SAND HILL
MDDP AMENDMENT TO "THE MDDP FOR THE SANDS"

NEC MARKSHEFFEL RD. & CONSTITUTION AVE.
COLORADO SPRINGS, COLORADO

August 15, 2018
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Galloway
Planning. Architecture. Engineering.

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CERTIFICATION STATEMENTS

This report and plan for the drainage design of Sand Hill was prepared by me (of under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the *City of Colorado Springs Drainage Criteria Manual* and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

COLORADO LICENSED SCOTT MICHAEL BROWN 45900 PROFESSIONAL ENGINEER

Scott Brown, PE, Date
Registered Professional Engineer
State of Colorado No. 45900

04/12/2019

Developer's Statement:

Armstrong Capital Development hereby certifies that the drainage facilities for Sand Hill shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Armstrong Capital Development, guarantee that final drainage design review will absolve Armstrong Capital Development and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Armstrong Capital Development

Name of Developer

4/12//2019

Authorized Signature Date

Jarrett Armstrong

Printed Name

Manager

Title

4643 S. Ulster Street, Suite 240 Denver, Colorado 80237

Address:

CITY OF COLORADO SPRINGS:

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

04/19/2019

For City Engineer Date

Conditions:

I. Introduction

This document is the MDDP Amendment Report for Sand Hill, which serves as an amendment to "The MDDP for The Sands." It has been prepared for Armstrong Capital Development who owns approximately 10.3 acres of vacant land at the northeast corner of Marksheffel Road and Constitution Avenue. This 10.3 acres of commercial property has been named "Sand Hill." This project will dedicate 0.67 acres as Right-of-Way to the City of Colorado Springs and in the future will develop the remaining area as retail and commercial parcels. There will be 8 future retail pads and a lot of approximately 40,120 square-feet containing a convenience store. A new public roadway, Larzac Drive, will be constructed from the existing intersection at Constitution Avenue and tie into a future development to the north. A new local private road will run through the middle of the property and tie into Larzac Drive. Final drainage reports will be prepared for each lot as they develop. A Final Drainage report for Filing 1, Lot 1 has been submitted concurrently with this report as well as a Final Drainage report for the Filing 1 roadway, grading, and street improvements. Those reports should be referenced for specific design relating to the detention ponds, storm sewer, and inlets.

The purpose of this report is to identify on and offsite drainage patterns, locate and identify tributary or downstream drainage features and facilities that impact the site and to identify drainage facility preliminary sizing and locations. An MDDP has been previously prepared and approved for this site by M&S Civil Consultants, Inc. The "Master Development Drainage Plan for The Sands and Preliminary Drainage Report", dated March 2018 identifies basins and detention locations for the Sand Hill Filing No. 1 project site. This report intends to modify those assumptions per the conceptual design for the site.

II. General Location and Description

Sand Hill is located in the west ½ of Section 33, Township 13 South, Range 65 West, of the 6th P.M. City of Colorado Springs, El Paso County, State of Colorado. Sand Hill Filing No. 1 is approximately 10.3 acres. It is a portion of the 114.3 acres that is known as The Sands. The project site is bounded to the west by Marksheffel Road, to the south by Constitution Avenue, to the east by Sand Creek, and to the north by The Sands residential development. The site itself is currently undeveloped. A Vicinity Map is located in Appendix A for reference.

Soil data for Sand Hill Filing No. 1 was obtained from the United States Department of Agriculture Natural Resources Conservation Service (NRCS) Web Soil Survey. Soils within the site are predominantly Blendon sandly loam (60%), hydrologic soil group B, and Ellicott loamy coarse sand (40%), hydrologic soil group A. A map depicting the soil types on the project site is contained in Appendix A for reference.

The Sand Creek East Tributary bounds the eastern edge of the property. However, Sand Creek is contained outside of the property limits. Improvements to Sand Creek are being designed and constructed as part of the overall development. A CLOMR has been approved for the proposed improvements to Sand Creek. There are no major drainageways or irrigation facilities located on the site.

