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STORMWATER REPORT

for

BARLOW TRAIL VETERINARIAN CLINIC

38952 PIONEER BLVD
SANDY, OR 97055

JULY 2022

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0.0 PROJECT INFORMATION

0.1 CLIENT:

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0.2 REVIEWING AGENCY:

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0.3 PROJECT ENGINEER:

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1.0 PROJECT OVERVIEW AND DESCRIPTION

The intent of this report is to demonstrate stormwater management and jurisdictional flow control requirements for the City of Sandy's storm recurrence interval using a regional water quality treatment facility sized according to the City of Portland 2020 Stormwater Management Manual and a regional stormwater detention facility.

1.1 PROJECT DESCRIPTION

Proposed are commercial, residential and public improvements in a clustered development. Proposed for the commercial lots at the north is a new veterinary clinic building with parking. Required frontage improvements are proposed for Junker Street and Strauss Avenue. Residential development for the southern lots is sketched in to size a stormwater management system that has the capacity to capture, treat, manage, and convey these proposed improvements in a regional stormwater management system (SWMS).

1.2 EXISTING CONDITIONS

Pioneer Boulevard: Frontage along Pioneer features a completed street width, existing curb and gutter, and public sidewalks. Drainage from the Pioneer Boulevard frontage discharges to the north and is not part of the SWMS.

Strauss Avenue: Strauss is a one-way street heading south along the west property line of the proposed veterinary clinic. The street is not crowned and runoff sheets over the surface of the street, by grade, toward the southwest.

Junker Street: Junker Street is a one-way street heading east along the southern property line of the proposed veterinary clinic. A ditch inlet to a piped stormwater system sits just south of the edge of existing pavement and conveys stormwater westerly down the alley and to the storm system connected there. The street is not crowned and runoff sheets over the paved surface to the ditch inlet.

Junker Alley: Junker Alley is graveled running east-to-west with both storm and sanitary utility lines.

Commercial Lots: The commercial lots to the north are being redeveloped together as a veterinarian clinic. Previous buildings/development on these lots has already been demolished and the lots have largely been cleared with the current appearance of an open, sloped, grassy field.

Residential Lots: The residential lots to the south have some outbuildings present from previous development located onsite, but remain largely undeveloped. Much of the property is sloped greater than 10% (but less than 25%) and the southern edge of the property line overlooks Tupper Road. There is a ditch inlet located on the north side of Tupper Road that is the proposed stormwater utility connection.

Please see Appendix A for the Pre-Development Basin Map.

2.0 METHODOLOGY

New development on the site creates new impervious surfaces. Stormwater runoff from these surfaces will be collected, treated for water quality (where required), and detained for slow release to mimic historic discharge rates.

2.1 DRAINAGE AND CONVEYANCE

Historic stormwater runoff discharge limits were determined for the entire site using the surface cover of pasture in good condition and existing development. See Appendix A for both the Pre-Development and Post Development Basin Maps.

2.2 INFILTRATION TESTING RESULTS

Infiltration testing was conducted by Rapid Soil Solutions on 2/26/2021. The measured infiltration rates were 1.2 and 1.1 in/hr. With a safety factor of 2 – this leaves a design infiltration rate of 0.55 in/hr. See Appendix B for infiltration test results from the Geotechnical Report.

However, the regional water quality planter is located on a site with >10% slopes and the local soil profile is clay starting from about 1' bgs until the measured depth of boring at about 4'. See Appendix B for boring logs from the Geotechnical Report.

The NRCS custom soil survey estimated the clay layer to continue to about 75" or 6.25' bgs. Please see Appendix C for the custom soil survey.

Due to the presence of a thick clay subsurface layer with the possibility of perched groundwater, surface slopes in excess of 10%, and the location of the water quality planter upslope of the stormwater discharge location; infiltration is not used for this SWMS. The water quality planter is lined to prevent saturating the slope and all runoff is managed through the detention pipe.

2.3 PROPOSED STORMWATER SYSTEMS

Pioneer Boulevard: Improvements along Pioneer include the placement of four new street trees, the widening of the public sidewalk and connecting to the proposed veterinary clinic entrance with a paved plaza. Each new street tree has a 4'x4' pervious planter – adding new pervious area to the existing paved sidewalk and creating a tree canopy for stormwater management adding stormwater management benefits from interception, throughfall, transpiration, and infiltration from new proposed street trees. The total new impervious area created by required development but draining to a separate storm system include 330 SF of new public sidewalk.

STORMWATER MANAGEMENT IN EXCHANGE	(SF)
UNCAPTURABLE NEW IMPERVIOUS TOTAL	**3761**
PIONEER BOULEVARD	330
JUNKER ALLEY	3431
EXISTING IMPERVIOUS AREA MANAGED IN EXCHANGE	
(E) PAVEMENT STRAUSS AVENUE	3983
(E) PAVEMENT TREATED AS NEW IN EXCHANGE	3761
REMAINING (E) PAVEMENT STRAUSS ROW	222

Other impervious area proposed by development but not capturable to the proposed SWMS is runoff from the lower end of Junker Alley for a total of 3,431 SF. This amount of impervious surface will be deducted from existing impervious surfaces from Strauss Ave so as to provide stormwater management for the proposed impervious surfaces that are not captured to the SWMS by treating existing impervious area that will be captured to the SWMS in exchange.

Strauss Avenue: Strauss frontage improvement require a half street improvement, crowned at centerline, with parking taken from the available planting strip, and a public sidewalk w/ ADA ramp access. A catch basin has been sited at the low point in the southeast corner of the parking to capture the increased impervious area required by these frontage improvements and convey the runoff to a water quality facility.

Junker Street: Junker frontage improvements include providing the full paved width for Junker, crowned at centerline, with required curbing, public sidewalk, and stormwater management. Proposed development will drain to the proposed catch basins in the street before being conveyed to the water quality planter for water quality treatment and then detained before being discharged to match historic conditions.

Junker Alley: Junker Alley will need to be paved for proposed development of the row townhouses, but not all of it is capturable to the SWMS. The capturable portions of this proposed development will drain to the proposed catch basins in the street before being conveyed to the water quality planter for water quality treatment and then detained before being discharged to match historic conditions.

OFFSITE PROPOSED DEVELOPMENT

CATCHMENT (SF)	PRE-DEV[1]	POST DEV	IMPERVIOUS INCREASE	TOTAL AREA TO SWMS	PRE-DEV[2]	POST DEV
TOTAL ROW	**24772**			**15277**	**15277**	
TOTAL PAVEMENT	*11885*	*22811*	**10926**	**13768**	**2842**	**13768**
TOTAL GREEN SPACE	*12887*	*1961*		**1509**	**12435**	**1509**
PIONEER ROW	**6064**		--	--		
PAVEMENT	*5282*	*5612*	*330*	--	--	--
GREEN SPACE	*782*	*452*	--	--	--	--
STRAUSS ROW	**6545**		--	--		
PAVEMENT	*3983*	*5092*	*1109*	*5092*	222	5092
GREEN SPACE	*2562*	*1453*	--	*1453*	6323	1453
JUNKER ROW	**5123**		--	--		
PAVEMENT	*2620*	*5067*	*2447*	*5067*	2620	5067
GREEN SPACE	*2503*	*56*	--	*56*	2503	56
JUNKER STREET	**3609**		--	--		
PAVEMENT	*0*	*3609*	*3609*	*3609*	0	3609
GREEN SPACE	*3609*	*0*	--	*0*	3609	0
JUNKER ALLEY	**3431**		--	--		
PAVEMENT	*0*	*3431*	*3431*	--	--	--
GREEN SPACE	*3431*	*0*	--	--	--	--

[1]SWMS ALLOWABLE DISCHARGE BASED ON (E) CONDITIONS W/ GREEN SPACE AS PASTURE

[2]ACCOUNTING FOR EXCHANGE TREATS 3761 SF OF (E) PAVEMENT FROM STRAUSS AVE AS NEW PAVEMENT

Commercial Lots: Proposed development on the commercial lots is a single-story building with a tall crawl space. The veterinary clinic has been sited so that all roofline runoff from the commercial building and all runoff from new pavement can be captured, treated for water quality, and detained before being discharged at a rate to match historic flow control conditions

Residential Lots: Proposed for the southern residential lots are row townhouses with the required improvements. The residential roofline will be collected and detained to mimic historic conditions. Runoff from paving will be directed to a water quality planter and then detained before being discharged to match historic conditions.

ONSITE PROPOSED DEVELOPMENT

CATCHMENT AREA (SF)	PRE-DEV	POST DEV	TO SWMS*
TOTAL ONSITE	***48333***		***48333***
TOTAL IMPERVIOUS	***13***	***39332***	***39332***
TOTAL GREEN SPACE	***48320***	***9001***	***9001***
COMMERCIAL SITE	**20768**		**20768**
COMMERCIAL ROOF		*6903*	*6903*
PAVEMENT	*13*	*8821*	*8821*
GREEN SPACE	*20755*	*5044*	*5044*
RESIDENTIAL SITE	**27565**		**27565**
RESIDENTIAL ROOF		16989	16989
PAVEMENT		4763	4763
WQ PLANTER		1856	1856
GREEN SPACE	27565	3957	3957

See Appendix A for the Post Development Basin Map.

3.0 ANALYSIS

Dynamic Storage-Indication routing of the SBUH runoff method for design storm were modeled in HydroCAD to determine historic flow control requirements for this proposed re-development and to model stormwater facility performance for design selection.

3.1 Design Assumptions

24-HR RAINFALL

DESIGN STORM	(IN)
2-YR	3.50
5-YR	4.50
10-YR	4.80
25-YR	5.50
100-YR	6.50

CURVE NUMBERS

C_N	DESCRIPTIONS
98	ROOFS
98	PAVEMENT
98	PLANTER
74	C-SOILS; LANDSCAPING
74	C-SOILS; HISTORIC PASTURE

Constraints: Hydrologic Soil Group: C

3.2 HydroCAD Results

Flow control is provided. Post development discharges are demonstrated to match pre-development total discharge calculations.

FLOW CONTROL RESULTS FOR 24-HOUR DESIGN STORM EVENT

PEAK FLOW RATE (CFS)				TIME OF CONCENTRATION (MIN.)	
DESIGN STORM	PRE-DEV	TARGET	Q TOTAL	PRE	POST
2-YR	0.353	*0.35*	0.35	12.3	5.0
5-YR	0.613	*0.61*	0.53	12.3	5.0
10-YR	0.697	*0.70*	0.65	12.3	5.0
25-YR	0.901	*0.90*	0.90	12.3	5.0

Please see Appendix D for HydroCAD results.

3.3 Downstream Analysis

Adverse effects to the downstream capacity of the system are not anticipated. This site is not located in an area of limited downstream capacity. Proposed total site stormwater discharge is less than or matches the calculated historic discharge.

4.0 ENGINEERING CONCLUSIONS

4.1 RETENTION

Infiltration is not used in the SWMS due to site slope constraints and subsurface soil composition.

4.2 WATER QUALITY

Water quality treatment is accomplished using filtration and bioremediation in vegetated stormwater facility.

WATER QUALITY PLANTER SIZING	(SF)
TOTAL NEW IMPERVIOUS AREA FROM ROW	**7165**
STRAUSS	1109
JUNKER ROW	2447
JUNKER STREET	3609
TOTAL NEW IMPERVIOUS AREA FROM ONSITE	**20487**
COMMERCIAL ROOF	6903
COMMERCIAL PAVEMENT	8821
RESIDENTIAL PAVEMENT	4763
TOTAL NEW IMPERVIOUS AREA TO WQ PLANTER	**27652**
WQ PLANTER SIZING FACTOR	0.06
WQ PLANTER REQUIRED SIZE	1659
WQ PLANTER BOTTOM AREA PROVIDED	**1672**

4.3 FLOW CONTROL

Flow Control is accomplished by collecting stormwater runoff to a detention pipe where flow control is provided for post development storm discharges to match historic discharge flow rates.

Flow control targets were met in the HydroCAD model and results are tabulated and shown in Section 3.2.

4.4 FACILITY MAINTENANCE

The Water Quality Planter and Detention Pipe will have regular maintenance activities. These facilities will be maintained by the property owner under the direction of the City.

APPENDIX A

Basin Maps

ONSITE PROPOSED DEVELOPMENT

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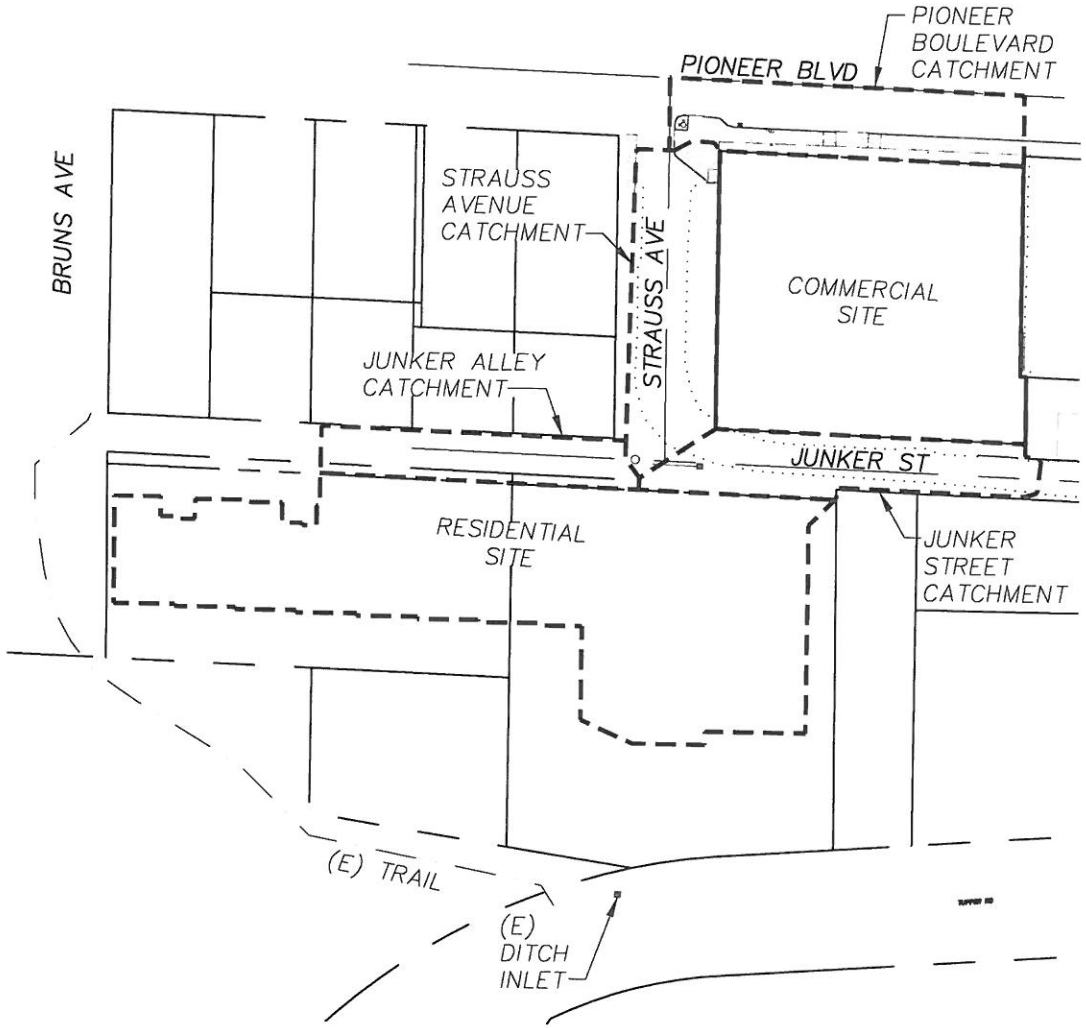
RESIDENTIAL SITE	**27565**	
RESIDENTIAL ROOF		16989
PAVEMENT		4763
WQ PLANTER		1856
GREEN SPACE	27565	3957

ROW PROPOSED DEVELOPMENT		
CATCHMENT AREA (SF)	**PRE-DEV**	**POST DEV**
TOTAL ROW	***24772***	
TOTAL PAVEMENT	*8124*	*22811*
TOTAL GREEN SPACE	*16648*	*1961*
PIONEER BOULEVARD*	**6064**	
PAVEMENT	*5282*	*5612*
GREEN SPACE	*782*	*452*
STRAUSS AVENUE	**6545**	
PAVEMENT**	*222*	*5092*
GREEN SPACE	6323	*1453*
JUNKER STREET	**5123**	
PAVEMENT	*2620*	*5067*
GREEN SPACE	*2503*	*56*
JUNKER ALLEY	**3609**	
PAVEMENT	*0*	*3609*
GREEN SPACE	*3609*	*0*
UNCAPTURED DEVELOPMENT*	**3431**	
PAVEMENT	0	3431
GREEN SPACE	3431	0

*CATCHMENTS DO NOT CONTRIBUTE TO SWMS

**(E) PAVEMENT REDUCED IN EXCHANGE



PRE-DEVELOPMENT

NORTH

SCALE: 1" = 80'

0 20 40 80 160

ONSITE PROPOSED DEVELOPMENT

CATCHMENT AREA (SF)	PRE-DEV	POST DEV
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GREEN SPACE	*3609*	*0*
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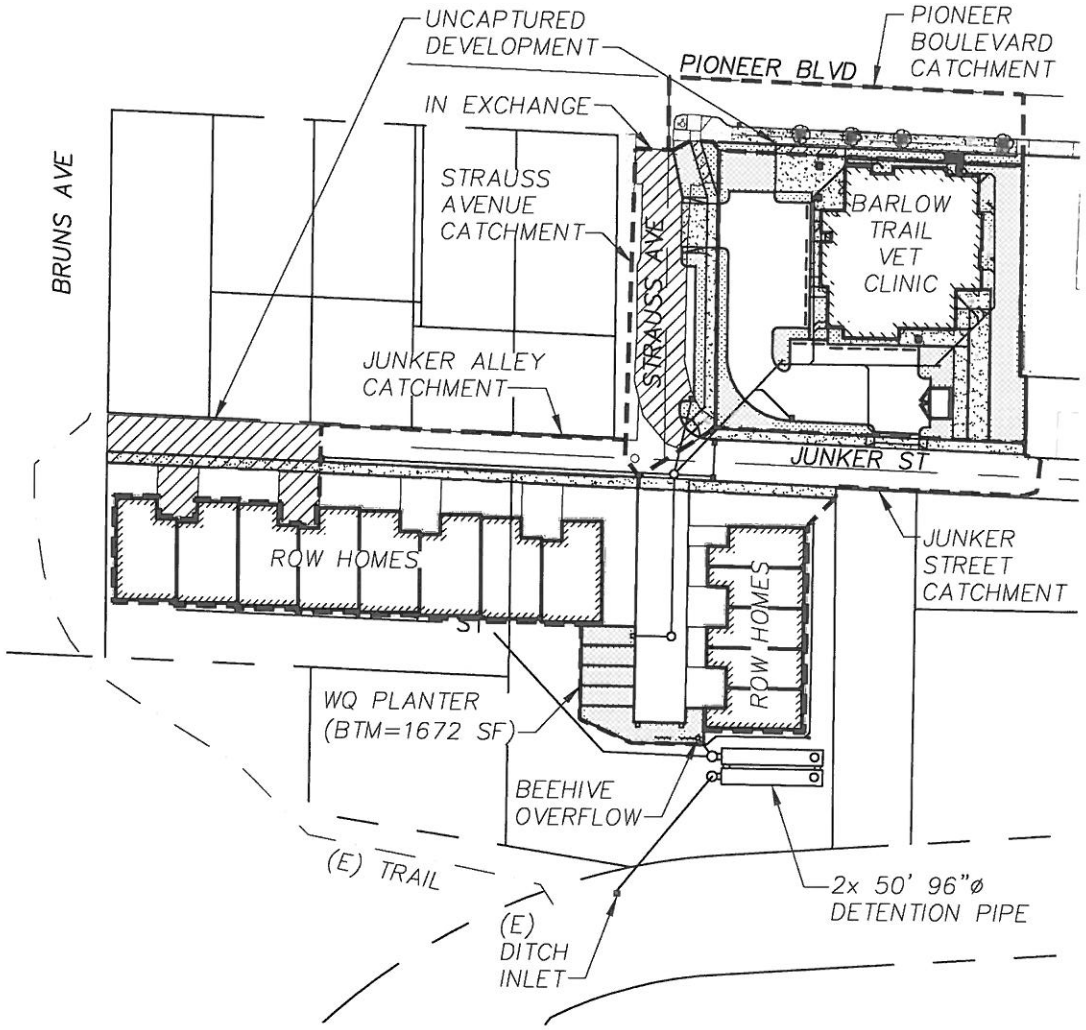
PAVEMENT	0	3431
GREEN SPACE	3431	0

*CATCHMENTS DO NOT CONTRIBUTE TO SWMS
**(E) PAVEMENT REDUCED IN EXCHANGE



POST DEVELOPMENT NORTH

SCALE: 1" = 80'

0 20 40 80 160

APPENDIX B

Geotechnical Report

GEOTECHNICAL REPORT

38952 Pioneer Blvd
Sandy, Oregon

For
Barlow Trail Veterinary Clinic, LLC
4 March 2021

Rapid Soil Solutions INC
3915 SW Plum Street
Portland, OR 97219
503-816-3689

Introduction

Rapid Soil Solutions Inc (RSS) has prepared this geotechnical report, as requested, for three Clackamas County tax parcels currently assigned the state tax lot identification numbers of 24E13CA05500, 24E13CA05600, and 24E13CA05700. RSS understands that the proposed development will place a new, 5,698 square foot veterinary clinic in the northern end of the site, adjacent to Pioneer Blvd, and a 6-space parking lot in the southern end off the site, accessed off Junker Street. Together the three parcels encompass about 0.34 acres in the historic downtown of Sandy, Oregon. The parcel extends between Pioneer Blvd and Junker Street, roughly 50 feet east of Strauss Ave and 100 feet west of Shelley Ave. Street addresses referencing portions of the site include 38952 Pioneer Blvd and 38953 Junker St.

The subject site is located near the center of Sandy, Oregon (97055). It is about 0.95 miles south of the Sandy River, 0.39 miles east of Bluff Road, and 0.13 miles west of Meinig Ave/OR-211. The site is located in the Junkers Addition to Sandy, occupying lots 2 and 3 in block 3 as well as the western 3 feet of the southern 40 feet of lot 4. It is positioned directly west of 38982 Pioneer Blvd (Sandy Community Action Center and Thrift Store) and 38975 Junker St. The site can be found in the northeast quarter of the southwest quarter of Section 13, Township 2-South, Range 4-East (W.M.) in Clackamas County and can be distinguished by the lot numbers 5500, 5600, and 5700. The latitude and longitude of the site are 45.396107 and -122.262494 (45°23'46.0"N, 122°15'45.0"W). The site can be found in the southeast quarter of the Sandy 7.5-minute quadrangle (NE ¼ of the Boring 15' Quad).

