STORMWATER POLLUTION PREVENTION PLAN

FOR

REDEVLOPMENT OF FROZEN ROPES – THE YARD

STATE SCHOOL ROAD

TOWN OF WARWICK
ORANGE COUNTY, NEW YORK

PREPARED BY

ENGINEERING & SURVEYING PROPERTIES
Achieving Successful Results with Innovative Designs
71 Clinton Street
Montgomery, NY 12549

JANUARY 2015
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W.O. 1056.03

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1.0 INTRODUCTION

Engineering & Surveying Properties, PC is pleased to submit this report summarizing the impact the proposed redevelopment of the property, formally known as the Mid-Orange Correctional Facility, currently proposed as the Frozen Ropes – The Yard project site will have on downstream properties and receiving waters.

1.1 PURPOSE

The purpose of the Stormwater Pollution Prevention Plan is to:

a. Maintain existing drainage patterns and continue the conveyance of upland watershed runoff;
b. Mitigate potential stormwater quality and peak stormwater flow impacts, and prevent soil erosion and sedimentation resulting from stormwater runoff.

1.2 SCOPE

The scope of the Stormwater Pollution Prevention Plan described herein is as follows:

a. Describe and estimate existing stormwater runoff conditions;
b. Describe and estimate proposed stormwater runoff conditions;
c. Describe and evaluate stormwater management facilities planned as part of the proposed redevelopment.

2.0 PROJECT DESCRIPTION

The project site is 36.0± acres in size and is located in the Town of Warwick in Orange County, New York. The project consists of one Town of Warwick tax lot, Section 46 Block 1 Lot 34.12. The project is located on the easterly side of State School Road in the Town of Warwick, Orange County. The parcel was previously a New York State owned and operated correctional facility, but was recently closed and is currently being proposed for redevelopment as a sports training facility. All the former buildings, fencing, paved and gravel parking and outdoor storage areas, and storm drainage infrastructure are still on-site. A site location map is attached as Figure 1.

As proposed, the project involves the renovation of some of the existing buildings, and the removal of some buildings and accessories for the installation of three (3) athletic fields. Other buildings on the site will be left vacant with the possibility for future reuse.

To the west of the property is State School Road and additional vacant buildings from the previous state run correctional facility. To the north, east and south of the property is vacant land that was also part of the correctional facility but has since been acquired by the Town of Warwick for parkland use.

The project area is roughly a rectangular shaped plot of land that is bordered by Town of Warwick parkland to the north, east and south, and by the Town road to the west. Most of the property is flat and generally slopes from the south to the north. The majority of existing site is covered with impervious ground cover consisting of buildings, pavement or gravel. Redevelopment of the property will convert some of the impervious area to pervious area through the construction of the three (3) athletic fields and with adjacent lawn areas. For detailed construction sequencing, please refer to sheet C-106 of the approved Site Plan set for Frozen Ropes – "The Yard".

3.0 METHODOLOGY

The methodology utilized for this analysis is based upon the U.S.D.A. Soil Conservation Service's Technical Release No. 20 and Technical Release No. 55, as utilized by the software entitled Hydraflow Hydrographs.

Hydraflow Hydrographs, developed by Intelisolve of Alpharetta, Georgia, is a Microsoft Windows based program for analyzing the hydrology and hydraulics of stormwater runoff. It utilizes the latest techniques to predict the stormwater flows from any given storm event.

Hydraflow Hydrographs has the capability of computing hydrographs (representing discharge rates characteristic of specific watershed conditions, precipitation and geologic factors), combining hydrographs, and routing flows through pipes, streams and ponds. A drainage model can consist of four different components - subareas, combinations, reaches and reservoirs.

A subarea consists of a relatively homogeneous area of land, which produces a volume and rate of runoff unique to that watershed. A subarea combination is the hydrologic addition of two subareas in order to determine the peak runoff at a design point. A reach is a channelized conveyance structure which routes the runoff from one point to another. A reservoir consists of a natural or man-made impoundment which temporarily stores

stormwater runoff and that empties in a manner determined by various hydraulic structures located at its outlet.

This Stormwater Pollution Prevention Plan was based upon the New York State Stormwater Management Design Manual published by the New York State Department of Environmental Conservation (NYSDEC). Criteria set forth by this manual, requires analysis and determination of the required Water Quality Volume (WQv), to provide extended detention of the 1-year storm event for Stream Channel Protection (Cpv), to control the peak discharge of the 10-year storm event also known as Overbank Flood Protection Criteria (Qp), and to control the peak discharge and safely pass the 100-year storm event otherwise known as Extreme Flood Control Criteria (Qf).

This Stormwater Pollution Prevention Plan was developed utilizing the “five step” process for Stormwater Site Planning and Practice Selection. The five steps consist of site planning, determination of the water quality treatment volume, runoff reduction volumes applied through use of “green technologies”, application of standard stormwater management practices for remaining water quality volumes, and application of volume and peak rate control methods as required. Each of the five “steps” is further discussed in detail within this report.

Using the criteria mentioned above, the post development condition was analyzed utilizing standard stormwater management practices. In this analysis, it was determined that standard stormwater management practices could not be properly sized or installed with the redevelopment of the property as proposed. In accordance with the NYSDEC Stormwater Management Design Manual, this SWPPP will be written, designed and prepared as a redevelopment project. The stormwater management practices for this redevelopment project will follow an approach to balance between:

1. Maximizing improvements during site design that can reduce the impacts of stormwater runoff.
2. Providing a maximum level of on-site treatment that is feasible given the site constraints present where the redevelopment activities are occurring.

Initial site planning included the development of an existing conditions map showing existing natural resources and drainage patterns. The map was created utilizing a

boundary survey completed in July 2013 by Schmick Surveying, Inc., topography information from a map prepared by Chazen Engineering, Land Surveying & Landscape Architecture Co. P.C., USGS 2000 scale topographic maps and field inspections. This map is included as Figure 2 in the appendix.

The proposed site plan was then prepared attempting to protect and preserve natural features, maintain natural drainage patterns, and avoid to the greatest extent practical the disturbance of erodible soils and steep slopes. The site plan with proposed watershed boundaries can be seen as Figure 3 of the appendix.

4.0 TOPOGRAPHY AND SOILS

The topography in the project area is flat, varying from approximately 555 feet above mean sea level (AMSL) to 536 feet AMSL. Much of the project area is flat but gently slopes in a northerly direction from the on-site high point, towards the northeast low point. Much of the existing property sits atop a plateau, surrounded to the northeast and southeast by New York State Department of Environmental Conservation jurisdictional wetlands. These NYSDEC jurisdictional wetlands are outside the parcel limits with no wetlands within the project site. Small portions of the one hundred foot adjacent buffer areas overlap the parcel limits, but are outside the area of development.

Beyond the project area, the surrounding areas generally slope away from the on-site high point to the north and south. These off-site low points ultimately discharge to NYSDEC wetlands WR-27 to the south, and NYSDEC wetlands WR-29 to the north. These wetlands bodies are tributary to the Wickham Lake located to the northwest of the project site or Long House Creek located Southeast of the project site.

Information assembled by the U.S. Department of Agriculture Soil Conservation Service printed in the Soil Survey of Orange County identifies the presence of the following soil groups: Alden (8.8%), Canandaigua (0.2%), Fredon (20.8%), Mardin (0.1%), Udorthents (3.0%) within the limits of the project area and a large portion of the site (67.2%) is classified as Urban Land. The majority of the existing parcel area is defined as Urban Land due to the fact that the existing structures and infrastructure found on site predate the soil survey performed in 1971. An Existing Soil Map is attached as Figure 4. Udorthents soils are considered to be a part of the “A” hydrologic group, Canandaigua

and Fredon soils are part of a “B / D” group complex, Alden soils part of a “C / D” group complex and Mardin soils are part of the “D” hydrologic group.

5.0 HYDROLOGIC AND HYDRAULIC ANALYSIS

Analysis was performed by dividing the tributary watershed into relatively homogeneous subareas. The separation of the watershed into subareas was dictated by watershed conditions, methods of collection, conveyance and points of discharge. Watershed characteristics for each subarea were then assessed from topographical maps, soil surveys, site investigations and land use maps.

5.1 EXISTING CONDITIONS

The watershed analyzed in this study is depicted in Figure 2 in Appendix 1. The characteristics of each existing subarea of this watershed are detailed in Table 1 below. The proposed site is broken up into three (3) drainage areas, each area corresponding to the subsequent proposed athletic field. The design point for each area typically represents the point at which stormwater, generated within the subareas, will exit this area.

Each area was delineated and a Curve Number (CN) was determined for each area. Calculations for the CN’s are included in Appendix 2. An assumed Time of Concentration (Tc) of 20 minutes was utilized for each one of the three (3) areas due to the extremely flat topography observed in each location.

TABLE 1: EXISTING DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	AREA (AC)	CN	Tc (min)
EX Field 1	1.71	83	20.00
EX Field 2	2.53	84	20.00
EX Field 3	2.65	81	20.00

5.2 PROPOSED CONDITIONS

For this analysis, the post-development watershed was broken down into a network consisting of the same three (3) subareas. The subareas in the post-

development condition are identified in Figure 3. The characteristics of each proposed subarea is detailed in Table 2 below.

TABLE 2: PROPOSED DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	AREA (AC)	CN	Tc (min)
PR Field 1	1.71	80	20.00
PR Field 2	2.53	80	20.00
PR Field 3	2.65	80	20.00

A Curve Number (CN) of 80 was selected for the proposed synthetic turf cover for each of the three (3) fields in order to create a model that would closely represent the existing vegetated land cover. Included in Appendix 2 of this report is a copy of a report entitled "*Effectiveness of FieldTurf Artificial Turf for Management of Stormwater*" prepared by AKRF, Inc & D. S. Thaler and Associates, LLC. This report analyzed the measured stormwater flow from an existing 2.09± acre FieldTurf installation at the Coatesville High School in Coatesville, Pennsylvania. As shown on page 12 of this report, the report preparers modify the stormwater model to reflect the actual documented stormwater flows from the site and theorize that the CN associated with the installation of the FieldTurf was less than the comparable Grass – Good Condition for the specific hydrologic soil group or the existing underlying soils.

This redevelopment project results in a net decrease in impervious area, therefore in accordance with the NYSDEC Stormwater Management Design Manual, the Overbank (10-yr) and Extreme (100-yr) Flood Control mitigation is not required.

Furthermore, by utilizing the same Tc value for both the existing and proposed condition analysis, the stormwater runoff investigation will yield a more conservative result. The proposed conditions can be anticipated to generate a longer Tc path as a result to the removal of the existing impervious cover. This "longer" Tc path would then increase the amount of time required for the stormwater runoff to traverse the proposed land cover, thus decreasing the amount of stormwater runoff at the design point.

The water quality treatment volume (WQ_v) treatment objective is met by a reduction of existing impervious cover by a minimum of 25% of the total disturbed, impervious area. As calculated and shown below, there is a 96.6% reduction of existing impervious cover.

Total Impervious Area in existing condition to be disturbed:	0.87 Ac.
Total Impervious Area in proposed condition:	0.03 Ac.
Percent Reduction of Impervious Area:	**96.6%**

The Channel Protection Volume (Cpv) for a redevelopment project is not required if the 1-yr 24-hour discharge rate and the velocity are less than the pre-construction discharge rate and velocity.

To confirm that the peak discharge rates for re-development of each of the three (3) basins is less than the pre-development rates they have each been calculated and are shown below in Table 3.

5.3 COMPARISON OF EXISTING AND PROPOSED CONDITIONS

The total peak runoff rates at the design points for 1, 10 and 100 year design storms in the existing condition as well as the final proposed condition have been calculated and shown below in Table 3. Discharge rates have been reduced in the proposed conditions for each of the design storms. Since the runoff rates are all decreased in the post-development condition, there will be no adverse impact to the downstream receiving waters. Therefore the stormwater management plan designed for the redevelopment of the Frozen Ropes – The Yard, formally known as the Mid-Orange Correctional Facility, will accomplish the intent of its design.

TABLE 3: SUMMARY OF RESULTS AT THE DESIGN POINTS

Criteria	1 – YEAR (Cpv)		10 – YEAR (Qp)		100 – YEAR (Qf)	
	Existing (cfs)	Proposed (cfs)	Existing (cfs)	Proposed (cfs)	Existing (cfs)	Proposed (cfs)
Field 1	2.03	1.73	5.07	4.67	8.22	7.81
Field 2	3.15	2.56	7.69	6.92	12.36	11.56
Field 3	2.83	2.68	7.45	7.24	12.32	12.10

As both the pre-development and re-development condition are sheet flow of stormwater, and the redevelopment condition results in a reduction in discharge rates, the velocities of the discharges will also be reduced.

6.0 STORMWATER POLLUTION PREVENTION PLAN

The implemented stormwater pollution prevention plan will also incorporate the following water and natural resource management objectives.

a. Prevent increases in flooding and flood damage through the reduction of impervious areas which will reduce the rate of runoff from all areas.

b. Reduce the erosion potential from the re-development through the reduction of the rate of runoff from the project site and through the implementation of the soil and erosion control measures outlined on the project plans and as highlighted herein.

c. Decrease non-point source pollution and water quality degradation through the reduction of impervious surfaces.

7.0 EROSION AND SEDIMENT CONTROL MEASURES

Soil erosion and sediment control measures have been detailed on the plans and outlined herein. The following are general measures that should be implemented:

a. Damage to surface waters resulting from erosion and sedimentation shall be minimized by stabilizing disturbed areas and by removing sediment from construction site discharges.

b. Following the completion of construction activities in any portion of the site, permanent vegetation shall be re-established on all exposed soils within 14 days. Also, in areas where construction will temporarily cease for 21 days or more, the site shall be stabilized within 7 days of the last construction activity. After completion of rough grading, topsoil shall be spread to a depth of 6 inches or more and tested for nutrient and soil composition. The topsoil shall be amended as necessary to encourage successful growth of proposed vegetation.

c. Site preparation activities shall be planned to minimize the area and duration of soil disturbance. Individual disturbances of each construction phase will be under the five acre threshold as required in accordance with the NYSDEC GP-0-15-002 permit and therefore this applicant shall not have to apply to the MS4 for the ability to disturb more than 5 acres at one time.

d. Permanent traffic corridors shall be established and “routes of convenience” shall be avoided. Off-site sediment tracking shall be minimized through regularly scheduled sweeping and good housekeeping of construction vehicles.

e. A qualified professional shall inspect and log the erosion and sediment control measures once every seven days. If more than five (5) acres is disturbed at one time, the inspection shall take place twice every 7 days. The professional shall make recommendations to the operator on how to maintain the integrity and function of all temporary erosion control measures throughout the duration of the redevelopment process. Any deficiencies in the measures shall be corrected as soon as possible by the operator.

f. An up to date Construction Site Log Book which includes this Stormwater Pollution Prevention Plan shall be maintained on site at all times. The Construction Site Log Book shall also include the items found in the most recent

version of the New York Standards and Specifications for Erosion and Sediment Control.

In particular, the following measures will be implemented:

a. Pre-Construction Installation: Prior to any disturbance on site, silt fence shall be installed in accordance with the approved plans in all areas bordering the property. Siltation barriers shall be maintained in good condition and reinforced, extended, repaired or replaced as necessary.

b. Stone Check Dams: Until such time as final site stabilization is completed, swales/ditches shall receive treatment with stone check dams so as to effectively trap sediment and minimize its release off-site. Stone check dams shall be constructed within each ditch beginning at its downstream terminus and should be placed at intervals of less than 250 feet.

c. In no case shall erodible materials be stockpiled within 25 feet of any ditch, stream or other surface water body.

d. Permanent vegetative cover: Immediately following the completion of construction activity in any portion of the site, permanent vegetation shall be established on all exposed soils by properly seeding at a coverage rate as noted on the approved plans and covered with straw. Water shall be applied to newly seeded areas as needed until grass cover is well established.

e. Washouts shall be immediately repaired, reseeded and protected from further erosion. All accumulated sediment shall be removed and contained in appropriate spoil areas. To effectively control wind erosion, water shall be applied to all exposed soils as necessary.

These procedures will be followed for each phase of construction. There will be two phases in the proposed project. Phase 1 will include the demolition of buildings 49, 50 and 87 with associated grading, removal and/or abandonment of existing underground utilities, construction of Field 1 and Field 2 including the installation of the proposed Field Turf. The total disturbance of Phase 1 will be approximately 4.25 acres. Phase 2 will include the removal of several concrete pads and existing structures in the area of Field 3 along with the associated grading, the construction of Field 3 including the installation

of the proposed Field Turf. The total disturbance of Phase 2 will be approximately 2.65 acres. Upon completion of the project, an as-built of the abandoned underground utilities will be provided to the applicant.

8.0 SUMMARY OF FINDINGS AND CONCLUSIONS

Based on the analysis of the pre-development and post-development stormwater conditions and the implementation of stormwater quality and sediment and erosion control measures, the potential stormwater impacts of the redevelopment of the Frozen Ropes – The Yard site will be mitigated to the greatest extent practical.

a. All criteria set forth in the New York State Stormwater Management Design Manual for redevelopment projects have been met.
b. Post-development peak discharge rates will be reduced below pre-development peak discharge rates or their impacts minimized.
c. Sediment and erosion control measures are designed to minimize erosion loss and downstream sediment deposits.

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APPENDIX 1

FIGURES

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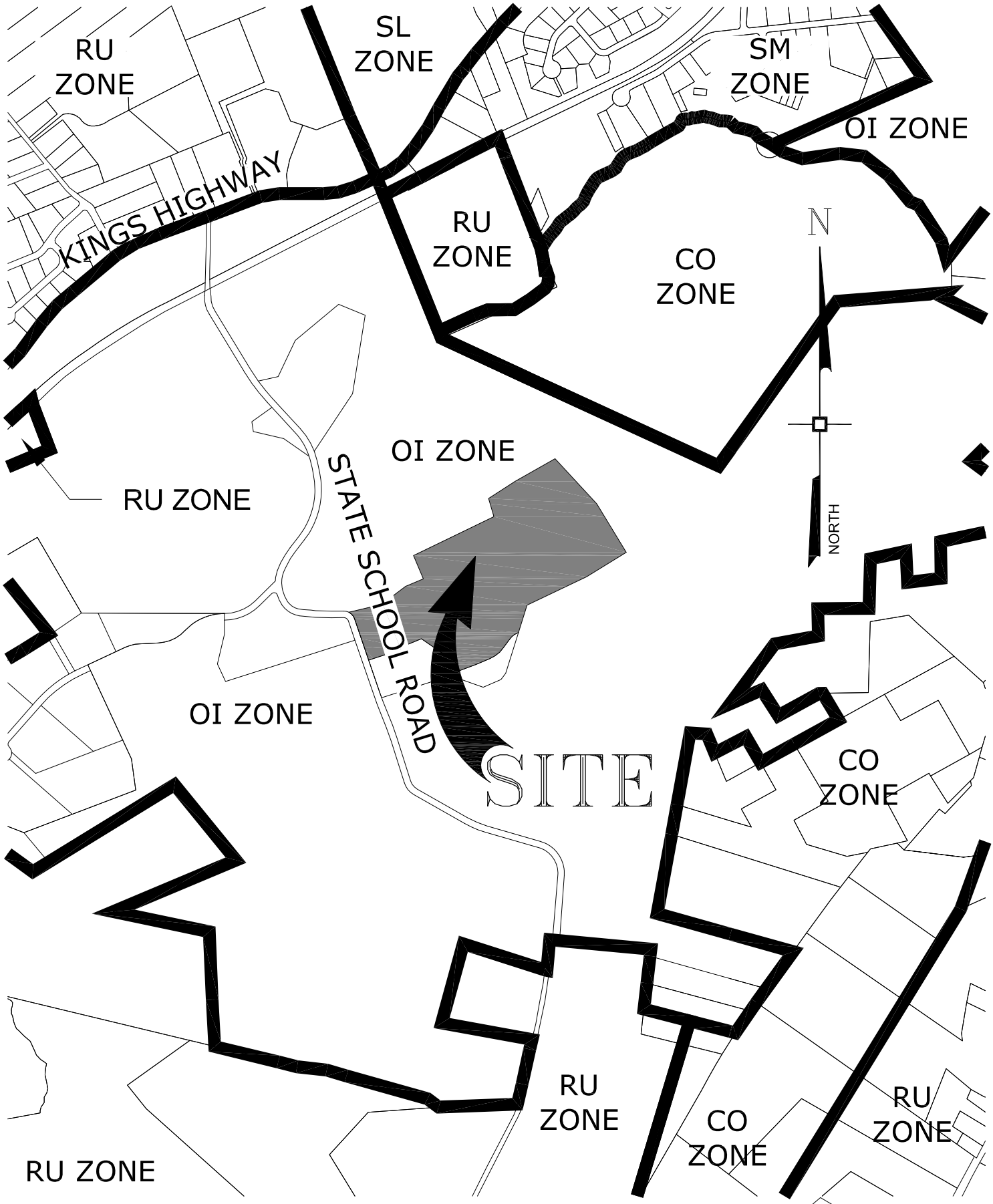

LOCATION MAP	FROZEN ROPES - THE YARD STATE SCHOOL ROAD TOWN OF WARWICK ORANGE COUNTY, NEW YORK	DATE: 01/19/15 SCALE: 1"=1,000'	JOB # 1056.03 SHEET # F-1	ENGINEERING & SURVEYING PROPERTIES Achieving Successful Results with Innovative Designs

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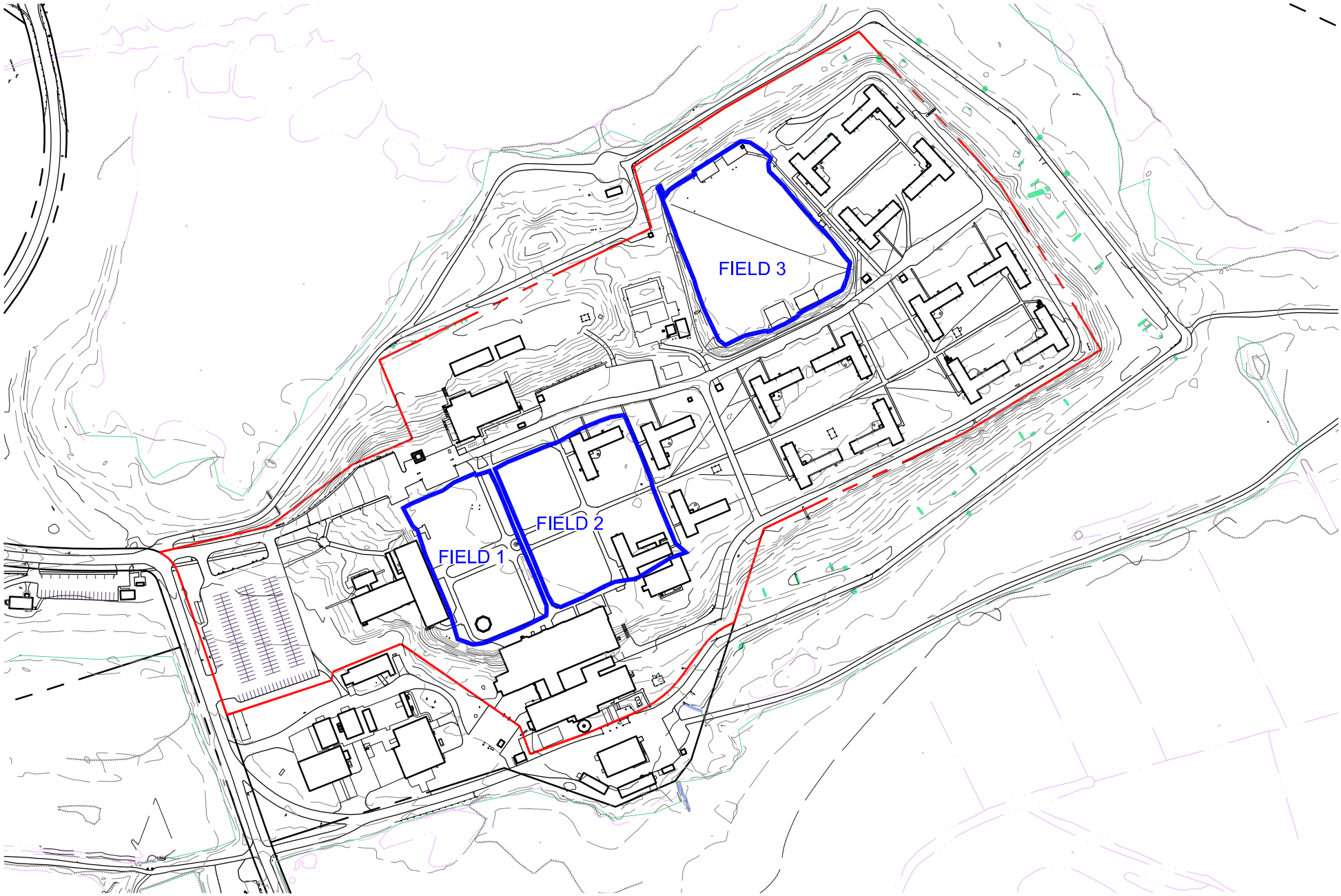