III. Historic Drainage Patterns and Features

The Sand Hill Filing No. 1 site is located within the Sand Creek Drainage Basin as described in the Sand Creek Drainage Basin Planning Study (DBPS) prepared by Kiowa Engineering Corporation revised March 1996. An MDDP has been previously been prepared and approved for the site. The "Master Development Drainage Plan for The Sands and Preliminary Drainage Report", by M&S Civil Consultants dated March 2018 has been used as the basis for this report. The M&S MDDP identifies general drainage patterns as well as detention and water quality facilities for the Sand Hill Filing No. 1 site. These patterns and facilities will be revised with this report.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Panel 756 (FIRM Number 08041C0756 G), effective date December 7, 2018 a portion of the site lies within Shaded Zone X, and is outside of Zone AE. It is also known that a CLOMR is being prepared for the channel improvements associated with the overall development. For the purposes of development the site has used the new panel and the CLOMR for the site layout. A copy of the FIRM maps is included for reference in Appendix A.

In existing conditions, the site is comprised of undeveloped land covered mostly by native grasses and weeds. Existing slopes are generally between 1% and 5% although there are a few areas with slopes of 25%.

A historic basin map was included in the M&S MDDP, a copy is included in Appendix A, which identifies the larger basins associated with the overall development. This map is used to get an overall sense of historic patters, but a historic basin map has been prepared for this site calculating the historic releases for just the subject property. This will aide in identifying the allowable releases in the proposed design.

Basin H-1 (2.30 AC, Q_5 = 0.8 cfs, Q_{100} = 5.4 cfs): is associated with the eastern portion of the site. The basin is currently undeveloped. Runoff from the basin is captured in an existing low point which is drained to the south by and existing 24" storm pipe. The pipe continues south under Constitution Ave. and outfalls into Sand Creek east of the recent development.

Basin H-2 (2.01 AC, Q_5 = 0.7 cfs, Q_{100} = 4.7 cfs): is associated with the middle eastern portion of the site. The basin is currently undeveloped. Is captured in a low point and then is directed east into Basin H-1.

The total flow leaving the eastern portion of the site is 1.5 cfs in the 5-year event and 10.0 cfs in the 100-year event.

Basin H-3 (2.71 AC, Q_5 = 0.9 cfs, Q_{100} = 6.3 cfs): is associated with the middle western portion of the site. The basin is currently undeveloped. Runoff from the basin enters Constitution Ave. and is collected in an existing storm inlet at the intersection of Marksheffel Road and Constitution Ave.

Basin H-4 (3.98 AC, Q_5 = 1.4 cfs, Q_{100} = 9.0 cfs): is associated with the western portion of the site. The basin is currently undeveloped. Runoff from the basin enters Constitution Ave. via the existing area inlet.

The total flow leaving the western portion of the site is 2.3 cfs in the 5-year event and 15.2 cfs in the 100-year event.

IV. DRAINAGE DESIGN CRITERIA

The analysis and design of the Stormwater management system for this project was prepared in accordance with the criteria set for th in the City of Colorado Springs Drainage Criteria Manual (DCM) Volumes 1 & 2, dated May 2014.

The rational method was used to calculate peak flows as the tributary areas are less than 100 acres. The rational method has been proven to be accurate for basins of this size and is based on the following formula:

Q = CIA

Where:

Q = Peak Discharge (cfs)

C = Runoff Coefficient

I = Runoff intensity (inches/hour)

A = Drainage area (acres)

The runoff coefficients are calculated based on land use, percent imperviousness, and design storm for each basin, as shown in the DCM Table 6-6. Percent impervious was assumed to be 90% for the commercial areas of the site.

The 100-year event was used as the major storm event and the 5-year event was used as the minor storm event. These storm intervals were used for the sizing of the pipes and inlets.

The rainfall intensity calculations are based on the DCM Figure 6-5 and IDF equations. The one hour point rainfall data for the design are listed in Table 1 below.

Table 1 - Precipitation Data

Return Period	One Hour Depth (in).	Intensity (in/hr)
5-year	1.50	5.17
100-year	2.52	8.68

Time of concentrations have been adapted from the equation 6-7 of The City of Colorado Springs Drainage Criteria Manual, Volume 1 which are as follows:

$Tc = T_i + T_t$

Where:

T_c = time of concentration (min)
T_i = overland (initial) flow time (min)
T_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

Overland (Initial) Flow Time: from equations 6-8 from the City of Colorado Springs Drainage Criteria Manual, Volume 1.

$$t_t = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$

Where:

T_i = overland (initial) flow
C_5 = runoff coefficient for 5-year frequency
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope

Travel Time

$V = C_v*S_w0.5$

Where:

V = Velocity (ft/s)
C_v = conveyance coefficient
S_w = watercourse slope (ft/ft)

The DCM requires that full spectrum detention (FSD) be utilized for new development. FSD attributes two design volumes; one being the Excess Urban Runoff Volume (EURV) and the other being the 100-year detention volume. The EURV methodology includes the Water Quality Capture Volume (WQCV) within the EURV volume. Therefore, no additional volume for the WQCV is required. The equations contained within the DCM were utilized to calculate the required EURV and WQCV values.