SITE CONDITIONS

Surface Conditions

The subject parcel encompasses 0.34 acres in the city of Sandy, Oregon. The site is positioned within the historic downtown area, local properties were originally developed along this stretch of Pioneer Blvd as early as 1873. The site and surrounding properties were historically developed, but only the commercial structure at 38982 Pioneer Blvd (built 1954) and the dwelling at 38975 Junker Street (built 1945) remain on the local block. The Junker subdivision is named for the Junker family/Casper Junker, who moved to the area in 1888; the Mr. Junker was a hotel owner, saloon owner, restauranteur, land developer, and builder/operator of commercial and rental buildings. At the site, Pioneer Blvd (US-26) is a two-lane one-way road with a bike lane on the southern side of the road, as well as sidewalks and street parking on both sides of the road. Junker Street and the associated sections of Strauss and Shelley Avenues are paved, narrow residential roads without shoulders, curbs, or sidewalks. Junker Street is a one-way road with traffic flowing eastward.

The local region is relatively developed with commercial properties along Pioneer Blvd (US-26), which quickly transition to residential properties south of the main drag. The 1997 comprehensive plan denotes the subject site and most adjacent properties as retail and commercial space. The land area adjacent to the southern end of the site is mapped for high density residential development in the comprehensive plan.

General Conditions

The subject site is currently occupied by a short-cropped lawn. There are no structures on the property. There are no major trees on the property. The site historically contained a single-family dwelling and a detached garage; a small concrete pad is located within the footprint of that dwelling. The grass texture and density are slightly different within the footprint of the now demolished structure. The northern edge of the property abuts the sidewalk along Pioneer Blvd and is at the same grade as the concrete. The southern end of the structure abuts the asphalt edge of Junker Street; a very slight southward slope in present along the southern margin of the site. The eastern property line contain fencing separating the parcel from the adjacent structures. The western property margin is un-marked, with the grass lawn extending across the subject site and the parcel adjacent to the west.

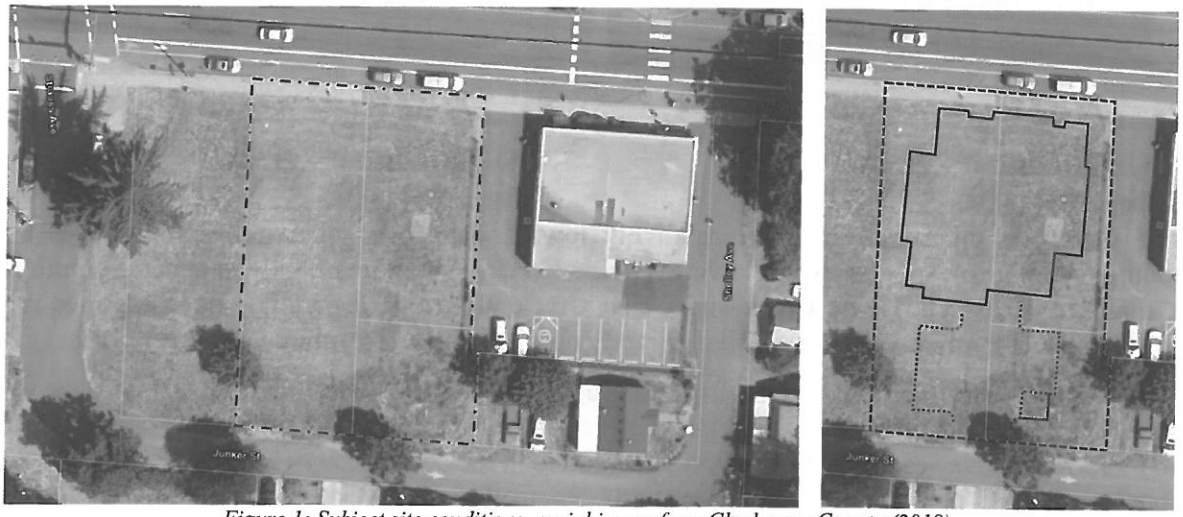


Figure 1: Subject site conditions, aerial image form Clackamas County (2018).

Historic Site Conditions

Historic aerial imagery dating back to 1952 was referenced as part of this investigation.

Imagery from 1952 through 1956 depicts the local block to contain three primary structures along Pioneer Blvd. Between 1956 and 1960, the dwelling structure at the corner of Pioneer Blvd and Shelley Ave was replaced by a commercial structure. The buildings in the northwestern corner of the stie appear to be a pair of structure, with commercial segment and a residential segment. On the subject parcels, the dwelling in the northeastern corner of the site as well as the garage in the southeastern corner of the stie are both visible in these early images.

Conditions within the subject parcel appear to remain consistent from 1952 through at least 2016. Between 2016 and 2018, both structures within the subject stie were removed. Additionally, the structures at the southeast corner of Pioneer Blvd and Strauss Ave were also removed. The site appears to have remained vacant and undeveloped since at least 2018. Small remnants from the structures once standing on the subject site, including a small concrete pad, remain on the parcel.

Figure 2: Subject stie conditions. LEFT: 2016. RIGHT: 2018.

Slopes

The slopes on the subject site are relatively low. Local slopes descending southwards and southwestward, towards the west-flowing Trickle Creek. Downtown Sandy is generally built on a slight rise between Tickle Creek and Cedar Creek; the ridge separating slope regimes runs between Proctor Blvd and Pioneer Blvd, directly north of the subject site.

Two-foot contours presented by Metro Map suggest that there is less than 8 feet of elevation change across the subject site. The highest elevation is in the northeastern corner, between 980- and 982-feet above sea level. The lowest elevation is in the southwestern corner at about 974 feet above sea level. The average slope is roughly 5% to the southwest. Portland Maps includes a slope model derived from a 5-ft DEM, this slope model incites that the slopes within the subject site are generally less than 5% (blue) with small areas falling in the slope regime of 5-10% (green) and 10-15% (yellow). South of the subject stie the slopes increase to includes areas of 15-20% slopes (orange) and greater than 20% slopes (red).

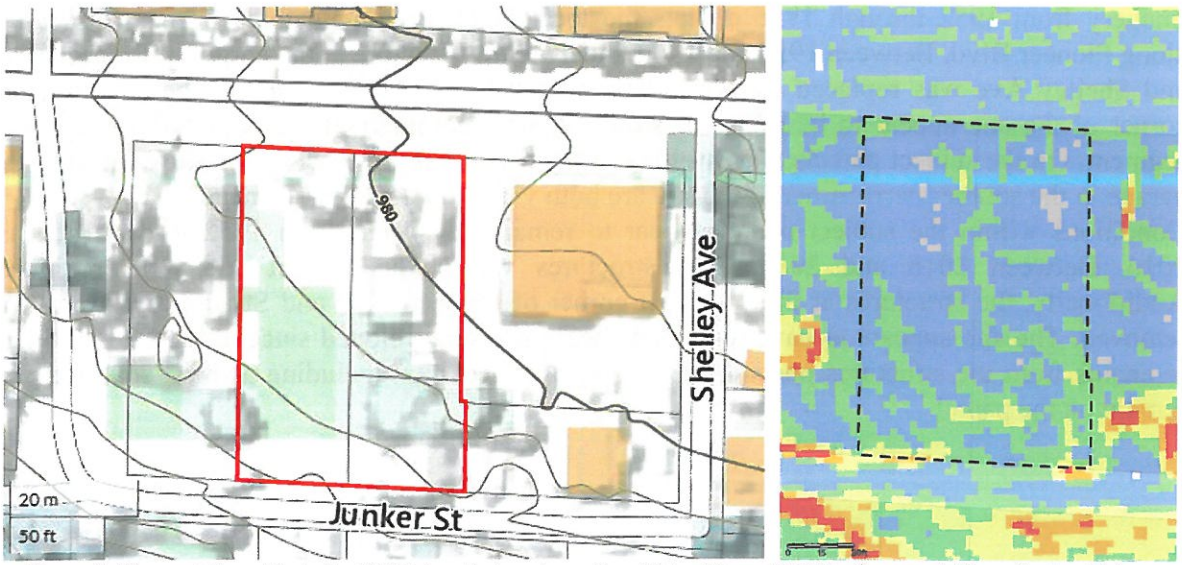


Figure 3: Slopes at the subject site. LEFT: two-foot contours from Metro Maps. RIGHT: slope model from Portland Maps.

Lidar imagery of the subject site and surrounding areas depicts relatively smooth slopes. Minor grading appears to have occurred with the installation of local roadways, as is typical. No morphology indicative of substantial grading is observed on or adjacent to the subject site. No morphology typically associated with landslides is observed on or adjacent to the subject site.

Geology

Current geologic literature classifies the slopes underlaying the subject site as "Older gravel of Cascade Arc origin" (Wells et al, 2020). These gravels have also been classified by various workers as ancient river rocks (Ma et al, 2012), Pliocene-Pleistocene gravels (Schlicker & Finlayson, 1979), and the conglomerate member of the Springwater formation (Trimble, 1963). The local subgrade is comprised of unconsolidated sand and sandy to cobbly gravels. This deposit is generally found southeast of Powell Butte/Happy Valley and extends from the Sandy River to the Clackamas River. It underlays the entirety of the City of Sandy.

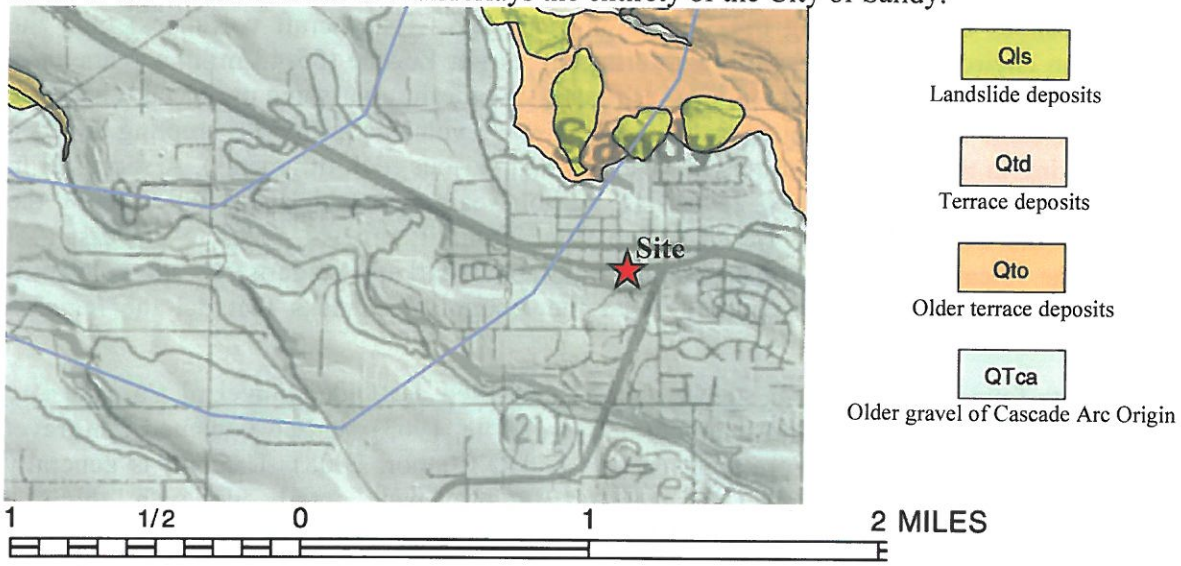


Figure 4: Geology at the subject site. Excerpt from Wells et al, 2020.

Geologic History

The subject site is generally situated within the forearc basin of the Cascadia subduction system between the Cascade Range (volcanic arc) and the Coastal Range (accretionary/subduction complex). The site is tucked along the eastern margin of the Portland Basin. This basin is part of a series of topographic and structural depressions that constitute the Puget-Willamette forearc trough of the Cascadia subduction system. It is a relatively low-relief valley, characterized by broad, flat, lowlands surrounded by prominent uplands controlled primarily by structural features (faulting and folding) in the underlying bedrock. Tectonic compressional stress, associated with the subduction zone and associated mountain building, both initiated basin development and produced prolonged the basin's enlargement. This basin contains a thick accumulation of material that preserves a complex record of deposition and erosion (aggradation and incision)

produced by the lakes and rivers that that flowed through the basin concurrent with its development.
The basin is floored by flows of the Columbia River Basalt Group; the lacustrine and fluvial sediments found within the basin were emplaced after the massive basalt flows. About 360 meters of sediments can be found in the Tualatin and northern Willamette Basins, about 600 meters of sediment can be found in the deepest sections of the Portland Basin. The gravels at the subject site are among the younger basin fill sediments and are part of an unnamed conglomerate where the clasts are generally derived from the nearby Cascade Range mountains. This unit interfingers with igneous deposits of the Boing Lava fields.
East of the subject site the slopes ascend into the High Cascade Range. The mountainous Cascade Range has formed over the past 40 million years. Roughly 200 million years ago, the Farallon oceanic plate began to subduct below the more buoyant continent of North America. This process scraped materials off of the oceanic plate and onto the edge of the continent resulting in the accretion of terrains and a large amount of ocean floor sediments, volcanic island chains and basalts from underwater volcanoes. Then, during the late Eocene, the earliest Cascade Range volcanoes began erupting (43-37 million years ago – Northcraft volcanoes) onto the coastal plain environment that has formed during the earlier Eocene (55-43 million years ago). Much of this volcanism emplaced mafic lavas (basalt & andesite) but some produced felsic lava and ash. Volcanic activity continued as the early Cascade volcanic arc began erupting at a fast pace (resulting in massive outpourings of lava, ash and various rock fragments). A short lull in volcanic activity occurred between 21 and 18 million years ago, which was followed by the invasion of the Columbia River Basalt Group flows from fissure volcanoes to the east (not related to the volcanic arc, but forms a useful stratigraphic marker). Modern Cascade volcanism began roughly 500,000 years ago and formed the recognizable peaks that dot the regional skyline.

The deposits found at the subject stie have been classified as 'Older gravel of Cascade Arc origin' (Wells et al, 2020), Springwater Formation (Trible, 1963), and an unnamed fan gravel younger than the Springwater Formation (Evarts and O'Connor, 2008). The unit is generally described as weathered fluvial gravel of Cascade Range provenance interbedded with lithic-rich sand (unconsolidated sand and sandy to cobbly gravel) with local poorly sorted, matrix supported deposit with angular clasts up to 1 meter in diameter (diamicton). Morphologically these deposits comprise the distal edge of a broad, west-northwest-sloping, moderately dissected piedmont. The deposits appear to be fan aggradation associated with the ancestral Sandy River; the deposits were likely emplaced in conjunction with alpine glaciation and associated outwash-gravel production in the Cascade Range. The sands and gravels of the unit are punctuated by lahars.

Site Geology

Madin et al (2020) describes the conglomerate at the subject site as comprised of well-rounded to subrounded pebbles and cobbles of volcanic rock, chiefly andesite, derived from Cascade Range slopes east of the site.

Undivided, the unit underlaying the subject site is part of the ancient river rocks of Ma et al (2012) comprises the youngest bedrock in the Portland area, and it typically comprised of cemented and compacted sediments deposited by the ancestral Tualatin, Willamette, Clackamas, Sandy and Columbia Rivers. They include layers of sandstone, mudstone, siltstone, and conglomerate or cemented gravel. In the Tualatin Valley, there are almost 1,000 feet of siltstone,

mudstone and sandstone mostly derived from older sedimentary rocks of the Coast Range. These rocks may have been laid down as long ago as 15 million years after the cessation of the Columbia River Basalt lava flows, as a recently as 2.5 million years when the Boring volcanic field became active.

The site is further classified as Pliocene-Pleistocene aged Gravels by some and as part of the Springwater Formation by others. The Springwater Formation as described by Madin (2004 - Open-File Report O-04-02), is comprised of fluvial conglomerate, volcaniclastic sandstone, siltstone, and debris flows derived from the Cascade Range. The conglomerate generally consists of well-rounded pebbles, cobbles and boulders of basalt, andesite and dacite but can also include metamorphic and plutonic rocks. The sand and silt component of the conglomerate mix contains varying amounts of feldspathic and volcanic lithic and vitric sediment. It is not uncommon to observe massive and profoundly weathered sections of this unit. The weathered conglomerate presents as a vari-colored mass of red, brown, gray-green and orange. In the portion of this unit comprised of debris flows, the mix of clasts includes angular to rounded basalts, andesites and dacite lavas with a matrix of clay, ash, and sand. Scoria and pumice can also be found in this portion of the unit. The sandstone fraction of the Springwater formation includes fine to coarse sand while the siltstone and mudstone fractions include quartzo-feldspathic silt, ash and clay.

Geohazard Review

The Oregon HazVu: Statewide Geohazard Viewer was reviewed 01 March 2021 to investigated mapped geological hazards.

This review indicates that the subject site is outside the 100-year floodplain, as mapped by FEMA.

The expected earthquake-shaking hazard is classified as 'very strong' with no mapped earthquake liquefaction hazard. The nearest faults mapped as active by DOGAMI include a NE trending fault near Boring Oregon, roughly 6.3 miles northwest of the subject site. Other faults are likely positioned closer to the site, but these are not classified as active by DOGMAI.

There are no landslides mapped on or adjacent to the subject site. No landslide morphology is observed at the subject site. The landslide hazard at the subject site is generally mapped as 'low'.

Field Exploration and subsurface conditions

A total of four (4) borings were excavated with a hand auger. The locations of the borings are shown on figure 3 in the appendix. An EIT, engineer-in-training, observed the excavation of the borings and logged the subsurface materials. A registered professional engineer reviewed the results. Boring logs detailing materials encountered is in the appendix. The logs were created using the Unified Soil Classification and Visual Manual Procedure (ASTM-D 2488). The soils found on site were highly plastic silty clay that stayed relatively the same up to the boring depths of 2 feet and 4 feet. Moisture contents ranged from 28.6% to 32.0%. Groundwater was not encountered.

In addition, another bore hole was excavated within the former residence envelope (1922-2017), along the northeast quarter of parcel. RSS found the same highly plastic silty clay up to the

boring depth of 4 feet. From our explorations we found no signs of unusal fill from the old house removal. It possible it did not contain a basement. However, it is still possible there could be trash pits or other buried items from

Mapped Soils
The soils on the subject site, as mapped by the USDA National Resource Conservation Service Web Soil, are classified as Cazadero silty clay loam (0-7% slopes). These soils form on terraces from old mixed alluvium. They are classified as well drained with a water table typically found at depths of greater than 80 inches. The typical profile is comprised of silty clay loam (H1: 0"-21") and clay (H2: 21"-75").

Excavations
The initial site preparation will consist of topsoil stripping, and the removal of trees, where applicable. Removal of trees should include removal of the root ball, and any roots greater than ½-inch in diameter. ***Please allow 24-hour notice for subgrade inspections.***

Excavations can be accomplished with conventional excavating equipment. All excavations for footings and subgrades in the coarse-grained sand should be performed by an excavator or backhoe equipped with a bucket with teeth.

Because of safety considerations and the nature of temporary excavations, the Contractor should be made responsible for maintaining safe temporary cut slopes and supports for utility trenches, etc. We recommend that the Contractor incorporate all pertinent safety codes during construction, including the latest OSHA revised excavation requirements, and based on soil conditions and groundwater evidenced in cuts made during construction.

Structural Fills
Depending upon finished building pad elevations, structural fills may be required to raise the site grades. Additionally, fill may be required for the backfilling of the proposed new foundation walls. Native or imported material may be used for fill, provided the soil is free of organics, cobbles larger than 6 inches in maximum diameter, or other deleterious matter; is of low plasticity; and, is at the proper water content.

Fills should be placed on level benches in thin lifts and compacted to a dry density of at least 92% of its Maximum Dry Density (MDD) as determined by the Modified Proctor Test (ASTM D-1557).

For any over-excavation completed in the area of footings or slabs, the backfill material shall consist of free-draining, well-graded, crushed aggregate base with a maximum particle size of ¾ inch. The rock shall not contain more than 5% fines (material passing the No. 200 sieve, as tested by ASTM D-1140). The rock shall be compacted to a dry density of at least 92% of its MDD.

Foundation Design
The building foundations may be installed on either engineered fill or firm native sub-grade that is found at a depth of about 12 inches. This depth may be locally variable and should be confirmed by a geotechnical engineer or their representative at the time of construction. ***Please allow 48hours notice to call for foundation inspections.***

Continuous wall and isolated spread footings should be at least 16 and 24 inches wide, respectively. The bottom of exterior footings should be at least 16 inches below the lowest adjacent exterior grade. The bottom of interior footings should be at least 12 inches below the base of the floor slab.

Footings placed on engineered fill or firm native sub-grade should be designed for an allowable bearing capacity of 1,*500 pounds per square foot* (**psf**) SAND. The recommended allowable bearing pressure can be doubled for short-term loads such as those resulting from wind or seismic forces.

Lateral loads on footings can be resisted by passive earth pressure on the sides of the structures and by friction at the base of the footings. An allowable lateral bearing pressure of 150 *pounds per cubic foot* (**psf/f**) below grade may be used. Adjacent floor slabs, pavements or the upper 12-inch depth of adjacent, unpaved areas should not be considered when calculating passive resistance.

If construction is undertaken during wet weather, we recommend a thin layer of compacted, crushed rock be placed over the footing sub-grades to help protect them from disturbance due to the elements and foot traffic.

Engineering values summary

Bearing capacity: CLAY	1,500psf
Coefficient of friction: CLAY	0.28
Active pressure	40pcf
Passive pressure	300pcf

Note: factors of safety of 1.5 has been applied to the above values

Pavement section
Parking lot shall be 3in of AC with 8in of rock and geo-textile fabric shall be used if building during wet season from Mid October to Mid May. RSS shall be given up to 48hours notice to proof roll the parking areas prior to rock placement.

Seismic Design Criteria
The seismic design criteria for this project found herein is based on the IBC 2018. A summary of IBC seismic design criterion is below it is generated from the USGS web site for earthquake hazards using a latitude of 45.396107 and a longitude of -122.262494, soil site class D.
Null = see section 11.4.8

	Short Period	1 Second
Maximum Credible Earthquake Spectral Acceleration	S_S = 0.712 g	S_1 = 0.316 g
Adjusted Spectral Acceleration	S_{MS} = 0.876 g	S_{M1} = null
Design Spectral Response Acceleration Perimeters	S_{DS} = 0.584 g	S_{D1}= null

Infiltration testing

RSS performed one infiltration tests per the Clackamas Storm water manual in a future storm water disposal area in the future parking area. The tests results and location are in the appendix. RSS had in HA#1a rate of 1.2in/hr and in HA#2 a rate of 1.1in/hr.

Settlement

Based on our knowledge of the project scope, and for footings designed as described in the preceding paragraphs, maximum settlement should not exceed 1 inch. Differential settlement should be on the order of 50 to 75% of the maximum settlement over 50 feet. Our settlement estimate assumes that no disturbance to the foundation soils would be permitted during excavation and construction, and that footings are prepared as described in the preceding paragraphs.

Drainage

The Contractor should be made responsible for temporary drainage of surface water and groundwater as necessary to prevent standing water and/or erosion at the working surface. The ground surface around the structure should be sloped to create a minimum gradient of 2% away from the building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or into a storm drainage system. "Trapped" planting areas should not be created next to any buildings without providing means for drainage. Foundation house drains are required.

Construction Observations

Satisfactory pavement and earthwork performance depends on the quality of construction. Sufficient monitoring of the activities of the contractor is a key part of determining that the work is completed in accordance with the construction drawings and specifications. I recommend that a geotechnical engineer observe general excavation, stripping, fill placement, and sub-grades in addition to base. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience. Therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

Limitations

This report has been prepared for the exclusive use of the addressee, and their architects and engineers for aiding in the design and construction of the proposed development. It is the

addressee's responsibility to provide this report to the appropriate design professionals, building officials and contractors to ensure correct implementation of the recommendations.