EXISTING CONDITIONS	FROZEN ROPES - THE YARD STATE SCHOOL ROAD TOWN OF WARWICK ORANGE COUNTY, NEW YORK	DATE: 01/19/15 REV: MARCH '15	JOB # 1056.03	ENGINEERING & SURVEYING PROPERTIES Achieving Successful Results with Innovative Designs
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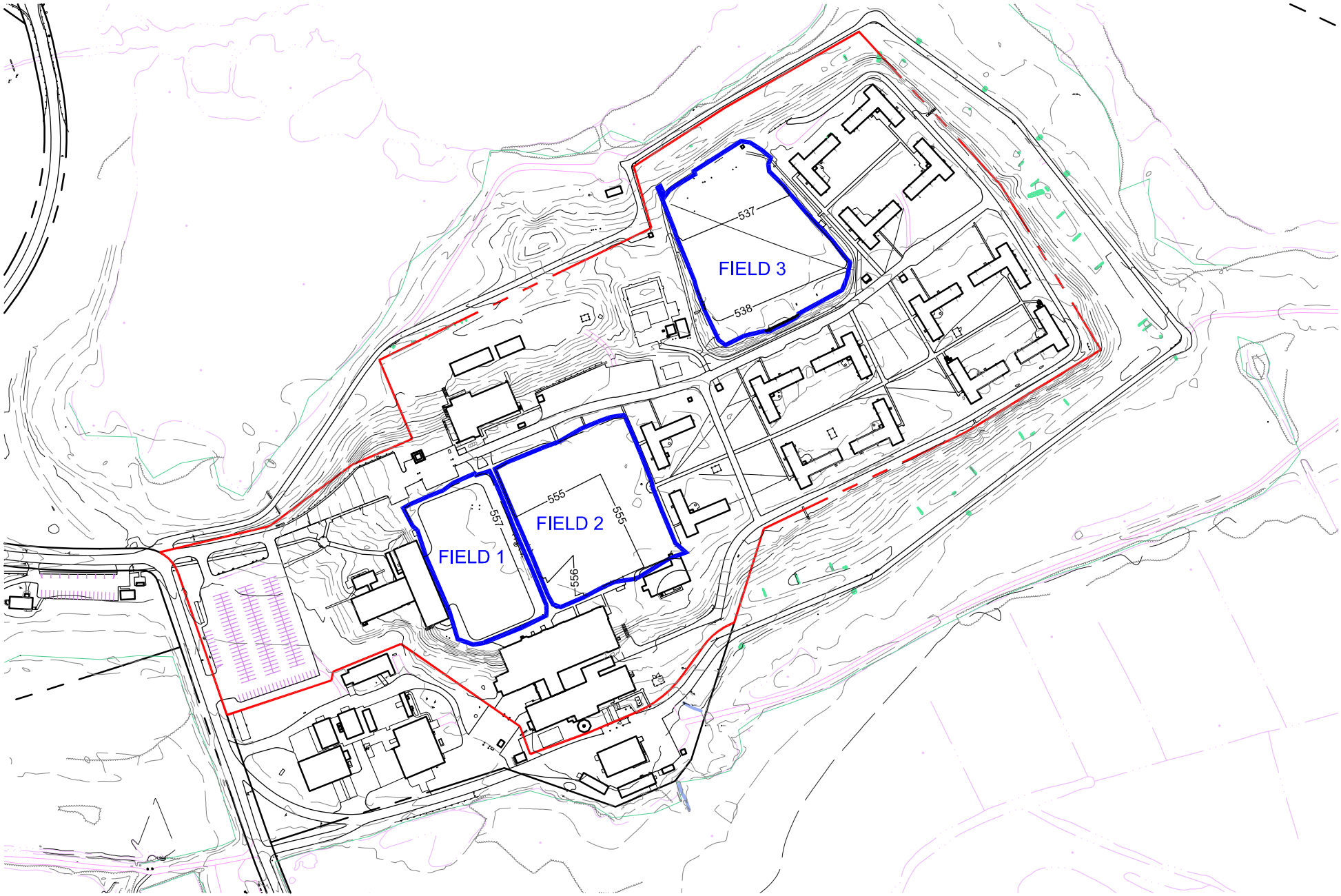

PROPOSED CONDITIONS	FROZEN ROPES - THE YARD STATE SCHOOL ROAD TOWN OF WARWICK ORANGE COUNTY, NEW YORK	DATE: 01/19/15 REV: MARCH '15	JOB # 1056.03	ENGINEERING & SURVEYING PROPERTIES Achieving Successful Results with Innovative Designs
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Soil Map—Orange County, New York
(Frozen Ropes - The Yard)

Map Scale: 1:4,220 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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 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 1:15,800.

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

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting 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 Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the 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 data as of the version date(s) listed below.

Soil Survey Area: Orange County, New York
Survey Area Data: Version 15, Sep 17, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 20, 2011—Apr 16, 2012

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

Map Unit Legend

Orange County, New York (NY071)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Alden silt loam	3.2	8.8%
Ca	Canandaigua silt loam	0.1	0.2%
Fd	Fredon loam	7.5	20.8%
MdC	Mardin gravelly silt loam, 8 to 15 percent slopes	0.0	0.1%
UH	Udorthents, smoothed	1.1	3.0%
Ur	Urban land	24.2	67.2%
Totals for Area of Interest		**36.0**	**100.0%**

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APPENDIX 2

CURVE NUMBER

CALCULATIONS

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CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**1**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY **KW**	APPROVED BY **RW**	REF DRAWING(S) **DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing Proposed Subarea: **Field 1**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.29	28.42
D	Grass - Good Condition	80	1.42	113.60
		TOTAL =	1.71	142.02

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{142.02}{1.71}$$

CN (weighted) = 83.053 Use CN= **83**

2. Runoff S = 2.05

		Storm #1	*Storm #2*	*Storm #3*
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

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CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**2**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY	APPROVED BY	REF DRAWING(S)
KW	**RW**	**DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing Proposed Subarea: **Field 2**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.50	49.00
D	Grass - Good Condition	80	2.03	162.40
		TOTAL =	2.53	211.4

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{211.4}{2.53}$$

CN (weighted) = 83.557 Use CN= **84**

2. Runoff S = 1.90

		Storm #1	*Storm #2*	*Storm #3*
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

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CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**3**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY **KW**	APPROVED BY **RW**	REF DRAWING(S) **DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing Proposed Subarea: **Field 3**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.08	7.84
D	Grass - Good Condition	80	2.57	205.60
		TOTAL =	2.65	213.44

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{213.44}{2.65}$$

CN (weighted) = 80.543 Use CN= **81**

2. Runoff S = 2.35

		Storm #1	*Storm #2*	*Storm #3*
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

ENGINEERING & SURVEYING PROPERTIES
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CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**4**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY	APPROVED BY	REF DRAWING(S)
KW	**RW**	**DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing [Proposed] Subarea: **Field 1**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.00	
D	FieldTurf Syntheic Turf	80	1.71	136.80
		TOTAL =	1.71	136.8

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{136.8}{1.71}$$

CN (weighted) = 80.000 Use CN= **80**

2. Runoff S = 2.50

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

ENGINEERING & SURVEYING PROPERTIES
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CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**5**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY	APPROVED BY	REF DRAWING(S)
KW	**RW**	**DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing [Proposed] Subarea: **Field 2**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.00	
D	FieldTurf Syntheic Turf	80	2.53	202.40
		TOTAL =	2.53	202.4

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{202.4}{2.53}$$

CN (weighted) = 80.000 Use CN= **80**

2. Runoff S = 2.50

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

ENGINEERING & SURVEYING PROPERTIES
Achieving Successful Results with Innovative Designs

CURVE NUMBER (CN) WORKSHEET

WO. NO.	DATE	REVISED	SHEET	OF
1056.03	**01/16/15**	**03/16/15**	**6**	**6**

PROJECT TITLE		LOCATION
Frozen Ropes - The Yard		**Town of Warwick**
CALCULATED BY **KW**	APPROVED BY **RW**	REF DRAWING(S) **DWG LAST REV. XX/XX/XX**

1. Runoff curve number (CN) Existing [Proposed] Subarea: **Field 3**

Soil Name & Hydrologic Group	Cover Description (cover type, treatment & conditions)	CN	Area (acres)	Product of CN x Area
	Impervious Cover	98	0.03	2.94
D	FieldTurf Syntheic Turf	80	2.62	209.60
		TOTAL =	2.65	212.54

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{212.54}{2.65}$$

CN (weighted) = 80.204 Use CN= **80**

2. Runoff S = 2.50

		Storm #1	*Storm #2*	*Storm #3*
Frequency	yr			
Rainfall, P	in			
Runoff, Q	in			

(Use P and CN with table 2-1, fig 2-1, or eqns. 2-3 and 2-4)

Effectiveness of FieldTurf Artificial Turf for Management of Stormwater

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June 2011

A. INTRODUCTION

The Maryland Stormwater Management Act of 2007 has created a new paradigm for the management of stormwater in Maryland. The primary goal of the Act is to mimic, after development or redevelopment, pre-development runoff characteristics, to the extent that it is possible. Traditional designs for stormwater management are less likely to mimic predevelopment conditions because they focus on managing large volumes of polluted stormwater rather than treating runoff closer to the source.

The comprehensive design strategy for maintaining predevelopment runoff conditions is referred to as Environmental Site Design (ESD). ESD relies on integrating site design, natural hydrology, and smaller controls to capture and treat runoff. The objective of ESD is to replicate the hydrology and water quality of forested systems. Each ESD practice is intended to incrementally reduce the volume of stormwater on its way to the stream, thereby reducing the amount of conventional stormwater infrastructure. ESD measures are further defined as those that can minimize the use of impervious surfaces and slow down runoff and increase infiltration and evapotranspiration.

The most recent version of the Maryland Stormwater Design Manual identifies various ESD practices that may be used in commercial areas and urban watersheds. While artificial turf is not specifically mentioned, it appears that products such as FieldTurf should be considered as a potential ESD practice in numerous situations. Use of products such as FieldTurf to achieve stormwater targets would be desirable to counties in Maryland who are tasked with meeting draconian stormwater management requirements. However, the infiltration characteristics of artificial turf products such as FieldTurf would need to be identified to determine how they compare to natural turf and perhaps other developed ESD practices (e.g., permeable pavements). This report will provide a preliminary assessment of the suitability and potential use of FieldTurf as an ESD practice.

B. MARYLAND'S CURRENT STORMWATER REGULATIONS

As described above, MDE updated the current stormwater regulations in 2009. As stated in these regulations:

> The criteria for sizing ESD practices are based on capturing and retaining enough rainfall so that the runoff leaving a site is reduced to a level equivalent to a wooded site in good condition as determined using United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) methods (e.g., TR-55). The basic principle is that a reduced runoff curve number (RCN) may be applied to post-development conditions when ESD practices are used. The goal is to provide enough treatment sing ESD practices to address CP_v requirements [i.e., the 24-hour extended of a post-developed 1-year, 24-hour storm event] by replicating an RCN for woods in good condition for the 1-year rainfall event. This eliminates the need for structural practices… If the design rainfall captured and treated using ESD is short of the target rainfall, a reduced RCN may be applied to post development conditions when addressing stormwater management requirements. (MDE 2009)

MDE (2009) set four performance standards for ESD:

- the standard for characterizing predevelopment runoff characteristics for new development projects shall be woods in good hydrologic condition;
- ESD shall be implemented to the [maximum extent practicable] to mimic predevelopment conditions;
- as a minimum, ESD shall be used to address both Re_v [the volume of groundwater recharge that must be maintained] and WQ_v [storage needed to capture and treat the runoff from 90% of the average annual rainfall] requirements; and
- channel protection obligations are met when ESD practices are designed according to the Reduced [RCN] Method…

In order to comply with Maryland's stormwater regulations, an ESD practice must treat the runoff from one inch of rainfall (i.e., P_e = 1 inch) and ESD practices must address the 24-hour extended detention of a post-developed 1-year, 24-hour storm event (i.e., CP_v). If the reduced RCN for a drainage area reflects woods in good condition, then the CP_v has been satisfied. Structural practices must be used to treat any targeted rainfall that is not met by ESD.

<u>For those readers who wish to more fully understand MDE's requirements, and some of the key underlying terms/concepts such as WQ_v, Re_v, and P_e, the following sections titled Water Quality Volume, Recharge Volume Requirement and Volumetric Runoff Coefficient are presented below. Other readers may wish to skip directly to the section titled Runoff Curve Numbers on Page 4.</u>

WATER QUALITY VOLUME

Water quality volume, or WQ_v, is the storage needed to capture and treat the runoff from 90% of the average annual rainfall. WQ_v is measured in acre-feet. WQ_v can be calculated using the following formula:

$$WQ_v = \frac{P_e * R_v * A}{12}$$

where:

WQ_v = water quality volume, in acre feet

Pe = rainfall target used to determine ESD goals and size practices, in inches

R_v = volumetric runoff coefficient

A = site area, in square feet or acres

RECHARGE VOLUME REQUIREMENT

The recharge volume requirement, or Re_v, is the volume of groundwater recharge that must be maintained at a development or redevelopment site. According to MDE (2009):

> This helps to preserve existing water table elevations thereby maintaining the hydrology of streams and wetlands during dry weather. The volume of recharge that occurs on a site depends on slope, soil type, vegetative cover, precipitation and evapo-transpiration. Sites with natural ground cover, such as forest and meadow, have higher recharge rates, less runoff, and greater transpiration losses under most conditions.

Re_v is a fraction of WQ_v, depending on the pre-development soil hydrologic group. Therefore, Re_v and WQ_v are inclusive.

There are two formulas that can be used to calculate Re_v in acre-feet, the percent volume method and the percent area method:

$$Re_v = \frac{S * R_v * A}{12}$$

and

$$Re_v = S * A_i$$

where:

A = site area in acres;

A_i = the measured impervious cover;

S = the soil specific recharge factor (found in Chapter 2 of MDE 2009); and

R_v = the volumetric runoff coefficient.

VOLUMETRIC RUNOFF COEFFICIENT

Volumetric runoff coefficient, or R_v, is used to calculate the water quality volume. It can be calculated using the formula:

$$R_v = 0.05 + 0.009 * I$$

where:

I = the percent impervious cover.

RUNOFF CURVE NUMBERS

Runoff curve numbers (RCN)[1] are used to predict total runoff of a storm event for a given rainfall event. Higher RCNs indicate that less infiltration will occur and that greater volumes of runoff will be produced. There are eight major factors that influence RCN values: hydrologic soil group (HSG); cover type; treatment; hydrologic condition; antecedent runoff condition; urban impervious area modifications; connected impervious areas; and unconnected impervious areas (NRC 1986).

NRC (1986) solves the runoff equations and presents a series of curves and tables that can be used to identify the appropriate value(s) for RCN for a given set of conditions. MDE's 2009 stormwater regulations rely on these curves and tables to identify the target RCN for woodlands (see Table 1, below).

[1] United States Department of Agriculture, Department of Natural Resources Conservation Service (NRC) and other state agencies commonly use the acronym "CN" to represent the runoff curve number. To maintain consistency with MDE and the current stormwater regulations, the acronym RCN is being used throughout this document.

It is quite clear that the soil characteristics exert a very strong influence on the degree of infiltration and runoff. Table 1 indicates that hydrologic soil type A, which typically consists of 90% sand or gravel and less than 10% clay, has excellent infiltration characteristics (RCN = 30). This can be contrasted with soil type D, which typically consists of greater than 40% clay and therefore has a much higher runoff curve number (RCN = 77).

Table 1
RCN Values for Woods

Hydrologic Condition	Hydrologic Soil Group			
	A	B	C	D
Woods	30	55	70	77
Sources: NRC 1986				

NRC (1986) also presents hydrologic curve numbers for open spaces (e.g., lawns, parks, golf courses, cemeteries). This is the type of landuse that artificial turf could be expected to replace. The RCN values for open spaces, depending on the hydrologic condition and hydrologic soil type, range from 39 to 89. Table 2, below, presents the RCN values for this "natural turf."

Table 2
RCN Values for Natural Turf

Hydrologic Condition	Hydrologic Soil Group			
	A	B	C	D
Poor condition (grass cover < 50%)	68	79	86	89
Fair condition (grass cover 50% to 75%)	49	69	79	84
Good condition (grass cover > 75%)	39	61	74	80
Notes: RCN values originally presented for open space/pasture – here defined as "natural turf"				
Sources: NRC 1986				

As can be seen from a comparison of the RCN values presented in Tables 1 and 2, natural turf does not provide the same level of natural stormwater runoff control as does wooded property (i.e., RCN values for natural turf are considerably higher than for woods, for a given landuse). This means that more water runs off of a natural turf site than is allowed under current MDE stormwater regulations for the development (or redevelopment) of a site.

C. FIELDTURF

DESCRIPTION OF PRODUCT

FieldTurf, like other synthetic turf products, consists of four main components: the fiber, (or grass like material), the backing to which the fiber is tied, the infill, and the prepared subsurface. FieldTurf offers a number of different product lines, each with different variations of nylon or polyethylene fibers. FieldTurf's backing is 40% porous; it has a coating applied only along the fiber rows, allowing the remainder of the backing to drain. The infill is a combination of cryogenic rubber and silica sand (FieldTurf Tarkett Undated a).

While FieldTurf's unique coating allows for water to quickly pass through the turf system, overall drainage depends heavily on the quality of the underlying base. In most instances, the turf system will drain anywhere from 5 to 10 times faster than the base; therefore, the most

critical component in a field's drainage performance revolves around the design of the base and the quality of its materials and construction (FieldTurf Tarkett Undated b).

TYPICAL INSTALLATION

The Field Turf system is typically installed to be slightly higher in the center, sloping gradually at 0.5% towards the field's edges. The fibers are underlain with 1 to 2 inches of No. 8 and finishing stone. A free draining gravel subbase consisting of No. 57 stone is installed beneath the No. 8 stone layer. The depth of the No. 57 stone treatment is typically 4-5 inches at the center and gradually thickens to 8 to 9 inches towards the edges of the field. Therefore, the total subsurface depth of stone treatment for FieldTurf typically ranges from 6 to 11 inches. Underdrain systems are provided to enhance drainage and may serve to detain runoff.

D. LITERATURE REVIEW

Effective stormwater management involves addressing both water quality and water quantity concerns to prevent a range undesirable outcomes including biological impairment of surface waters, public health concerns, stream erosion, and downstream flooding. AKRF was tasked with compiling and reviewing existing literature to assess the relative efficacy of natural turf and synthetic turf systems in providing stormwater management.

WATER QUALITY

The effects of turf systems on water quality include both the ability of the turf system to remove pollutants associated with rainwater or incoming stormwater and the potential for pollutants to be generated by turf systems through processes such as erosion or leaching.

Several studies have looked at the potential for water quality impacts associated with artificial turf fields. Generally, these studies have focused on the potential for leaching of heavy metals and lead. The conclusions of most studies has been that the primary water quality concern associated with artificial turf fields is the potential for zinc leaching from crumb rubber. Yet the findings of these studies are certainly not conclusive with respect to toxicity. For instance, a study performed by the New York State Department of Environmental Conservation and New York State Department of Health (2009) concluded that leaching from crumb rubber did not pose a significant risk of groundwater contamination, but found that zinc leaching from crumb rubber made from truck tires could pose a threat to aquatic life. The same study concluded that leaching from crumb rubber made from mixed tires posed an insignificant risk for aquatic life.

A study of four artificial turf fields in Connecticut (Connecticut Department of Environmental Protection, 2010) found that zinc leaching from artificial turf fields was a potential risk to surface waters, but in evaluating the potential risks of stormwater runoff the study goes on to state that, *"Since the mean concentration of zinc in the stormwater samples is below surface water protection criteria, the discharge from the artificial turf fields to groundwater is intermittent, and zinc is immobilized in soils by adsorption, absorption and precipitation, the potential for impacts to surface waters being recharged by this groundwater is minimal."* A recent Montgomery County, Maryland report (Montgomery County Staff Work Group, 2011) reported that samples obtained from an on-going San Francisco Pubic Utilities synthetic turf monitoring study showed total zinc levels above the Maryland Toxic Substances Criteria for Ambient Surface Waters (120 µg/l) standard but showed dissolved zinc levels below the acute toxicity level.

In the same study, a review of literature found that many previous studies have shown that artificial turf fields are generally unlikely to generate pollutant at concentrations above water quality limits, although some studies do indicate that toxic compounds can be released from used tires, which are used to produce the rubber infill material associated with many synthetic turf products, during leachate studies (Montgomery County Staff Work Group 2011). Additionally, one study reported that artificial turf systems have been shown to support lower levels of bacteria than natural turf fields (California Department of Resources Recycling and Recovery 2010).

In summary, there is a perception based on limited studies that zinc can be an issue for aquatic life depending on the type of tires and crumb rubber used. Because the results of the previous studies are neither conclusive nor product specific, we plan on investigating the relationship between FieldTurf and zinc concentrations in stormwater runoff during a second phase field testing project.

Natural turf systems could potentially give rise to a number of water quality concerns including leaching of fertilizer, herbicides, or pesticides and through surface erosion, although these effects can be reduced to varying extents through the use of best management practices. There are also potential environmental risks from spills associated with lawnmower use, which is needed for managing turf systems. We did not locate any studies that quantified these potential impacts.

THERMAL IMPACTS

Increases in water temperature can pose a threat to certain types of aquatic life, particularly cold water fish. Several studies have shown that artificial turf surfaces have significantly higher ambient temperatures than natural turf areas (e.g., NYSDEC/NYSDOH 2009), although these effects can be mitigated by washing down the turf surface. As a result of elevated ground temperatures, surface runoff coming in contact with artificial surfaces could be subjected to higher levels of thermal loading than runoff coming in contact with natural turf, but the amount of temperature increase would be strongly influenced by the contact time between the runoff and turf surface. Also, thermal impacts may be mitigated by the increased potential for infiltration associated with artificial turf surfaces. We did not find any study that specifically compared stormwater runoff temperature between artificial and natural turf surfaces.