The site uses a series of parking lot detention with a downstream extended detention basin to work as a system and provide full spectrum detention for the property. Due to the ponds in series a SWMM model was utilized to identify the necessary parking lot detention and ensure that the downstream extended detention basins are sized appropriately. One concern had with ponds in series is that the drain times of the various ponds affect the overall drain time at the furthest downstream point. For this reason plots of the depth vs. time from the SWMM model have been included to show that the pond does drain appropriately in the full spectrum of events. The SWMM model has been run for the WQ, 2, 5, 10, 25, 50, and 100 year events to verify that full spectrum detention is provided with the proposed design.

While it is preferred that the latest UD-Detention spreadsheet be utilized with the design it was felt that given the ponds in series this spreadsheet was not appropriate. The SWMM model was used to produce hydrographs of the site and verify drain times. The UD-Detention v2.35 spreadsheet was utilized for the sizing of various aspects of the extended detention basin. It was utilized to determine the required EURV volume and size the orifice plate for the EURV portion of the pond. The UD-Detention spreadsheet was also utilized to create stage release curves that were utilized in the SWMM model.

Assumptions made in the SWMM model are as follows:

- Kinematic Wave Method
- Horton's Infiltration Method
- Manning's n for impervious areas – 0.011
- Manning's n for pervious areas – 0.24
- Depression storage for impervious areas – 0.1"
- Depression storage for pervious areas – 0.35"

V. PROPOSED DRAINAGE PLAN

A. General Concept

The Sand Hill Filing No. 1 site is located within basins Q, R, V and Y from The Sands MDDP report. Basin Q equates to a portion of Sand Hill Filing No. 1 Basins C & D. Basin R equates to a portion of Sand Hill Filing No. 1 Basins A & C. Basin V equates to a portion of Sand Hill Filing No. 1 Basin B. Basin Y equates to a portion of Sand Hill Filing No. 1 Basin A. Basins R and V were planned to drain north to the proposed Pond 5, north of Sand Hill Filing No. 1. Basin Q was planned to drain to Pond 4. Basin Y was planned to drain to Pond 6. With proposed site layout and grading it is no longer possible to drain Basin R to Pond 5. It will be rerouted to Pond 4 & Pond 6. This report will modify the required volumes for Ponds 6 (now Pond A) and Pond 4 (now Pond C).

Basins denoted with an A designation are proposed to be routed to Pond A at the southeast corner of the site. Basins denoted with a B designation are proposed to be routed to Pond 5 north of Sand Hill Filing No. 5. Basins denoted with a C designation are proposed to be routed to Pond C at the southwest corner of the site. Basins denoted with a D designation are proposed to be routed to Pond D at the northwest corner of the site. Basins denoted with an E designation are proposed to be routed through the CSU easement to the existing outfall at the southwest corner of the site.

The proposed drainage system is designed to safely convey the storm runoff generated from the proposed development. To achieve full spectrum detention on the Sand Hill site a system of parking lot detention was used in conjunction with extended detention basins. The parking lot detention is intended to provide flood control only, while the downstream extended detention basins provide the EURV volume and any additional flood control necessary to control the site release. Proposed Pond A will provide EURV and a portion of the flood control for all A basins. The B basins will all drain offsite to the proposed Pond 5 as described in The Sands MDDP. Proposed Pond C will provide EURV and a portion of the flood control for all C basins. Basin D will have a full spectrum detention pond provided for the basin separate from all other ponds. All ponds proposed with this development will be privately owned and maintained.