The opinions, comments and conclusions presented in this report were based upon information derived from our literature review, field investigation and laboratory testing. Conditions between, or beyond, my exploratory test pits may vary from those encountered. Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples. Such variations may result in changes to our recommendations and may require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

If there is more than 2 years time between the submission of this report and the start of work at the site; if conditions have changed due to natural causes or construction operations at, or adjacent to, the site; or, if the basic project scheme is significantly modified from that assumed, it is recommended this report be reviewed to determine the applicability of the conclusions and recommendations. The work has been conducted in general conformance with the standard of care in the field of geotechnical engineering currently in practice in the Pacific Northwest for projects of this nature and magnitude. No warranty, express or implied, exists on the information presented in this report. By utilizing the design recommendations within this report, the addressee acknowledges and accepts the risks and limitations of development at the site, as outlined within the report.

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Google Earth 2021

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Clackamas County GIS recourse https://www.clackamas.us/gis)

USGS Topo View https://ngmdb.usgs.gov/topoview/

DOGAMI Oregon State Wide Geohazard Viewer (HazVu) https://gis.dogami.oregon.gov/maps/hazvu/

DOGAMI Lidar Viewer https://gis.dogami.oregon.gov/maps/lidarviewer/

DOGMAI Statewide Landslide Information Layer for Oregon https://gis.dogami.oregon.gov/maps/slido/

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Appendix

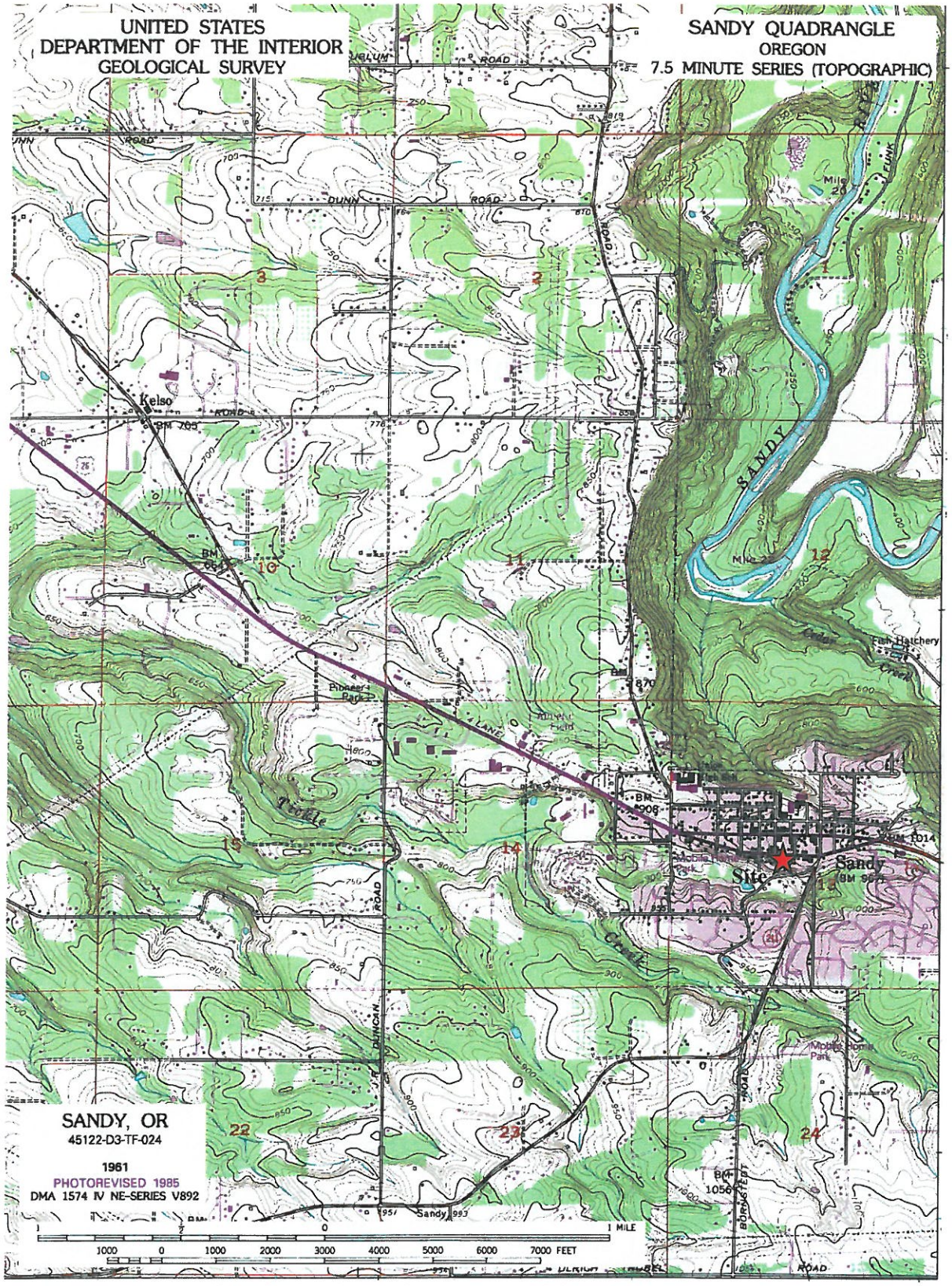


Figure 1: Subject site location on the SE quarter of the Sandy 7.5-minute quadrangle

N.E.1/4 S.W.1/4 SEC.13 T.2S. R.4E. W.M.
CLACKAMAS COUNTY

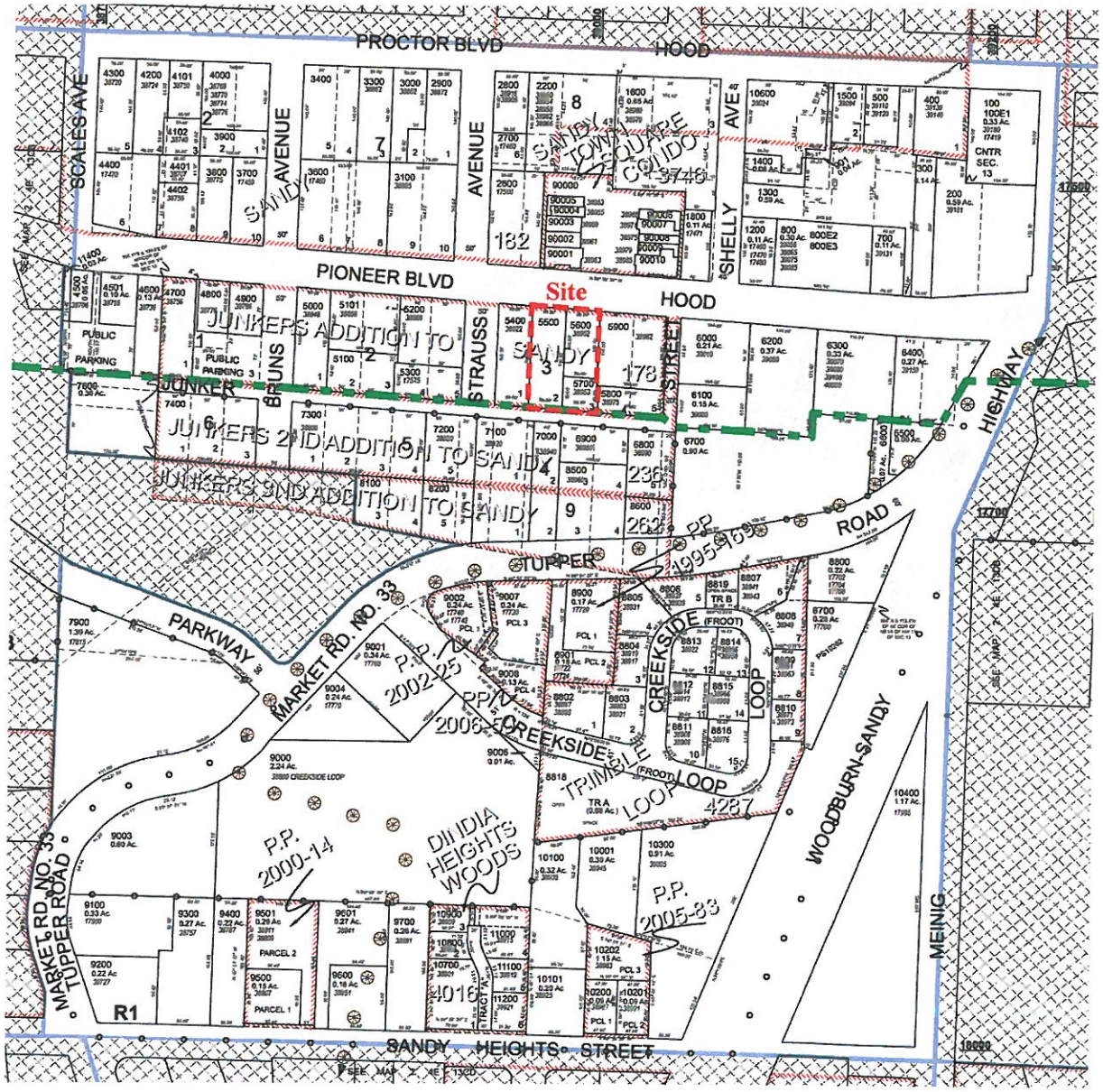


Figure 2: Subject site location on the Clackamas County Assessor's Map

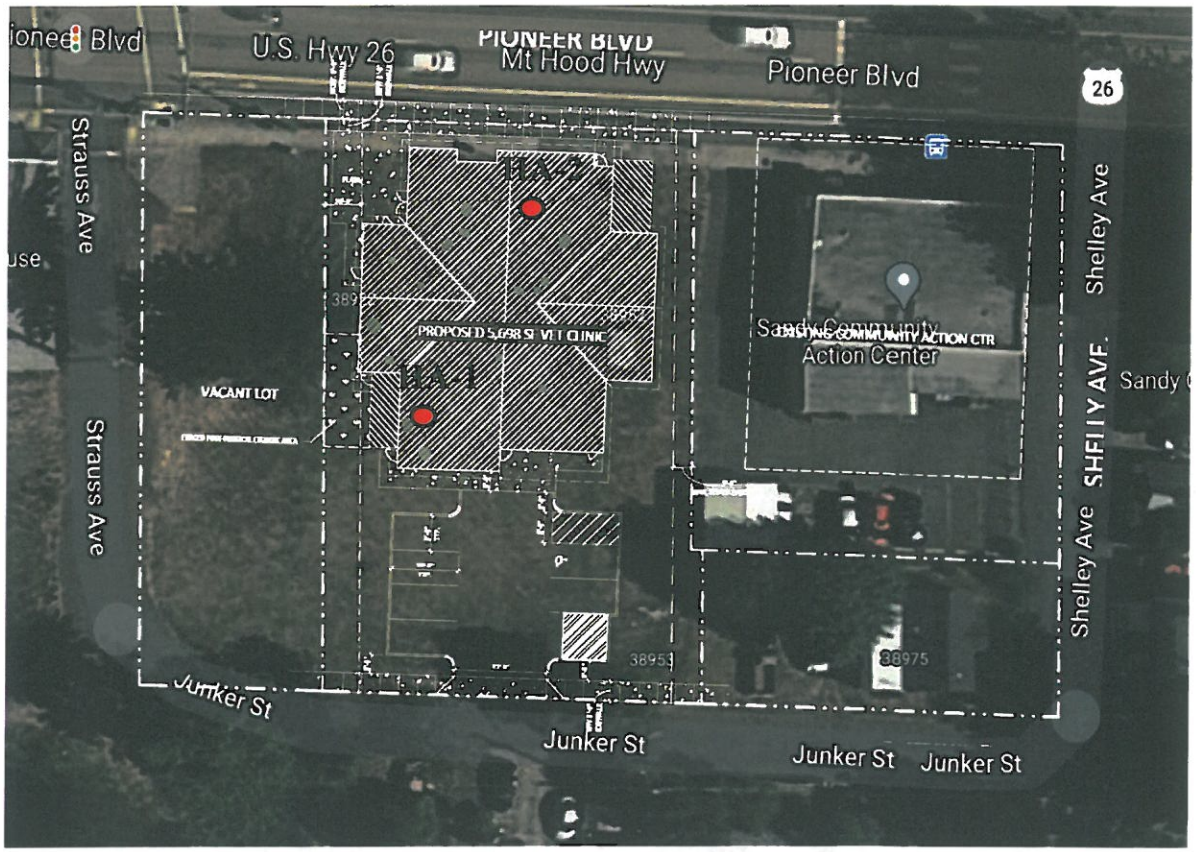


Figure 3: Testing Locations

Preliminary Information		
Location:	38952 Pioneer Blvd, Sandy	**Tester's Name** : Wilton A. Roberts, PE, retired, supervised by Mia Mahedy, PE, GE **Tester's Company**: Rapid Soil Solutions

HA #1

Soil Profile Detail

Depth (ft)	Description
0-4”	Topsoil
4”-4’	Red clay
No water found	

Presaturation Start Time : 2/26/21 9:35 46.22”. 36.37”@10:35. 31.49”@11:35. 28.58”@12:35.
Presaturation End Time: 2/26/21 13:35 26.18”

Date & Time:	2/26/2021 13:35	Instrument Used:	4" hand auger 2” pipe
Weather:	Light rain, 38 deg.	**Depth:**	4’

Time	Measurement (inches)	Level Refilled To (inches)	Rate (inches/hour)
13:35	26.2		
14:05	25.5		1.4
14:35	24.7		1.6
15:05	24.1		1.2
15:35	23.5		1.2
16:05	22.9		1.2
16:35	22.3		1.2
Infiltration rate at this test site			1.2

HA #2			
Soil Profile Detail			
Depth (ft)	**Description**		
0-4"	Topsoil		
4"-4'	Red clay		
No water found			
Presaturatlon Start Time : 2/26/21 9:28 42.12". 37.44"@10:28. 35.16"@11:28. 34.01"@12:28. Presaturatlon End Time: 2/26/21 13:28 32.75"			
Date & Time:	2/26/2021 13:28	**Instrument Used:**	4" hand auger 2" pipe
Weather:	Light rain, 38 deg.	**Depth:**	4'
Time	**Measurement (inches)**	**Level Refilled To (inches)**	**Rate (inches/hour)**
13:28	33.3		
13:58	32.5		1.5
14:28	31.8		1.4
14:58	31.2		1.2
15:28	30.6		1.3
15:58	30.0		1.1
16:28	29.5		1.1
Infiltration rate at this test site			1.1

Rapid Soil Solutions INC | 503-816-3689 | mia@rapidsoilsolutions.com

Lab Results

Project Name: 38952 Pioneer Blvd., Sandy Sample Date 2/26/2021

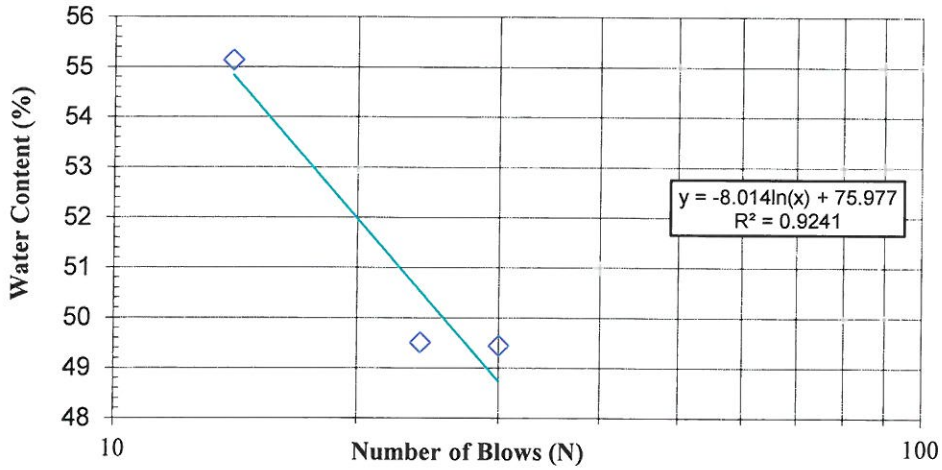
Moisture

	Sample number	HA#1A	HA#1B	HA#2		
1	Date and time in oven	2/26/2021 - 1:34PM	2/26/2021 - 1:34PM	2/26/2021 - 1:34PM		
2	Date and time out of oven	3/1/2021 - 7:20AM	3/1/2021 - 7:20AM	3/1/2021 - 7:20AM		
3	Depth (ft)	2	4	2		
4	Tare No.	7	8	9		
5	Tare Mass	231	234	231		
6	Tare plus sample moist	825	964	1043		
7	Tare plus sample dry	693	787	856		
8	Mass of water (g)	132	177	187		
9	Mass of soil (g)	462	553	625		
10	Water Content (%)	28.6	32.0	29.9		

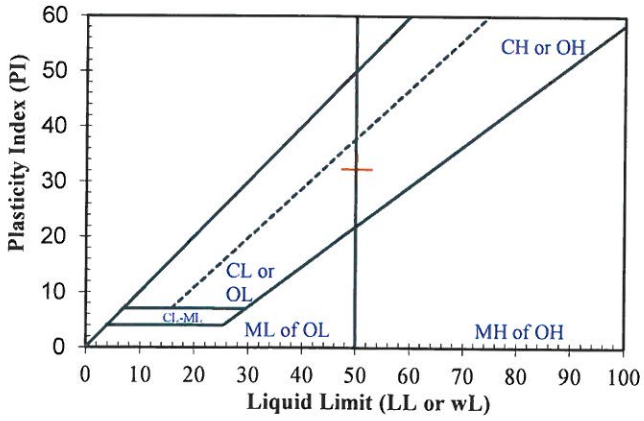
Atterberg Limit Test

Sample Number: HA#1A Depth: 2

		Liquid Limit			Plastic Limit	
1	Tare No.	d1.1	d1.2	d1.3	r1.1	r1.2
2	Tare Mass (g)	39.49	39.93	40.46	39.37	40.16
3	Tare Plus Wet Soil (g)	99.10	89.12	101.56	50.50	51.32
4	Tare Plus Dry Soil (g)	79.38	71.64	81.33	48.92	49.52
5	Mass of Water (g)	19.72	17.48	20.23	1.58	1.80
6	Mass of Soil (g)	39.89	31.71	40.87	9.55	9.36
7	Water Content (%)	49.44	55.12	49.50	16.54	19.23
8	No. Blows	30	14	24		

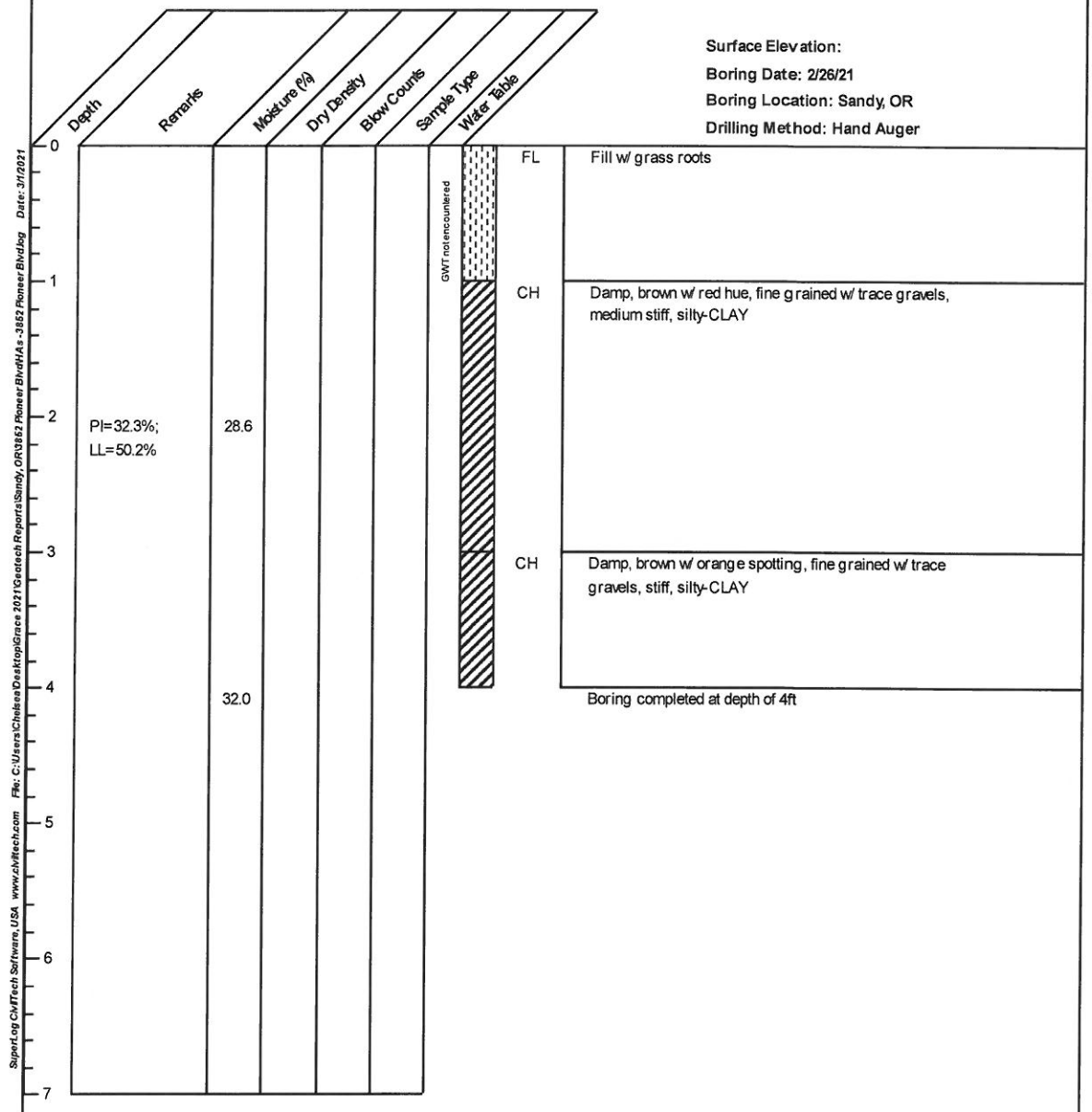


Liquid Limit (%) **50.2**
Plastic Limit (%) **17.9**
Plasticity Index (%) **32.3**
USCS Classification of fines: CH