INFILTRATION

Infiltrating stormwater into the ground is an effective means for mitigating many of the negative impacts associated with stormwater runoff and has emerged as the stormwater management strategy of choice throughout much of the U.S. The potential for precipitation to infiltrate into the ground is generally a function of the permeability of the ground surface and subsoils.

Infiltration rates associated with natural turf systems vary with a host of factors including the type and density of turf grass, root development, maintenance, compaction and soil characteristics. However, we found few studies that systematically looked at how these characteristics influence infiltration rates. One study by Hamilton and Waddington (1999), who measured infiltration rates associated with 15 residential lawns in central Pennsylvania, provides some insight into the potential range of infiltration rates associated with grass/soil complexes. The study showed that most lawns had infiltration rates less than 1.18 in/hr and that soil characteristics or maintenance were not correlated with infiltration rates.

Logically, engineered natural turf systems (e.g., turf over sand or other engineered media, etc.) may produce much higher infiltration rates than conventional natural turf (e.g., in residential lawns, etc). For instance, Davis (1981) reported compacted infiltration rates for sand samples obtained from nine sports fields in California and found that most infiltrates rates exceeded 20 in/hr.

Laboratory testing provided by FieldTurf reported permeability rates of 139.2 in/hr, suggesting that precipitation moves very rapidly through the turf surface and to the subsurface gravel bed. A study by James and McLeod (2010) looking at the effect of maintenance on the performance of sand filled synthetic turf showed that infiltration rates declined significantly (approximately 18 in/hr at installation to between approximately 2-4 in/hr) as the infill became contaminated by fine material. It is unclear to what extent this effect would be present for rubber filled turf systems or for natural turf.

E. POTENTIAL USE OF FIELDTURF UNDER MARYLAND REGULATIONS

POTENTIAL FOR USE AS AN ESD PRACTICE

Very high surface infiltration rates (up to 139.2 in/hr; TSI 2010) suggest that FieldTurf effectively conveys stormwater from the ground surface to subsurface soils similar to other approved ESD porous alternative surfaces, such as permeable pavements. In fact, the measured infiltration rate associated with FieldTurf appears to be one to two orders of magnitude higher that the 8 in/hr required of permeable pavement in the MDE Stormwater Design Manual. This comparison suggests that FieldTurf is highly porous and will not impede conveyance of stormwater even during high intensity precipitation events.

Given its high infiltration rate, FieldTurf applications offer the potential to infiltrate stormwater to a greater extent than from natural turf fields, provided sufficient subsurface storage (i.e., gravel media) is provided beneath the turf. While typical installation of FieldTurf is not currently identical to the installation of permeable pavements, the installation could be readily adapted to match or be similar to the guidelines set forth by MDE (2009) for permeable pavements (e.g., depth and drainage characteristics of subsurface media, required infiltration rates for subsoils etc.). ESD design guidelines for permanent pavements are presented in Attachment A.

The high surface infiltration rate associated with FieldTurf suggests that it would be appropriate to, at a minimum, apply the RCN values provided in the MDE Stormwater Design Manual for permeable pavers to FieldTurf applications, provided that the installation of the subsurface bed beneath the FieldTurf met, or was similar to, MDE requirements for permeable pavements. A comparison between RCN values associated with natural turf and permeable pavements is presented in Table 3. As is shown, the RCN associated with permeable pavements is a direct function of the hydrologic soil group and the depth of the gravel subbase. Assuming RCN values for permeable pavements could be applied to FieldTurf and comparing those RCN values to RCN values for natural turf, replacing natural turf with FieldTurf systems *could* provide the ability to lower the RCN, particularly if the existing natural turf is in fair or poor condition and if a 12”, or possibly a 9” subbase is used beneath the FieldTurf. However, in other situations (e.g., good condition turf converted to FieldTurf using a shallower gravel bed, etc.) the RCN may be significantly increased when converting from natural turf to FieldTurf, at least according to the RCN values provided in the MDE Stormwater Design Manual.

Based on the typical construction details provided to AKRF, the typical FieldTurf installation consists of a roughly 6 to 11 inch stone layer beneath the FieldTurf system. If we assume that RCNs for FieldTurf would be similar to those presented the MDE Stormwater Design Manual for permeable pavements, in most cases the depth of the gravel layer would need to be increased to provide a substantial reduction in RCN. According to Table 3, providing a 12 in. subbase beneath the FieldTurf system would provide RCN values roughly equaling those provided for a "woods in good condition" target, thus eliminating the need to provide additional treatment for runoff generated by the FieldTurf installation.

Table 3

Comparison Between RCN Values for Natural Turf and Permeable Pavements for Various Hydrologic Condition, Depth of Subbase, and Hydrologic Soil Group (HSG) as Reported in the MDE Stormwater Design Manual

Natural turf					Permeable Pavements					Difference in RCN			
Hydrologic Condition	HSG				Depth of Subbase	HSG				HSG			
	A	B	C	D		A	B	C	D	A	B	C	D
Poor condition (grass cover < 50%)	68	79	86	89	6"	76	84	93	N/A	-8	-5	-7	N/A
	68	79	86	89	9"	62	65	77	N/A	6	14	9	N/A
	68	79	86	89	12"	40	55	70	N/A	28	24	16	N/A
Fair condition (grass cover 50% to 75%)	49	69	79	84	6"	76	84	93	N/A	-27	-15	-14	N/A
	49	69	79	84	9"	62	65	77	N/A	-13	4	2	N/A
	49	69	79	84	12"	40	55	70	N/A	9	14	9	N/A
Good condition (grass cover > 75%)	39	61	74	80	6"	76	84	93	N/A	-37	-23	-19	N/A
	39	61	74	80	9"	62	65	77	N/A	-23	-4	-3	N/A
	39	61	74	80	12"	40	55	70	N/A	-1	6	4	N/A

HYDROLOGIC MODELING OF RCN VALUE FOR FIELDTURF

To further characterize the runoff characteristics associated with FieldTurf applications, AKRF performed a hydrologic modeling study of an existing FieldTurf installation, which had been previously studied by ELA Group, Inc. (2007) (Project No: 103-070, January 9, 2007). The project site is a 6.33 acre watershed located at Coatesville High School in Coatesville, Pennsylvania. This watershed contains a 2.09 acre synthetic turf field that is the subject of this analysis. The approach of this study is to model the hydrologic response of the project site to actual precipitation events and to compare and attempt to match these results to measured runoff data previously collected by ELA Group, Inc. by varying synthetic turf RCN inputs.

AKRF's modeling study utilizes the U.S. Army Corps of Engineers Hydrologic Modeling System (HEC-HMS) and is based on data provided in the report titled Field Test Data Study for the Stormwater Runoff From Synthetic Turf Fields at Coatesville High School, prepared by ELA Group, Inc. (2007). ELA's study included measured runoff from the project site for several precipitation events before and after the conversion of an existing natural turf field to a FieldTurf field. Data utilized from this report for AKRF's modeling study include post development

drainage area cover descriptions and rational method runoff coefficients, time of concentration, field recorded post development peak flow rates and runoff volumes for seven storm events from 9/2006 to 11/2006, and 24 hour rainfall volumes from the Coatesville 2W rain gage (NOAA Station ID: PA361591), which is located 3.68 miles from the project site. These data were supplemented with 15 minute rain gage data from the Glenmoore rain gage (NOAA Station ID: PA363321), located 7.18 miles from the project site. It should be noted that the Post Development Watershed Map that accompanies ELA Group's report was not provided for the analysis.

The project site contains four defined post development land cover classifications, which include impervious modular classrooms, an impervious track, a pervious grass area, and the pervious synthetic turf field. To develop a hydrologic model using NRCS methodology, RCNs were assumed for each land cover based upon soil data and the provided cover descriptions and rational runoff coefficients. The project site lies predominately over Conestoga silt loam (CtB) soil, which is in the 'B' hydrologic soil group. All impervious areas were assumed to have a RCN of 98, and the pervious grass area was assumed to be in good condition based on aerial imagery. The watershed land cover and assumed RCNs used in the hydrologic model are summarized in Table 4. Synthetic turf RCN was isolated and varied as it is the main focus of this hydrologic study.

Table 4
Watershed Land Cover Summary

Land Cover	Area (acres)	RCN
Modular Classrooms	0.83	98
Grass	0.74	61
Impervious Track	2.67	98
Synthetic Turf	2.09	---

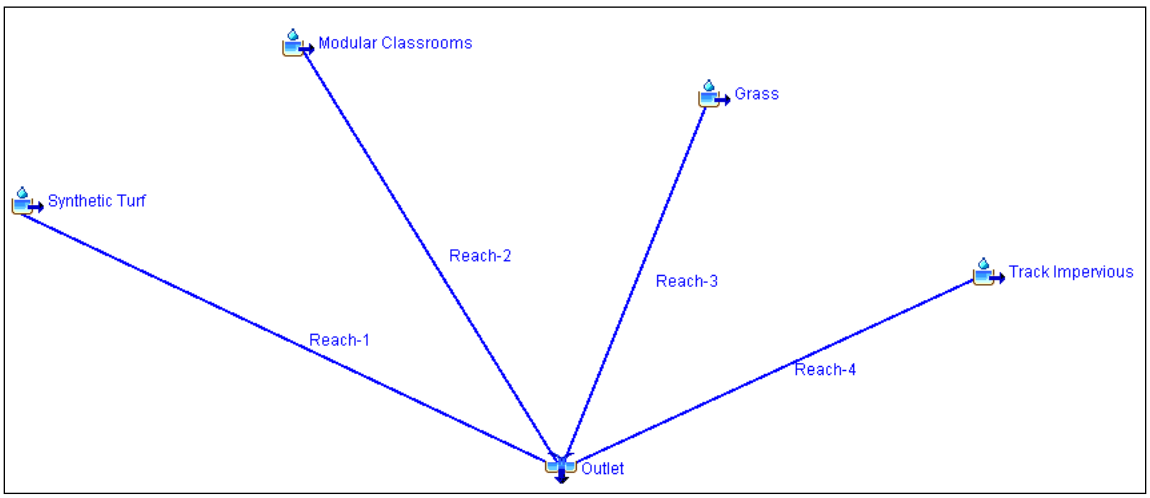
Glenmoore rain gage (NOAA Station ID: PA363321) 15 minute rainfall data were used as the precipitation input for hydrologic modeling. Although the Coatesville 2W rain gage is located closer to the project site, only daily rainfall totals are provided for this rain gage. It is understood that actual rainfall patterns and intensities would more accurately model field recorded peak flow rates than synthetic rainfall distributions based only on daily rainfall totals. Despite the close proximity of both rain gages, differences in total rainfall volumes were observed for the seven rainfall events examined. The rainfall records for these rain gages are summarized in Table 5. Based on the available data, Event #4 (10/17/2006 to 10/18/2006) and Event #6 (10/27/2006 to 10/29/2006) were selected as the events to focus modeling efforts. Event #4 was selected due to the size of the event and the close correlation of total precipitation volumes between both rain gages. Event #6 was chosen because it was the largest event in the provided data set.

Table 5
Rainfall Gage Records

Event Number	Date	Total Recorded Precip. (inches)	
		Coatesville	Glenmoore
1	9/28 to 9/29/2006	0.86	0.6
2	10/1/2006	0.1	0.1
3	10/6 to 10/7/2006	0.56	0.4
4	**10/17 to 10/18/2006**	**0.79**	**0.8**
5	10/19 to 10/21/2006	1.01	0.6
6	**10/27 to 10/29/2006**	**1.74**	**1.9**
7	11/2/2006	0.55	0.4

A schematic of the hydrologic model is shown in Figure 1. All watershed land covers were modeled as individual subareas and assumed to flow directly to the watershed outlet. This assumption was necessary due to the lack of provided information about the physical layout of the watershed and information about the location of the flow recording instrumentation. A time of concentration of 5 minutes was applied to all subareas, as specified in ELA Group's report. A lag time of 1 minute was assumed for each reach.

Figure 1. Hydrologic model schematic



The RCN input for the synthetic turf subarea was varied from a range of 50 to 90. Model results and field recorded data are summarized for total runoff volume in Table 6 and for peak flow in Table 7.

Table 6
Hydrologic Model Runoff Volume Results Summary

Event Number	4	6
Glenmoore Gage Recorded Precipitation Volume (in)	0.8	1.9
Field Recorded Runoff Volume (in)	**0.12**	**0.57**
Model Total Runoff Volume (in)		
Turf RCN=50	0.33	0.93
Turf RCN=60	0.33	0.94
Turf RCN=65	0.33	0.96
Turf RCN=70	0.33	1.00
Turf RCN=75	0.33	1.04
Turf RCN=80	0.34	1.09
Turf RCN=85	0.36	1.17
Turf RCN=90	0.39	1.26
Model Runoff Volume from Impervious Areas (in)	0.33	0.93

Table 7
Hydrologic Model Peak Flow Results Summary

Event Number	4	6
Glenmoore Gage Recorded Precipitation Volume (in)	0.8	1.9
Recorded Peak Flow (cfs)	**0.20**	**1.21**
Model Peak Flow (cfs)		
Turf RCN=50	1.3	1.4
Turf RCN=60	1.3	1.5
Turf RCN=65	1.3	1.6
Turf RCN=70	1.3	1.7
Turf RCN=75	1.3	1.8
Turf RCN=80	1.5	1.9
Turf RCN=85	1.6	2.0
Turf RCN=90	1.8	2.1

The hydrologic model results consistently predict higher observed runoff volumes for both Event #4 and for Event #6. In fact, the predicted runoff volume from the impervious areas alone (modular classrooms and impervious track) is greater than the actual observed runoff for both events. Peak flow rates are also over predicted for both events.

These results led to the conclusion that the difference between the modeled runoff volume and observed runoff volume has been stored or infiltrated by the pervious watershed areas, which include the grass area and the synthetic turf. This infiltrated volume could potentially be as great as 0.21 inches for Event #4 and 0.36 inches for Event #6. The difference in peak flow rate may also be a result of this removed runoff volume. While there is strong evidence to support these conclusions, further watershed information is necessary to begin to isolate the stormwater management benefits of the synthetic turf from those of the natural grass area. The Post Development Watershed Map that accompanies ELA Group's report, site survey data if available, and a detailed site inspection may offer further insight. If watershed mapping confirms that newly constructed impervious areas drain to the FieldTurf area, **the study may**

suggest that the effective RCN for the FieldTurf installation is actually much lower than reported RCN values for porous pavement provided in the MDE manual.

It is the recommendation of AKRF that an additional field study is necessary to conclusively assess and relate the stormwater management performance and benefits of FieldTurf's synthetic turf system to the NRCS RCN methodology. Ideal study conditions would consist of an isolated synthetic turf system specifically designed for observation, and outfitted with instrumentation to record and log onsite precipitation, inflow, and outflow.

F. ADVANTAGES OF USING FIELDTURF

Field Turf offers many advantages to natural turf and is more consistent with sustainability initiatives being implemented both in Maryland and on the national level. Maintenance costs are substantially lower for artificial turf products and far fewer days are lost in terms of usage due to field conditions. Furthermore, FieldTurf does not require labor associated with frequent mowing or striping of natural turf athletic fields. The use of gas powered mowers on natural systems also results in air emissions of metals and hydrocarbon breakdown products.

In addition, there are a number of stormwater management advantages to the use of artificial turf, specifically FieldTurf. These include:

WATER QUANTITY IMPROVEMENTS

DRAINAGE

Artificial turf has superior water drainage characteristics, when compared to natural turf. It was designed to drain water to limit the periods of time that an athletic field is unavailable for play due to a storm event. This capability to drain rainfall is also beneficial when considering ways to manage stormwater, increasing infiltration and limiting the amount of runoff that leaves the field/site.

REDUCTION IN PEAK STORMWATER FLOW

Stormwater that falls on artificial turf must travel through the different components of the artificial turf product before entering a natural waterway, including the infill turf, infill, backing, and subsurface. This results in a reduction in the peak stormwater flow to the waterway, which can have positive effects, such as a reduction in erosion.

WATER QUALITY IMPROVEMENTS

DECREASE IN FERTILIZER AND PESTICIDE USE

Artificial turf (e.g., FieldTurf) does not require the traditional lawn supplements that are necessary to maintain healthy natural turf. Among other inputs, this includes fertilizers and pesticides. Fertilizers and pesticides can and do wash off of natural turf in a rain event, degrading downstream water quality. The use of artificial turf can improve the quality of any stormwater that does leave the site and minimize the requirements for stormwater quality controls.

FILTRATION

Artificial turf can act as a filter, capturing solid material suspended in stormwater that flows over and/or through the surface. This filtering action can reduce the phosphorus and sediment load carried by the stormwater that ultimately reaches natural waterways, thereby improving water quality.

G. EXPERIMENTAL DESIGN AND STUDY PLAN FOR A FIELD TESTING PROGRAM – RELATIVE EFFICIENCY OF FIELDTURF VS. NATURAL TURF FOR MANAGING STORMWATER

Further experimental testing could help to refine appropriate RCNs for FieldTurf applications. As is reflected in the RCN values provided in the MDE Stormwater Design Manual for porous pavement, RCNs for Field Turf applications are likely to be a function of both the depth of the underlying subsurface gravel bed and the Hydrologic Soil Group associated with the subgrade material.

Given these parameters, an effective experimental design to develop RCNs for FieldTurf applications would systematically vary both Hydrologic Soil Group (i.e., A, B ,C) and Gravel depth (i.e., 6 in., 9 in., and 12 in.) Thus, nine (9) experimental plots would be required to fully capture the range of possible hydrologic soil groups and gravel depth combinations. Ideally, each plot would be replicated, yielding a total of 18 plots.

Individual plots should be identical in size and slope and should be located in a similar geographic area to permit the use of directly comparable precipitation data. Plots should be located on mildly sloping ground (no more than 5% slope) and should be at least 50 ft. x 50 ft. in size. Plots should be located on open ground with no overhanging cover.

To measure surface runoff from the site, the drainage area associated with each field plot must be isolated. If possible, plots should be located at or near a natural drainage divide to avoid the necessity of rerouting upstream flow around the plots. However, if needed, small earthen berms can be constructed at the upstream extents of the plots to redirect upstream flows.

Surface runoff from the each plot should be collected into a downslope piping system or earthen channel. Since the plots are small, a relatively modest channel or piping network will suffice. AKRF would develop a flow rating curve for the conveyance channel or pipe using manual velocity measurements. Flow stage within the pipe or channel would then be measured continuously using pressure transduction and converted to discharge measures using the aforementioned rating curve. Alternatively, flow could be conveyed to a weir structure and discharge could be calculated using standard equations for weir flow by measuring the flow stage at the weir.

In addition to flow monitoring, the FieldTurf test plots could be used to evaluate the effects of FieldTurf on water quality, both for surface water and water that is infiltrated through the turf system. Evaluation of surface water quality would involve collection of flow-weighted water samples using an ISCO sampler or similar automated sampling device. Typical constituents of interest would include nitrate, nitrate, ammonia, dissolved phosphorus, total phosphorus, total suspended solids, and toxic metals. Measured concentrations could be either compared with rainwater samples collected near the test plots, or alternatively with surface runoff collected from a nearby control plot (i.e., a similarly sized plot covered with natural turf). Collection of water quality samples to characterize infiltrated rainwater would involve the collection of infiltrated water via an underdrain system located beneath the porous gravel bed.

The final experimental design will depend on further coordination with FieldTurf representatives. We do note that the experiment design described above represents an ideal configuration. However, less intensive studies may yield useful, although perhaps not as widely applicable results. Accordingly, the experimental design can be simplified/reduced as needed to accommodate available resources. For instance, a smaller experimental design could be

developed using only Hydrologic Soil Groups A and C and gravel depths of 6" and 12". We would also need to coordinate with FieldTurf to determine whether any of their existing installations could be useful or modified for incorporation into our experimental design.

Once an experimental design is developed and agreed upon, we may wish to coordinate with MDE prior to conducting additional field studies.

H. COMPARISON WITH OTHER PRODUCT

AKRF compared permeability rates associated with FieldTurf to another leading synthetic turf product (AstroTurf Gameday Grass). It appears that FieldTurf had much higher permeability rates (139.2 in./hr vs. >30 in/hr) than AstroTurf using the same test (ASTM F1551-03). Even if AstroTurf's permeability rate were doubled to 60 in/hr, it would still be less than half of that for FieldTurf. Therefore, if both products used the same subsurface treatment, it is reasonable to assume that FieldTurf would exhibit substantially better infiltration characteristics for stormwater management purposes. Both products have infiltration rates that are significantly higher than the 8.0 in/hr required for permeable pavement by the MDE Stormwater Design Manual.

I. CONCLUSION

A number of approaches were developed that suggest FieldTurf has considerable promise as an ESD practice under the Maryland Stormwater regulations. FieldTurf's infiltration potential appears to be as good or superior to that of permeable pavements, which is an accepted ESD practice. Results of a hydrologic model applied to field data from the Coatesville High School study further support these findings and suggest that RCNs for FieldTurf may be lower than those for permeable pavements. However, additional experimental testing to refine the appropriate runoff curve numbers for FieldTurf applications is needed before a case for ESD can be made to the Maryland Department of the Environment.

J. REFERENCES

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Attachment A

A-2. Permeable Pavements

Permeable pavements are alternatives that may be used to reduce imperviousness. While there are many different materials commercially available, permeable pavements may be divided into three basic types: porous bituminous asphalt, pervious concrete, and permeable interlocking concrete pavements. Permeable pavements typically consist of a porous surface course and open graded stone base/subbase or sand drainage system. Stormwater drains through the surface course, is captured in the drainage system, and infiltrates into the surrounding soils. Permeable pavements significantly reduce the amount of impervious cover, provide water quality and groundwater recharge benefits, and may help mitigate temperature increases.

Applications:

Permeable pavements are effective for reducing imperviousness in pedestrian pavements, parking lots, driveways, plazas, and access roads. They may be used in both new and redevelopment applications in residential, commercial, and industrial projects. Permeable pavements are particularly useful in high-density areas where space is limited.

Performance:

When designed according to the guidance provided below, areas covered by permeable pavements will have runoff characteristics more closely resembling vegetated areas. The capacity of permeable pavements to capture and detain runoff is governed by the storage capacity, compaction of the soil subgrade, and in-situ soil properties. Consequently, RCN's applied to these systems vary with individual design characteristics. The effective RCN's shown in Table 5.5 are used when addressing the ESD Sizing Criteria.

Constraints:

The following constraints are critical when considering the use of permeable pavements to capture and treat stormwater runoff:

- **Space:** The size and distribution of paved surfaces within a project must be considered early during planning and design. Permeable pavements should not be used in areas where there are risks for foundation damage, basement flooding, interference with subsurface sewage disposal systems, or detrimental impacts to other underground structures.

- **Topography:** Runoff should sheetflow across permeable pavements. Pavement surfaces should be gradual (≤ 5%) to prevent ponding of water on the surface and within the subbase.

- **Soils:** Sandy and silty soils are critical to successful application of permeable pavements. The HSG should be A, B or C.

Subsurface water conditions (e.g., water table) will help determine the stone reservoir thickness used. The probability of practice failure increases if the reservoir intercepts groundwater. Therefore, subbase inverts should be above local groundwater tables.