As was described above parking lot detention or other alternative methods (e.g. landscape islands) will be utilized to provide flood control at the source of runoff for each future lot. Conceptual locations for these parking lot detention areas have been shown on the drainage map, they are hatched solid gray. Additionally, approximate volumes for these ponds have been given later in the report. The intent for these approximate volumes is that if the tributary area and percent impervious at these locations matches at the time of development what is contained within this report then it is the maximum required volume for that area. If percent impervious or area is increased, then the required volume must be reviewed through updating the SWMM model prepared for the overall sizing of the system. If it is so desired to reduce the required volume a SWMM model may be provided and update the design at such time. This review should be done at the time of Final Drainage Report for each future lot development.

Each lot will be required to provide some detention upstream of the main ponds in order to reduce the overall volume of the downstream ponds. Detention may be provided in the form of parking lot detention or other alternative methods (e.g. landscape islands). Approximate volumes of these smaller ponds are provided within the calculations and are to be used as a guideline for lots as they develop. The volumes should be verified as each lot develops by updating the provided SWMM model.

The Final Drainage Report for each lot will need to provide a calculation showing the provided volume of the parking lot detention, show the depth of the ponding, and show the area that is ponded as a part of the parking lot detention. Parking lot detention should adhere to the following criteria:

- The maximum allowable depth of parking lot detention for the 100-year event is 9 inches within a parking stall.
- An emergency spillway sized for the 100-year peak inflow rate shall be provided with a crest elevation set at the 100-year water surface elevation and a maximum flow depth over the emergency spillway of 6 inches. No freeboard above the emergency spillway 100-year water surface elevation is required. The finished first floor elevation of any adjacent structures shall be at least 1.0 foot above the 100-year emergency overflow water surface elevation (equivalent to 18 inches above the 100-year pond water surface). The emergency spillway should be integrated into the site plan and landscaping and can be vegetated over stabilization material such as soil riprap or a geotextile. Embankment protection may be eliminated if the depth of flow and velocities for the 100-year flow are low enough to avoid erosion during overtopping.
- All parking lot detention areas shall have a minimum of two signs posted identifying the area of potential flooding. The signs shall be fabricated of durable materials, such as metal or plastic, using red lettering on a white background and shall have a minimum area of 1.5 square feet and contain the following message: "WARNING THIS AREA IS A DETENTION POND AND IS SUBJECT TO PERIODIC FLOODING TO A DEPTH OF 9 INCHES OR MORE". Signs shall be located at the edge of the parking area adjacent to where flooding may occur and facing the parking area. Any suitable geometry of the signs is permissible. The property owner shall be responsible to ensure that the sign is provided and maintained at all times.

A portion of the site lies within the streamside overlay that is being created by the overall development. The streamside overlay has been identified a Type 1 Overlay and only affects the eastern lot on the site. Per the Streamside Design Guidelines a Type 1 Overly has total buffer zone of 70' with inner buffers of 20' and outer buffers of 50'. These are measured out from toe of the bank. As the eastern lot develops the overlay will be taken into account. Uses for the buffer zones are identified in the Streamside Design Guidelines and should be consulted at the time of site planning the eastern lot.

B. Four Step Process

The Four Step Process to minimize the adverse impacts of urbanization is a vital component of developing a balanced, sustainable project. Below identifies the proposed approach to the four step process. Further details will be provided with each final drainage report.

a. Employ Runoff Reduction Practices

This step uses low impact development (LID) practices to reduce runoff at the source. Generally, rather than creating point discharges that are directly connected to impervious areas runoff is routed through pervious areas to promote infiltration. Grass buffers and swales are encouraged with future developments and are used where practical. Runoff reduction plays a large role in the overall system design as detention volume is minimized.

b. Implement BMPs That Provide a Water Quality Capture Volume with Slow Release

This step utilizes formalized water quality capture volume to slow the release of runoff from the site. The three main ponds Pond A, Pond C, and Pond D are designed to provide EURV volume for the new development which incorporates a 72 hour release. Contained within the EURV volume is the WQCV which will release in no less than 40 hours.

c. Stabilize Drainageways

This step implements stabilization to channels to accommodate developed flows while protecting infrastructure and controlling sediment loading from erosion in the drainageways. Improvements to Sand Creek are being made as part of the overall development of The Sands project. These improvements have already taken into account developed flows from the site. Therefore, no channel improvements to Sand Creek will be required with the Sand Hill Filing No. 1 development. The channel improvements are currently under construction and are anticipated to be completed in the summer of 2019.

d. Implement Site Specific and other Source Control BMPs

Trash enclosures will be provided for the lots as they develop which will reduce trash from leaving the lots. As each lot develops they will identify any outdoor storage areas of pollutants and address as necessary. The biggest source control BMP is public education which can be found on the City of Colorado Springs website and discusses topics such as pet waste, car washing, lawn care, fall leaves, and snow melt and deicer.

