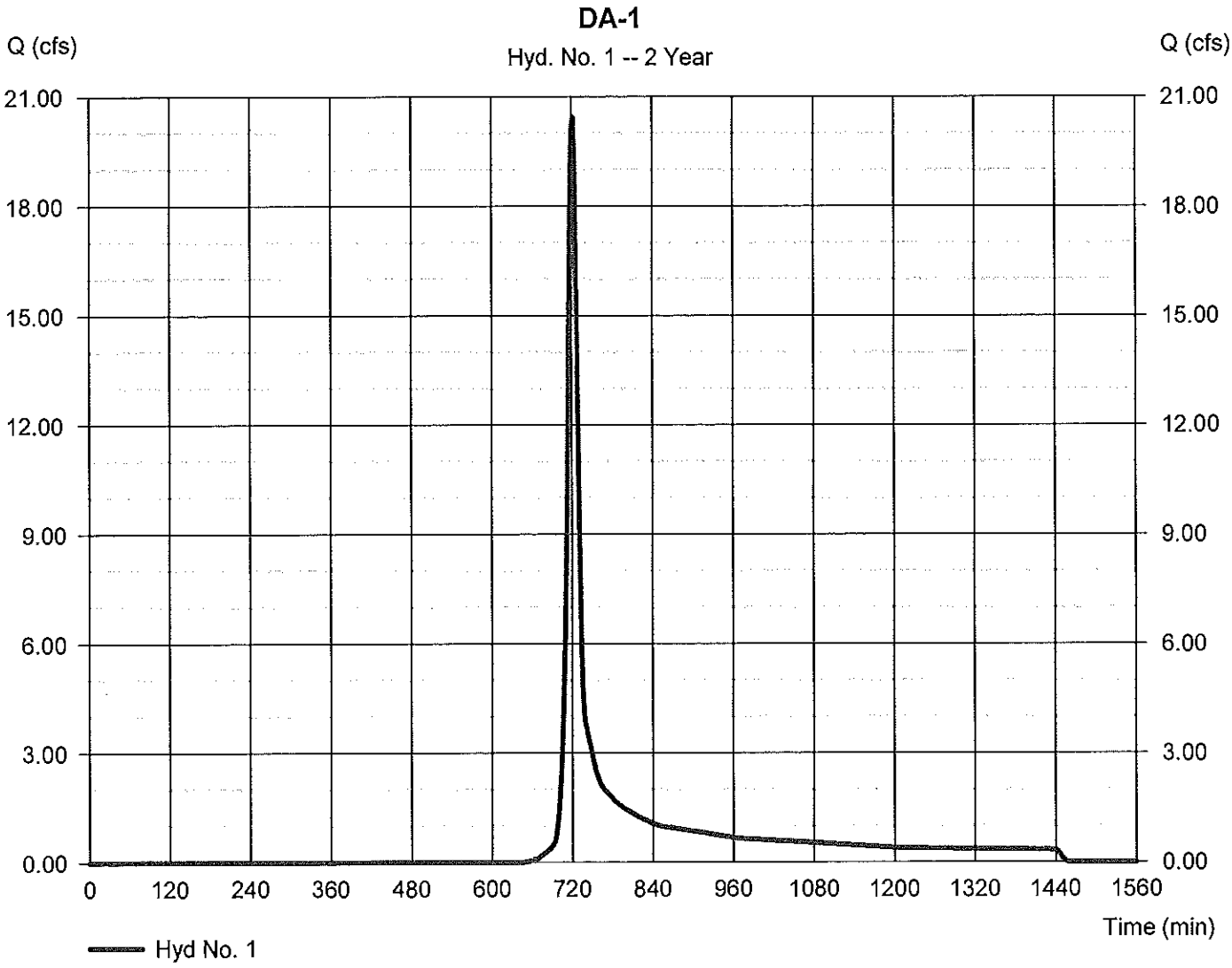
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 20.43 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 54,465 cuft
Drainage area	= 14.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

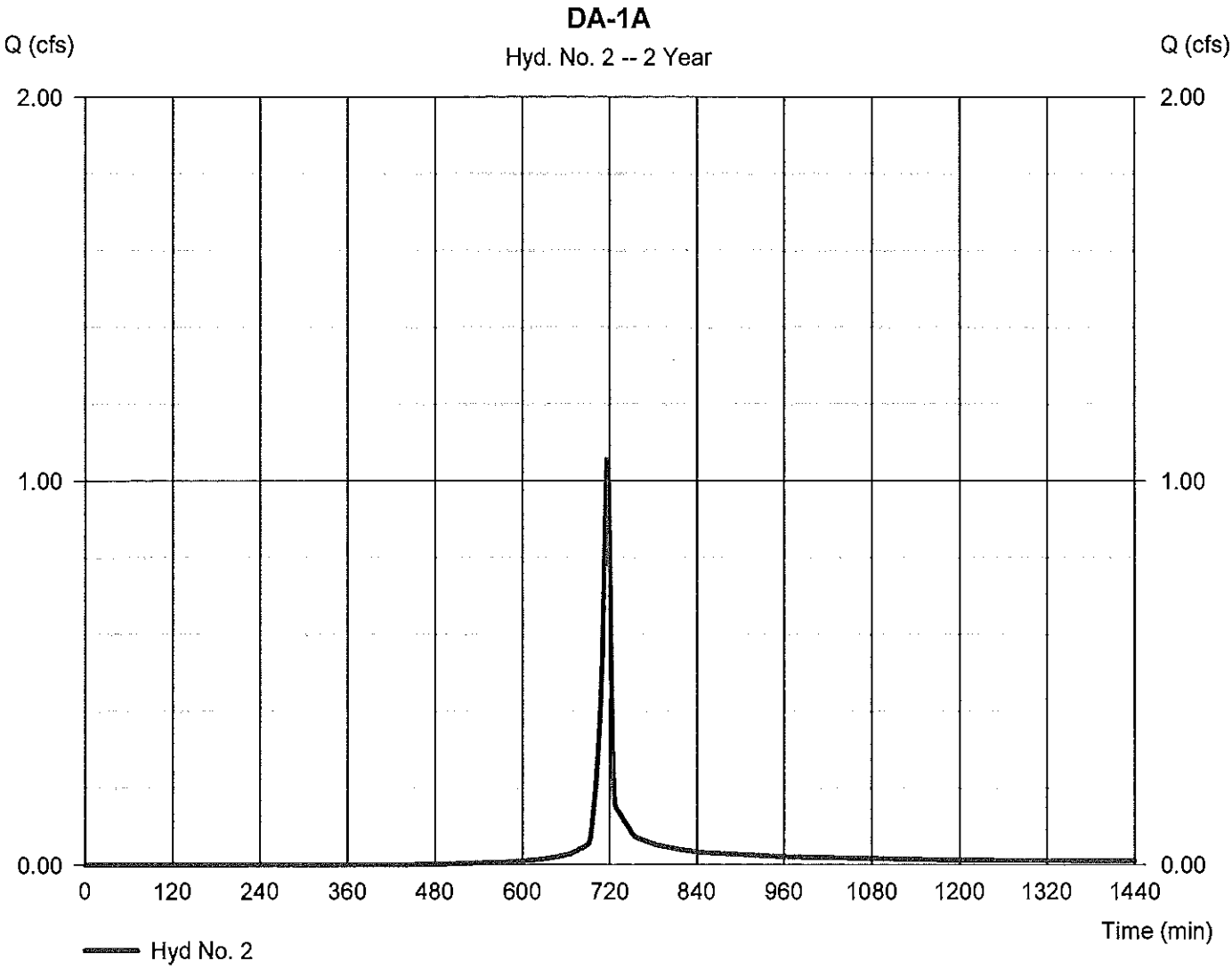


Hydrograph Report

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 1.055 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,142 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



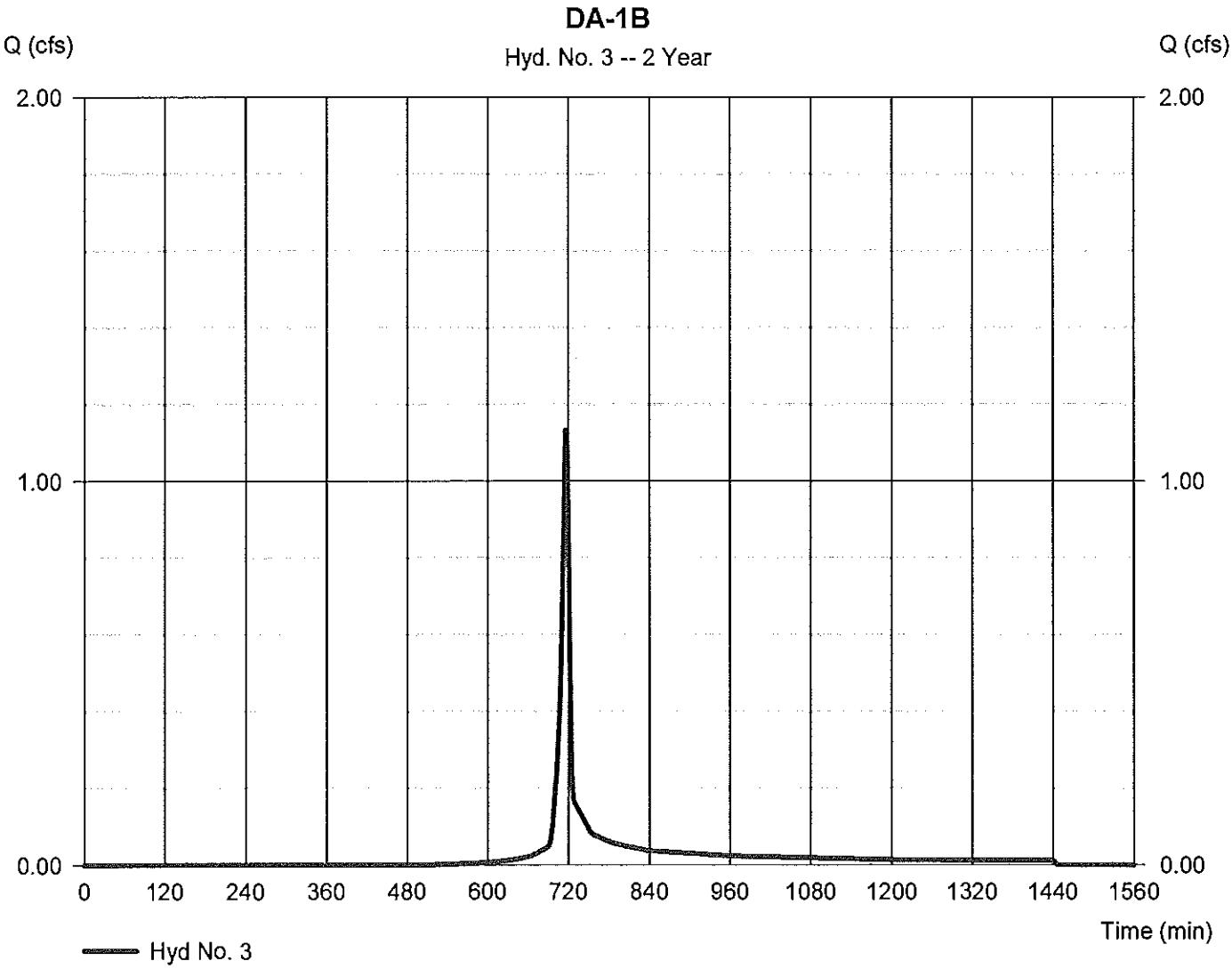
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 1.133 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,287 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



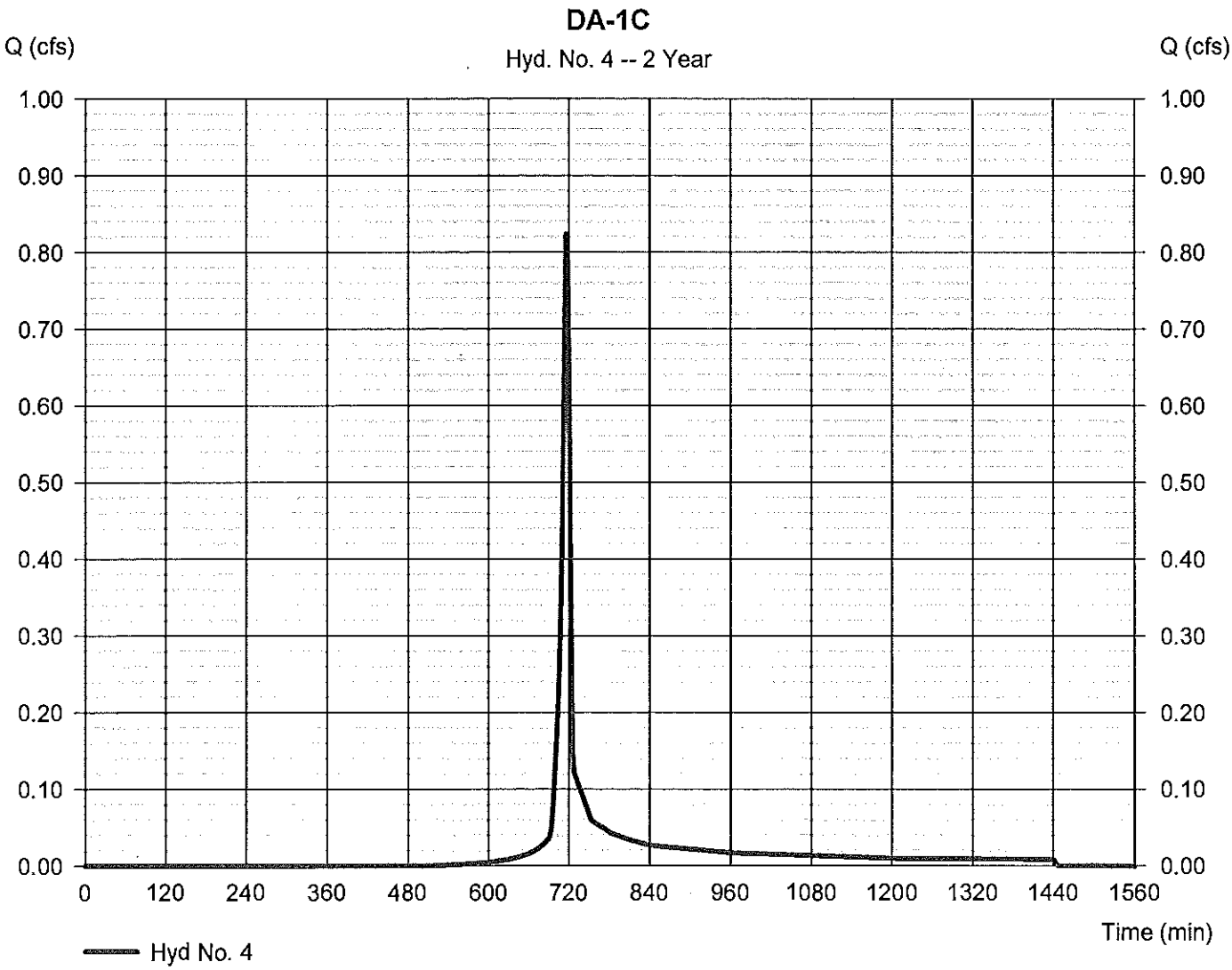
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 0.824 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,663 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

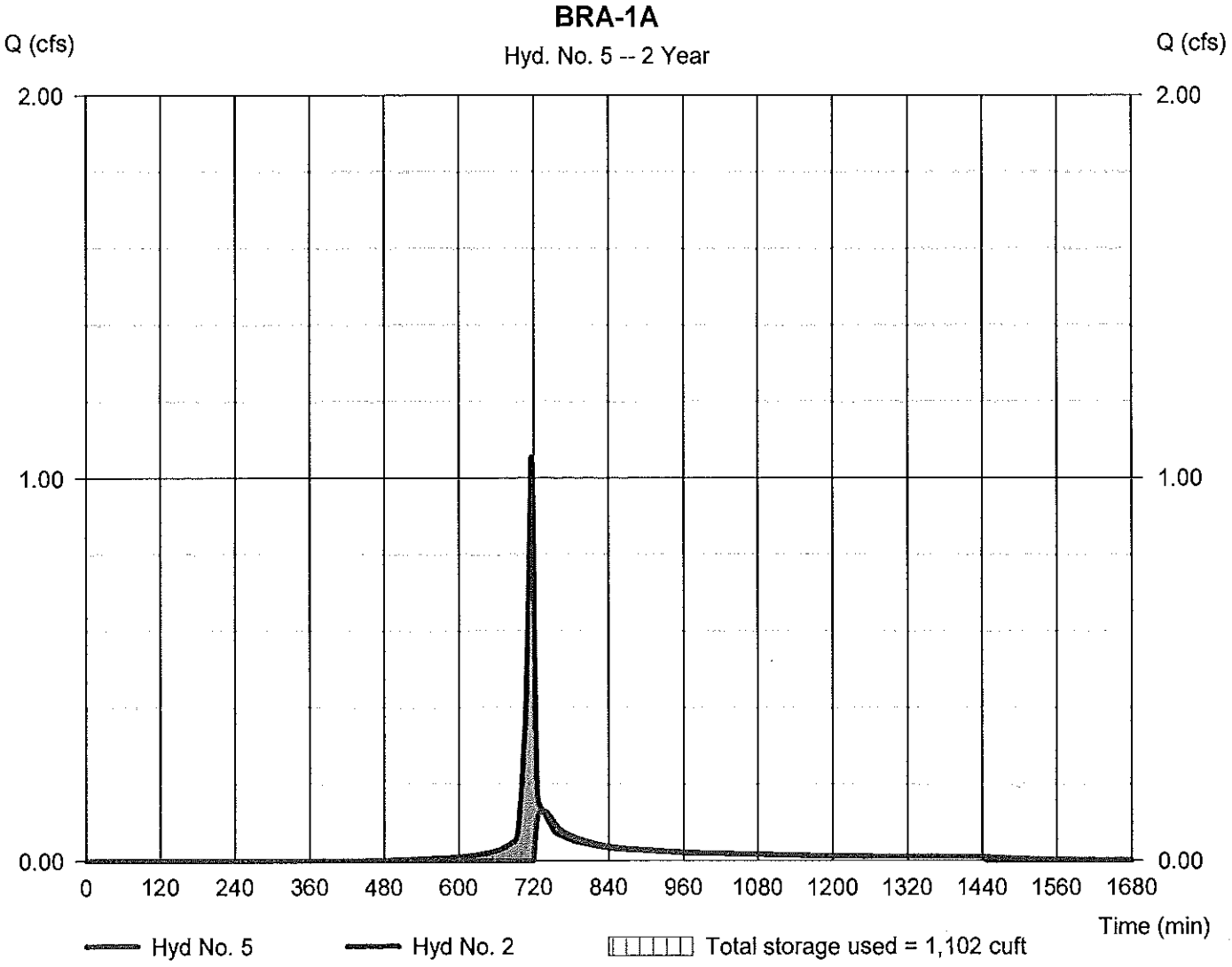
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.130 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 1,188 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.13 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,102 cuft

Storage Indication method used.



Hydrograph Report

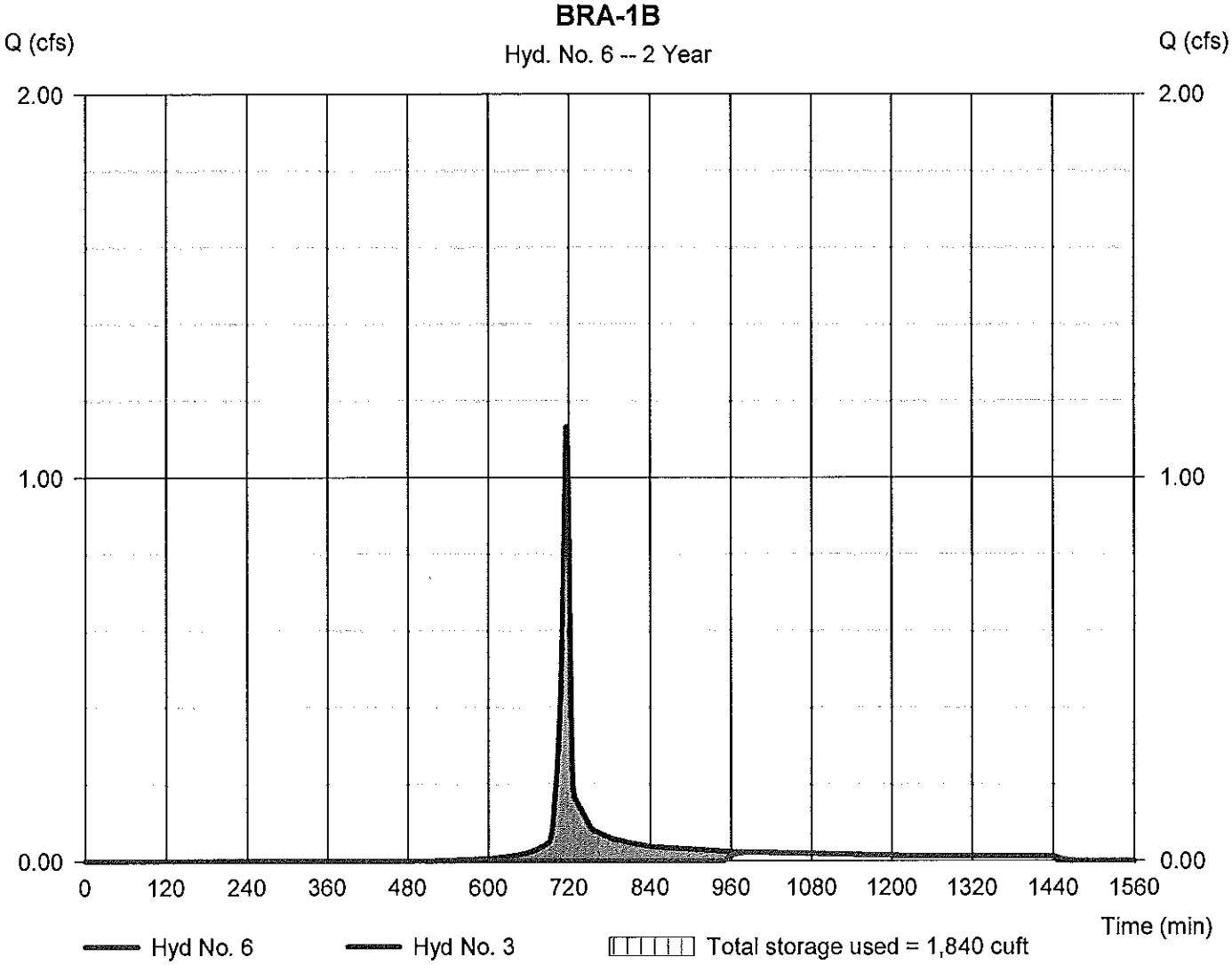
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.022 cfs
Storm frequency	= 2 yrs	Time to peak	= 996 min
Time interval	= 2 min	Hyd. volume	= 462 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.01 ft
Reservoir name	= BRA-1B	Max. Storage	= 1,840 cuft

Storage Indication method used.



Hydrograph Report

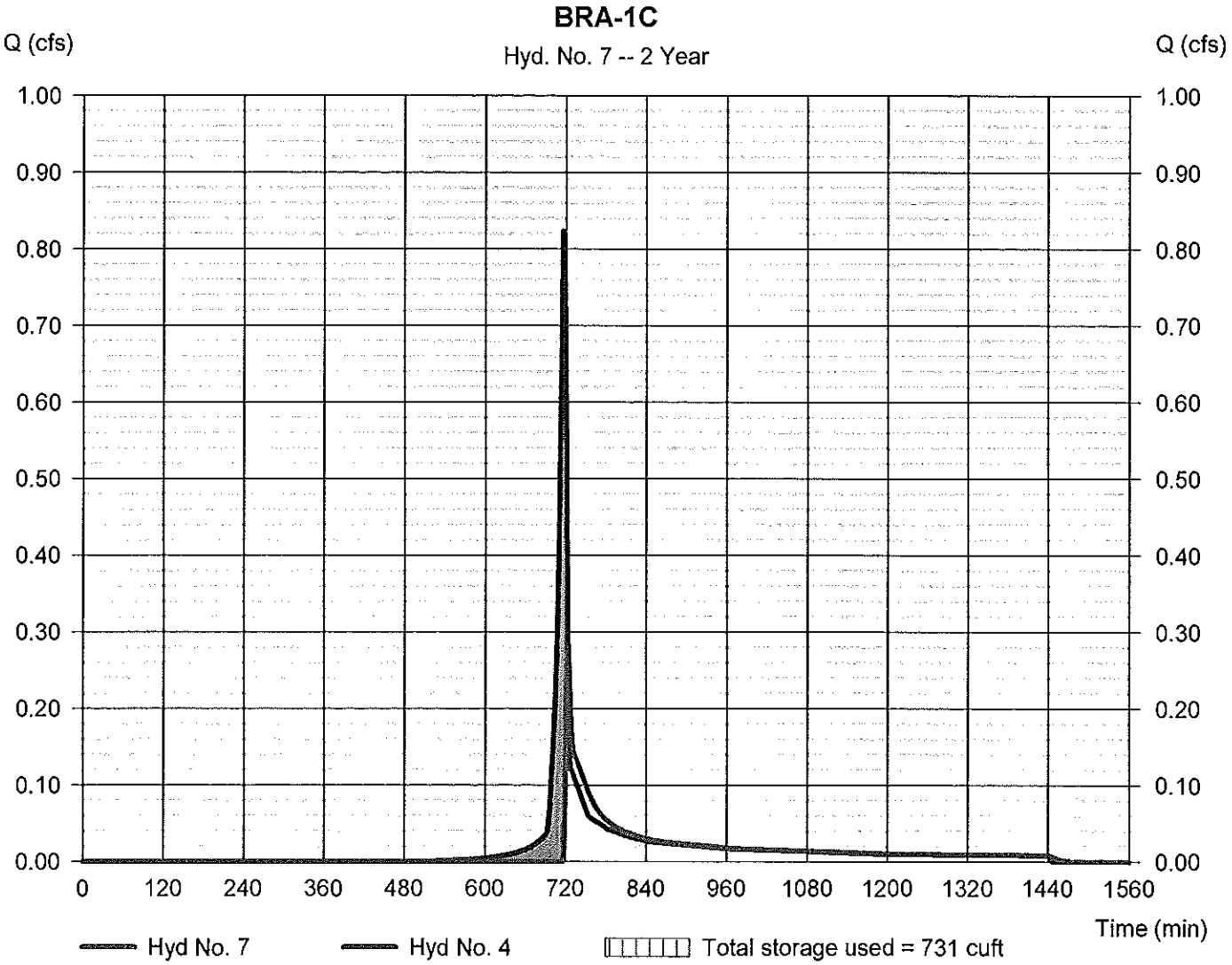
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 0.283 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 1,076 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.62 ft
Reservoir name	= BRA-1C	Max. Storage	= 731 cuft

Storage Indication method used.



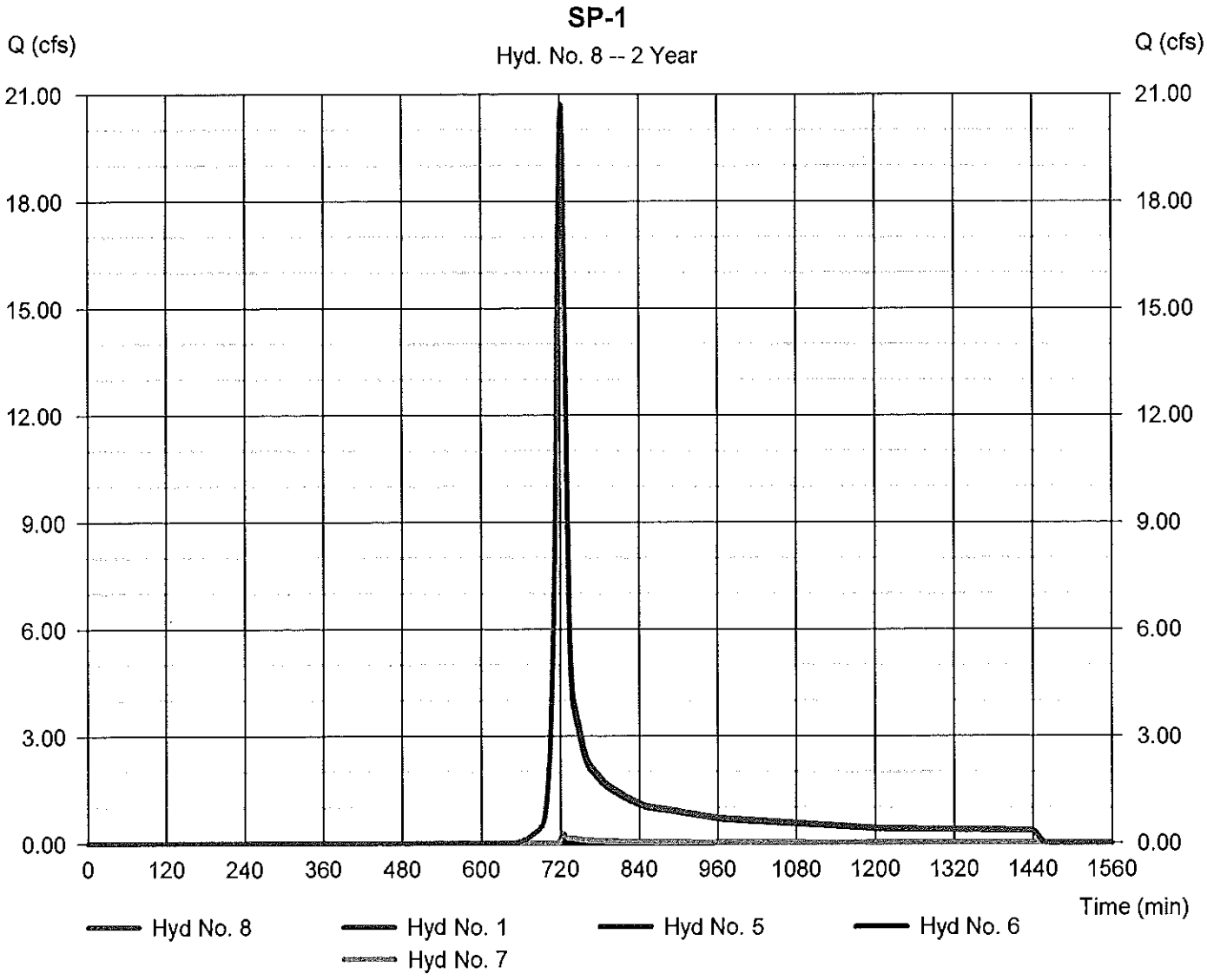
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 8

SP-1

Hydrograph type	= Combine	Peak discharge	= 20.71 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 57,191 cuft
Inflow hyds.	= 1, 5, 6, 7	Contrib. drain. area	= 14.170 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	46.20	2	720	120,098	------	------	------	DA-1
2	SCS Runoff	1.918	2	716	3,985	------	------	------	DA-1A
3	SCS Runoff	2.168	2	716	4,442	------	------	------	DA-1B
4	SCS Runoff	1.577	2	716	3,231	------	------	------	DA-1C
5	Reservoir	0.920	2	730	3,031	2	636.44	1,658	BRA-1A
6	Reservoir	0.631	2	724	2,617	3	637.13	2,197	BRA-1B
7	Reservoir	1.444	2	718	2,643	4	629.78	914	BRA-1C
8	Combine	48.84	2	720	128,389	1, 5, 6, 7	------	------	SP-1

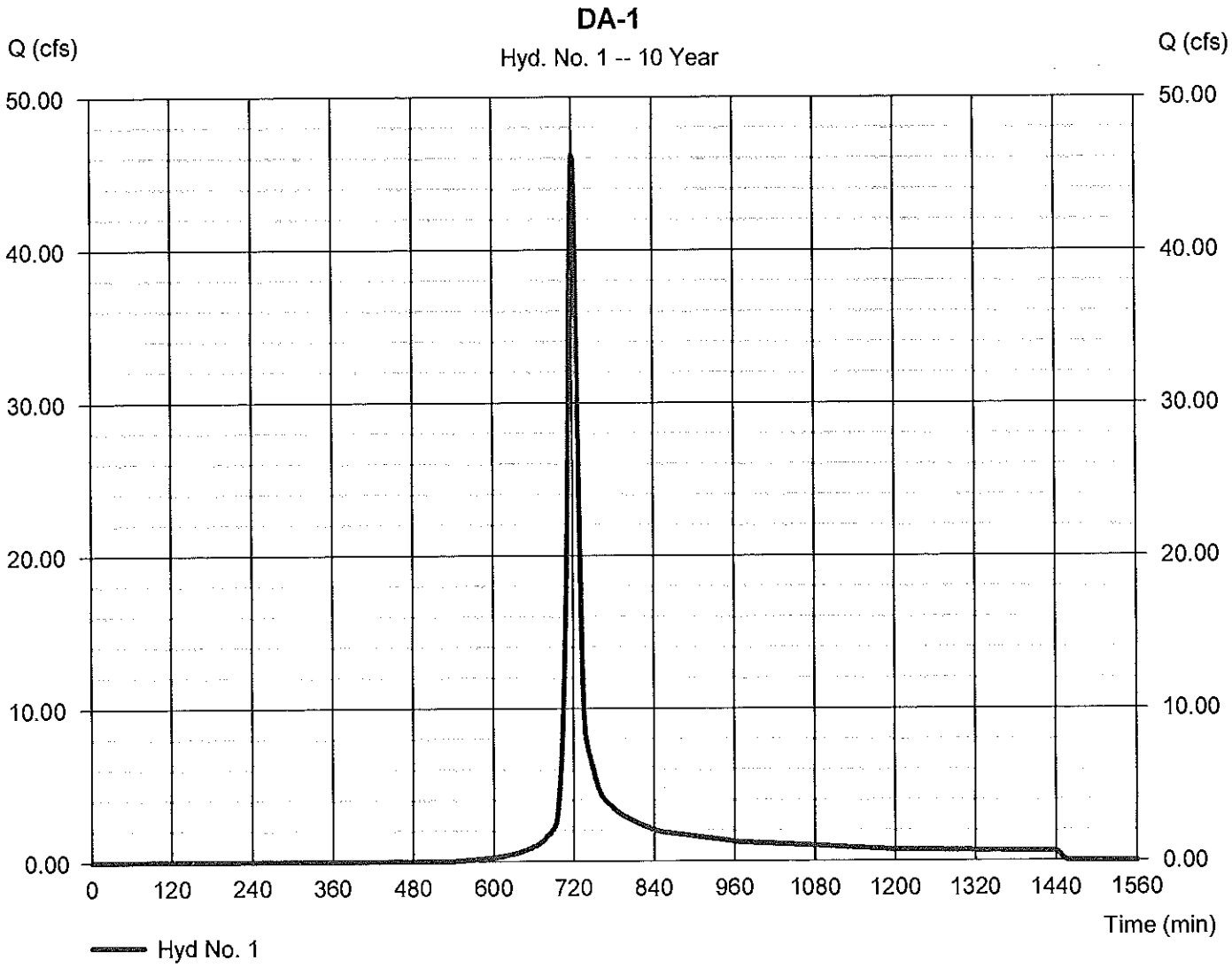
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 46.20 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 120,098 cuft
Drainage area	= 14.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



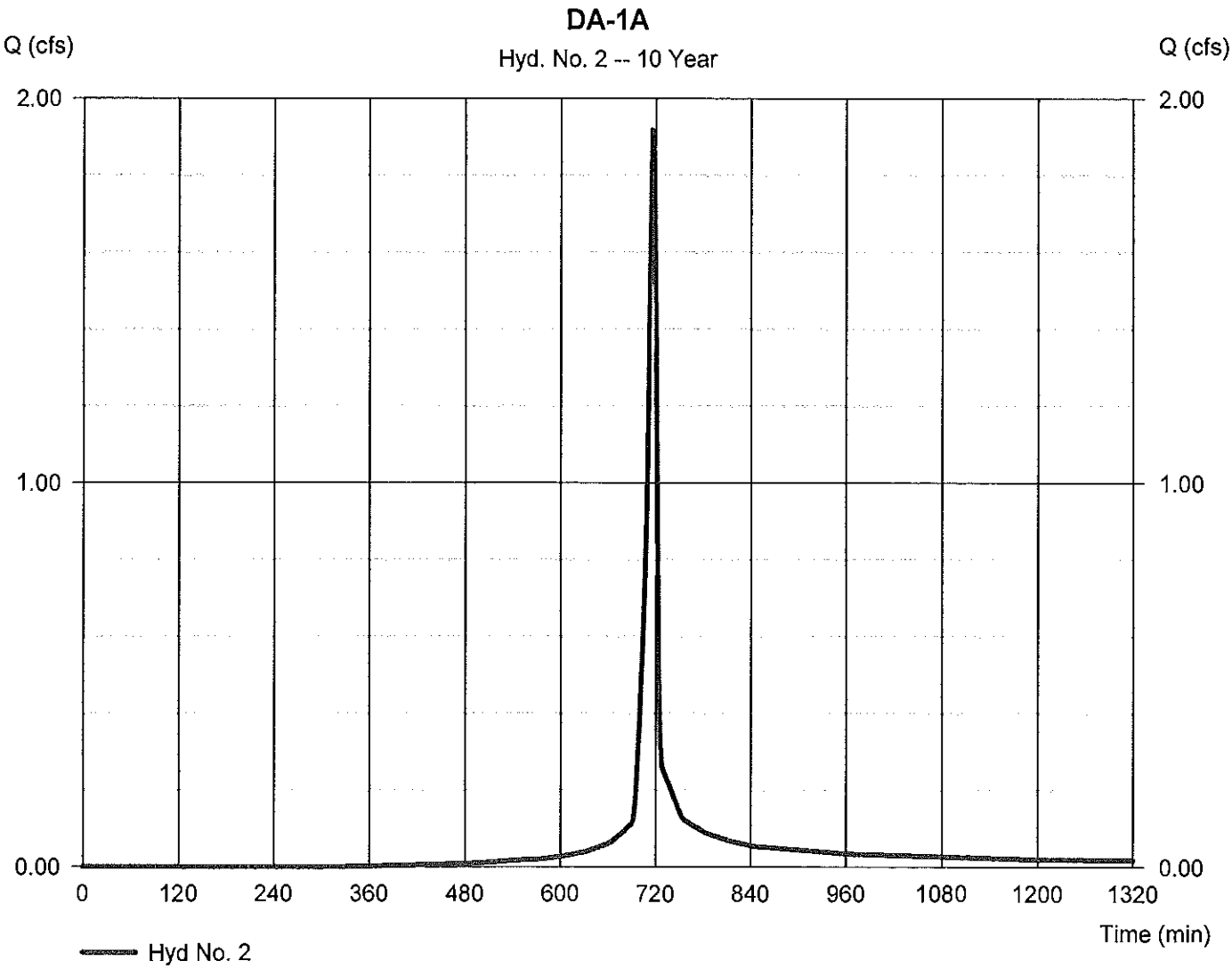
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 1.918 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,985 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



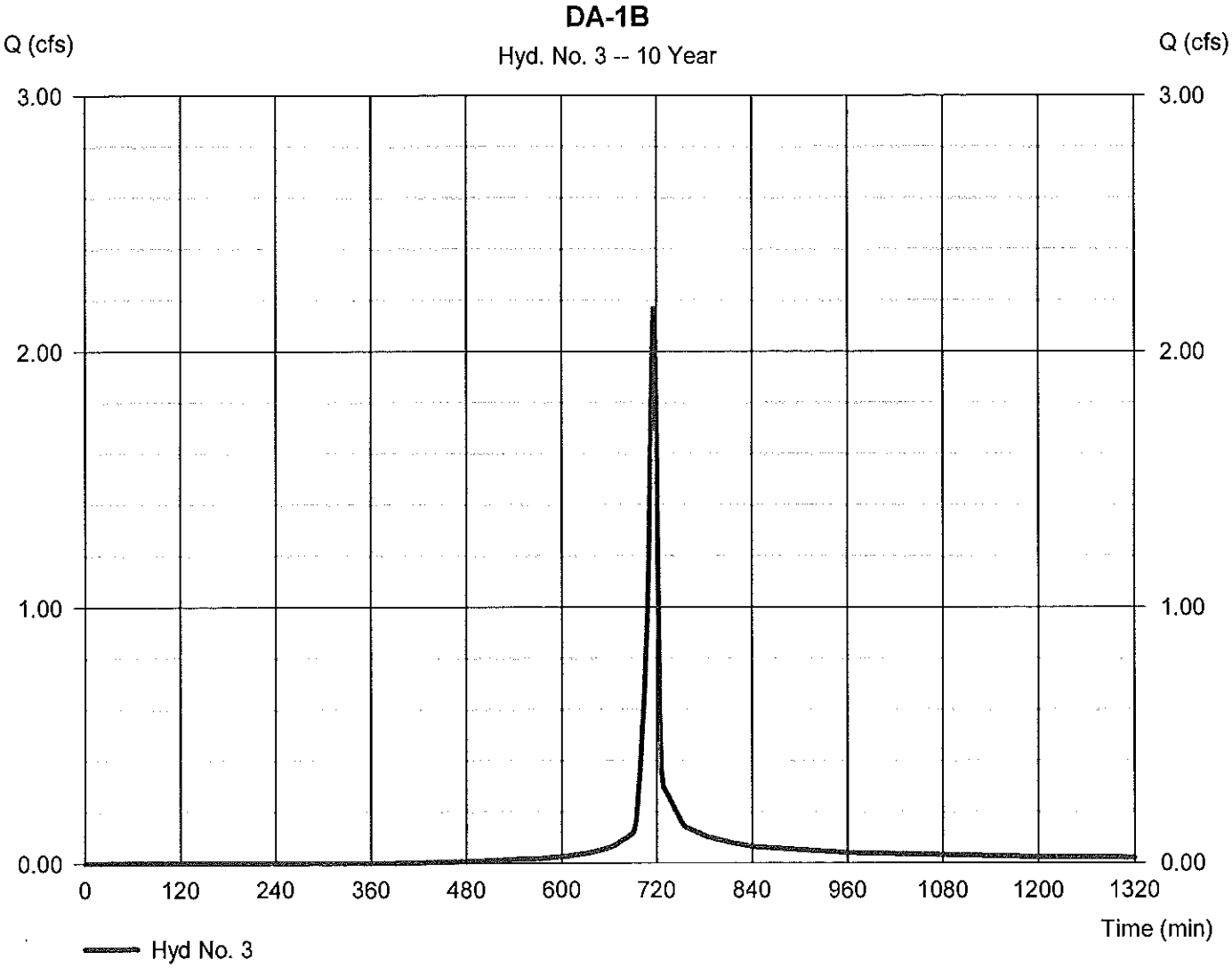
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.168 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,442 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



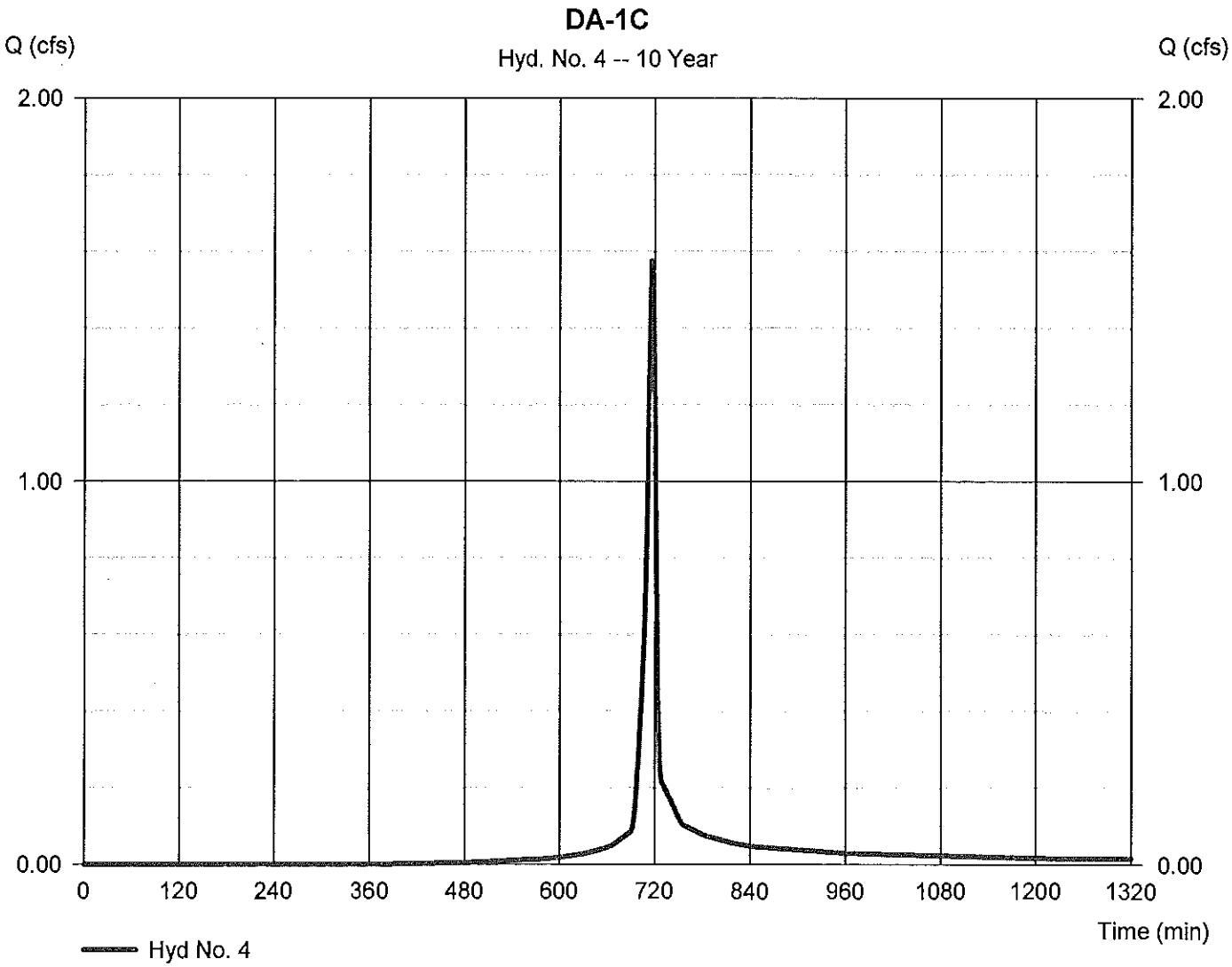
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 1.577 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,231 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

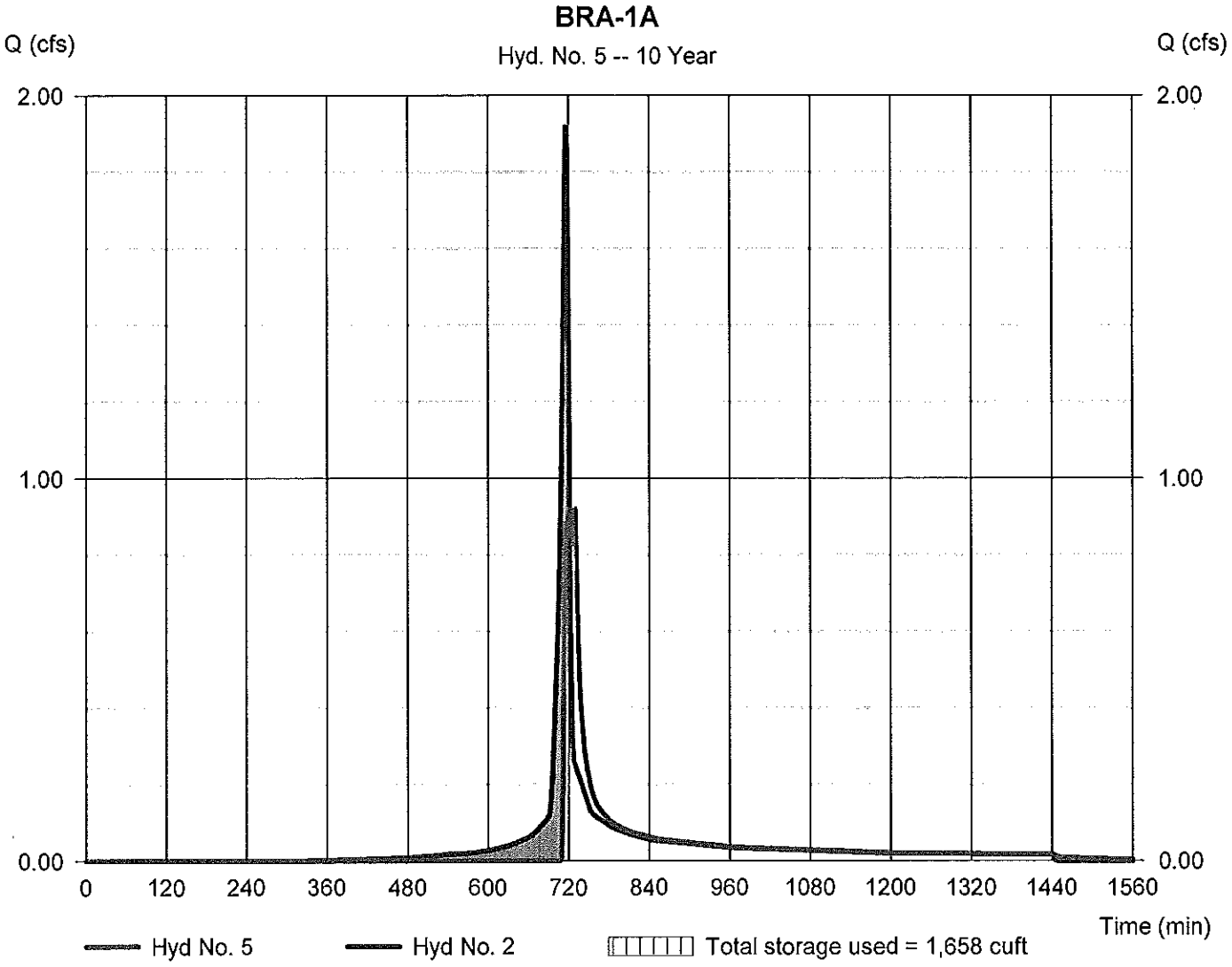
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.920 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 3,031 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.44 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,658 cuft

Storage Indication method used.