- **Drainage Area:** Permeable pavements are an at-source practice for reducing the effects of impervious cover and addressing ESD criteria. As the impervious area draining to each practice increases, practice effectiveness weakens. Therefore, runoff from adjacent areas (or "run-on") should be limited.

- **Hotspot Runoff:** Permeable pavements should not be used to treat hotspots that generate higher concentrations of hydrocarbons, trace metals, or toxicants than are found in typical stormwater runoff and may contaminate groundwater.

- **Structure:** Most permeable alternatives have a lower load bearing capacity than conventional pavements. Therefore, applications should be limited to locations that do not receive heavy vehicle traffic and where sub soils are not compacted.

- **Operation:** Permeable pavements are highly susceptible to clogging and subject to owner neglect. Individual owners need to be educated to ensure that proper maintenance and winter operation activities will allow the system to function properly.

Design Guidance:

The following conditions should be considered when designing permeable pavements:

- **Conveyance:** *Runoff shall flow through and exit permeable pavements in a safe and non-erosive manner.* Permeable pavements should be designed off-line whenever possible. Runoff from adjacent areas should be diverted to a stable conveyance system. If bypassing these areas is impractical, then runoff should sheetflow onto permeable pavements.

  Pavement surfaces shall have a permeability of eight inches per hour or greater to convey water into the subbase rapidly. The slope of the permeable pavement shall be no greater than 5%. Any grade adjustments requiring fill should be accomplished using the subbase material. Permeable pavements may be placed in sloped areas by terracing levels along existing contours.

  Pavement systems should include an alternate mode for runoff to enter the subbase reservoir. In curbless designs, this may consist of a two-foot wide stone edge drain. Raised inlets may be required in curbed applications.

  The bottom of the subbase shall be level to enhance distribution and reduce ponding within the reservoir. A network of perforated pipes may be used to uniformly distribute runoff over the bed bottom. Perforated pipes may also be used to connect structures (e.g., cleanouts, inlets) located within the permeable pavement section.

All permeable pavements shall be designed to ensure that water surface elevations for the 10-year 24 hour design storm do not rise into the pavement to prevent freeze/thaw damage to the surface. Designs should include overflow structures like overdrains, inlets, edge drains, or similar devices that will convey excess runoff safely to a stable outfall.

- **Treatment:** All permeable pavement systems shall meet the following conditions:
  - *Applications that exceed 10,000 ft^2 shall be designed as infiltration practices using the design methods outlined in Appendix D.13 for infiltration trenches. A porosity (n) of 30% and an effective area of the trench (A_t) equal to 30% of the pavement surface area shall be used.*
  - *A subbase layer of a clean, open graded, washed aggregate with a porosity (n) of 30% (1.5" to 2" stone is preferred) shall be used below the pavement surface.* The subbase may be 6", 9" or 12" thick.
  - *Filter cloth shall not be used between the subbase and soil subgrade.* If needed, a 12" layer of washed concrete sand or pea gravel (⅛" to ⅜" stone) may be used to act as a bridging layer between the subbase reservoir and subsurface soils.

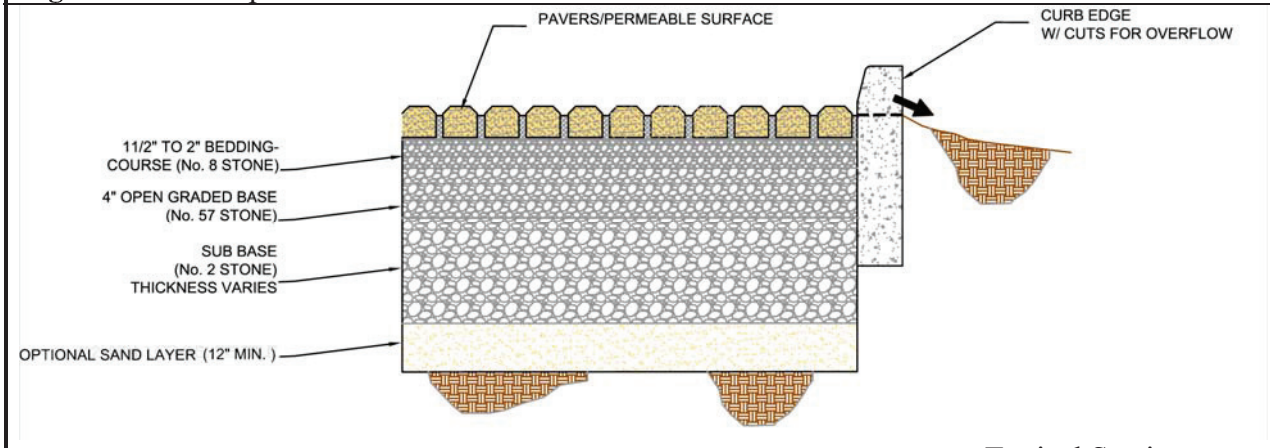
Table 5.5 Effective RCNs for Permeable Pavements

Subbase	Hydrologic Soil Group			
	A	B	C	D
6"	76[1]	84[1]	93[2]	—
9"	62[3]	65[3]	77[3]	—
12"	40	55	70	—

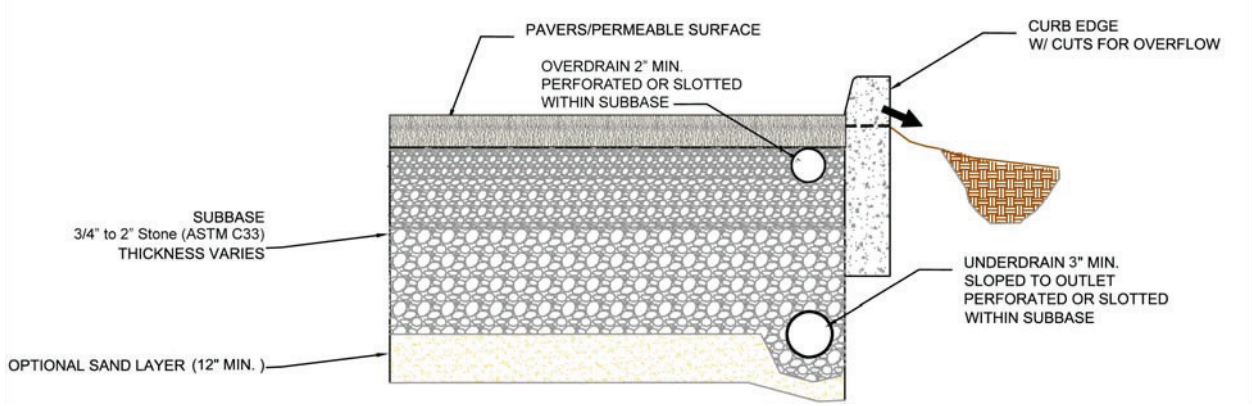
1. Design shall include 1 - 2" min. overdrain (inv. 2" below pavement base) per 750 s.f. of pavement area.
2. Design shall include 1 - 2" min. overdrain (inv. 2" below pavement base) per 600 s.f. of pavement area
3. Design shall include 1 - 3" min. overdrain (inv. 3" below pavement base) and a ½" underdrain at subbase invert.

- **Soils:**
  - *Permeable pavements shall not be installed in HSG D or on areas of compacted fill. Underlying soil types and condition shall be field-verified prior to final design.*
  - *For applications that exceed 10,000 ft^2, underlying soils shall have an infiltration rate (f) of 0.52 in/hr or greater.* This rate may be initially determined from NRCS soil textural classification and subsequently confirmed by geotechnical tests in the field as required in Chapter 3.3.1.
  - *The invert of the subbase reservoir shall be at least four feet above (two feet on the lower Eastern Shore) the seasonal high water table.*

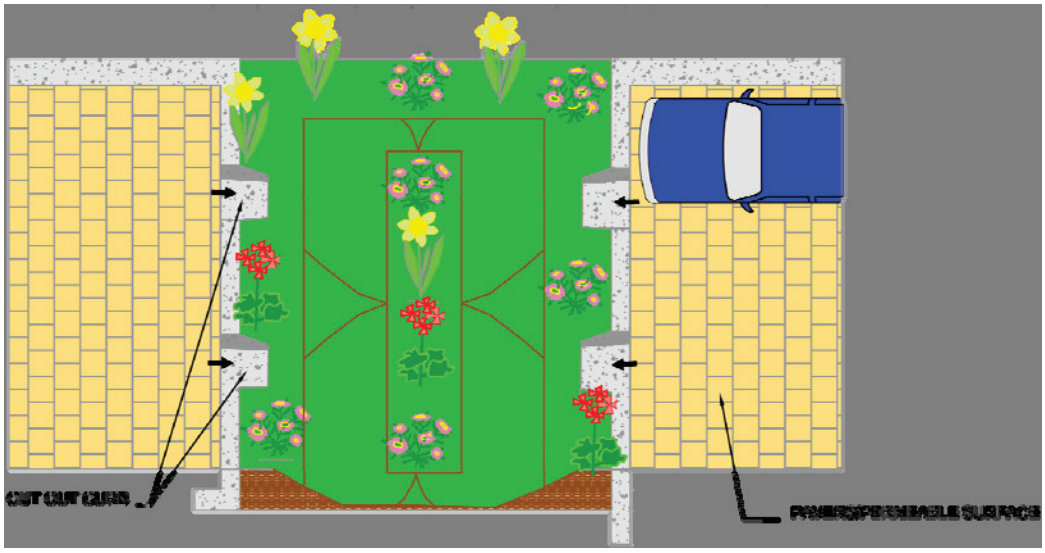
Figure 5.3 Examples of Permeable Pavements



Typical Section



Typical Section w/Overdrain & Underdrain



Permeable Pavement w/Micro-Bioretention - Plan View

- **Setbacks:**
  - *Permeable pavements shall be located down gradient of building structures and be setback at least 10 feet from buildings, 50 feet from confined water supply wells, 100 feet from unconfined water supply wells, and 25 feet from septic systems.*
  - Permeable pavements should also be sized and located to meet minimum local requirements for underground utility clearance.

- **Structure:** *All permeable pavement systems shall be capable of bearing the anticipated vehicle and traffic loads.* Pavement systems conforming to the specifications found in Appendix B.4 should be structurally stable for typical (e.g., light duty) applications.

- **Landscaping:** *Permeable pavement shall be identified on landscaping plans.* Trees and shrubs should not be located adjacent to asphalt and concrete if damage by root penetration and clogging from leaves is a concern.

Construction Criteria:

The following items should be addressed during construction of projects with permeable pavement:

- **Erosion and Sediment Control:** Final grading for installation should not take place until the surrounding site is stabilized. *If this cannot be accomplished, runoff from disturbed areas shall be diverted around proposed pavement locations.*

- **Soil Compaction:** *Sub soils shall not be compacted.* Construction should be performed with lightweight, wide tracked equipment to minimize compaction. Excavated materials should be placed in a contained area.

- **Distribution Systems:** *Overdrain, underdrain, and distribution pipes shall be checked to ensure that both the material and perforations meet specifications (see Appendix B.4). The upstream ends of pipes should be capped prior to installation.* All underdrain or distribution pipes used should be installed flat along the bed bottom.

- **Subbase Installation:** *Subbase aggregate shall be clean and free of fines. The subbase shall be placed in lifts and lightly rolled according to the specifications (see Appendix B.4).*

APPENDIX 3

HYDROGRAPH SUMMARIES

AND DIAGRAMS

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Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Legend

Hyd.	Origin	Description
1	SCS Runoff	Ex Field 1
2	SCS Runoff	Ex Field 2
3	SCS Runoff	Ex Field 3
5	SCS Runoff	Pr Field 1
6	SCS Runoff	Pr Field 2
7	SCS Runoff	Pr Field 3

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Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	------	2.026	-------	-------	-------	5.071	-------	-------	8.221	Ex Field 1
2	SCS Runoff	------	3.148	-------	-------	-------	7.694	-------	-------	12.36	Ex Field 2
3	SCS Runoff	------	2.831	-------	-------	-------	7.451	-------	-------	12.32	Ex Field 3
5	SCS Runoff	------	1.730	-------	-------	-------	4.674	-------	-------	7.810	Pr Field 1
6	SCS Runoff	------	2.559	-------	-------	-------	6.916	-------	-------	11.56	Pr Field 2
7	SCS Runoff	------	2.681	-------	-------	-------	7.244	-------	-------	12.10	Pr Field 3

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APPENDIX 4

1-YEAR DESIGN STORM

HYDROGRAPHS

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.026	2	734	8,979	------	------	------	Ex Field 1
2	SCS Runoff	3.148	2	734	13,925	------	------	------	Ex Field 2
3	SCS Runoff	2.831	2	734	12,635	------	------	------	Ex Field 3
5	SCS Runoff	1.730	2	734	7,759	------	------	------	Pr Field 1
6	SCS Runoff	2.559	2	734	11,480	------	------	------	Pr Field 2
7	SCS Runoff	2.681	2	734	12,024	------	------	------	Pr Field 3

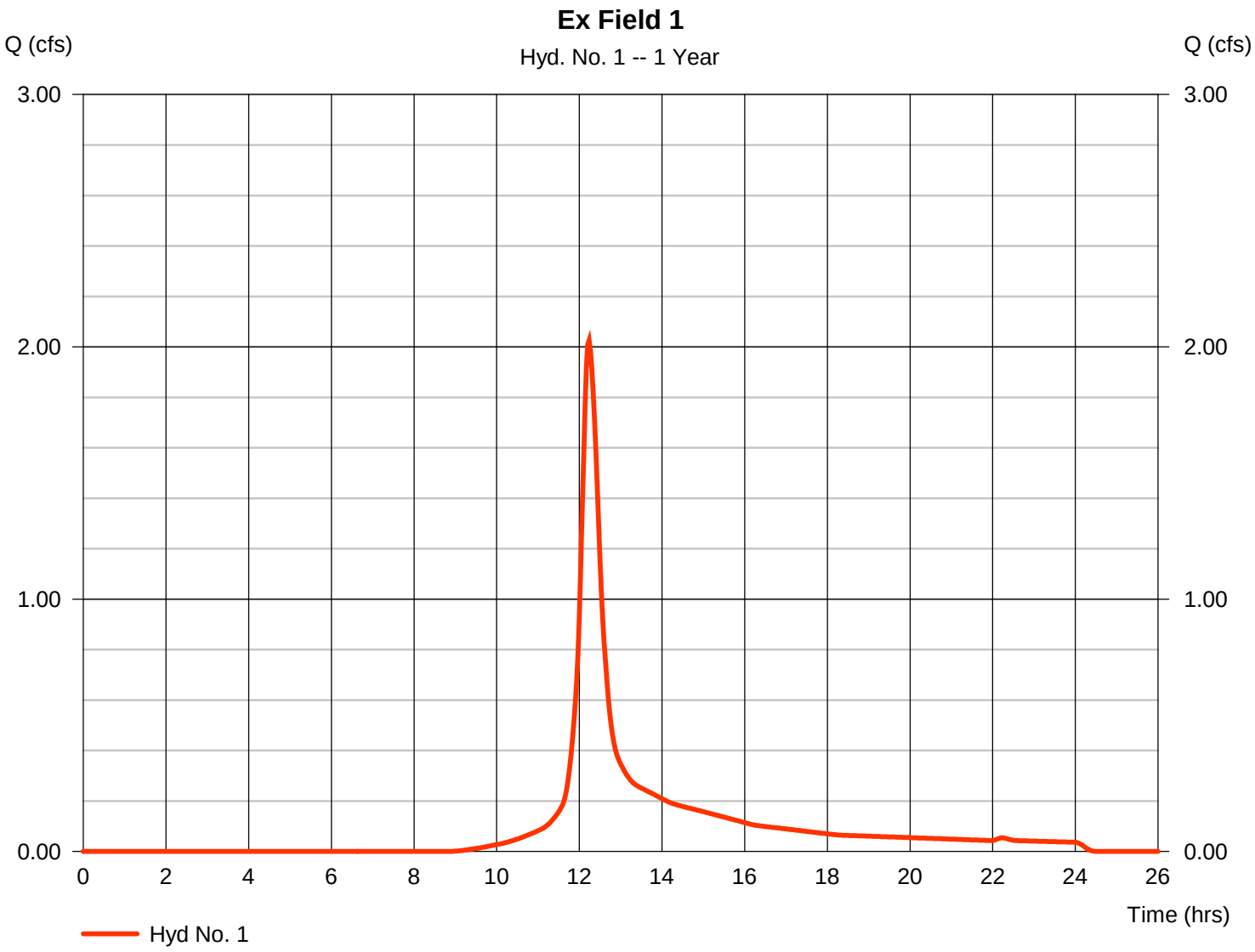
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 1

Ex Field 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.026 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 8,979 cuft
Drainage area	= 1.710 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 3.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



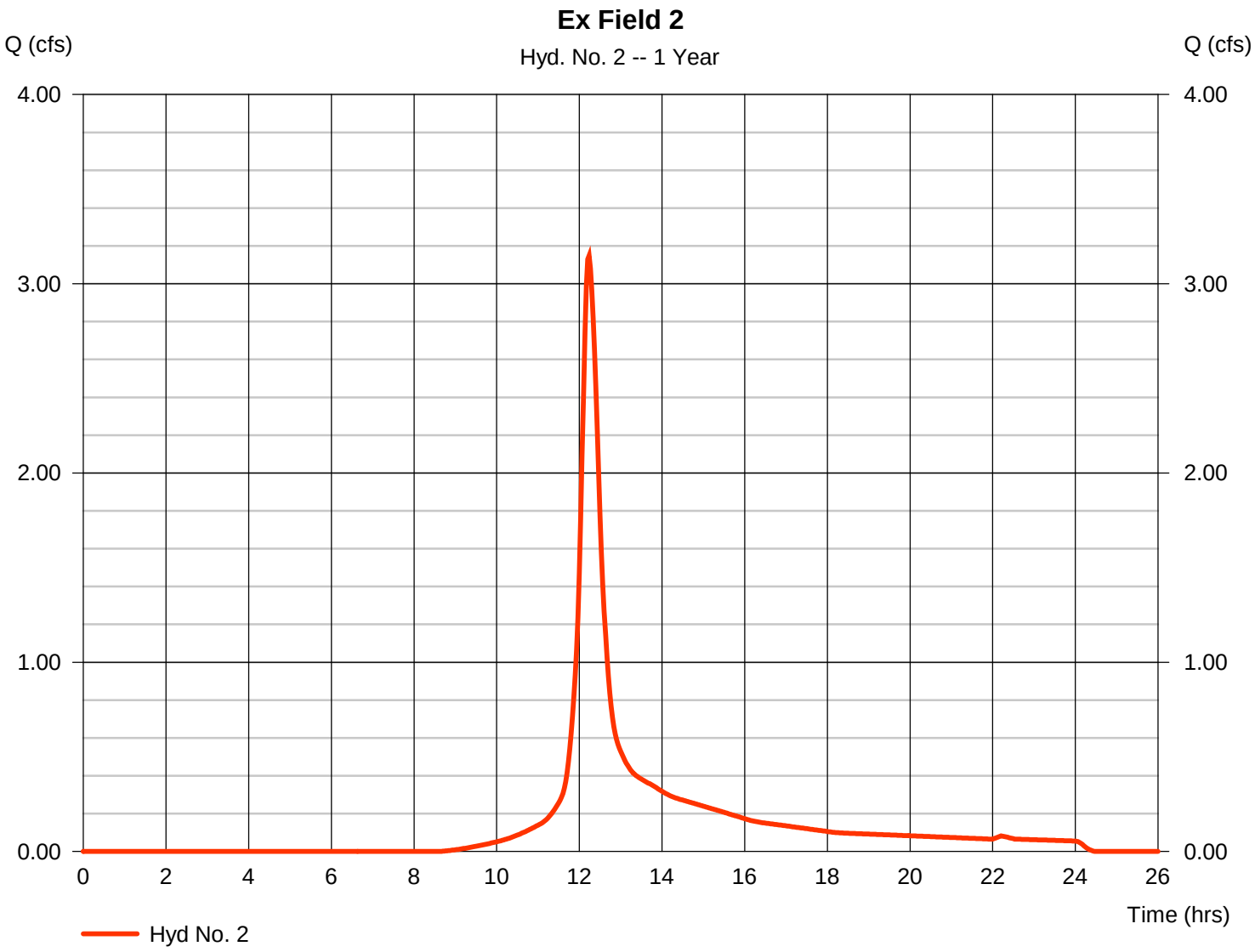
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 2

Ex Field 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.148 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	13,925 cuft
Drainage area	=	2.530 ac	Curve number	=	84
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



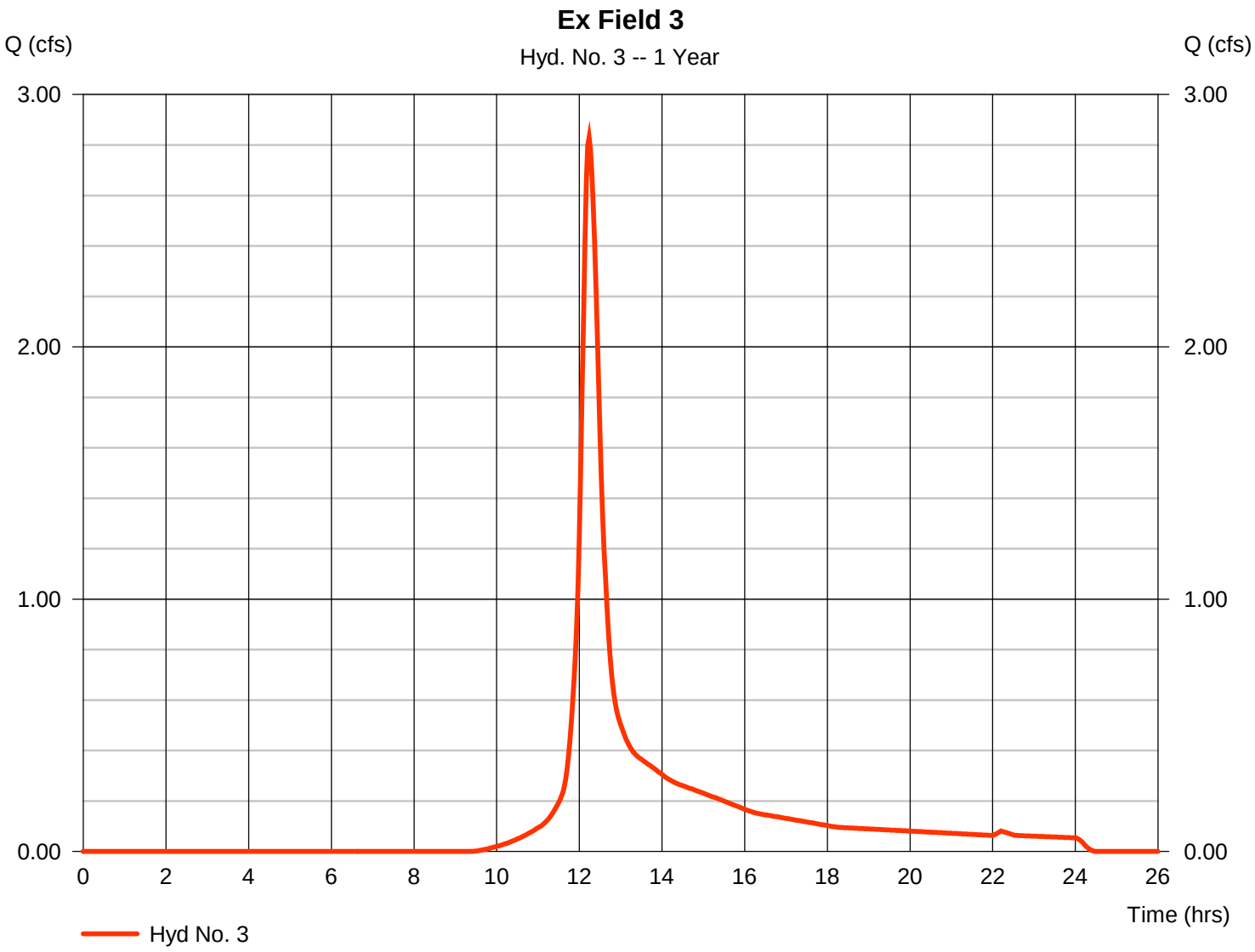
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 3