Rapid Soil Solutions INC

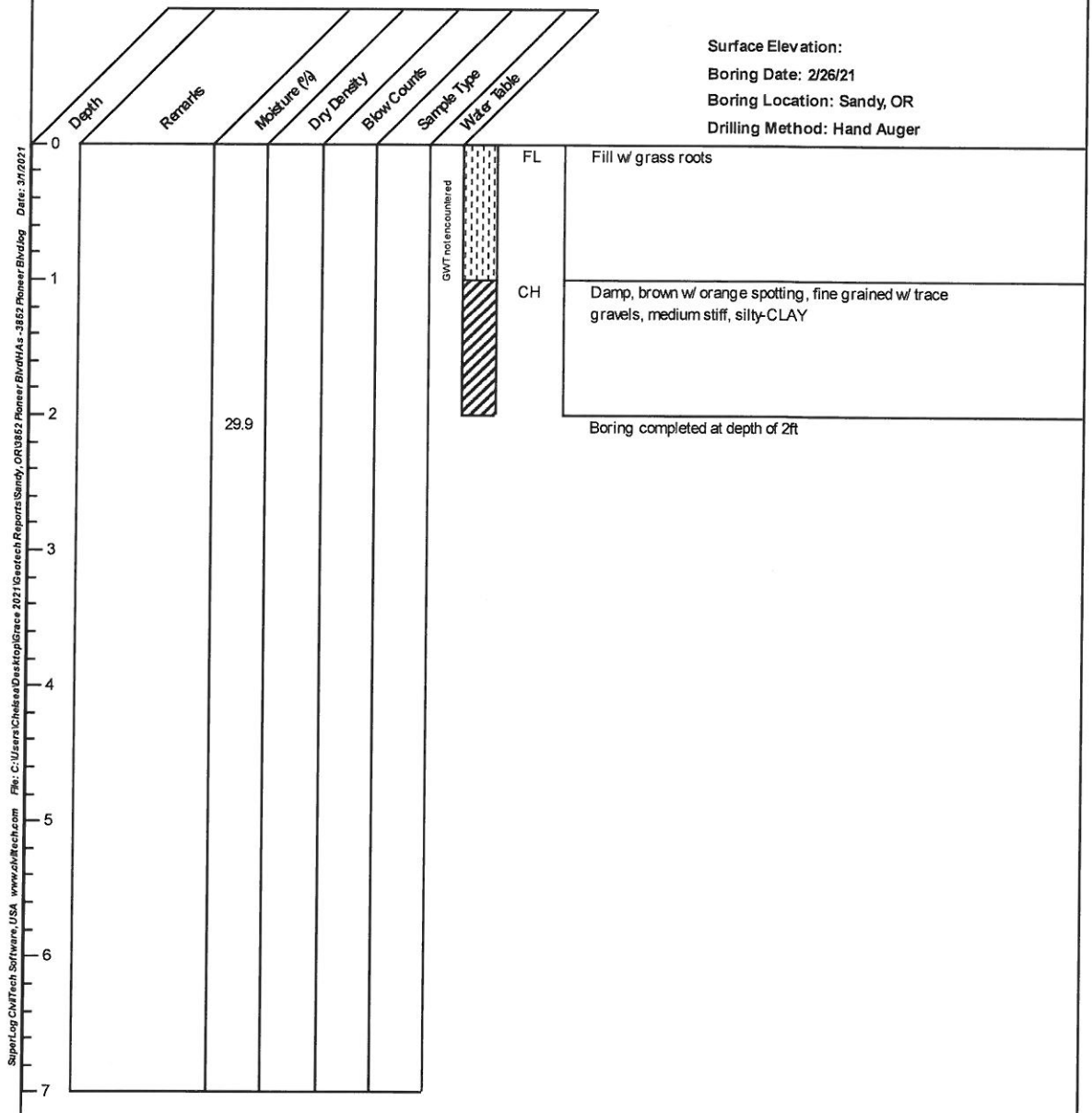
HA-1



LOG OF BORING

Rapid Soil Solutions	38952 Pioneer Blvd.	Plate 1

HA-2



LOG OF BORING

Rapid Soil Solutions	38952 Pioneer Blvd.	Plate 2

APPENDIX C

Custom Soil Resource Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Clackamas County Area, Oregon

Regional SWMS for Barlow Trail Vet Clinic

July 5, 2022

Preface

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

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

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

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

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

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

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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Contents

Soil Map

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

Custom Soil Resource Report
Soil Map

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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:
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: Clackamas County Area, Oregon
Survey Area Data: Version 18, Oct 27, 2021

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

Date(s) aerial images were photographed: Jun 22, 2020—Jun 26, 2020

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.

onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Clackamas County Area, Oregon

15B—Cazadero silty clay loam, 0 to 7 percent slopes

Map Unit Setting

National map unit symbol: 223c
Elevation: 300 to 900 feet
Mean annual precipitation: 48 to 85 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cazadero and similar soils: 85 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cazadero

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old mixed alluvium

Typical profile

H1 - 0 to 21 inches: silty clay loam
H2 - 21 to 75 inches: clay

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F003XC003OR - Glaciated Western Cascades Mesic Udic Forest Group
Forage suitability group: Well drained < 15% Slopes (G002XY002OR)
Other vegetative classification: Well drained < 15% Slopes (G002XY002OR)
Hydric soil rating: No

Minor Components

Borges

Percent of map unit: 2 percent
Landform: Hillslopes, depressions on terraces

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

15D—Cazadero silty clay loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 223f
Elevation: 600 to 900 feet
Mean annual precipitation: 60 to 85 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cazadero and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cazadero

Setting

Landform: Terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old mixed alluvium

Typical profile

H1 - 0 to 21 inches: silty clay loam
H2 - 21 to 75 inches: clay

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.0 inches)

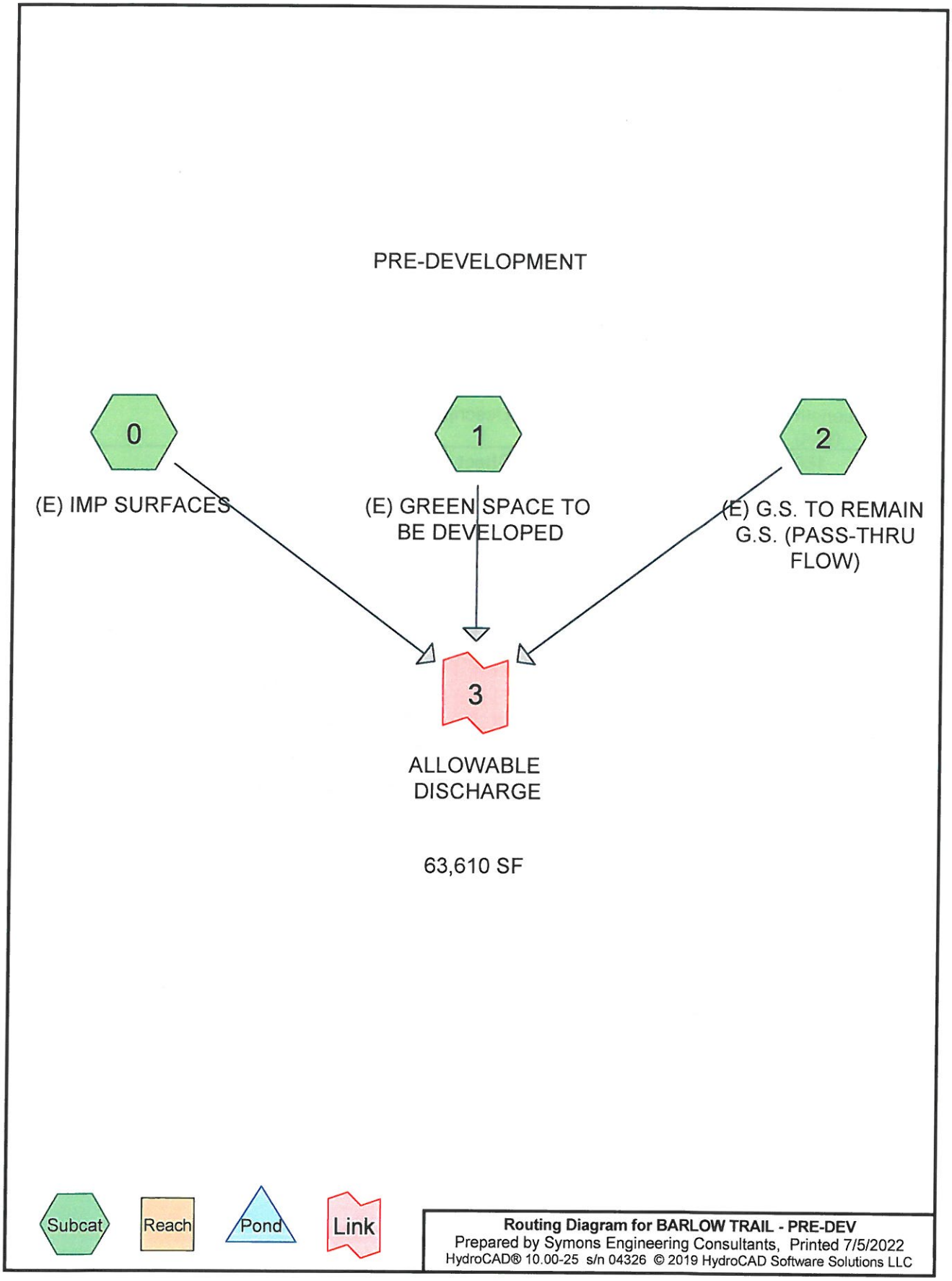
Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F003XC003OR - Glaciated Western Cascades Mesic Udic Forest Group

Forage suitability group: Well Drained > 15% Slopes (G002XY001OR)
Other vegetative classification: Well Drained > 15% Slopes (G002XY001OR)
Hydric soil rating: No

APPENDIX D

HydroCAD Results


PRE-DEVELOPMENT
0
(E) IMP SURFACES
1
(E) GREEN SPACE TO BE DEVELOPED
2
(E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)
3
ALLOWABLE DISCHARGE
63,610 SF
Subcat
Reach
Pond
Link
Routing Diagram for BARLOW TRAIL - PRE-DEV
Prepared by Symons Engineering Consultants, Printed 7/5/2022
HydroCAD® 10.00-25 s/n 04326 © 2019 HydroCAD Software Solutions LLC

Summary for Subcatchment 0: (E) IMP SURFACES

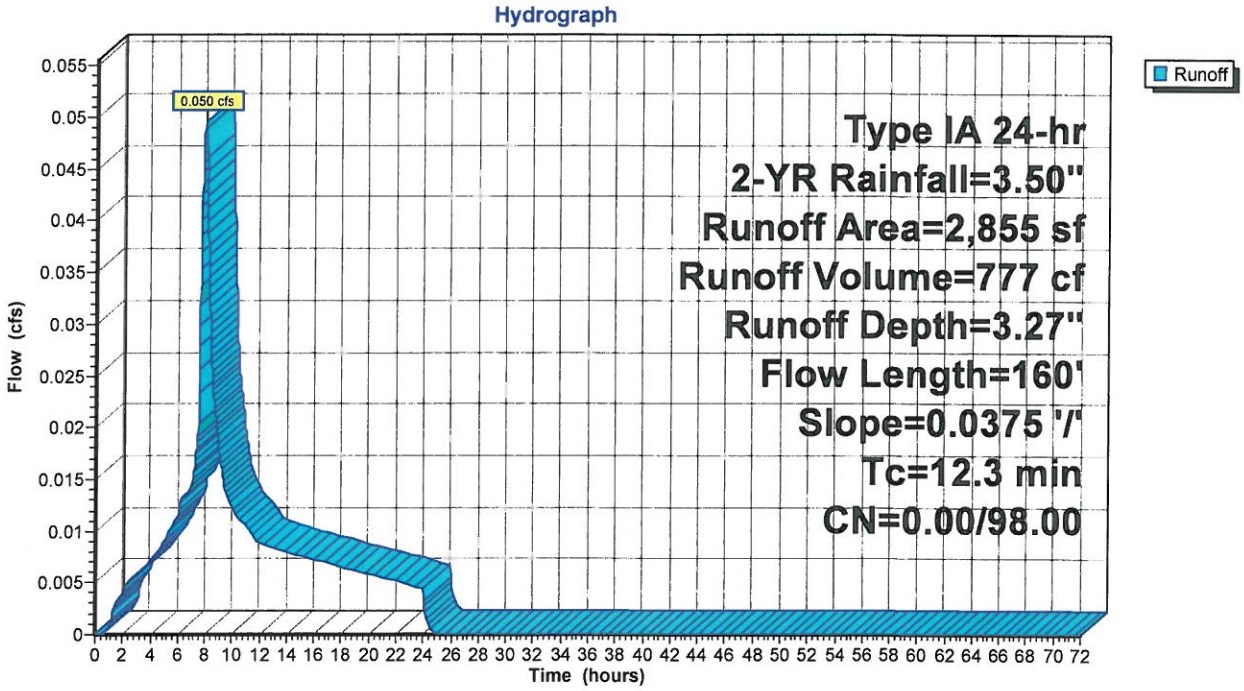
Runoff = 0.050 cfs @ 7.99 hrs, Volume= 777 cf, Depth= 3.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

	Area (sf)	CN	Description
*	2,842	98.00	Unconnected pavement, HSG C
*	13	98.00	Unconnected pavement, HSG C
	2,855	98.00	Weighted Average
	2,855	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 0: (E) IMP SURFACES



Summary for Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED

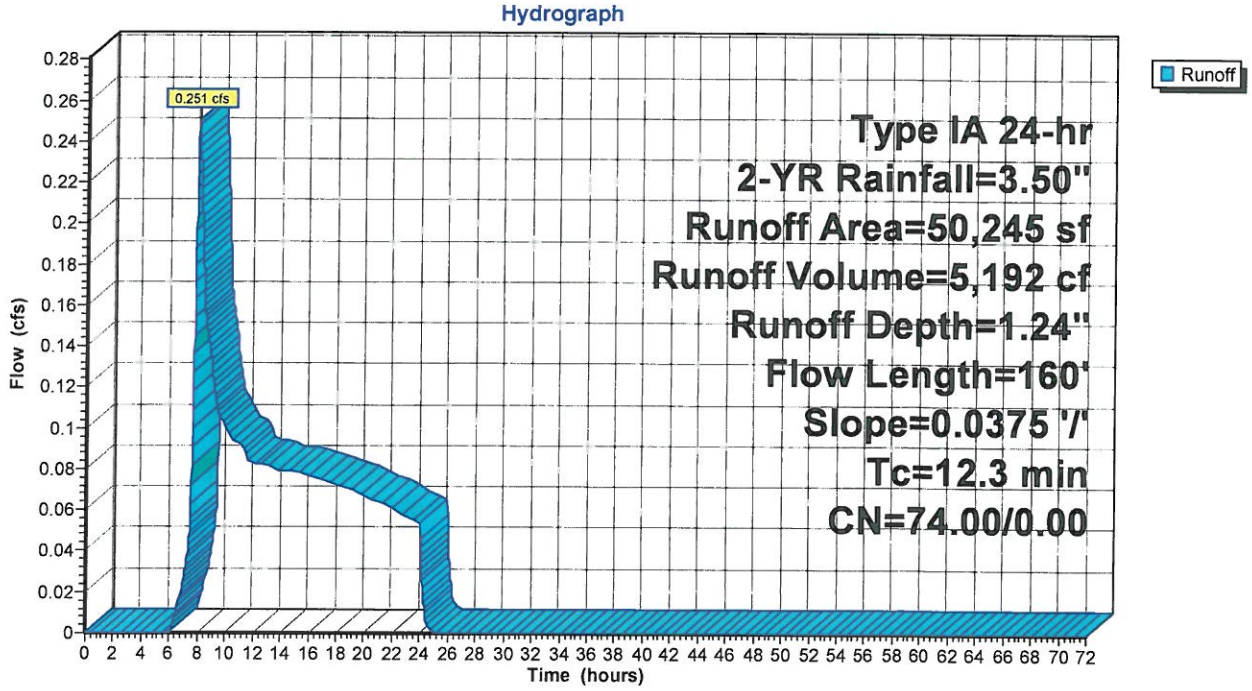
Runoff = 0.251 cfs @ 8.01 hrs, Volume= 5,192 cf, Depth= 1.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

	Area (sf)	CN	Description
*	10,926	74.00	>75% Grass cover, Good, HSG C
*	39,319	74.00	>75% Grass cover, Good, HSG C
	50,245	74.00	Weighted Average
	50,245	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED



Summary for Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

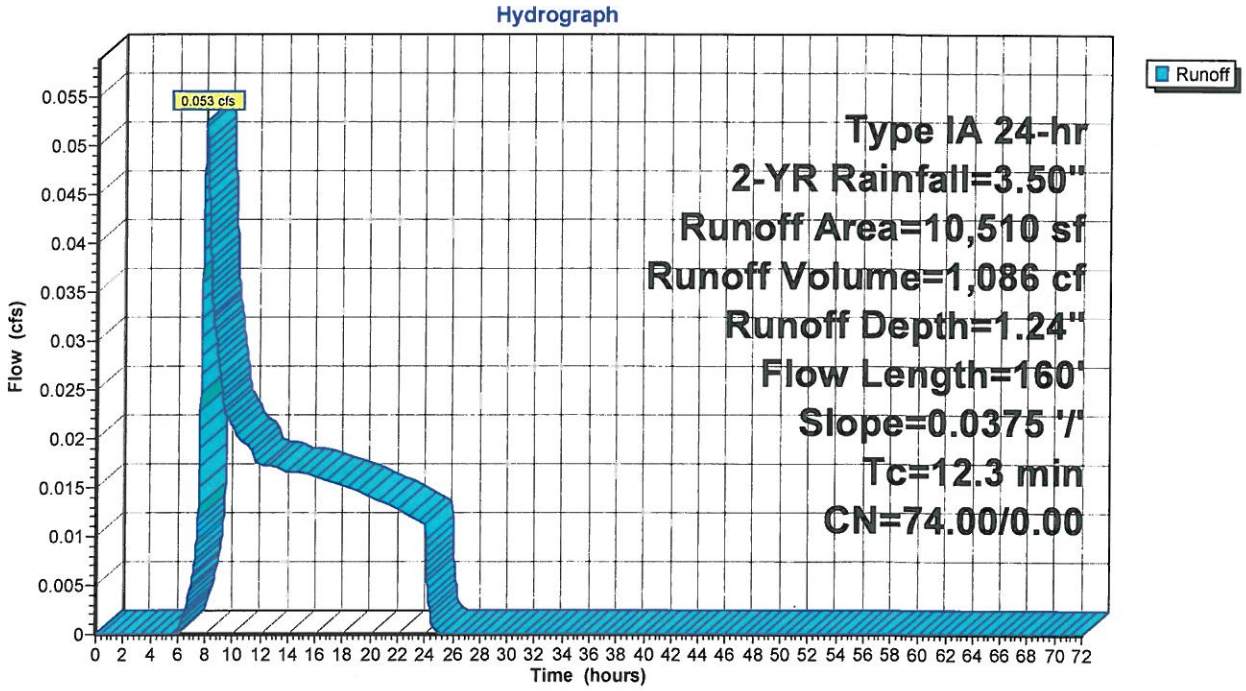
Runoff = 0.053 cfs @ 8.01 hrs, Volume= 1,086 cf, Depth= 1.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

	Area (sf)	CN	Description
*	1,509	74.00	>75% Grass cover, Good, HSG C
*	9,001	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

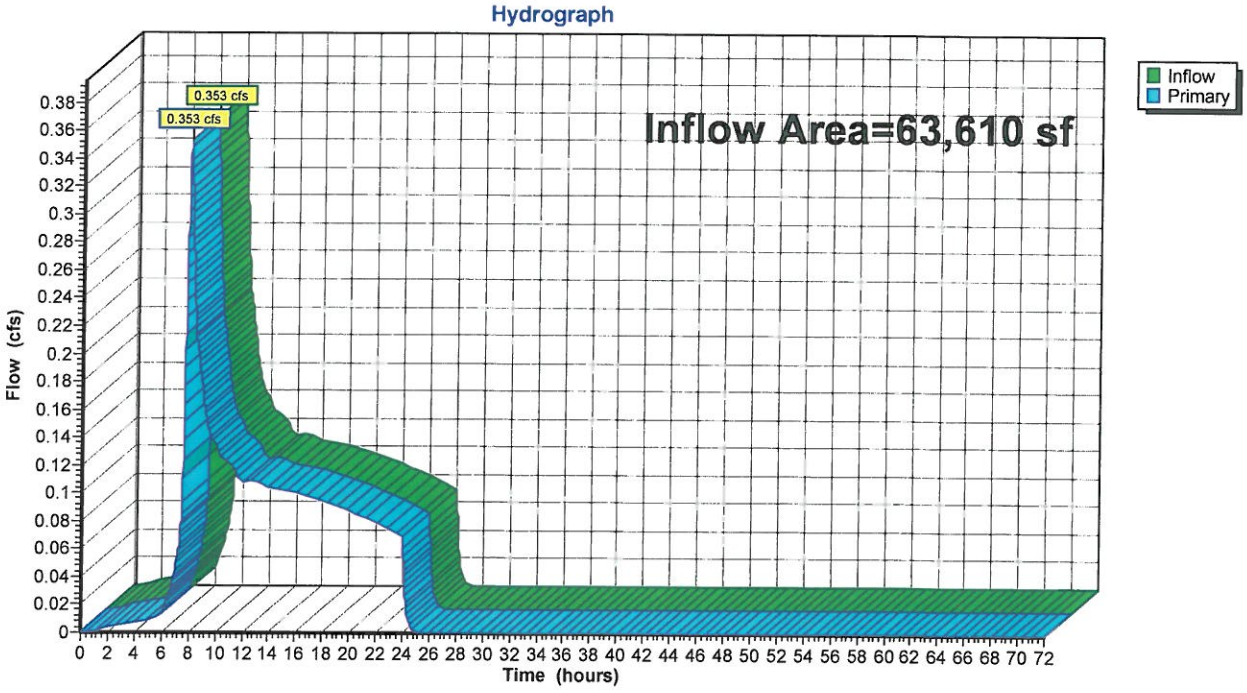


Summary for Link 3: ALLOWABLE DISCHARGE

Inflow Area = 63,610 sf, 4.49% Impervious, Inflow Depth = 1.33" for 2-YR event
Inflow = 0.353 cfs @ 8.01 hrs, Volume= 7,055 cf
Primary = 0.353 cfs @ 8.01 hrs, Volume= 7,055 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Link 3: ALLOWABLE DISCHARGE