Hydrograph Report

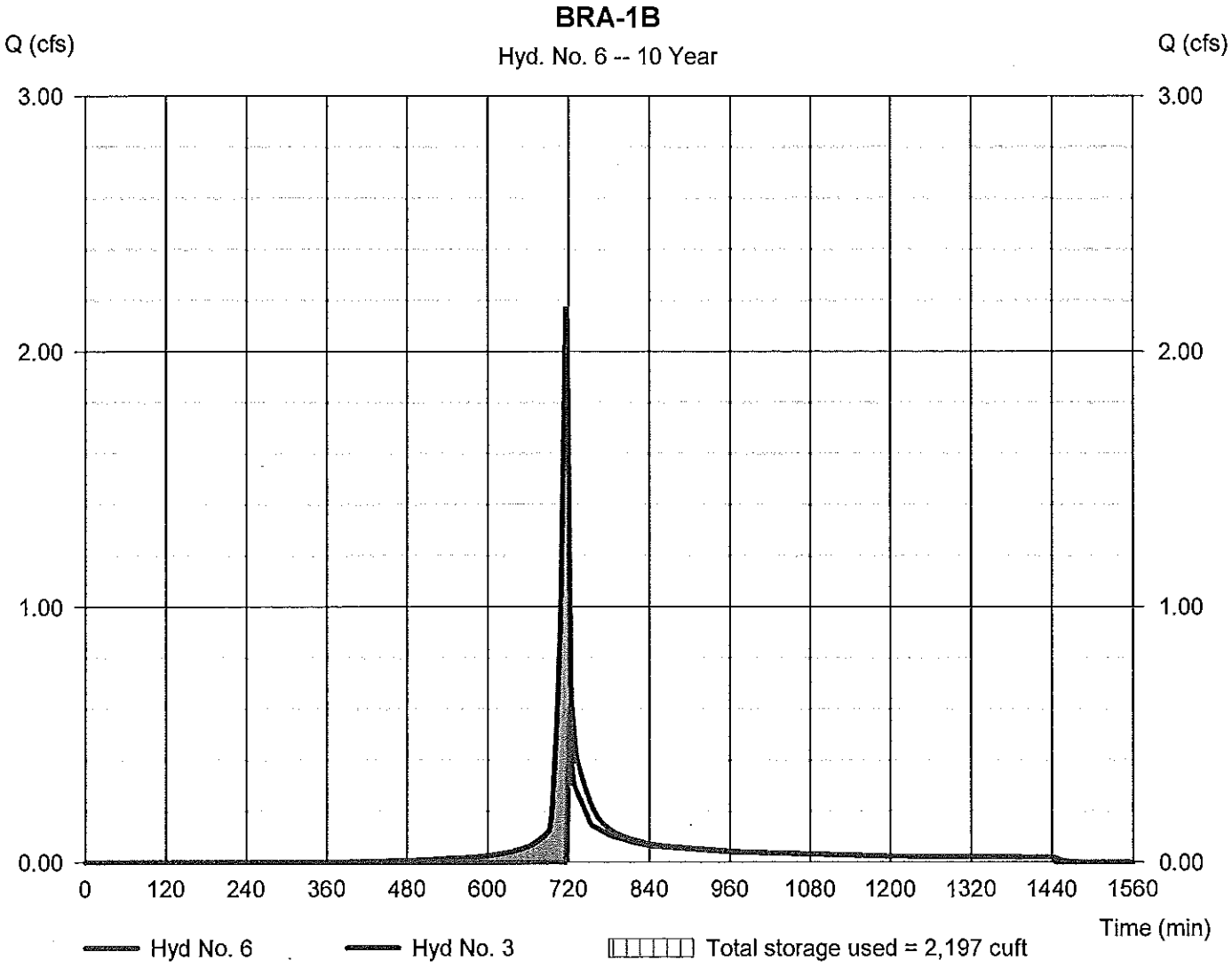
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.631 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 2,617 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.13 ft
Reservoir name	= BRA-1B	Max. Storage	= 2,197 cuft

Storage Indication method used.



Hydrograph Report

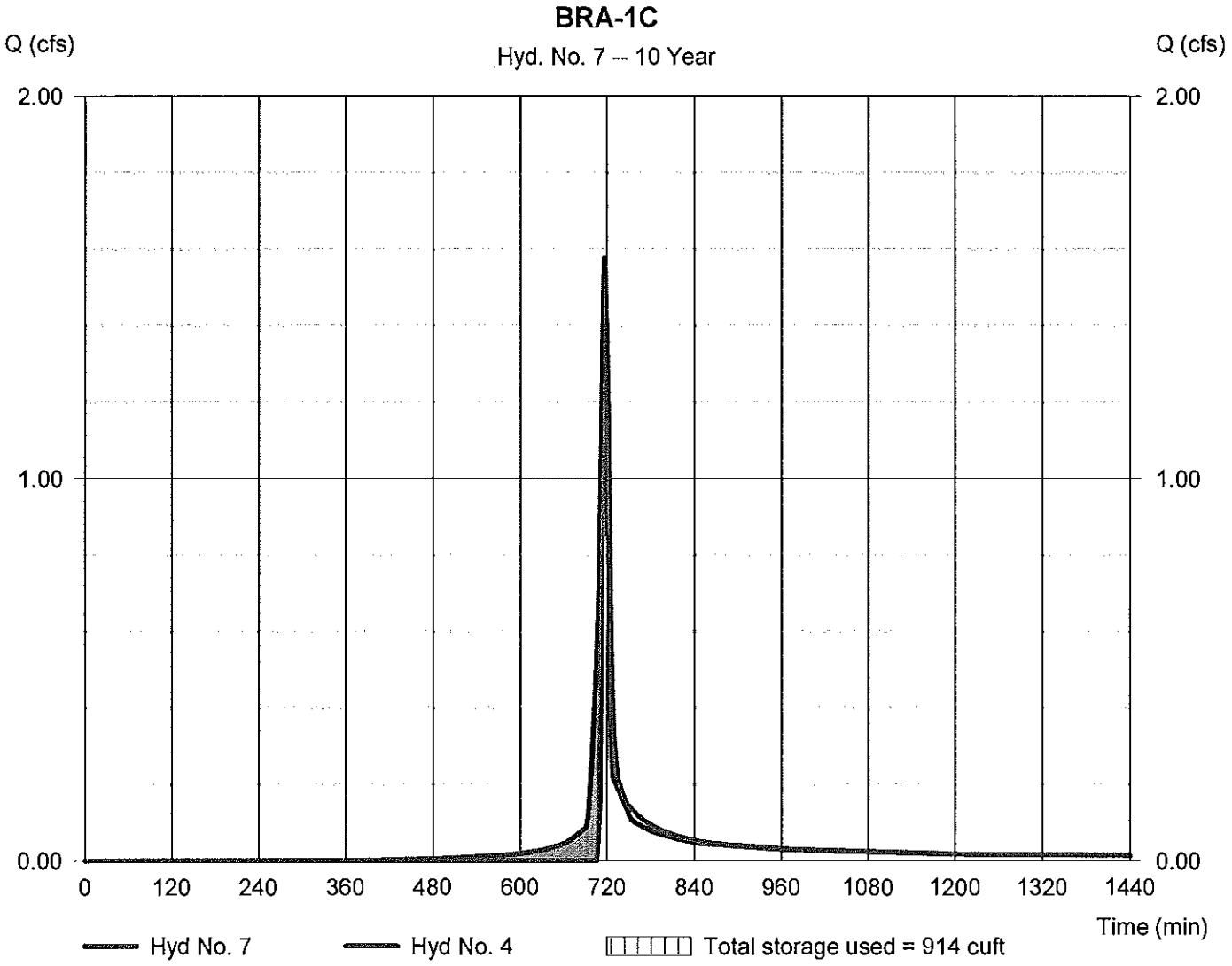
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 1.444 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 2,643 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.78 ft
Reservoir name	= BRA-1C	Max. Storage	= 914 cuft

Storage Indication method used.



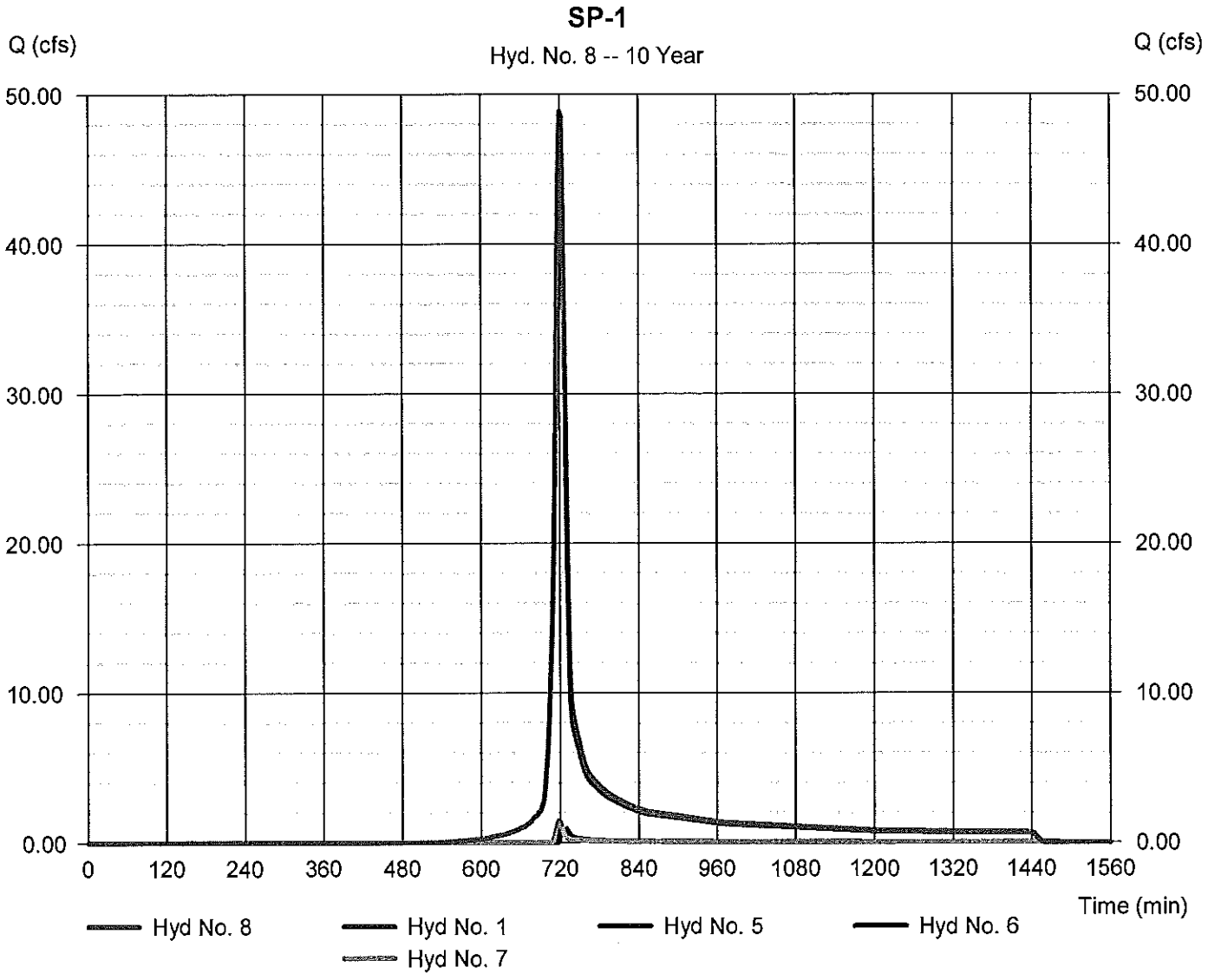
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 8

SP-1

Hydrograph type	= Combine	Peak discharge	= 48.84 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 128,389 cuft
Inflow hyds.	= 1, 5, 6, 7	Contrib. drain. area	= 14.170 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	106.59	2	720	278,467	------	------	------	DA-1
2	SCS Runoff	3.709	2	716	8,030	------	------	------	DA-1A
3	SCS Runoff	4.363	2	716	9,280	------	------	------	DA-1B
4	SCS Runoff	3.173	2	716	6,749	------	------	------	DA-1C
5	Reservoir	1.479	2	722	7,076	2	637.07	2,916	BRA-1A
6	Reservoir	3.631	2	720	7,454	3	637.43	3,054	BRA-1B
7	Reservoir	3.051	2	718	6,161	4	629.93	1,089	BRA-1C
8	Combine	114.47	2	720	299,158	1, 5, 6, 7	------	------	SP-1

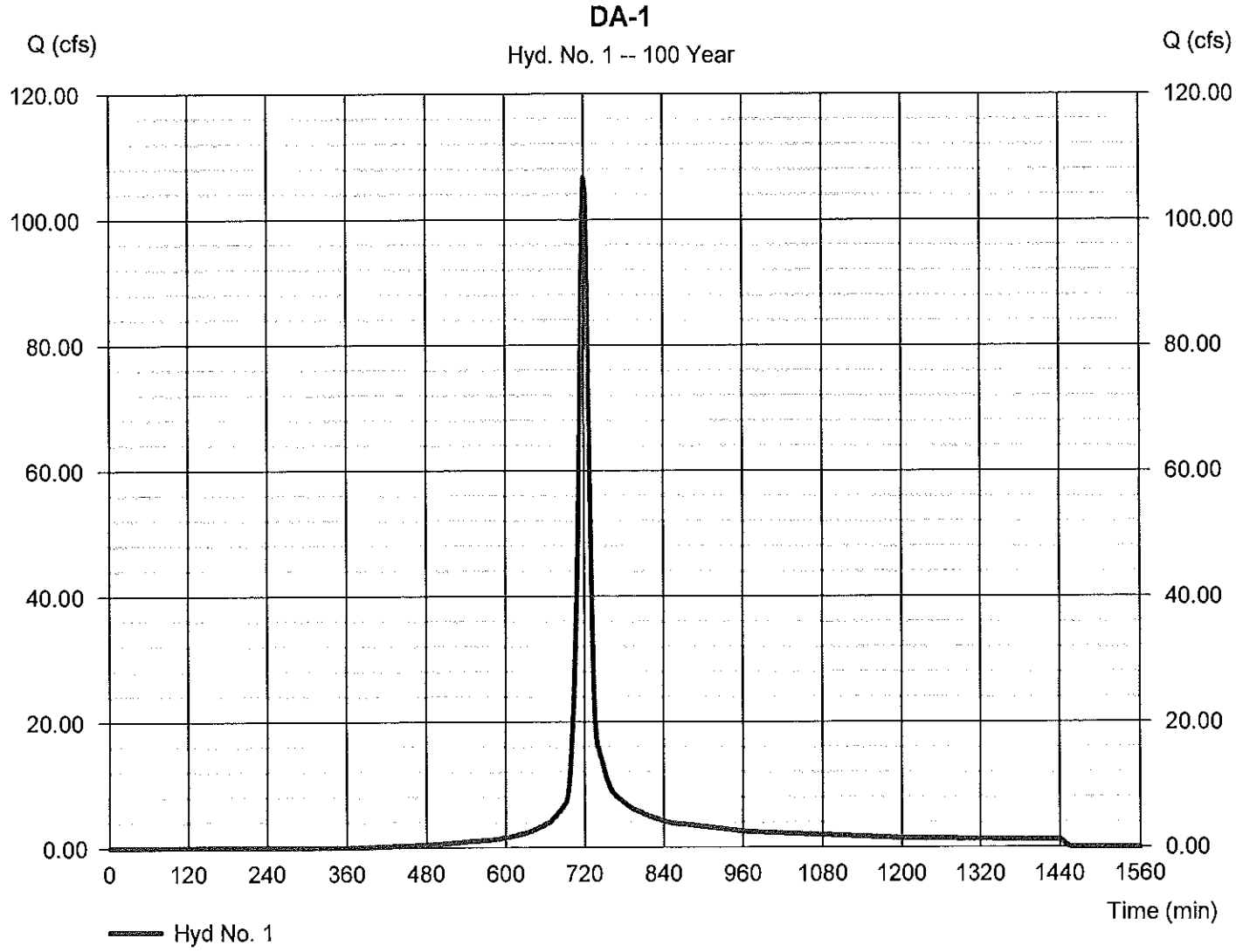
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 1

DA-1

Hydrograph type	= SCS Runoff	Peak discharge	= 106.59 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 278,467 cuft
Drainage area	= 14.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



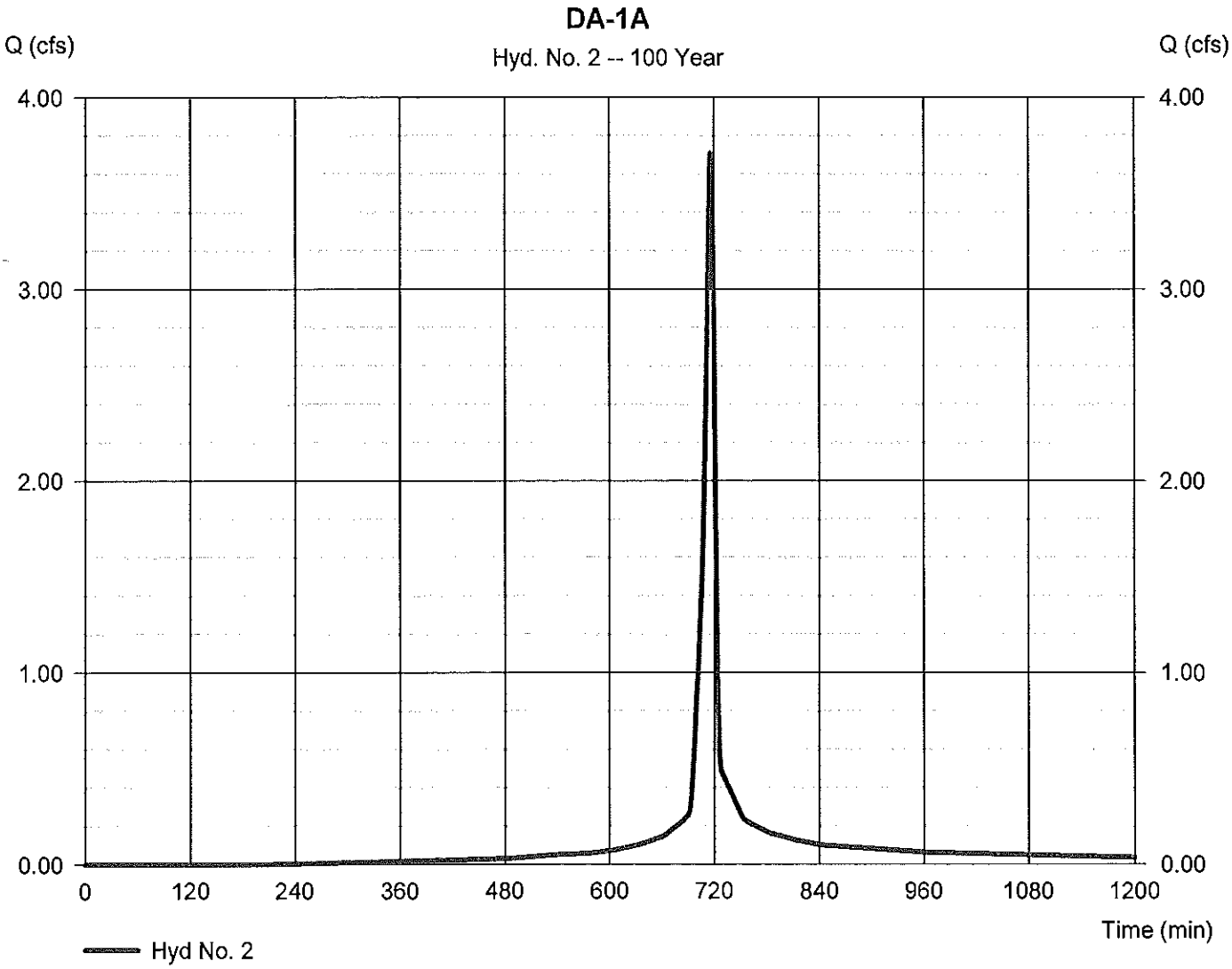
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 3.709 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 8,030 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



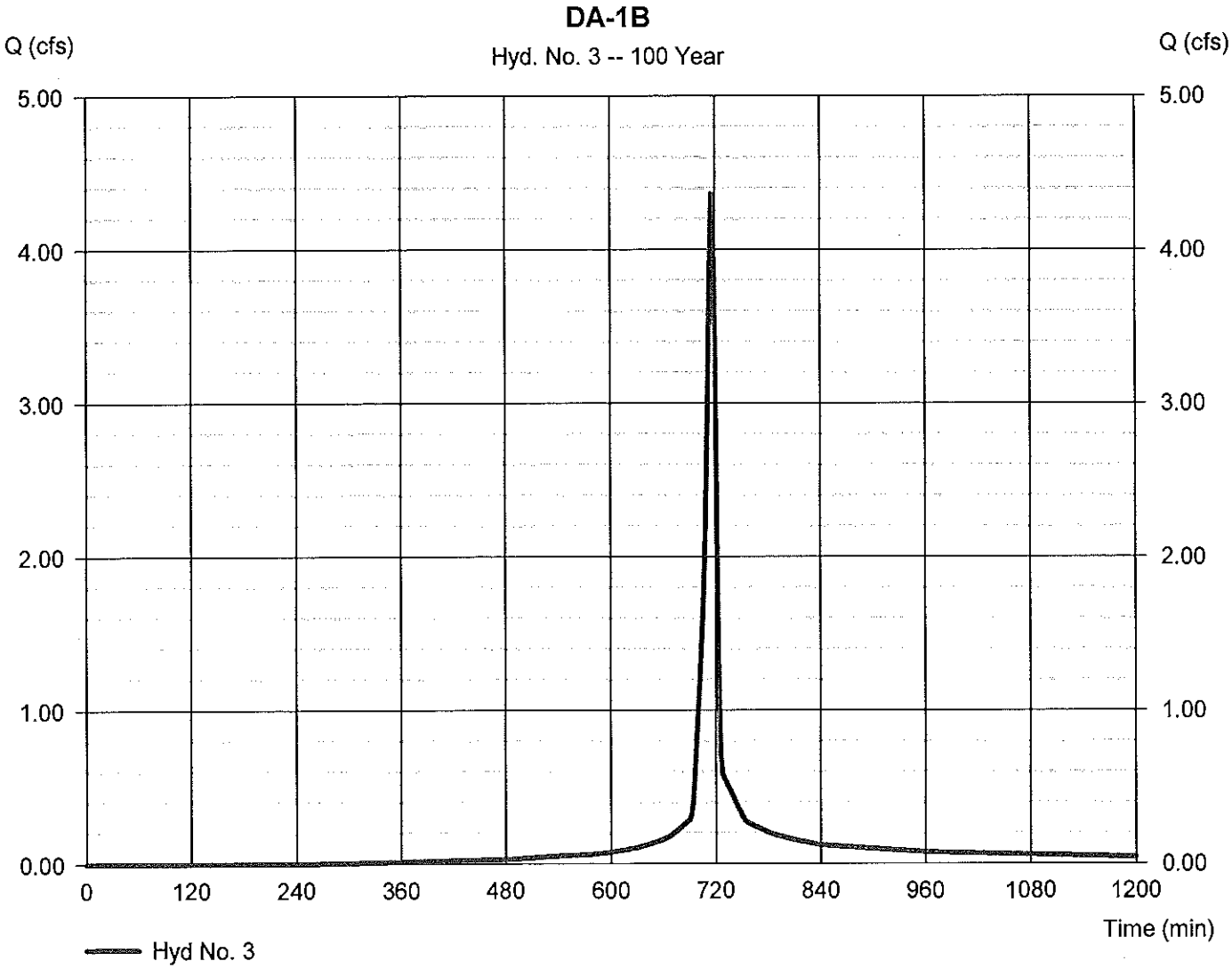
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 4.363 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 9,280 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



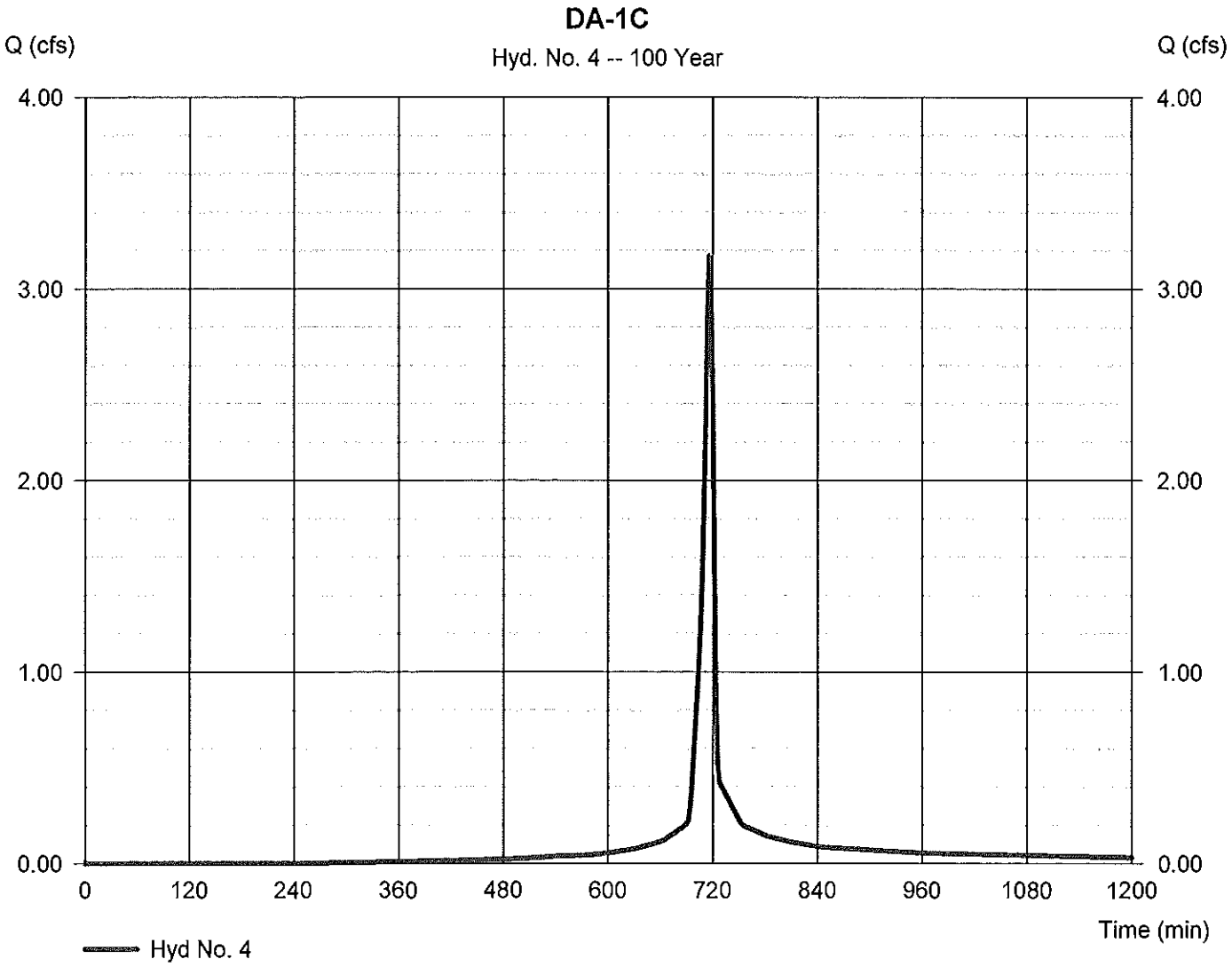
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 3.173 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 6,749 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

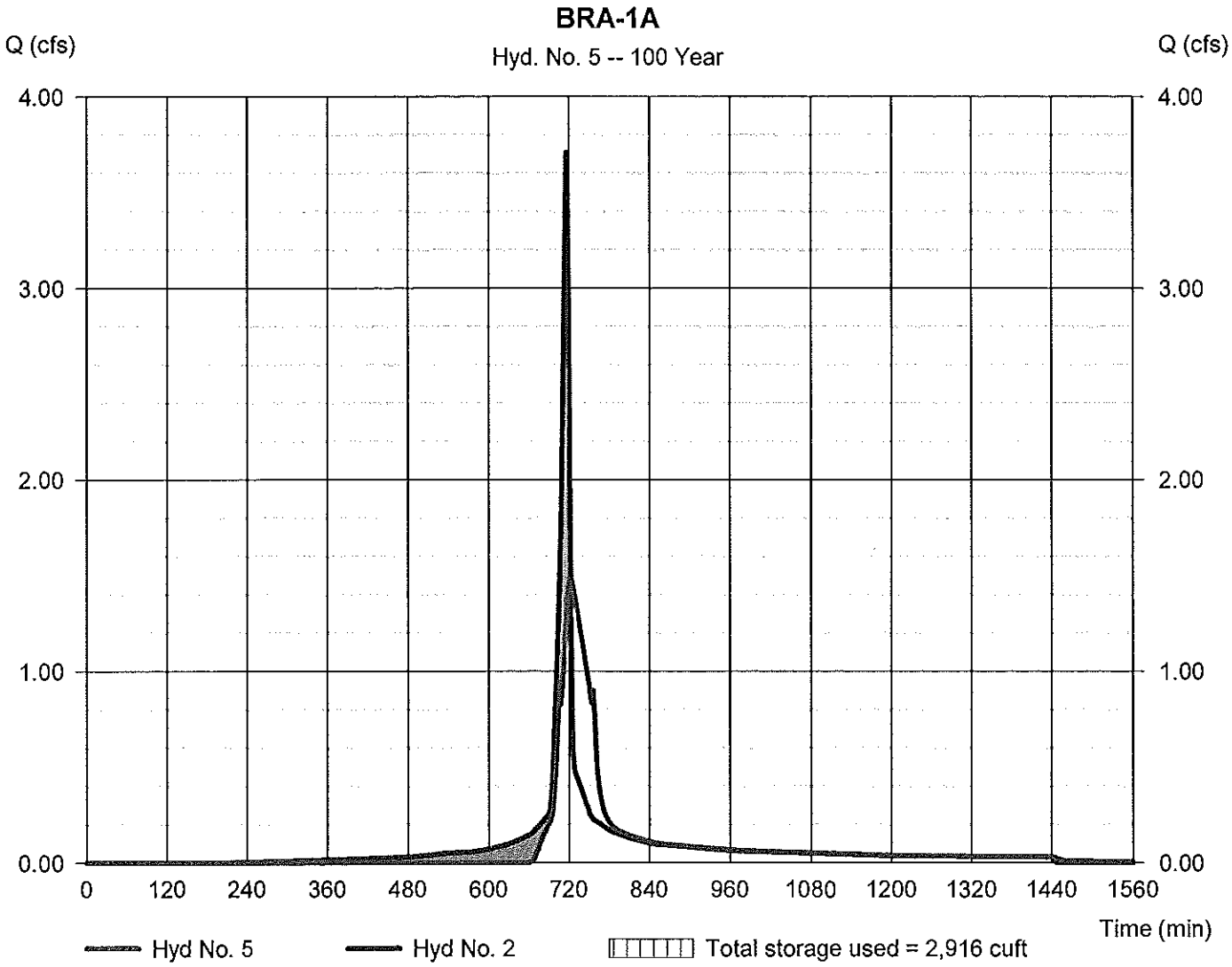
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 1.479 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 7,076 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 637.07 ft
Reservoir name	= BRA-1A	Max. Storage	= 2,916 cuft

Storage Indication method used.



Hydrograph Report

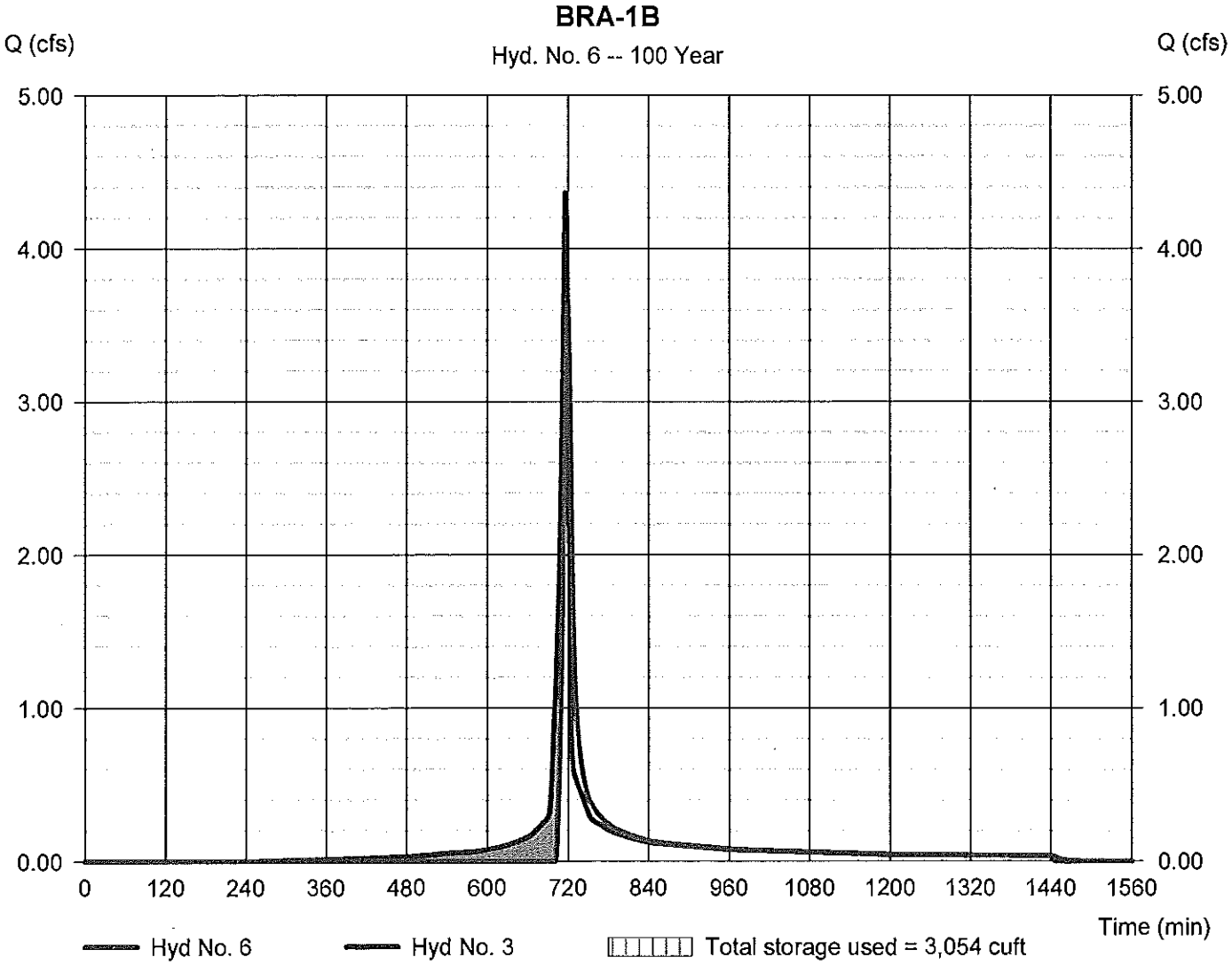
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 3.631 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 7,454 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.43 ft
Reservoir name	= BRA-1B	Max. Storage	= 3,054 cuft

Storage Indication method used.



Hydrograph Report

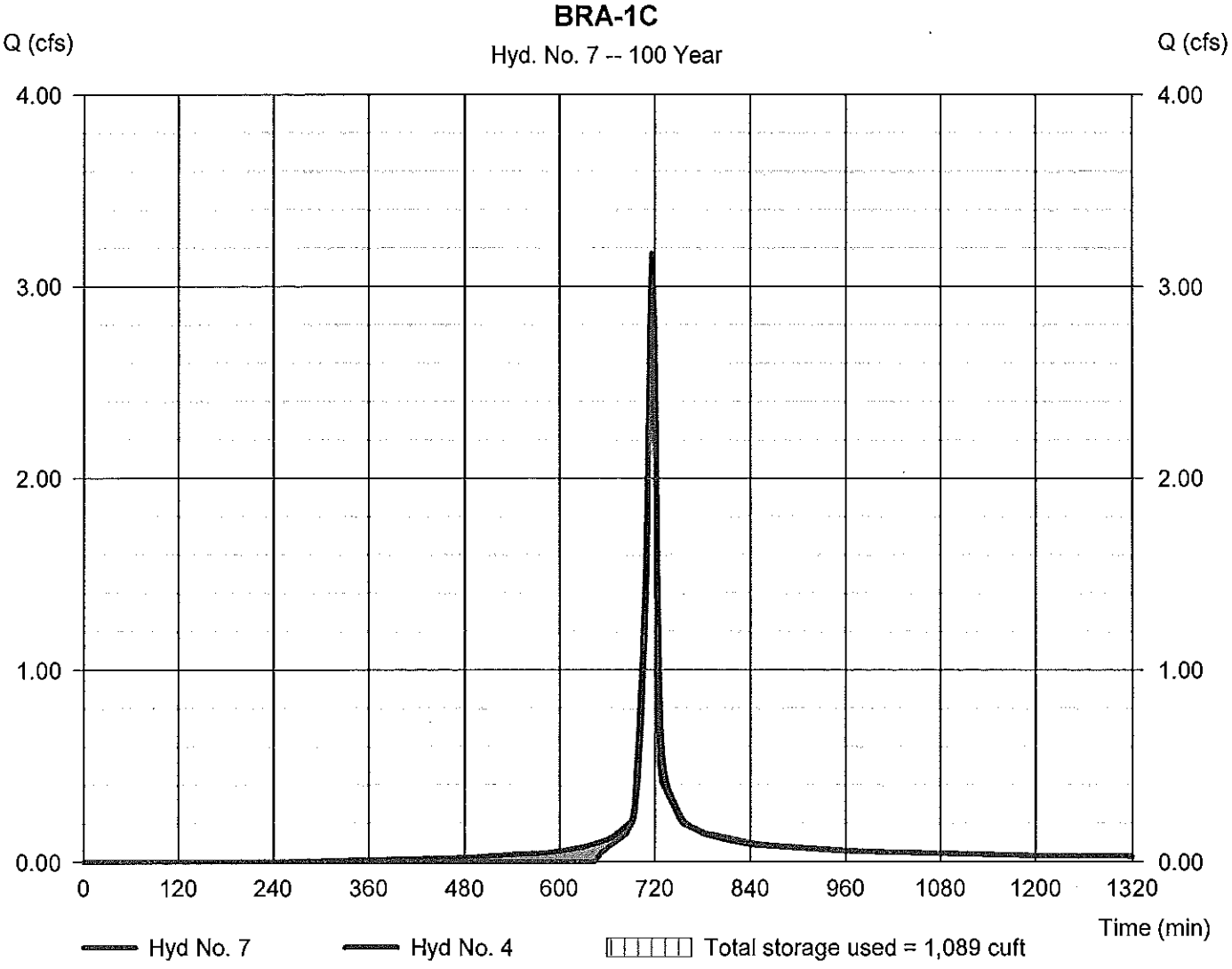
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 3.051 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 6,161 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.93 ft
Reservoir name	= BRA-1C	Max. Storage	= 1,089 cuft

Storage Indication method used.



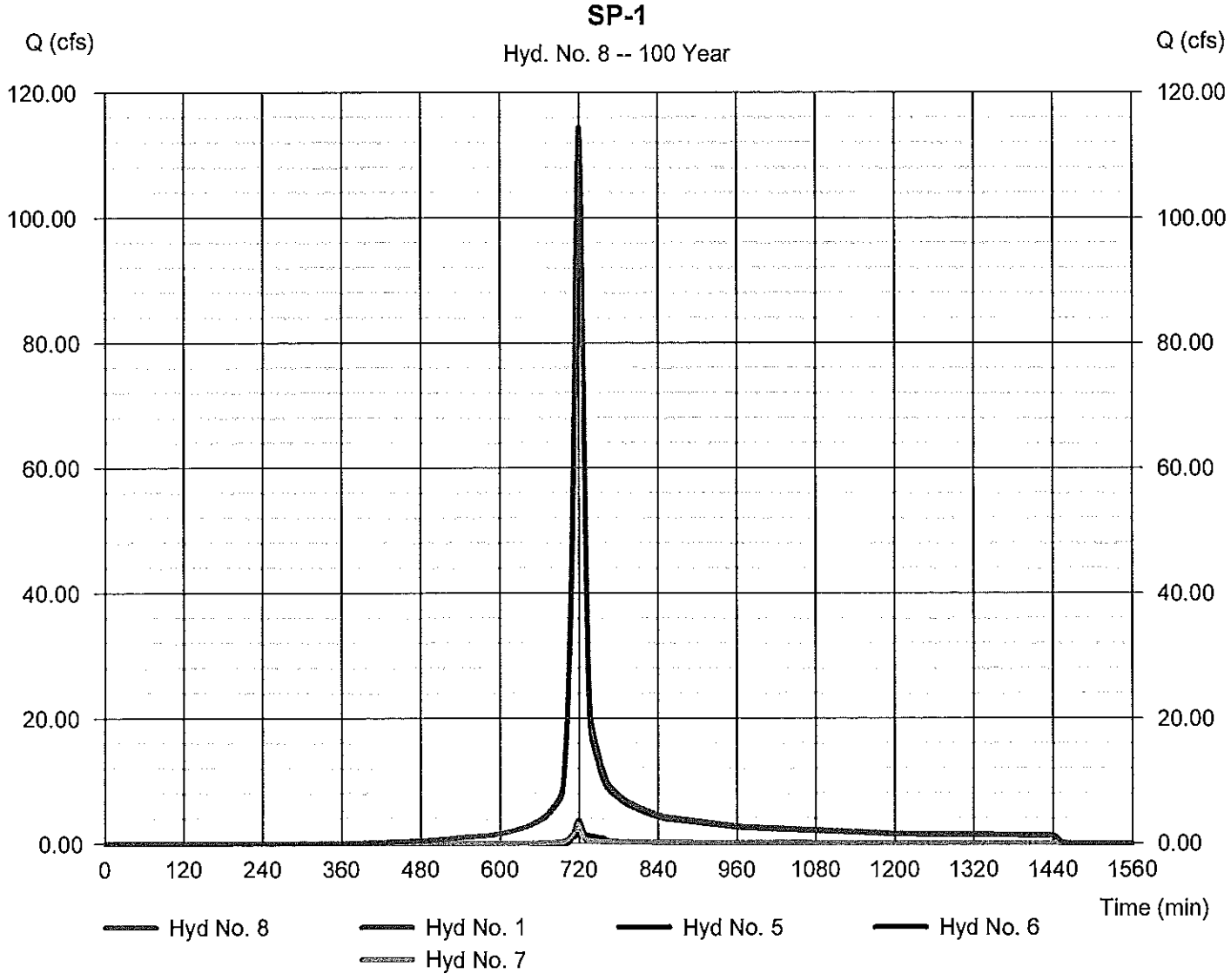
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 8

SP-1

Hydrograph type	= Combine	Peak discharge	= 114.47 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 299,158 cuft
Inflow hyds.	= 1, 5, 6, 7	Contrib. drain. area	= 14.170 ac



APPENDIX - E

BMP Sizing Calculations
(Includes IART Data, P_e , ESD_v , and R_{ev} Calculations)

CARROLL ENGINEERING, INC.
JOB: Brink Zone Reliability Improvments
DATE:09/21/16
BY: C Fishman

Impervious Area Requiring Treatment (IART) Summary Table

Drainage Area: 1 (DA-1)

Total DA Area =	666,186 s.f.	LOD Area =	82,106 s.f. (19628 s.f. of linear utility installation)
New Impervious Area (A_{in}) =		18,297 s.f.	
Reconstructed Existing Impervious Area (A_{ir}) =		0 s.f.	
Existing Impervious Area Removed (A_{ire}) =		0 s.f.	
Existing Impervious Area (Ex Ai = Air + Aire) =		0 s.f.	
Proposed Impervious Area (Prop Ai = Air + Ain) =		18,297 s.f.	
Δ Impervious Area (Δ Ai = Prop Ai - Ex Ai) =		18,297 s.f.	
IART= Existing Imp Area + Δ Imp Area=		18,297 s.f.	

TOTAL IART (DA-1) = 18,297 s.f.

Table 5.3 Rainfall Targets/Runoff Curve Number Reductions used for ESD

Hydrologic Soil Group A										
%I	RCN*	P_E = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	40									
5%	43									
10%	46									
15%	48	38								
20%	51	40	38	38						
25%	54	41	40	39						
30%	57	42	41	39	38					
35%	60	44	42	40	39					
40%	61	44	42	40	39					
45%	66	48	46	41	40					
50%	69	51	48	42	41	38				
55%	72	54	50	42	41	39				
60%	74	57	52	44	42	40	38			
65%	77	61	55	47	44	42	40			
70%	80	66	61	55	50	45	40			
75%	84	71	67	62	56	48	40	38		
80%	86	73	70	65	60	52	44	40		
85%	89	77	74	70	65	58	49	42	38	
90%	92	81	78	74	70	65	58	48	42	38
95%	95	85	82	78	75	70	65	57	50	39
100%	98	89	86	83	80	76	72	66	59	40

Hydrologic Soil Group B										
%I	RCN*	P_E = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	61									
5%	63									
10%	65									
15%	67	55								
20%	68	60	55	55						
25%	70	64	61	58						
30%	72	65	62	59	55					
35%	74	66	63	60	56					
40%	75	66	63	60	56					
45%	78	68	66	62	58					
50%	80	70	67	64	60					
55%	81	71	68	65	61	55				
60%	83	73	70	67	63	58				
65%	85	75	72	69	65	60	55			
70%	87	77	74	71	67	62	57			
75%	89	79	76	73	69	65	59			
80%	91	81	78	75	71	66	61			
85%	92	82	79	76	72	67	62	55		
90%	94	84	81	78	74	70	65	59	55	
95%	96	87	84	81	77	73	69	63	57	
100%	98	89	86	83	80	76	72	66	59	55

Cp_v Addressed (RCN = Woods in Good Condition)

RCN Applied to Cp_v Calculations

Table 5.3 Runoff Curve Number Reductions used for Environmental Site Design (continued)

Hydrologic Soil Group C										
%I	RCN*	P_E = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	74									
5%	75									
10%	76									
15%	78									
20%	79	70								
25%	80	72	70	70						
30%	81	73	72	71						
35%	82	74	73	72	70					
40%	84	77	75	73	71					
45%	85	78	76	74	71					
50%	86	78	76	74	71					
55%	86	78	76	74	71	70				
60%	88	80	78	76	73	71				
65%	90	82	80	77	75	72				
70%	91	82	80	78	75	72				
75%	92	83	81	79	75	72				
80%	93	84	82	79	76	72				
85%	94	85	82	79	76	72				
90%	95	86	83	80	77	73	70			
95%	97	88	85	82	79	75	71			
100%	98	89	86	83	80	76	72	70		

Hydrologic Soil Group D										
%I	RCN*	P_E = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	80									
5%	81									
10%	82									
15%	83									
20%	84	77								
25%	85	78								
30%	85	78	77	77						
35%	86	79	78	78						
40%	87	82	81	79	77					
45%	88	82	81	79	78					
50%	89	83	82	80	78					
55%	90	84	82	80	78					
60%	91	85	83	81	78					
65%	92	85	83	81	78					
70%	93	86	84	81	78					
75%	94	86	84	81	78					
80%	94	86	84	82	79					
85%	95	86	84	82	79					
90%	96	87	84	82	79	77				
95%	97	88	85	82	80	78				
100%	98	89	86	83	80	78	77			

[ ] Cp_v Addressed (RCN = Woods in Good Condition)

[ ] RCN Applied to Cp_v Calculations

ESDv / Rev Calculations - Overall

Environmental Site Design Volume Calculations (ESDv) (2007 Regulations)

DA-1(Drains to the East)

Prop. DA:	**666,186**	s.f.	IART:	18,297	s.f.
Total LOD:	**82,106**	s.f.			
Total Prop. Imp.:	**18,297**	s.f.	(Existing Ai = Air + Aire = 0		

Proposed Ai = Air + Ain = 18297

Δ Ai = Prop Ai - Ex Ai= 18297- 0 = 18297

IART = 100% Existing Ai + 100% Δ Ai = 0 + 18297 = 18297)

ESDv Calculations - LOD

Overall LOD:

LOD Area: **82,106** s.f.
Imperv: **18,297** s.f.

- **Soil Type HSG-B (S=0.26)**

LOD Area: **2,843** s.f.
Imperv: **0** s.f.

% Imp.= Imp Area(within LOD)/ LOD Area =
% Imp.= 0.0% (New Development)

Pe = 1.0" (New Development)
Soil: HSG-B (S = 0.26)

Rv = 0.05+(0.009 x Imp.)
Rv = 0.05+(0.009 x 0.00)
Rv = 0.05

$$\text{ESDv (HSG-C)} = \frac{(Pe)(Rv)(A)}{12}$$

$$\text{Target ESDv (HSG-C)} = \frac{(1.0)\quad(0.05)\quad(2843)}{12} = 12 \text{ c.f.}$$

$$\text{Rev} = \frac{(S)(Rv)(A)}{12}$$

$$\text{Required Rev (HSG-C)} = \frac{(0.26)\quad(0.05)\quad(2843)}{12} = 3 \text{ c.f.}$$

(Continued on following sheets)

- **Soil Type HSG-C (S=0.13)**

LOD Area: **79,263** s.f.
Imperv: **18,429** s.f.

% Imp.= Imp Area(within LOD)/ LOD Area =
% Imp.= 23.3% (New Development)

Pe = 1.2" (New Development)
Soil: HSG-C (S = 0.13)

Rv = 0.05+(0.009 x Imp.)
Rv = 0.05+(0.009 x 23.25)
Rv = 0.26

$$\text{ESDv (HSG-C)} = \frac{(Pe)(Rv)(A)}{12}$$

$$\text{Target ESDv (HSG-C)} = \frac{(1.2)\quad(0.26)\quad(79263)}{12} = 2{,}061 \text{ c.f.}$$

$$Re_v = \frac{(S)(Rv)(A)}{12}$$

$$\text{Required } Re_v \text{ (HSG-C)} = \frac{(0.13)\quad(0.26)\quad(79263)}{12} = 223 \text{ c.f.}$$

Total **Target ESDv** for LOD = **2073** c.f.
Total **Required Rev** for for LOD = **226** c.f.

ESDv / Rev Calculations - Drainage Areas

BRA-1A:

Sub-DA: **15,533** s.f.
Imperv: **8,043** s.f.

% Imp.= Imp Area(within LOD)/ LOD Area =
% Imp.= 51.8% (New Development)

Pe = 1.8" (New Development)
Soil: HSG-C (S = 0.13)

Rv = 0.05+(0.009 x Imp.)
Rv = 0.05+(0.009 x 51.78)
Rv = 0.52

$$\text{ESDv (HSG-C)} = \frac{(Pe)(Rv)(A)}{12}$$

$$\text{Target ESDv (HSG-C)} = \frac{(1.8)\quad(0.52)\quad(15533)}{12} = 1{,}212 \text{ c.f.}$$

$$\text{Rev} = \frac{(S)(Rv)(A)}{12}$$

$$\text{Required Rev (HSG-C)} = \frac{(0.13)\quad(0.52)\quad(15533)}{12} = 88 \text{ c.f.}$$

(Continued on following sheets)

BRA-1B:

Sub-DA: **19,321** s.f.
Imperv: **7,080** s.f.