Ex Field 3

Hydrograph type	= SCS Runoff	Peak discharge	= 2.831 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 12,635 cuft
Drainage area	= 2.650 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 3.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



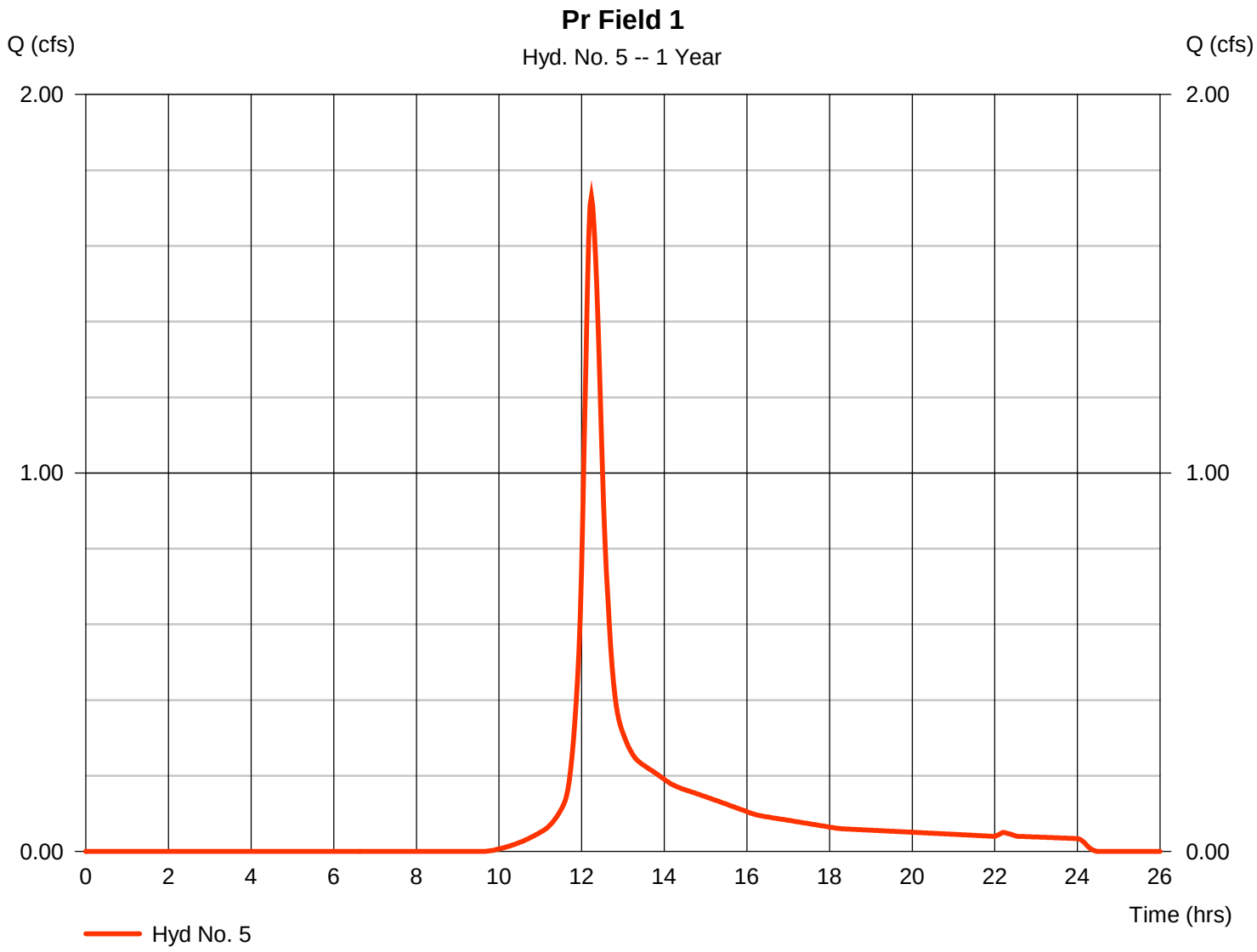
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 5

Pr Field 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.730 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	7,759 cuft
Drainage area	=	1.710 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



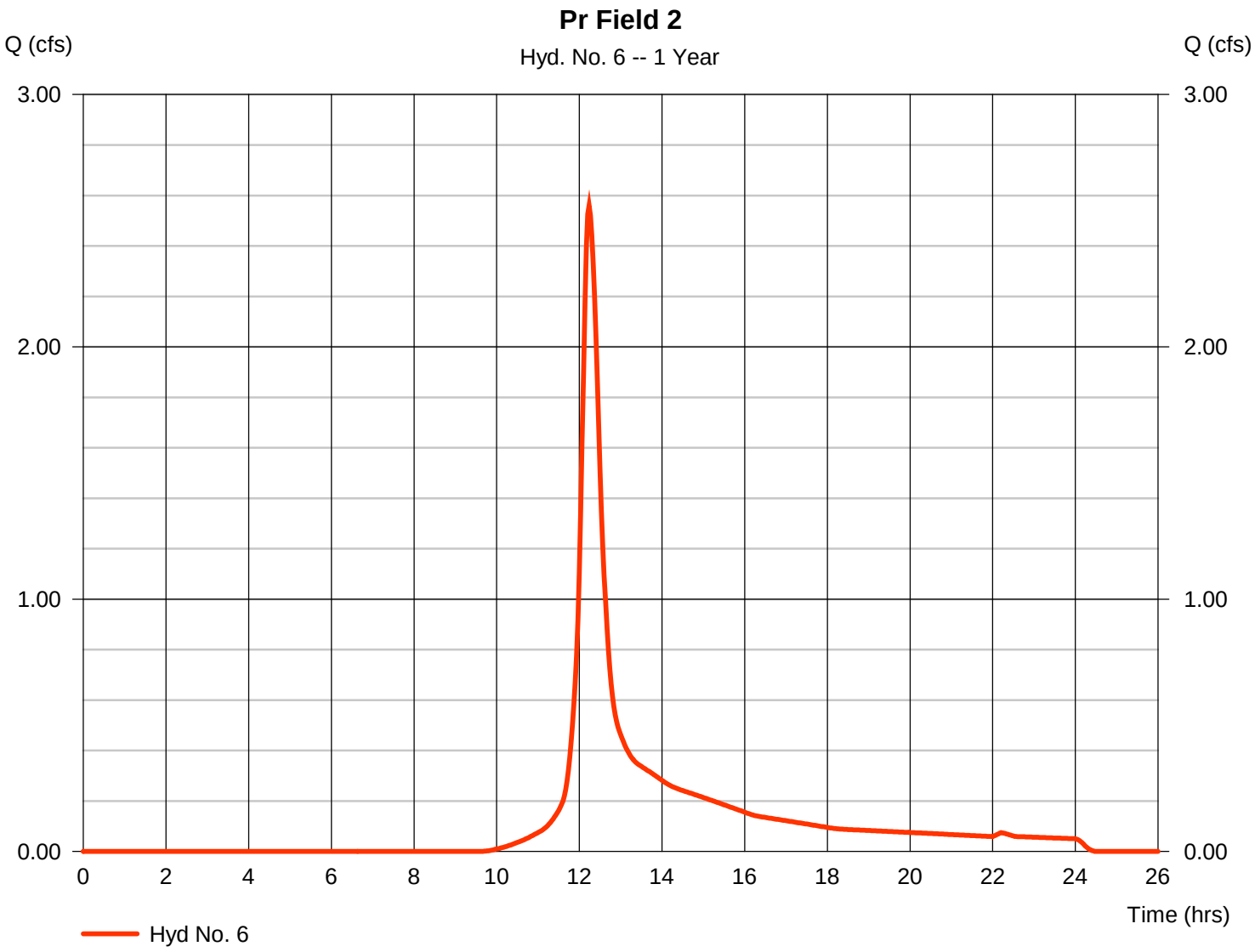
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 6

Pr Field 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.559 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	11,480 cuft
Drainage area	=	2.530 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



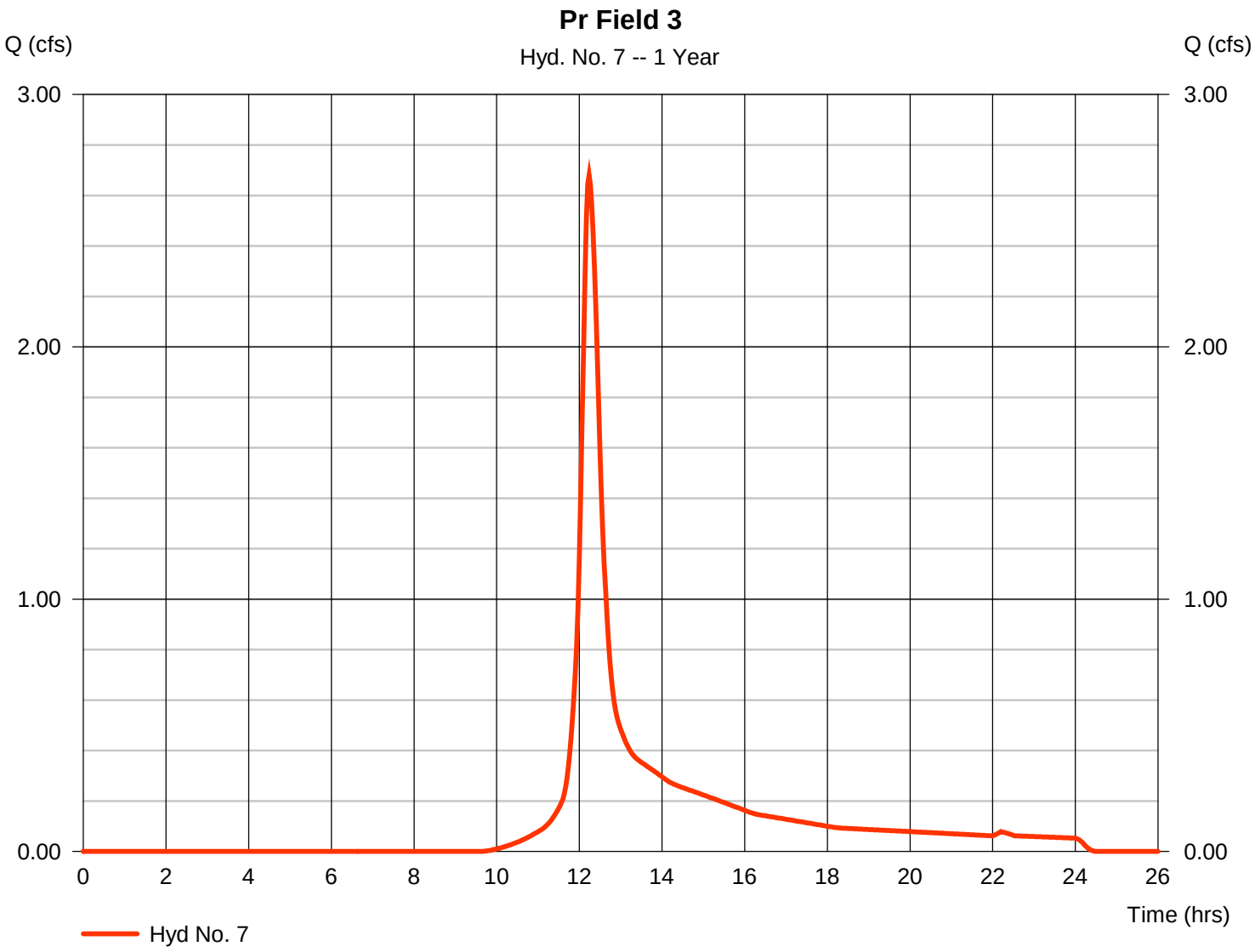
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 7

Pr Field 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.681 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	12,024 cuft
Drainage area	=	2.650 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



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APPENDIX 5

10-YEAR DESIGN STORM HYDROGRAPHS

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	5.071	2	732	22,531	------	------	------	Ex Field 1
2	SCS Runoff	7.694	2	732	34,264	------	------	------	Ex Field 2
3	SCS Runoff	7.451	2	732	33,005	------	------	------	Ex Field 3
5	SCS Runoff	4.674	2	732	20,691	------	------	------	Pr Field 1
6	SCS Runoff	6.916	2	732	30,613	------	------	------	Pr Field 2
7	SCS Runoff	7.244	2	732	32,065	------	------	------	Pr Field 3

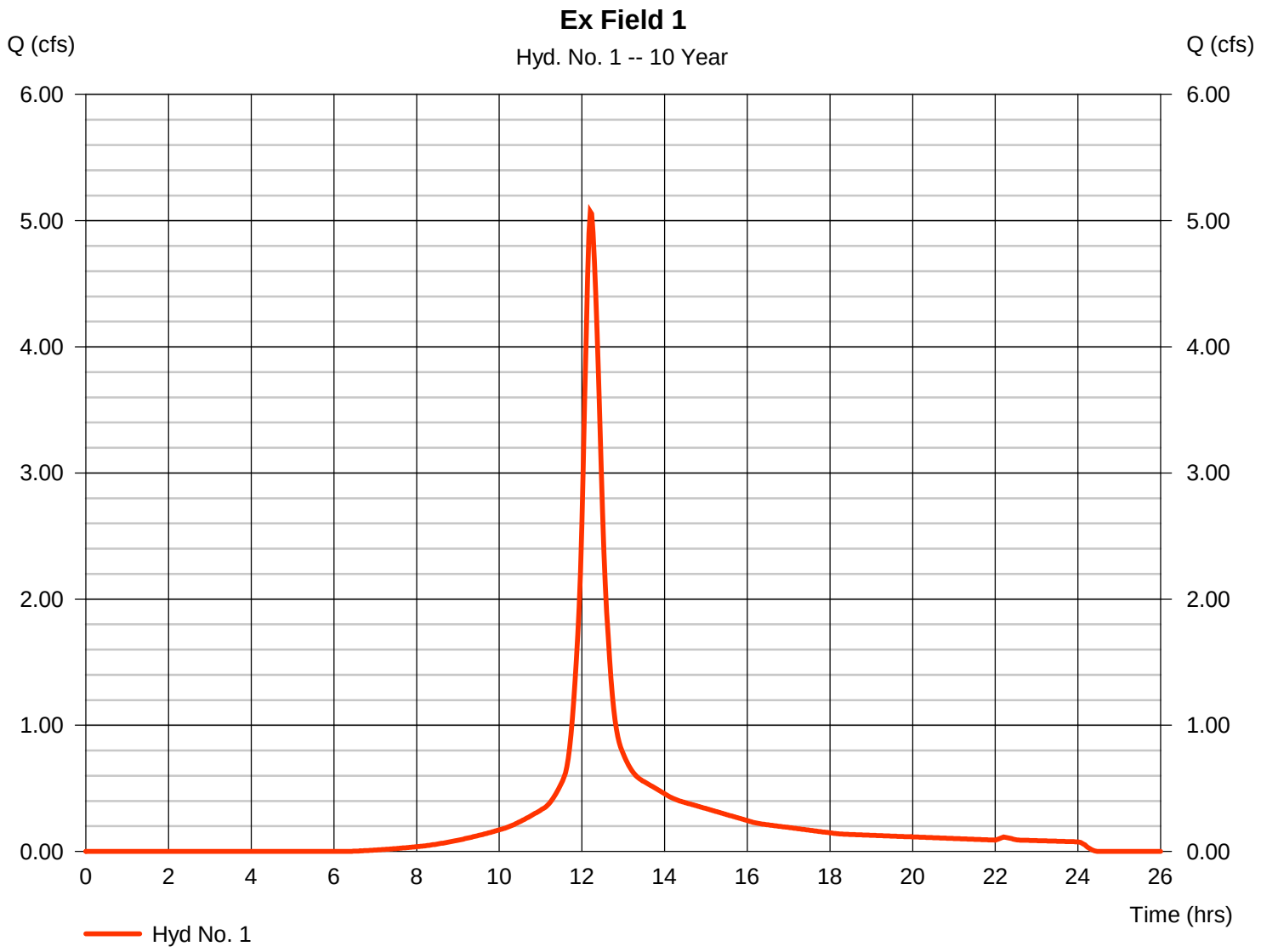
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 1

Ex Field 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.071 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	22,531 cuft
Drainage area	=	1.710 ac	Curve number	=	83
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



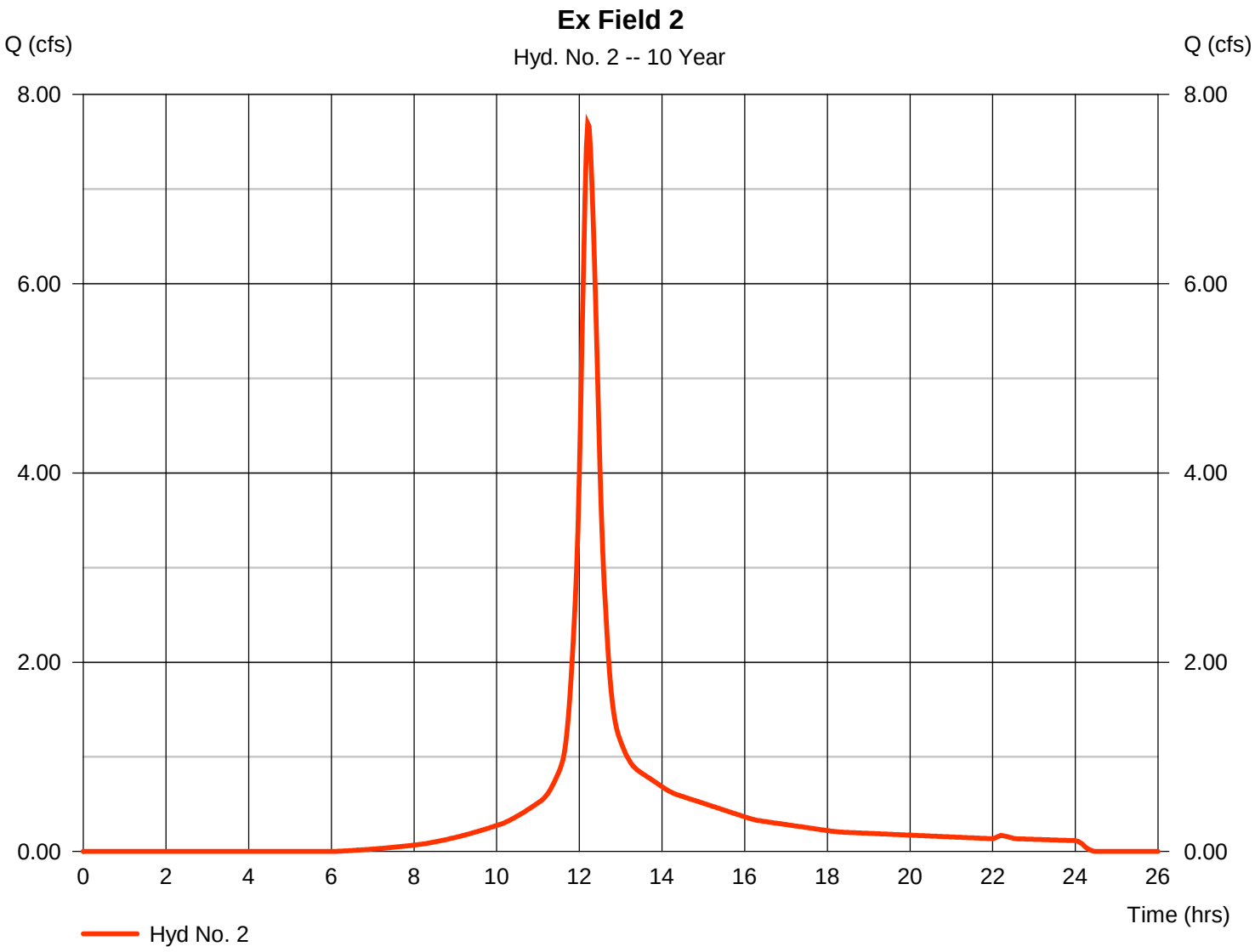
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 2

Ex Field 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.694 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	34,264 cuft
Drainage area	=	2.530 ac	Curve number	=	84
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



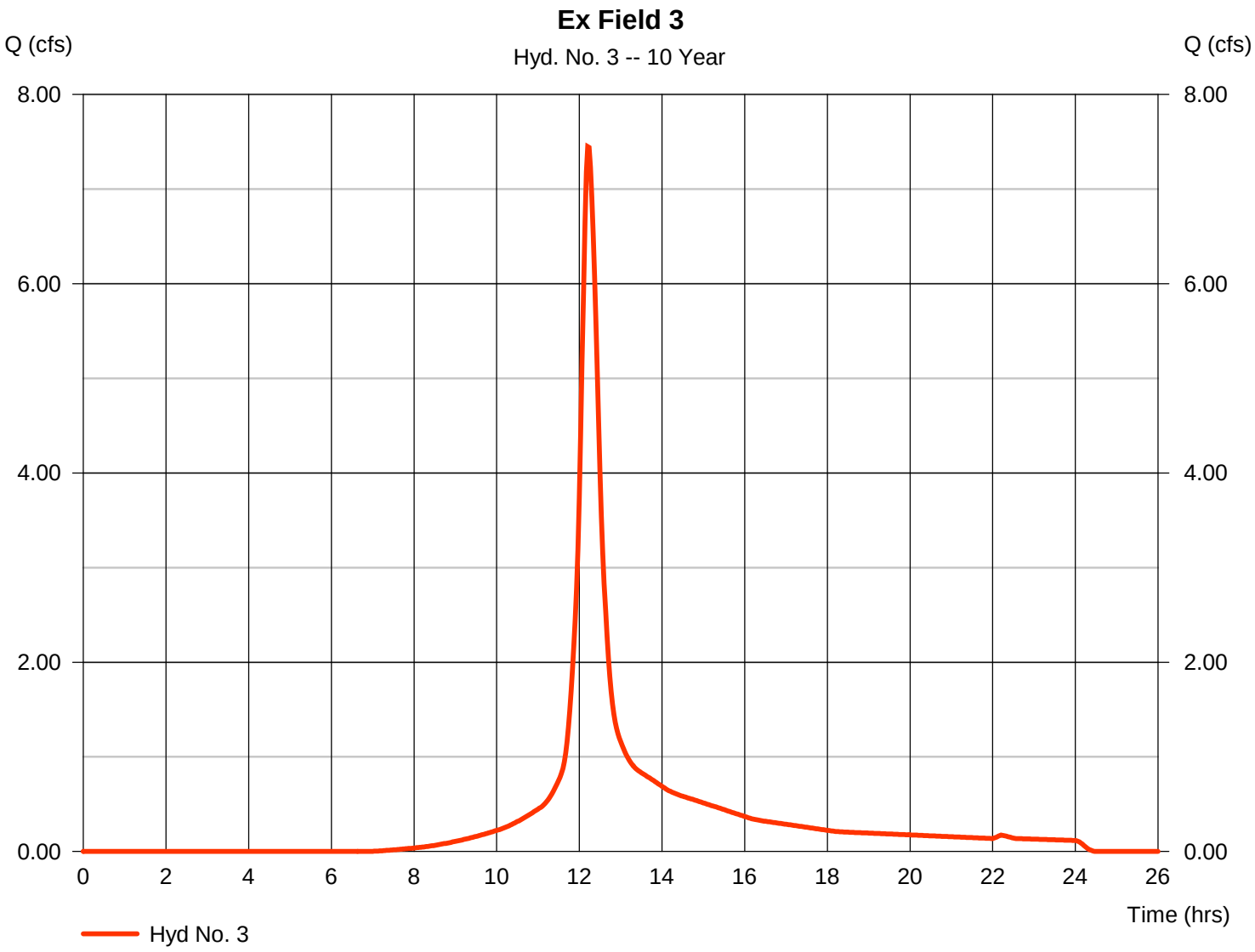
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 3