Summary for Subcatchment 0: (E) IMP SURFACES

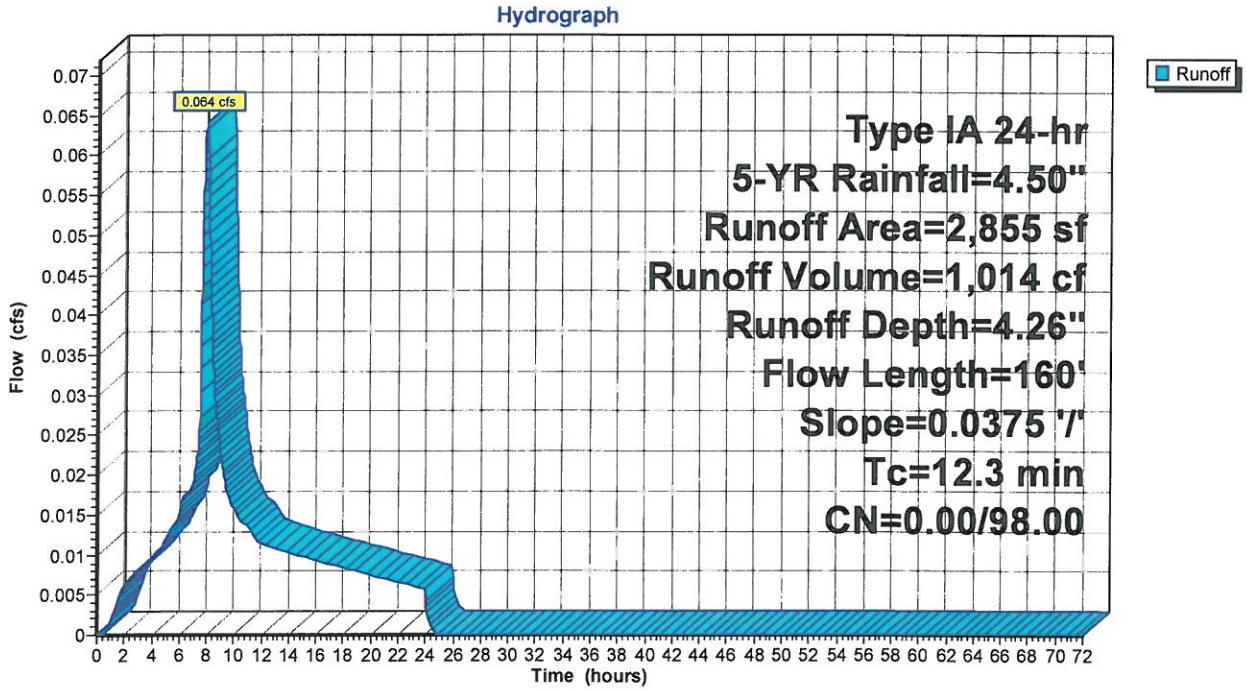
Runoff = 0.064 cfs @ 7.99 hrs, Volume= 1,014 cf, Depth= 4.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

	Area (sf)	CN	Description
*	2,842	98.00	Unconnected pavement, HSG C
*	13	98.00	Unconnected pavement, HSG C
	2,855	98.00	Weighted Average
	2,855	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 0: (E) IMP SURFACES



Summary for Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED

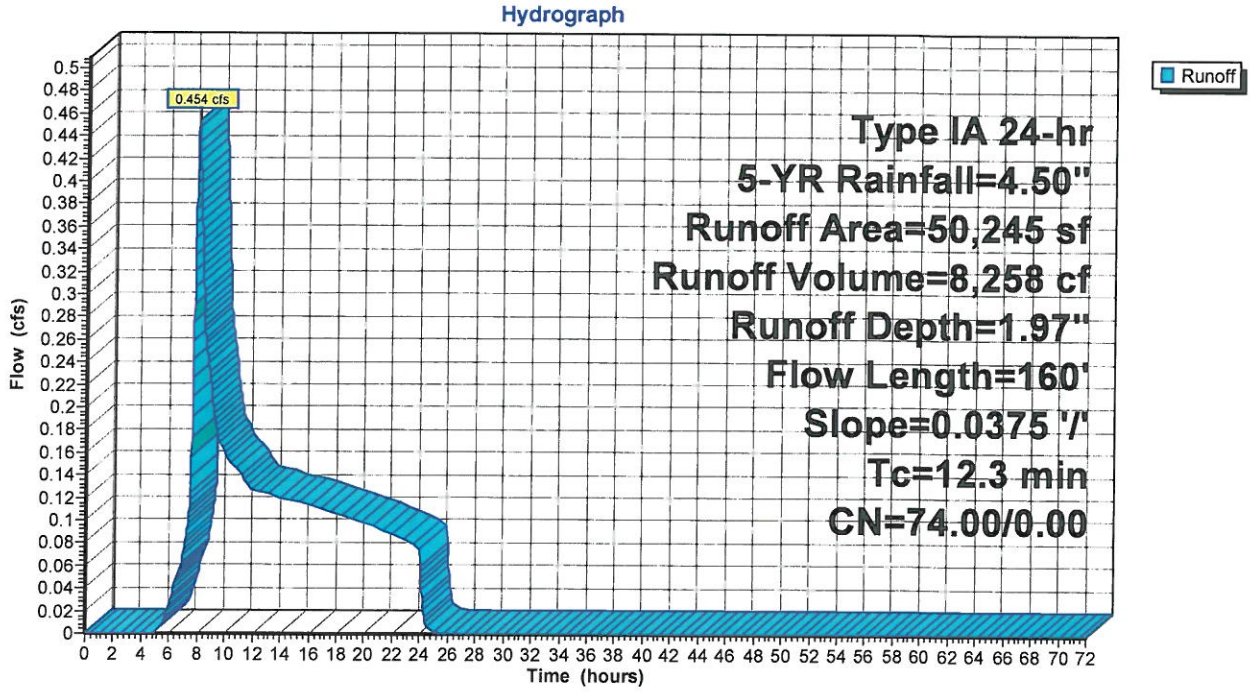
Runoff = 0.454 cfs @ 8.00 hrs, Volume= 8,258 cf, Depth= 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

	Area (sf)	CN	Description
*	10,926	74.00	>75% Grass cover, Good, HSG C
*	39,319	74.00	>75% Grass cover, Good, HSG C
	50,245	74.00	Weighted Average
	50,245	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED



Summary for Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

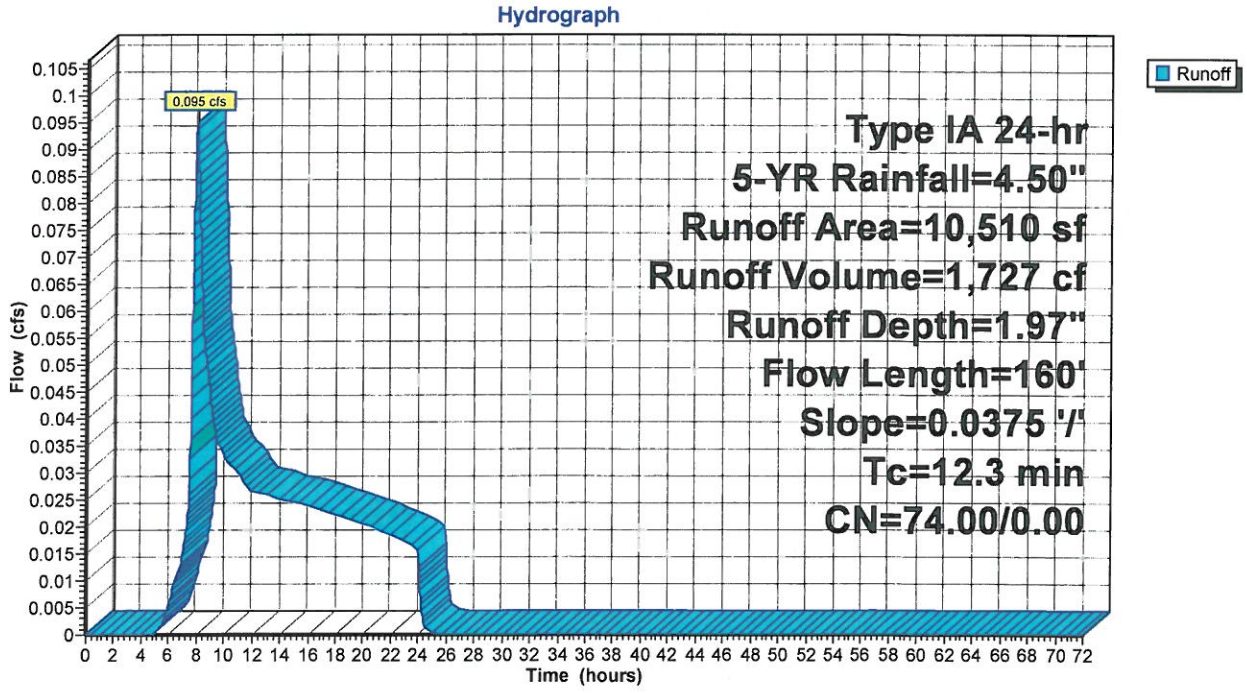
Runoff = 0.095 cfs @ 8.00 hrs, Volume= 1,727 cf, Depth= 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

	Area (sf)	CN	Description
*	1,509	74.00	>75% Grass cover, Good, HSG C
*	9,001	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

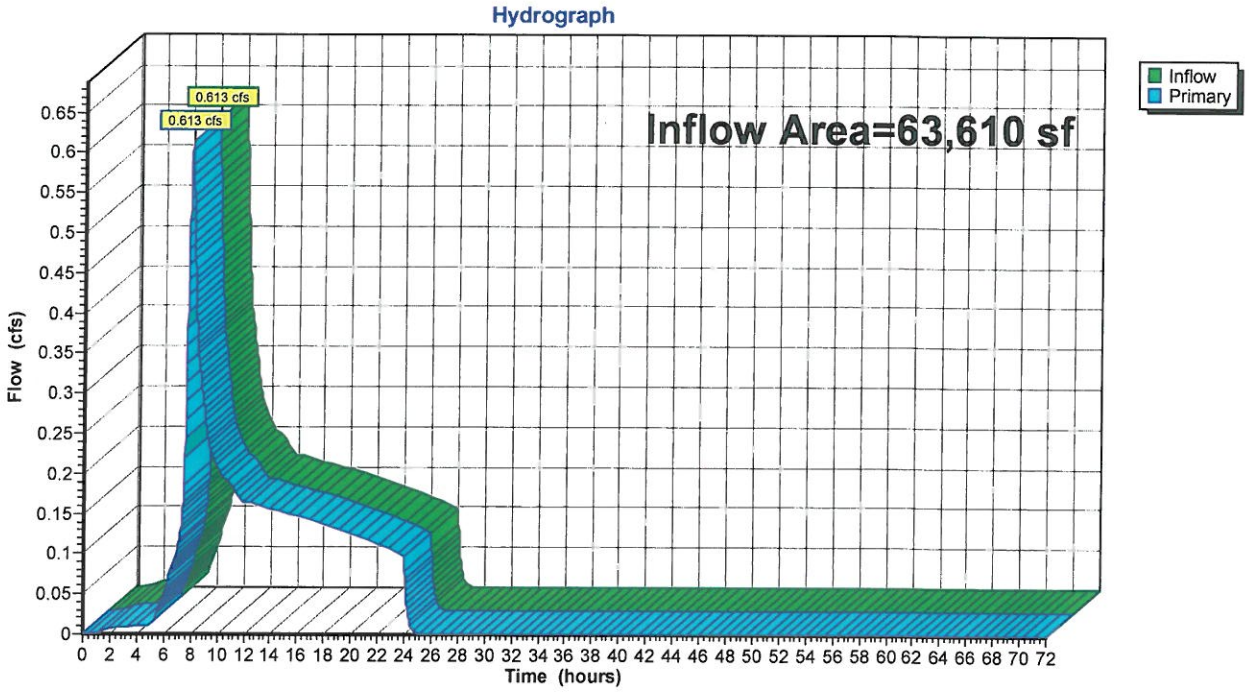


Summary for Link 3: ALLOWABLE DISCHARGE

Inflow Area = 63,610 sf, 4.49% Impervious, Inflow Depth = 2.08" for 5-YR event
Inflow = 0.613 cfs @ 8.00 hrs, Volume= 11,000 cf
Primary = 0.613 cfs @ 8.00 hrs, Volume= 11,000 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Link 3: ALLOWABLE DISCHARGE



Summary for Subcatchment 0: (E) IMP SURFACES

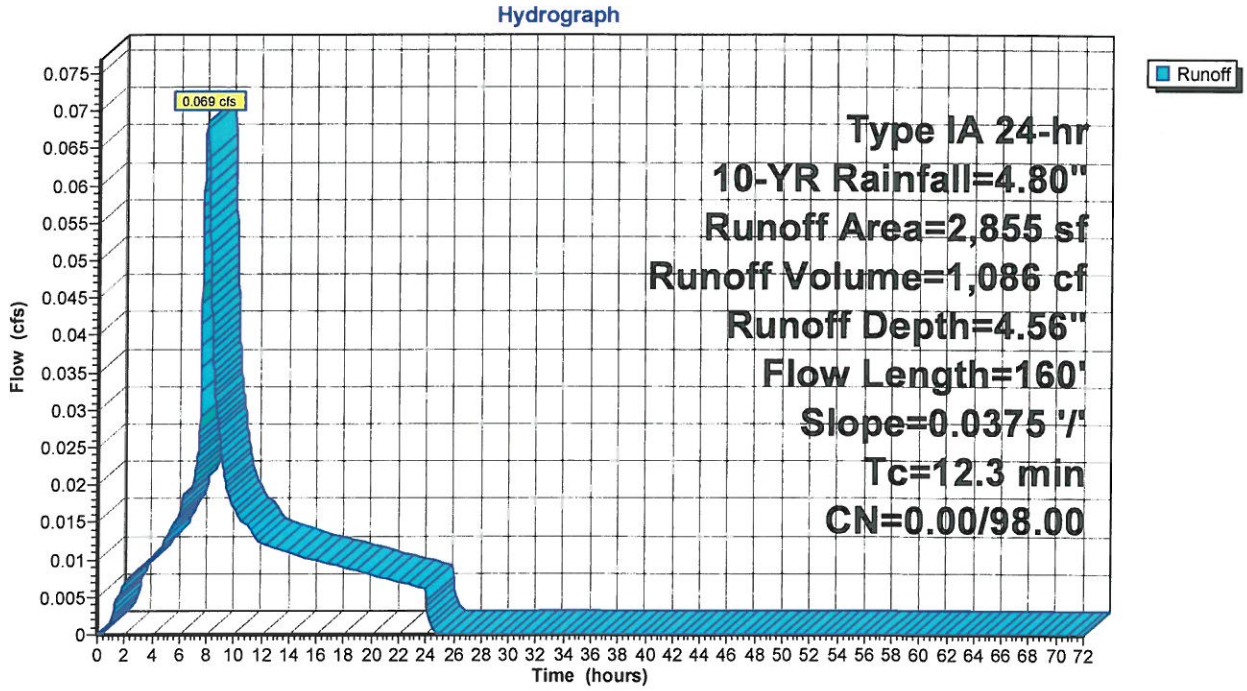
Runoff = 0.069 cfs @ 7.99 hrs, Volume= 1,086 cf, Depth= 4.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

	Area (sf)	CN	Description
*	2,842	98.00	Unconnected pavement, HSG C
*	13	98.00	Unconnected pavement, HSG C
	2,855	98.00	Weighted Average
	2,855	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 0: (E) IMP SURFACES



Summary for Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED

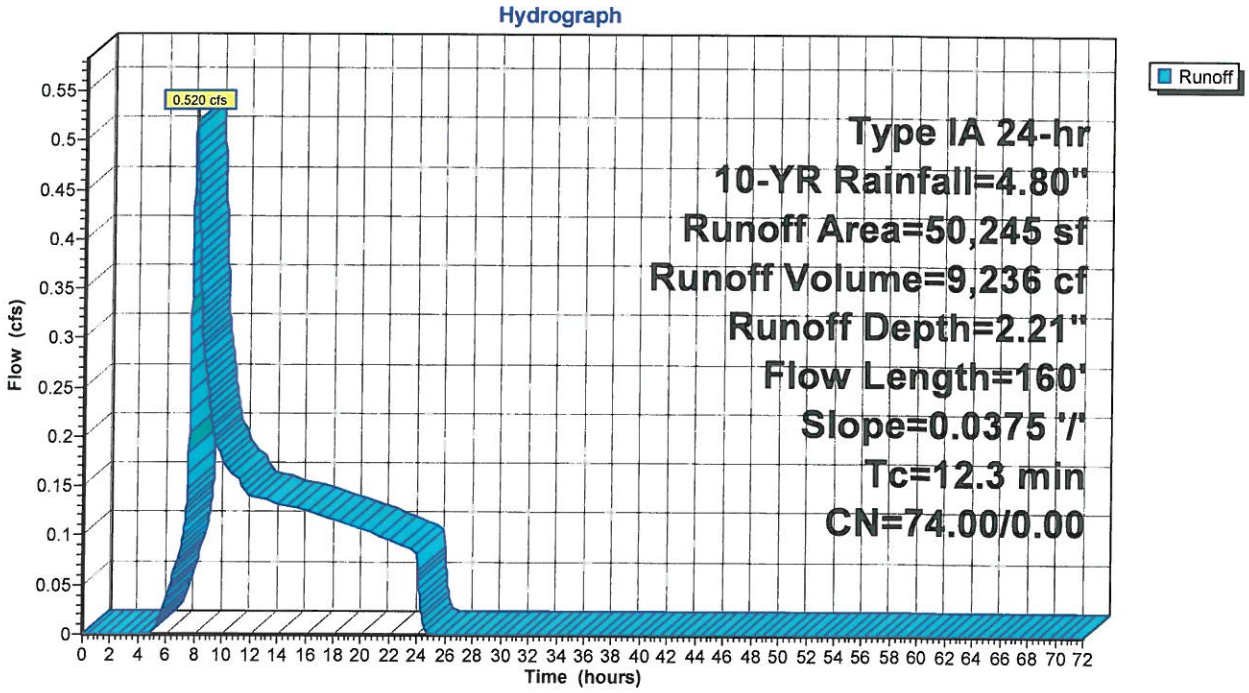
Runoff = 0.520 cfs @ 8.00 hrs, Volume= 9,236 cf, Depth= 2.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

	Area (sf)	CN	Description
*	10,926	74.00	>75% Grass cover, Good, HSG C
*	39,319	74.00	>75% Grass cover, Good, HSG C
	50,245	74.00	Weighted Average
	50,245	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED



Summary for Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

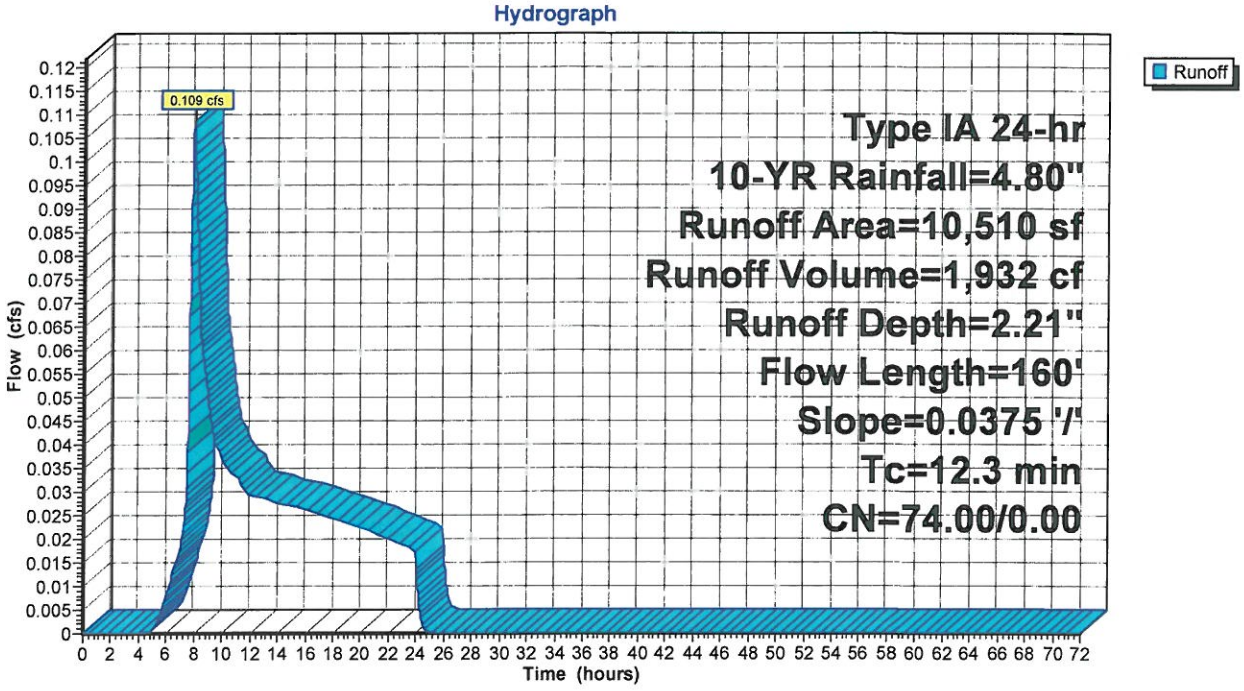
Runoff = 0.109 cfs @ 8.00 hrs, Volume= 1,932 cf, Depth= 2.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

	Area (sf)	CN	Description
*	1,509	74.00	>75% Grass cover, Good, HSG C
*	9,001	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

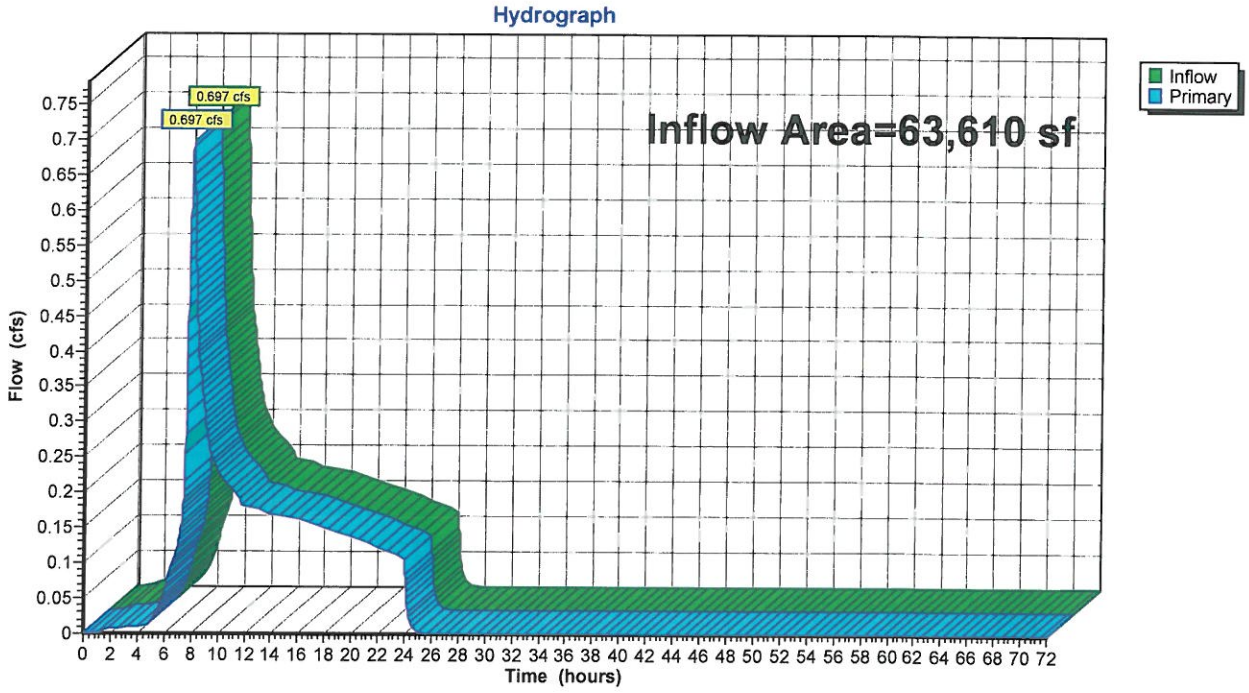


Summary for Link 3: ALLOWABLE DISCHARGE

Inflow Area = 63,610 sf, 4.49% Impervious, Inflow Depth = 2.31" for 10-YR event
Inflow = 0.697 cfs @ 8.00 hrs, Volume= 12,253 cf
Primary = 0.697 cfs @ 8.00 hrs, Volume= 12,253 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Link 3: ALLOWABLE DISCHARGE