% Imp.= Imp Area(within LOD)/ LOD Area =
% Imp.= 36.6% (New Development)

Pe = 1.7" (New Development)
Soil: HSG-C (S = 0.13)

Rv = 0.05+(0.009 x Imp.)
Rv = 0.05+(0.009 x 36.64)
Rv = 0.38

$$\text{ESDv (HSG-D)} = \frac{(Pe)(Rv)(A)}{12}$$

$$\text{Target ESDv (HSG-D)} = \frac{(1.7)\quad(0.38)\quad(19321)}{12} = 1{,}040 \text{ c.f.}$$

$$\text{Rev} = \frac{(S)(Rv)(A)}{12}$$

$$\text{Required Rev (HSG-C)} = \frac{(0.13)\quad(0.38)\quad(19321)}{12} = 80 \text{ c.f.}$$

(Continued on following sheets)

BRA-1C:

Sub-DA: **14,023** s.f.
Imperv: **4,986** s.f.

% Imp.= Imp Area(within LOD)/ LOD Area =
% Imp.= 35.6% (New Development)

Pe = 1.6" (New Development)
Soil: HSG-C (S = 0.13)

Rv = 0.05+(0.009 x Imp.)
Rv = 0.05+(0.009 x 35.56)
Rv = 0.38

$$\text{ESDv (HSG-D)} = \frac{(Pe)(Rv)(A)}{12}$$

$$\text{Target ESDv (HSG-D)} = \frac{(1.6)\quad(0.38)\quad(14023)}{12} = 710 \text{ c.f.}$$

$$\text{Rev} = \frac{(S)(Rv)(A)}{12}$$

$$\text{Required Rev (HSG-C)} = \frac{(0.13)\quad(0.38)\quad(14023)}{12} = 58 \text{ c.f.}$$

Total **Target ESDv** for DAs = **2962** c.f.
Total **Required Rev** for for DAs = **226** c.f.

Brink Zone
Reliability Improvements Project
Montgomery NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
DA-1	Open space; grass cover > 75%	(good)	B	.193	61
	Open space; grass cover > 75%	(good)	C	13.215	74
	Paved parking lots, roofs, driveways		B	.01	98
	Paved parking lots, roofs, driveways		C	.753	98
	Total Area / Weighted Curve Number			14.17	75
DA-1A	Open space; grass cover > 75%	(good)	C	.172	74
	Paved parking lots, roofs, driveways		C	.185	98
	Total Area / Weighted Curve Number			.36	86
DA-1B	Open space; grass cover > 75%	(good)	C	.281	74
	Paved parking lots, roofs, driveways		C	.163	98
	Total Area / Weighted Curve Number			.44	83
DA-1C	Open space; grass cover > 75%	(good)	C	.207	74
	Paved parking lots, roofs, driveways		C	.114	98
	Total Area / Weighted Curve Number			.32	83

BMP Calculations
Sub DA: BRA -1A

Treatment Method: M-6 Micro-Bioretention Soils: C
Total Sub-Drainage Area: 15,533 s.f.
Total Impervious Area: 8,043 s.f.
Total Landscape Area: 7,490 s.f.

% Impervious: 51.8% Rv = 0.05+(0.009 x % Imp.)
0.05+(0.009 x 51.78)

Target P_E = 1.8 0.52

Target ESDv = [(P_E)(Rv)(Total Drainage Area)] / 12

$$\text{Target ESDv} = \frac{1.8 \times 0.52 \times 15{,}533}{12} = \underline{1212} \text{ c.f.}$$

Required Ponding Volume = 0.75 x 1212 = **909** cf

A_f (min) = ESDv (d_f) / [k(h_f +d_f)(t)] k= 0.5 in/hr
A_f (min) = 1031 s.f. d_f = 2 ft.
h_f= 0.350
A_f (furnished) = 1222 s.f. t= 2 days
ESDv= 1212 c.f.

Ponding Volume: Stage-Storage Data

Elev.	Area (sf)	Inc. Volume (cf)	Total Volume (cf)
635.36	1222		
		888	888
636.00	1554		
		595	1484
636.36	1753		
		2138	3621
637.40	2358		

Lowest Adjacent Elev. = 637.40

Outlet Rim: Take Required ESDv volume (above) and divide by highest total Ponding volume.

Outlet Rim Height = 909 / 3621 = 0.25
Outlet Rim Elevation = 636.06
ESDv Ponding Volume provided @ 636.06 = 987 c.f.
ESDv Credit = **1212**

(0.70' will be used in order to ensure that adequate ponding is provided)

BMP Calculations
Sub-DA BRA -1A - Layout Data

Layout Data:

Top of Mulch:	635.36	
Top of Media:	635.11	(3" Mulch)
Bottom of Media:	633.44	(20" Filter Media)
Bottom of Sand:	633.11	(4" Sand)
Bottom of Pea Gravel:	632.61	(6" Pea Gravel)
Max Inv. Of Underdrain:	632.03	(Length of 4" Perf.
Inv. Of Underdrain @ Outlet:	631.76	PVC @ 0.50% slope)
Bottom of Recharge Bed:	630.76	
Groundwater Elev.:	623.70	(Max depth of boring: 623.7)
Separation (4' Minimum):	7.06	

Outlet: 8" PVC Riser w/ Beehive Grate

Rim:	636.06
Inv. In.:	631.76 (4" underdrain)
Inv. Out:	631.66

Outlet Pipe: 38' of 8" PVC Piping @ 4.89%

Inv. Up:	631.66 8" PVC
Inv. Dn:	629.80

10-yr Pool = 636.44 Freeboard = 0.96 ft

100-yr Pool = 637.07 Freeboard = 0.33 ft

Rev (Required) = [(S)(Rv)(A)]/12

Rev (Required) = 88 cf

Cpv (Required)* =

Cpv (Required)* = 0 cf

Rev (Furnished) = (0.40) (1.00) (1222.00) = 489 cf

* Total ESDv has been met, therefore, no Cpv is required

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Pond No. 1 - BRA-1A

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 635.36 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	635.36	1,222	0	0
0.64	636.00	1,554	888	888
1.00	636.36	1,753	595	1,484
2.04	637.40	2,358	2,138	3,621

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 631.66	0.00	0.00	0.00
Length (ft)	= 38.00	0.00	0.00	0.00
Slope (%)	= 4.89	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 2.10	0.00	0.00	0.00
Crest El. (ft)	= 636.06	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	635.36	0.00	---	---	---	0.00	---	---	---	---	---	0.000
0.64	888	636.00	3.08 ic	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,484	636.36	3.08 ic	---	---	---	0.81 ic	---	---	---	---	---	0.812
2.04	3,621	637.40	3.08 ic	---	---	---	1.72 ic	---	---	---	---	---	1.716

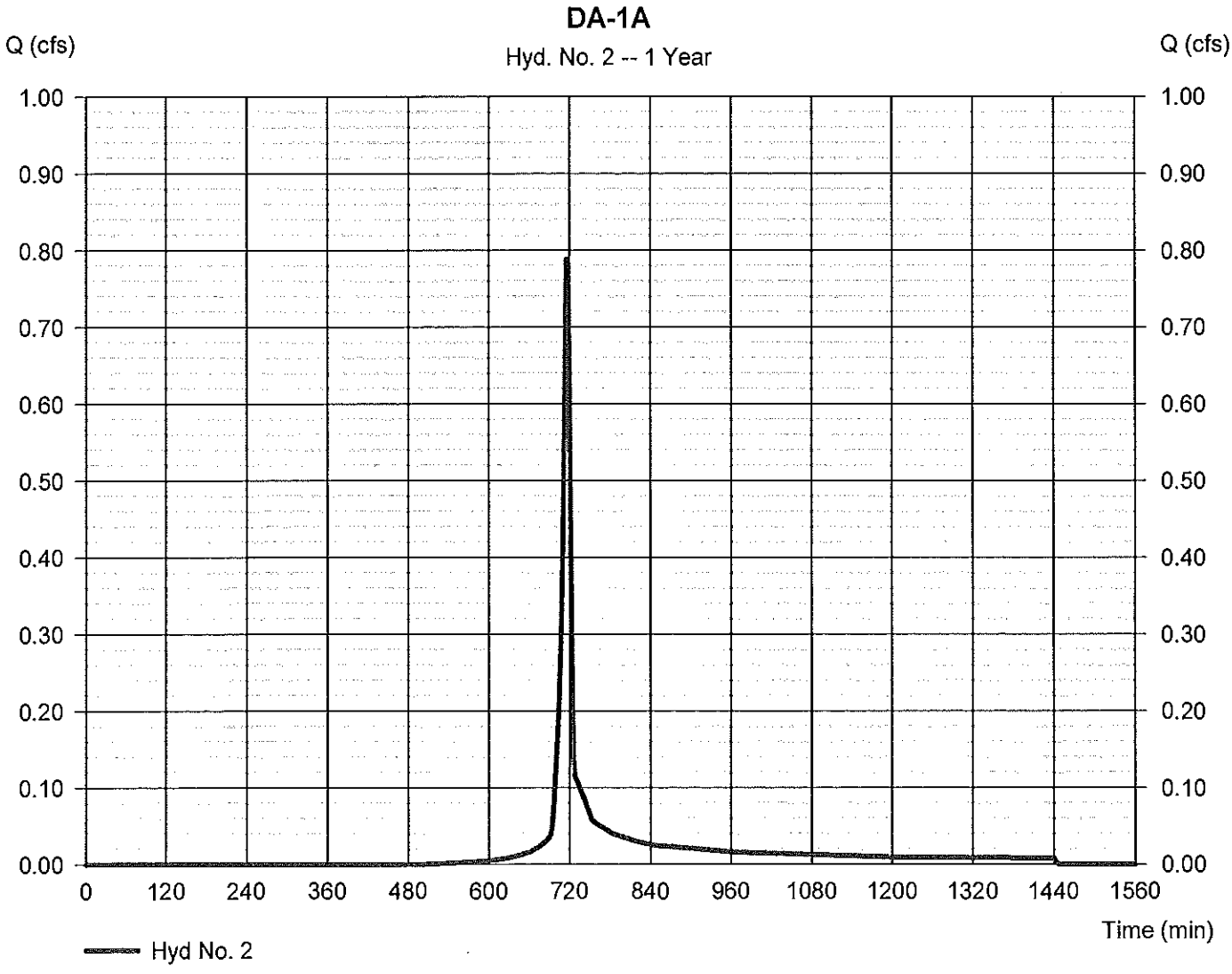
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 0.789 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,594 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

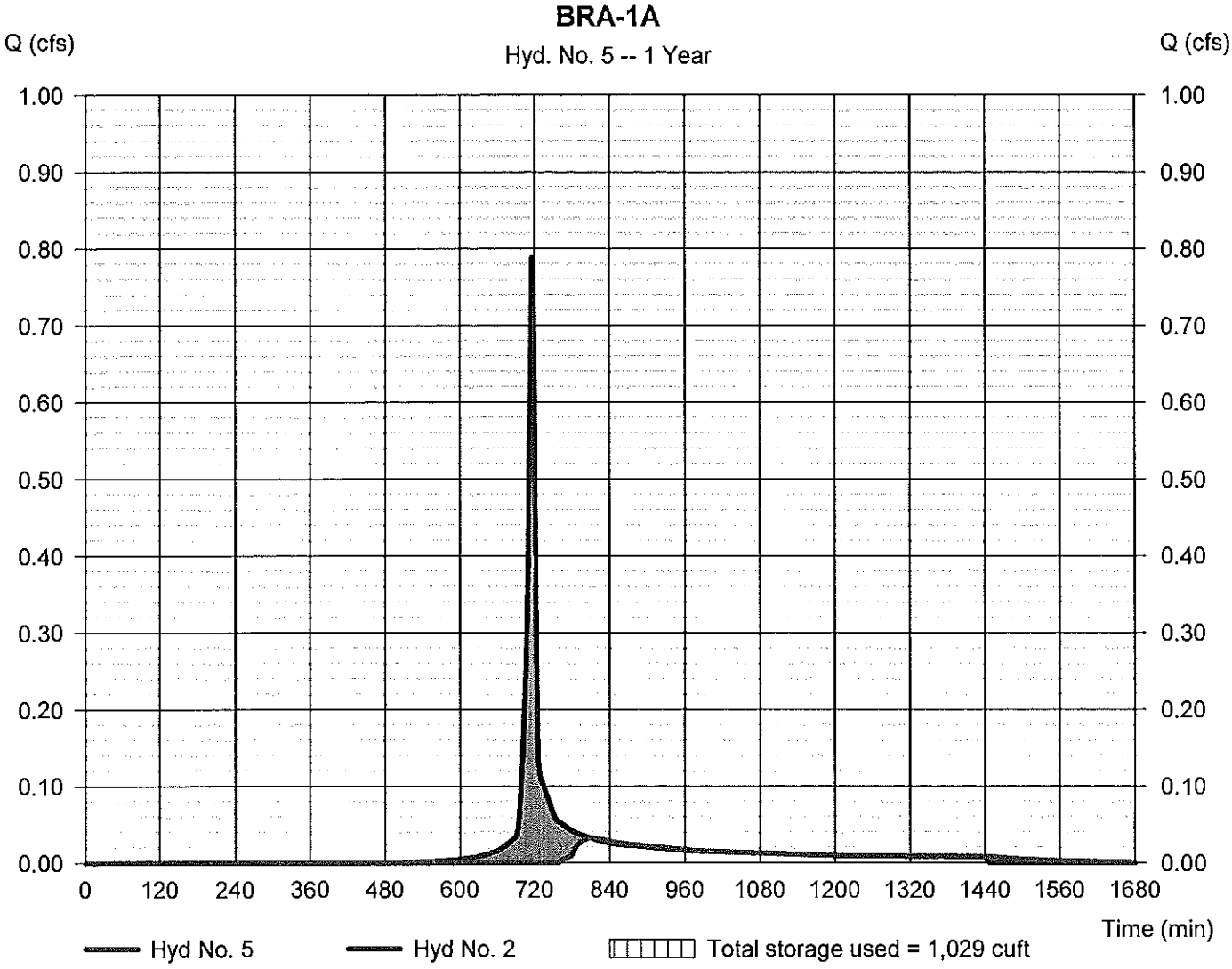
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.032 cfs
Storm frequency	= 1 yrs	Time to peak	= 812 min
Time interval	= 2 min	Hyd. volume	= 639 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.08 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,029 cuft

Storage Indication method used.

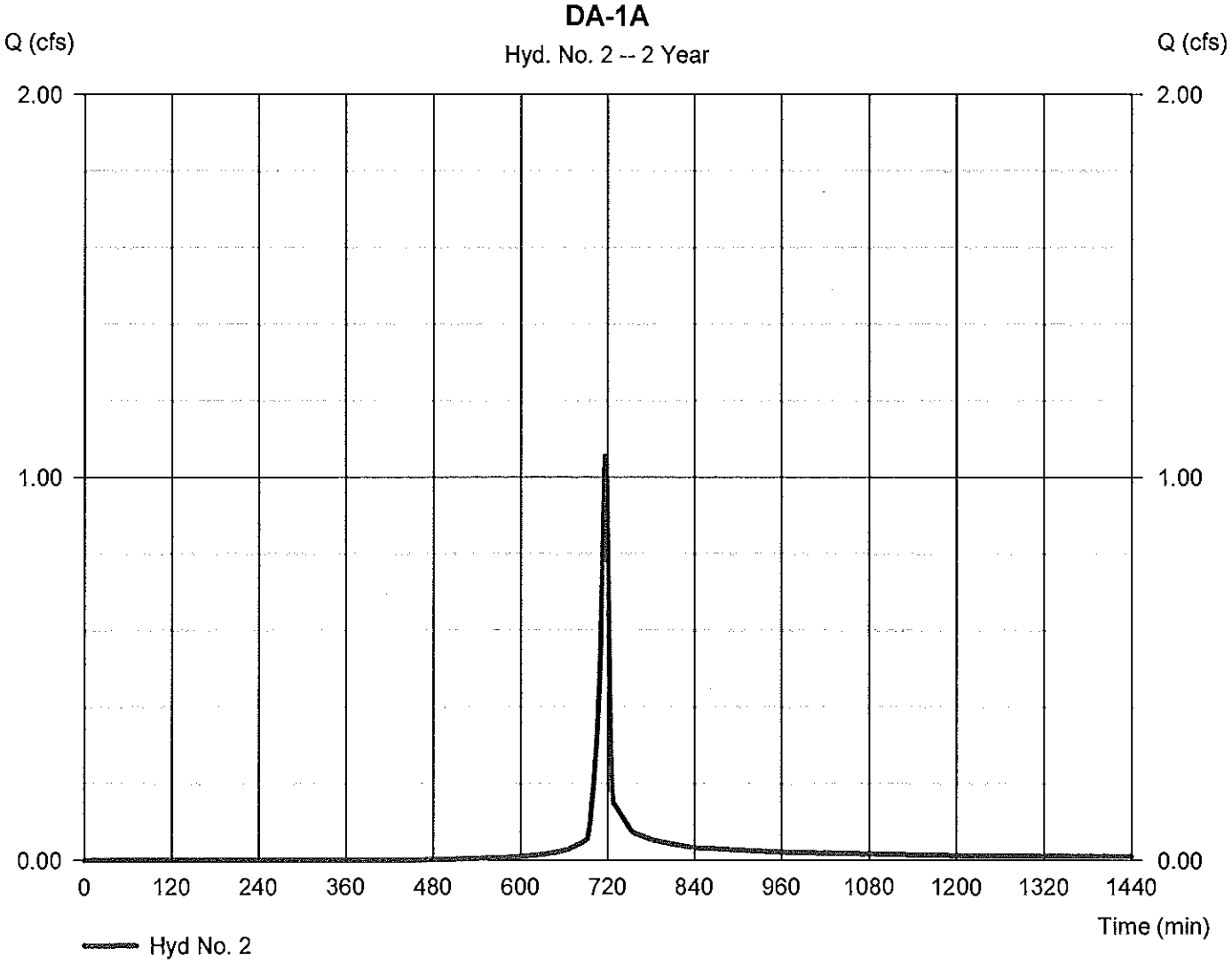


Hydrograph Report

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 1.055 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,142 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

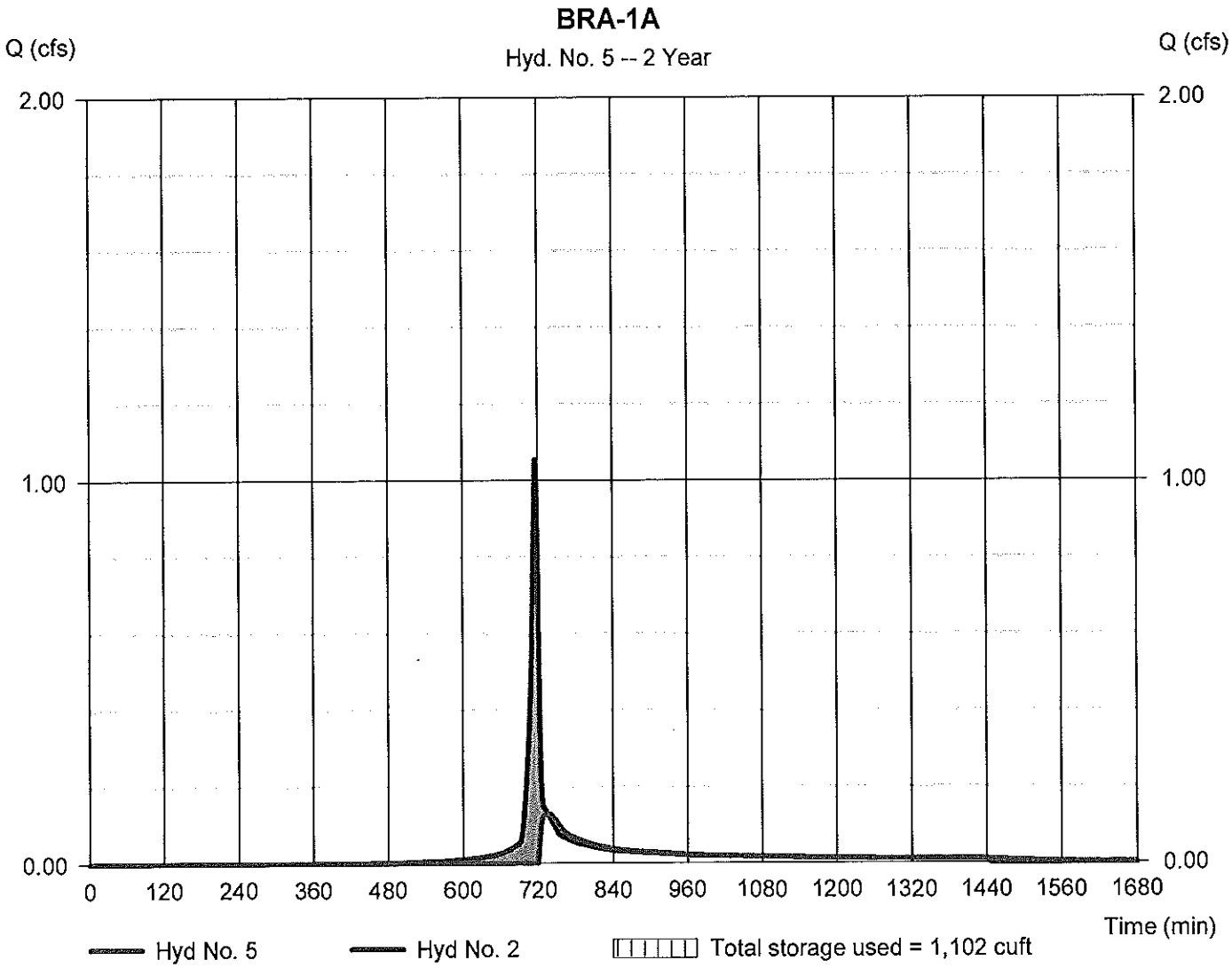
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.130 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 1,188 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.13 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,102 cuft

Storage Indication method used.



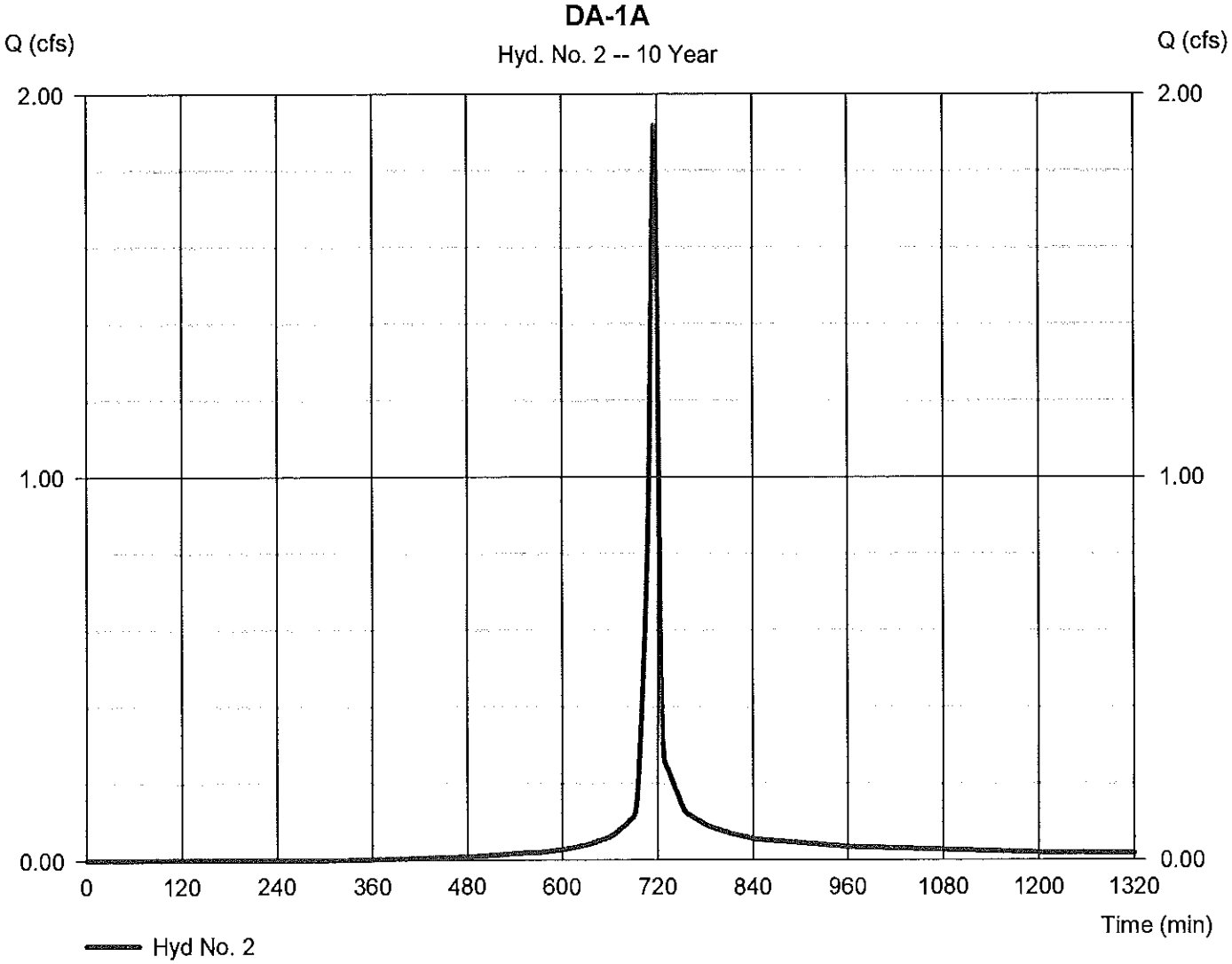
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 1.918 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,985 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

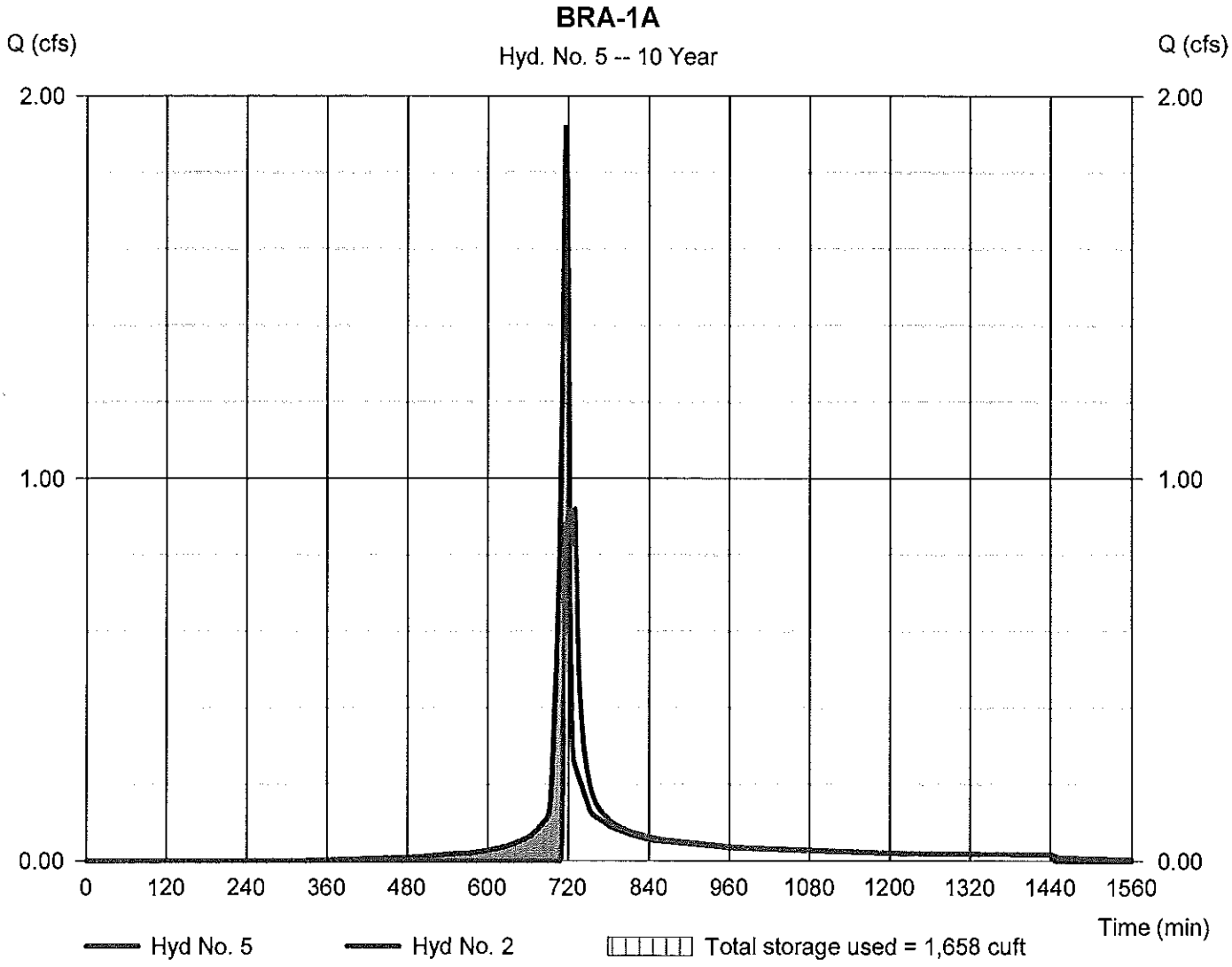
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 0.920 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 3,031 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 636.44 ft
Reservoir name	= BRA-1A	Max. Storage	= 1,658 cuft

Storage Indication method used.



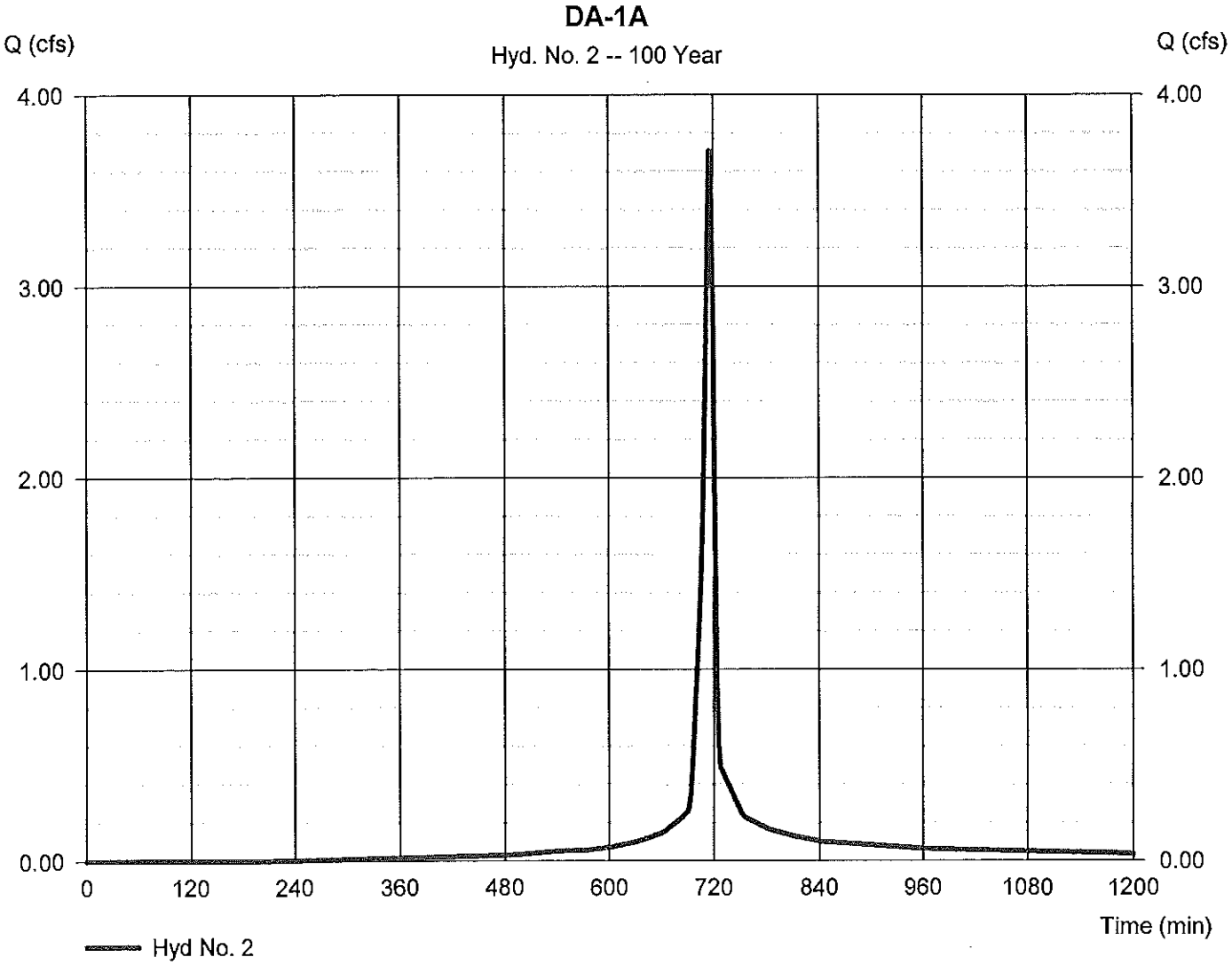
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 2

DA-1A

Hydrograph type	= SCS Runoff	Peak discharge	= 3.709 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 8,030 cuft
Drainage area	= 0.360 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

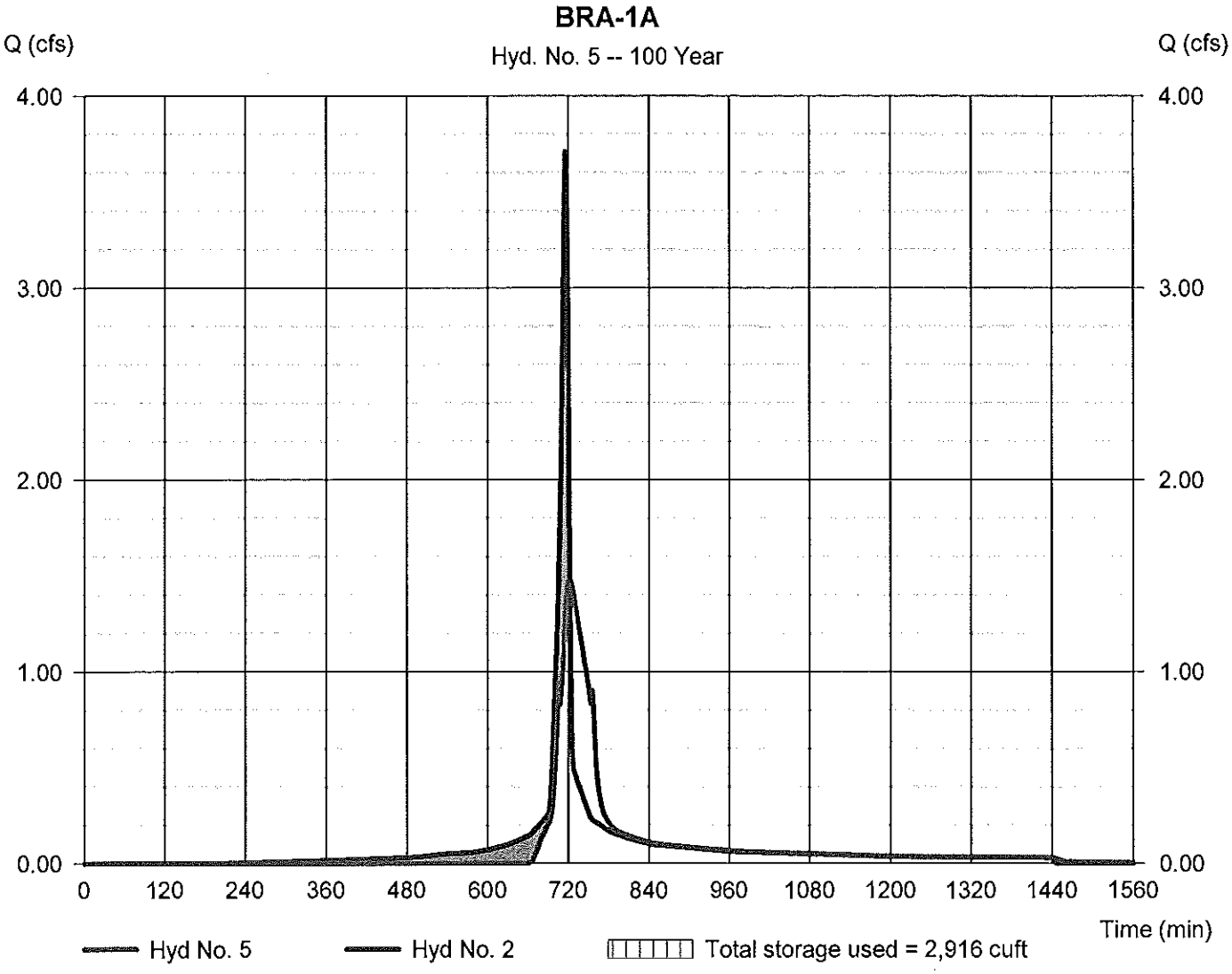
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 5

BRA-1A

Hydrograph type	= Reservoir	Peak discharge	= 1.479 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 7,076 cuft
Inflow hyd. No.	= 2 - DA-1A	Max. Elevation	= 637.07 ft
Reservoir name	= BRA-1A	Max. Storage	= 2,916 cuft

Storage Indication method used.



BMP Calculations
Sub DA: BRA -1B

Treatment Method: M-6 Micro-Bioretention Soils: C
Total Sub-Drainage Area: 19,321 s.f.
Total Impervious Area: 7,080 s.f.
Total Landscape Area: 12,241 s.f.

% Impervious: 36.6% $R_V = 0.05+(0.009 \times \%\ Imp.)$
$0.05+(0.009 \times 36.64)$

Target P_E = 1.8 0.38

Target ESDv = $[(P_E)(R_V)(\text{Total Drainage Area})] / 12$

Target ESDv = $\frac{1.8 \times 0.38 \times 19{,}321}{12}$ = **1101** c.f.*

Required Ponding Volume = 0.75 x 1101 = **826** cf

A_f (min) = ESDv (d_f) / [k(h_f +d_f)(t)] k= 0.5 in/hr
A_f (min) = 881 s.f. d_f = 2 ft.
h_f= 0.500
A_f (furnished) = 1479 s.f. t= 2 days
WQv/ESDv= 1101 c.f.

Ponding Volume: Stage-Storage Data

Elev.	Area (sf)	Inc. Volume (cf)	Total Volume (cf)
636.00	1479		
		1825	1825
637.00	2170		
		2897	4722
638.00	3624		

Lowest Adjacent Elev. = 638.00

Outlet Rim: Take Required ESDv volume (above) and divide by highest total Ponding volume.

Outlet Rim Height = 826 / 4722 = 0.17 (1.0 will be used in order to ensure that adequate ponding is provided)
Outlet Rim Elevation = 637.00
ESDv Ponding Volume provided @ 637.00 = 1825 c.f.
ESDv Credit = 1101

BMP Calculations

Sub-DA BRA -1B - Layout Data

Layout Data:

Top of Mulch:	636.00	
Top of Media:	635.75	(3" Mulch)
Bottom of Media:	634.08	(20" Filter Media)
Bottom of Sand:	633.75	(4" Sand)
Bottom of Pea Gravel:	633.25	(6" Pea Gravel)
Max Inv. Of Underdrain:	632.67	(Length of 4" Perf.
Inv. Of Underdrain @ Outlet:	632.30	PVC @ 0.50% slope)
Bottom of Recharge Bed:	631.30	
Groundwater Elev.:	626.00	(Max depth of boring: 626.0)
Separation (4' Minimum):	5.29	

Outlet: 15" PVC Riser w/ Beehive Grate

Rim:	637.00	
Inv. In.:	632.30	(4" underdrain)
Inv. Out:	632.20	

Outlet Pipe: 95' of 12" PVC Piping @ 4.87%

Inv. Up:	632.20	12" PVC
Inv. Dn:	627.57	

10-yr Pool =	637.13	Freeboard =	0.87 ft
100-yr Pool =	637.43	Freeboard =	0.57 ft

Re_v (Required)= [(S)(Rv)(A)]/12

Re_v (Required) = 80 cf

Cp_v (Required)* =

Cp_v (Required)* = 0 cf

Re_v (Furnished) =	(0.40)	(1.00)	(1479.00)	=	**592** cf

* Total ESDv has been met, therefore, no Cpv is required

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Pond No. 2 - BRA-1B

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 636.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	636.00	1,479	0	0
1.00	637.00	2,170	1,825	1,825
2.00	638.00	3,624	2,897	4,722

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 632.20	0.00	0.00	0.00
Length (ft)	= 95.00	0.00	0.00	0.00
Slope (%)	= 4.87	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.93	0.00	0.00	0.00
Crest El. (ft)	= 637.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	636.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,825	637.00	6.87 ic	---	---	---	0.00	---	---	---	---	---	0.000
2.00	4,722	638.00	6.87 ic	---	---	---	5.19 ic	---	---	---	---	---	5.190

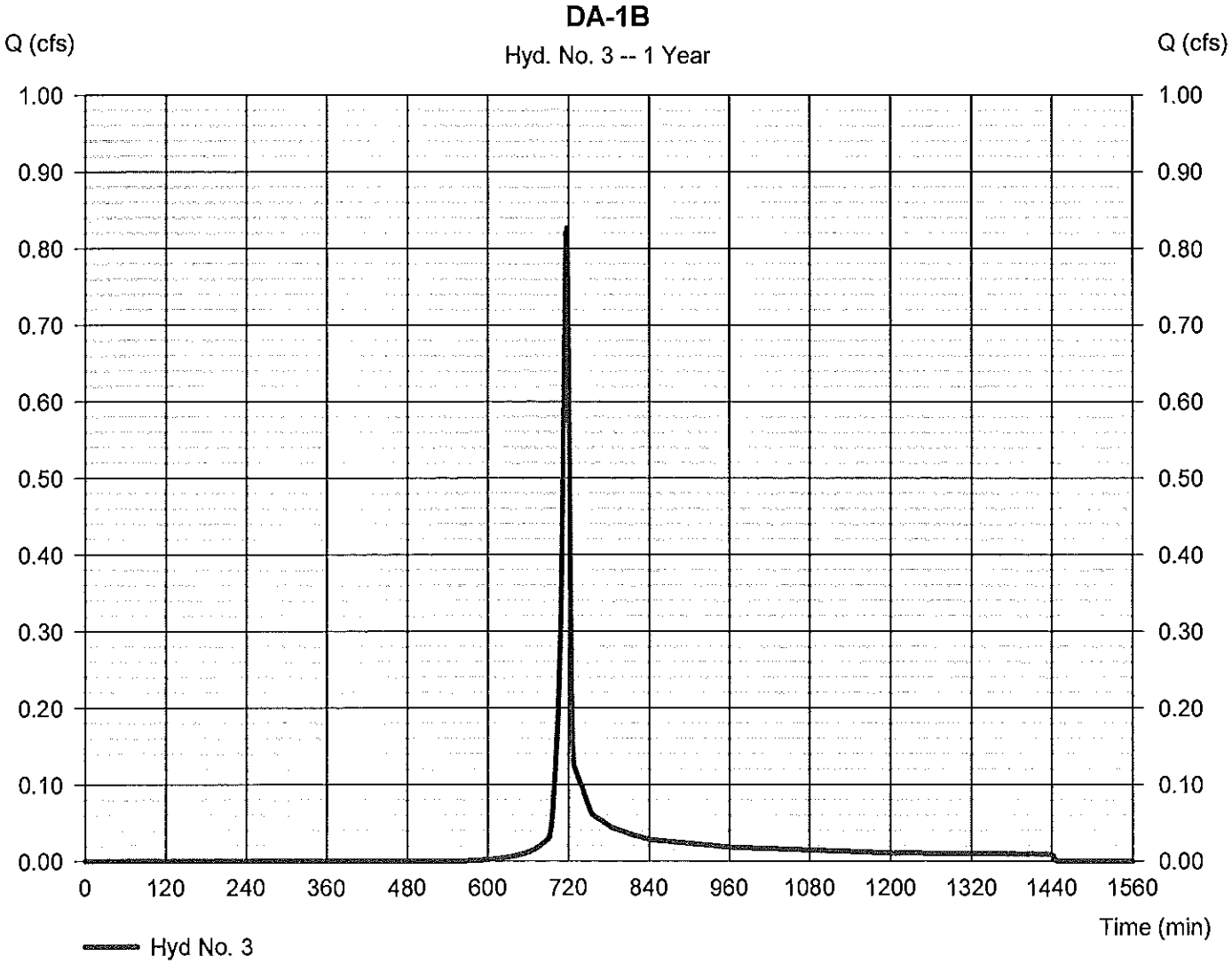
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.827 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,661 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

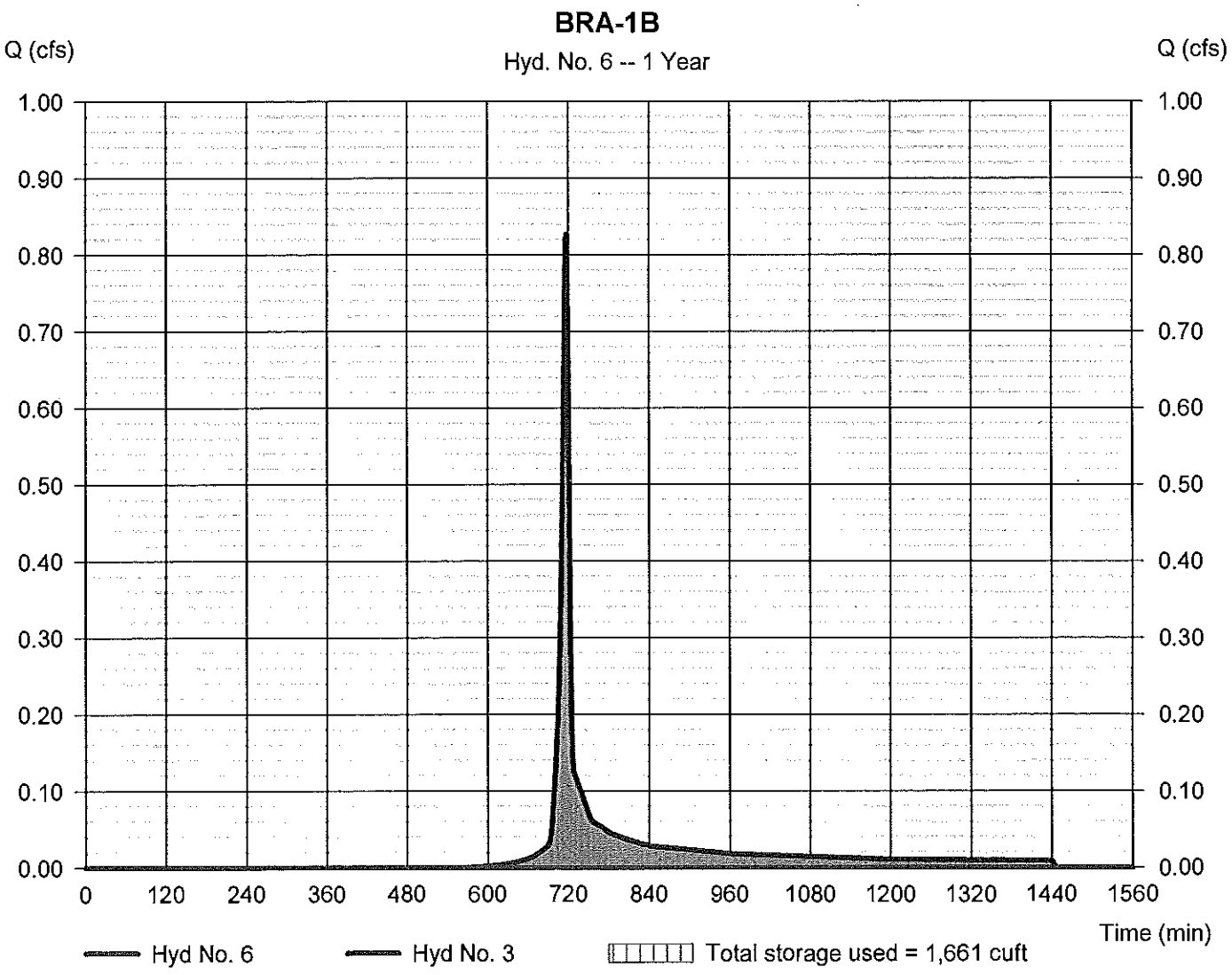
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 1 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 636.91 ft
Reservoir name	= BRA-1B	Max. Storage	= 1,661 cuft

Storage Indication method used.