Ex Field 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.451 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	33,005 cuft
Drainage area	=	2.650 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



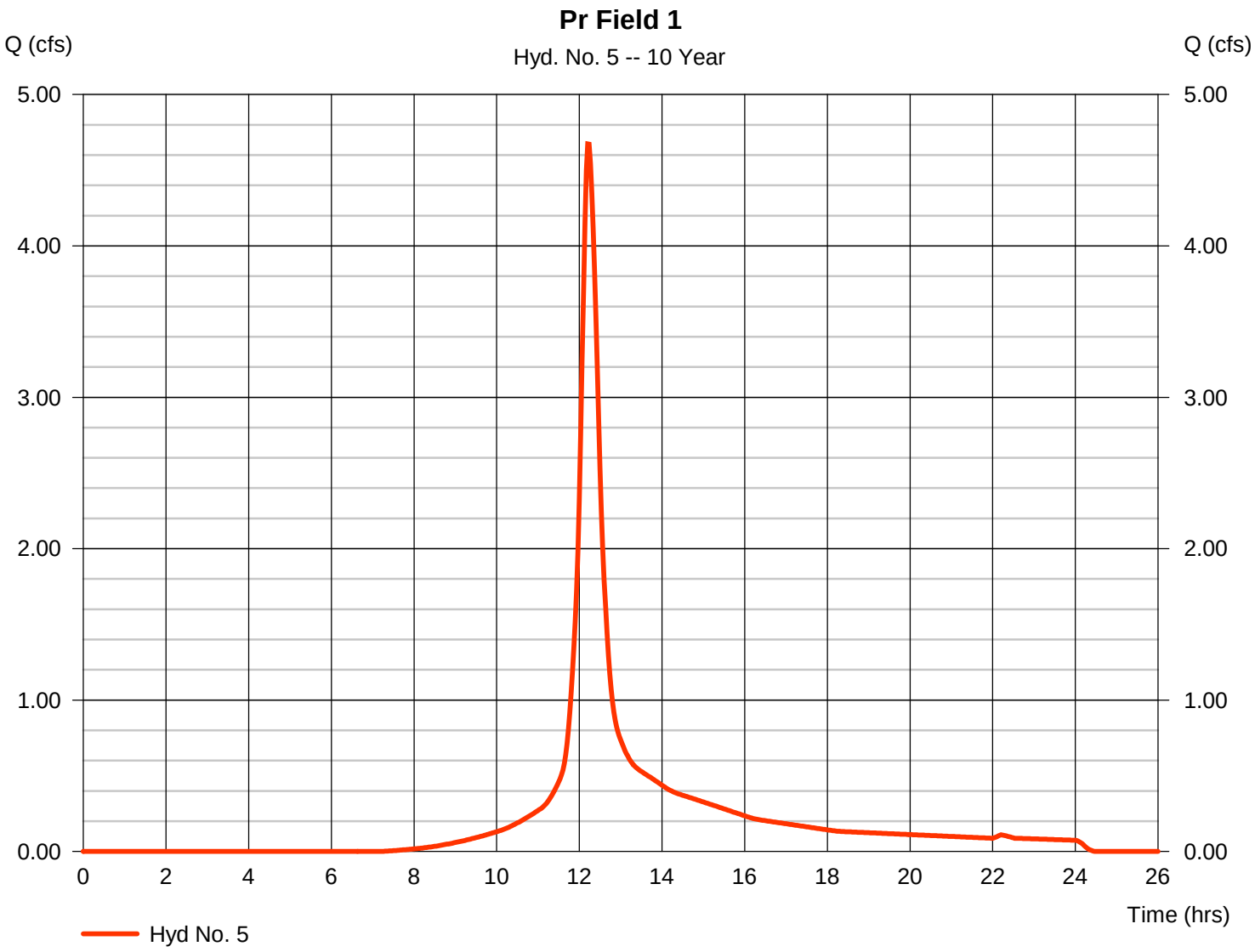
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 5

Pr Field 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.674 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	20,691 cuft
Drainage area	=	1.710 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



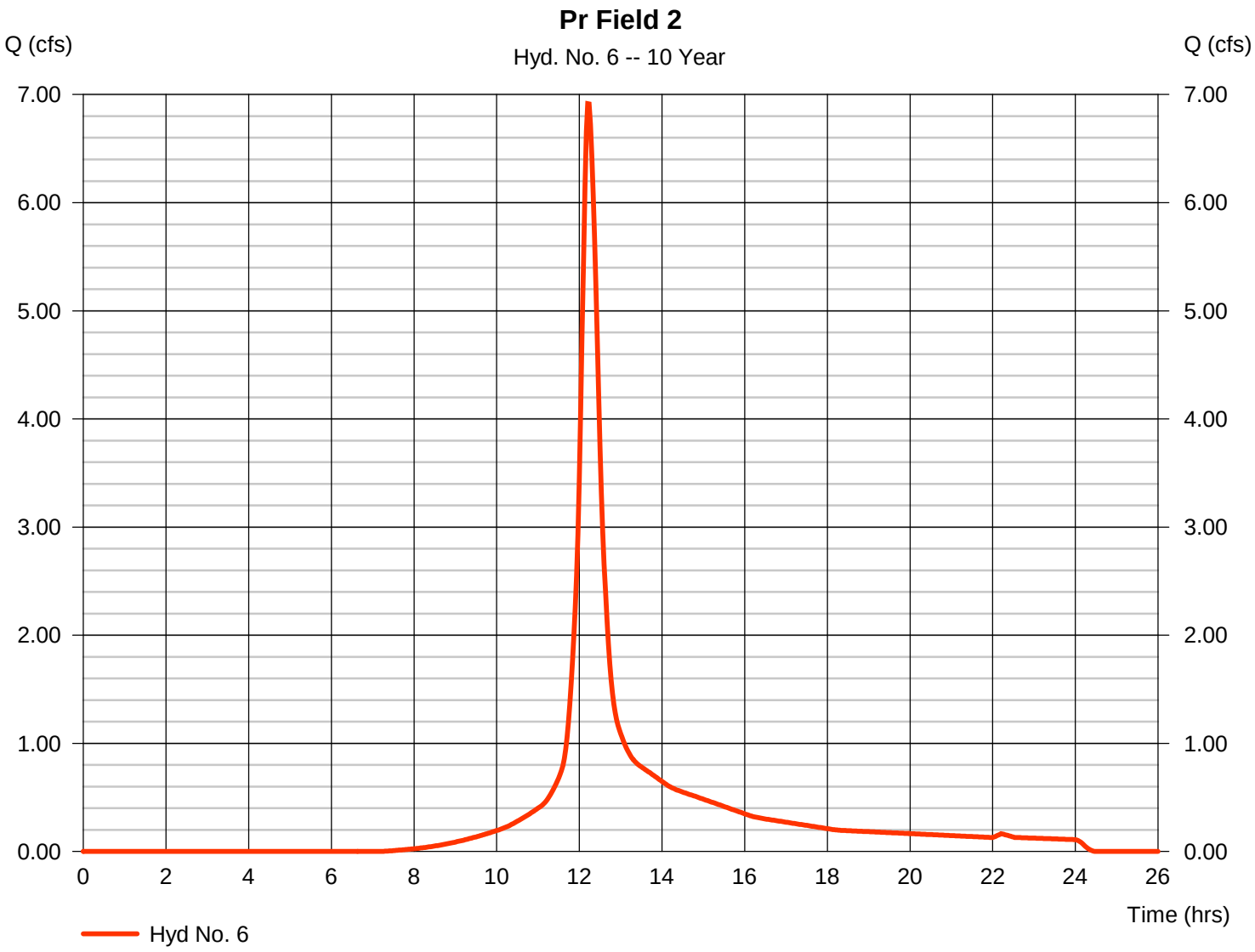
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 6

Pr Field 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.916 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	30,613 cuft
Drainage area	=	2.530 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



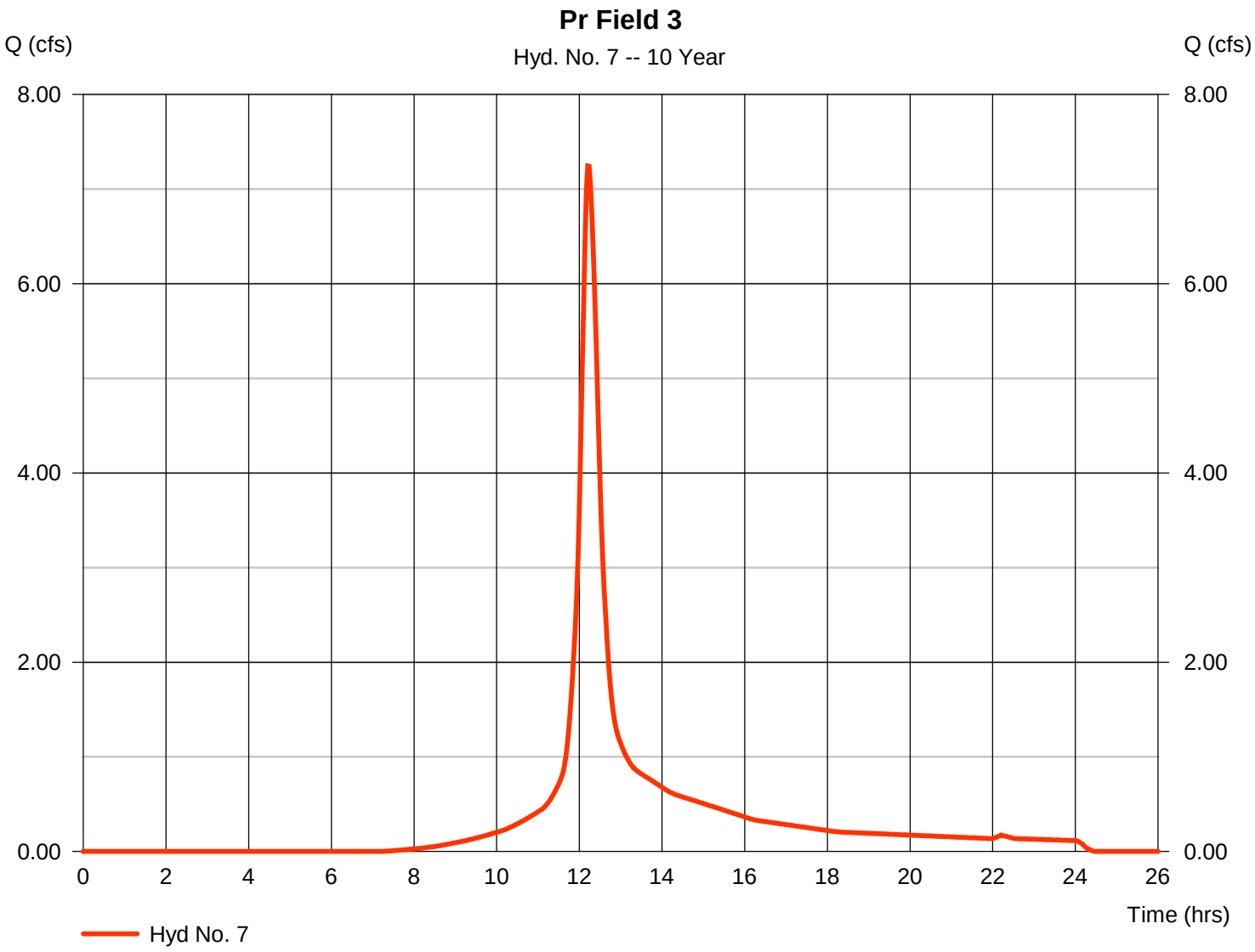
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 7

Pr Field 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.244 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	32,065 cuft
Drainage area	=	2.650 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



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APPENDIX 6

100-YEAR DESIGN STORM HYDROGRAPHS

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	8.221	2	732	37,104	------	------	------	Ex Field 1
2	SCS Runoff	12.36	2	732	55,978	------	------	------	Ex Field 2
3	SCS Runoff	12.32	2	732	55,238	------	------	------	Ex Field 3
5	SCS Runoff	7.810	2	732	34,916	------	------	------	Pr Field 1
6	SCS Runoff	11.56	2	732	51,659	------	------	------	Pr Field 2
7	SCS Runoff	12.10	2	732	54,110	------	------	------	Pr Field 3

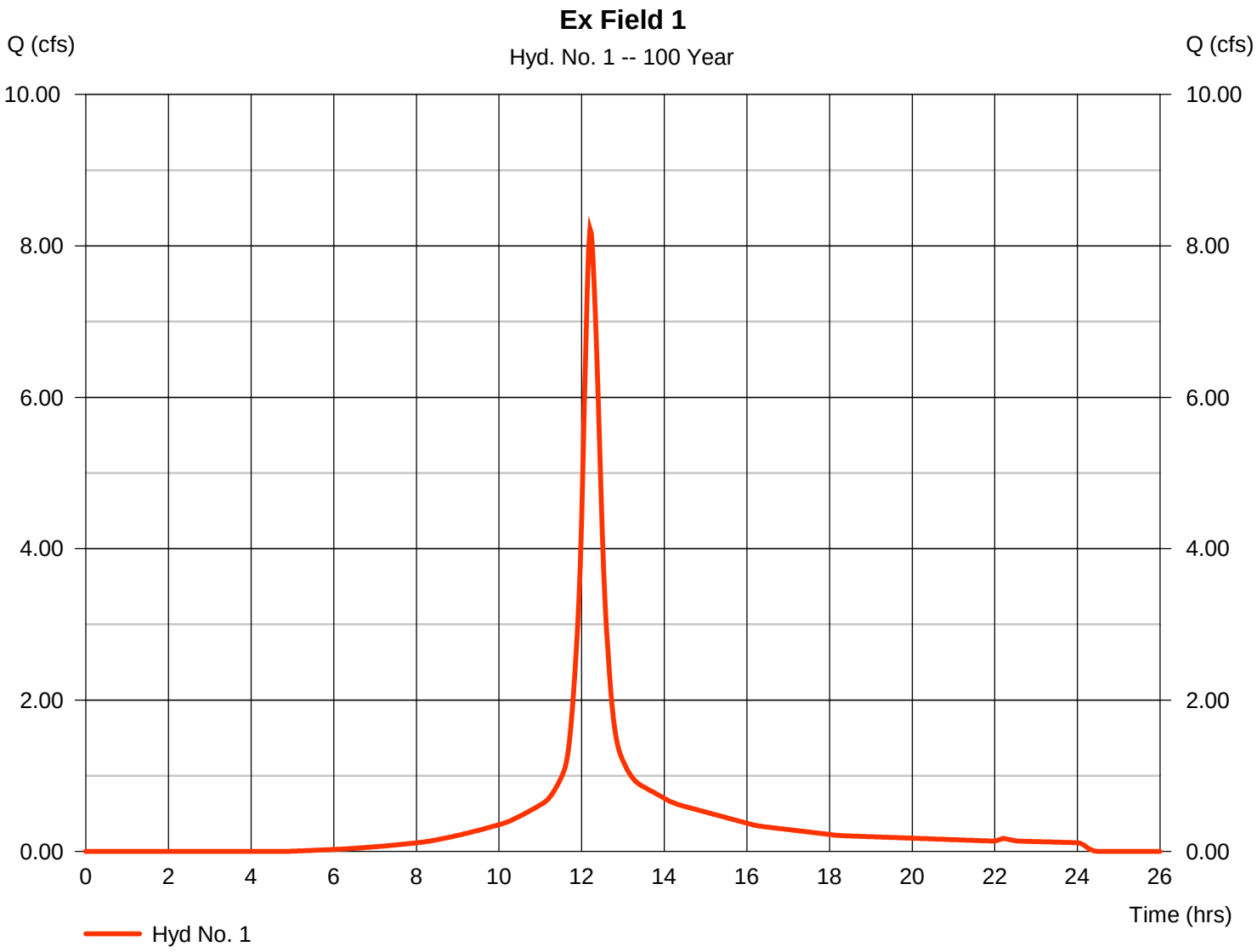
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 1

Ex Field 1

Hydrograph type	= SCS Runoff	Peak discharge	= 8.221 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.20 hrs
Time interval	= 2 min	Hyd. volume	= 37,104 cuft
Drainage area	= 1.710 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 8.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



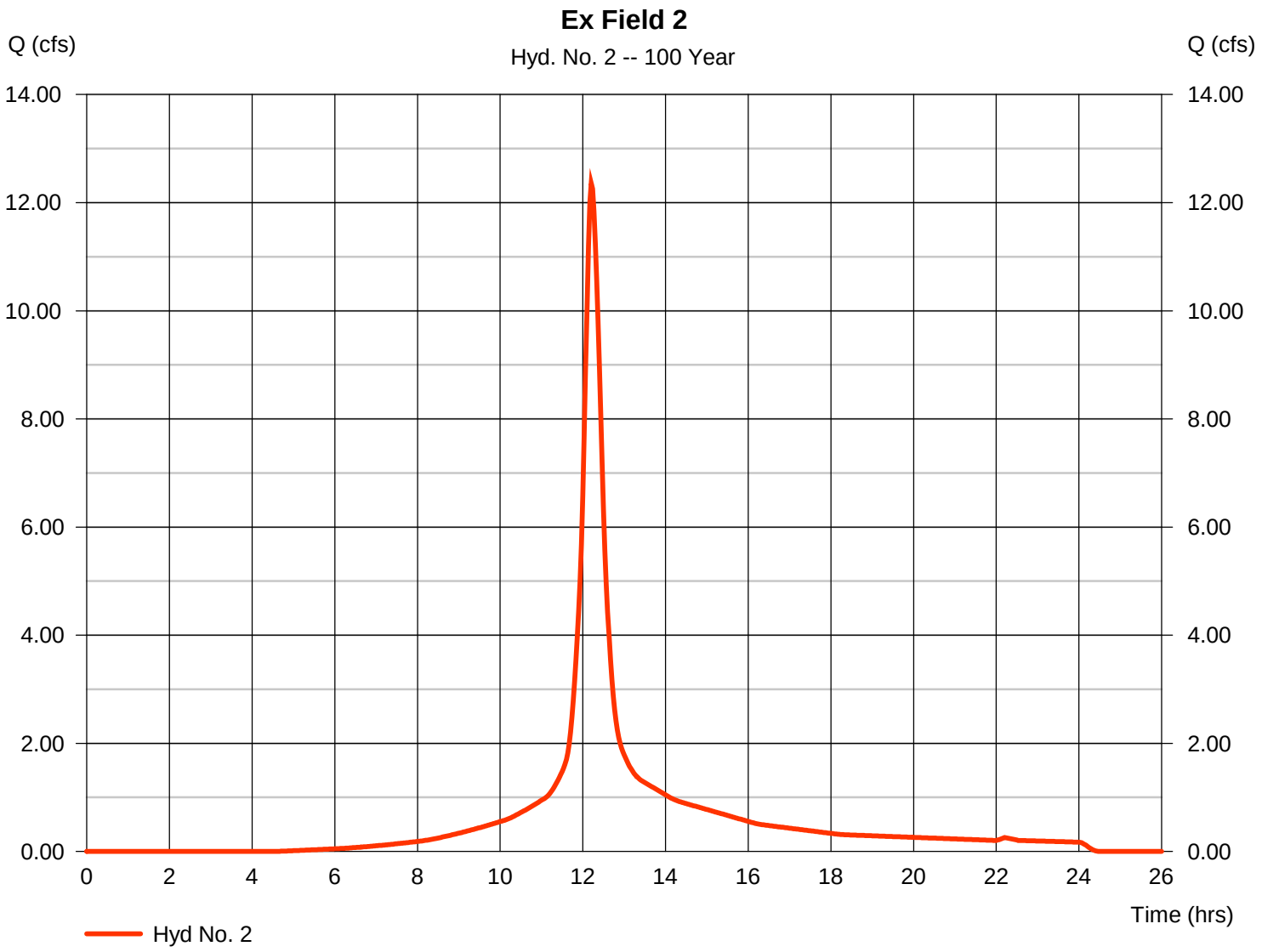
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 2

Ex Field 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.36 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	55,978 cuft
Drainage area	=	2.530 ac	Curve number	=	84
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



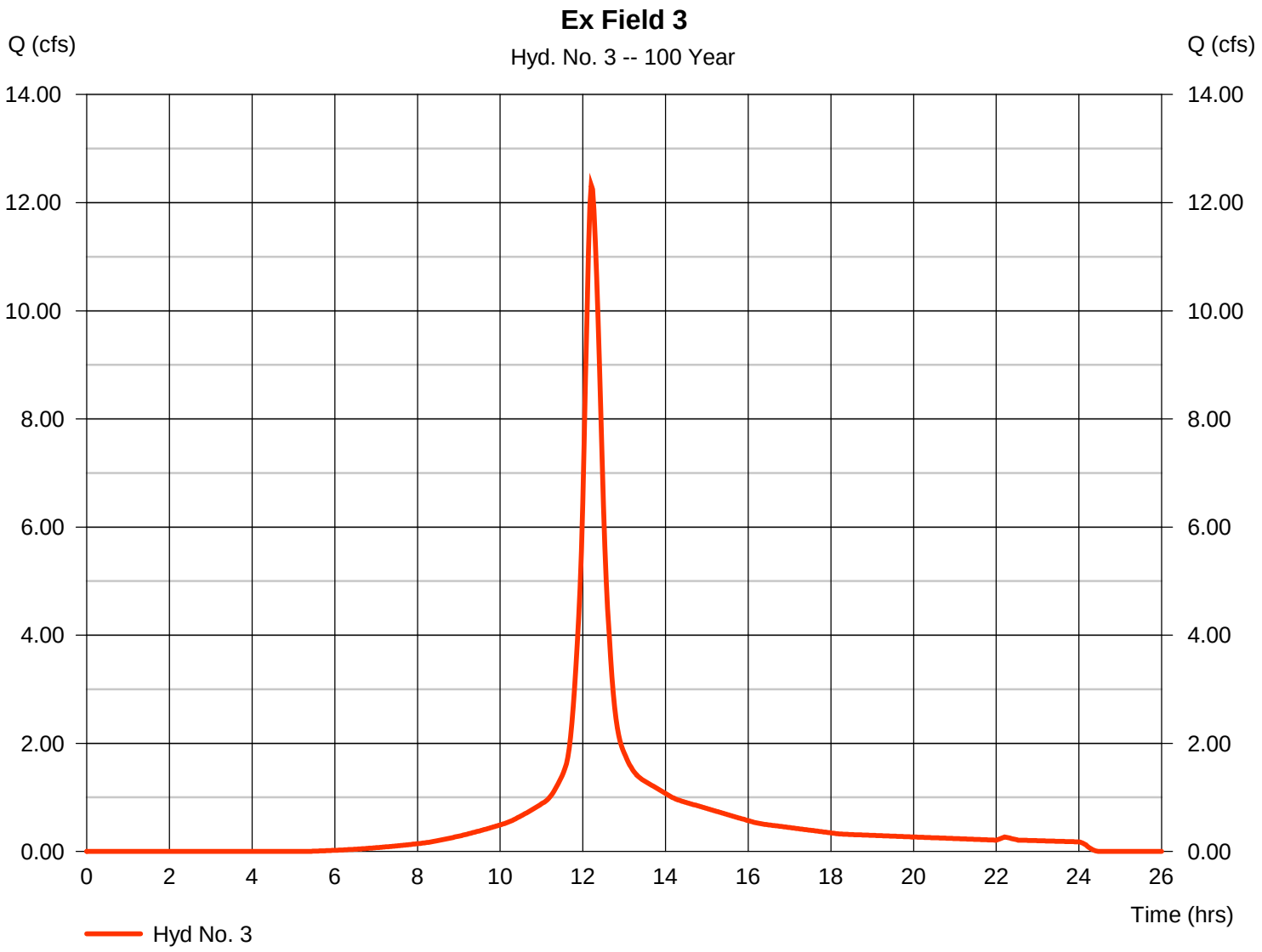
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 3