Summary for Subcatchment 0: (E) IMP SURFACES

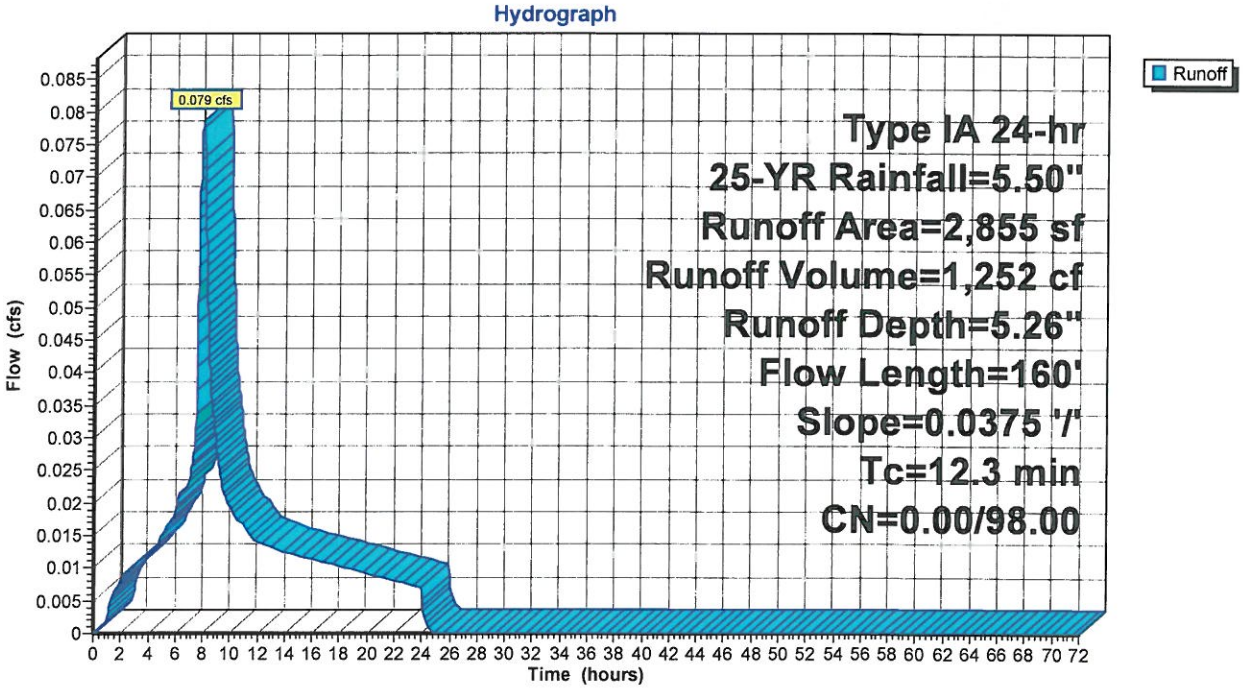
Runoff = 0.079 cfs @ 7.99 hrs, Volume= 1,252 cf, Depth= 5.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

	Area (sf)	CN	Description
*	2,842	98.00	Unconnected pavement, HSG C
*	13	98.00	Unconnected pavement, HSG C
	2,855	98.00	Weighted Average
	2,855	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 0: (E) IMP SURFACES



Summary for Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED

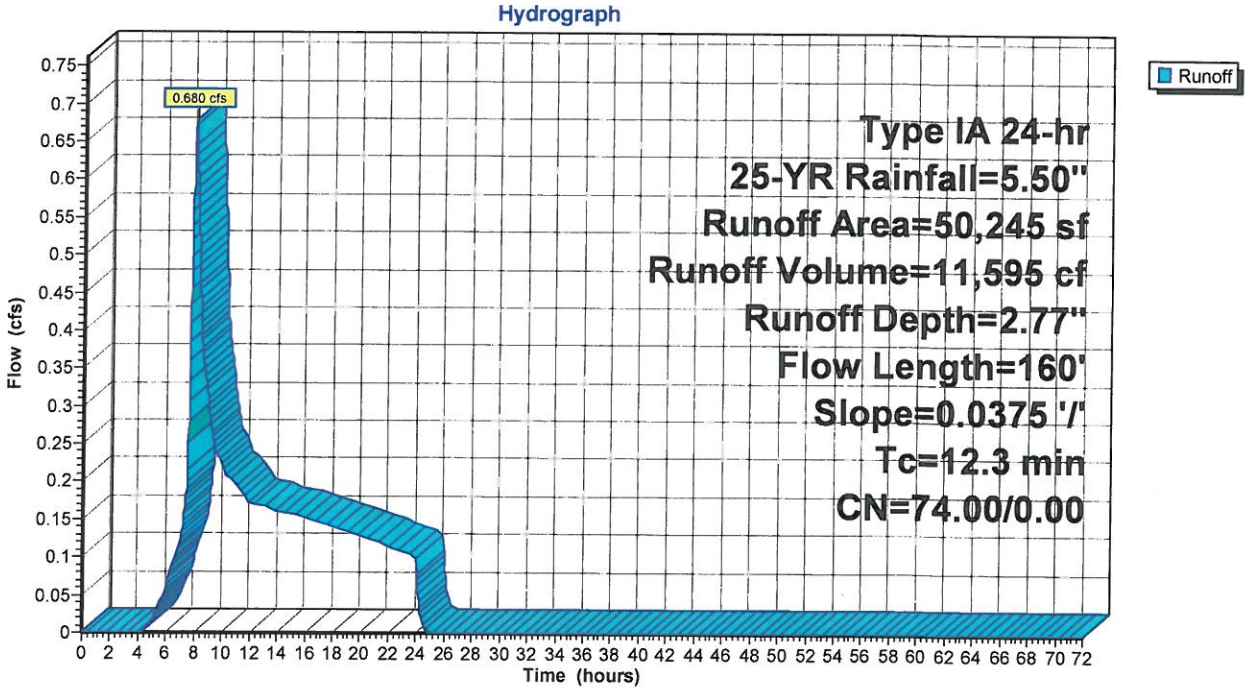
Runoff = 0.680 cfs @ 8.00 hrs, Volume= 11,595 cf, Depth= 2.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

	Area (sf)	CN	Description
*	10,926	74.00	>75% Grass cover, Good, HSG C
*	39,319	74.00	>75% Grass cover, Good, HSG C
	50,245	74.00	Weighted Average
	50,245	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 1: (E) GREEN SPACE TO BE DEVELOPED



Summary for Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

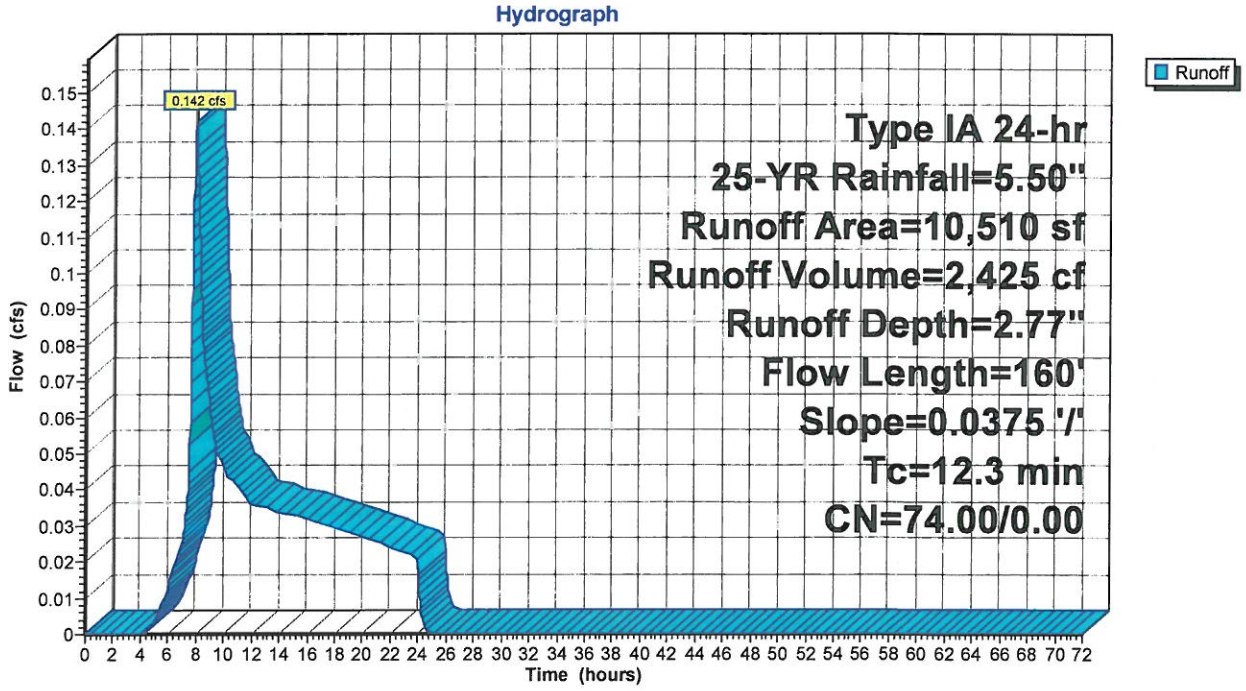
Runoff = 0.142 cfs @ 8.00 hrs, Volume= 2,425 cf, Depth= 2.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

	Area (sf)	CN	Description
*	1,509	74.00	>75% Grass cover, Good, HSG C
*	9,001	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 2: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

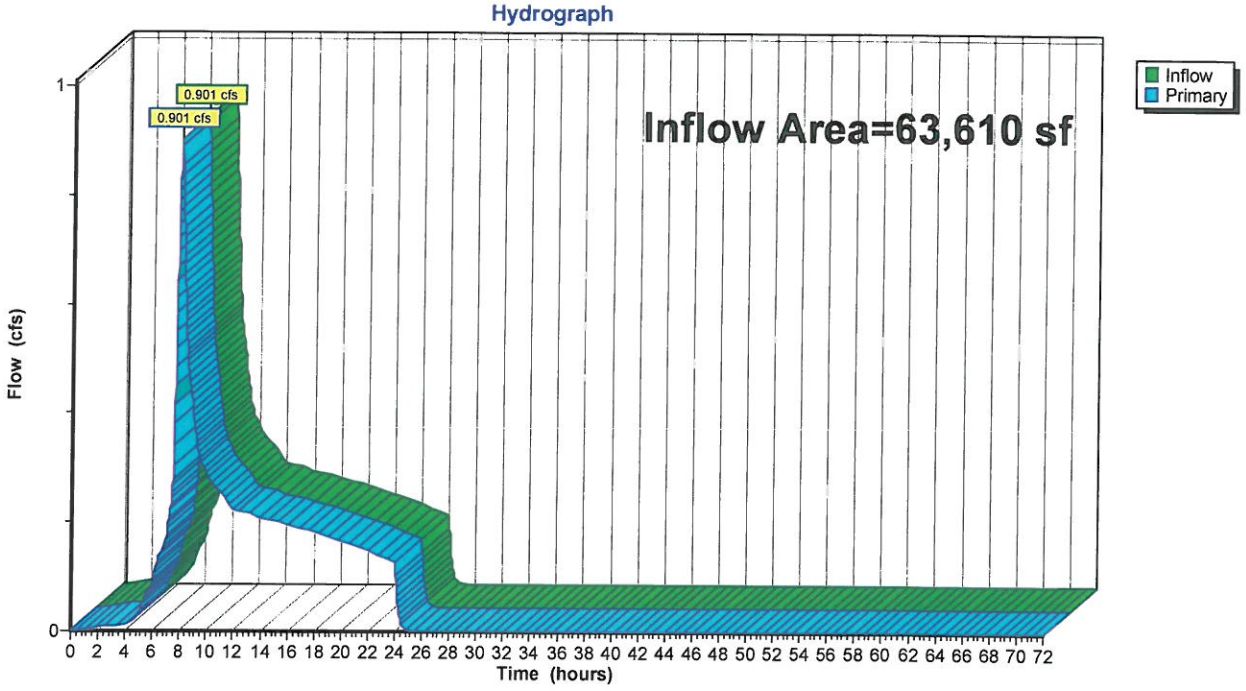


Summary for Link 3: ALLOWABLE DISCHARGE

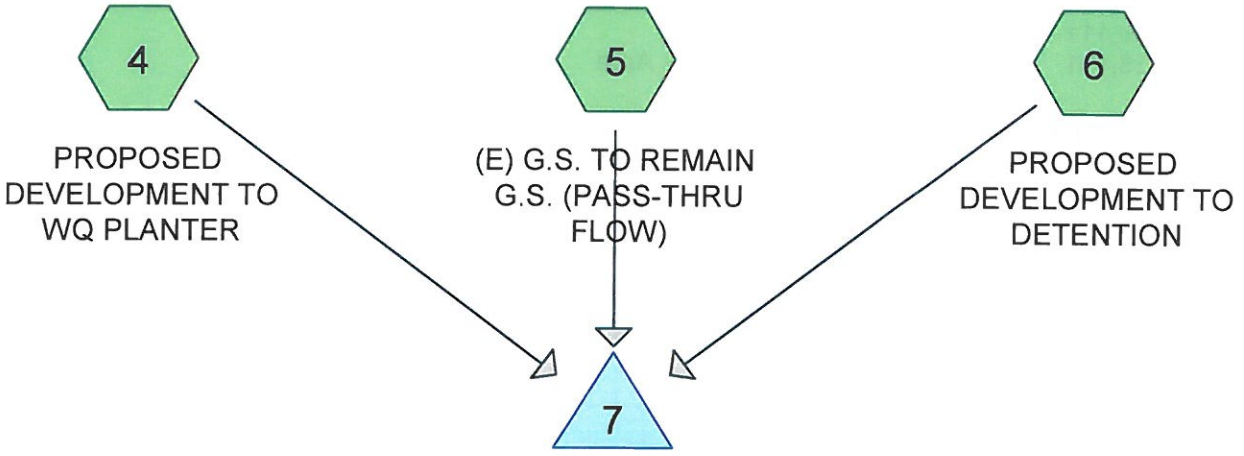
Inflow Area = 63,610 sf, 4.49% Impervious, Inflow Depth = 2.88" for 25-YR event
Inflow = 0.901 cfs @ 8.00 hrs, Volume= 15,272 cf
Primary = 0.901 cfs @ 8.00 hrs, Volume= 15,272 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Link 3: ALLOWABLE DISCHARGE



POST-DEVELOPMENT



DETENTION PIPE

63,610 SF

Subcat Reach Pond Link

Routing Diagram for BARLOW TRAIL - POST DEV
Prepared by Symons Engineering Consultants, Printed 7/5/2022

Summary for Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER

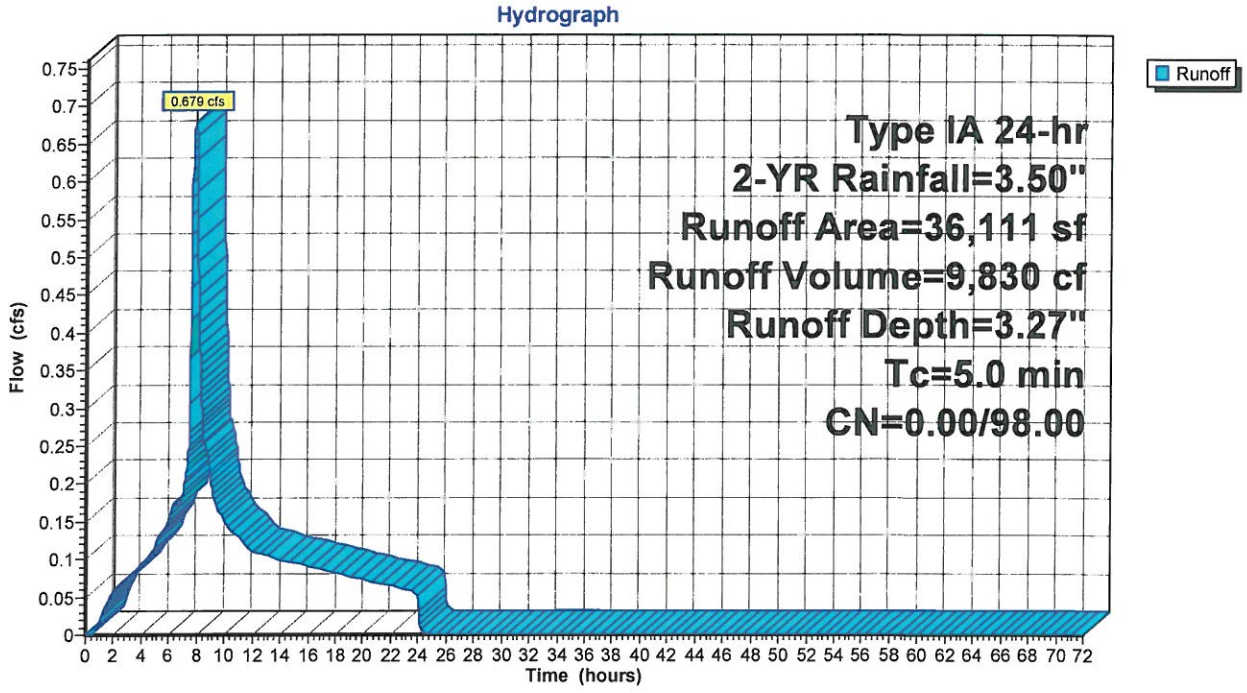
Runoff = 0.679 cfs @ 7.88 hrs, Volume= 9,830 cf, Depth= 3.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

	Area (sf)	CN	Description
*	13,768	98.00	Unconnected pavement, HSG C
	6,903	98.00	Unconnected roofs, HSG C
	8,821	98.00	Unconnected pavement, HSG C
	4,763	98.00	Unconnected pavement, HSG C
	1,856	98.00	Water Surface, HSG C
	36,111	98.00	Weighted Average
	36,111	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER



Summary for Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

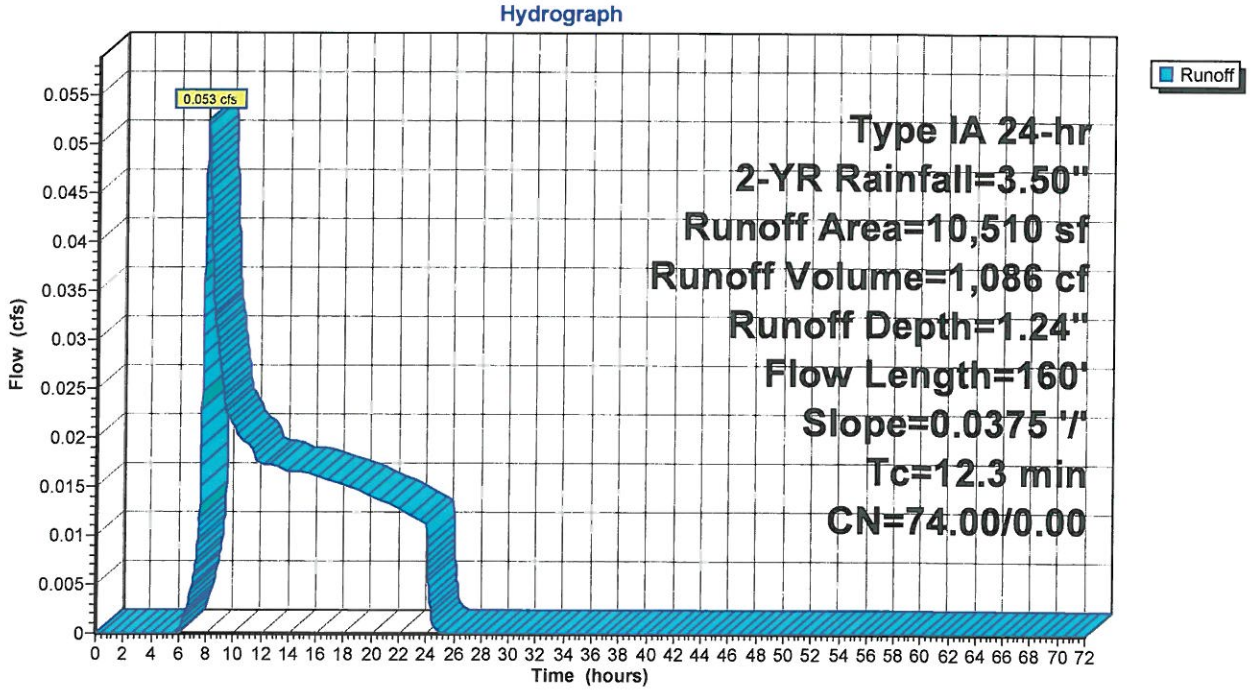
Runoff = 0.053 cfs @ 8.01 hrs, Volume= 1,086 cf, Depth= 1.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

	Area (sf)	CN	Description
*	9,001	74.00	>75% Grass cover, Good, HSG C
*	1,509	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)



Summary for Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION

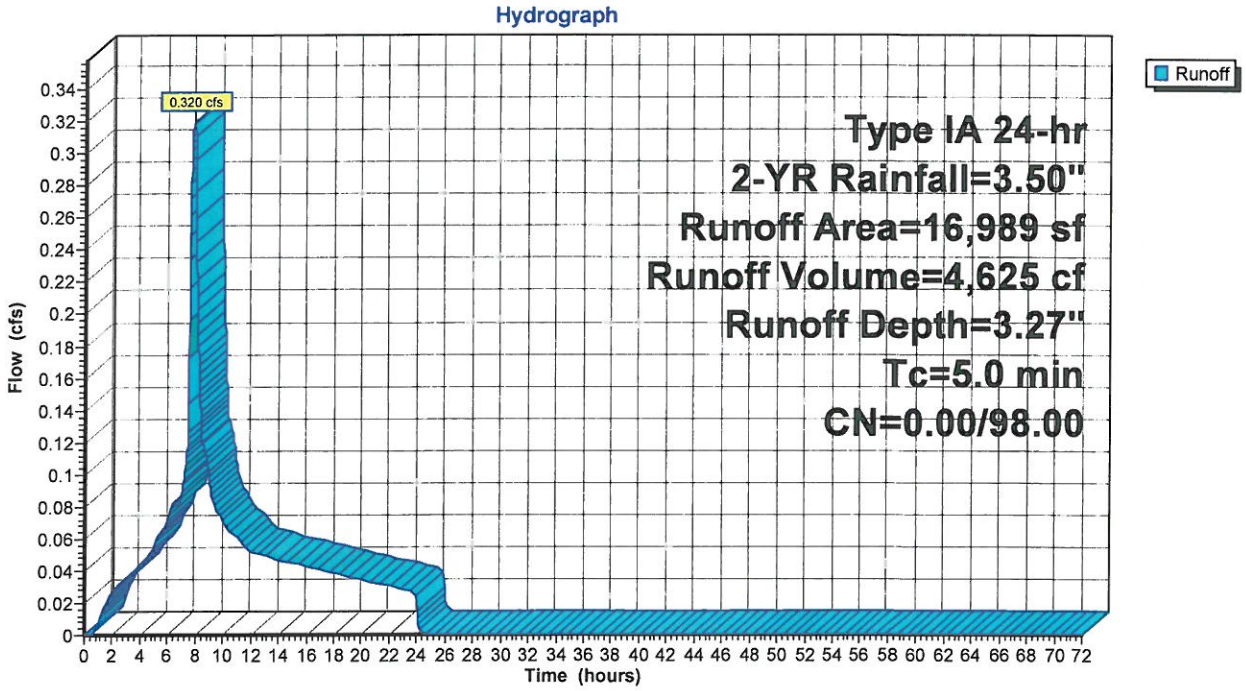
Runoff = 0.320 cfs @ 7.88 hrs, Volume= 4,625 cf, Depth= 3.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 2-YR Rainfall=3.50"