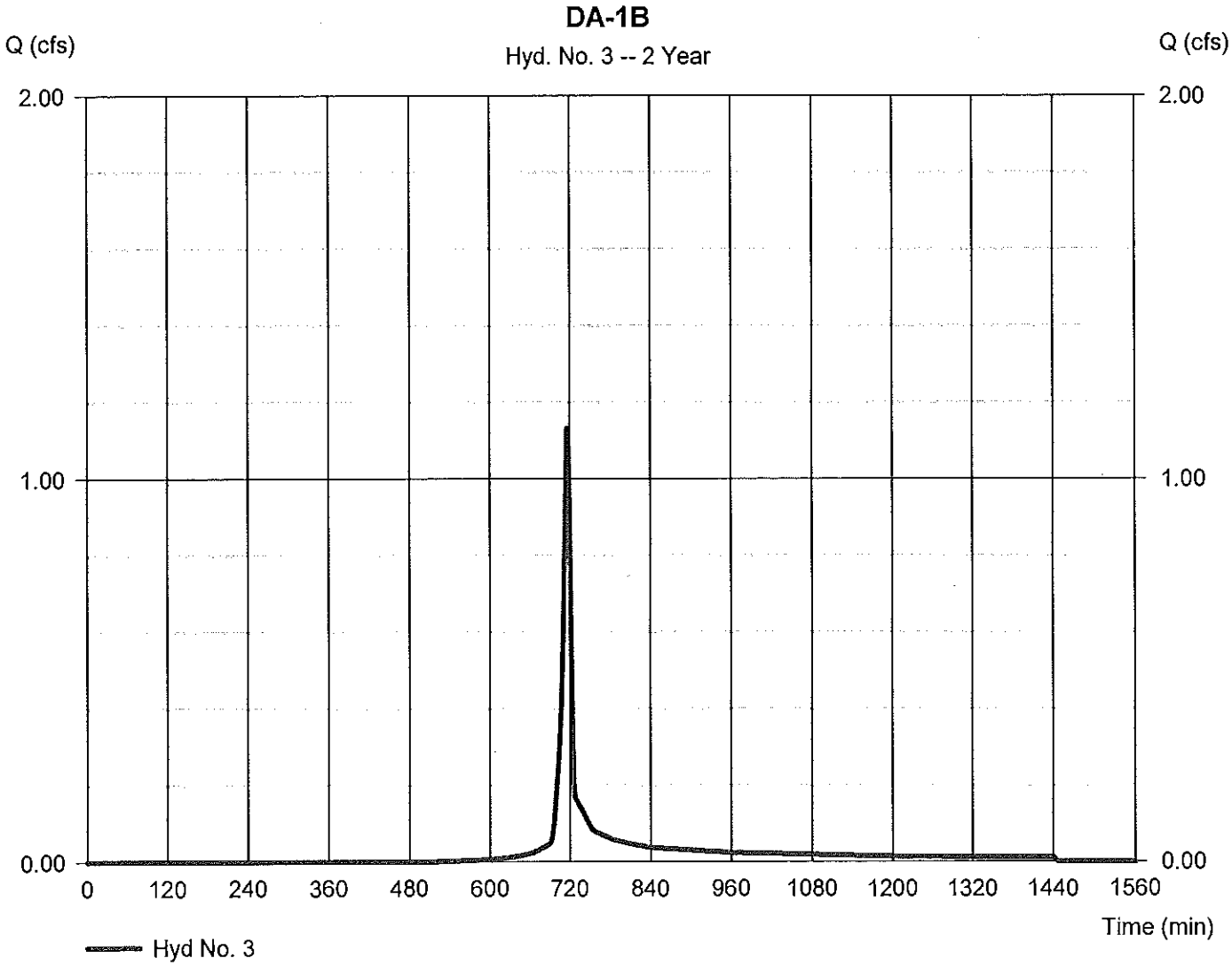
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 1.133 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,287 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

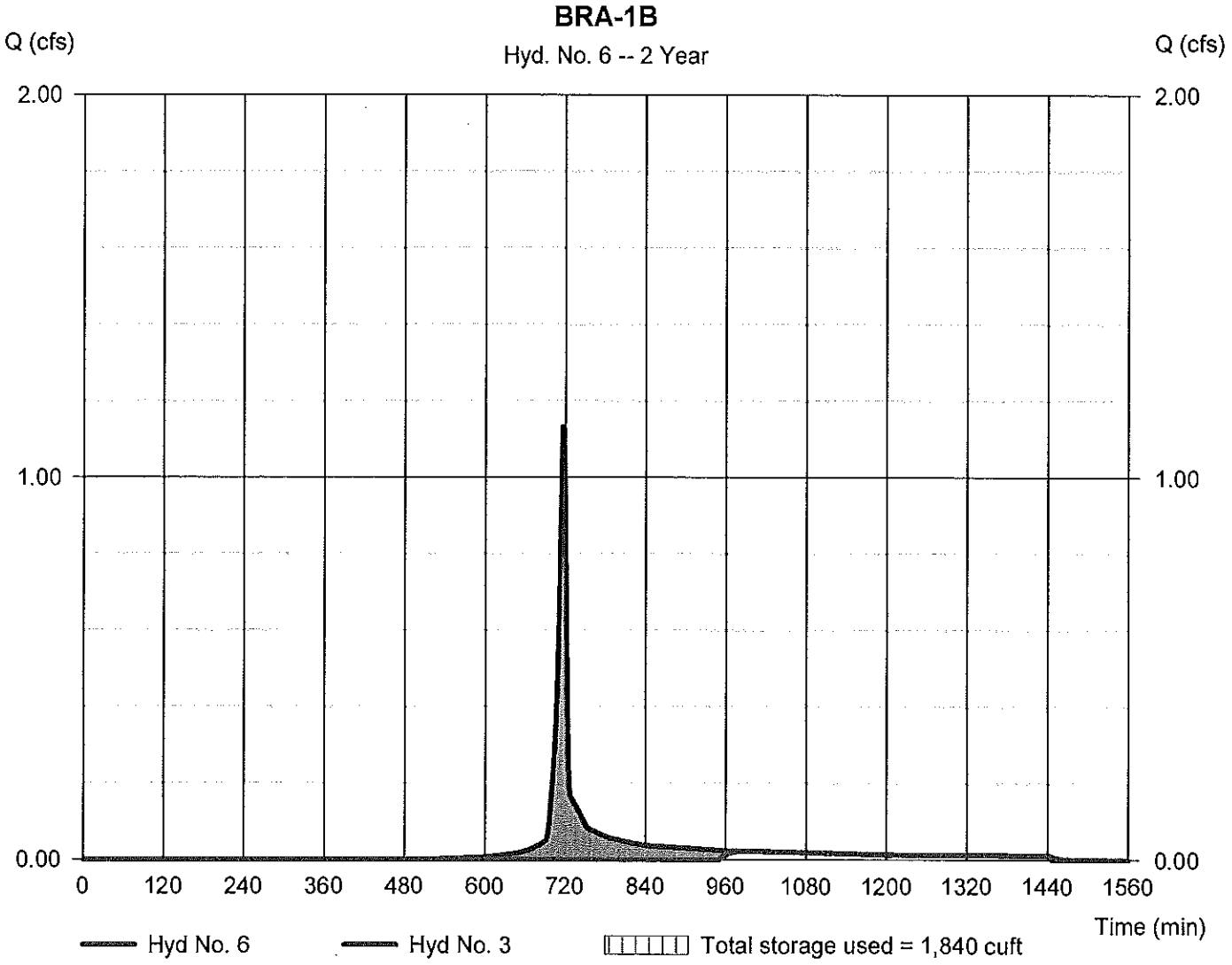
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.022 cfs
Storm frequency	= 2 yrs	Time to peak	= 996 min
Time interval	= 2 min	Hyd. volume	= 462 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.01 ft
Reservoir name	= BRA-1B	Max. Storage	= 1,840 cuft

Storage Indication method used.

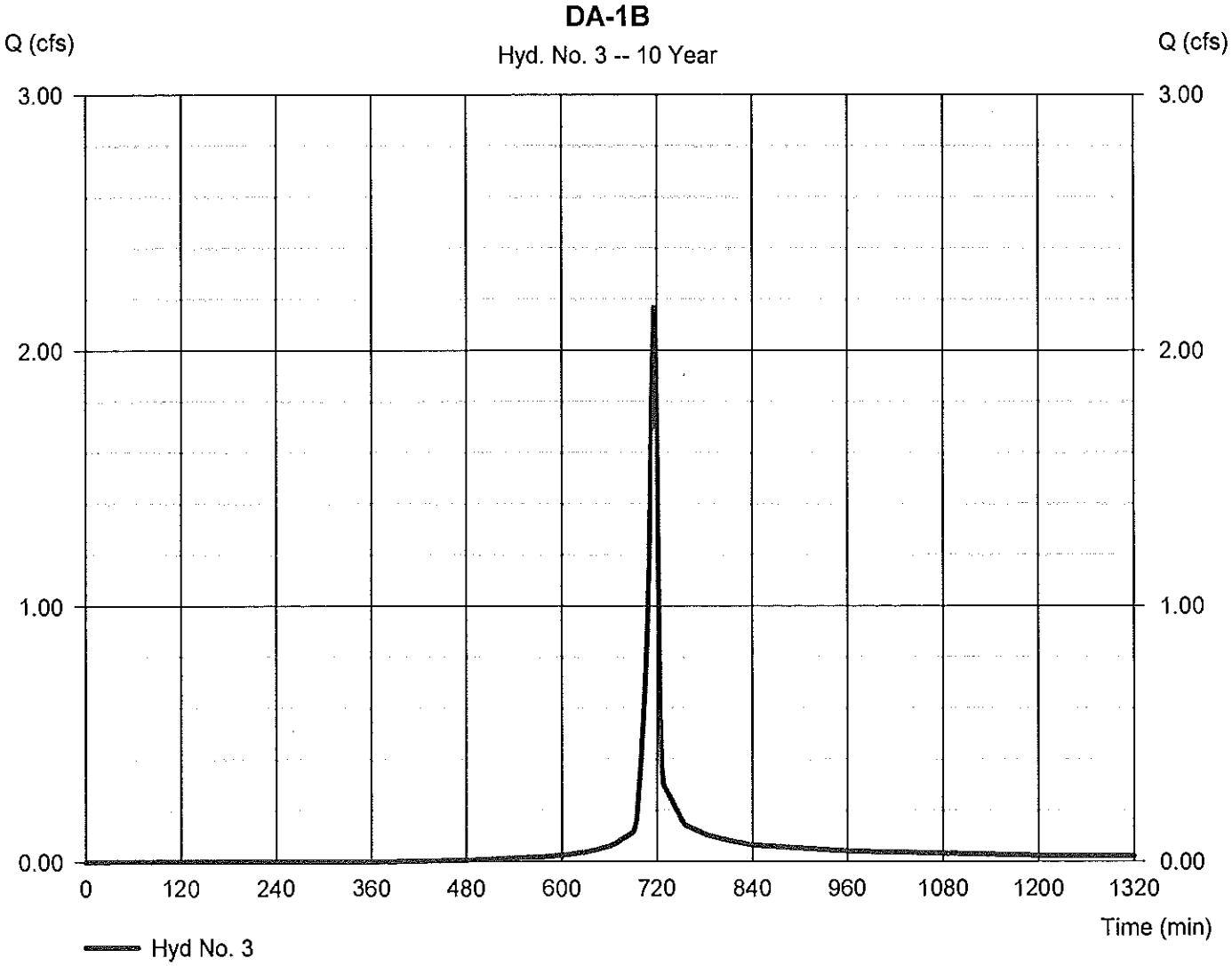


Hydrograph Report

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.168 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,442 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

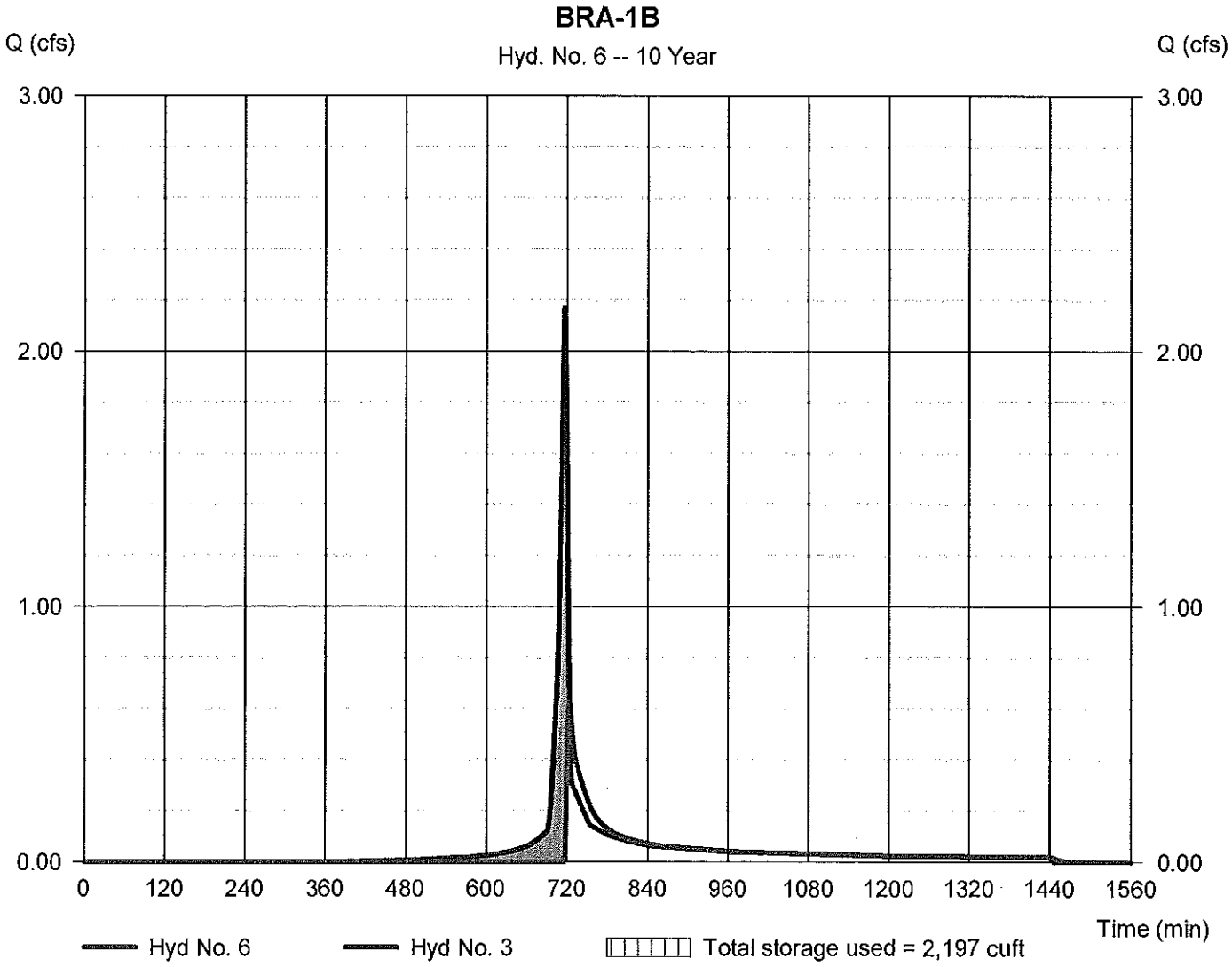
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 0.631 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 2,617 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.13 ft
Reservoir name	= BRA-1B	Max. Storage	= 2,197 cuft

Storage Indication method used.



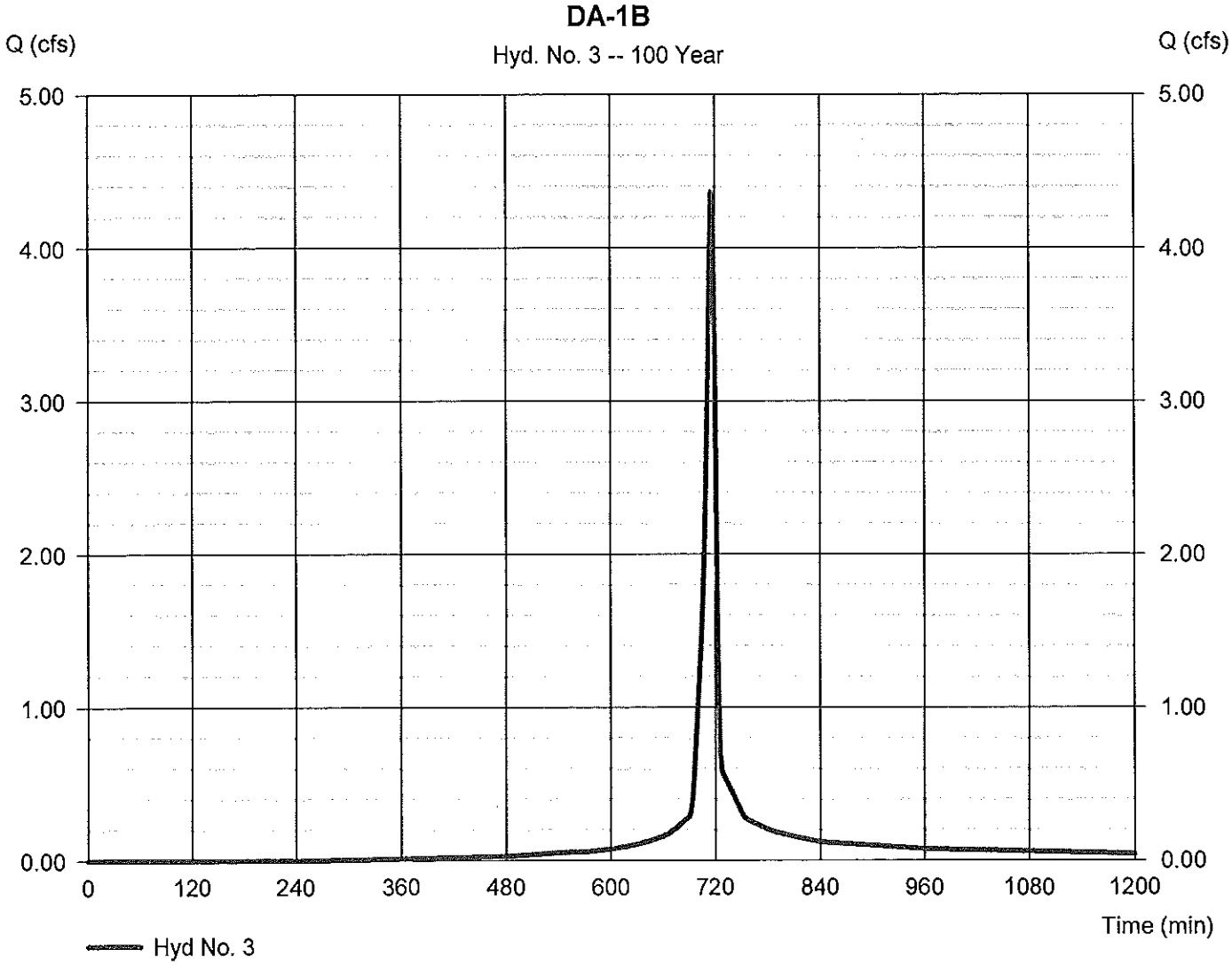
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 3

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 4.363 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 9,280 cuft
Drainage area	= 0.440 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

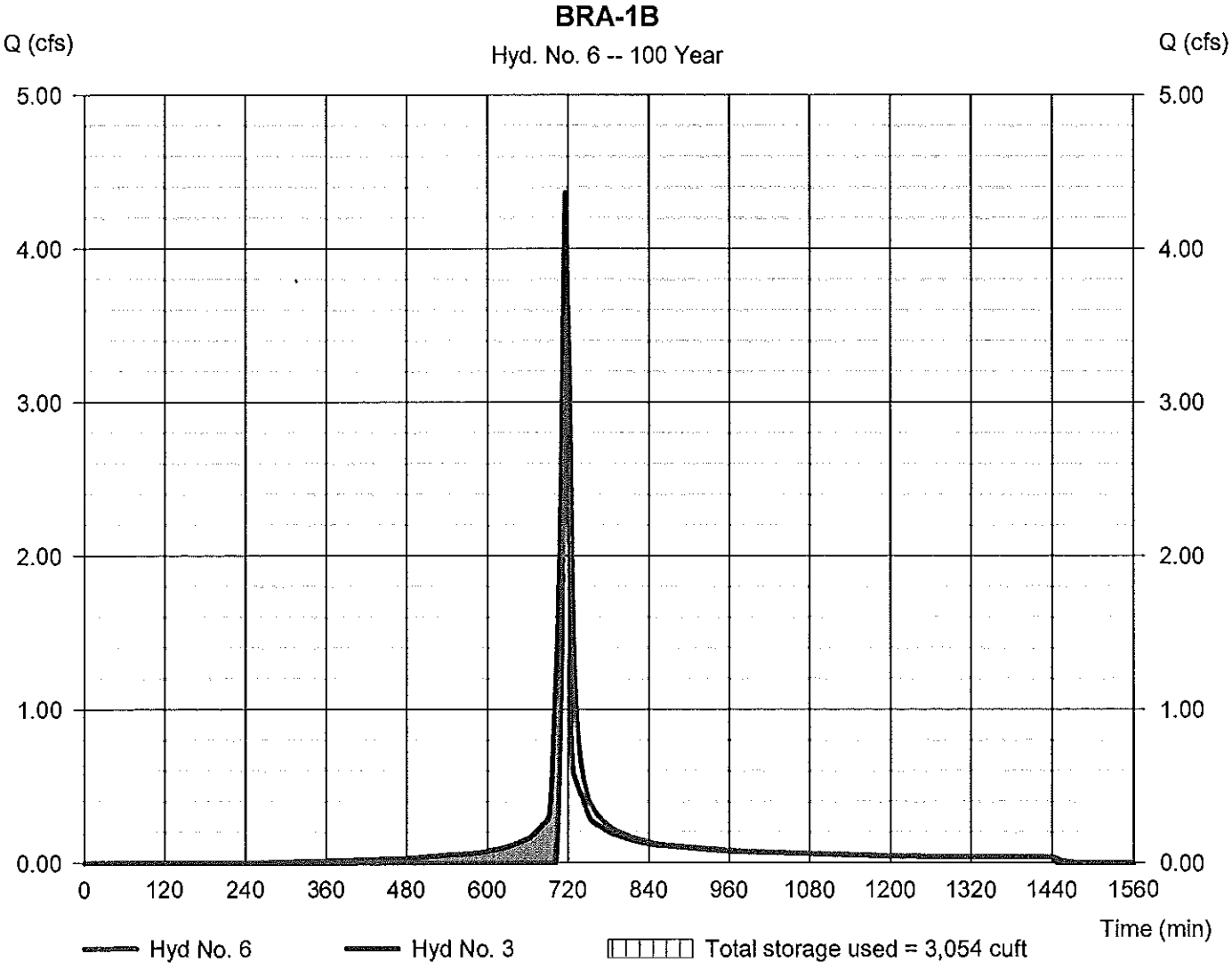
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 6

BRA-1B

Hydrograph type	= Reservoir	Peak discharge	= 3.631 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 7,454 cuft
Inflow hyd. No.	= 3 - DA-1B	Max. Elevation	= 637.43 ft
Reservoir name	= BRA-1B	Max. Storage	= 3,054 cuft

Storage Indication method used.



BMP Calculations
Sub DA: BRA -1C

Treatment Method:	M-6 Micro-Bioretention	Soils:	C
Total Sub-Drainage Area:	14,023 s.f.		
Total Impervious Area:	4,986 s.f.		
Total Landscape Area:	9,037 s.f.		

% Impervious: 35.6%

$Rv = 0.05+(0.009 \times \%\ Imp.)$

$0.05+(0.009 \times 35.56)$

Target P_E = 1.8 → 0.38

Target ESDv = [(P_E)(Rv)(Total Drainage Area)] / 12

$$\text{Target ESDv} = \frac{1.8 \times 0.38 \times 14{,}023}{12} = \underline{\mathbf{799}} \text{ c.f.}$$

Required Ponding Volume = 0.75 x 799 = **599** cf

A_f (min) = ESDv (d_f) / [k(h_f +d_f)(t)]

A_f (min) = 703 s.f.

A_f (furnished) = 971 s.f.

k= 0.5 in/hr

d_f = 2 ft.

h_f= 0.275

t= 2 days

WQv/ESDv= 799 c.f.

Ponding Volume: Stage-Storage Data

Elev.	Area (sf)	Inc. Volume (cf)	Total Volume (cf)
629.00	971		
		1174	1174
630.00	1377		

Lowest Adjacent Elev. = 630.00

Outlet Rim: Take Required ESDv volume (above) and divide by highest total Ponding volume.

Outlet Rim Height = 599 / 1174 = 0.51 (0.55 will be used in order to ensure that adequate ponding is provided)

Outlet Rim Elevation = 629.55

ESDv Ponding Volume provided @ 629.55 = 646 c.f.

ESDv Credit = 799

BMP Calculations

Sub-DA BRA -1C - Layout Data

Layout Data:

Top of Mulch:	629.00	
Top of Media:	628.75	(3" Mulch)
Bottom of Media:	627.08	(20" Filter Media)
Bottom of Sand:	626.75	(4" Sand)
Bottom of Pea Gravel:	626.25	(6" Pea Gravel)
Max Inv. Of Underdrain:	625.67	(Length of 4" Perf.
Inv. Of Underdrain @ Outlet:	625.50	PVC @ 0.50% slope)
Bottom of Recharge Bed:	624.50	
Groundwater Elev.:	617.90	(Max depth of boring: 617.9)
Separation (4' Minimum):	6.60	

Outlet: 15" PVC Riser w/ Beehive Grate

Rim:	629.55	
Inv. In.:	625.50	(4" underdrain)
Inv. In.:	614.25	(6" PVC)
Inv. Out:	614.15	

Outlet Pipe: 244' of 12" PVC Piping @ 0.9%

Inv. Up:	614.15	12" PVC
Inv. Dn:	612.00	

10-yr Pool = 629.78 Freeboard = 0.22 ft

100-yr Pool = 629.93 Freeboard = 0.07 ft

Rev (Required)= [(S)(Rv)(A)]/12 Cpv (Required)* =

Rev (Required) = 58 cf Cpv (Required)* = 0 cf

Rev (Furnished) = (0.40) (1.00) (971.00) = **388** cf

* Total ESDv has been met, therefore, no Cpv is required

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Pond No. 3 - BRA-1C

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 629.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	629.00	971	0	0
1.00	630.00	1,377	1,174	1,174

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 614.15	0.00	0.00	0.00
Length (ft)	= 245.00	0.00	0.00	0.00
Slope (%)	= 0.90	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.93	0.00	0.00	0.00
Crest El. (ft)	= 629.55	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	629.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
1.00	1,174	630.00	8.38 oc	---	---	---	3.95	---	---	---	---	---	3.951

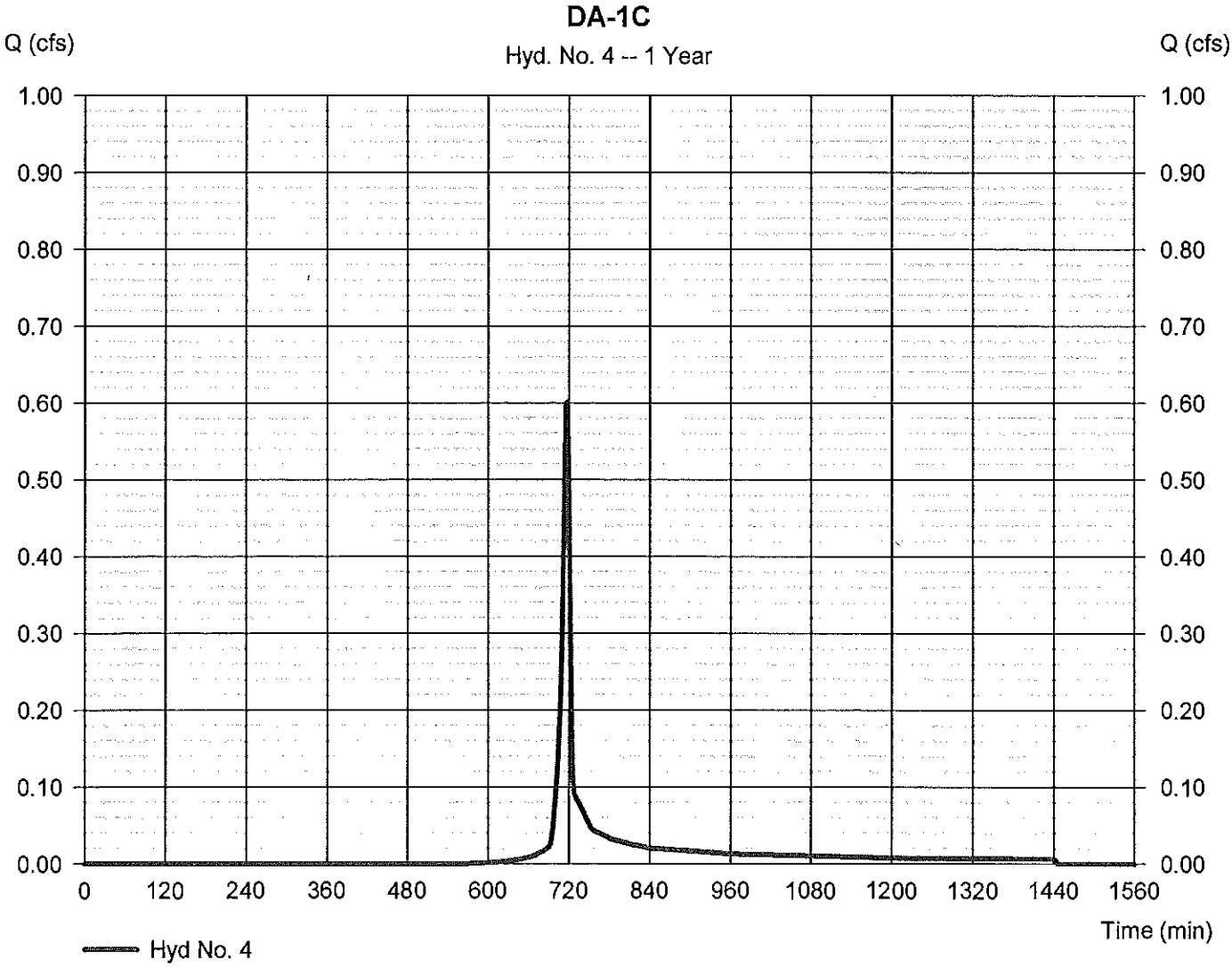
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 0.602 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,208 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

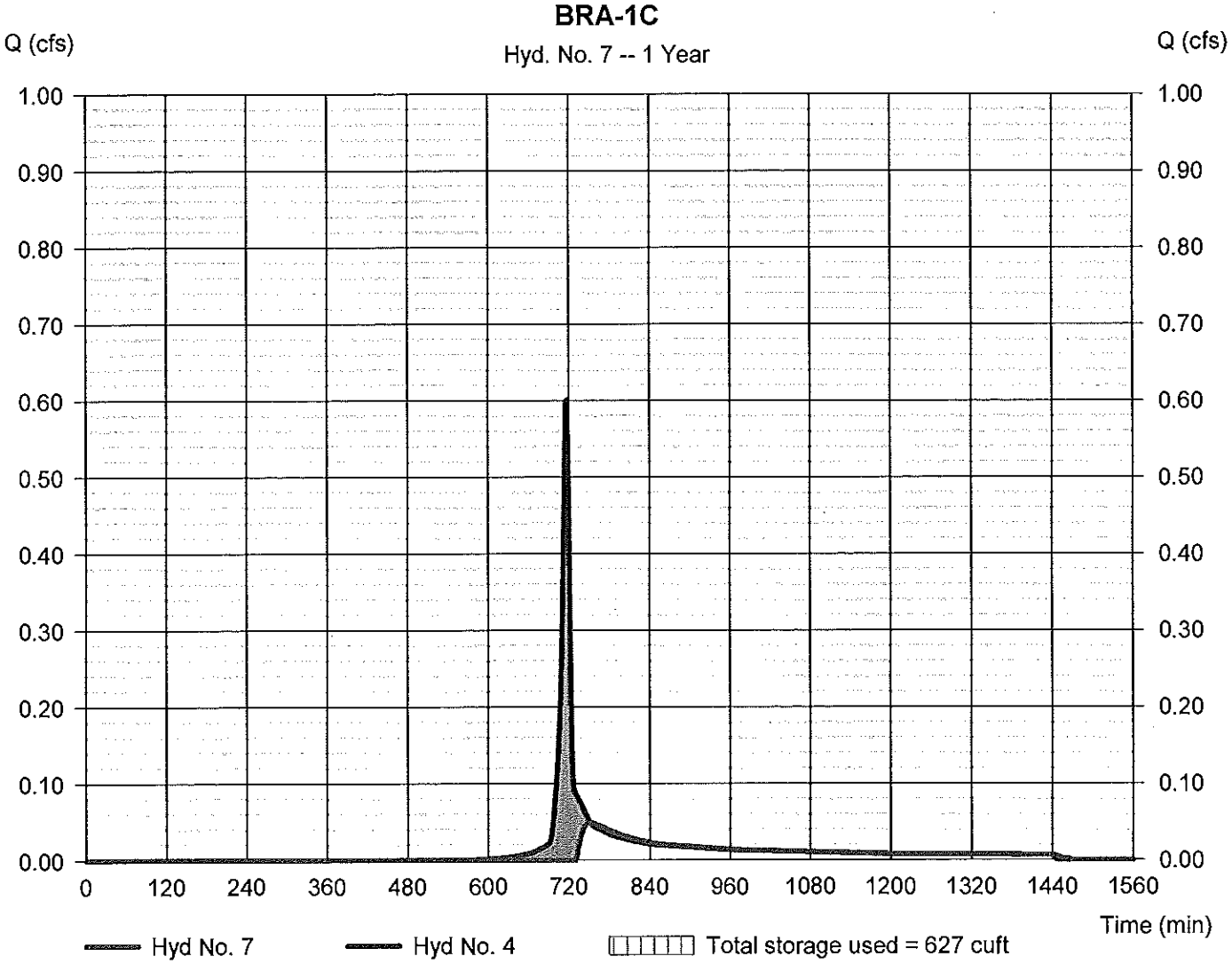
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 0.049 cfs
Storm frequency	= 1 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 620 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.53 ft
Reservoir name	= BRA-1C	Max. Storage	= 627 cuft

Storage Indication method used.



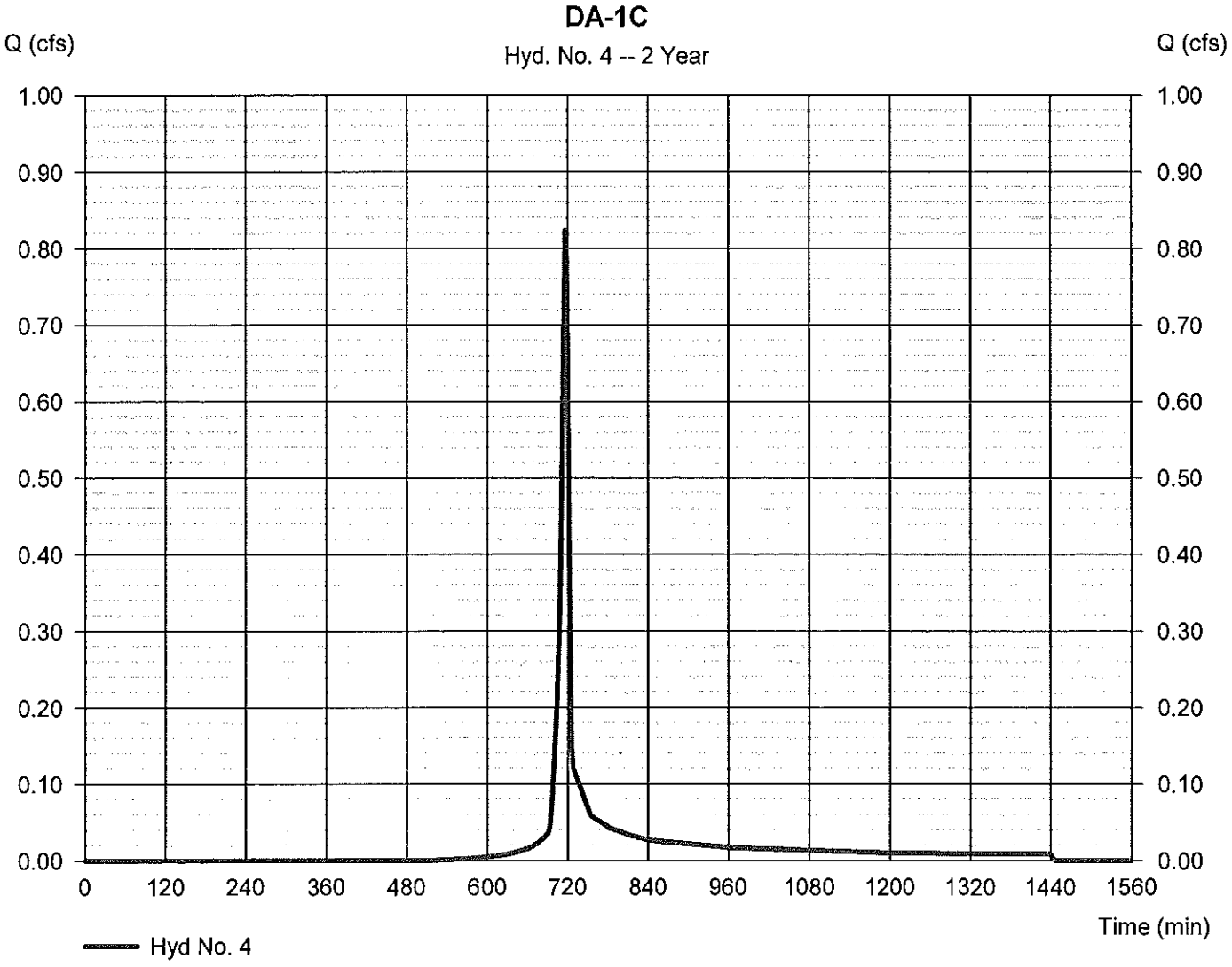
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 0.824 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,663 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

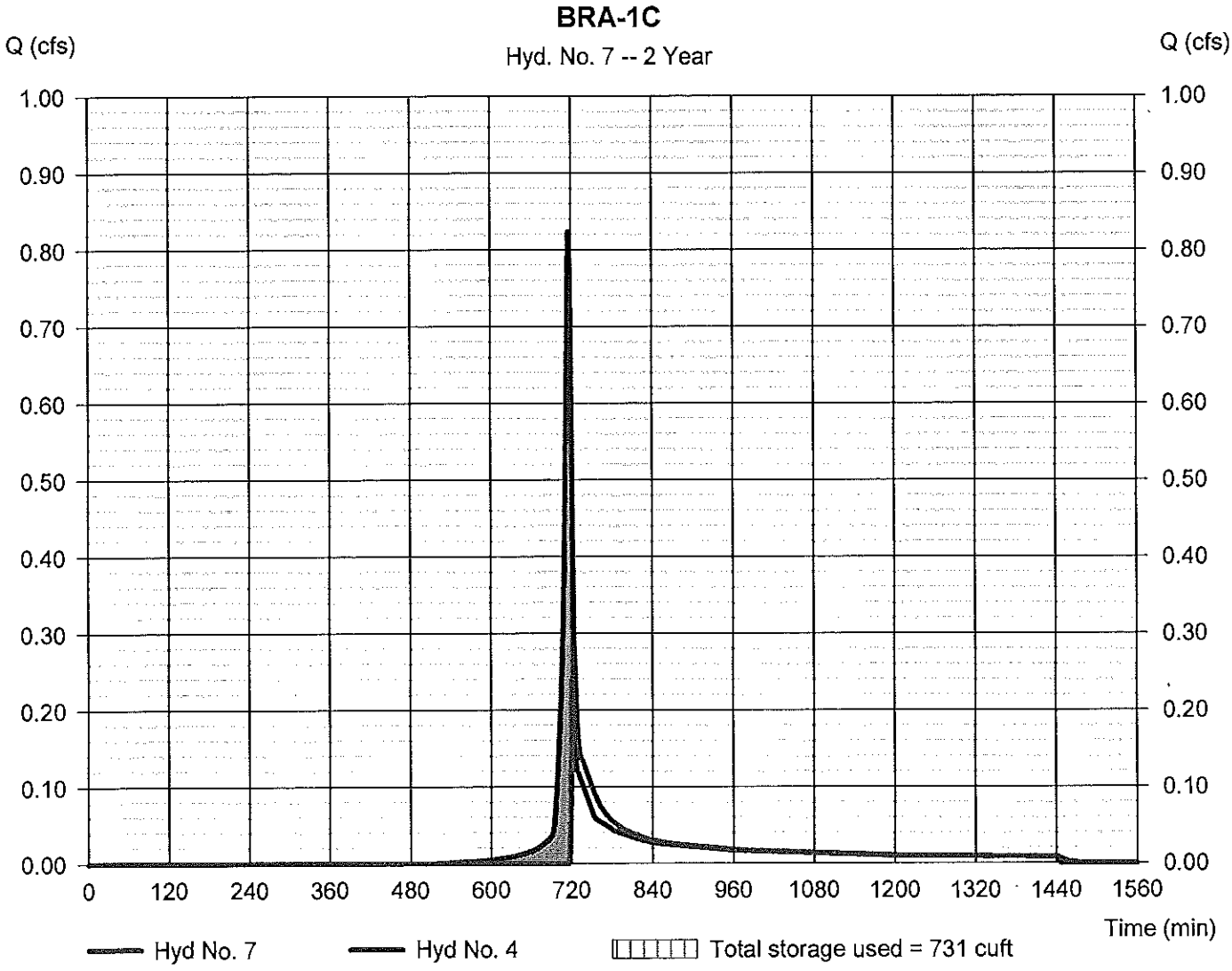
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 0.283 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 1,076 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.62 ft
Reservoir name	= BRA-1C	Max. Storage	= 731 cuft

Storage Indication method used.



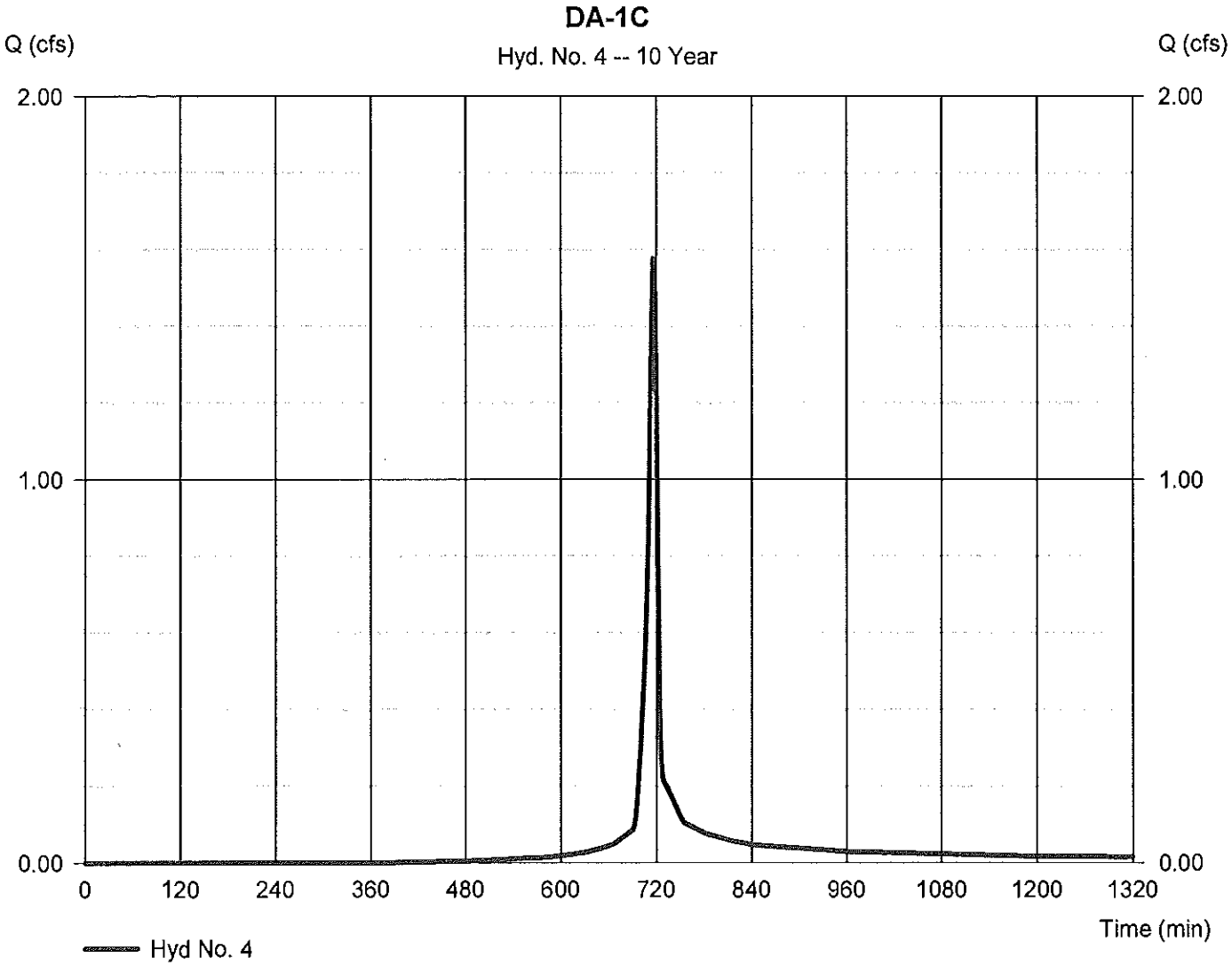
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 1.577 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,231 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 4.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

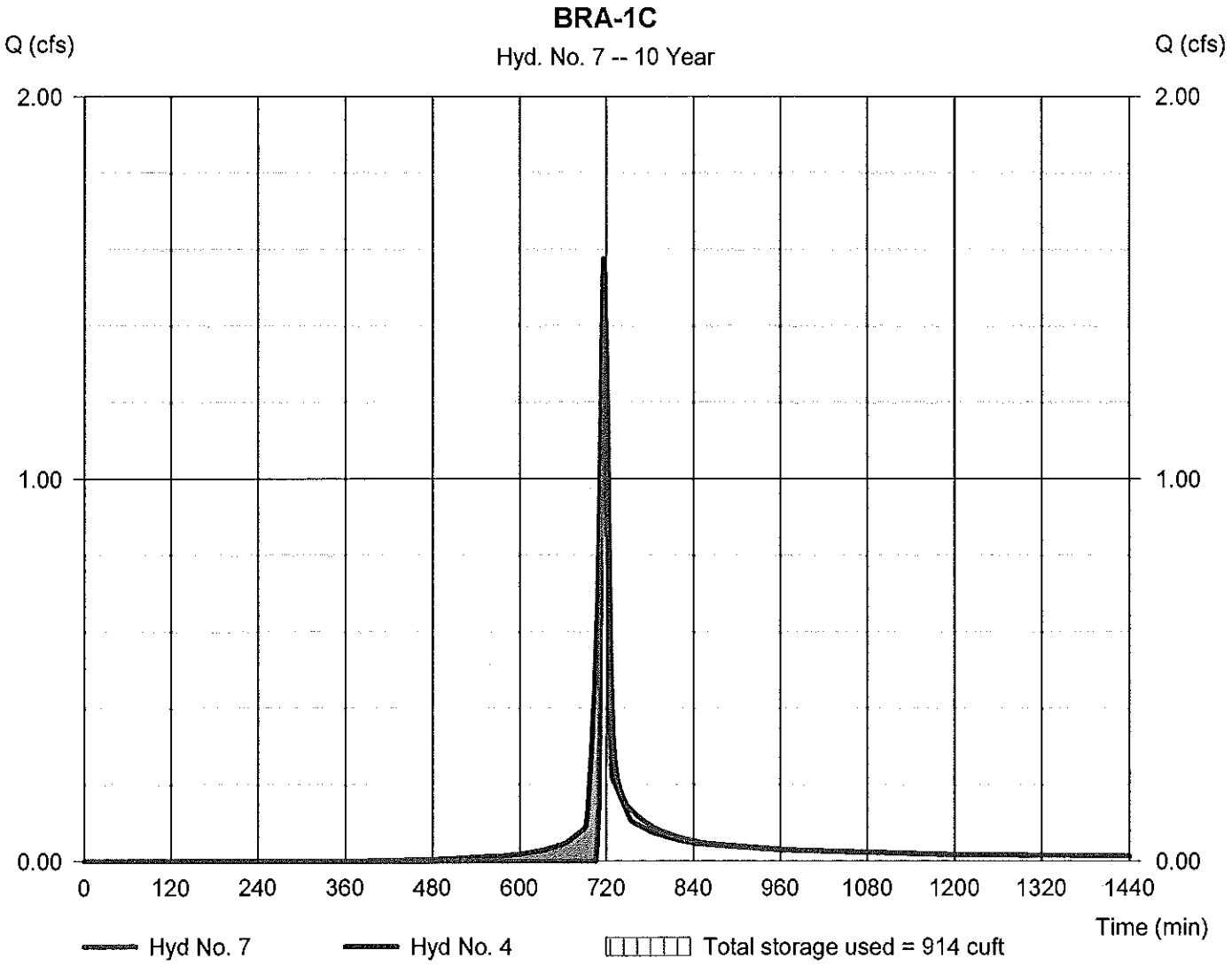
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 1.444 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 2,643 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.78 ft
Reservoir name	= BRA-1C	Max. Storage	= 914 cuft

Storage Indication method used.