Ex Field 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.32 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	55,238 cuft
Drainage area	=	2.650 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



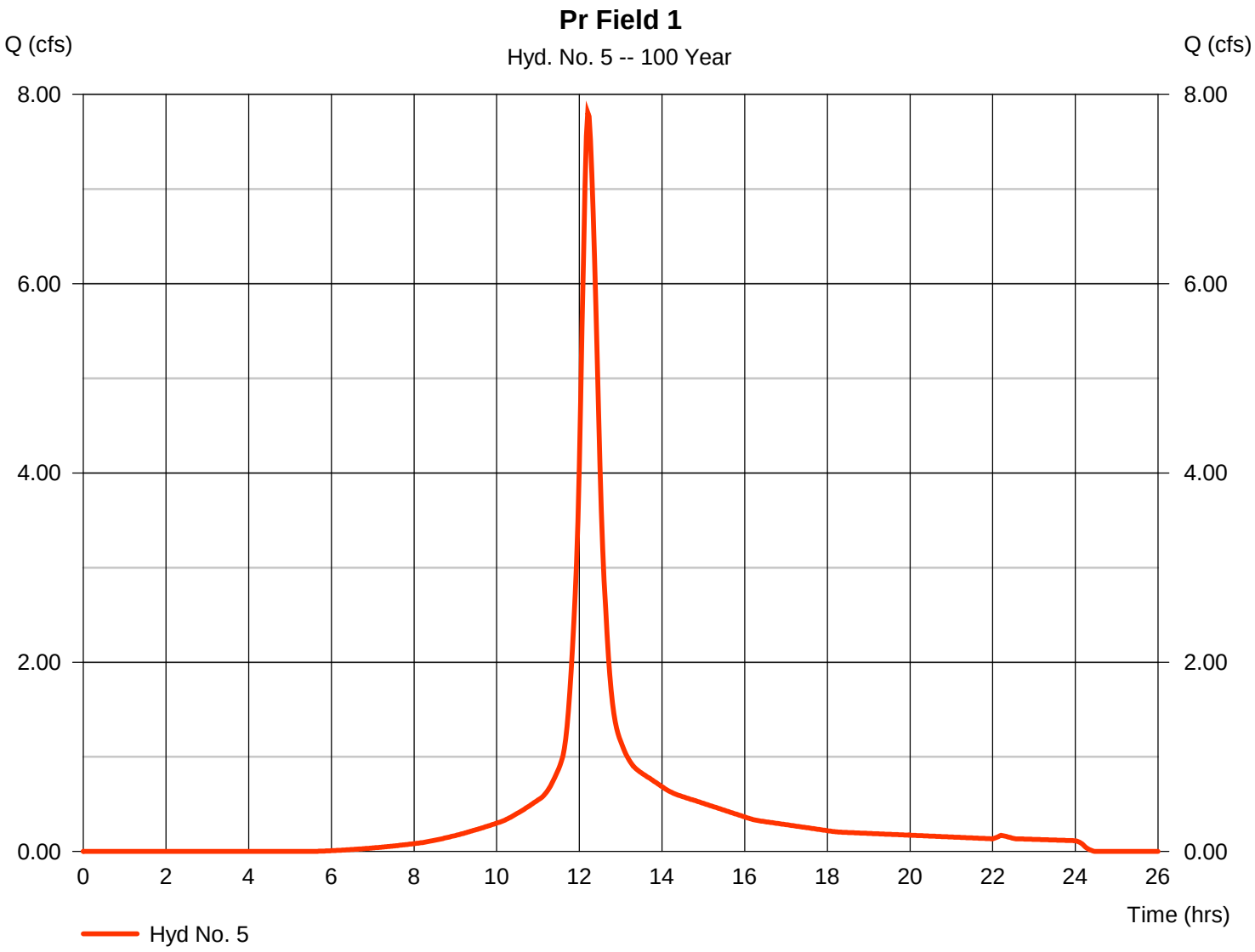
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 5

Pr Field 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.810 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	34,916 cuft
Drainage area	=	1.710 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



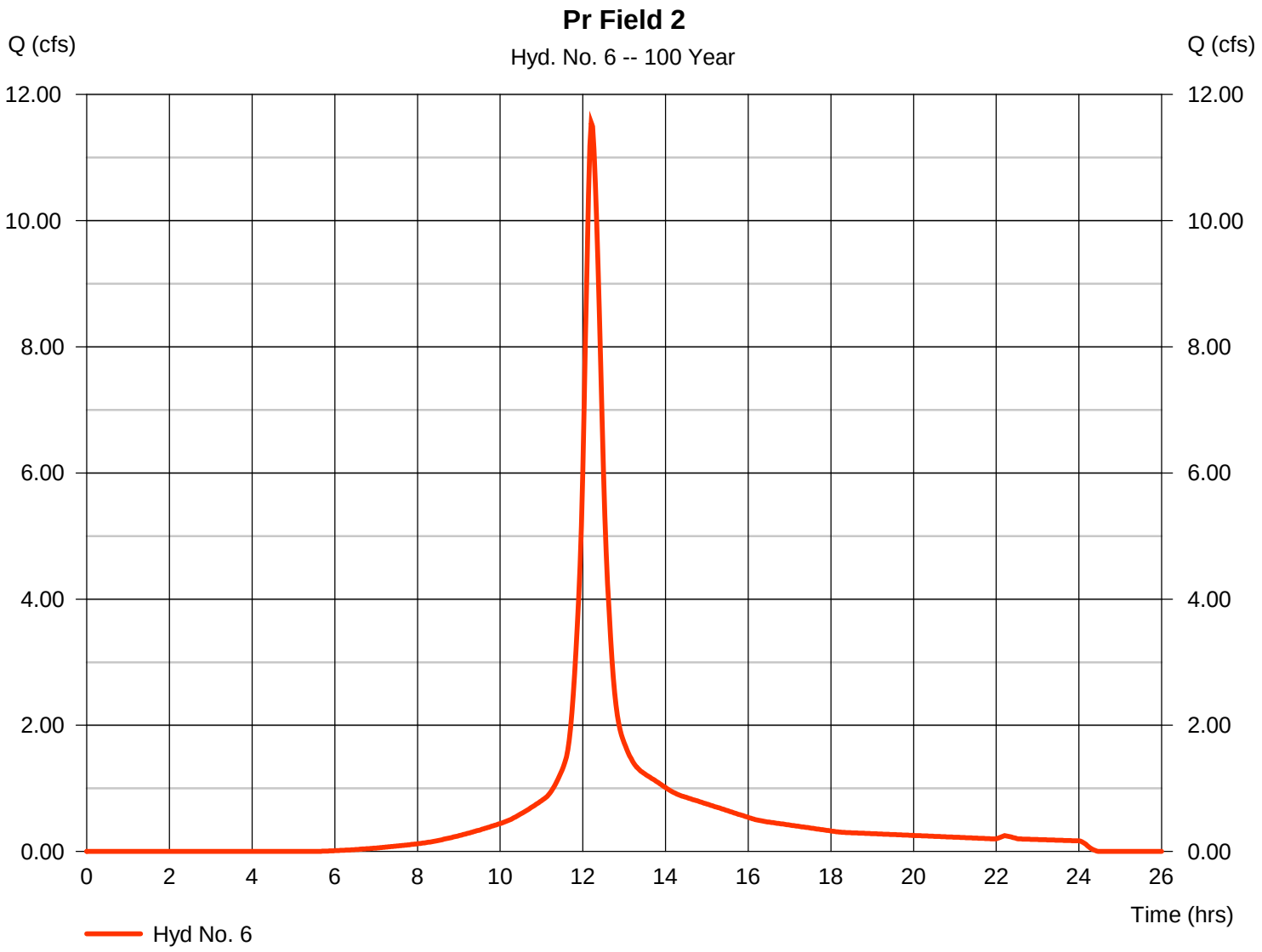
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 6

Pr Field 2

Hydrograph type	= SCS Runoff	Peak discharge	= 11.56 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.20 hrs
Time interval	= 2 min	Hyd. volume	= 51,659 cuft
Drainage area	= 2.530 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 8.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



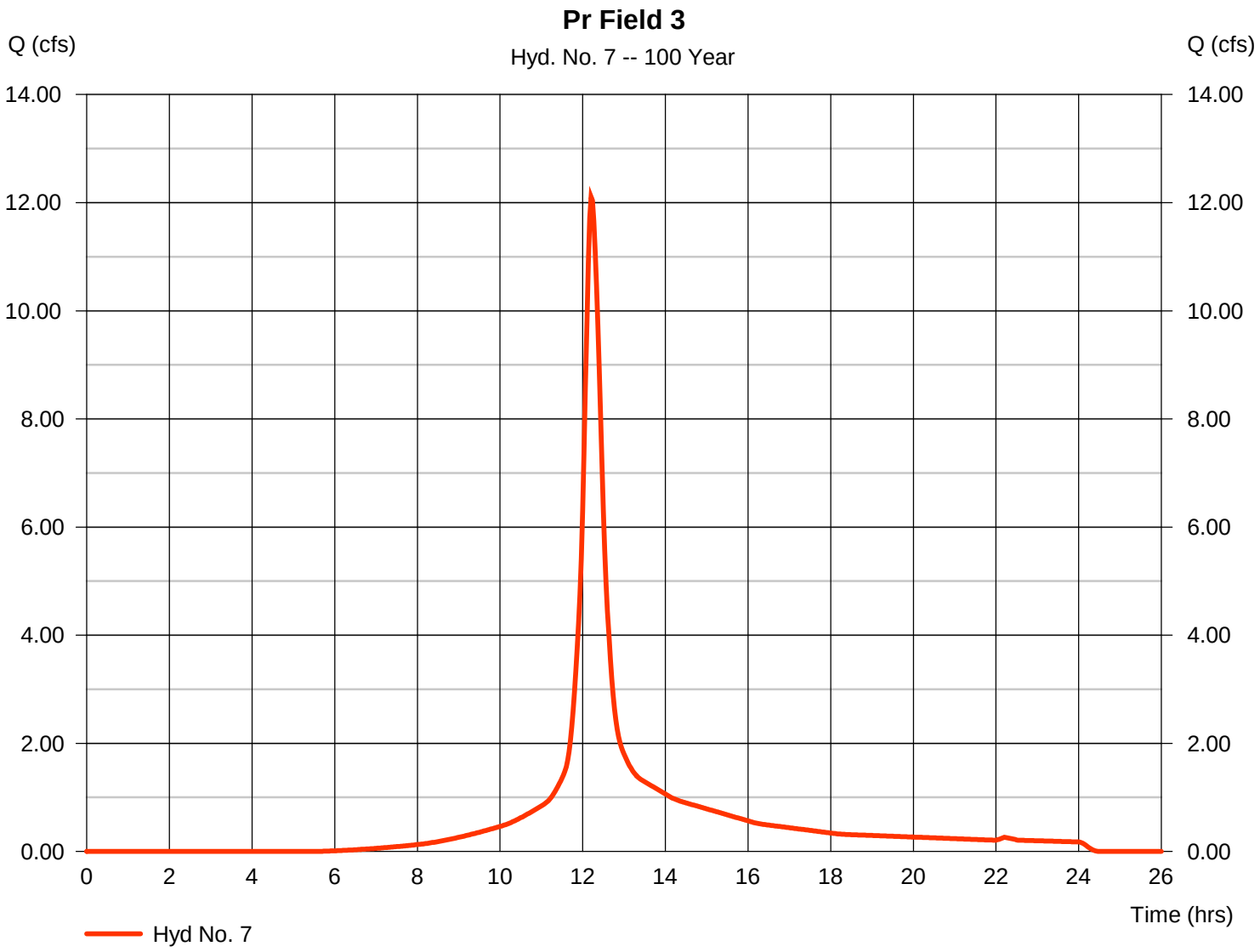
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Monday, 01 / 19 / 2015

Hyd. No. 7

Pr Field 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.10 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	54,110 cuft
Drainage area	=	2.650 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.00 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484



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APPENDIX 7

CONSTRUCTION SITE

INSPECTION FORMS

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SWPPP INSPECTION REPORT

ENGINEERING & SURVEYING PROPERTIES
Achieving Successful Results with Innovative Designs

W.O. No.:	Date:	Greater than 5 Ac. Of Disturbance? Waiver?	Page Of
Project Name:		Weather Conditions: ☐ Dry ☐ Rain ☐ Snow	
		Soil Conditions: ☐ Dry ☐ Wet ☐ Saturated	
Location:		Arrival Time :	Photographs Taken?
		Departing Time:	☐ Yes ☐ No

Owner:	**Phone:**	**Documents on-site?**		SWPPP:	
Contractor:	**Phone:**	Weekly Inspections:		NOI:	

1. Description of current activities onsite and phase of construction (attach sketch showing areas of stabilization, current work, and photo locations):

2. Description of the condition of the runoff at all points of discharge from the construction site (including onsite conveyance systems):

3. Description of the condition of all natural surface water bodies located within, or immediately adjacent to the construction site:

4. Identify all erosion and sediment control practices that require repair and/or maintenance:

5. Identify all erosion and sediment control practices that were not installed properly or are not functioning as designed:

6. Identify current status of construction for all post-construction stormwater management practices:

7. Corrective action(s) required to erosion and sediment control measures and post-construction stormwater management practices:

Was the owner and contractor(s) notified of the deficiencies and repairs needed within one (1) business day? ☐ Yes ☐ No

Qualified Inspector

Notice:

This inspection was performed solely for the purpose of determining compliance with NYSDEC SPDES General Permit:

☐ GP-02-01
☐ GP-08-001
☐ GP-10-001

Name and Title

Signature

CONTRACTOR and SUBCONTRACTOR CERTIFICATION STATEMENT

for the New York State Department of Environmental Conservation (DEC) State Pollutant Discharge Elimination System Permit for Stormwater Discharges from Construction Activity (GP-0-10-001)

As per *Part III.A.6* on page 13 of *GP-0-10-001* (effective January 29, 2010):

'Prior to the *commencement of construction activity*, the *owner or operator* must identify the contractor(s) and subcontractor(s) that will be responsible for installing, constructing, repairing, replacing, inspecting and maintaining the erosion and sediment control practices included in the SWPPP; and the contractor(s) and subcontractor(s) that will be responsible for constructing the post-construction stormwater management practices included in the SWPPP. The *owner or operator* shall have each of the contractors and sub-contractors identify at least one person from their company that will be responsible for implementation of the SWPPP. This person shall be known as the *trained contractor*. The *owner or operator* shall ensure that at least one *trained contractor* is on site on a daily basis when soil disturbance activities are being performed.'

The *owner or operator* shall have each contractor and subcontractor involved in soil disturbance sign a copy of the following certification statement before they commence any *construction activity*:

Frozen Ropes - The Yard	**NYR** _____	Town of Warwick
Name of Construction Site	*DEC Permit ID*	*Municipality (MS4)*

"I hereby certify that I understand and agree to comply with the terms and conditions of the SWPPP and agree to implement any corrective actions identified by the qualified inspector during a site inspection. I also understand that the owner or operator must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") general permit for stormwater discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings.

Responsible Corporate Officer/Partner Signature	Date
Name of above Signatory	Name of Company
Title of above Signatory	Mailing Address
Telephone of Company	City, State and Zip

Identify the specific elements of the SWPPP the contractor or subcontractor is responsible for:

***'TRAINED CONTRACTOR'* FOR THE CERTIFIED CONTRACTOR OR SUBCONTRACTOR**

Name of Trained Employee	*Title of Trained Employee*	*NYSDEC SWT #*

A copy of this signed contractor certification statement must be maintained at the SWPPP on site

APPENDIX 8

NOTICE OF INTENT &

MS4 SWPPP ACCEPTANCE

FORM

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NOTICE OF INTENT

New York State Department of Environmental Conservation
Division of Water
625 Broadway, 4th Floor
Albany, New York 12233-3505

NYR _____
(for DEC use only)

Stormwater Discharges Associated with Construction Activity Under State Pollutant Discharge Elimination System (SPDES) General Permit # GP-0-15-002

All sections must be completed unless otherwise noted. Failure to complete all items may result in this form being returned to you, thereby delaying your coverage under this General Permit. Applicants must read and understand the conditions of the permit and prepare a Stormwater Pollution Prevention Plan prior to submitting this NOI. Applicants are responsible for identifying and obtaining other DEC permits that may be required.

-IMPORTANT-
RETURN THIS FORM TO THE ADDRESS ABOVE
OWNER/OPERATOR MUST SIGN FORM

Owner/Operator Information

Owner/Operator (Company Name/Private Owner Name/Municipality Name)
The Warwick Yard, LLC

Owner/Operator Contact Person Last Name (NOT CONSULTANT)
Abbatine

Owner/Operator Contact Person First Name
Tony

Owner/Operator Mailing Address
24 Old Black Meadow Road

City
Chester

State: NY
Zip: 10918 -

Phone (Owner/Operator): 845-469-7331
Fax (Owner/Operator): 845-469-6742

Email (Owner/Operator)
tony.abbatine@frozenropes.com

FED TAX ID
- (not required for individuals)

Project Site Information

Project/Site Name

Frozen Ropes - The Yard

Street Address (NOT P.O. BOX)

122 State School Road

Side of Street

○ **North** ○ **South** ● **East** ○ **West**

City/Town/Village (THAT ISSUES BUILDING PERMIT)

Town of Warwick

State: NY

Zip: 10990-

County: Orange

DEC Region: 3

Name of Nearest Cross Street

Kings Highway

Distance to Nearest Cross Street (Feet)

3900

Project In Relation to Cross Street

○ **North** ● **South** ○ **East** ○ **West**

Tax Map Numbers
Section-Block-Parcel

46-1-34.12

Tax Map Numbers

1. Provide the Geographic Coordinates for the project site in NYTM Units. To do this you **must** go to the NYSDEC Stormwater Interactive Map on the DEC website at:

www.dec.ny.gov/imsmaps/stormwater/viewer.htm

Zoom into your Project Location such that you can accurately click on the centroid of your site. Once you have located your project site, go to the tool boxes on the top and choose "i"(identify). Then click on the center of your site and a new window containing the X, Y coordinates in UTM will pop up. Transcribe these coordinates into the boxes below. For problems with the interactive map use the help function.

X Coordinates (Easting): 558533

Y Coordinates (Northing): 4569643

2. What is the nature of this construction project?

○ **New Construction**

○ **Redevelopment with increase in impervious area**

● **Redevelopment with no increase in impervious area**

3. Select the predominant land use for both pre and post development conditions.
SELECT ONLY ONE CHOICE FOR EACH

Pre-Development Existing Land Use

- ○ FOREST
- ○ PASTURE/OPEN LAND
- ○ CULTIVATED LAND
- ○ SINGLE FAMILY HOME
- ○ SINGLE FAMILY SUBDIVISION
- ○ TOWN HOME RESIDENTIAL
- ○ MULTIFAMILY RESIDENTIAL
- ○ INSTITUTIONAL/SCHOOL
- ○ INDUSTRIAL
- ○ COMMERCIAL
- ○ ROAD/HIGHWAY
- ○ RECREATIONAL/SPORTS FIELD
- ○ BIKE PATH/TRAIL
- ○ LINEAR UTILITY
- ○ PARKING LOT
- ● OTHER

Correctional

Post-Development Future Land Use

- ○ SINGLE FAMILY HOME
- ○ SINGLE FAMILY SUBDIVISION — Number of Lots
- ○ TOWN HOME RESIDENTIAL
- ○ MULTIFAMILY RESIDENTIAL
- ○ INSTITUTIONAL/SCHOOL
- ○ INDUSTRIAL
- ○ COMMERCIAL
- ○ MUNICIPAL
- ○ ROAD/HIGHWAY
- ● RECREATIONAL/SPORTS FIELD
- ○ BIKE PATH/TRAIL
- ○ LINEAR UTILITY (water, sewer, gas, etc.)
- ○ PARKING LOT
- ○ CLEARING/GRADING ONLY
- ○ DEMOLITION, NO REDEVELOPMENT
- ○ WELL DRILLING ACTIVITY *(Oil, Gas, etc.)
- ○ OTHER

***Note**: for gas well drilling, non-high volume hydraulic fractured wells only

4. In accordance with the larger common plan of development or sale, enter the total project site area; the total area to be disturbed; existing impervious area to be disturbed (for redevelopment activities); and the future impervious area constructed within the disturbed area. (Round to the nearest tenth of an acre.)

Total Site Area	Total Area To Be Disturbed	Existing Impervious Area To Be Disturbed	Future Impervious Area Within Disturbed Area
36.0	6.9	0.9	0.0

5. Do you plan to disturb more than 5 acres of soil at any one time? ● **Yes** ○ **No**

6. Indicate the percentage of each Hydrologic Soil Group(HSG) at the site.

A	B	C	D
3%	0%	0%	97%

7. Is this a phased project? ● **Yes** ○ **No**

8. Enter the planned start and end dates of the disturbance activities.

Start Date 04/01/2015 - **End Date** 08/01/2015

9. Identify the nearest surface waterbody(ies) to which construction site runoff will discharge.

Name

NYSDEC WETLAND WR-TWENTY SEVEN &

WR-TWENTY NINE

9a. Type of waterbody identified in Question 9?

- ○ Wetland / State Jurisdiction On Site (Answer 9b)
- ● Wetland / State Jurisdiction Off Site
- ○ Wetland / Federal Jurisdiction On Site (Answer 9b)
- ○ Wetland / Federal Jurisdiction Off Site
- ○ Stream / Creek On Site
- ○ Stream / Creek Off Site
- ○ River On Site
- ○ River Off Site
- ○ Lake On Site
- ○ Lake Off Site
- ○ Other Type On Site
- ○ Other Type Off Site

9b. How was the wetland identified?