Area (sf)	CN	Description
16,989	98.00	Unconnected roofs, HSG C
16,989	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION



Summary for Pond 7: DETENTION PIPE

Inflow Area = 63,610 sf, 83.48% Impervious, Inflow Depth = 2.93" for 2-YR event
Inflow = 1.045 cfs @ 7.90 hrs, Volume= 15,540 cf
Outflow = 0.351 cfs @ 8.92 hrs, Volume= 15,540 cf, Atten= 66%, Lag= 61.6 min
Primary = 0.351 cfs @ 8.92 hrs, Volume= 15,540 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= -5.10' @ 8.92 hrs Surf.Area= 824 sf Storage= 3,407 cf

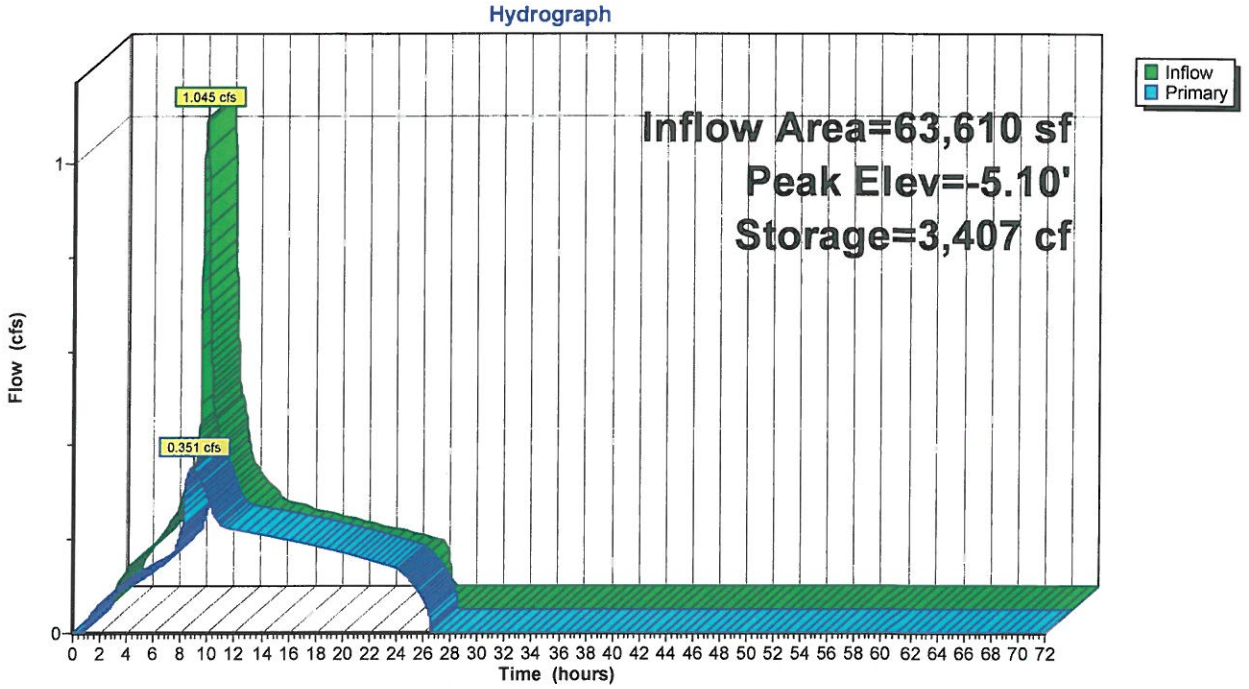
Plug-Flow detention time= 158.0 min calculated for 15,536 cf (100% of inflow)
Center-of-Mass det. time= 158.0 min (834.8 - 676.8)

Volume	Invert	Avail.Storage	Storage Description
#1	-10.00'	5,027 cf	**96.000" Round 50' DETENTION PIPE (X2)** x 2 L= 50.0' S= 0.0050 '/'
#2	-10.00'	216 cf	**5.00'D x 11.00'H 60" FC MH**
#3	-10.00'	216 cf	**5.00'D x 11.00'H 60" WQ MH**
#4	-10.00'	85 cf	**36.000" Round 36" CONNECTOR** L= 12.0'
		5,543 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-10.00'	**12.000" Round Culvert** L= 150.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= -10.00' / -11.50' S= 0.0100 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf
#2	Device 1	-10.00'	**2.000" Horiz. LOWER ORIFICE** C= 0.600
#3	Device 1	-5.50'	**2.000" Vert. MIDDLE 1 ORIFICE X 2.00** C= 0.600
#4	Device 1	-3.50'	**2.000" Vert. MIDDLE 2 ORIFICE X 2.00** C= 0.600
#5	Device 1	-2.00'	**12.000" Horiz. OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.351 cfs @ 8.92 hrs HW=-5.10' (Free Discharge)
└**1=Culvert** (Passes 0.351 cfs of 6.636 cfs potential flow)
  ├**2=LOWER ORIFICE** (Orifice Controls 0.233 cfs @ 10.66 fps)
  ├**3=MIDDLE 1 ORIFICE** (Orifice Controls 0.118 cfs @ 2.71 fps)
  ├**4=MIDDLE 2 ORIFICE** (Controls 0.000 cfs)
  └**5=OVERFLOW WEIR** (Controls 0.000 cfs)

Pond 7: DETENTION PIPE



Summary for Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER

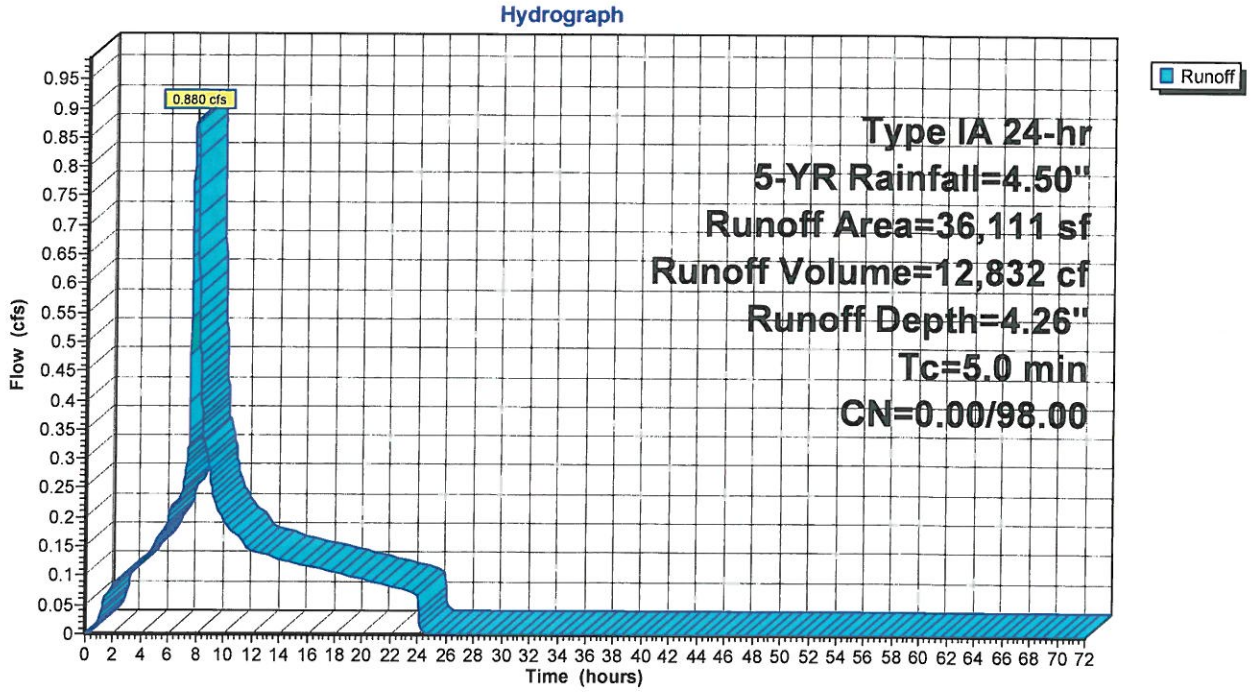
Runoff = 0.880 cfs @ 7.88 hrs, Volume= 12,832 cf, Depth= 4.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

	Area (sf)	CN	Description
*	13,768	98.00	Unconnected pavement, HSG C
	6,903	98.00	Unconnected roofs, HSG C
	8,821	98.00	Unconnected pavement, HSG C
	4,763	98.00	Unconnected pavement, HSG C
	1,856	98.00	Water Surface, HSG C
	36,111	98.00	Weighted Average
	36,111	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER



Summary for Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

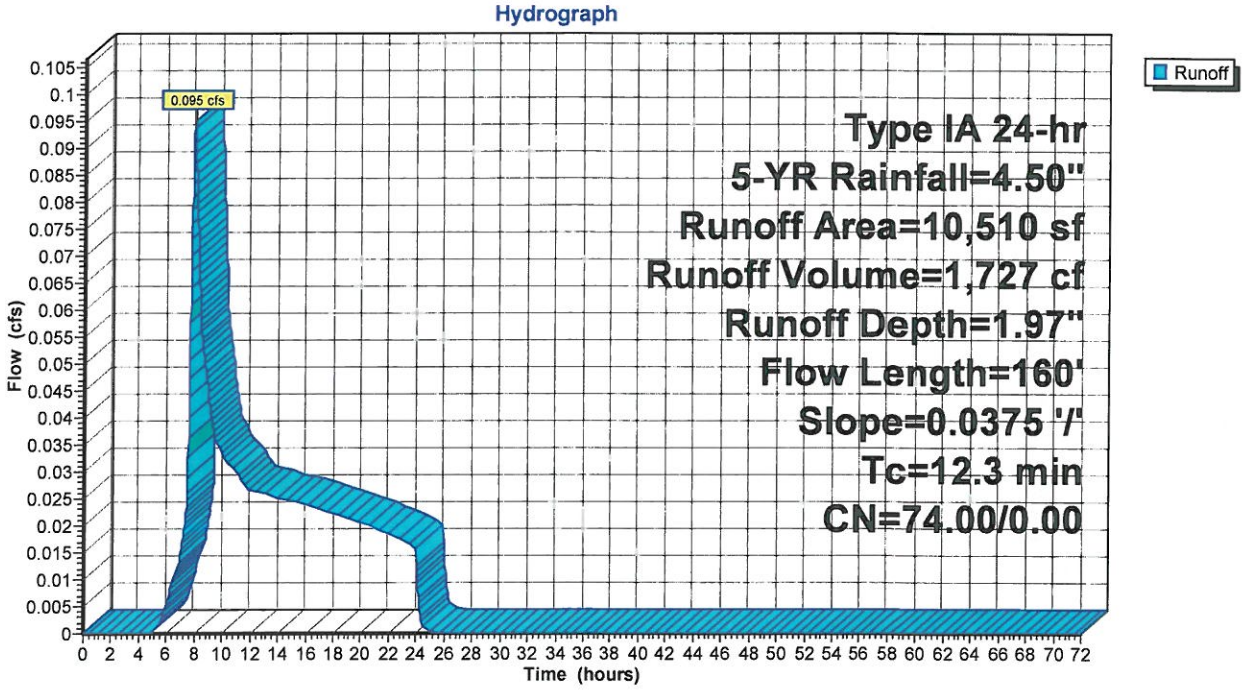
Runoff = 0.095 cfs @ 8.00 hrs, Volume= 1,727 cf, Depth= 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

	Area (sf)	CN	Description
*	9,001	74.00	>75% Grass cover, Good, HSG C
*	1,509	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)



Summary for Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION

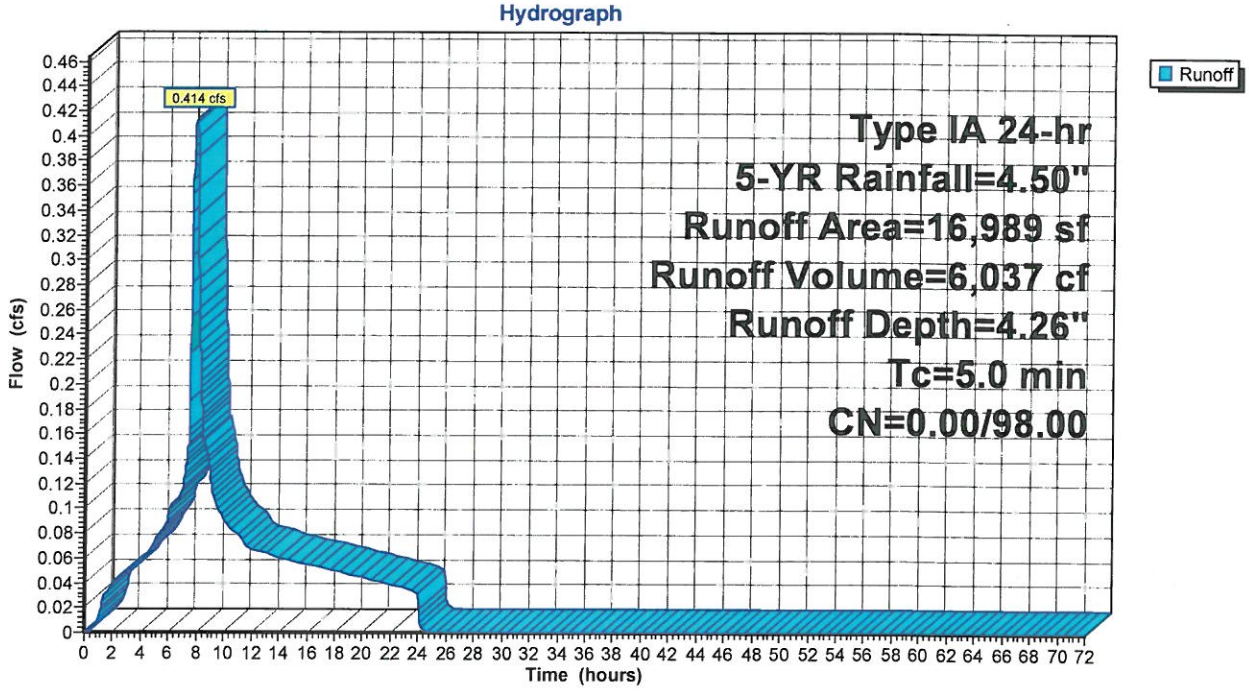
Runoff = 0.414 cfs @ 7.88 hrs, Volume= 6,037 cf, Depth= 4.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 5-YR Rainfall=4.50"

Area (sf)	CN	Description
16,989	98.00	Unconnected roofs, HSG C
16,989	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION



Summary for Pond 7: DETENTION PIPE

Inflow Area = 63,610 sf, 83.48% Impervious, Inflow Depth = 3.89" for 5-YR event
Inflow = 1.380 cfs @ 7.90 hrs, Volume= 20,596 cf
Outflow = 0.534 cfs @ 8.66 hrs, Volume= 20,596 cf, Atten= 61%, Lag= 45.8 min
Primary = 0.534 cfs @ 8.66 hrs, Volume= 20,596 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= -3.75' @ 8.66 hrs Surf.Area= 717 sf Storage= 4,458 cf

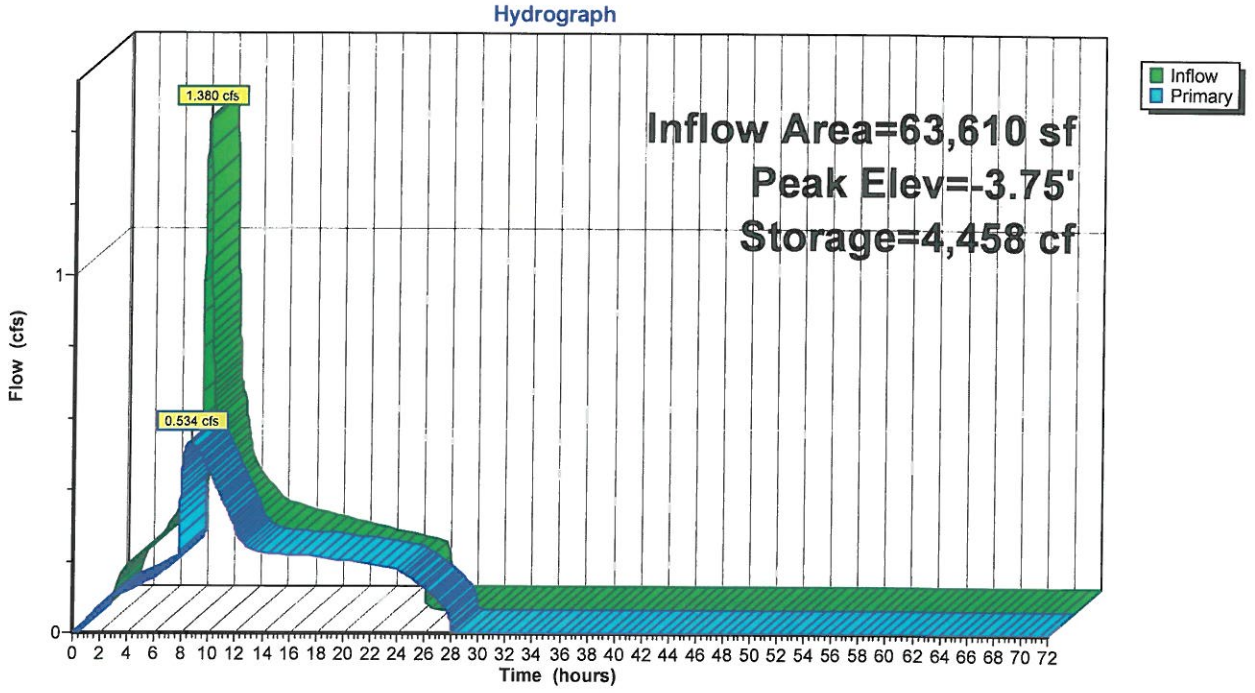
Plug-Flow detention time= 164.2 min calculated for 20,590 cf (100% of inflow)
Center-of-Mass det. time= 164.2 min (835.8 - 671.5)

Volume	Invert	Avail.Storage	Storage Description
#1	-10.00'	5,027 cf	**96.000" Round 50' DETENTION PIPE (X2)** x 2 L= 50.0' S= 0.0050 '/'
#2	-10.00'	216 cf	**5.00'D x 11.00'H 60" FC MH**
#3	-10.00'	216 cf	**5.00'D x 11.00'H 60" WQ MH**
#4	-10.00'	85 cf	**36.000" Round 36" CONNECTOR** L= 12.0'
		5,543 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-10.00'	**12.000" Round Culvert** L= 150.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= -10.00' / -11.50' S= 0.0100 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf
#2	Device 1	-10.00'	**2.000" Horiz. LOWER ORIFICE** C= 0.600
#3	Device 1	-5.50'	**2.000" Vert. MIDDLE 1 ORIFICE X 2.00** C= 0.600
#4	Device 1	-3.50'	**2.000" Vert. MIDDLE 2 ORIFICE X 2.00** C= 0.600
#5	Device 1	-2.00'	**12.000" Horiz. OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.534 cfs @ 8.66 hrs HW=-3.75' (Free Discharge)
└**1=Culvert** (Passes 0.534 cfs of 7.417 cfs potential flow)
  ├**2=LOWER ORIFICE** (Orifice Controls 0.263 cfs @ 12.04 fps)
  ├**3=MIDDLE 1 ORIFICE** (Orifice Controls 0.271 cfs @ 6.21 fps)
  ├**4=MIDDLE 2 ORIFICE** (Controls 0.000 cfs)
  └**5=OVERFLOW WEIR** (Controls 0.000 cfs)

Pond 7: DETENTION PIPE



Summary for Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER

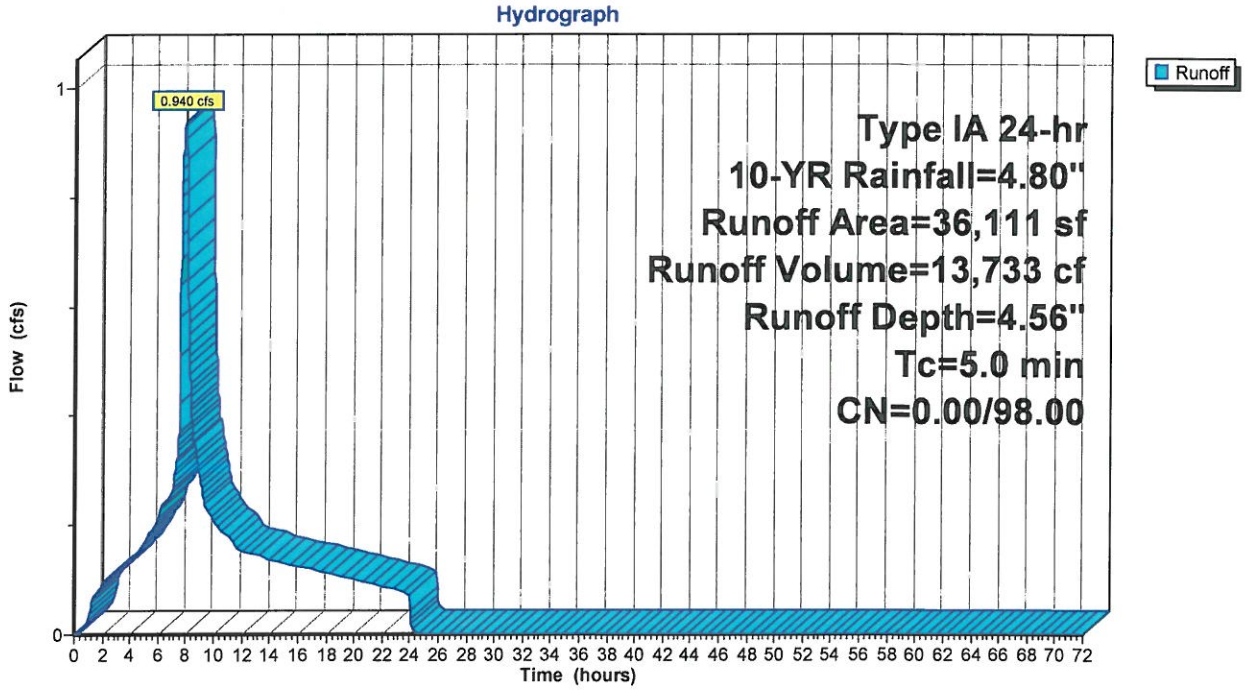
Runoff = 0.940 cfs @ 7.88 hrs, Volume= 13,733 cf, Depth= 4.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

	Area (sf)	CN	Description
*	13,768	98.00	Unconnected pavement, HSG C
	6,903	98.00	Unconnected roofs, HSG C
	8,821	98.00	Unconnected pavement, HSG C
	4,763	98.00	Unconnected pavement, HSG C
	1,856	98.00	Water Surface, HSG C
	36,111	98.00	Weighted Average
	36,111	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER



Summary for Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

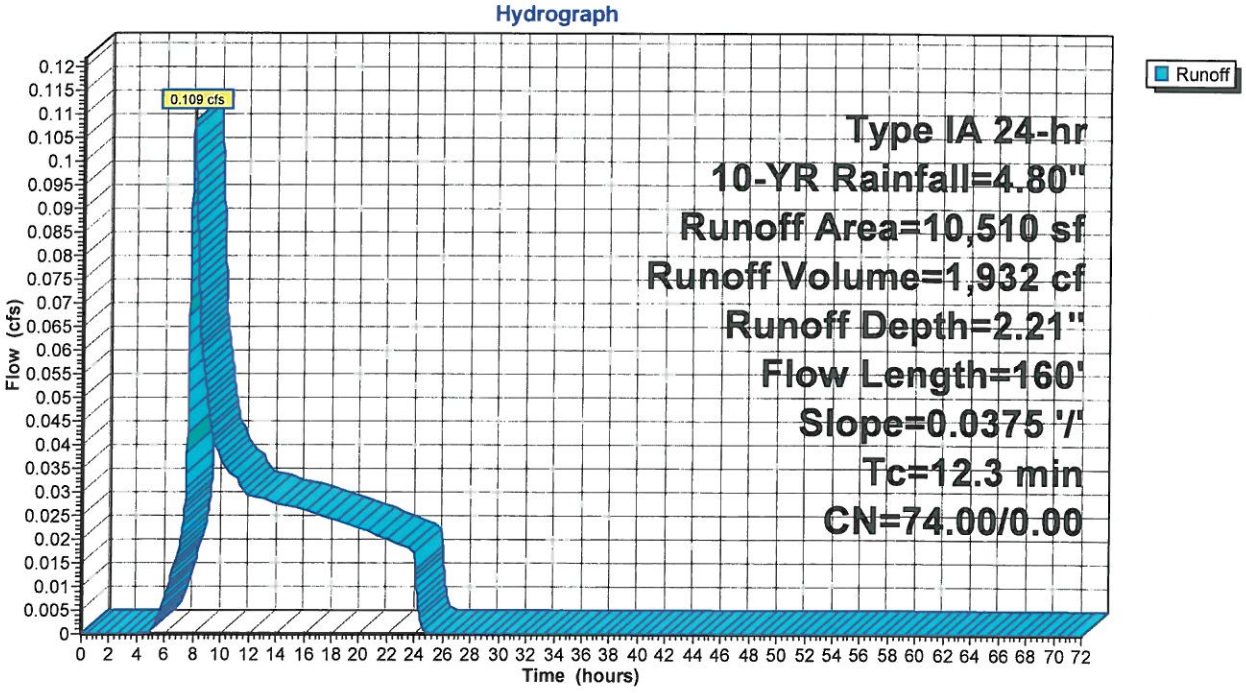
Runoff = 0.109 cfs @ 8.00 hrs, Volume= 1,932 cf, Depth= 2.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

	Area (sf)	CN	Description
*	9,001	74.00	>75% Grass cover, Good, HSG C
*	1,509	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)



Summary for Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION

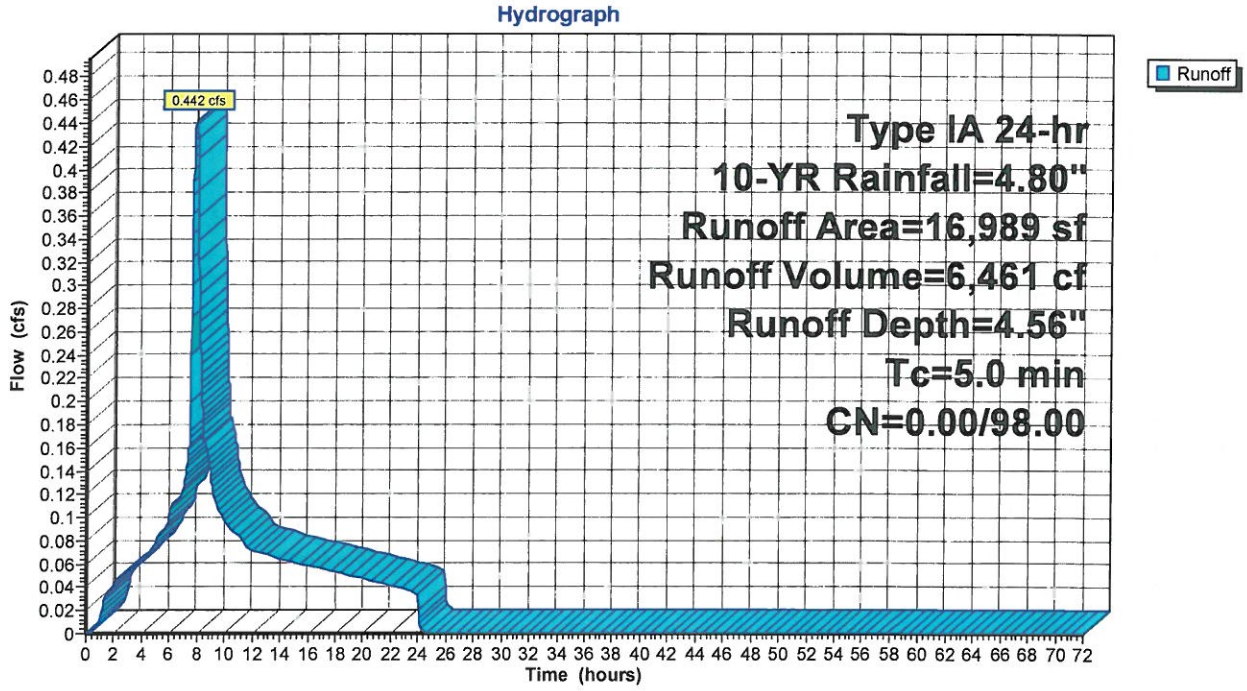
Runoff = 0.442 cfs @ 7.88 hrs, Volume= 6,461 cf, Depth= 4.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 10-YR Rainfall=4.80"

Area (sf)	CN	Description
16,989	98.00	Unconnected roofs, HSG C
16,989	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION



Summary for Pond 7: DETENTION PIPE

Inflow Area = 63,610 sf, 83.48% Impervious, Inflow Depth = 4.17" for 10-YR event
Inflow = 1.481 cfs @ 7.90 hrs, Volume= 22,125 cf
Outflow = 0.647 cfs @ 8.41 hrs, Volume= 22,125 cf, Atten= 56%, Lag= 30.9 min
Primary = 0.647 cfs @ 8.41 hrs, Volume= 22,125 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= -3.31' @ 8.41 hrs Surf.Area= 652 sf Storage= 4,764 cf

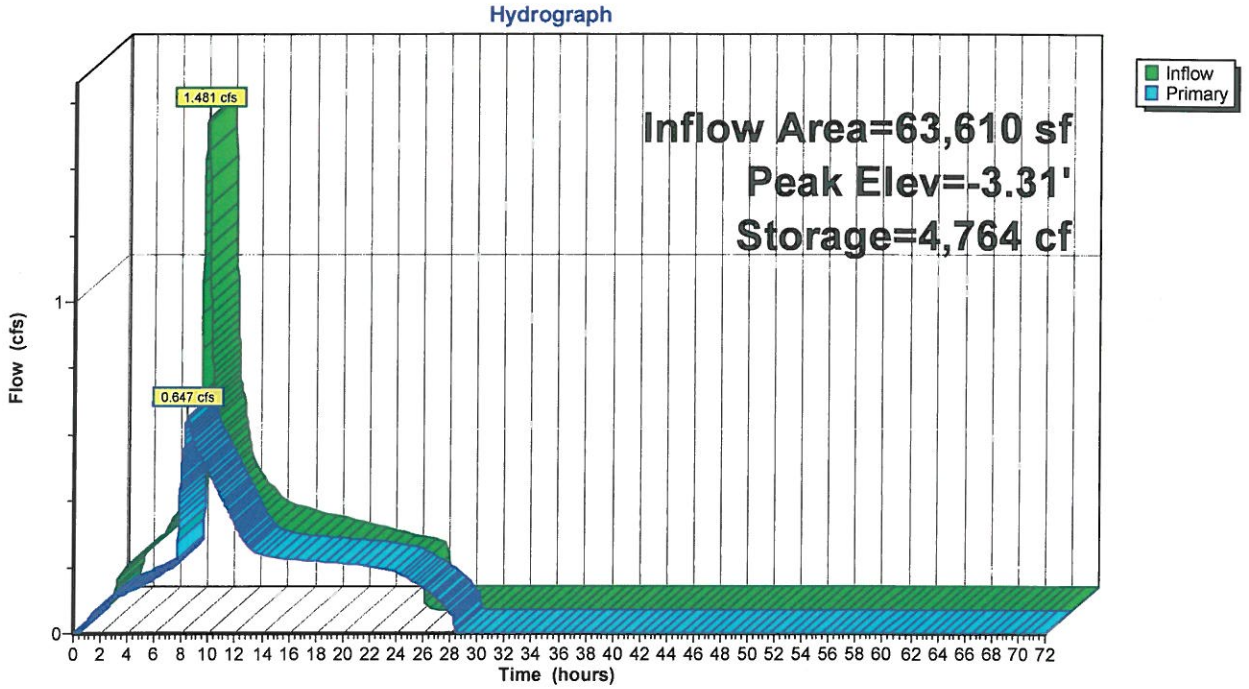
Plug-Flow detention time= 164.5 min calculated for 22,125 cf (100% of inflow)
Center-of-Mass det. time= 164.2 min (834.4 - 670.3)

Volume	Invert	Avail.Storage	Storage Description
#1	-10.00'	5,027 cf	**96.000" Round 50' DETENTION PIPE (X2)** x 2 L= 50.0' S= 0.0050 '/'
#2	-10.00'	216 cf	**5.00'D x 11.00'H 60" FC MH**
#3	-10.00'	216 cf	**5.00'D x 11.00'H 60" WQ MH**
#4	-10.00'	85 cf	**36.000" Round 36" CONNECTOR** L= 12.0'
		5,543 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-10.00'	**12.000" Round Culvert** L= 150.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= -10.00' / -11.50' S= 0.0100 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf
#2	Device 1	-10.00'	**2.000" Horiz. LOWER ORIFICE** C= 0.600
#3	Device 1	-5.50'	**2.000" Vert. MIDDLE 1 ORIFICE X 2.00** C= 0.600
#4	Device 1	-3.50'	**2.000" Vert. MIDDLE 2 ORIFICE X 2.00** C= 0.600
#5	Device 1	-2.00'	**12.000" Horiz. OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.647 cfs @ 8.41 hrs HW=-3.31' (Free Discharge)
└**1=Culvert** (Passes 0.647 cfs of 7.659 cfs potential flow)
  ├**2=LOWER ORIFICE** (Orifice Controls 0.272 cfs @ 12.46 fps)
  ├**3=MIDDLE 1 ORIFICE** (Orifice Controls 0.305 cfs @ 6.99 fps)
  ├**4=MIDDLE 2 ORIFICE** (Orifice Controls 0.070 cfs @ 1.60 fps)
  └**5=OVERFLOW WEIR** (Controls 0.000 cfs)

Pond 7: DETENTION PIPE



Summary for Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER

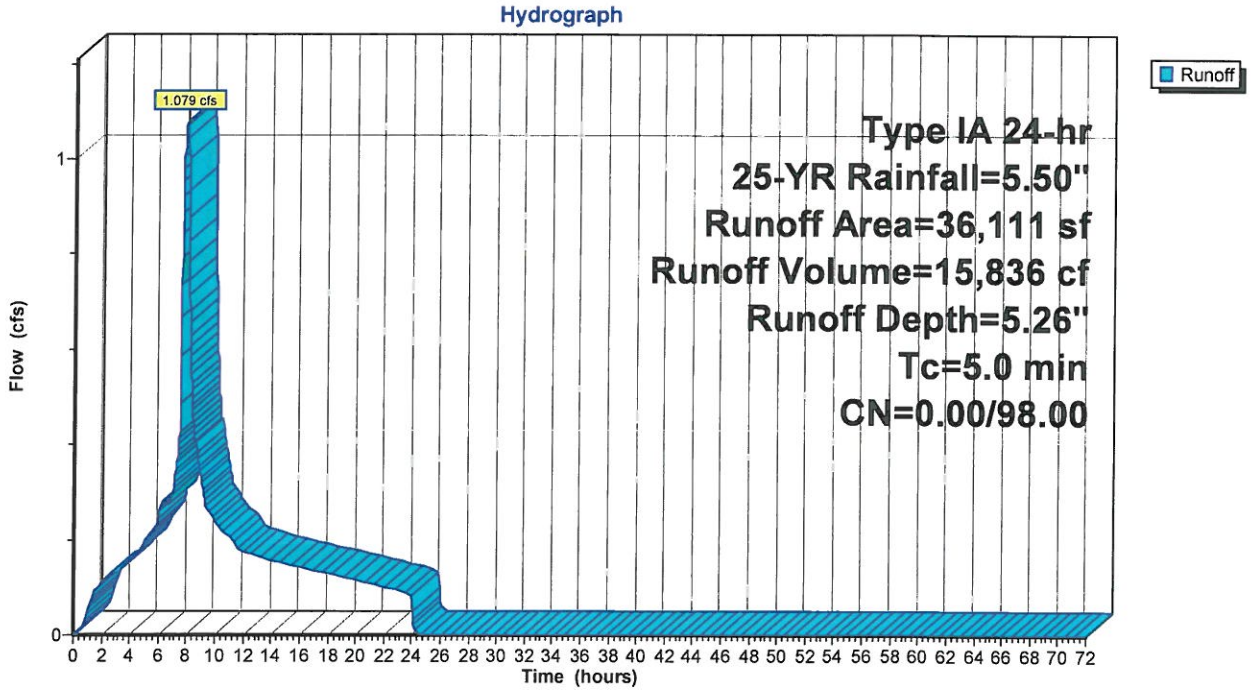
Runoff = 1.079 cfs @ 7.88 hrs, Volume= 15,836 cf, Depth= 5.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

	Area (sf)	CN	Description
*	13,768	98.00	Unconnected pavement, HSG C
	6,903	98.00	Unconnected roofs, HSG C
	8,821	98.00	Unconnected pavement, HSG C
	4,763	98.00	Unconnected pavement, HSG C
	1,856	98.00	Water Surface, HSG C
	36,111	98.00	Weighted Average
	36,111	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 4: PROPOSED DEVELOPMENT TO WQ PLANTER



Summary for Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)

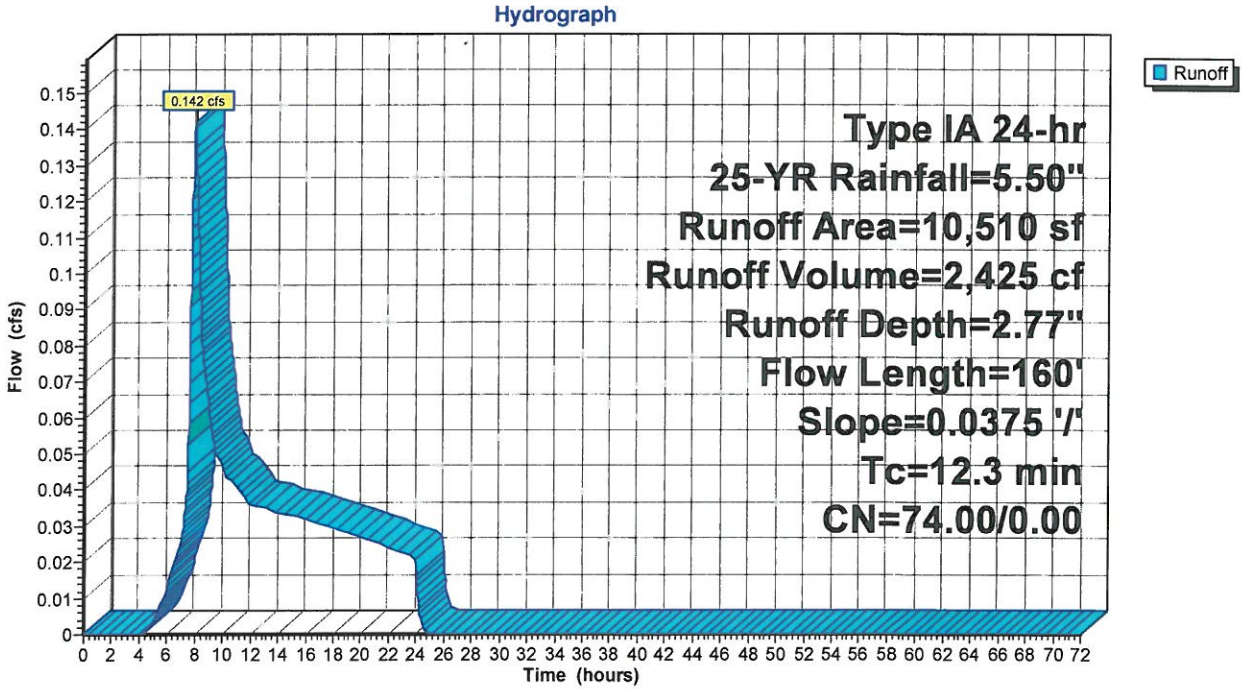
Runoff = 0.142 cfs @ 8.00 hrs, Volume= 2,425 cf, Depth= 2.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

	Area (sf)	CN	Description
*	9,001	74.00	>75% Grass cover, Good, HSG C
*	1,509	74.00	>75% Grass cover, Good, HSG C
	10,510	74.00	Weighted Average
	10,510	74.00	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	160	0.0375	0.22		**Sheet Flow, SHEET** Grass: Short n= 0.150 P2= 2.60"

Subcatchment 5: (E) G.S. TO REMAIN G.S. (PASS-THRU FLOW)



Summary for Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION

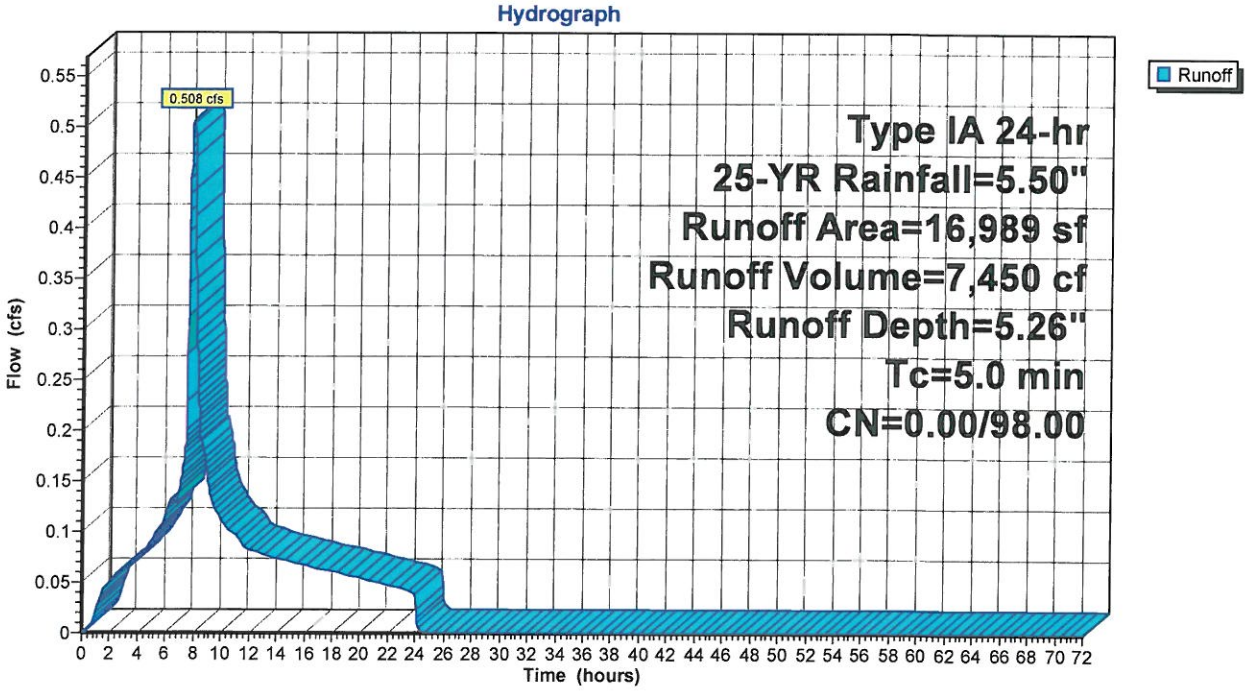
Runoff = 0.508 cfs @ 7.88 hrs, Volume= 7,450 cf, Depth= 5.26"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type IA 24-hr 25-YR Rainfall=5.50"

Area (sf)	CN	Description
16,989	98.00	Unconnected roofs, HSG C
16,989	98.00	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, DIRECT**

Subcatchment 6: PROPOSED DEVELOPMENT TO DETENTION



Summary for Pond 7: DETENTION PIPE

Inflow Area = 63,610 sf, 83.48% Impervious, Inflow Depth = 4.85" for 25-YR event
Inflow = 1.718 cfs @ 7.90 hrs, Volume= 25,712 cf
Outflow = 0.904 cfs @ 8.28 hrs, Volume= 25,712 cf, Atten= 47%, Lag= 23.2 min
Primary = 0.904 cfs @ 8.28 hrs, Volume= 25,712 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= -2.19' @ 8.28 hrs Surf.Area= 347 sf Storage= 5,351 cf

Plug-Flow detention time= 159.6 min calculated for 25,712 cf (100% of inflow)
Center-of-Mass det. time= 159.2 min (826.9 - 667.7)

Volume	Invert	Avail.Storage	Storage Description
#1	-10.00'	5,027 cf	**96.000" Round 50' DETENTION PIPE (X2)** x 2 L= 50.0' S= 0.0050 '/'
#2	-10.00'	216 cf	**5.00'D x 11.00'H 60" FC MH**
#3	-10.00'	216 cf	**5.00'D x 11.00'H 60" WQ MH**
#4	-10.00'	85 cf	**36.000" Round 36" CONNECTOR** L= 12.0'
		5,543 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	-10.00'	**12.000" Round Culvert** L= 150.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= -10.00' / -11.50' S= 0.0100 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf
#2	Device 1	-10.00'	**2.000" Horiz. LOWER ORIFICE** C= 0.600
#3	Device 1	-5.50'	**2.000" Vert. MIDDLE 1 ORIFICE X 2.00** C= 0.600
#4	Device 1	-3.50'	**2.000" Vert. MIDDLE 2 ORIFICE X 2.00** C= 0.600
#5	Device 1	-2.00'	**12.000" Horiz. OVERFLOW WEIR** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.904 cfs @ 8.28 hrs HW=-2.19' (Free Discharge)
└**1=Culvert** (Passes 0.904 cfs of 8.232 cfs potential flow)
  ├**2=LOWER ORIFICE** (Orifice Controls 0.294 cfs @ 13.46 fps)
  ├**3=MIDDLE 1 ORIFICE** (Orifice Controls 0.377 cfs @ 8.65 fps)
  ├**4=MIDDLE 2 ORIFICE** (Orifice Controls 0.233 cfs @ 5.33 fps)
  └**5=OVERFLOW WEIR** (Controls 0.000 cfs)

Pond 7: DETENTION PIPE