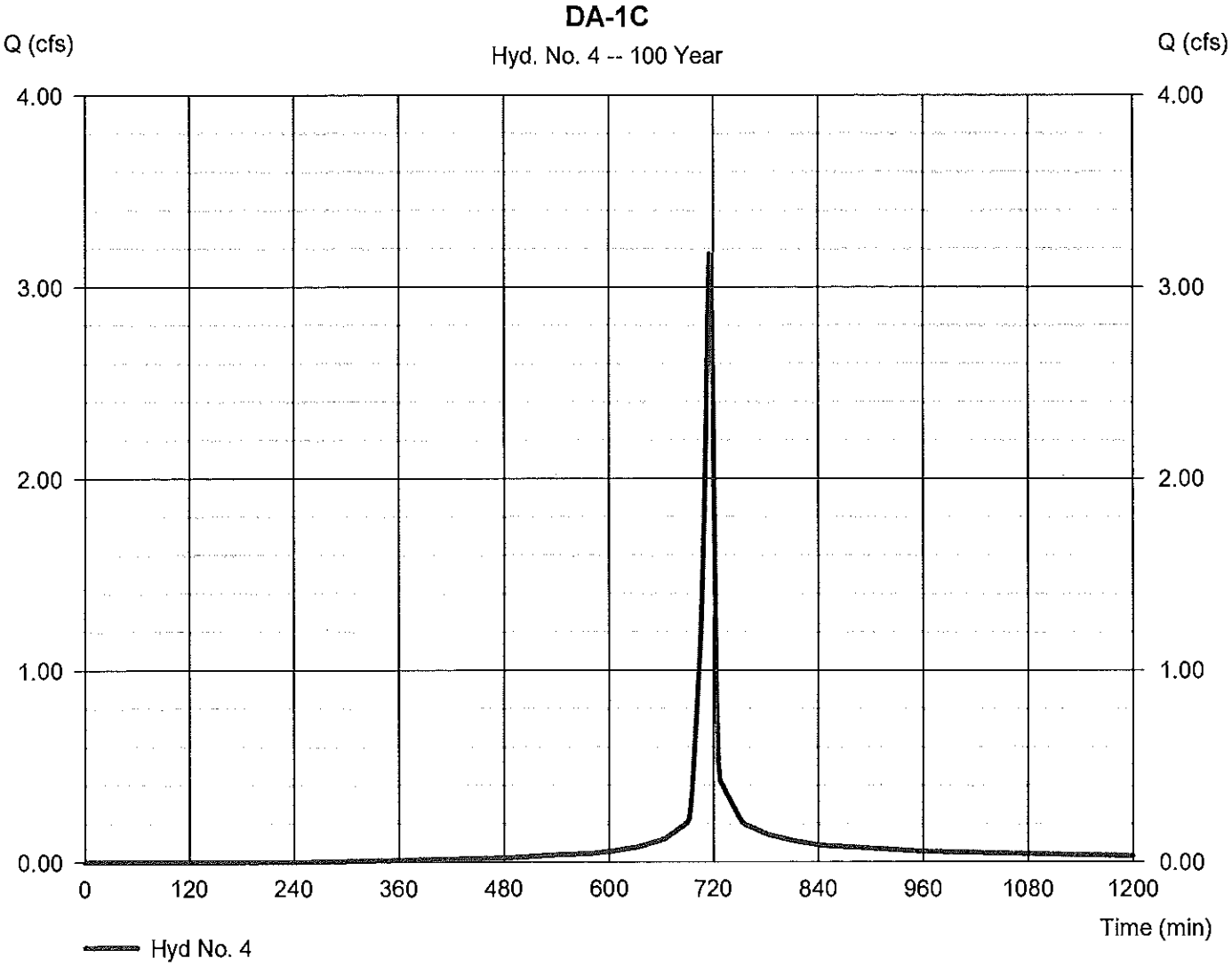
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 4

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 3.173 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 6,749 cuft
Drainage area	= 0.320 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 8.23 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

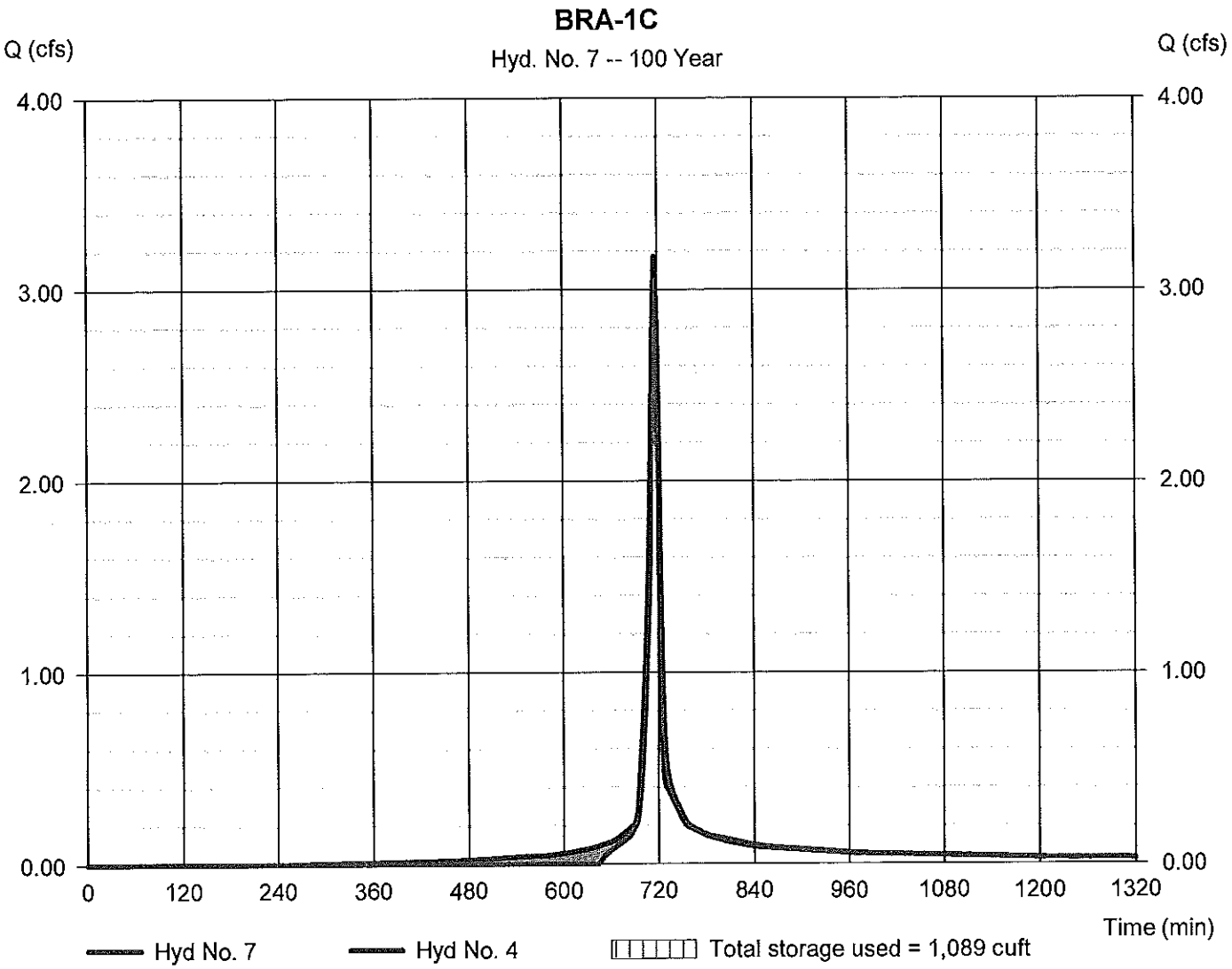
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 — Thursday, 09 / 22 / 2016

Hyd. No. 7

BRA-1C

Hydrograph type	= Reservoir	Peak discharge	= 3.051 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 6,161 cuft
Inflow hyd. No.	= 4 - DA-1C	Max. Elevation	= 629.93 ft
Reservoir name	= BRA-1C	Max. Storage	= 1,089 cuft

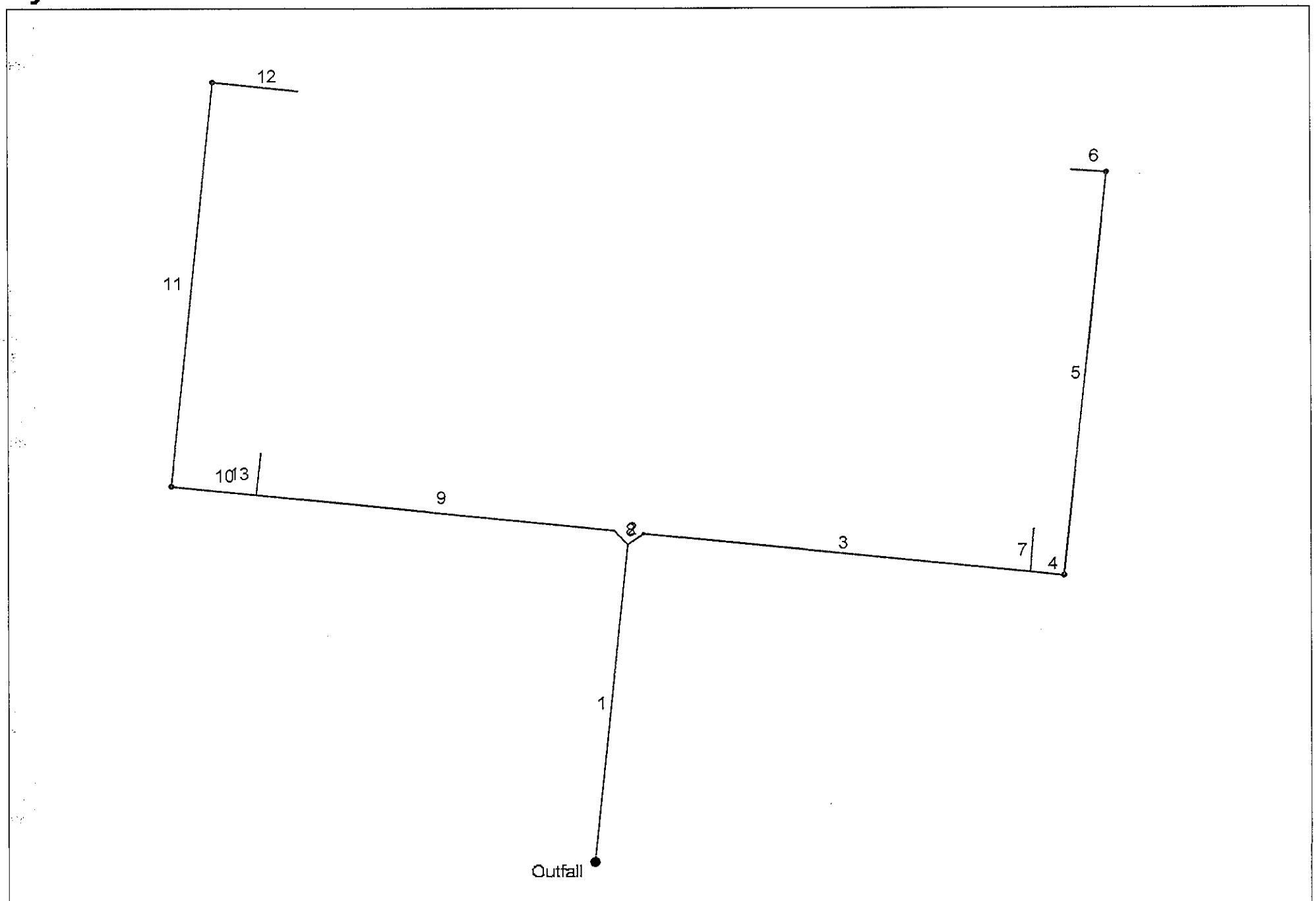
Storage Indication method used.



APPENDIX - F

Hydroflow Storm Sewer Hydraulic Computations

Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2013 Plan



Project File: RL-4 TO LS-3.stm	Number of lines: 13	Date: 9/1/2016

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	51.332	0.00	0.00	0.00	0.00	0.00	0.0	6.3	0.0	1.24	0.93	3.55	8	0.51	635.61	635.87	636.28	636.74	636.80	638.23	Pipe - (30) (RL-4
2	1	3.052	0.00	0.00	0.00	0.00	0.00	0.0	6.1	0.0	0.62	0.60	3.16	6	0.98	635.87	635.90	636.89	636.92	638.23	638.26	Pipe - (23) (RL-4
3	2	61.450	0.00	0.00	0.00	0.00	0.00	0.0	5.8	0.0	0.62	0.61	3.16	6	0.99	636.00	636.61	637.03	637.67	638.26	638.50	Pipe - (17) (1) (RL
4	3	5.280	0.00	0.00	0.00	0.00	0.00	0.0	5.7	0.0	0.31	0.75	1.58	6	1.52	636.61	636.69	637.83	637.84	638.50	638.34	Pipe - (17) (RL-4
5	4	65.425	0.00	0.00	0.00	0.00	0.00	0.0	5.1	0.0	0.31	0.61	1.58	6	1.00	636.69	637.35	637.88	638.05	638.34	638.58	Pipe - (16) (1) (RL
6	5	5.513	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.31	0.58	1.58	6	0.91	637.35	637.40	638.09	638.10	638.58	638.42	Pipe - (15) (RL-4
7	3	6.955	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.31	0.98	1.58	6	2.59	636.61	636.79	637.83	637.85	638.50	638.42	Pipe - (21) (RL-4
8	1	3.095	0.00	0.00	0.00	0.00	0.00	0.0	6.3	0.0	0.62	0.60	3.16	6	0.97	635.87	635.90	636.89	636.93	638.23	638.27	Pipe - (27) (RL-4
9	8	57.060	0.00	0.00	0.00	0.00	0.00	0.0	6.0	0.0	0.62	0.61	3.16	6	1.00	635.90	636.47	637.03	637.63	638.27	638.27	Pipe - (26) (1) (RL
10	9	13.570	0.00	0.00	0.00	0.00	0.00	0.0	5.8	0.0	0.31	0.61	1.58	6	0.99	636.47	636.61	637.78	637.82	638.27	638.03	Pipe - (26) (RL-4
11	10	65.474	0.00	0.00	0.00	0.00	0.00	0.0	5.1	0.0	0.31	0.61	1.58	6	1.00	636.61	637.26	637.86	638.03	638.03	638.10	Pipe - (25) (RL-4
12	11	13.576	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.31	0.62	1.58	6	1.03	637.26	637.40	638.07	638.10	638.10	638.42	Pipe - (24) (RL-4
13	9	6.792	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.31	1.30	1.58	6	4.56	636.48	636.79	637.78	637.80	638.27	638.42	Pipe - (28) (RL-4

Project File: RL-4 TO LS-3.stm | Number of lines: 13 | Run Date: 9/1/2016

NOTES:Known Qs only ; c = cir e = ellip b = box

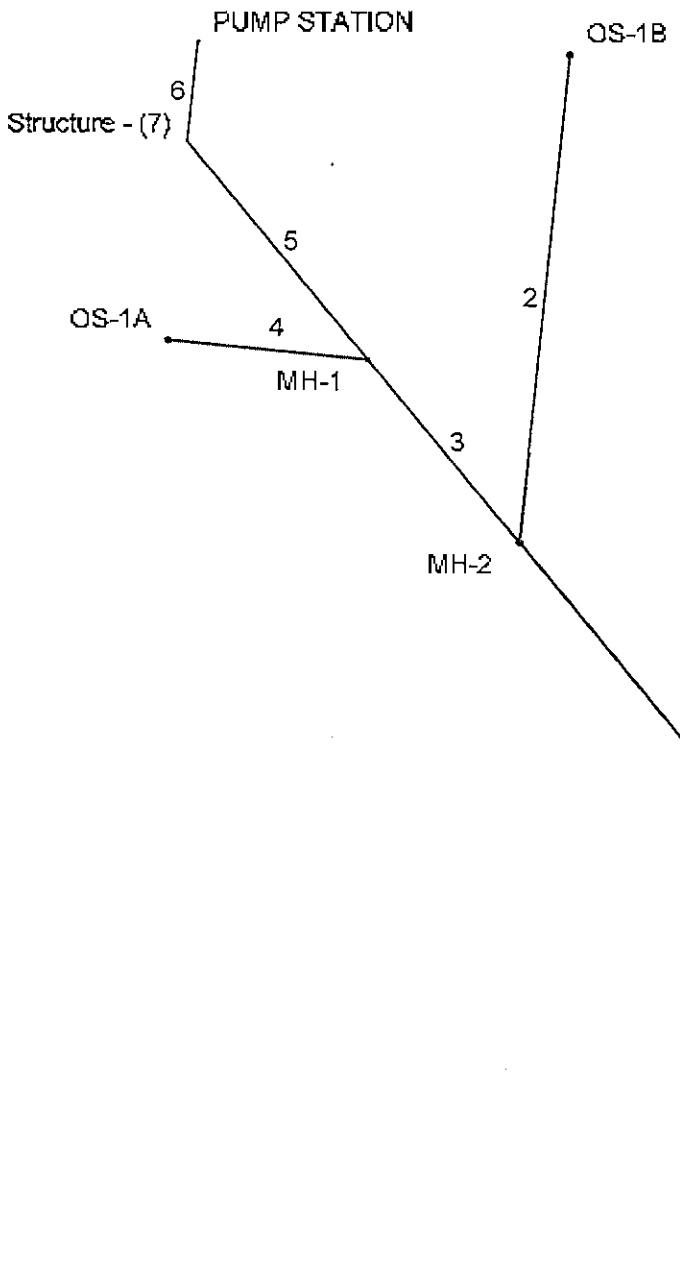
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	8	1.24	635.61	636.28	0.67	0.35	3.55	0.20	636.47	0.899	51.332	635.87	636.74	0.67	0.35	3.55	0.20	636.93	0.898	0.898	0.461	0.79	0.15
2	6	0.62	635.87	636.89	0.50	0.20	3.16	0.16	637.05	1.042	3.052	635.90	636.92	0.50	0.20	3.16	0.16	637.08	1.042	1.042	0.032	0.70	0.11
3	6	0.62	636.00	637.03	0.50	0.20	3.16	0.16	637.19	1.042	61.450	636.61	637.67	0.50	0.20	3.16	0.16	637.83	1.042	1.042	0.640	1.00	0.16
4	6	0.31	636.61	637.83	0.50	0.20	1.58	0.04	637.87	0.261	5.280	636.69	637.84	0.50	0.20	1.58	0.04	637.88	0.260	0.260	0.014	1.00	0.04
5	6	0.31	636.69	637.88	0.50	0.20	1.58	0.04	637.92	0.261	65.425	637.35	638.05	0.50	0.20	1.58	0.04	638.09	0.260	0.260	0.170	1.00	0.04
6	6	0.31	637.35	638.09	0.50	0.20	1.58	0.04	638.13	0.261	5.513	637.40	638.10	0.50	0.20	1.58	0.04	638.14	0.260	0.260	0.014	1.00	0.04
7	6	0.31	636.61	637.83	0.50	0.20	1.58	0.04	637.87	0.261	6.955	636.79	637.85	0.50	0.20	1.58	0.04	637.89	0.260	0.260	0.018	1.00	0.04
8	6	0.62	635.87	636.89	0.50	0.20	3.16	0.16	637.05	1.042	3.095	635.90	636.93	0.50	0.20	3.16	0.16	637.08	1.042	1.042	0.032	0.70	0.11
9	6	0.62	635.90	637.03	0.50	0.20	3.16	0.16	637.19	1.042	57.060	636.47	637.63	0.50	0.20	3.16	0.16	637.78	1.042	1.042	0.595	1.00	0.16
10	6	0.31	636.47	637.78	0.50	0.20	1.58	0.04	637.82	0.261	13.570	636.61	637.82	0.50	0.20	1.58	0.04	637.86	0.260	0.260	0.035	1.00	0.04
11	6	0.31	636.61	637.86	0.50	0.20	1.58	0.04	637.90	0.261	65.474	637.26	638.03	0.50	0.20	1.58	0.04	638.07	0.260	0.260	0.171	1.00	0.04
12	6	0.31	637.26	638.07	0.50	0.20	1.58	0.04	638.11	0.261	13.576	637.40	638.10	0.50	0.20	1.58	0.04	638.14	0.260	0.260	0.035	1.00	0.04
13	6	0.31	636.48	637.78	0.50	0.20	1.58	0.04	637.82	0.261	6.792	636.79	637.80	0.50	0.20	1.58	0.04	637.84	0.260	0.260	0.018	1.00	0.04

Project File: RL-4 TO LS-3.stm | Number of lines: 13 | Run Date: 9/1/2016

; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2013 Plan



Project File: PUMP STATION TO LS-1.stm	Number of lines: 6	Date: 9/23/2016

Storm Sewers v10.0

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	177.827	0.00	0.00	0.00	0.00	0.00	0.0	7.7	0.0	2.88	3.76	4.19	12	0.95	612.00	613.69	613.00	614.42	613.52	635.86	Pipe - (10)
2	1	96.623	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	1.86	8.45	6.28	12	4.79	627.57	632.20	627.89	632.78	635.86	637.00	Pipe - (14)
3	1	46.443	0.00	0.00	0.00	0.00	0.00	0.0	7.5	0.0	1.02	1.15	3.34	8	0.78	613.79	614.15	614.42	614.64	635.86	636.96	Pipe - (9)
4	3	38.808	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.92	2.86	5.47	8	4.79	629.80	631.66	630.06	632.11	636.96	636.06	Pipe - (12)
5	3	55.375	0.00	0.00	0.00	0.00	0.00	0.0	5.7	0.0	0.10	0.60	1.20	6	0.99	614.25	614.80	614.80	614.96	636.96	615.55	Pipe - (8)
6	5	20.075	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.10	0.61	1.65	6	1.00	614.80	615.00	615.00	615.16	615.55	616.02	Pipe - (7)

Project File: PUMP STATION TO LS-1.stm | Number of lines: 6 | Run Date: 9/23/2016

NOTES:Known Qs only ; c = cir e = ellip b = box

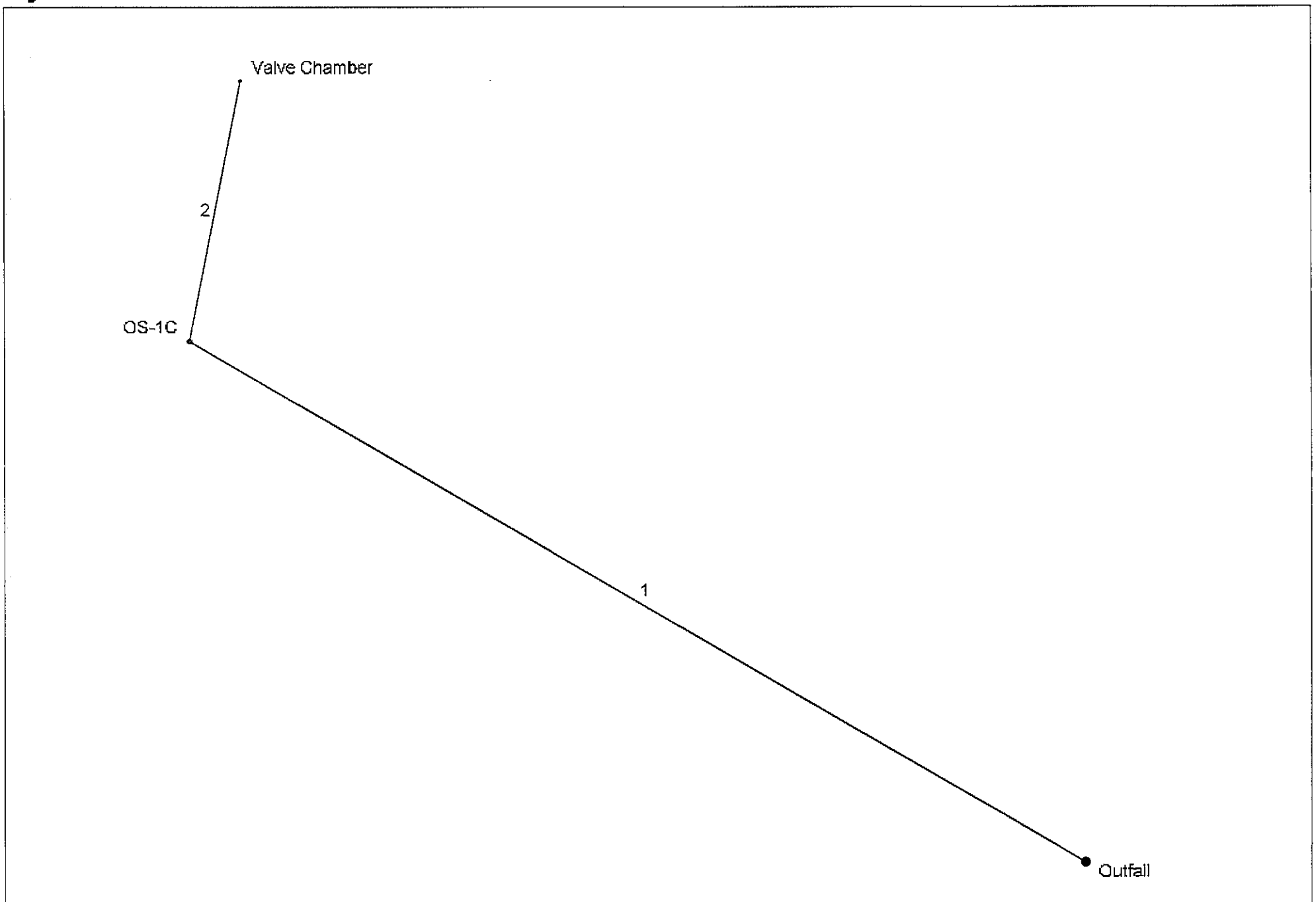
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	12	2.88	612.00	613.00	1.00	0.61	3.67	0.21	613.21	0.557	177.827	613.69	614.42 j	0.73**	0.61	4.71	0.34	614.76	0.722	0.640	n/a	0.75	n/a
2	12	1.86	627.57	627.89	0.32*	0.22	8.62	0.24	628.13	0.000	96.623	632.20	632.78	0.58**	0.47	3.93	0.24	633.02	0.000	0.000	n/a	1.00	0.24
3	8	1.02	613.79	614.42	0.63	0.34	2.99	0.14	614.56	0.525	46.443	614.15	614.64	0.49	0.28	3.69	0.21	614.85	0.759	0.642	0.298	0.75	0.16
4	8	0.92	629.80	630.06	0.26*	0.13	7.31	0.20	630.26	0.000	38.808	631.66	632.11	0.45**	0.25	3.63	0.20	632.32	0.000	0.000	n/a	1.00	0.20
5	6	0.10	614.25	614.80	0.50	0.05	0.51	0.00	614.81	0.027	55.375	614.80	614.96 j	0.16**	0.05	1.89	0.06	615.01	0.588	0.308	0.170	0.75	0.04
6	6	0.10	614.80	615.00	0.20	0.05	1.38	0.06	615.05	0.000	20.075	615.00	615.16 j	0.16**	0.05	1.91	0.06	615.21	0.000	0.000	n/a	1.00	0.06

Project File: PUMP STATION TO LS-1.stm | Number of lines: 6 | Run Date: 9/23/2016

Notes: * depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2013 Plan



Project File: OS-1C TO LS-2.stm	Number of lines: 2	Date: 9/23/2016

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	245.386	0.00	0.00	0.00	0.00	0.00	5.0	7.2	0.0	1.55	3.61	2.83	12	0.88	612.00	614.15	613.00	614.68	613.52	629.55	Pipe - (3)
2	1	68.310	0.00	0.00	0.00	0.00	0.00	5.0	5.0	0.0	0.10	0.52	1.23	6	0.73	614.25	614.75	614.68	614.91	629.55	632.50	Underdrain

Project File: OS-1C TO LS-2.stm

Number of lines: 2

Run Date: 9/23/2016

NOTES:Known Qs only ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	12	1.55	612.00	613.00	1.00	0.42	1.97	0.06	613.06	0.161	245.386	614.15	614.68 j	0.53**	0.42	3.69	0.21	614.89	0.539	0.350	n/a	0.93	0.20
2	6	0.10	614.25	614.68	0.43	0.05	0.56	0.06	614.73	0.000	68.310	614.75	614.91 j	0.16**	0.05	1.91	0.06	614.96	0.000	0.000	n/a	1.00	0.06

Project File: OS-1C TO LS-2.stm | Number of lines: 2 | Run Date: 9/23/2016

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

APPENDIX - G

Geotechnical Report

Geotechnical Engineering Report

WSSC Contract No. BP5692A14
Brink Zone Reliability Improvements Project
Montgomery County, Maryland

Prepared For:
Washington Suburban Sanitary Commission

Submitted To:
Hatch Mott MacDonald, LLC
11019 McCormick Road, Suite 260
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Submitted: August 25, 2015
N&W #1502MD017

NAVARRO & WRIGHT
CONSULTING ENGINEERS

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EXECUTIVE SUMMARY

Washington Suburban Sanitary Commission (WSSC) Contract No. BP5692A14 is identified as the "Brink Zone Reliability Improvement Project". The project site is located along State Route 27 (Ridge Road) in Montgomery County, Maryland. The Geotechnical Engineering Report (GER) herewith was prepared by Navarro & Wright Consulting Engineers, Inc. (N&W) for WSSC through Hatch Mott MacDonald, LLC (HMM). The purpose of this report is to effectively characterize the site subsurface conditions in order to provide guidance for the structural and site civil engineering designs of the proposed 13 MGD Water Pumping Station and ancillary facilities that will service the City of Gaithersburg and surrounding areas.

Test Borings B-2, B-3 were preformed within the proposed pump house footprint area, and Boring B-1 was performed adjacent to the proposed vault. These structure borings sampled both soil and rock and ranged in depth from 15.0 to 32.1 feet. Borings I-1, I-2 and I-3 were advanced to depths ranging from 4.1 to 12.3 feet below the existing ground surface prior to reaching refusal on very dense materials. Infiltration testing was performed at test locations I-1 and I-2 to provide data for the development of stormwater designs. Infiltration testing was not performed at Boring I-3 where limiting zones were encountered.

According to the U.S. Geological Survey, the project site is underlain by the undivided Ijamsville and Marburg Schist formations of late Precambrian age. These formations consist primarily of phyllite, slate and schist. Based on the results of the test borings, the depth to the apparent rock surface is somewhat erratic; however, rock should be consistently encountered along the base of the proposed pump house. It should be possible for large and heavy duty excavation equipment to remove the upper portions of the rock; however, such excavation is anticipated to be difficult. The majority of the site soils encountered by the borings are considered to be residual soils formed by the in-place weathering of the site bedrock. Some fill materials are present as the result of previous construction phases. Soil samples were classified in the laboratory as silts, sands and gravels. Laboratory moisture and compaction testing results suggest that the site soils could be successfully recompacted if strict quality control requirements are enforced.

The project site is suitable to support conventional spread footing or mat foundations typically used for water treatment and conveyance systems. The depth of the proposed exterior wall footings for the pump house relative to the depth of the pump room mat foundation will dictate the foundation configurations and the amount of structural capacity necessary for the proposed retaining walls. Processed aggregates should be used for retaining wall backfill, and AASHTO No. 57 Coarse Aggregate should be used where free-draining materials are necessary.

1.0 INTRODUCTION

1.1 Purpose and Scope

The Geotechnical Evaluation Report (GER) herewith was prepared by Navarro & Wright Consulting Engineers, Inc. (N&W) for WSSC through Hatch Mott MacDonald, LLC (HMM) and summarizes the results of the test borings, laboratory tests and geotechnical engineering analyses associated with the proposed Brink Zone Reliability Improvement Project for WSSC. The GER is based upon currently available design concepts along with the field and laboratory data obtained from the test boring and laboratory testing programs.

1.2 Available Information

The Design Team and WSSC assisted N&W with the preparation of this report by providing the following information:

- Test Pit and Boring Location Plan by Hatch Mott MacDonald, LLC, (undated), 2014.
- A hardcopy of a preliminary conceptual floor plan illustrating the pump station layout received by N&W from Hatch Mott MacDonald during a design progress meeting on June 2, 2015. Proposed floor elevations were discussed during this meeting.
- Construction Plan Set, 10 MG Brink Water Storage Reservoir, by Burns & McDonnell, dated November 23, 1983.
- Various construction plans for Brink and Cedar Heights Pumping Station, by Matz, Childs and Associates, dated March 22, 1966.

1.3 Site Location and Description

The existing pumping station and elevated water storage reservoir are situated directly northeast of the intersection of Ridge and Brink Roads in Montgomery County, Maryland. The original pumping station was constructed circa 1966 and the elevated water storage tank circa 1984. The proposed construction includes a new pumping station, a new vault and ancillary facilities. The majority of the proposed construction is situated to the south of the existing facilities outside of the existing fenced-in enclosure.

Current site grades across the proposed facility expansion area typically fall gently from north to south, or from approximate elevation 642 to 630, respectively. The existing Brink Zone pump facilities are positioned within a topographic high area, and the surrounding grades fall to all sides of this elevated zone. The agricultural fields to the east of the site drain to a channel that forms a small surface stream under Wildcat Road to the east of the site. At the project site, groundcover consists of short to long grass, dependent upon seasonal mowing. The grass areas are interspersed with some trees.

1.4 Proposed Construction

The proposed improvements include a new 13 MGD pumping station and a new vault. New water lines, electric lines and other facilities will support the new construction. The upgraded capacity will be used to serve the City of Gaithersburg and surrounding areas. The proposed pump station will involve two (2) floor levels. Four (4) pumps will bear on machine foundations or a floor at elevation 615 feet, while the control room, a truck bay, a generator room and ancillary floor spaces will be positioned on a floor at elevation 640 feet. Plans for the proposed vault were not available; however, we understand that the vault facility will include a subsurface structure with cast-in-place reinforced concrete walls and floor.

2.0 GEOLOGIC SETTING

According to the Maryland Geologic Survey, the project site lies within the Mt. Airy Upland District of the Piedmont Plateau Province. The Piedmont physiographic province is positioned between the Coastal Plain Province to the southeast and the Blue Ridge Province to the northwest and extends through several Maryland counties. Fact Sheet 19 by the Maryland Department of Natural Resources describes the Piedmont as follows:

> *The Piedmont is underlain primarily by metamorphic and igneous crystalline rocks. Over time the rocks have been folded, faulted, and fractured to varying degrees, and the region is commonly referred to as fractured-rock terrane (Nutter and Otton, 1969). The boundary between the Piedmont and Coastal Plain provinces is known as the Fall Line, and it separates the hard, fractured rocks of the Piedmont from the unconsolidated sediments of the Coastal Plain.*

Generally, bedrock in the Piedmont Plateau Province has undergone varying degrees of metamorphic processes; therefore, transitions and distinctions between one rock unit and another are typically subtle. Bedrock in the eastern part of the Piedmont consists of schist, gneiss, gabbro, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin. In several places these rocks have been intruded by granitic plutons and pegmatites. Deep drilling has revealed that similar metamorphic and igneous rocks underlie the sedimentary rocks of the Coastal Plain. Several domal uplifts of Precambrian gneiss mantled with quartzite, marble, and schist are present in Baltimore County and in parts of adjacent counties in the eastern Piedmont. Differential erosion of these contrasting rock types has produced a distinctive topography in this part of the Piedmont. The rocks of the western part of the Piedmont are diverse and include phyllite, slate, marble, and moderately to slightly metamorphosed volcanic rocks. The Piedmont Plateau Province contains a variety of mineral resources. Formerly, building stone, slate, and small deposits of nonmetallic minerals, base-metal sulfides, gold, chromite, and iron ore were mined in the Piedmont. Currently, crushed stone is important for aggregate, concrete, and lime.

According to the Physiographic Map of Maryland by the Maryland Geologic Survey, the project site falls within the Mt. Airy Upland District of the Piedmont Plateau Province and is described as follows:

> *Rolling upland; herringbone texture due to interaction of thin siltstones and quartzites with stream reaches controlled by joints oblique to bedrock strike; streams often incised (e.g. Bennett, Little Bennett, Bush, Linganore, and Israel Creeks).*

Based on the Geologic Map of Maryland (1968) by the Maryland Geologic Survey, the WSSC Brink Zone facility is situated within the undivided Ijamsville and Marburg Schist formations of the late Precambrian Era. These formations are described as follows:

> *Ijamsville Formation - Blue, green, or purple phyllite and phyllitic slate, with interbedded metasiltstone and metagraywacke; flattened pumiceous blebs occur locally; and Marburg Schist - Bluish-gray to silvery-green, fine-grained, muscovite-chlorite-albite-quartz schist; intensely cleaved and closely folded; contains interbedded quartzites.*

The 1968 mapping is not considered to meet cartographic standards; consequently, the geologic conditions must be confirmed by other means. The site-specific bedrock was explored via core borings, and the recovered cores were visually reviewed by geologists of N&W.

3.0 SUBSURFACE EXPLORATIONS AND INFILTRATION TESTING

Soil and rock explorations were performed in general accordance with WSSC Common Design Guidelines, Appendix E. Six (6) test borings were drilled by a subcontractor to N&W between July 23 and 27, 2015 and were logged by an onsite representative of N&W. Drilling was conducted in general compliance with methodologies specified by the American Society for Testing and Materials (ASTM) including the Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils, Designation D1586, and the Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation, Designation D2113. Structure area Borings B-1 through B-3, along with stormwater management area infiltration Borings I-1 through I-3, were conducted to characterize soils within the area of the proposed construction. Boring B-1 was performed adjacent to the proposed vault. Boring Nos. B-2 and B-3 were drilled within the footprint area of the proposed pump station. Borings I-1 through I-3 were drilled at the preliminary design locations for the proposed stormwater facilities. Borings I-1, I-2 and I-3 were originally designated as Borings B-4, B-5 and B-6, respectively; however, the numbering convention was altered in order to distinguish the structure borings from

the borings associated with infiltration testing. Infiltration tests were conducted directly adjacent to Borings I-1 and I-2 in order to determine infiltration rates that can be used to support the stormwater management designs. No infiltration testing was performed in Boring I-3 as a limiting zone was encountered at 4.1 feet when refusal of the augers occurred on the apparent rock surface.

The initial boring locations were programmed by Hatch Mott MacDonald. All initially proposed boring points were staked by a survey crew from N&W, and their respective ground surface elevations were recorded. Hatch Mott MacDonald abandoned the originally proposed position of Boring I-3 (B-6) in order to avoid a conflict with an existing septic field. The as-drilled positions of each of the borings relative to the proposed construction are illustrated on the Boring Location Plan, Figure 3. The scheduled boring depths were programmed by Hatch Mott MacDonald at 45 feet deep for Borings B-2 and B-3 and at 15 feet for the remainder of the borings. In most cases, borings were terminated above their respective scheduled depths within rock or very dense materials. Boring B-2 was terminated at 32.1 feet after sampling seven (7.0) lineal feet of rock, and Boring B-3 was terminated at 30.0 feet after sampling 4.9 lineal feet of rock. Boring B-1 was advanced to the scheduled depth of 15.0 feet. Borings I-1, I-2, and I-3 encountered auger refusals on the apparent bedrock surface at depths of 11.4, 12.3 and 4.1 feet, respectively.

At each infiltration test boring/characterization boring except Boring I-3, an independent companion auger boring was performed adjacent to the Standard Penetration Test (SPT) boring. Borehole infiltration tests were performed within each of these companion auger borings in general accordance with the procedures for "Testing Requirements for Infiltration Bioretention and Sand Filter Subsoils" published in Appendix D.1 of the Maryland Stormwater Design Manual, Volume 1 (2009). The results of the calculated infiltration rates are presented in this report. Typed Engineers Field Boring Logs and photographs of the rock cores recovered from the test borings are presented in Appendix A. The results of the infiltration tests are summarized below.

INFILTRATION TESTING RESULTS SUMMARY

Boring Number	Ground Surface Elevation (feet)	Elevation of Infiltration Test (feet)	Stabilized Infiltration Rate (inches / hour)
I-1 (B-4)	637.9	627.9	0.57
I-2 (B-5)	640.5	630.5	0.48
I-3 (B-6)	637.3	633.2*	Limiting Zone*

* Boring I-3 encountered split spoon refusal on very dense saprolite at 4.1 feet below the existing ground. This dense zone is regarded as a "limiting zone".

A common soil stratum in both Borings I-1 and I-2 was tested at ten feet below the ground surface; therefore, designs may account for one generalized soil zone near Borings I-1 and I-2 with an average infiltration rate of 0.53 inches/hour. The design of infiltration facilities in the general area of Boring I-3 is not recommended inasmuch as limiting zones in the form of rock or obstructions within possible fill materials were encountered within the test borings.

4.0 LABORATORY TESTING

Upon completion of the subsurface explorations, N&W completed laboratory analysis of selected soil samples. All soil testing was performed in N&W's in-house, AASHTO-accredited laboratory. Testing included ten (10) natural moisture content tests (ASTM D2216) conducted on sealed jar samples and three (3) USCS classifications (ASTM D2487) with sieve (ASTM D422), hydrometer (ASTM D422) and Atterberg Limits (D4318). Hydrometer testing was performed to determine the distribution of clay-size particles. The potential behavior of the onsite soils when reused as compacted fill materials was reviewed by completing a Standard Proctor test (ASTM D698) on a bag sample recovered from the site soils.

Detailed laboratory testing results are included in Appendix B. The table to follow summarizes the results of the soil classification and compaction testing.

LABORATORY SOIL TESTING RESULTS SUMMARY

Boring No.	Sample No.	Depth (ft)	USCS	LL (%)	PI (%)	Max. Dry Density γ_{DRY} (pcf)	Optimum Moisture Std.-w_{opt} (%)	Natural Water Content w (%)
B-1	S-4	4.5 – 6.0	-	-	-	-	-	8.0
B-1	S-7	9.0 – 10.5	-	-	-	-	-	18.0
B-2	S-4	4.5 – 6.0	-	-	-	-	-	10.9
B-2	S-9	15.0 – 15.9	-	-	-	-	-	6.5
B-3	S-2	1.5 – 3.0	-	-	-	-	-	10.5
B-3	S-3	3.0 – 4.5	GC	36	13	-	-	15.0
B-3	S-10	20.0 – 20.4	-	-	-	-	-	10.0
B-3	Cuttings	0.0 – 25.0	-	-	-	121.0	13.5	-
I-1	S-2	1.5 – 3.0	-	-	-	-	-	16.9
I-2	S-4	4.5 – 6.0	SM	34	5	-	-	14.8
I-3	S-2	1.5 – 3.0	ML	28	4	-	-	13.5

5.0 SUBSURFACE CONDITIONS

The results of the test borings and laboratory testing programs will be reviewed in order to characterize the subsurface soil, bedrock and groundwater conditions.

5.1 Soil

The site soils generally consist of fill materials and residual soils. Fill materials are assumed to be present as a result of site grading activities for previous construction phases and from past agricultural activities. The apparent fill materials were distinguished from the site residual soils and ranged in thickness from 1.5 to 4.5 feet. Residual soils are formed by the complete in-place weathering of the native site bedrock. Portions of the site residual soils could best be characterized as saprolites. Saprolites are comprised of bedrock that has weathered in-place, but has maintained the original volume of the parent rock material while demonstrating a lower overall in-place density relative to the parent rock. Visually, this soil maintains the fabric and structure of the original rock but can be easily excavated as a soil material.

Per the Unified Soil Classification System (USCS) convention, the fill materials and residual site soils (including saprolites) characteristically consist of silty sands, silts and clayey gravels. A typical subsurface strata profile, illustrating the generalized soil and rock conditions revealed by the test borings, is presented via the following table:

Typical Depth Below Gd. Surface (feet)	Typical Subsurface Strata Description
0	Ground Surface
½	Sandy SILT with organics, brown, moist, loose (*Topsoil*)
3	Sandy SILT with a little gravel, (ML), brown to orangish brown, moist, medium dense (*Fill*)
11	Silty SAND, (SM) with some rock fragments and clay, orangish brown to brown, moist, medium dense to dense (*Residual with Saprolites)*
25	Clayey GRAVEL with SAND, (GC), orangish brown to reddish brown, moist, medium dense to very dense (*Residual – Saprolite)*
Below 25	GNEISS, gray to reddish brown, highly to moderately weathered, narrowly spaced fractures, soft to medium hard *(Bedrock)*

The typical subsurface strata profile shown above is conceptual and does not represent the subsurface conditions at any specific point on the project site. Detailed descriptions of the soils encountered at each test boring point are presented on the typed Engineers Field Boring Logs in Appendix A.

5.2 Bedrock

For classification purposes, the materials on the Engineers Test Boring Logs in Appendix A are either described as soil or rock. In a more practical sense, there is a gradual transition of soil to rock. For purposes of geotechnical engineering evaluations, the bedrock surface is typically considered to be positioned at the depth where auger refusals occur, or at the depth were diamond-bit core sampling is initiated. Based upon this geotechnical engineering convention, we have compiled the depth to bedrock table below considering the test boring data, and our interpretations and extrapolations from the test boring data as follows:

DEPTH TO BEDROCK TABLE

Boring Number	Ground Surface Elevation (feet)	Depth to Bedrock (feet)	Top-of-Rock Elevation (feet)
B-1	632.9	>15.0	<617.9
B-2	639.3	25.1	614.2
B-3	641.9	25.0	616.9
I-1	637.9	>11.4*	<626.5*
I-2	640.5	>12.3*	<628.2*
I-3	637.3	> 4.1*	<633.2*

* Note: The level of split-spoon refusal is noted.

Geotechnical engineering conventions have established the top-of-bedrock level in Borings B-2 and B-3 at the depths and elevations as shown in the table above. Nonetheless, highly weathered rock, or very dense residual materials including saprolites, were encountered above these "top-of-bedrock" levels in Borings I-1, I-2 and I-3 where refusal to further advancement of the split-spoon sampler occurred. When paired with a drill rig with sufficient torque, the augers are typically capable of advancing through very dense materials which possess visible rock structure. Consequently, the Engineers Logs for Borings I-1, I-2 and I-3 presented in Appendix A, associate the "apparent top-of-rock" surface with the depth to split-spoon refusal. We have defined split-spoon refusal as failure to advance the spoon more than six inches with 50 or more blows of the 140-pound hammer.

As discussed in the Geologic Setting section above, the site bedrock is mapped as *phyllite and phyllitic slate.* Subtle differences involving the extent of the metamorphic processes are used to distinguish between phyllite, slate, schist and gneiss. We have described the site bedrock as "gneiss"; however, all of these descriptions represent a transitional geologic process; therefore, various geologists may have different ways to describe this rock. The precise mineralogical identification of these strata are not as significant as the potential impact of the presence of rock will have upon the proposed construction. Where split-spoon refusals are encountered within dense saprolites, potential infiltration rates in such zones are typically very slow. However, these dense saprolites can typically be removed by heavy duty excavation equipment, such as a Caterpillar E325 Excavator, without difficulty and without the assistance of pneumatic hammers or blasting. Finally, at levels where auger refusal occurs in the test borings, difficult excavation with heavy duty excavation equipment typically begins. Difficult excavation may require constant prizing of rock beds with an excavator bucket, ripping with the ripper of a large bulldozer such as a Caterpillar D-8, or the use of pneumatic hammers in order to efficiently advance excavations through these rock materials. However, blasting is not recommended due to the potential damage to the existing infrastructure.

Rock quality is reflected by the percent recovery as well as the Rock Quality Designation (RQD) values recorded on the boring logs in Appendix A. RQD is defined as the cumulative length of solid core pieces greater than 4.0 inches in length expressed as a percentage of the particular core run length. Therefore, the condition of the site bedrock, including its potential resistance to excavation, is reflected by the condition of the recovered rock samples in terms of core recovery and Rock Quality Designation (RQD). Core recoveries of 16 and 30 percent were recorded in Boring B-2, while a core recovery of 73 percent was recorded in the only core run Boring B-3. In addition to poor to fair core recoveries, very poor rock "quality" was disclosed by RQD values of zero (0) percent within each core run in Boring B-2 and 20 percent within the only core run in Boring B-3. Consequently, the uppermost portions of the bedrock contain a significant number of open joints and soil seams that were washed away by the drilling fluids during the core recovery process. Consequently, difficult excavation of rock is not anticipated for the proposed vault and should also not occur until approximate elevations of 614 to 617 are reached when excavating to create the lower levels of the proposed pump house.

5.3 Groundwater

The level of the free water surface is likely positioned below the bedrock surface, but perched groundwater will play a role in the design of the proposed facilities. Seepage of surface water along natural site gradients originating to the north near the existing Brink Zone facilities will promote the formation of a perched groundwater table on top of rock and dense soil zones. Another potential source

of subsurface water could be the existing septic drainage field, which we understand is positioned a short distance to the north of the proposed pump house. Both of these potential water sources could contribute to the build-up of hydrostatic pressure around the proposed pump house foundation walls. Subsurface water was observed in Borings B-2 and B-3 at depths of 21.5 feet and 23.4 feet below the existing ground surface, equating to elevations 617.8 and 618.5 feet, respectively, or several feet above the finish floor elevation for the lowest level of the proposed pump station at 615 feet.

Contractors should be prepared to temporarily control groundwater in deep foundation or utility trenches as the top-of-rock level is approached. Otherwise, typical design and construction practices should prevail. Foundation drains installed along the exterior and interior sides of the foundation walls and routed to a sump pit will be necessary to prevent water infiltration onto the pump house and vault floors. Retaining walls should be backfilled with well-compacted free draining coarse aggregates. The extensive use of water stops and waterproofing materials are considered necessary if the proposed pump station and vault must remain dry.

6.0 ENGINEERING ANALYSES AND CONCLUSIONS

6.1 Trenching and Earthwork

Based on the results of the test borings, conflicts with the site bedrock are anticipated at the base of the excavation for the proposed pump house as well as within any accompanying pipe trenches ancillary to the pump house involving water lines with inverts near or below elevation 617 feet. Although it may meet criteria to be classified as "rock excavation", it may still be possible to remove the upper portions of the rock with aggressive excavation by a large trackhoe excavator such as a Caterpillar E325. Temporary shoring or extensive benching will likely be necessary when performing trenching to establish the proposed floor level of elevation 615 feet. Shoring, bracing, benching or sloped excavation sides must comply with OSHA requirements, including 29 CFR, Part 1926. The precise soil type must be assigned during construction and must include factors such as vibrations and weather conditions. Based strictly upon the characterization and condition of the recovered soil samples, the site soils are consistent with Type B soils. Sidewalls of temporary excavations in Type B soils are typically sloped at a ratio of 1:1 (horizontal: vertical).

Some excavation spoils generated from the installation of the pump house and vault foundations may be reused as fill and backfill materials at select locations under strict controls and limitations. At the time of the test boring program, the majority of the site soils possessed natural moisture contents appropriate for compaction and reuse within fill sections. Nevertheless, the site soils will be moisture sensitive and difficult to compact efficiently due to the significant presence of fine sands and silts. Saprolites in particular are very difficult to

compact when their natural moisture contents are outside of the workable range relative to their respective optimum moisture contents. Therefore, the construction team must understand that the reuse of onsite soils could potentially involve an extended earthwork or trenching schedules when significant moisture-conditioning of the saprolitic soils is required.

6.2 Foundation Designs and Installations

The project site is considered suitable for conventional foundations such as spread footings or mat foundations. Conventional foundations are generally the most cost-effective systems that can be installed in an efficient manner. The significant difference in elevation between adjacent floor levels within the proposed pump house will present challenges for the design and construction of this building. We understand that design concepts assign the pump room floor level at elevation 615 feet, while the control room, the generator room and truck bay areas are slab-on-grade construction with a finish floor elevation of 640 feet. Consequently, if the perimeter wall footings are founded at frost depth, perimeter foundations, or intermediate interior foundations, will likely bear upon wall backfill zone materials and transmit surcharge loading to the retaining walls that envelope the pump room.

When backfilled with dense well-graded gravel, the top of the pump room retaining walls will need to tilt a lateral distance of approximately 0.005H (where H is the height of the wall) in order to establish an "active" pressure state. Such movement will result in a corresponding vertical displacement of the backfill zone materials. If such a displacement is unacceptable, the Structural Engineer should consider designing the retaining walls for "at-rest" conditions.

The mat foundation for the pump room will have a finish floor level of 615 feet and an associated mat subgrade level related to the mat thickness. The bottom-of-footing (BOF) level for exterior wall footings enveloping the entire pump house, along with the BOF level for any intermediate footings adjacent to the truck bay or other rooms, could be established and designed in a number of potentially feasible ways. The precise foundation bearing levels should be assigned by the project Structural Engineer in consideration of the analyses, conclusions and recommendations presented in this Report.

Intermediate partition walls, which support only their respective dead weight and do not support structural roof loading, could be positioned upon conventional footings or upon thickened or "turned-down" slab sections. In such cases, modest surcharge loading associated with the intermediate walls should be considered when designing the structural capacity of the pump room retaining walls. Of course, live loads such as trucks will also generate surcharges. The exterior wall footings will also generate surcharge loading on the pump room walls if the exterior BOF level is held at frost depth. Foundation stress influence zones for

the perimeter wall footings, which support roof loading, will overlap with the backfill zones behind the pump room retaining walls. Placement of adjacent wall and/or retaining wall footings at diametrically opposed bearing levels in this manner is not ideal, but would be serviceable if high quality backfill materials are properly compacted. The use of select granular materials, such as well-graded gravels meeting the gradational requirements for CR6, should be required to backfill bulk excavation zones. Where hydrostatic pressure relief is desired, free-draining gravel, such as AASHTO No. 57 Coarse Aggregate should be specified.

In order to eliminate surcharges generated by higher-level footings, all footings could be positioned at the same bearing level of the lower level mat foundation. The disadvantage of this alternative would be an increase in excavation and backfill quantities. In order to decrease excavation and backfill quantities, the design team could consider altering the floor plan to incorporate the use of a mezzanine for the control room or other similar reconfigurations. Such alternative configurations are beyond the scope of the Geotechnical Engineering Report; therefore, comments and recommendations are confined to the preliminary building design concepts.