- ● Regulatory Map
- ○ Delineated by Consultant
- ○ Delineated by Army Corps of Engineers
- ○ Other (identify)

10. Has the surface waterbody(ies) in question 9 been identified as a 303(d) segment in Appendix E of GP-0-15-002? ○ **Yes** ● **No**

11. Is this project located in one of the Watersheds identified in Appendix C of GP-0-15-002? ○ **Yes** ● **No**

12. Is the project located in one of the watershed areas associated with AA and AA-S classified waters? ○ **Yes** ● **No**
If no, skip question 13.

13. Does this construction activity disturb land with no existing impervious cover and where the Soil Slope Phase is identified as an E or F on the USDA Soil Survey? ○ **Yes** ○ **No**
If Yes, what is the acreage to be disturbed?

.

14. Will the project disturb soils within a State regulated wetland or the protected 100 foot adjacent area? ○ **Yes** ● **No**

15. Does the site runoff enter a separate storm sewer system (including roadside drains, swales, ditches, culverts, etc)? ● Yes ○ No ○ Unknown

16. What is the name of the municipality/entity that owns the separate storm sewer system?

Town of Warwick

17. Does any runoff from the site enter a sewer classified as a Combined Sewer? ○ Yes ● No ○ Unknown

18. Will future use of this site be an agricultural property as defined by the NYS Agriculture and Markets Law? ○ Yes ● No

19. Is this property owned by a state authority, state agency, federal government or local government? ○ Yes ● No

20. Is this a remediation project being done under a Department approved work plan? (i.e. CERCLA, RCRA, Voluntary Cleanup Agreement, etc.) ○ Yes ● No

21. Has the required Erosion and Sediment Control component of the SWPPP been developed in conformance with the current NYS Standards and Specifications for Erosion and Sediment Control (aka Blue Book)? ● Yes ○ No

22. Does this construction activity require the development of a SWPPP that includes the post-construction stormwater management practice component (i.e. Runoff Reduction, Water Quality and Quantity Control practices/techniques)? ○ Yes ● No
If No, skip questions 23 and 27-39.

23. Has the post-construction stormwater management practice component of the SWPPP been developed in conformance with the current NYS Stormwater Management Design Manual? ○ Yes ○ No

24. The Stormwater Pollution Prevention Plan (SWPPP) was prepared by:

- ● **Professional Engineer (P.E.)**
- ○ **Soil and Water Conservation District (SWCD)**
- ○ **Registered Landscape Architect (R.L.A)**
- ○ **Certified Professional in Erosion and Sediment Control (CPESC)**
- ○ **Owner/Operator**
- ○ **Other**

SWPPP Preparer: Engineering & Surveying Properties, PC

Contact Name (Last, Space, First): Winglovitz, Ross

Mailing Address: 71 Clinton Street

City: Montgomery

State: NY Zip: 12549-

Phone: 845-457-7727 Fax: 845-457-1899

Email: ross@ep-pc.com

SWPPP Preparer Certification

I hereby certify that the Stormwater Pollution Prevention Plan (SWPPP) for this project has been prepared in accordance with the terms and conditions of the GP-0-15-002. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of this permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings.

First Name: Ross **MI**:

Last Name: Winglovitz

Signature:

Date: 03/03/2015

25. Has a construction sequence schedule for the planned management practices been prepared? ● Yes ○ No

26. Select **all** of the erosion and sediment control practices that will be employed on the project site:

Temporary Structural

- ○ Check Dams
- ○ Construction Road Stabilization
- ● Dust Control
- ○ Earth Dike
- ○ Level Spreader
- ○ Perimeter Dike/Swale
- ○ Pipe Slope Drain
- ○ Portable Sediment Tank
- ○ Rock Dam
- ○ Sediment Basin
- ○ Sediment Traps
- ● Silt Fence
- ● Stabilized Construction Entrance
- ● Storm Drain Inlet Protection
- ○ Straw/Hay Bale Dike
- ○ Temporary Access Waterway Crossing
- ○ Temporary Stormdrain Diversion
- ● Temporary Swale
- ○ Turbidity Curtain
- ○ Water bars

Biotechnical

- ○ Brush Matting
- ○ Wattling

Vegetative Measures

- ○ Brush Matting
- ○ Dune Stabilization
- ○ Grassed Waterway
- ● Mulching
- ● Protecting Vegetation
- ○ Recreation Area Improvement
- ● Seeding
- ● Sodding
- ○ Straw/Hay Bale Dike
- ○ Streambank Protection
- ○ Temporary Swale
- ● Topsoiling
- ○ Vegetating Waterways

Permanent Structural

- ○ Debris Basin
- ○ Diversion
- ○ Grade Stabilization Structure
- ● Land Grading
- ○ Lined Waterway (Rock)
- ○ Paved Channel (Concrete)
- ○ Paved Flume
- ○ Retaining Wall
- ○ Riprap Slope Protection
- ○ Rock Outlet Protection
- ○ Streambank Protection

Other

Post-construction Stormwater Management Practice (SMP) Requirements

Important: Completion of Questions 27-39 is not required if response to Question 22 is No.

27. Identify all site planning practices that were used to prepare the final site plan/layout for the project.

- ○ **Preservation of Undisturbed Areas**
- ○ **Preservation of Buffers**
- ○ **Reduction of Clearing and Grading**
- ○ **Locating Development in Less Sensitive Areas**
- ○ **Roadway Reduction**
- ○ **Sidewalk Reduction**
- ○ **Driveway Reduction**
- ○ **Cul-de-sac Reduction**
- ○ **Building Footprint Reduction**
- ○ **Parking Reduction**

27a. Indicate which of the following soil restoration criteria was used to address the requirements in Section 5.1.6("Soil Restoration") of the Design Manual (2010 version).

- ○ All disturbed areas will be restored in accordance with the Soil Restoration requirements in Table 5.3 of the Design Manual (see page 5-22).
- ○ Compacted areas were considered as impervious cover when calculating the **WQv Required**, and the compacted areas were assigned a post-construction Hydrologic Soil Group (HSG) designation that is one level less permeable than existing conditions for the hydrology analysis.

28. Provide the total Water Quality Volume (WQv) required for this project (based on final site plan/layout).

Total WQv Required

☐☐☐.☐☐☐ **acre-feet**

29. Identify the RR techniques (Area Reduction), RR techniques(Volume Reduction) and Standard SMPs with RRv Capacity in Table 1 (See Page 9) that were used to reduce the Total WQv Required(#28).

Also, provide in Table 1 the total impervious area that contributes runoff to each technique/practice selected. For the Area Reduction Techniques, provide the total contributing area (includes pervious area) and, if applicable, the total impervious area that contributes runoff to the technique/practice.

Note: Redevelopment projects shall use Tables 1 and 2 to identify the SMPs used to treat and/or reduce the WQv required. If runoff reduction techniques will not be used to reduce the required WQv, skip to question 33a after identifying the SMPs.

Table 1 - Runoff Reduction (RR) Techniques and Standard Stormwater Management Practices (SMPs)

	Total Contributing Area (acres)		Total Contributing Impervious Area(acres)
RR Techniques (Area Reduction)			
○ Conservation of Natural Areas (RR-1) ...	___.___	and/or	___.___
○ Sheetflow to Riparian Buffers/Filters Strips (RR-2)	___.___	and/or	___.___
○ Tree Planting/Tree Pit (RR-3)	___.___	and/or	___.___
○ Disconnection of Rooftop Runoff (RR-4)..	___.___	and/or	___.___
RR Techniques (Volume Reduction)			
○ Vegetated Swale (RR-5)			___.___
○ Rain Garden (RR-6)			___.___
○ Stormwater Planter (RR-7)			___.___
○ Rain Barrel/Cistern (RR-8)			___.___
○ Porous Pavement (RR-9)			___.___
○ Green Roof (RR-10)			___.___
Standard SMPs with RRv Capacity			
○ Infiltration Trench (I-1)			___.___
○ Infiltration Basin (I-2)			___.___
○ Dry Well (I-3)			___.___
○ Underground Infiltration System (I-4)			___.___
○ Bioretention (F-5)			___.___
○ Dry Swale (O-1)			___.___
Standard SMPs			
○ Micropool Extended Detention (P-1)			___.___
○ Wet Pond (P-2)			___.___
○ Wet Extended Detention (P-3)			___.___
○ Multiple Pond System (P-4)			___.___
○ Pocket Pond (P-5)			___.___
○ Surface Sand Filter (F-1)			___.___
○ Underground Sand Filter (F-2)			___.___
○ Perimeter Sand Filter (F-3)			___.___
○ Organic Filter (F-4)			___.___
○ Shallow Wetland (W-1)			___.___
○ Extended Detention Wetland (W-2)			___.___
○ Pond/Wetland System (W-3)			___.___
○ Pocket Wetland (W-4)			___.___
○ Wet Swale (O-2)			___.___

Table 2 - Alternative SMPs (DO NOT INCLUDE PRACTICES BEING USED FOR PRETREATMENT ONLY)

Alternative SMP	Total Contributing Impervious Area(acres)
○ **Hydrodynamic**	___ . ___
○ **Wet Vault**	___ . ___
○ **Media Filter**	___ . ___
○ **Other** _____	___ . ___

Provide the name and manufacturer of the Alternative SMPs (i.e. proprietary practice(s)) being used for WQv treatment.

Name _____

Manufacturer _____

Note: Redevelopment projects which do not use RR techniques, shall use questions 28, 29, 33 and 33a to provide SMPs used, total WQv required and total WQv provided for the project.

30. Indicate the Total RRv provided by the RR techniques (Area/Volume Reduction) and Standard SMPs with RRv capacity identified in question 29.

Total RRv provided

___ . ___ **acre-feet**

31. Is the Total RRv provided (#30) greater than or equal to the total WQv required (#28).

○ **Yes** ○ **No**

If Yes, go to question 36.
If No, go to question 32.

32. Provide the Minimum RRv required based on HSG.
[Minimum RRv Required = (P)(0.95)(Ai)/12, Ai=(S)(Aic)]

Minimum RRv Required

___ . ___ **acre-feet**

32a. Is the Total RRv provided (#30) greater than or equal to the Minimum RRv Required (#32)?

○ **Yes** ○ **No**

If Yes, go to question 33.
Note: Use the space provided in question #39 to summarize the specific site limitations and justification for not reducing 100% of WQv required (#28). A detailed evaluation of the specific site limitations and justification for not reducing 100% of the WQv required (#28) must also be included in the SWPPP.
If No, sizing criteria has not been met, so NOI can not be processed. SWPPP preparer must modify design to meet sizing criteria.

33. Identify the Standard SMPs in Table 1 and, if applicable, the Alternative SMPs in Table 2 that were used to treat the remaining total WQv(=Total WQv Required in 28 - Total RRv Provided in 30).

Also, provide in Table 1 and 2 the total impervious area that contributes runoff to each practice selected.

Note: Use Tables 1 and 2 to identify the SMPs used on Redevelopment projects.

33a. Indicate the Total WQv provided (i.e. WQv treated) by the SMPs identified in question #33 and Standard SMPs with RRv Capacity identified in question 29.

WQv Provided

☐☐☐.☐☐☐ **acre-feet**

Note: For the standard SMPs with RRv capacity, the WQv provided by each practice = the WQv calculated using the contributing drainage area to the practice - RRv provided by the practice. (See Table 3.5 in Design Manual)

34. Provide the sum of the Total RRv provided (#30) and the WQv provided (#33a). ☐☐☐.☐☐☐

35. Is the sum of the RRv provided (#30) and the WQv provided (#33a) greater than or equal to the total WQv required (#28)? ○ **Yes** ○ **No**

If Yes, go to question 36.
If No, sizing criteria has not been met, so NOI can not be processed. SWPPP preparer must modify design to meet sizing criteria.

36. Provide the total Channel Protection Storage Volume (CPv) required and provided or select waiver (36a), if applicable.

CPv Required

☐☐☐.☐☐☐ **acre-feet**

CPv Provided

☐☐☐.☐☐☐ **acre-feet**

36a. The need to provide channel protection has been waived because:

○ Site discharges directly to tidal waters or a fifth order or larger stream.

○ Reduction of the total CPv is achieved on site through runoff reduction techniques or infiltration systems.

37. Provide the Overbank Flood (Qp) and Extreme Flood (Qf) control criteria or select waiver (37a), if applicable.

Total Overbank Flood Control Criteria (Qp)

Pre-Development

☐☐☐.☐☐☐ **CFS**

Post-development

☐☐☐.☐☐☐ **CFS**

Total Extreme Flood Control Criteria (Qf)

Pre-Development

☐☐☐.☐☐☐ **CFS**

Post-development

☐☐☐.☐☐☐ **CFS**

37a. The need to meet the Qp and Qf criteria has been waived because:

- ○ Site discharges directly to tidal waters or a fifth order or larger stream.
- ○ Downstream analysis reveals that the Qp and Qf controls are not required

38. Has a long term Operation and Maintenance Plan for the post-construction stormwater management practice(s) been developed? ○ **Yes** ○ **No**

If Yes, Identify the entity responsible for the long term Operation and Maintenance

39. Use this space to summarize the specific site limitations and justification for not reducing 100% of WQv required(#28). (See question 32a) This space can also be used for other pertinent project information.

40. Identify other DEC permits, existing and new, that are required for this project/facility.

○ Air Pollution Control

○ Coastal Erosion

○ Hazardous Waste

○ Long Island Wells

○ Mined Land Reclamation

○ Solid Waste

○ Navigable Waters Protection / Article 15

○ Water Quality Certificate

○ Dam Safety

○ Water Supply

○ Freshwater Wetlands/Article 24

○ Tidal Wetlands

○ Wild, Scenic and Recreational Rivers

○ Stream Bed or Bank Protection / Article 15

○ Endangered or Threatened Species(Incidental Take Permit)

○ Individual SPDES

○ SPDES Multi-Sector GP N Y R

○ Other

● None

41. Does this project require a US Army Corps of Engineers Wetland Permit? ○ **Yes** ● **No**
If Yes, Indicate Size of Impact. .

42. Is this project subject to the requirements of a regulated, traditional land use control MS4? ● **Yes** ○ **No**
(If No, skip question 43)

43. Has the "MS4 SWPPP Acceptance" form been signed by the principal executive officer or ranking elected official and submitted along with this NOI? ● **Yes** ○ **No**

44. If this NOI is being submitted for the purpose of continuing or transferring coverage under a general permit for stormwater runoff from construction activities, please indicate the former SPDES number assigned. N Y R

Owner/Operator Certification

I have read or been advised of the permit conditions and believe that I understand them. I also understand that, under the terms of the permit, there may be reporting requirements. I hereby certify that this document and the corresponding documents were prepared under my direction or supervision. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further understand that coverage under the general permit will be identified in the acknowledgment that I will receive as a result of submitting this NOI and can be as long as sixty (60) business days as provided for in the general permit. I also understand that, by submitting this NOI, I am acknowledging that the SWPPP has been developed and will be implemented as the first element of construction, and agreeing to comply with all the terms and conditions of the general permit for which this NOI is being submitted.

Print First Name: Tony

MI:

Print Last Name: Abbatine

Owner/Operator Signature:

Date: / /

NYS Department of Environmental Conservation
Division of Water
625 Broadway, 4th Floor
Albany, New York 12233-3505

MS4 Stormwater Pollution Prevention Plan (SWPPP) Acceptance Form

for

Construction Activities Seeking Authorization Under SPDES General Permit

*(NOTE: Attach Completed Form to Notice Of Intent and Submit to Address Above)

I. Project Owner/Operator Information
1. Owner/Operator Name:
2. Contact Person:
3. Street Address:
4. City/State/Zip:
II. Project Site Information
5. Project/Site Name:
6. Street Address:
7. City/State/Zip:
III. Stormwater Pollution Prevention Plan (SWPPP) Review and Acceptance Information
8. SWPPP Reviewed by:
9. Title/Position:
10. Date Final SWPPP Reviewed and Accepted:
IV. Regulated MS4 Information
11. Name of MS4:
12. MS4 SPDES Permit Identification Number: NYR20A _____
13. Contact Person:
14. Street Address:
15. City/State/Zip:
16. Telephone Number:

MS4 SWPPP Acceptance Form - continued

V. Certification Statement - MS4 Official (principal executive officer or ranking elected official) or Duly Authorized Representative

I hereby certify that the final Stormwater Pollution Prevention Plan (SWPPP) for the construction project identified in question 5 has been reviewed and meets the substantive requirements in the SPDES General Permit For Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). Note: The MS4, through the acceptance of the SWPPP, assumes no responsibility for the accuracy and adequacy of the design included in the SWPPP. In addition, review and acceptance of the SWPPP by the MS4 does not relieve the owner/operator or their SWPPP preparer of responsibility or liability for errors or omissions in the plan.

Printed Name:

Title/Position:

Signature:

Date:

VI. Additional Information

(NYS DEC - MS4 SWPPP Acceptance Form - January 2015)

APPENDIX 9

NOTICE OF GROUND DISTURBANCE

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Print Form

Town of Warwick
Notice of Ground Disturbance

Please complete this form and submit it to the Town of Warwick Planning or Building Department for land disturbance greater than 0.25-acres. "Land Development Activity" resulting in Ground Disturbance is defined as all activities including clearing, grubbing, grading, excavating, stockpiling, placement of fill, paving, installation of utilities, and construction of buildings or structures that result in soil disturbance. This form will enable the Town of Warwick staff to assist Applicants in meeting local stormwater standards.

Landowner's Name: The Warwick Yard, LLC Date: 01-19-2015

Mailing Address: 24 old Black Meadow Road; Chester, NY 10918

Phone Number: (845) 469-7331 Fax Number: (845) 469-6742 Email: tony.abbatine@frozenropes.com

Project Applicant (If different than Owner):

Mailing Address:

Phone Number: Fax Number: Email:

Project Site Address/Location: 122 State School Road; Warwick, NY 10990

Tax Parcel(s) S-B-L: 46-1-34.12

Brief Description of the Project: Removal of existing impervious structures for the installation of two (2) athletic fields and the rehabilitation of an existing athletic field.

(Attach additional sheets as necessary and include a sketch of the proposed project)

Project and Site Characteristics

1. Will the project involve multiple phases? ◉ YES ○ NO If YES, how many phases? 3

2. What is the shortest distance from the project area of disturbance to the edge of any stream, pond, lake, or wetland in the vicinity of the project? (in Feet) > 100'

3. Are there any mapped wetland areas on site or within 100-ft of the property? If YES, check applicable boxes below: ◉ YES ○ NO

☒ NYSDEC Wetlands ☒ USACE Wetlands

4. Describe the slopes on site, including percent & areal extent (e.g. steep or flat areas, stream banks, gullies, bluffs, etc.)

82% (0-10% slopes), 6% (10-15%), 6% (15-25%), 6% (>25%)

5. Will the project include a linear excavation that is more than 500 feet long and 3 feet wide? ○ YES ◉ NO

6. Will the project involve excavation or fill resulting in the movement of more than 250 CY of soil, sand or similar material? ◉ YES ○ NO

7. Will the project require any State of Federal environmental permits? ○ YES ◉ NO

List Permit(s):

8. Do connected proposed impervious areas exceed 1/2 acre? (if YES, a Full SWPPP is required) ○ YES ◉ NO

9. Area Tally

Fill in the approximate area to be disturbed by each of the following, in square feet, as applicable. If more than five acres is being disturbed, then a Full SWPPP is necessary and the information below can be included in the Full SWPPP when it is prepared.

Driveway		Parking Area	
House/Main Building		Other Buildings	
Grading/Clearing/Lawn		Utility Laying	
Drainage Structures		Drainage Ditches	
Additional Areas		(for construction access, stockpiling, etc)	
Total Area	See SWPPP	**(do not total overlapping areas)**	

10. Is the project considered redevelopment, as defined by Chapter 9 of the DEC's Design Manual? ◉ YES ○ NO

11. Total Parcel Area (Acres) 36.0±

12. Total area of existing impervious surface prior to development 0.9

13. Total area of impervious surface proposed after project completion 0.0

Signature of Applicant Tony Abbatine Date 01-19-2015

For Town Use Only

Required Action: ☐ **None** ☐ **Simple SWPPP** ☐ **Intermediate SWPPP** ☐ **Full SWPPP**

APPENDIX 10

CONSTRUCTION WASTE MANAGEMENT & SPILL PREVENTION PLANS

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CONSTRUCTION WASTE MANAGEMENT & SPILL PREVENTION PLAN

Early in the construction activities, land clearing materials will be collected and recycled either off-site or re-used on site as erosion control materials. During early phase construction activities, cardboard, concrete, metal, wood and general trash collection dumpsters will be on site for collection and processing. As the project progresses, concrete dumpsters will be changed over to drywall collection, site clearing dumpsters will be changed over to finish material containers, etc. Typically, two (2) open top containers will be on site for the duration of the project. General waste and cardboard/paper containers will be on site for the duration of the project. The contractor will be responsible for organizing and placing containers on site and timely removal/replacement when containers are filled to capacity. As necessary, the contractor will provide areas of collection or hoppers for subcontractors to utilize for intermediate storage of construction and demolition (CD) materials. All containers will be clearly identified with signage indicating stored materials.

Those CD materials generated on this project will be salvaged and re-processed as listed. The contractor will research available processing sources specific to the job site and make all trades aware of project qualifying CD recyclable materials as follows:

Brick: Materials will be stored on site and palletized by processor who will resell as product.

Cardboard: Materials will be separated on the jobsite and stored within dedicated on-site dumpster and delivered loose to processor. Processor will bale materials and deliver/resell to end market users.

Concrete: Scrap and loose materials will either be crushed on site and used for aggregate or stored within dedicated on-site dumpster and delivered to processor. Processor will reuse or resell materials as clean fill back or crush and use for aggregate.

Metals: Materials will be sorted and stored within dedicated on-site dumpster and delivered to processor. Processor will sell materials to metal recyclers (steel, aluminum, brass, copper, lead, stainless).

Stone and Granite: Materials will be collected on site in piles or containers and processor will palletize and haul materials. Processor will re-sell as product or crushed and use as aggregate.

Plastic, paper goods, and aluminum cans: Materials will be collected on job site within construction trailers, cantina areas, etc. and stored in on-site trailers. Materials will be hauled/recycled by processor.

Drywall: Waste materials will be sorted and collected in dedicated on-site containers or materials will be ground on site and used as an erosion control product. Hauled materials to processor will be processed as a soil amendment or used in alternate fuel mixture.

Wood or Lumber: Materials will be sorted and stored on-site within dedicated on-site containers and either resold as retail lumber by processor or ground and mixed with commercial land clearing and/or approved materials for erosion control applications. Lumber will need to be clean, no paint or other wood treatment.

Land Clearing Debris: Woody materials (stumps, large limbs) will be ground on-site and used for soil erosion control products or hauled to processor to be ground as re-sold as erosion control products.

Roofing Shingles: Materials will be stored on site and processed as temporary road base, mixed into hot asphalt mix or used as alternate fuel blend or hauled offsite via appropriate methods to an authorized disposal/recycling facility.

Fuel Tanks: On site storage of fuel chemicals shall be equipped with a spill kit. The contractor must provide secondary containment for storing any hazardous chemicals on site.

Equipment storage: All equipment stored on site shall be inspected daily by the contractor for any oil or lubricant spills or leaks. Any leaks shall be repaired immediately. In addition all equipment must be closely inspected prior to working in the Town R.O.W.

Spill Response: The contractor shall clean all spills immediately and shall report all spills to the New York State Department of Environmental Conservation.

This Plan will be displayed in the construction jobsite trailer at all times.