Assuming earthwork contractors will slope the pump room temporary excavation sides at an approximate slope rate of 1:1, perimeter exterior wall pump house footings could be lowered below conventional frost depth to bear within existing undisturbed soils. Based on the existing site soil properties, a maximum slope ratio of 1.75 horizontal to 1.0 vertical should be maintained between adjacent foundation bearing levels in order to eliminate the contribution of surcharge loading on the pump room walls from the structural design. Accounting for some minor overexcavation in a lateral direction during construction of the lower mat, the BOF level for the exterior eastern wall line footings would ultimately be positioned near elevation 634 feet, or about six (6) feet below the exterior grade. The northern wall footing and any intermediate footings would be positioned much lower when maintaining the 1.75:1 adjacent foundation bearing strata ratio, or a slope rate that is not as steep. At the discretion of the Structural Engineer, grade beams may be substituted for select portions of foundation walls where the goal is to reduce the overall height of foundation walls that have earth on both sides.

Evidence of uncontrolled fills from prior construction was found by examining samples at shallow depths within Borings B-1, B-2, B-3 and I-2. These fill materials will be automatically removed as the proposed foundations are installed adjacent to floor level 615 feet; however, any proposed footings that may be situated at frost depth might not penetrate existing shallow fill materials, nor would they necessarily penetrate new backfill materials around the pump room. For example, shallow-depth wall foundations under the south building wall in the truck bay area could hypothetically bear upon 25 feet of freshly placed backfill

materials. The proposed backfill materials have the potential to subside under building foundation loading in a proportionate manner to the quality of the backfill materials and the degree of compaction the backfill has received. Consequently, cracks in foundation walls associated with differential settlements of various bearing zone materials should be most noticeable at this or similar transition zones between opposing floor slabs situated at elevations 615 and 640 feet. As previously discussed, footings at frost depth, which would hypothetically abut the foundation walls for the pump room, will place surcharge loading on the retaining wall that separates the two distinct floor levels.

Matt footings and spread footings positioned on undisturbed existing site soils and subject to relatively light structural loading are anticipated to experience settlements not exceeding ½-inch. Consequently, differential settlements between adjacent foundation sections should be tolerable when the existing soil strata are utilized for support. Potential cracks in architectural features can be managed through the generous incorporation of control joints and construction joints.

A potential source of foundation distress and floor slab settlement at the proposed pump house is the thick backfill section adjacent to the pump house walls. Even well-compacted backfill of this significant thickness will experience some settlement when subject to the loading of the proposed building including roof loading and live loading associated with the truck(s) parked inside the building. Consequently, high quality backfill materials and extensive quality control procedures must be incorporated into the design and construction of the proposed structures. Appropriate maximum allowable design bearing pressures and design material properties are recommended below.

7.0 DESIGN RECOMMENDATIONS

7.1 Foundations

Spread Footings on Natural Site Soils

Shallow-depth spread footings, including continuously loaded wall footings or column footings, bearing upon existing undisturbed site soils may be designed on a maximum allowable design ground contact pressure of 4,000 p.s.f. Minimum footing widths should be 24 inches.

Spread Footings on Backfill Zone Materials

Shallow-depth spread footings, including continuously loaded wall footings or column footings, bearing upon structural backfill zones, may be designed on a maximum allowable design ground contact pressure of 2,000 p.s.f. Minimum footing widths should be 24 inches. High quality processed aggregate materials including "CR6" or "Graded Aggregate Base" as specified by Maryland Department of Transportation State Highway Administration Standard

Specifications for Construction and Materials, Section 901 must be used for structural backfill inside of structure areas.

Pump House Mat Foundation

When bearing at, or below, elevation 615 feet, the pump house mat foundation may be designed on a maximum allowable design ground contact pressure of 8,000 p.s.f. A shallow stone subbase section may be incorporated under the mat for relief of hydrostatic pressure where drains are used.

Vault Mat Foundation

When bearing on existing site soils at or below 12 feet from the preconstruction ground levels, the vault mat foundation may be designed on a maximum allowable design ground contact pressure of 4,000 p.s.f. A shallow stone subbase section may be incorporated under the mat for relief of hydrostatic pressure where drains are used.

Frost Cover

All foundation bases that could be exposed to potential freeze-thaw conditions should be positioned at least 30 inches below exterior grade levels. Incidental non-load-bearing interior partition walls intended to meet architectural criteria that do not carry framing loads may be positioned on "turned-down" or "thickened" slabs or soil-bearing footings.

Bearing Zone Conflicts

No foundation should be positioned to bear upon any existing or proposed utility or sewer line. Wall penetrations with sleeves that can accommodate foundation settlement are preferable to routing pipes below proposed foundations.

7.2 Floor Slabs

Materials

All proposed slab-on-grade floor slabs and subbase sections should be constructed in accordance with the latest standards established by the American Concrete Institute (ACI) as well as the Portland Cement Association (PCA).

Vapor Barrier

A polyethylene vapor barrier of at least five (5) mils in thickness may be incorporated into the interior floor slab/subbase section design. Plans should include notes requiring periodic pumping of rainwater from the top of the vapor barrier as necessary before pouring the floor slab.

Subbase

Stone subbase should consist of Graded Aggregate Base as specified by Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials, Section 901. A minimum six (6)-

inch layer of subbase should be provided. Subbase should be compacted in accordance with the project specification for structural fill.

7.3 Seismic Site Parameters

Based on the subsurface conditions documented in this report, the subsurface strata profile coincides with Site Class C of the International Building Code (IBC). This site class assumes foundation-bearing zones are prepared in accordance with the design parameters and procedures documented in this report and further assumes the position and level of the proposed structures are as indicated in this report.

7.4 Soil Properties for Foundation Design

N&W has reviewed the test boring and laboratory testing results and has assigned soil parameters that can be used for the design of retaining walls, basement walls, floor slabs and pavements. The parameters may be used to calculate Rankine earth pressures, equivalent fluid pressures, uplift resistance, subgrade reactions and subgrade strength. Based on the available data, coupled with published data, we recommend the use of the following soil parameters for foundation design:

Design Condition	Onsite Soil	Compacted Graded Aggregate Base	AASHTO No. 57 Coarse Aggregate
Range of Total Unit Weight, γ_t (above the water table)	115 - 135 p.c.f.	125 - 145 p.c.f.	85 - 115 p.c.f.
Range of Total Buoyant Unit Weight, γ_b (below the water table)	58 - 78 p.c.f.	68 - 88 p.c.f.	28 - 58 p.c.f.
Angle of Internal Friction, ϕ (for lateral pressure coefficients)	34°	40°	38°
K_a (Active Lateral Pressure Coefficient)	0.28	0.22	0.24
K_p (Passive Lateral Pressure Coefficient)	3.39	4.60	4.20
K_o (At-Rest Lateral Pressure Coefficient)	0.44	0.36	0.38
Interface Friction Angle, δ (with mass concrete)	24°	31°	31°
Friction Factor with mass concrete, μ (0.8*tan δ)	0.36	0.48	0.48
Interface Friction Angle, δ (with formed concrete)	17°	26°	22°
Friction Factor with formed concrete, μ (0.8*tan δ)	0.24	0.39	0.32
Subgrade Modulus, k	100 p.c.i.	300 p.c.i.	250 p.c.i.

TABLE NOTES:

- Adequate drainage includes (but is not limited to) flow zones along walls backfilled with AASHTO No. 57 Coarse Aggregate and/or drainage boards as well a perimeter drain on the active pressure side of the wall.
- Adhesion (C_a), for the interface of formed concrete and onsite soil should be neglected.
- In order to develop active or passive pressure the following wall movements are necessary (where "H" is the height of the wall):
  - Onsite soils: 0.002H for active and 0.01H for passive
  - Graded Aggregate Base: 0.0005H for active and 0.005H for passive
  - AASHTO No. 57: 0.0005H for active and 0.005H for passive

7.5 Drainage

Perimeter Foundation Drains

To prevent the accumulation of water and saturation of soil within the foundation bearing zones for the pump room and vault, perimeter retaining wall footings should include an exterior perforated perimeter drain that discharges via a six-inch diameter perforated polyethylene pipe bedded in AASHTO No. 57 Coarse Aggregate. (Note: Subdrains will not prevent moisture vapor that can cause mold growth.)

7.6 Miscellaneous Design Considerations

Control Joints

Control joints should be liberally provided at regular intervals in masonry walls, at transitions between load-bearing columns or walls and non-load-bearing walls as well as at regular intervals in the floor slabs in general accordance with ACI requirements. Special attention should be given to transition zones between foundations with different ground/rock contact pressures, varying bearing levels or dissimilar foundation types.

Utility Routing

Existing utilities that conflict with proposed foundations should be rerouted. Proposed sanitary or storm drains (or utilities), which are scheduled for invert levels below the bearing levels of nearby foundations, should be routed as far away as reasonably possible from the proposed foundations. Whenever practically possible, no utilities should be positioned below foundations. Wall penetrations should be specified on the foundation plans instead of allowing routing of pipes below proposed foundations.

8.0 CONSTRUCTION RECOMMENDATIONS

8.1 Repair of Soft Subgrades under Slabs and Footings

If soft, excessively wet, organic, or otherwise unstable material is disclosed by proofrolling, all undesirable material should be removed until a stable base is reached. The unstable material should be wasted offsite or at onsite nonstructural locations approved by the Project Engineer and the Owner. Consideration should be

given to air-drying and reuse of materials that are "unsuitable" strictly due to excessive natural moisture.

The excavation resulting from removal of the unsuitable materials should be backfilled with aggregate that meets the gradations for AASHTO No. 1 Coarse Aggregate and Graded Aggregate Base or CR-6 as specified in Section 901 of Maryland State Highway Administration Standard Specifications for Construction and Materials. Graded Aggregate Base should be compacted in accordance with the recommendations for fill compaction below. If soft subgrades are encountered on a persistent basis, the project Geotechnical Engineer should be contacted to provide additional recommendations, which may involve the use of geogrids or geotextiles as necessary to provide appropriate stability.

8.2 Suitable and Unsuitable Onsite Fill Materials

Onsite materials should not be used as backfill in the interior of the proposed structures. Onsite soils reused for trench backfill or backfill along the exterior sides of the proposed structures should consist of inorganic materials that do not contain rock fragments which are retained on an eight (8)-inch mesh screen and are of suitable moisture content to achieve the compaction requirements. Onsite soils categorized as Unified Soil Classification System Group (ASTM D2487) Symbols GC, GM, SC, SM, CL and ML may be considered suitable onsite fill materials.

Onsite fill materials that do not classify as one of the USCS groups defined above should be considered unsuitable.

8.3 Suitable Offsite Borrow Materials

Maryland Department of Transportation Graded Aggregate Base or CR-6 is considered ideal for use as structural backfill material and should be required under floor slabs and behind retaining walls where drainage is not necessary. Where drainage is required, AASHTO No. 57 Coarse Aggregate, or AASHTO No. 8 Coarse Aggregate must be used.

8.4 Fill Zone Definitions

The zone definitions below are recommendations of this office. The contract documents, plans and specifications should be consulted to determine the contract requirements.

Structural Fill Zone – Any area scheduled for a proposed building, mechanical pad, retaining wall or roadway plus a perimeter buffer zone of at least 10 feet.

Nonstructural Fill Zone – Any area that is not within a Structural Fill Zone.

8.5 Compaction Requirements

Structural Fill Zone materials, including slope areas below buildings and roadways, should be compacted to at least 100 percent of the Standard Compaction Test maximum dry density, ASTM Designation D698. All fill materials should be placed in eight-inch (maximum uncompacted thickness) lifts at a moisture content which is no more than 3.0 percentage points above or 3.0 percentage points below the optimum moisture content established for the material by ASTM Designation D698. All fill and backfill placement should be closely observed and tested by a qualified geotechnical engineering technician. No fill or backfill should be placed on frozen ground or during exceptionally wet periods of inclement weather.

8.6 Blasting and Rock Removal

Blasting shall not be permitted. Otherwise, the means and methods of rock removal will be determined by the Contractor and in accordance with local and state regulations, but must be satisfactory to the Owner.

8.7 Trench Stability

All utility and foundation excavation should be performed in accordance with OSHA guidelines, including Part 1926. Typically, the predominately cohesionless soils that are not subjected to vibration or saturation can be characterized as Type B soils. Soil types should be confirmed on a case-by-case basis. Should it be required, all temporary sheeting and shoring should be designed by a qualified engineer registered in the State of Maryland.

8.8 Quality Control

Qualified geotechnical engineering observations and tests should be conducted on a full-time basis during all phases of the site preparation, foundation construction and roadway construction work to ensure its proper execution. Proofrolling of all subgrades should be witnessed and approved, all foundation subgrades should be approved before pouring foundations, and each lift of fill and backfill should be observed and tested on a layer-by-layer basis to ensure that the recommended degree of compaction is obtained and that the material is placed within the proper moisture content range. Overexcavation and backfill of localized soft material zones should be as recommended by the Owner's Representative.

9.0 LIMITATIONS

This report has been prepared for the exclusive use of WSSC and their Design Team, for specific application to the site grading and foundation designs at the Brinks Zone Reliability Improvements project in Montgomery County, MD. The recommendations presented in this report are based upon the available geotechnical information. The test borings depict the soil and rock conditions at the specific point locations and at specific times at which they were conducted. The soil and bedrock conditions at other locations and times may differ significantly from those encountered by the borings for this evaluation. The presence of hazardous waste was not apparent during the test boring program; however, this report does not address environmental conditions.

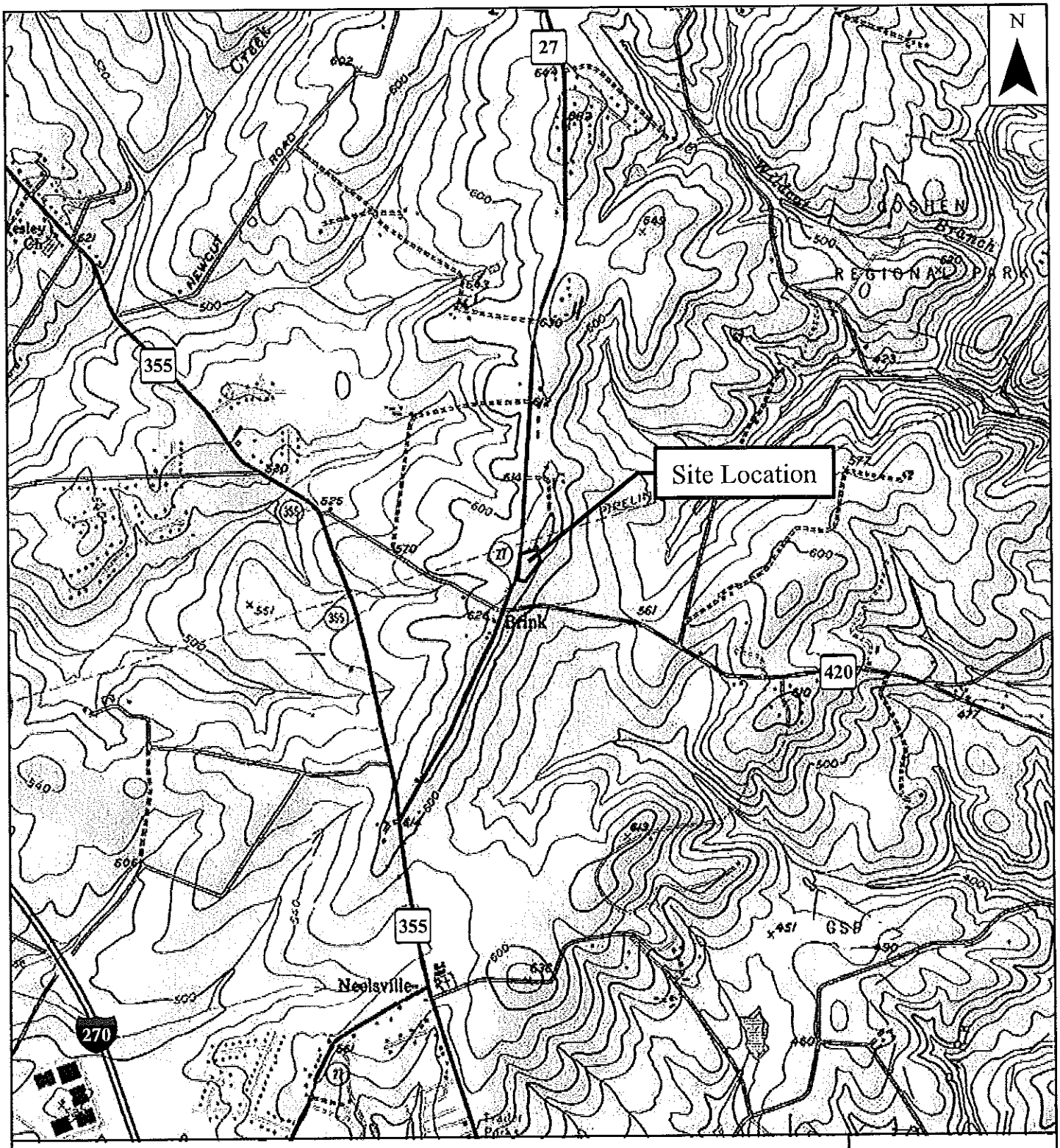
Any revisions to the plans for the proposed structures or for site design, made after the date of this report, should be brought to the attention of the Geotechnical Engineer, so that subsequent changes in foundation recommendations can be prepared as deemed appropriate by the Geotechnical Engineer. If deviations from the noted subsurface and foundation conditions are encountered during construction, they should also be brought to the immediate attention of the Geotechnical Engineer. The cost of additional design review or construction review services is not part of our current Professional Services Agreement. Additional services can be provided upon specific written notice to proceed with such evaluations.

This report addresses foundation installation and site grading conditions but does not evaluate the balance of earthwork quantities. Any revisions to the site grading plans or proposed foundations made after the date of this report should be brought to the attention of N&W, so that subsequent changes in our analyses and recommendations can be prepared as deemed appropriate. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the immediate attention of N&W.

Our professional services have been performed and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practice. N&W is not responsible for the conclusions made by others based upon the data contained herein.

WSSC CONTRACT NO. BP5692A14
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT
MONTGOMERY COUNTY, MARYLAND

FIGURES



Project Location Map

WSSC Contract No. BP5692A14
Brink Zone Reliability Improvements Project
Montgomery County, Maryland

Figure: 1

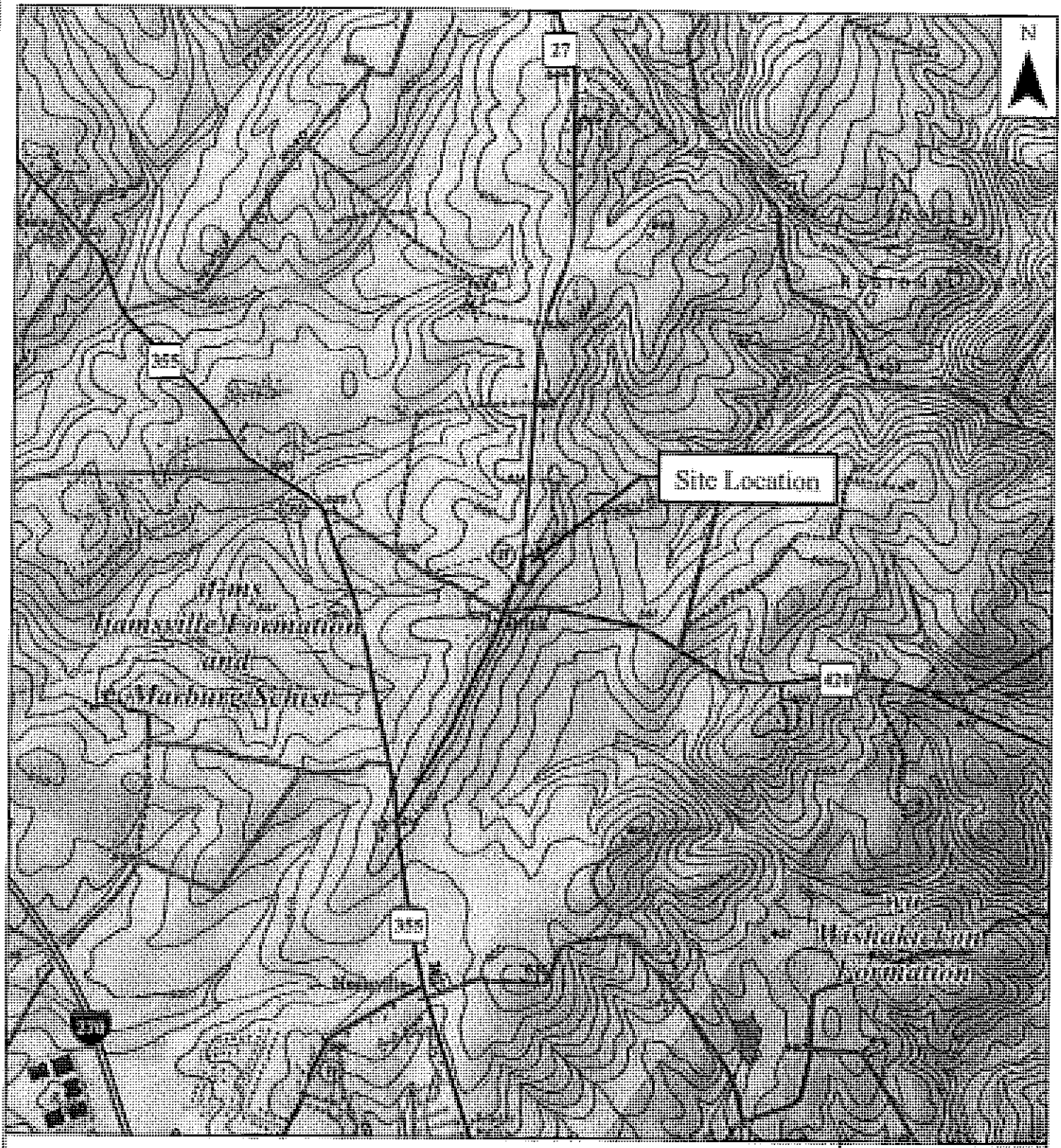
Sources:
ESRI Streetmap USA
ESRI Data Resource Center

Scale: 1:24,000

NAVARRO & WRIGHT CONSULTING ENGINEERS INC

Navarro & Wright Consulting Engineers, Inc
936 Ridgebrook Rd, Suite B1, Sparks, MD 21152
(443) 595-8629 (Telephone) (443) 595-8662 (Fax)

Date: 08/06/2015



Geology Map

WSSC Contract No. BPS692A14
Brink Zone Reliability Improvements Project
Montgomery County, Maryland

Figure: 2

Sources:
ESRI Basemap USA
ESRI Data Resource Center
USGS National Resources Conf Inc Spatial Data

Scale: 1:24,000

NAVARRO & WRIGHT
CONSULTING ENGINEERS

Navarro & Wright Consulting Engineers, Inc.
940 Hickory Ridge Rd, Suite 201, Lutherville, MD 21093
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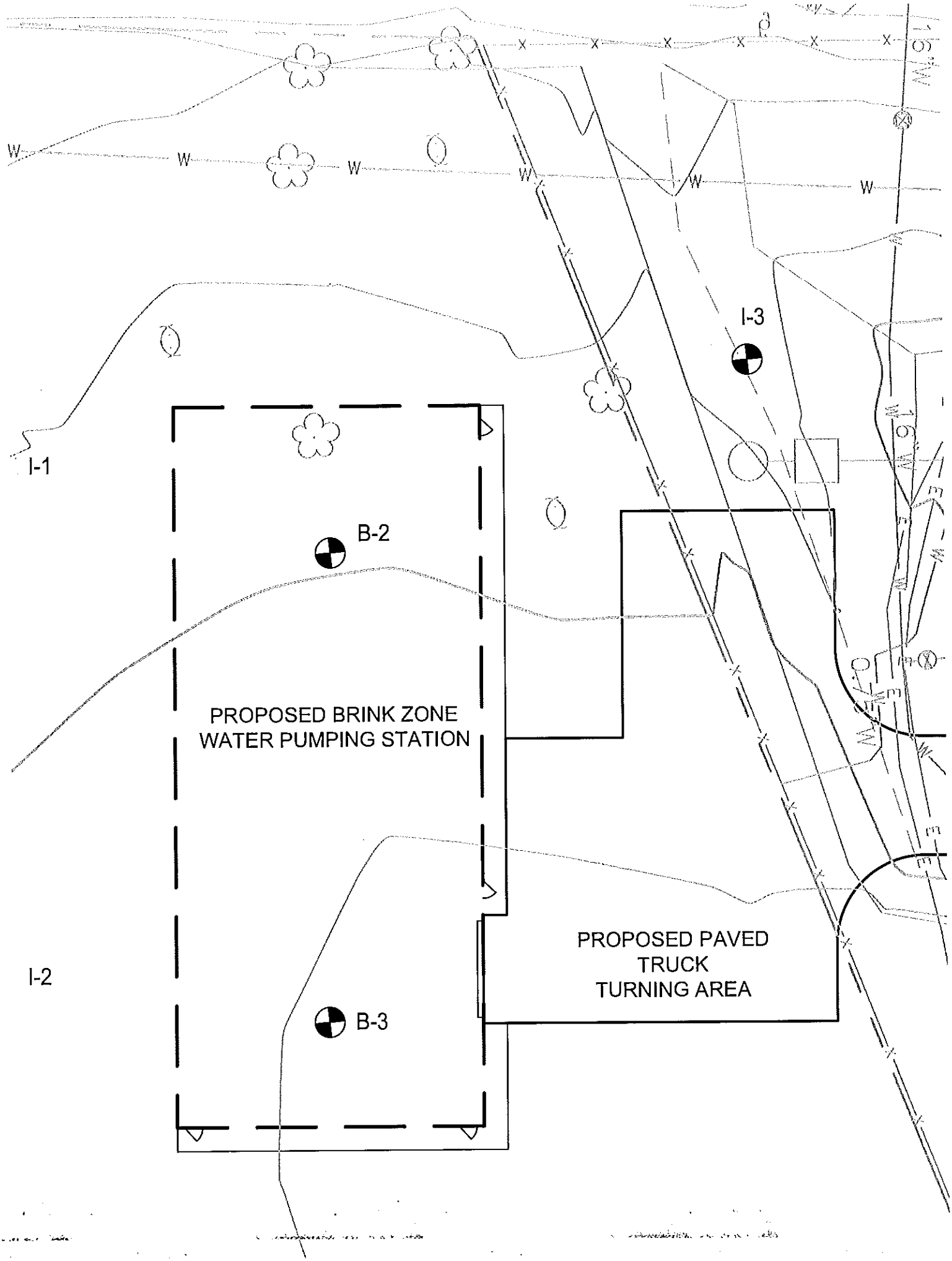
Date: 08/06/2015


I-1
I-2
I-3
B-2
B-3
PROPOSED BRINK ZONE
WATER PUMPING STATION
PROPOSED PAVED
TRUCK
TURNING AREA

WSSC CONTRACT NO. BP5692A14
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT
MONTGOMERY COUNTY, MARYLAND

APPENDIX A

ENGINEER'S FIELD BORING LOGS
CORE BOX PHOTOS

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. B-1
SHEET 1 OF 1
DATE: START 7/23/15
END 7/23/15
O.G. ELEV. 632.9
GWL ELEV. Dry(0 HR)

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT
CASING: SIZE: 3.25" ID ; DEPTH: 13.5' ; WATER: DEPTH: DRY TIME: 0 HR DATE: 7/23/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: _____ TIME: _____ DATE: _____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0		9						0.2 TOPSOIL 632.7	*Boring drillled as staked*
		10				gw-gm		0.5 GRAVEL 632.4	*0.2'-0.5': Gravel Fill*
1.5	S-1	9	1.5	100	-		Dr	(gw-gm, a-1-a), GRAVEL, some Sand, little Silt, orange brown to brown, medium dense (Fill)	*S-2: No recovery; reason unknown*
		9							
		4							
3.0	S-2	12	0.0	0	-		-		*S-3: Large chunks of gravel*
		12							
		7							
4.5	S-3	10	0.3	20	-	a-1-a	Dr	4.5 628.4	
5		12				sm		(sm, a-2-4), Fine SAND and SILT, orangish red to orangish brown, medium dense to dense, some rock fragments (Residual)	
		7							
6.0	S-4	10	0.2	13	-		Dp		*S-5: Saprolitic*
		10							
		9							
7.5	S-5	9	1.2	80	-		Dp		
		10							
		9							
9.0	S-6	8	1.0	67	-		M		*S-7: Silt increase*
		4							
		6							
10.5	S-7	8	1.2	80	-		M		
		5							
		12							
12.0	S-8	17	1.0	67	-		M		
		15							
		16							
13.5	S-9	16	1.5	100	-		M		
		10							
		14							
15.0	S-10	17	1.5	100	-	a-2-4	M	15.0 617.9	
15								End of boring at 15.0'	*Backfilled upon completion because hole was dry at 0 HR*
20									

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. B-2
SHEET 1 OF 2
DATE: START 7/27/15
END 7/27/15
O.G. ELEV. 639.3
GWL ELEV. 617.8

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT - 5' Interval SPT - NQ Rock Core
CASING: SIZE: 3.25" ID ; DEPTH: 25.0' ; WATER: DEPTH: 21.5' TIME: 0 HR DATE: 7/27/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: _____ TIME: _____ DATE: _____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0									
1.5	S-1	7 9 11	1.0	67	-	ml	Dp	(ml, a-4), SILT, some Gravel, little Sand, orangish brown to brown, very stiff (Fill)	*Moved boring 6.0' East of staked location, <0.5' change in elevation*
3.0	S-2	11 7 9	1.0	67	-	a-4	Dp	3.0 636.3	
4.5	S-3	5 8 8	1.1	73	1.8	sm	Dr	(sm, a-4), SAND, some Gravel, little SILT, dark reddish brown to light orange to white, very stiff to hard (Residual)	
5									
6.0	S-4	7 12 14	1.2	80	-		M		
7.5	S-5	21 20 35	1.2	80	-		M		
9.0	S-6	31 36 32	1.5	100	-		Dr		
10									
10.5	S-7	17 20 19	1.2	80	-		Dr		
12.0	S-8	9 14 16	1.2	80	-	a-4	Dr	12.0 627.3	
15.0	ADV		-	-	-	sm	-	(sm, a-2-4), SAND, some Gravel, little Silt, dark orangish brown to light brown, very dense (Residual)	*Switched to 5' interval SPT*
15									
15.9	S-9	48 50/0.4	0.9	100	-		Dr		
20.0	ADV		-	-	-	a-2-4	-		
20									

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. B-2
SHEET 2 OF 2
DATE: START 7/27/15
END 7/27/15
O.G. ELEV. 639.3
GWL ELEV. 617.8

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT - 5' Interval SPT - NQ Rock Core
CASING: SIZE: 3.25" ID ; DEPTH: 25.0' ; WATER: DEPTH: 21.5' TIME: 0 HR DATE: 7/27/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: _____ TIME: _____ DATE: _____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.8	S-10	25 50/0.3	0.8	100	-	sm	Dr	(sm, a-2-4), SAND, some Gravel, little Silt, dark orangish brown to light brown, very dense (Residual)	*Spoon refusal*
25.0	ADV		-	-	-	a-2-4	-	25.1 614.2	
25.1	S-11	50/0.1	0.1	100 16	-		W	GNEISS, dark reddish brown to dark orangish brown, highly weathered bedrock, sample material was very broken and very soft	*S-11: Spoon Saturated* *25.1': Spoon refusal/Auger refusal/TOR* *25.1'-29.0': Completely weathered rock and cored dense soil*
30.1	R-1		0.8	0 30	-		-		*29.0'-32.1': Broken rock (partly disintegrated)*
32.1	R-2		0.6	0	-		-	32.1 607.2 End of boring at 32.1'	*Boring grouted upon completion* *0.0'-4.5',6.0'-10.5',10.5-20.8;* *Small bag samples taken for corrosion testing*

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. B-3
SHEET 1 OF 2
DATE: START 7/24/15
END 7/24/15
O.G. ELEV. 641.9
GWL ELEV. 618.5

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT - 5' Interval SPT - NQ Rock Core
CASING: SIZE: 3.25" ID ; DEPTH: 25.0' ; WATER: DEPTH: 18.0' TIME: 0 HR DATE: 7/24/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: 23.4' TIME: 72 HR DATE: 7/27/15
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0		9				gm		(gm, a-1-a), GRAVEL, some Silt, light brown, medium dense (Fill)	
		13							
1.5	S-1	14	1.3	87	-	a-1-a	Dr	1.5 640.4	
		13				GC		(GC, A-6(2)), GRAVEL, some Clay and Silt, light orangish brown to dark reddish brown, medium dense to very dense (Residual)	
		17							
3.0	S-2	12	1.1	73	-		Dr		
		13						Lab Testing (3.0' to 4.5'): LL=36%, PL=23%, PI=13%, w=15.0%, USDA Class = Clay Loam	
		17							
4.5	S-3	15	1.5	100	-		Dp		
5		12							*S-4: Platy structure and rock fragments*
		19							
6.0	S-4	18	1.5	100	-		Dr		
		14							*S-5: Saprolite*
		18							
7.5	S-5	22	1.0	67	-		Dr		
		23							
		15							
9.0	S-6	19	1.2	80	-		Dr		
		44							
10		42							
10.2	S-7		1.2	100	-		Dr		
10.5	ADV	50/0.2	-	-	-	A-6(2)	-	10.5 631.4	
10.9	S-8	50/0.4	0.4	100	-	sm	Dr	(sm, a-2-4), SAND, some Gravel, little Silt, dark orangish brown to light brown, very dense (Residual)	*10.9': Spoon refusal/Switch to 5' interval SPT*
15									
15.0	ADV		-	-	-		-		
15.1	S-9	50/0.0	0.0	0	-		-		
20									
20.0	ADV		-	-	-	a-2-4	-		

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. B-3
SHEET 2 OF 2
DATE: START 7/24/15
END 7/24/15
O.G. ELEV. 641.9
GWL ELEV. 618.5

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT - 5' Interval SPT - NQ Rock Core
CASING: SIZE: 3.25" ID ; DEPTH: 25.0' ; WATER: DEPTH: 18.0' TIME: 0 HR DATE: 7/24/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: 23.4' TIME: 72 HR DATE: 7/27/15
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.4	S-10	50/0.4	0.4	100	-	sm	Dr	(sm, a-2-4), SAND, some Gravel, little Silt, dark orangish brown to light brown, very dense (Residual)	*20.4': Spoon refusal*
25.0	ADV		-	-	-	a-2-4	-	25.0 616.9	*25.0': Spoon refusal/Auger refusal/TOR*
25.1	S-11	50/0.0	0.0	73 / 0	-		-	GNEISS, greenish gray to reddish brown, medium hard, moderately weathered, narrow to moderate spaced fractures, soft	*R-1: Contains vertical fractures*
30.0	R-1		3.6	20	-		-	30.0 611.9 End of boring at 30.0'	*0.0'-25.0': Bulk sample collected from auger cuttings for corrosion testing*

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. I-1
SHEET 1 OF 1
DATE: START 7/23/15
END 7/23/15
O.G. ELEV. 637.9
GWL ELEV. Dry(0 HR)

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT
CASING: SIZE: 3.25" ID ; DEPTH: 10.5' ; WATER: DEPTH: DRY TIME: 0 HR DATE: 7/23/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: _____ TIME: _____ DATE: _____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0		4 8				ml		(ml, a-4), SILT, some Sand, dark reddish brown to reddish brown, very stiff (Residual)	*Boring drilled as staked*
1.5	S-1	9	1.0	67	-		Dr		
		5 10							*S-2: Trace clay*
3.0	S-2	7	1.0	67	3.0		Dp		
		10 10							
4.5	S-3	10	1.2	80	3.0	a-4	Dp	4.5 633.4	
5		11 12				sm		(sm, a-2-4), SAND, some Silt, little Gravel, dark reddish brown to light orange brown, medium dense to very dense (Residual)	
6.0	S-4	12	1.2	80	-		M		
		12 9							
7.5	S-5	6	0.8	53	-		Dp		
		8 18							
9.0	S-6	13	1.0	67	-		Dr		
		15 31							*S-7: Saprolite/Rock fragments*
10 10.5	S-7	36	1.2	80	-		Dp		
11.4	S-8	23 50/0.4	0.5	56	-	a-2-4	Dp	11.4 626.5 End of boring at 11.4'	
15									
20									

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

ENGINEERS FIELD BORING LOG

BORING NO. I-2
SHEET 1 OF 1
DATE: START 7/23/15
END 7/23/15
O.G. ELEV. 640.5
GWL ELEV. Dry(0 HR)

PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
STATION per Boring Location Plan OFFSET FROM CENTERLINE _____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT
CASING: SIZE: 3.25" ID ; DEPTH: 12.0' ; WATER: DEPTH: DRY TIME: 0 HR DATE: 7/23/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: _____ TIME: _____ DATE: _____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0		6 9				gm		(gm, a-2-4), GRAVEL, some Sand, some Silt, brown to orange brown, medium dense to dense	*Boring drilled as staked*
1.5	S-1	9	0.8	53	-		Dp	(Fill)	
		4 8							
3.0	S-2	27	0.8	53	-		Dp		*S-3: Gravel decrease, iron oxide staining*
		4 15							
4.5	S-3	17	0.8	53	-	a-2-4	Dr	4.5 636.0	*S-4: Saprolitic*
5		7 14				SM		(SM, A-4), SAND, some Gravel, some Silt, Little Clay, dark reddish brown to brown, medium dense to dense, rock fragments and platy structure	
6.0	S-4	14	1.0	67	-		Dr	(Residual)	*S-5: Low recovery; Reason unknown*
		5 6						Lab testing (4.5' to 6.0'): LL=34%, PL=29%, PI=29%, w=14.8%, USDA Class = Loam	
7.5	S-5	6	0.1	7	-		Dr		
		16 24							
9.0	S-6	21	1.2	80	-		Dp		
		20 20							
10 10.5	S-7	20	0.5	33	-		Dp		*S-8: Silt increase/pocket*
		20 17							
12.0	S-8	18	1.0	67	-		Dp		
12.3	S-9	50/0.3	0.3	100	-	A-4	Dr	12.3 628.2	*Backfilled upon completion and hole + 2.0' North to unsampled depth of 10.0'*
15								End of boring at 12.3'	
20									

Job Number: 1502MD017

Navarro & Wright
Consulting Engineers

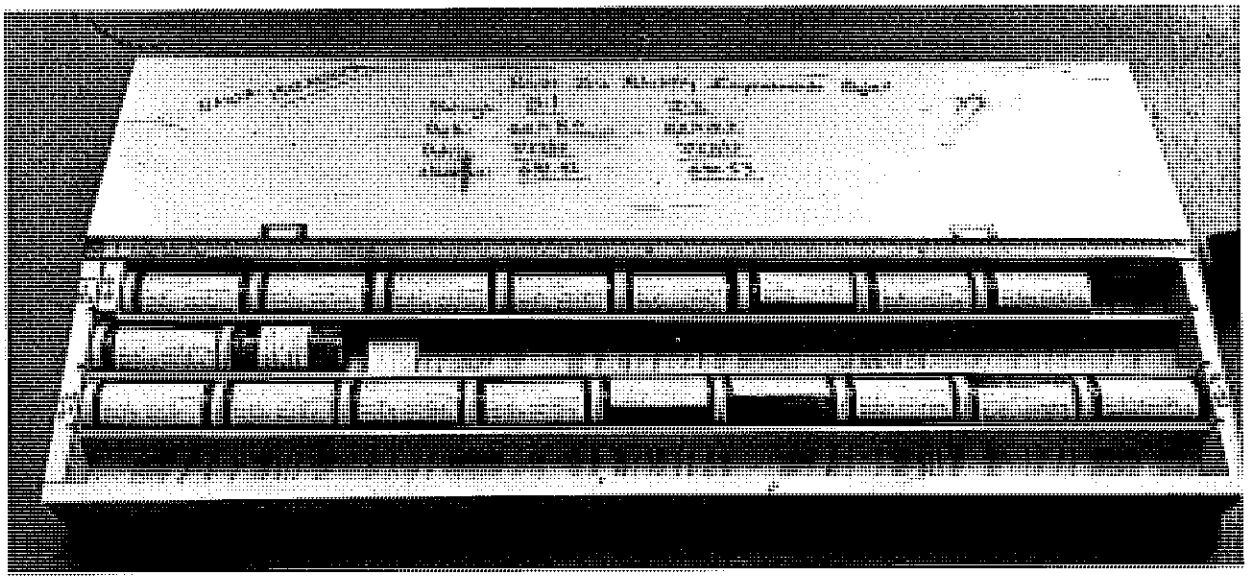
ENGINEERS FIELD BORING LOG

BORING NO. I-3
SHEET 1 OF 1
DATE: START 7/23/15
END 7/23/15
O.G. ELEV. ____
GWL ELEV. Dry(0 HR)

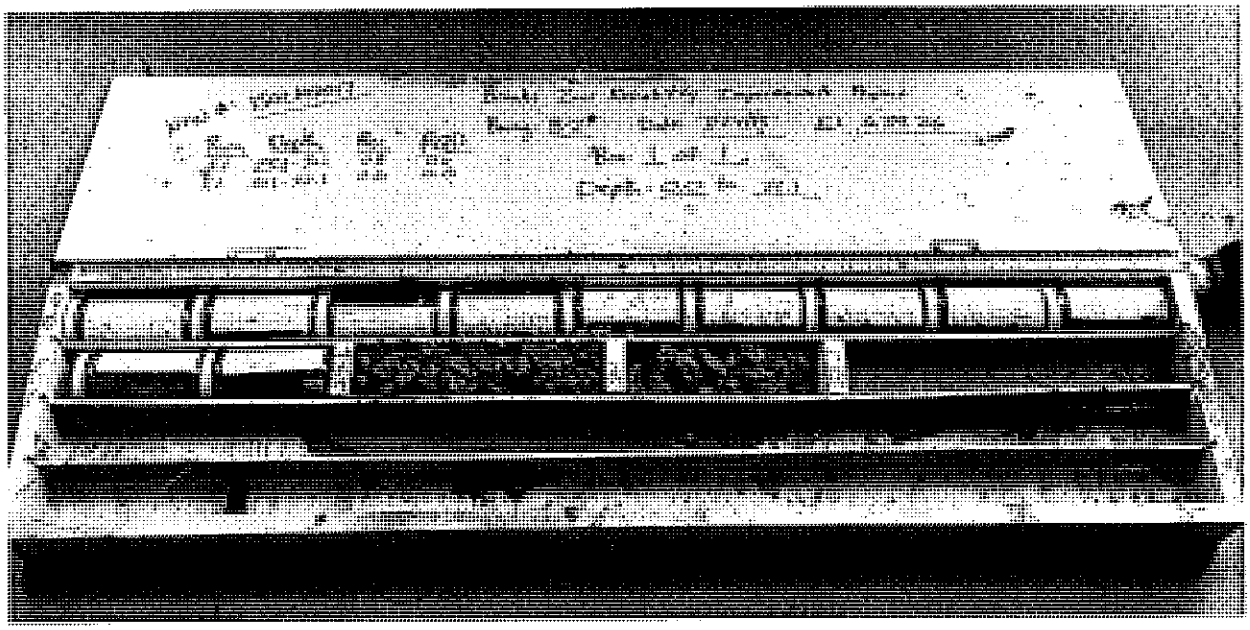
PROJECT NAME Brinks Zone Reliability Improvements Project COUNTY Montgomery, MD
STATE RT. NO. ____ SECT. ____ SEGMENT ____ OFFSET ____
STATION per Boring Location Plan OFFSET FROM CENTERLINE ____
INSPECTOR (SIGNED) Colin Gardner DRILLERS NAME/COMPANY A. Eichelberger/Allied
EQUIPMENT USED Track Rig w/Autohammer
DRILLING METHODS Continuous SPT
CASING: SIZE: 3.25" ID ; DEPTH: 3.0' ; WATER: DEPTH: DRY TIME: 0 HR DATE: 7/23/15
CHECKED BY: DCG ; DATE: 8/10/15 DEPTH: ____ TIME: ____ DATE: ____
NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0									
		4				ML		(ML, A-4(1)), SILT, some Sand, little Gravel, reddish brown to reddish orange, medium dense to very dense, rock fragments	*Proposed boring moved from originally proposed position by Hatch Mott MacDonald on 7/23/15*
1.5	S-1	6 8	1.1	73	-		Dr	(Residual)	
		8						Lab Testing (1.5' to 3.0'): LL=28%, PL=24%, PI=4%, w=13.5%	
3.0	S-2	8 8	1.2	80	-		Dp		*Rock in spoon shoe*
		19							
4.1	S-3	24 50/0.1	1.1	100	-	A-4(1)	Dp	4.1 End of boring at 4.1'	*4.1': Spoon refusal on apparent top of rock Limiting zone disclosed at top of rock; therefore, no infiltration test was conducted*
5									
10									
15									
20									

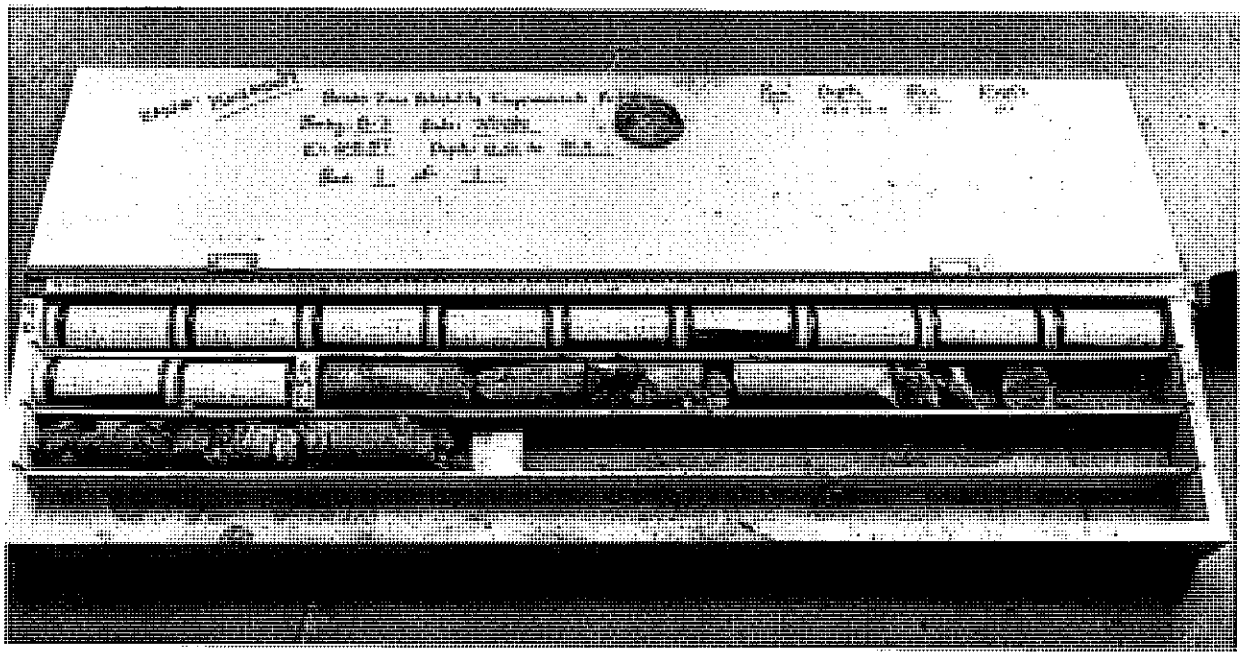
Job Number: 1502MD017



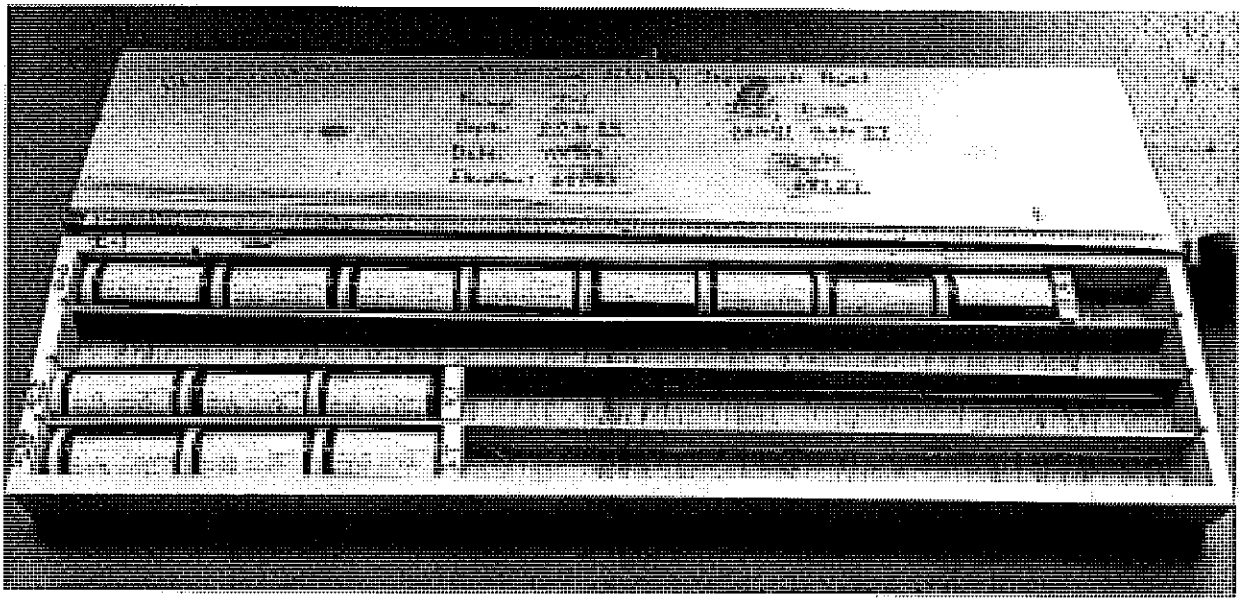
Borings B-1 and I-2



Boring B-2



Boring B-3



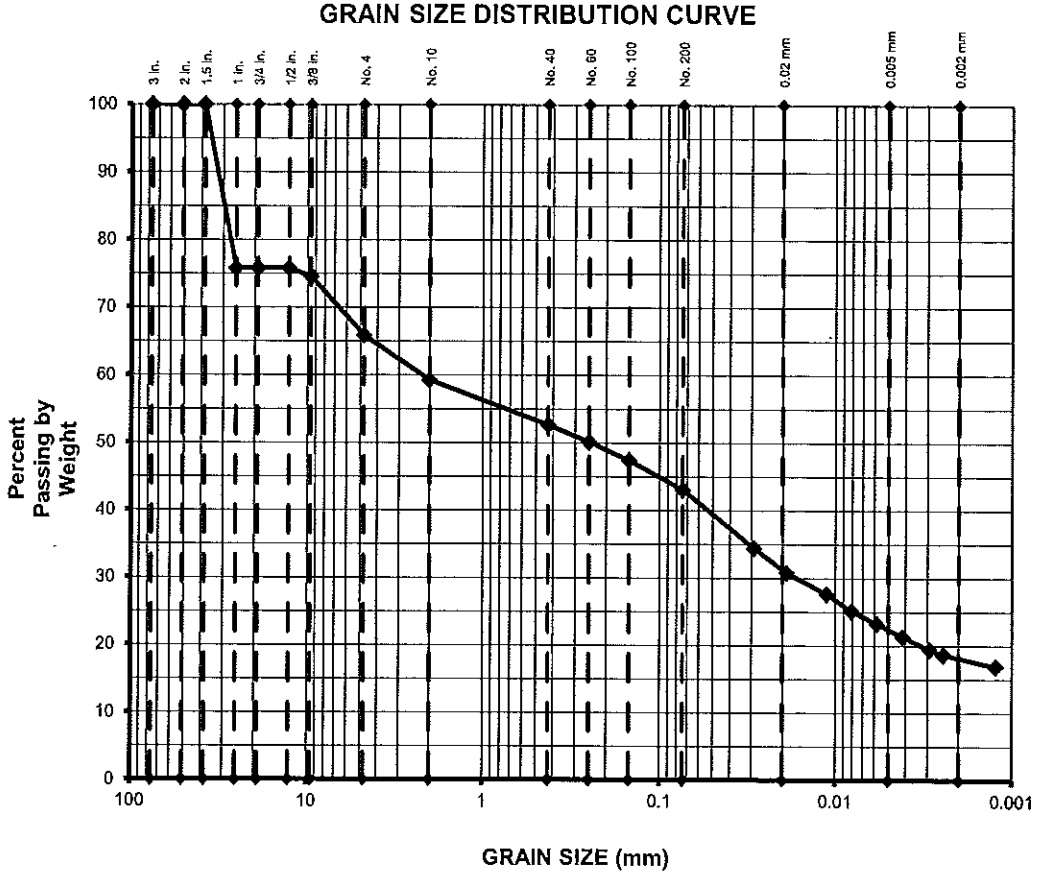
Borings I-1 and I-3

WSSC CONTRACT NO. BP5692A14
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT
MONTGOMERY COUNTY, MARYLAND

APPENDIX B

LABORATORY TESTING RESULTS

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
34.2%		22.8%			43.1%	
24.2%	9.9%	6.6%	6.6%	9.6%	20.8%	22.3%

GRAVEL			SAND		FINES	
COARSE	MEDIUM	FINE	COARSE	FINE	SILT	CLAY
40.8%			16.2%		43.1%	
24.2%	1.2%	15.3%	6.6%	9.6%	25.2%	17.9%

SAND	SILT	CLAY
27.3%	41.3%	31.4%

Project:	WSSC Contract BP5692A14	**Soil Type:**	clayey GRAVEL with sand
Boring No.:	B-3		
Station:	N/A	**USCS Classification:**	GC
Offset:	N/A	**AASHTO Classification:**	A-6 (2)
Sample No.:	S-3	**USDA Classification:**	clay loam
Depth:	3.0-4.5 ft	LL = 36 %	PL = 23 %
Spec. Grav.:	2.7 (assumed)	PI = 13 %	w = 15.0 %

NAVARRO & WRIGHT CONSULTING ENGINEERS, INC.

AASHTO R18

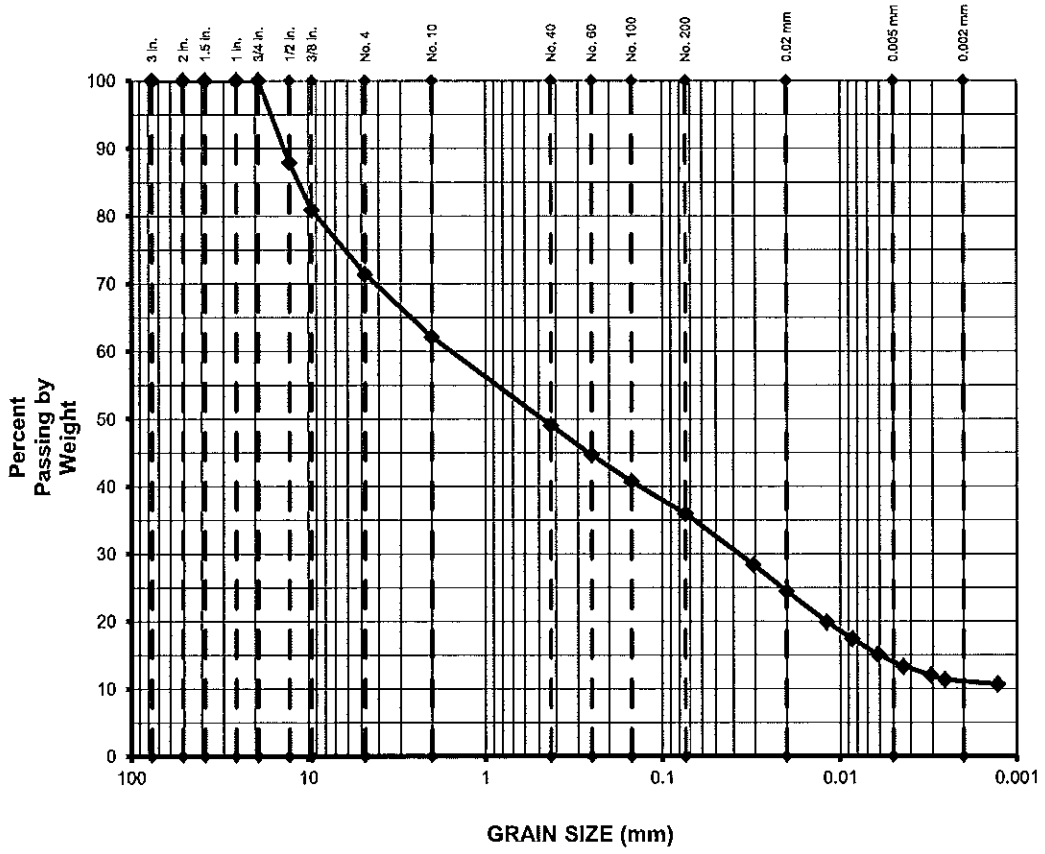
8/24/2015

Classification Testing Results

USCS & AASHTO

By: BBB Ckd: JDP

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
28.6%		35.4%			36.0%	
0.0%	28.6%	9.3%	13.1%	13.1%	22.0%	13.9%

GRAVEL			SAND		FINES	
COARSE	MEDIUM	FINE	COARSE	FINE	SILT	CLAY
37.9%			26.1%		36.0%	
0.0%	19.1%	18.8%	13.1%	13.1%	25.4%	10.6%

SAND	SILT	CLAY
42.1%	39.7%	18.2%

Project:	WSSC Contract BP5692A14	**Soil Type:**	silty SAND with gravel
Boring No.:	I-2		
Station:	N/A	**USCS Classification:**	SM
Offset:	N/A	**AASHTO Classification:**	A-4 (0)
Sample No.:	S-4	**USDA Classification:**	loam
Depth:	4.5-6.0 ft	LL = 34 %	PL = 29 %
Spec. Grav.:	2.7 (assumed)	PI = 5 %	w = 14.8 %

NAVARRO & WRIGHT CONSULTING ENGINEERS, INC.

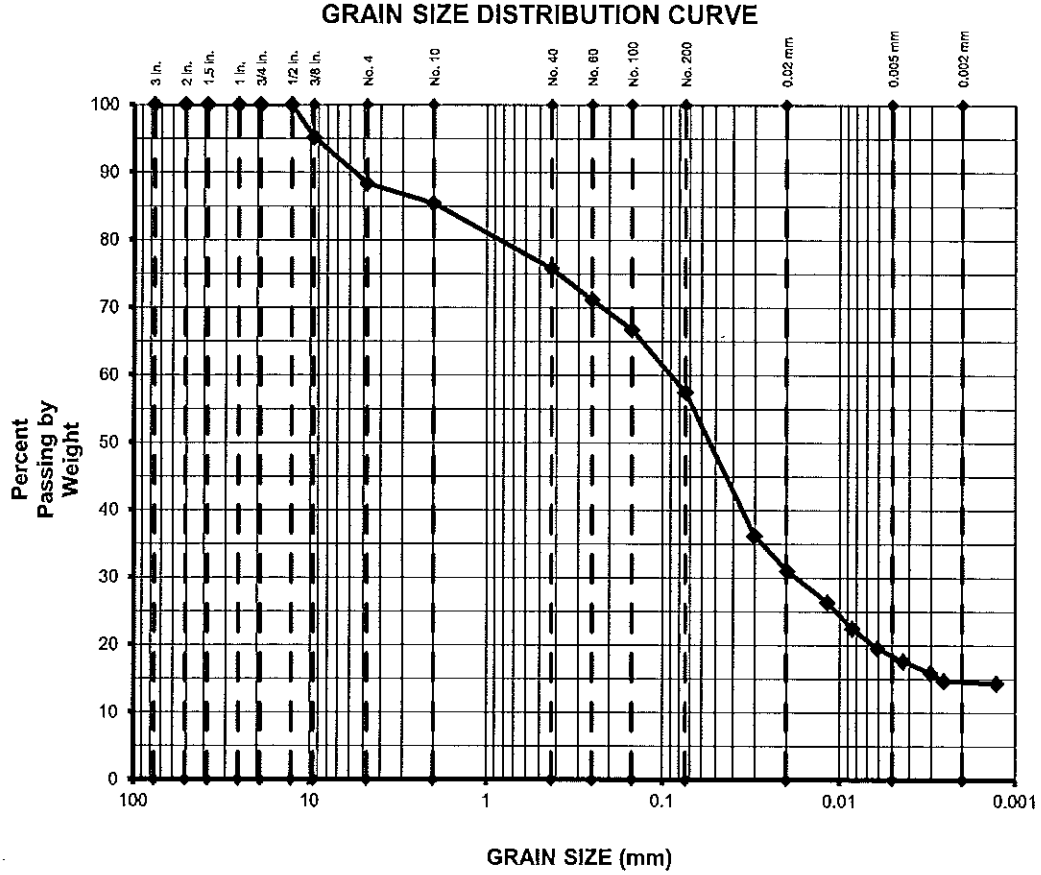
8/24/2015

Classification Testing Results

USCS & AASHTO

By: BBB Ckd: JDP

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
11.6%		30.9%			57.5%	
0.0%	11.6%	3.0%	9.6%	18.3%	39.1%	18.4%

GRAVEL			SAND		FINES	
COARSE	MEDIUM	FINE	COARSE	FINE	SILT	CLAY
14.6%			27.9%		57.5%	
0.0%	4.8%	9.8%	9.6%	18.3%	44.0%	13.4%

SAND	SILT	CLAY
32.7%	50.1%	17.2%

Project:	WSSC Contract BP5692A14	**Soil Type:**	sandy SILT
Boring No.:	I-3		
Station:	N/A	**USCS Classification:**	ML
Offset:	N/A	**AASHTO Classification:**	A-4 (1)
Sample No.:	S-2	**USDA Classification:**	loam
Depth:	1.5-3.0 ft	LL = 28 %	PL = 24 %
Spec. Grav.:	2.7 (assumed)	PI = 4 %	w = 13.5 %

NAVARRO & WRIGHT CONSULTING ENGINEERS, INC.

Classification Testing Results

8/24/2015

USCS & AASHTO

By: BBB Ckd: JDP

NAVARRO & WRIGHT
CONSULTING ENGINEERS, INC.

AASHTO R18

MOISTURE CONTENT OF SOIL
ASTM 2216

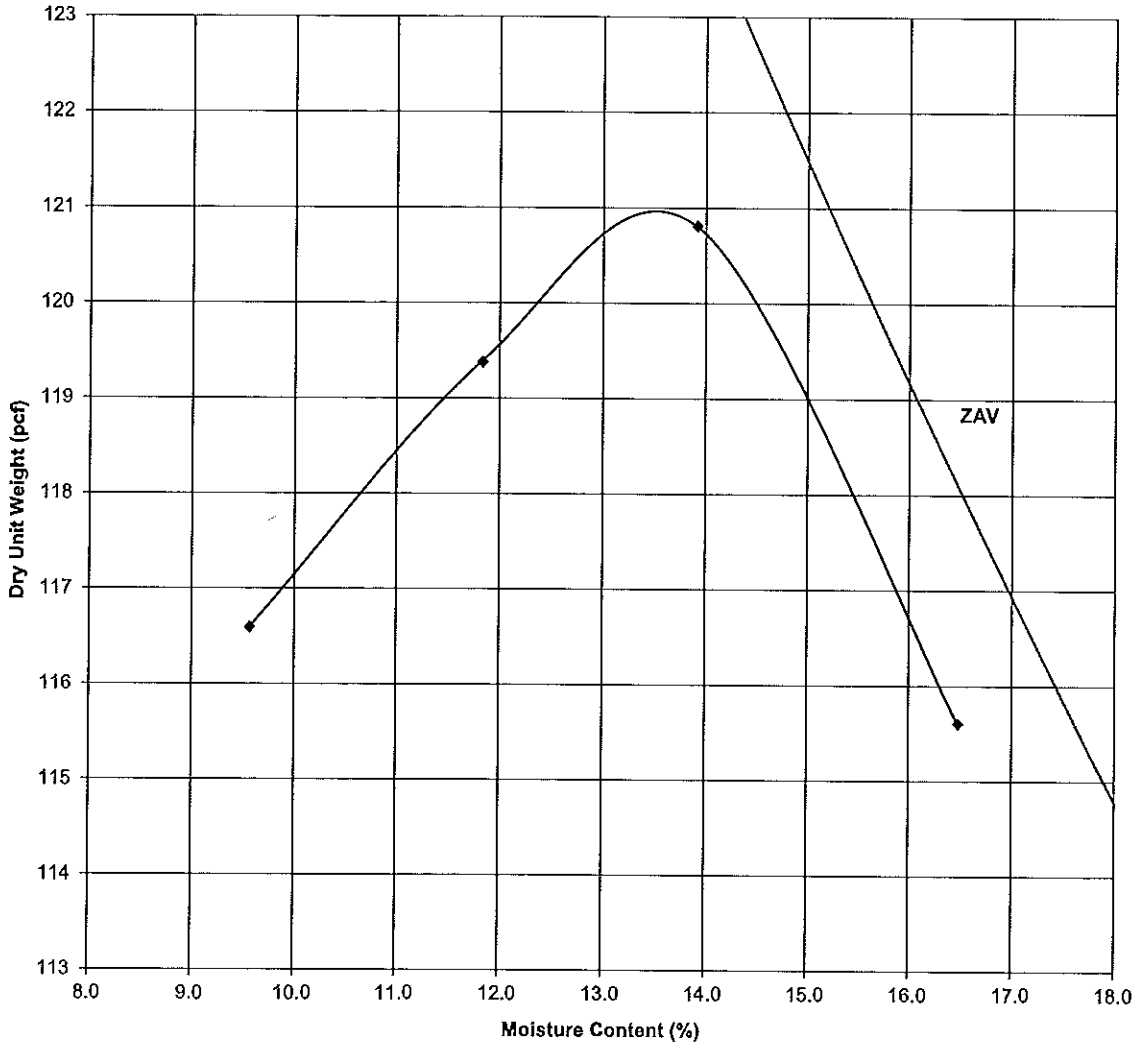
Project: WSSC Contract BP5692A14 - Brink Zone Reliability Improvements Project
Project #: 1502MD017
Date: 7/31/2015

BORING NO.	SAMPLE NO.	weight of tare	weight wet soil + tare	weight dry soil + tare	MOISTURE CONTENT (%)
I-1	S-2	320.07	575.23	538.28	16.9
B-1	S-4	9.03	170.41	158.52	8.0
B-1	S-7	9.08	297.61	253.63	18.0
B-2	S-4	9.23	305.91	276.84	10.9
B-2	S-9	9.13	239.21	225.16	6.5
B-3	S-2	8.70	273.04	247.93	10.5
B-3	S-10	8.81	242.65	221.33	10.0
B-3	S-3	*	*	*	15.0
I-2	S-4	*	*	*	14.8
I-3	S-2	*	*	*	13.5

* Data accompanies classification testing

By: BBB Ck'd: JDP

Compaction Curve



Project:	WSSC Contract BP5692A14	**Soil Type: Silty Sand with some gravel**	
Boring No.:	B-3		
Station:	N/A	**Classification: sm**	
Offset:	N/A		
Sample No.:	BK-1	**Max. Dry Density:**	121.0 pcf
Depth:	0.0-25.0 ft	**Opt. Moisture:**	13.5 %

NAVARRO & WRIGHT CONSULTING ENGINEERS, INC.

AASHTO R18

STANDARD PROCTOR COMPACTION TEST RESULTS

ASTM D698 / ASSHTO T99

APPENDIX - H

NRCS Soil Resource Report

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Montgomery County, Maryland

Brink Zone Reliability Improvements Project

September 9, 2015

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

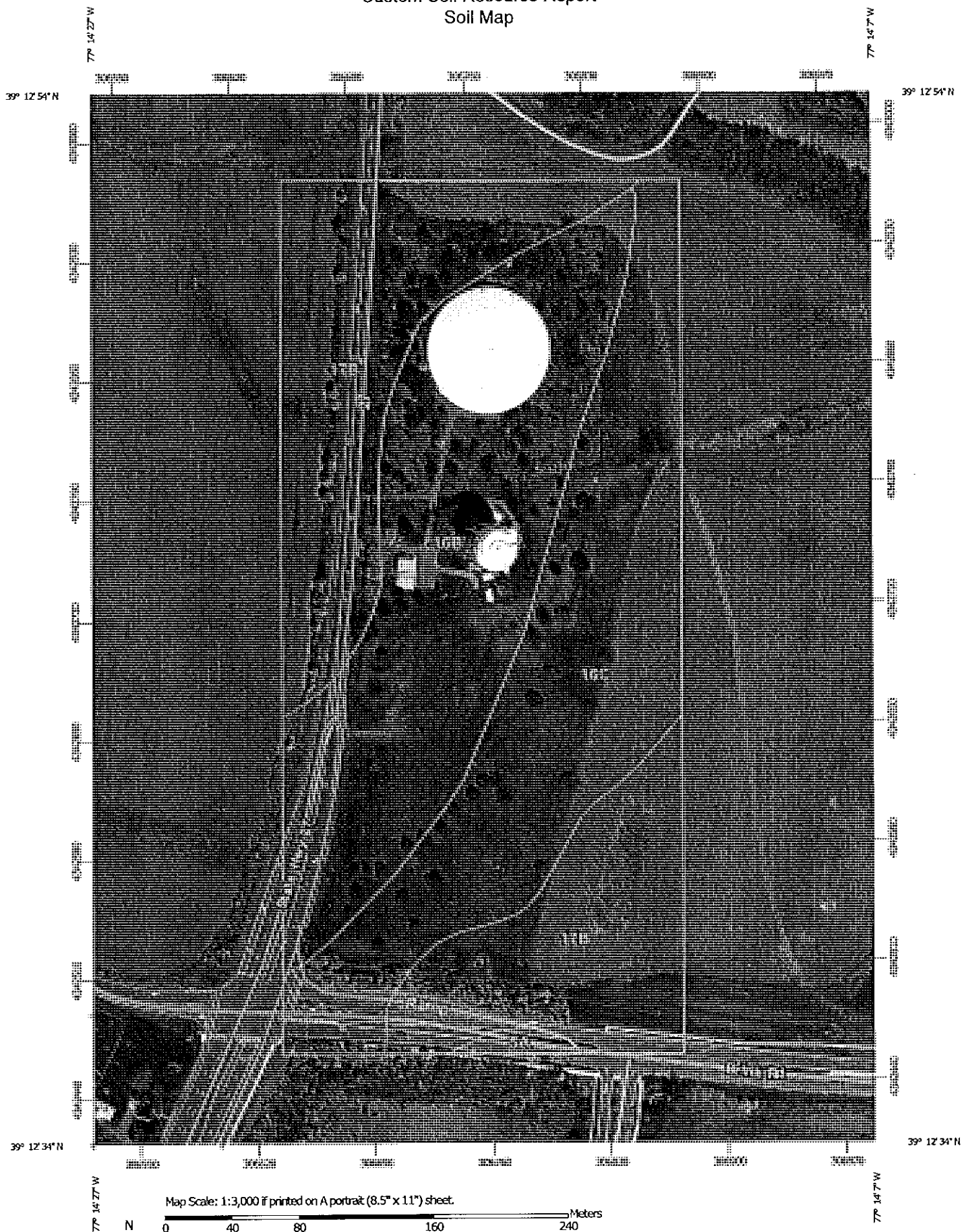
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:1

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cau misunderstanding of the detail of mapping and accuracy of s placement. The maps do not show the small areas of contra soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Merc projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as Albers equal-area conic projection, should be used if more ac calculations of distance or area are required.

This product is generated from the USDA-NRCS certified dat the version date(s) listed below.

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 9, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1: or larger.

Date(s) aerial images were photographed: Data not availa

The orthophoto or other base map on which the soil lines we compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor s of map unit boundaries may be evident.

Map Unit Legend

Montgomery County, Maryland (MD031)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	10.8	35.6%
Totals for Area of Interest		30.3	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Montgomery County, Maryland

5A—Glenville silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: kx9v
Elevation: 250 to 1,050 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 120 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Glenville and similar soils: 85 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Glenville

Setting

Landform: Drainageways, swales
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy colluvium derived from phyllite and/or loamy colluvium derived from schist

Typical profile

Ap - 0 to 8 inches: silt loam
Bt1, Bt2 - 8 to 30 inches: silt loam
Btx - 30 to 40 inches: loam
C1, C2 - 40 to 70 inches: loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 24 to 39 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 20 to 40 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C

Minor Components

Baile

Percent of map unit: 10 percent
Landform: Depressions, drainageways, hillslopes, swales
Landform position (three-dimensional): Head slope, base slope

Down-slope shape: Concave
Across-slope shape: Concave, linear

16B—Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: kx77
Elevation: 330 to 2,000 feet
Mean annual precipitation: 7 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Brinklow and similar soils: 50 percent
Blocktown and similar soils: 30 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brinklow

Typical profile

H1 - 0 to 10 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Description of Blocktown

Typical profile

H1 - 0 to 6 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: D

Minor Components

Baile

Percent of map unit: 5 percent
Landform: Flats

16C—Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: kx78
Elevation: 330 to 2,000 feet
Mean annual precipitation: 7 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Brinklow and similar soils: 50 percent
Blocktown and similar soils: 30 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brinklow

Typical profile

H1 - 0 to 10 inches: channery silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Description of Blocktown

Typical profile
H1 - 0 to 6 inches: channery silt loam

Properties and qualities
Slope: 8 to 15 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D

Minor Components

Baile
Percent of map unit: 5 percent
Landform: Flats

17B—Occoquan loam, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: kx7c
Elevation: 330 to 2,000 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 120 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Occoquan and similar soils: 80 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Occoquan

Typical profile
H1 - 0 to 8 inches: loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Minor Components

Baile

Percent of map unit: 5 percent
Landform: Flats

Table—Nonirrigated Capability Class

Nonirrigated Capability Class— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	2	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	2	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	3	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	3	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—Nonirrigated Capability Class

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydric Rating by Map Unit

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or

inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Map—Hydric Rating by Map Unit

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:1

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cau misunderstanding of the detail of mapping and accuracy of s placement. The maps do not show the small areas of contra soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Merc projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as Albers equal-area conic projection, should be used if more ac calculations of distance or area are required.

This product is generated from the USDA-NRCS certified dat the version date(s) listed below.

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 9, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1: or larger.

Date(s) aerial images were photographed: Data not availa

The orthophoto or other base map on which the soil lines we compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor s of map unit boundaries may be evident.

Table—Hydric Rating by Map Unit

Hydric Rating by Map Unit— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	10	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	5	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	5	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	5	10.8	35.6%
Totals for Area of Interest			30.3	100.0%

Rating Options—Hydric Rating by Map Unit

Aggregation Method: Percent Present

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Water Management

Water Management interpretations are tools for evaluating the potential of the soil in the application of various water management practices. Example interpretations include pond reservoir area, embankments, dikes, levees, and excavated ponds.

Irrigation, General

This interpretation evaluates a soil's limitation(s) for installation and use of irrigation systems. This interpretation is for non-specific irrigation methods and is intended to provide initial planning information. If the type of irrigation system has been determined, additional interpretations provide more specific information. This interpretation does not apply if the crop planned for irrigation is rice or other crops (such as cranberries) with unique plant physiological characteristics. The ratings are for soils in their natural condition and do not consider present land use.

Irrigation systems are used to provide supplemental water to crops, orchards, vineyards, and vegetables in areas where natural precipitation will not support desired production of crops being grown.

The soil properties and qualities important in design and management of irrigation systems are sodium adsorption ratio, depth to high water table, available water holding capacity, saturated hydraulic conductivity (Ksat), slope, calcium carbonate content,

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

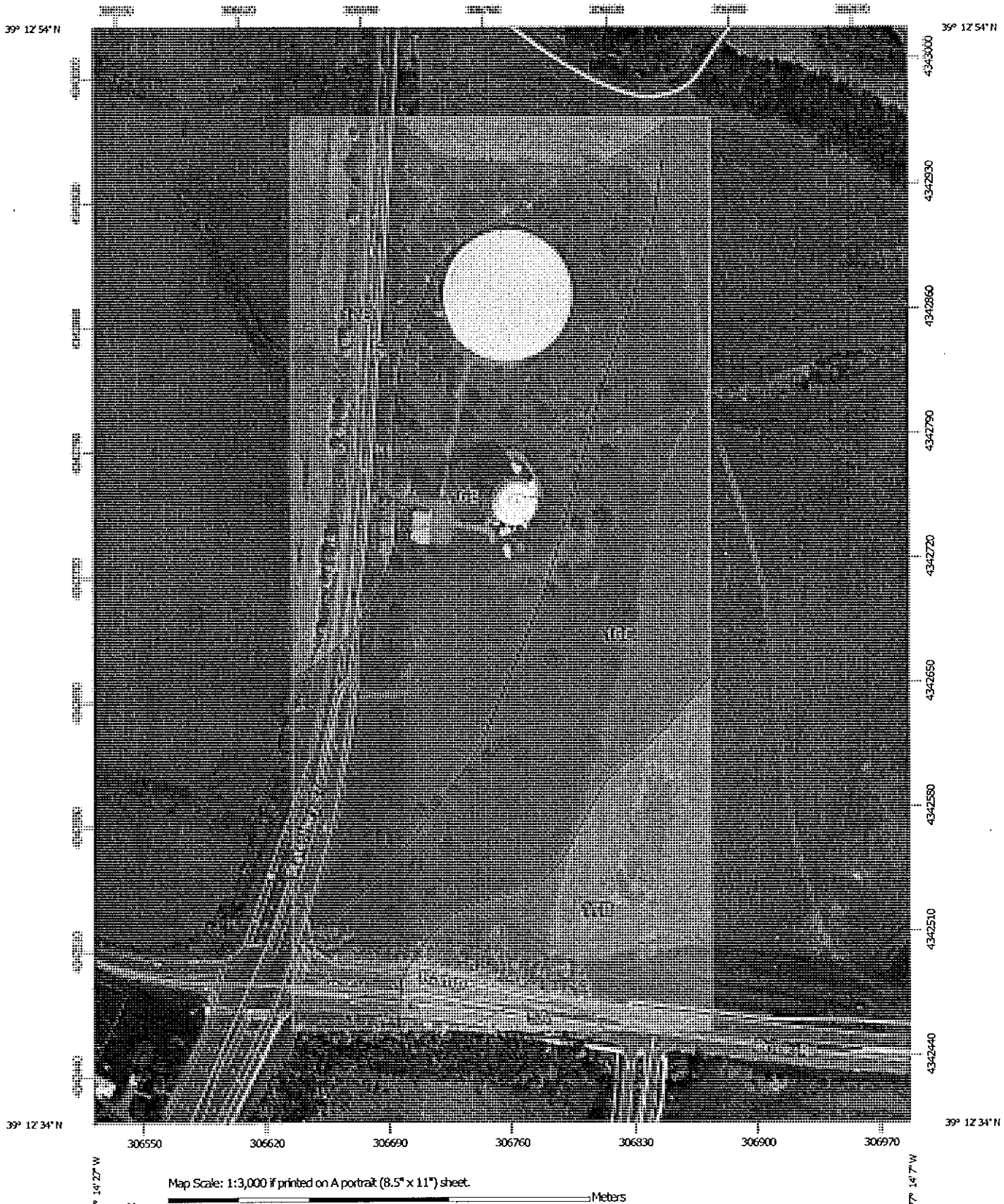
Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

K Factor, Rock Free

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kf (rock free)" indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.


77° 14' 27" W
77° 14' 7" W
39° 12' 54" N
39° 12' 34" N
4343000
4342930
4342860
4342790
4342720
4342650
4342580
4342510
4342440
306550
306620
306690
306760
306830
306900
306970
100
Map Scale: 1:3,000 if printed on A portrait (8.5" x 11") sheet.
Meters
0 40 80 160 240
Feet
0 100 200 400 600
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

:erest (AOI)
Area of Interest (AOI)

ing Polygons
.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

ing Lines
.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Water Features
Streams and Canals

Transportation
Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background
Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cau misunderstanding of the detail of mapping and accuracy of s line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more deta scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Merc projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified da of the version date(s) listed below.

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 9, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not availa

The orthophoto or other base map on which the soil lines we compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor sh of map unit boundaries may be evident.

Table—K Factor, Rock Free

K Factor, Rock Free— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
5A	Glenville silt loam, 0 to 3 percent slopes	.37	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	.43	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	.43	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	.37	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—K Factor, Rock Free

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

K Factor, Whole Soil

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Map—K Factor, Whole Soil

MAP LEGEND

:erest (AOI)
Area of Interest (AOI)

ing Polygons
.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

ing Lines
.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Water Features
Streams and Canals

Transportation
Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background
Aerial Photography

Soil Rating Points
.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cau misunderstanding of the detail of mapping and accuracy of s line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more deta scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Merc projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified da of the version date(s) listed below.

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 9, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not availa

The orthophoto or other base map on which the soil lines we compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor sh of map unit boundaries may be evident.

Table—K Factor, Whole Soil

K Factor, Whole Soil— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
5A	Glenville silt loam, 0 to 3 percent slopes	.37	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	.20	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	.20	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	.37	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—K Factor, Whole Soil

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Wind Erodibility Group

A wind erodibility group (WEG) consists of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Table—Wind Erodibility Group

Wind Erodibility Group— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	5	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	6	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	6	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	5	10.8	35.6%
Totals for Area of Interest			30.3	100.0%

Rating Options—Wind Erodibility Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Map—Drainage Class

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Lines

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Points

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:1

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cau misunderstanding of the detail of mapping and accuracy of s placement. The maps do not show the small areas of contra soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Merc projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as Albers equal-area conic projection, should be used if more ac calculations of distance or area are required.

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Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 9, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1: or larger.

Date(s) aerial images were photographed: Data not availa

The orthophoto or other base map on which the soil lines we compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor s of map unit boundaries may be evident.

Table—Drainage Class

Drainage Class— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	Moderately well drained	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	Well drained	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	Well drained	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	Well drained	10.8	35.6%
Totals for Area of Interest			30.3	100.0%

Rating Options—Drainage Class

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

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

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	C	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	C	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	C	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	B	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Map Unit Name

A soil map unit is a collection of soil areas or nonsoil areas (miscellaneous areas) delineated in a soil survey. Each map unit is given a name that uniquely identifies the unit in a particular soil survey area.

Table—Map Unit Name

Map Unit Name— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
5A	Glenville silt loam, 0 to 3 percent slopes	Glenville silt loam, 0 to 3 percent slopes	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	Occoquan loam, 3 to 8 percent slopes	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—Map Unit Name

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Lower

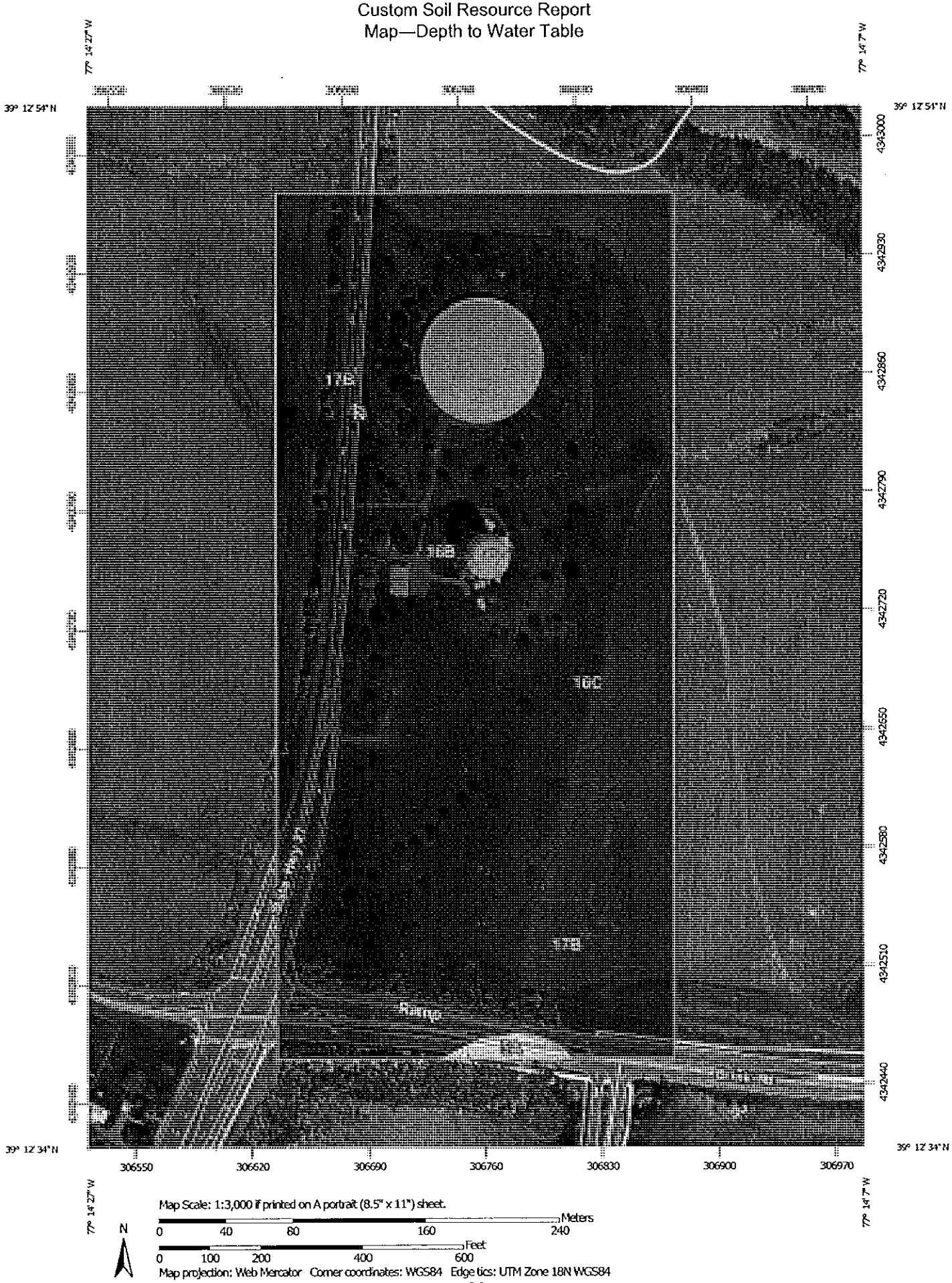
Water Features

Water Features include ponding frequency, flooding frequency, and depth to water table.

Depth to Water Table

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.


77° 14' 27" W
77° 14' 7" W
39° 12' 54" N
39° 12' 34" N
4343000
4342930
4342860
4342790
4342720
4342650
4342580
4342510
4342440
306550
306620
306690
306760
306830
306900
306970
17B
16B
16C
17B
Map Scale: 1:3,000 if printed on A portrait (8.5" x 11") sheet.
Meters
0 40 80 160 240
Feet
0 100 200 400 600
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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Date(s) aerial images were photographed: Data not availa

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Table—Depth to Water Table

Depth to Water Table— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
5A	Glenville silt loam, 0 to 3 percent slopes	76	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	>200	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	>200	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	>200	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—Depth to Water Table

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Flooding Frequency Class

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

"None" means that flooding is not probable. The chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years.

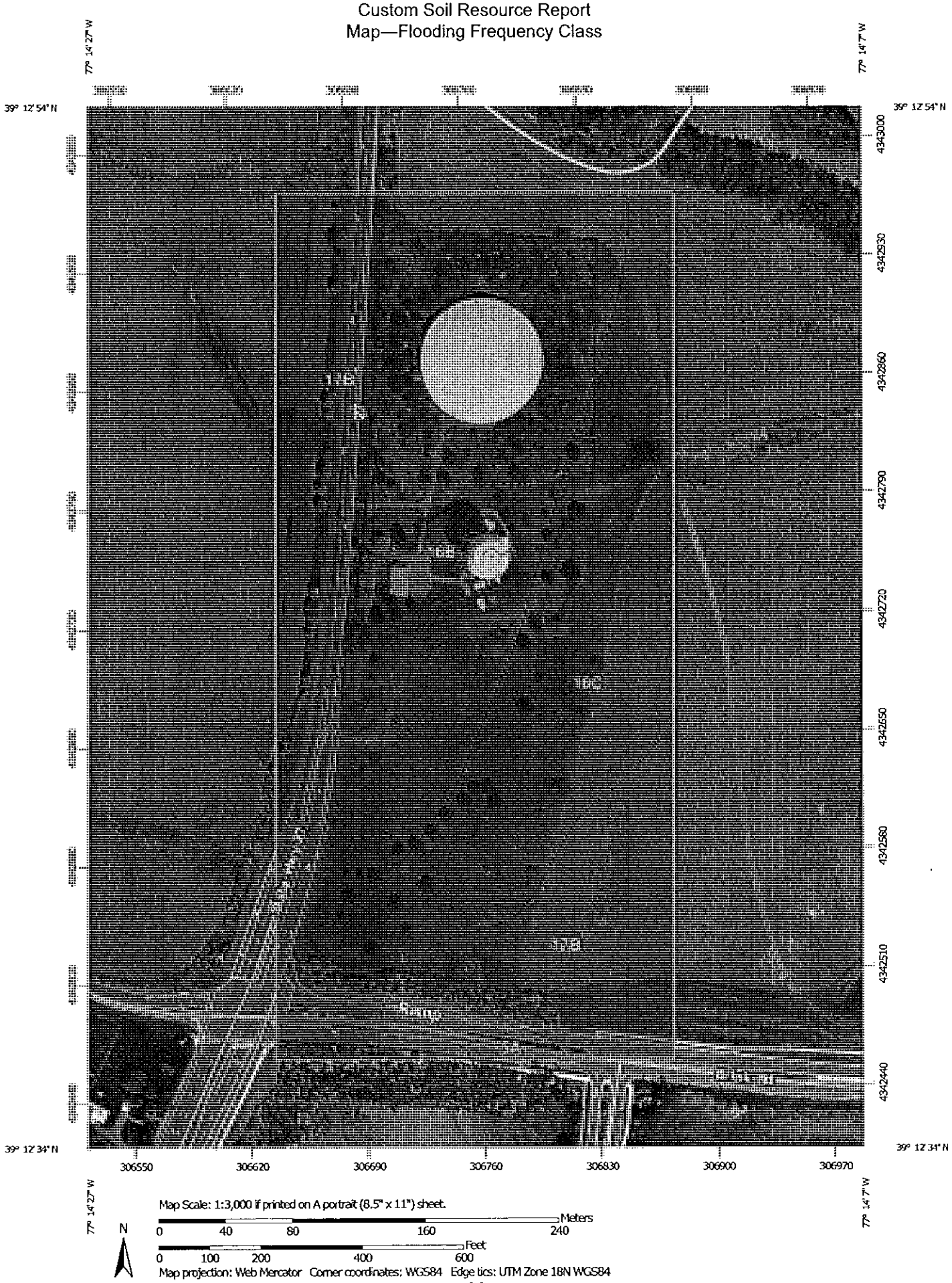
"Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1 percent in any year.

"Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1 to 5 percent in any year.

"Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5 to 50 percent in any year.

"Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year.

"Very frequent" means that flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50 percent in all months of any year.


77° 14' 27" W
77° 14' 7" W
39° 12' 54" N
39° 12' 34" N
4343000
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4342650
4342580
4342510
4342440
306550
306620
306690
306760
306830
306900
306970
Map Scale: 1:3,000 if printed on A portrait (8.5" x 11") sheet.
Meters
0 40 80 160 240
N
Feet
0 100 200 400 600
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- None
- Very Rare
- Rare
- Occasional
- Frequent
- Very Frequent
- Not rated or not available

Soil Rating Lines
- None
- Very Rare
- Rare
- Occasional
- Frequent
- Very Frequent
- Not rated or not available

Soil Rating Points
- None
- Very Rare
- Rare
- Occasional
- Frequent
- Very Frequent
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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Date(s) aerial images were photographed: Data not availa

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Table—Flooding Frequency Class

Flooding Frequency Class— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
5A	Glenville silt loam, 0 to 3 percent slopes	None	0.2	0.7%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	None	10.2	33.8%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	None	9.1	29.9%
17B	Occoquan loam, 3 to 8 percent slopes	None	10.8	35.6%
Totals for Area of Interest			**30.3**	**100.0%**

Rating Options—Flooding Frequency Class

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: More Frequent

Beginning Month: January

Ending Month: December

Ponding Frequency Class

Ponding is standing water in a closed depression. The water is removed only by deep percolation, transpiration, or evaporation or by a combination of these processes. Ponding frequency classes are based on the number of times that ponding occurs over a given period. Frequency is expressed as none, rare, occasional, and frequent.

"None" means that ponding is not probable. The chance of ponding is nearly 0 percent in any year.

"Rare" means that ponding is unlikely but possible under unusual weather conditions. The chance of ponding is nearly 0 percent to 5 percent in any year.

"Occasional" means that ponding occurs, on the average, once or less in 2 years. The chance of ponding is 5 to 50 percent in any year.

"Frequent" means that ponding occurs, on the average, more than once in 2 years. The chance of ponding is more than 50 percent in any year.

APPENDIX - I

Hydraflow Hydrologic Computational Methods

Hydrologic Methods

Hydraflow Hydrographs Extension uses the HEC-22, Soil Conservation Service, SCS (now called Natural Resources Conservation Service, NRCS), and the Rational methods for most hydrologic calculations. These methods have become the industry standard among practicing engineers and state agencies. This section provides a summary of the concepts used by Hydraflow Hydrographs Extension.

The following publications have been consulted when implementing the various hydrologic calculation methods:

- NEH-4: Hydrology; Section 4, National Engineering Handbook
- TR-20: Computer Program Manual, 1992
- TR-55: Urban Hydrology For Small Watersheds
- A Guide To Hydrologic Analysis Using SCS Methods, Richard McCuen
- HEC No. 12: FHA, Drainage of Highway Pavements
- HEC No. 22: FHA, Urban Drainage Design Manual
- Hydrology for Engineers; Linsley, Kohler & Paulhus
- Urban Storm Drainage Management; Sheaffer, Wright, Taggart & Wright
- Handbook of Hydraulics; Brater, King, Lindell, Wei

Computing SCS Unit Hydrograph

Hydraflow Hydrographs Extension uses the unit hydrograph method for calculating runoff hydrographs. It uses the triangular D-hour unit hydrograph approach as used in TR-20. The unit hydrograph represents a 1-inch rainfall over one time interval.

The peak flow for the unit hydrograph is computed using the following equation:

$$Qp = \frac{484AQ}{Tp}$$

Where:

Qp = peak flow (cfs)

484 = shape factor

A = area (sq. miles)

Q = total excess precipitation (1 inch)

Tp = time to peak (hrs)

The shape factor is a user defined variable. The default value is 484 and reflects a unit hydrograph that has 3/8 of its area under the rising limb. This factor is higher (for example, 600) in mountainous watersheds, and lower (approximately 300) in flat and swampy watersheds.

Tip If you don't know the exact value of the shape factor, leave the default.

The time to peak (Tp) and the time base (Tb) values determine the characteristics of the unit hydrograph. Hydraflow Hydrographs Extension computes these values using the following equations:

$$Tp = \frac{Tc + D}{1.7}$$

Where:

Tp = time to peak (hrs)

Tc = time of concentration (hrs)

D = unit duration or time interval (hrs)

Tc = 1.67 x L (lag time)

$$L = \frac{l^{0.8}(S+1)^{0.7}}{1900Y^{0.5}}$$

Where:

L = lag time (hrs)

l = hydraulic length (ft)

S = (1000 / CN) - 10

Y = basin slope (%)

CN = SCS curve number

$$Tb = 2.67Tp$$

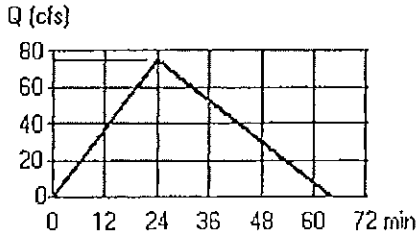
Where:

Tb = time base (hrs)

Tp = time to peak (hrs)

After the unit hydrograph ordinates have been computed, Hydraflow Hydrographs Extension lets you change the unit duration or time interval (D). This feature is useful when the input time interval (D) is too large related to the time to peak (Tp). Normally, the time interval (D) value should not exceed the time to peak (Tp) value by more than 0.5 times. When you change time interval (D), Hydraflow Hydrographs Extension recomputes time to peak (Tp) so that it falls on an even increment of the new time interval.

In the following example of a unit hydrograph (which represents one inch of rainfall over one time interval), peak flow (Qp) = 75, time to peak (Tp) = 24 min, time base (Tb) = 2.64 (24) = 64 min.



Culverts/Orifices

The equation used for culvert/orifice structures is:

$$Q = C_o A \sqrt{\frac{2gh}{k}} \times Nb$$

Where:

Under inlet control

Q = Discharge (cfs)

A = Culvert area (sqft)

h = Distance between the water surface and the centroid of the culvert barrel (1/2 flow depth during partial flow) (ft)

Nb = Number of barrels

Co = Orifice coefficient

k = 1

Under outlet control

Q = Discharge (cfs)

A = Culvert area (sqft)

h = Distance between the upstream and downstream water surface

Nb = Number of barrels

Co = 1

k = 1.5 + [(29n2L)/R1.33]

Where:

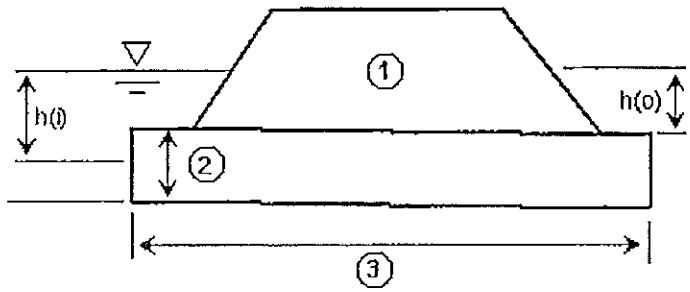
n = Manning's n-value

L = Culvert length (ft)

R = Area/wetted perimeter (ft)

Note When a non-zero tailwater (TW) elevation is entered, Hydraflow Hydrographs Extension compares the pond stage with TW and computes a tailwater head, hTW. If this head is less than the head computed as h, then h = hTW.

The following illustration shows a profile of a typical culvert, where h(i) is the head under inlet control and h(o) is the head under outlet control.



(1) Embankment

(2) Rise

(3) Pipe length

h(i) - Head under inlet control

h(o) - Head under outlet control

During the calculation process, both inlet and outlet control are evaluated. Inlet control means

that the inlet of the culvert controls the amount of flow the culvert can handle. Under inlet control, the discharge depends on the barrel shape, cross-sectional area and inlet edge. Outlet control means that flow can enter the structure at a faster rate than it can exit. Under outlet control, the discharge depends on the slope, length and roughness of the barrel.

Hydraflow Hydrographs Extension computes the discharge at each stage, including intermediate stage points that it generates, using both inlet and outlet control equation parameters. The smallest value is used as the discharge at that elevation. This is reflected on the screen tabulation as "ic", inlet control and "oc", outlet control.

Note Hydraflow Hydrographs Extension does not assume full flow when the depth is actually partial.

Weirs

The basic equations used to calculate weir flow are:

- Rectangular, Cipoletti, broad crested, and riser

$$Q = C_W L H^{1.5}$$

Where:

Q = Discharge over weir (cfs)

L = Length of the weir crest (ft)

H = Distance between water surface and the crest (ft)

Cw = Weir coefficient, typically 3.33

Note Hydraflow Hydrographs Extension uses the same weir equation for rectangular (sharp-crested weir with end contractions) and the Cipoletti weir (with no end contractions). Currently, there is not enough valid data available to support a unique equation for the weir with end contractions.

The following equation, supplied in HEC-22, attempts to adjust the weir length by subtracting 20% of H. However, by closer inspection, one can see that Q will eventually decrease to zero with increasing H.

$$Q = C_W (L - 0.2H) H^{1.5}$$

- V-notch

$$Q = 2.54 Tan\left(\frac{\theta}{2}\right) H^{2.5}$$

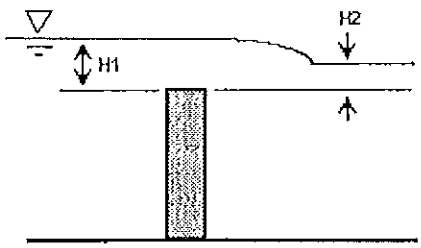
Where:

Q = discharge over weir (cfs)

θ = angle of v-notch (deg)

H = head on apex of v-notch (ft)

Rectangular, V-notch, and Cipoletti weirs are affected by submergence when the tailwater rises above the crest as follows.



This often occurs in multi-stage structures when the water surface in the riser (Riser HG) rises above the riser crest, due to the head produced by culvert A. As a result, the discharge over the weir is reduced. The equation for the reduction in flow is:

$$Qs = Qr\left(1-\left(\frac{H2}{H1}\right)^{1.5}\right)^{0.385}$$

Where:

Qs = submerged flow (cfs)

Qr = unsubmerged flow from standard weir equations

H1 = upstream head above crest (ft)

H2 = downstream head above crest (ft)

Note Numbers that are adjusted for submergence have the suffix 's' in the stage-discharge table.

See Also

- Weir Structures.

Exfiltration

Hydraflow Hydrographs Extension computes exfiltration outflows using the following equation:

$$Qex = \left(\frac{ER \times SA}{12 \times 3600} \right)$$

Where:

Qex = outflow (cfs)

ER = exfiltration rate (in/hr)

SA = surface area, wetted or contour (sqft)

Computing Detention Pond Routing

Detention pond routing is the process of passing a flood hydrograph through a storage reservoir or detention pond. This process changes the pattern of flow with respect to time but conserves volume. The purpose of detention pond routing is usually to reduce the peak flow to a predetermined level, or to delay the peak. The routing procedure used by Hydraflow Hydrographs Extension is known as the Storage Indication method and begins with a stage-storage-discharge relationship, an inflow hydrograph, and the following equation:

$$I - O = \frac{ds}{dt}$$

Where:

I = inflow

O = outflow

ds/dt = change in storage

Hydraflow Hydrographs Extension first uses the specified stage-storage-discharge table to internally plot a curve of 2s/dt + O. It then computes the outflow hydrograph using a procedure similar to the following example.

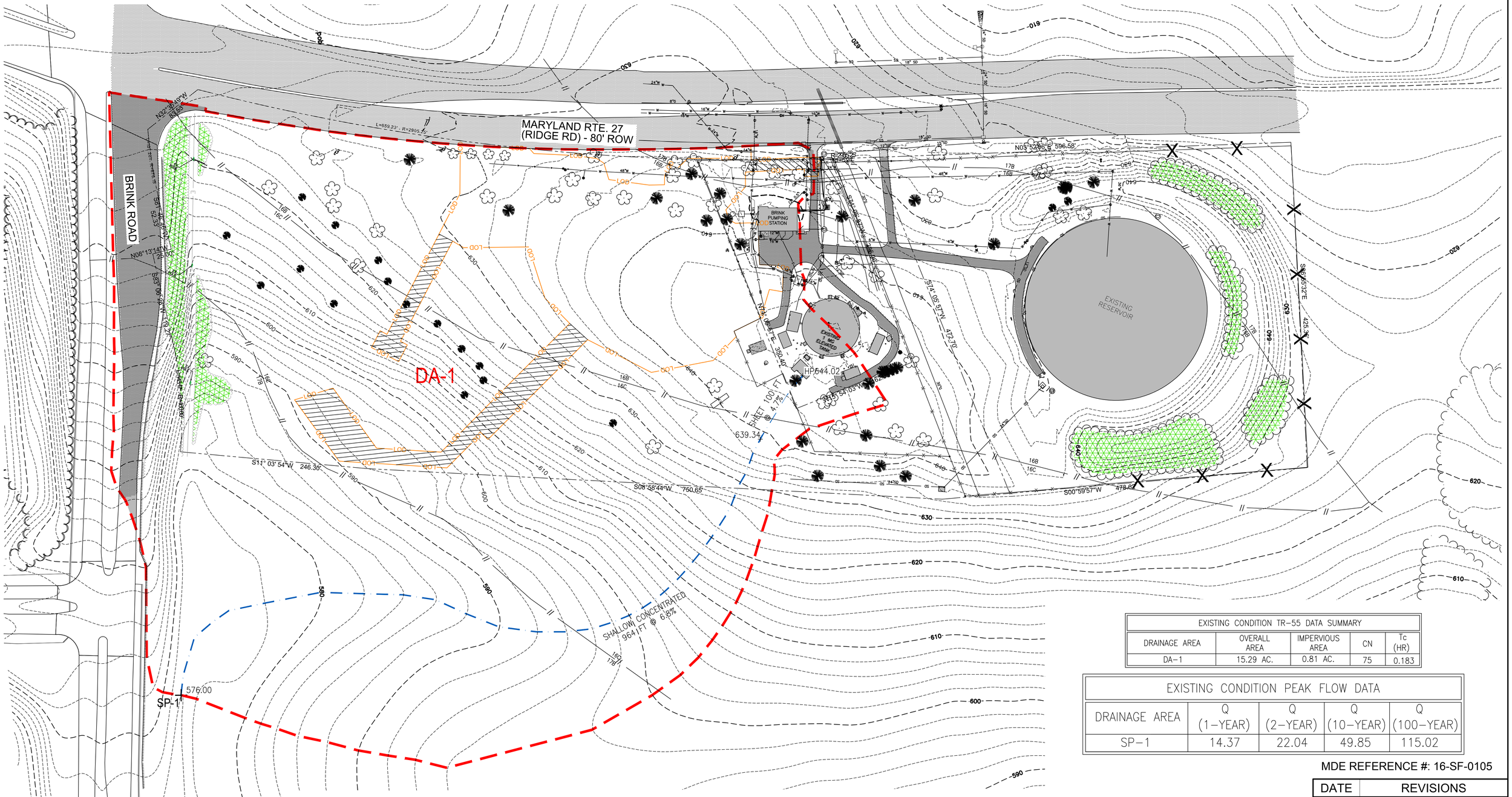
The following table contains values for sample detention pond calculations.

Time (min) (1)	Ii (cfs) (2)	Ij (cfs) (3)	2s/dt-Oi (4)	2S/dt+Oj (cfs) (5)	Outflow (cfs) (6)
0	0	24	0	-	0
4	24	95	4	24	10
8	95	206	33	123	45
12	206 +	345 +	174 = 725	334	80
16	345	500	439	725	143
20	500	655	884	1284	200
24	655	794	1509	2039	265
28	794	905	2292	2958	333
32	905	976	3239	3991	376
36	976	1000	4310	5120	404

40	1000	976	5426	6286	430
44	976	905	6502	7402	450
48	905	848	7453	8383	465
52	848	736	8252	9206	477
56	736	638	8866	9836	485
60	638	554	9260	10240	490
64	554	480	9468	10452	492
68	480	417	9514	10502	494<
72	417	0	10411	491	

Routing procedure.

- Column 1 and column 2 are read from the inflow hydrograph.
- Column 3 is the inflow at time j.
- Column 4 is column 5 - 2 x column 6.
- Column 5 for j is [column 2 + column 3 + column 4]j.
- Column 6 is computed by straight-line interpolation from the plot of 2S/dt + O vs. O.



SOIL TYPES		
SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
17B	OCCOQUAN LOAM	B

STORMWATER MANAGEMENT - EXISTING CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH
- LOD — LIMIT OF DISTURBANCE (LOD)
- LINEAR LIMIT OF DISTURBANCE
- 640 — INDEX CONTOURS
- INTERMEDIATE CONTOURS

EXISTING CONDITION TR-55 DATA SUMMARY				
DRAINAGE AREA	OVERALL AREA	IMPERVIOUS AREA	CN	Tc (HR)
DA-1	15.29 AC.	0.81 AC.	75	0.183

EXISTING CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1-YEAR)	Q (2-YEAR)	Q (10-YEAR)	Q (100-YEAR)
SP-1	14.37	22.04	49.85	115.02

MDE REFERENCE #: 16-SF-0105

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT EXISTING CONDITIONS EXHIBIT

SWM-1

NO 1
OF 4

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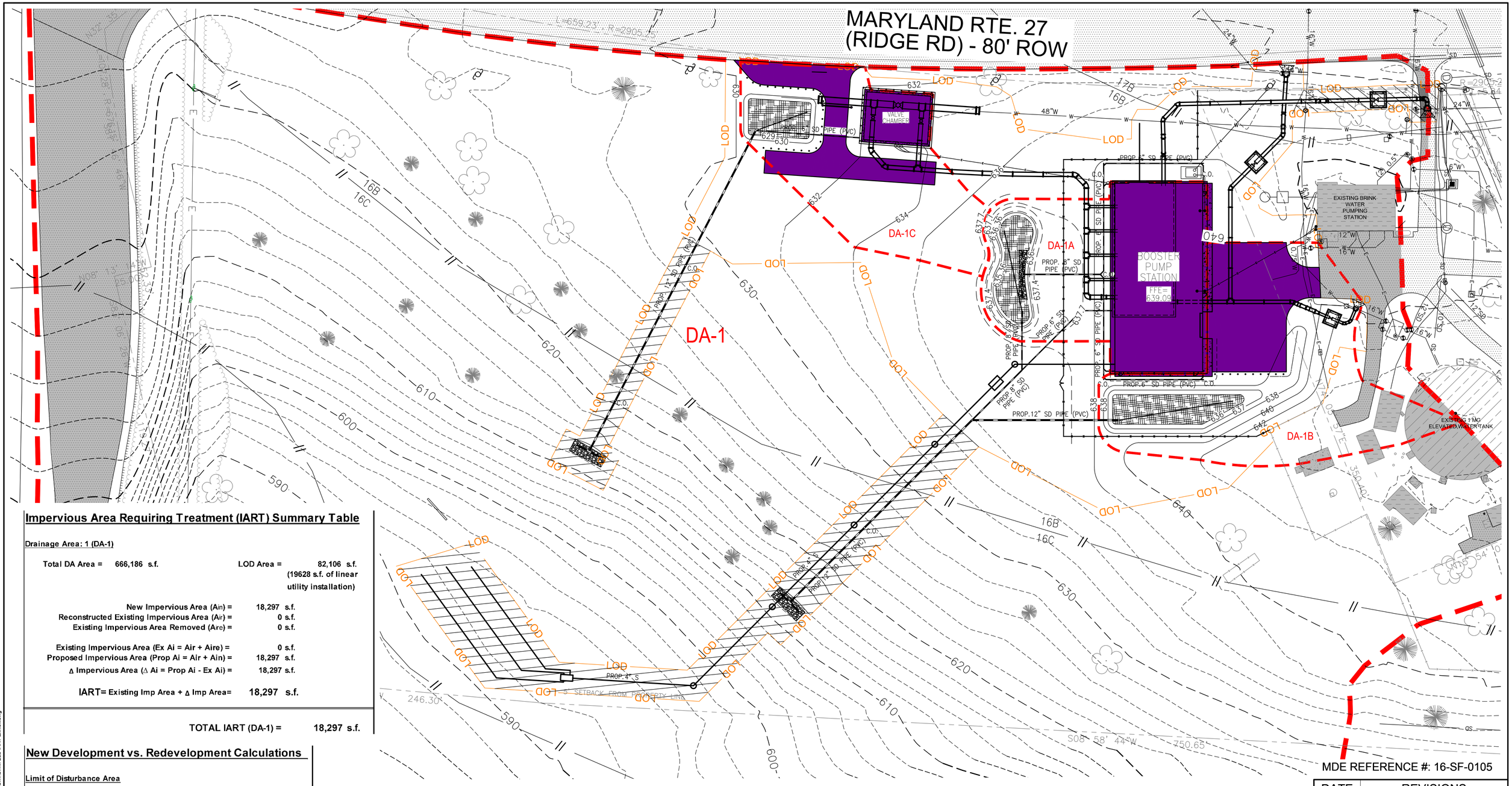

Impervious Area Requiring Treatment (IART) Summary Table

Drainage Area: 1 (DA-1)

Total DA Area =	666,186 s.f.	LOD Area =	82,106 s.f. (19628 s.f. of linear utility installation)
New Impervious Area (Ain) =	18,297 s.f.		
Reconstructed Existing Impervious Area (Air) =	0 s.f.		
Existing Impervious Area Removed (Aire) =	0 s.f.		
Existing Impervious Area (Ex Ai = Air + Aire) =	0 s.f.		
Proposed Impervious Area (Prop Ai = Air + Ain) =	18,297 s.f.		
Δ Impervious Area (Δ Ai = Prop Ai - Ex Ai) =	18,297 s.f.		
IART= Existing Imp Area + Δ Imp Area=	18,297 s.f.		

TOTAL IART (DA-1) = 18,297 s.f.

New Development vs. Redevelopment Calculations

Limit of Disturbance Area

Total LOD Area = 82,106 s.f.

Existing Impervious Area In LOD = 0
Existing Percent Impervious = 0 %

Existing % Impervious < 40% - New Development Condition

0 30 60
SCALE: 1" = 30'

SOIL TYPES

SYMBOL	DESCRIPTION	HSG
16B	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
16C	BRINKLOW–BLOCKTOWN CHANNERY SILT LOAM	C
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STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

LEGEND

- EXISTING UNDISTURBED IMPERVIOUS AREA
- RECONSTRUCTED IMPERVIOUS AREA
- NEW IMPERVIOUS AREA
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB–DRAINAGE AREA DELINEATION

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT IART EXHIBIT

SWM-2

NO 2
OF 4

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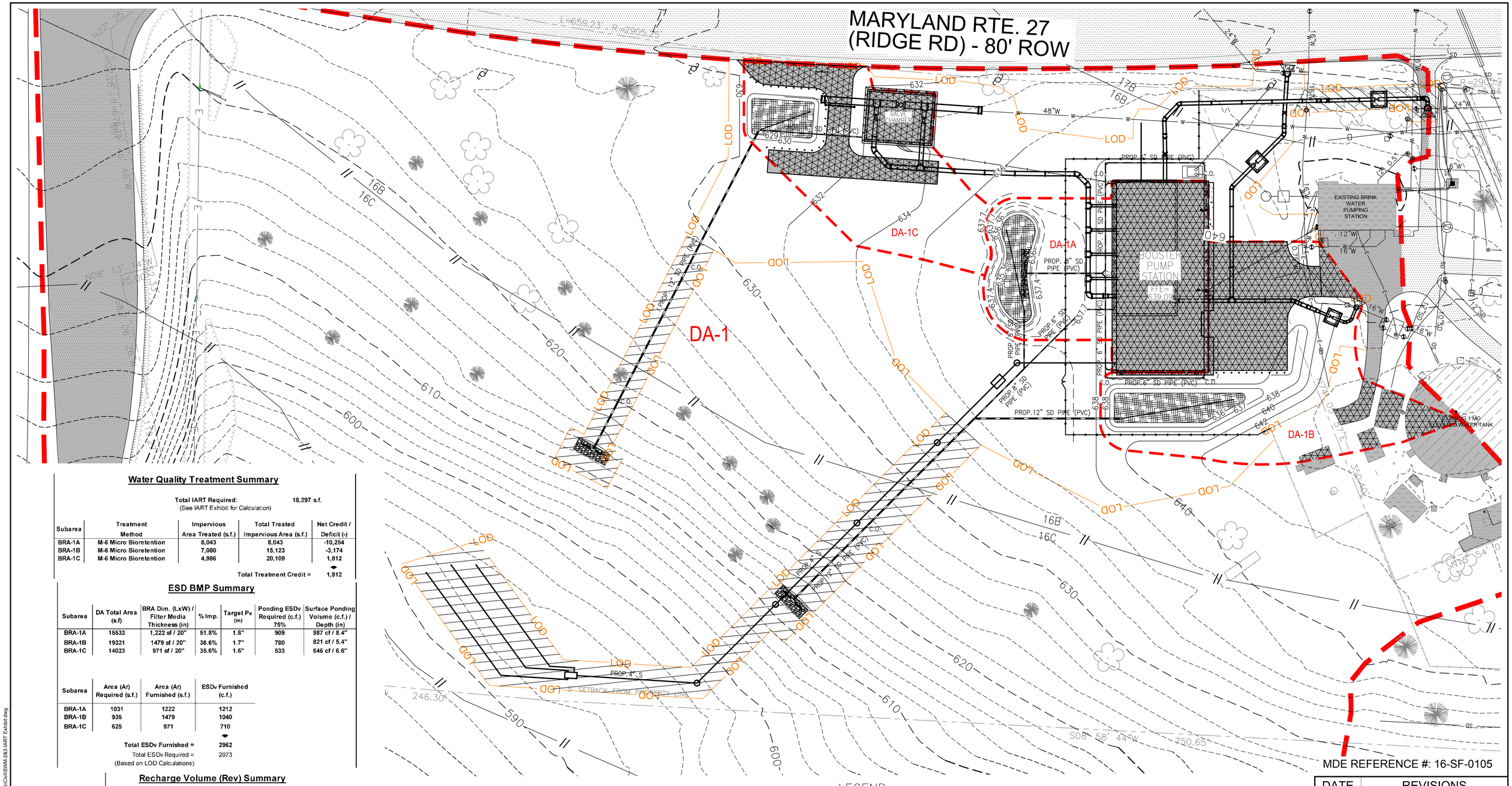

Water Quality Treatment Summary

Total IART Required: 18,297 s.f.
(See IART Exhibit for Calculation)

Subarea	Treatment Method	Impervious Area Treated (s.f.)	Total Treated Impervious Area (s.f.)	Net Credit / Deficit (-)
BRA-1A	M-6 Micro Bioretention	8,043	8,043	-10,254
BRA-1B	M-6 Micro Bioretention	7,080	15,123	-3,174
BRA-1C	M-6 Micro Bioretention	4,986	20,109	1,812
			Total Treatment Credit =	1,812

ESD BMP Summary

Subarea	DA Total Area (s.f)	BRA Dim. (LxW) / Filter Media Thickness (in)	% Imp.	Target Pe (in)	Ponding ESDv Required (c.f.) 75%	Surface Ponding Volume (c.f.) / Depth (in)
BRA-1A	15533	1,222 sf / 20"	51.8%	1.8"	909	987 cf / 8.4"
BRA-1B	19321	1479 sf / 20"	36.6%	1.7"	780	821 cf / 5.4"
BRA-1C	14023	971 sf / 20"	35.6%	1.6"	533	646 cf / 6.6"

Subarea	Area (Af) Required (s.f.)	Area (Af) Furnished (s.f.)	ESDv Furnished (c.f.)
BRA-1A	1031	1222	1212
BRA-1B	935	1479	1040
BRA-1C	625	971	710
		Total ESDv Furnished =	2962
		Total ESDv Required =	2073
		(Based on LOD Calculations)	

Recharge Volume (Rev) Summary

Subarea	Treatment Method	Rev Furnished (c.f.)
BRA-1A	M-6 Micro Bioretention	489
BRA-1B	M-6 Micro Bioretention	592
BRA-1C	M-6 Micro Bioretention	388
	Total Rev Furnished =	1081
	Total Rev Required =	226
	(Based on LOD Calculations)	

0 30 60
SCALE: 1" = 30'

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STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

LEGEND

- IMPERVIOUS AREA
- TREATED IMPERVIOUS AREA
- PROPOSED MICRO–BIORETENTION AREA
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB–DRAINAGE AREA DELINEATION

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT ESD-BMP EXHIBIT

SWM-3

NO 3
OF 4

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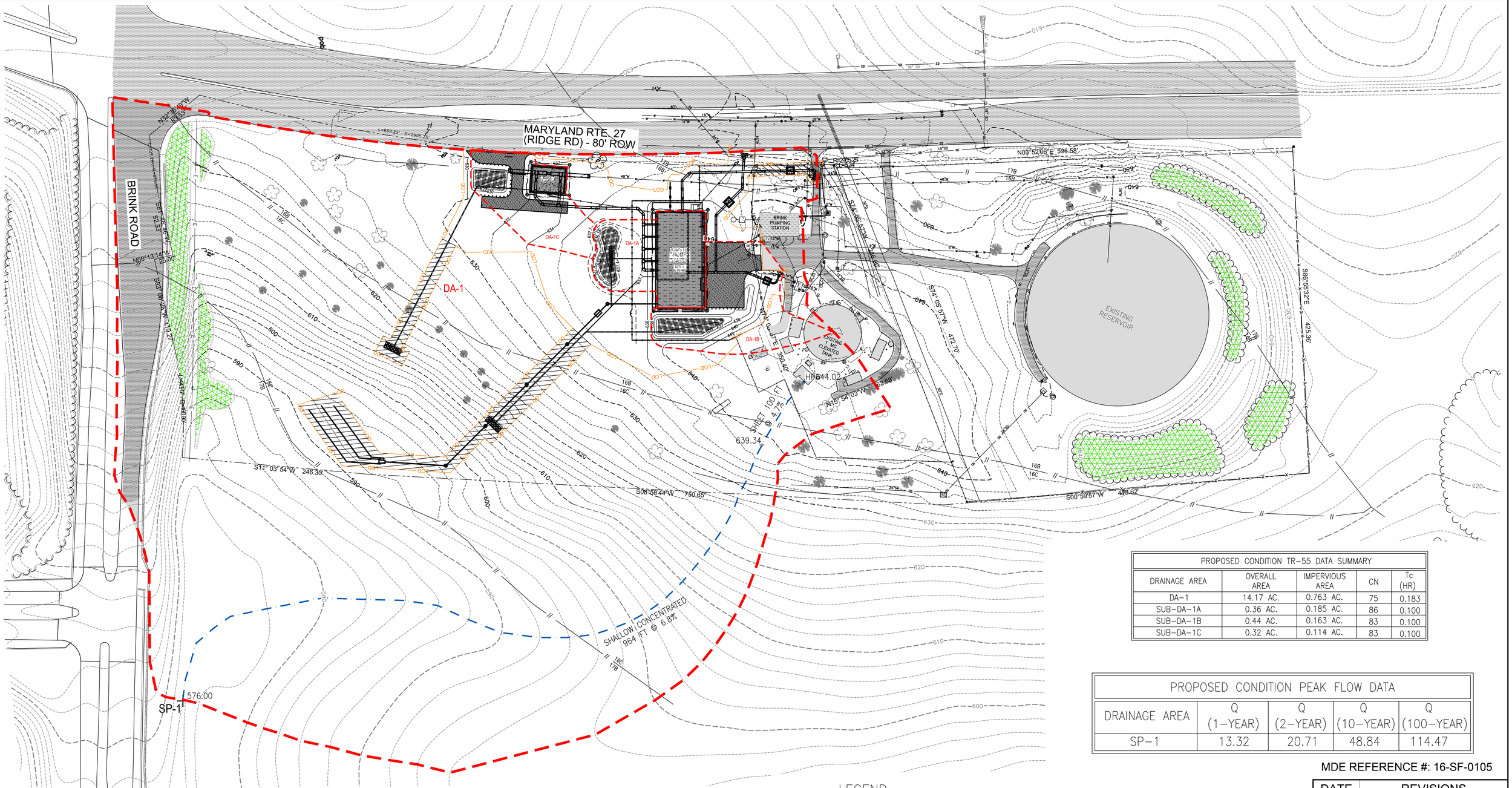

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17B	OCCOQUAN LOAM	B

PROPOSED CONDITION TR–55 DATA SUMMARY				
DRAINAGE AREA	OVERALL AREA	IMPERVIOUS AREA	CN	Tc (HR)
DA–1	14.17 AC.	0.763 AC.	75	0.183
SUB–DA–1A	0.36 AC.	0.185 AC.	86	0.100
SUB–DA–1B	0.44 AC.	0.163 AC.	83	0.100
SUB–DA–1C	0.32 AC.	0.114 AC.	83	0.100

PROPOSED CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1–YEAR)	Q (2–YEAR)	Q (10–YEAR)	Q (100–YEAR)
SP–1	13.32	20.71	48.84	114.47

MDE REFERENCE #: 16-SF-0105

STORMWATER MANAGEMENT - PROPOSED CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- PROPOSED CONDITIONS IMPERVIOUS AREA
- PROPOSED STORM DRAIN LINE
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB–DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH

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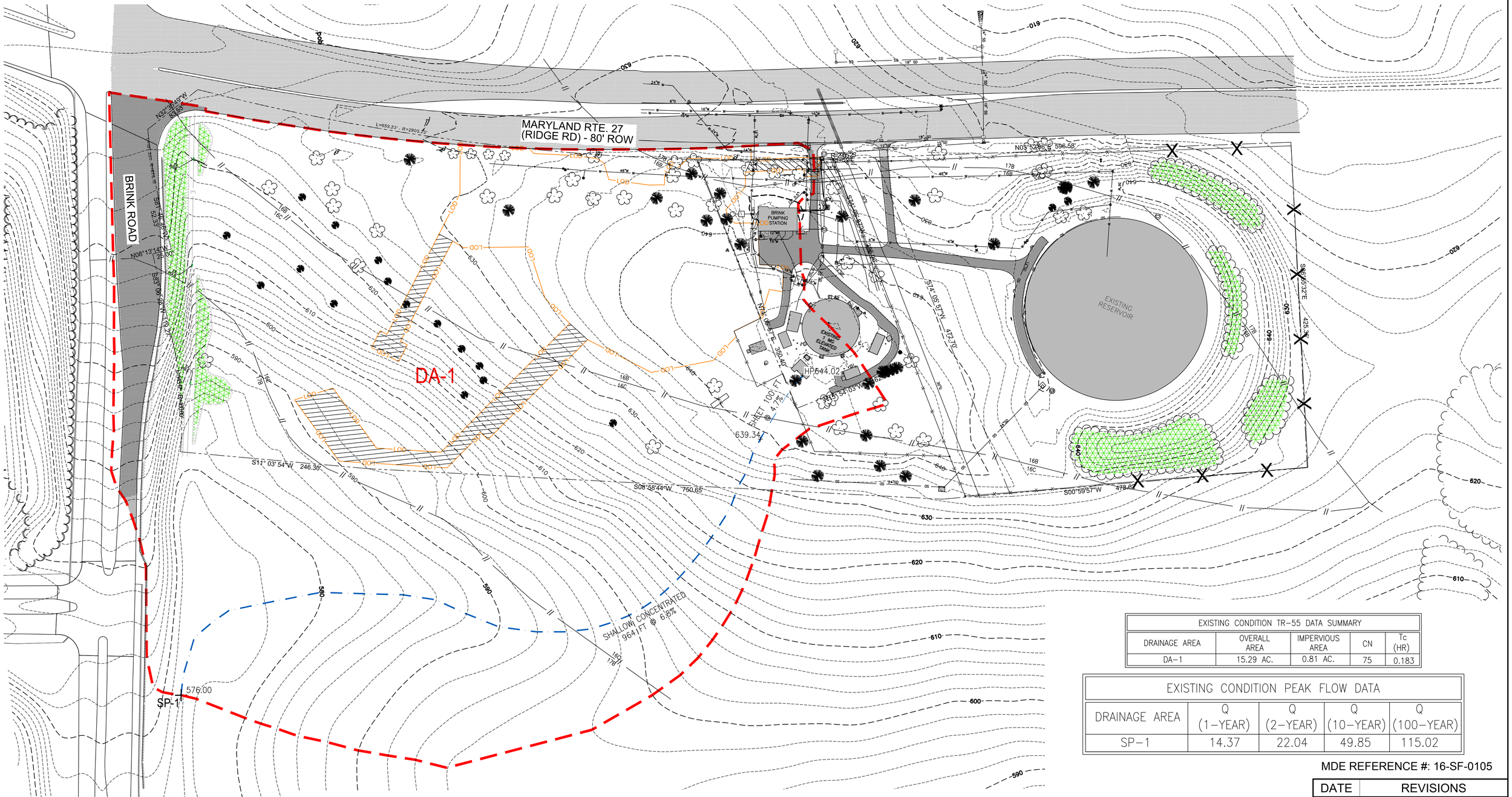
BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT PROPOSED CONDITIONS EXHIBIT

SWM-4

NO 4
OF 4



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STORMWATER MANAGEMENT - EXISTING CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH
- LOD — LIMIT OF DISTURBANCE (LOD)
- LINEAR LIMIT OF DISTURBANCE
- 640 — INDEX CONTOURS
- INTERMEDIATE CONTOURS

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DRAINAGE AREA	OVERALL AREA	IMPERVIOUS AREA	CN	Tc (HR)
DA-1	15.29 AC.	0.81 AC.	75	0.183

EXISTING CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1-YEAR)	Q (2-YEAR)	Q (10-YEAR)	Q (100-YEAR)
SP-1	14.37	22.04	49.85	115.02

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT EXISTING CONDITIONS EXHIBIT

SWM-1

NO 1
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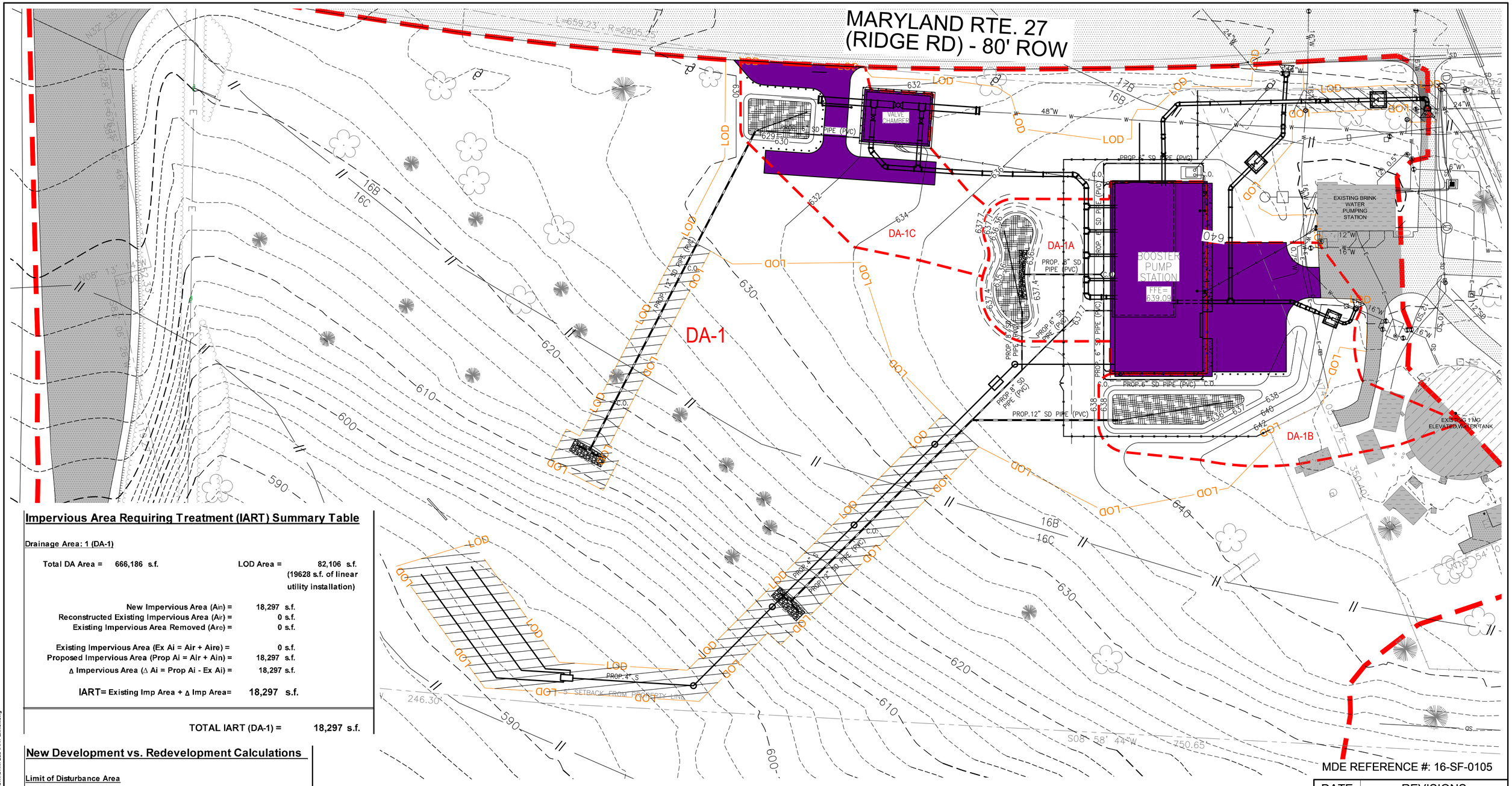

Impervious Area Requiring Treatment (IART) Summary Table

Drainage Area: 1 (DA-1)

Total DA Area =	666,186 s.f.	LOD Area =	82,106 s.f. (19628 s.f. of linear utility installation)
New Impervious Area (Ain) =	18,297 s.f.		
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Existing Impervious Area Removed (Aire) =	0 s.f.		
Existing Impervious Area (Ex Ai = Air + Aire) =	0 s.f.		
Proposed Impervious Area (Prop Ai = Air + Ain) =	18,297 s.f.		
Δ Impervious Area (Δ Ai = Prop Ai - Ex Ai) =	18,297 s.f.		
IART= Existing Imp Area + Δ Imp Area=	18,297 s.f.		

TOTAL IART (DA-1) = 18,297 s.f.

New Development vs. Redevelopment Calculations

Limit of Disturbance Area

Total LOD Area = 82,106 s.f.

Existing Impervious Area In LOD = 0
Existing Percent Impervious = 0 %

Existing % Impervious < 40% - New Development Condition

0 30 60
SCALE: 1" = 30'

SOIL TYPES		
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STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

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BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

STORMWATER MANAGEMENT IART EXHIBIT

SWM-2

NO 2
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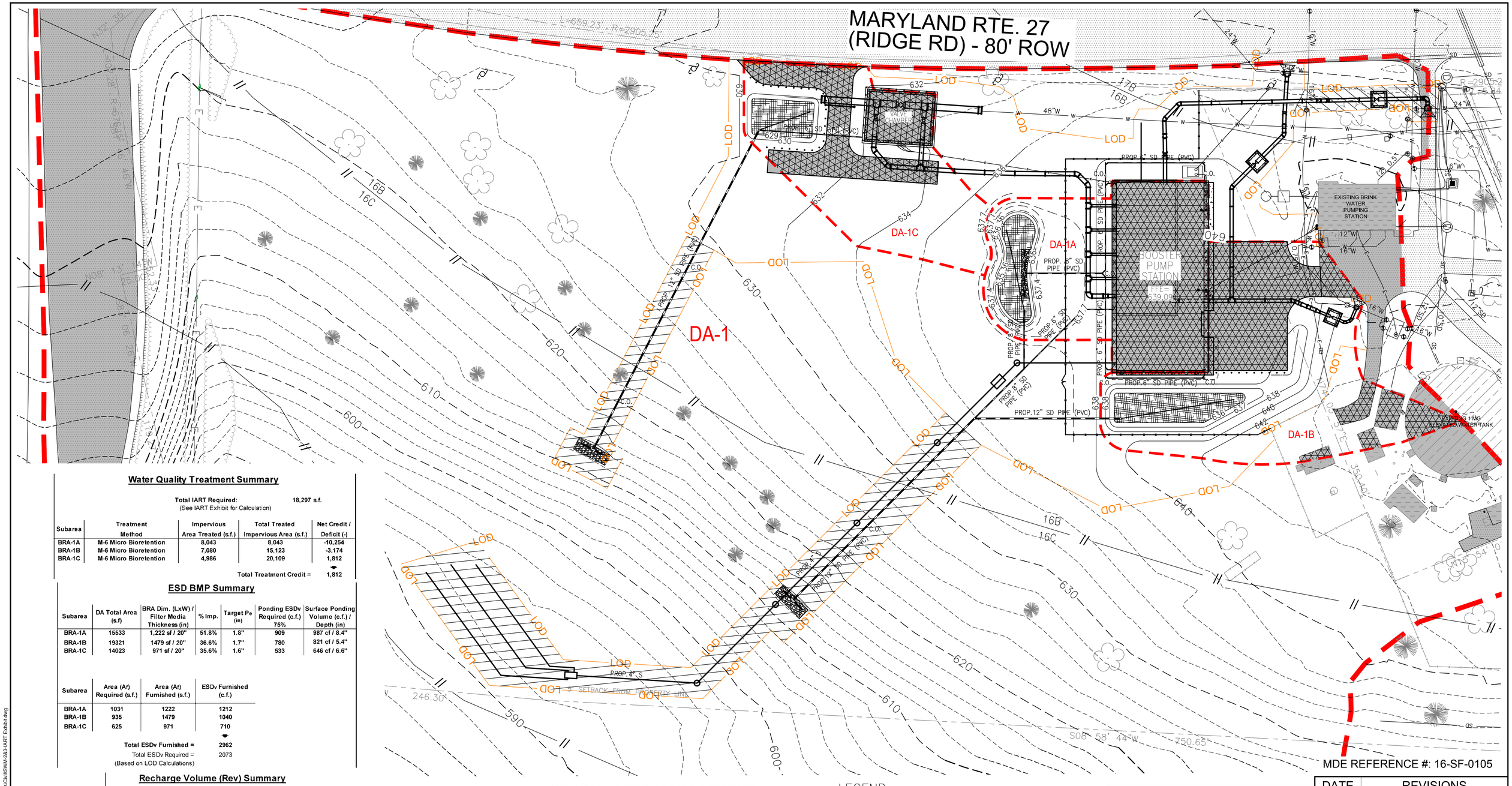

Water Quality Treatment Summary

Total IART Required: 18,297 s.f.
(See IART Exhibit for Calculation)

Subarea	Treatment Method	Impervious Area Treated (s.f.)	Total Treated Impervious Area (s.f.)	Net Credit / Deficit (-)
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ESD BMP Summary

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STORMWATER MANAGEMENT - IART EXHIBIT

SCALE: 1" = 30'

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STORMWATER MANAGEMENT ESD-BMP EXHIBIT

SWM-3

NO 3
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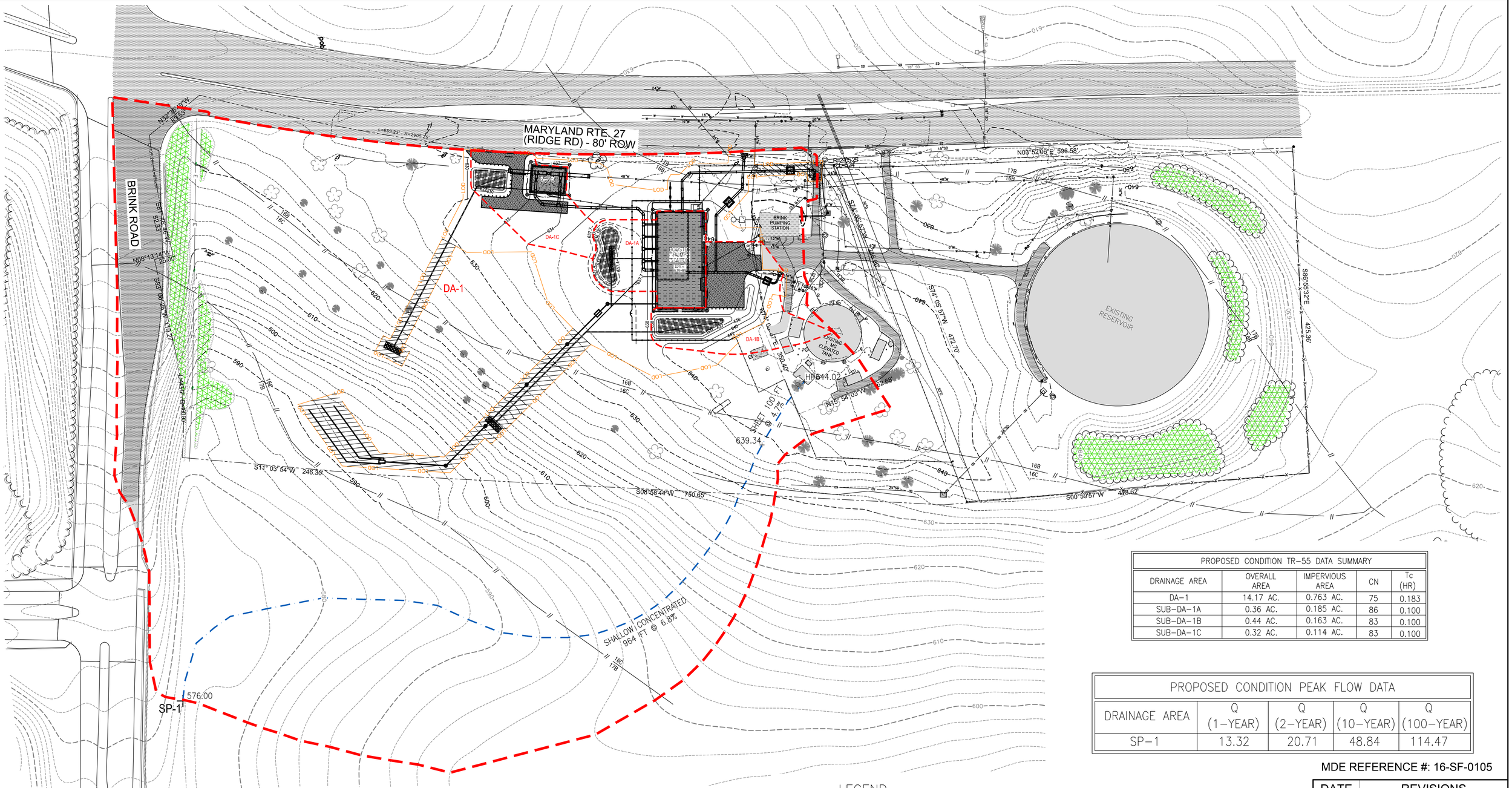

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SUB–DA–1A	0.36 AC.	0.185 AC.	86	0.100
SUB–DA–1B	0.44 AC.	0.163 AC.	83	0.100
SUB–DA–1C	0.32 AC.	0.114 AC.	83	0.100

PROPOSED CONDITION PEAK FLOW DATA				
DRAINAGE AREA	Q (1–YEAR)	Q (2–YEAR)	Q (10–YEAR)	Q (100–YEAR)
SP–1	13.32	20.71	48.84	114.47

MDE REFERENCE #: 16-SF-0105

STORMWATER MANAGEMENT - PROPOSED CONDITIONS EXHIBIT

SCALE: 1" = 60'

LEGEND

- EXISTING IMPERVIOUS AREA
- EXISTING FORESTED AREA
- PROPOSED CONDITIONS IMPERVIOUS AREA
- PROPOSED STORM DRAIN LINE
- LOD — LIMIT OF DISTURBANCE
- LINEAR LIMIT OF DISTURBANCE
- DRAINAGE AREA DELINEATION
- SUB–DRAINAGE AREA DELINEATION
- TIME OF CONCENTRATION PATH

CARROLL ENGINEERING, INC.
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031
phone: 410-785-7423
fax: 410-771-1313
www.ceiengineering.com

DESIGN:	CMF	
DRAWN:	CMF	
CHECKED:	CMS	

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

LICENSE NO.: 14446
EXPIRATION DATE: 05/25/2017

DATE	REVISIONS

CONTRACT: BP5692A14

PATH: P:\2015\1501.08.00 WSSC Brink Zone Reliability Improvements\Drawings\Civil\SWM-4-Prop Conditions Exhibit.dwg

VERIFY SCALE - BAR IS ONE INCH ON ORIGINAL DRAWING 0 1". IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

WASHINGTON SUBURBAN SANITARY COMMISSION

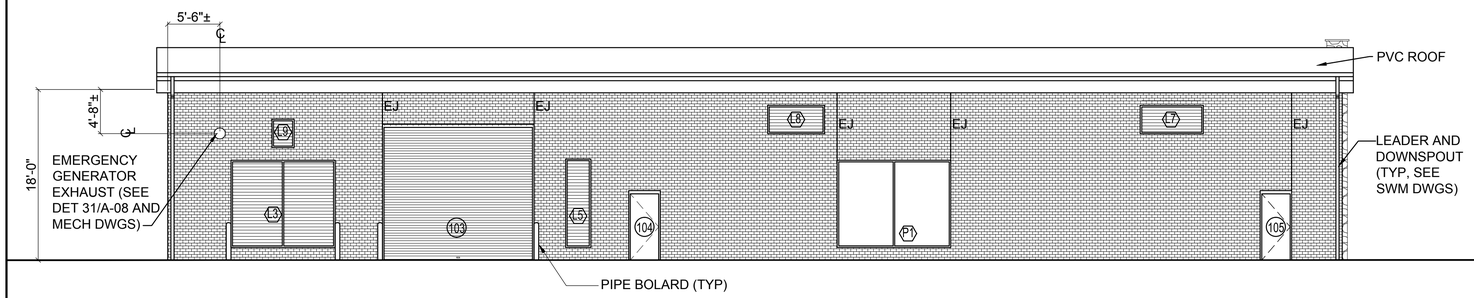
Hatch Mott MacDonald

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

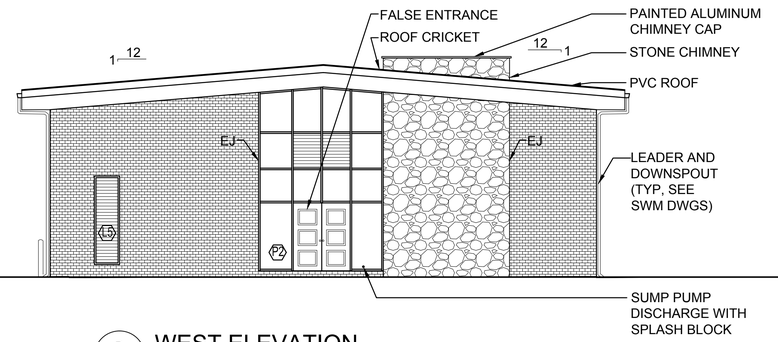
STORMWATER MANAGEMENT PROPOSED CONDITIONS EXHIBIT

SWM-4

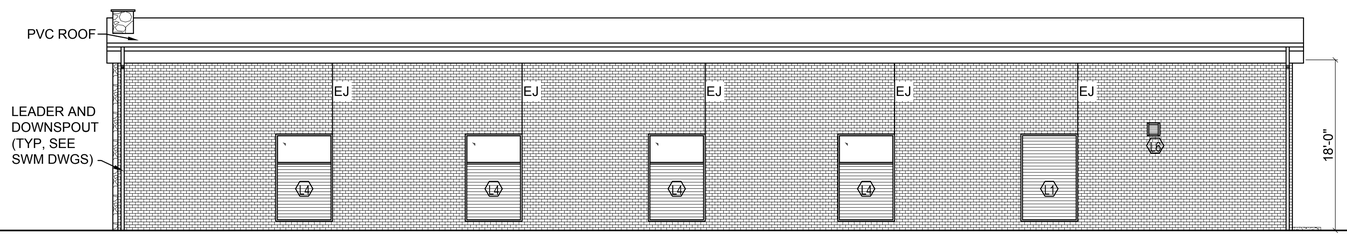
NO 4
OF 4



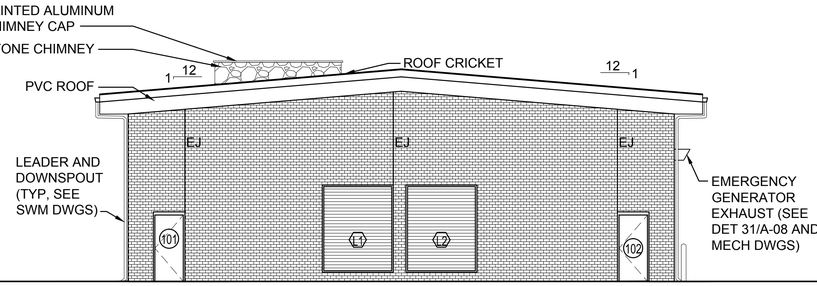
A A-03 **NORTH ELEVATION**
SCALE: 1/8" = 1'-0"



B A-03 **WEST ELEVATION**
SCALE: 1/8" = 1'-0"



C A-03 **SOUTH ELEVATION**
SCALE: 1/8" = 1'-0"

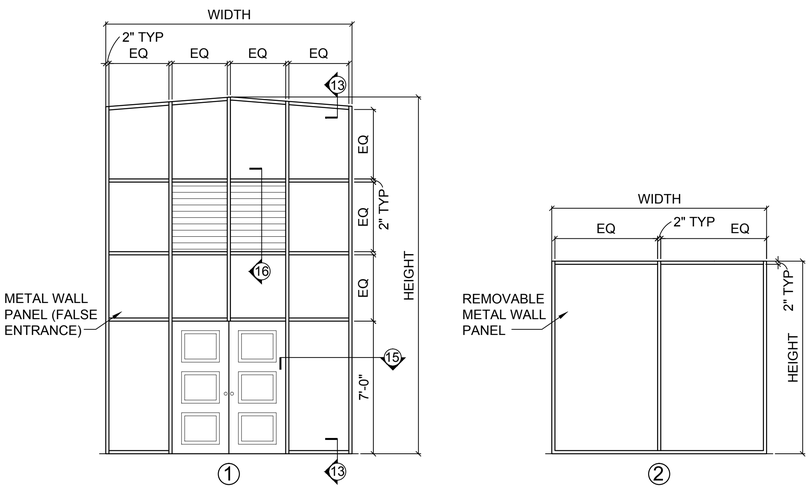


D A-03 **EAST ELEVATION**
SCALE: 1/8" = 1'-0"

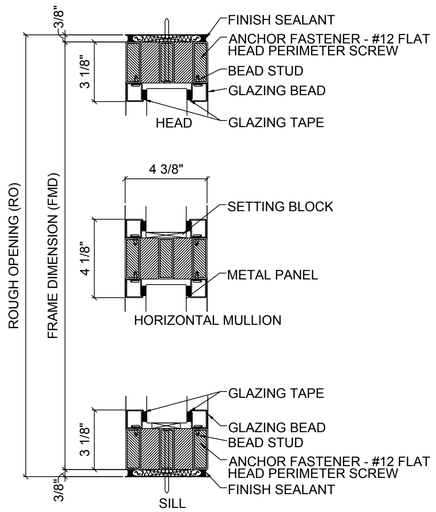
WALL PANEL SCHEDULE								
LOUVER NO.	WALL PANEL							
	SIZE			SILL HEIGHT	MATERIAL	TYPE	FINISH	REMARKS
	WIDTH	HEIGHT	THK					
P1	12'-0"	9'-2"	4"	1'-4"	AL	2	PAINT	1
P2	13'-2"	19'-6" ±	4"	0'-8"	AL	2	PAINT	-

WALL PANEL SCHEDULE REMARKS

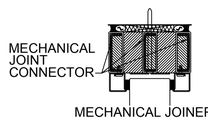
1. WALL PANEL SHALL BE REMOVABLE.



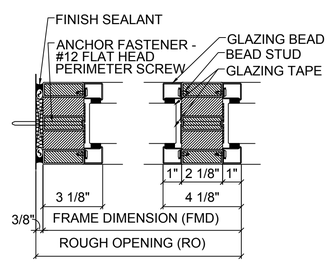
WALL PANEL TYPES
SCALE: 1/4" = 1'-0"



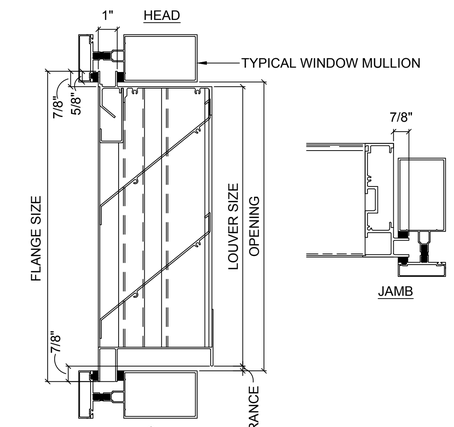
13 A-07 **WALL PANEL DETAIL**
SCALE: 3" = 1'-0"



14 A-07 **WALL PANEL DETAIL**
SCALE: 3" = 1'-0"



15 A-07 **WALL PANEL DETAIL**
SCALE: 3" = 1'-0"



16 A-07 **LOUVER DETAILS**
SCALE: 3" = 1'-0"

GRAPHIC SCALE
2" 0 2" 4" 6"
SCALE 3" = 1'-0"

GRAPHIC SCALE
8' 6' 4' 2' 0 8'
SCALE 1/8" = 1'-0"

DESIGN:	DLH	04/15/16
DRAWN:	DMR	04/15/16
CHECKED:	RKF	04/15/16

100% DESIGN

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WASHINGTON SUBURBAN SANITARY COMMISSION

MOTT MACDONALD

BRINK ZONE RELIABILITY IMPROVEMENTS PROJECT

PUMP STATION EXTERIOR ELEVATIONS

A-07

NO 42
OF 117

PATH: \\bal-data-vm\Projects\Projects\HMM\WSSC\Brink\Drawings\CAD\05 A-07 Pump Station Exterior Elevations.dwg

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