C. Specific Details

The general location and description of each basin is described below. General routing of the basins is described below. As each lot is developed, further detail will be provided regarding parking lot detention and ponding depth in the appropriate FDRs. Hydrology calculations are provided in Appendix B. The proposed Drainage Map is located in Appendix D.

Basin A-1 (0.54 AC, Q_5 = 2.0 cfs, Q_{100} = 3.8 cfs): a basin defining a future parking lot for a future commercial use. Runoff will generally flow to the southeast corner of the basin where parking lot detention will be provided for the basin at DP 1. Runoff will be collected in a future storm sewer system and will be directed to the east where it will be joined by Basin A-2 at DP 2. The ultimate outfall of the system is Pond A.

Basin A-2 (0.57 AC, Q_5 = 2.2 cfs, Q_{100} = 4.0 cfs): A basin defining a future commercial development. Runoff will generally flow to the southern portion of the basin where parking lot detention will be provided for the basin at DP 2. Runoff may enter grass buffers or grass swales depending on the final layout of the parcel which will reduce runoff from the basin. Runoff will be collected in a future storm sewer system and will be directed to the east to Pond A.

Basin A-3 (0.22 AC, Q_5 = 1.4 cfs, Q_{100} = 2.6 cfs): a basin defining a portion of the public ROW for Larzac Drive. Runoff will be collected in the curb & gutter of the roadway. Runoff will then be captured in a proposed on-grade inlet at DP 5. Captured runoff will be joined by runoff from Basins A-5 and A-6 and will be piped east to DP 6.

Basin A-4 (0.19 AC, Q_5 = 0.9 cfs, Q_{100} = 1.6 cfs): a basin defining a portion of the public ROW for Larzac Drive. Runoff will be collected in the curb & gutter of the roadway. Runoff will then be captured in a proposed on-grade inlet at DP 6. Captured runoff will be joined by runoff from Basins A-5, A-6, and A-3 and will be piped east to Pond A.

Basin A-5 (0.45 AC, Q_5 = 1.7 cfs, Q_{100} = 3.1 cfs): a basin defining a future commercial development. Runoff will generally flow to the south of the basin where parking lot detention will be provided for the basin at DP 3. Runoff will be collected in a future storm sewer system and will be directed to the east to Pond A.

Basin A-6 (0.76 AC, Q_5 = 2.5 cfs, Q_{100} = 5.0 cfs): a basin defining a future commercial development. Runoff will generally flow to the south and east. A combination of parking lot detention, grass swales and grass buffers will be utilized to reduce the runoff from the basin. Runoff will be collected in a future storm sewer system and will be joined with flows from Basin A-5 at DP 4. Runoff will be directed to the inlet at DP 5.

Basin A-7 (0.88 AC, Q_5 = 3.3 cfs, Q_{100} = 6.2 cfs): a basin defining a future commercial development. Runoff will generally flow to the south. A future storm sewer system will capture runoff and direct it into Pond A.

Basin OS-1 (0.07 AC, Q_5 = 0.3 cfs, Q_{100} = 0.6 cfs): a basin defining a portion of the public ROW for Larzac Drive. Runoff will be directed into the existing Constitution Ave. On-grade inlets have been placed in Larzac Drive in order to minimize the amount of runoff being directly released into Constitution Ave. The inlet on the western curb has been placed at the edge of the Cherokee Metro district easement for the existing sanitary sewer line. The inlet cannot be placed further south due to the restrictions of the easement. The eastern portion of the roadway is super elevating in order to match the slope of Constitution Ave. The inlet on the eastern curb has been placed at the point where the road will have a 0.25% cross slope. This was assumed to be the last reasonable placement for an inlet as any flatter cross slope will cause runoff to begin to spill over the crown rendering the inlet ineffective.

Basin B-1 (0.79 AC, Q_5 = 2.7 cfs, Q_{100} = 4.9 cfs): a basin defining a future commercial development. Runoff will be directed to the north where it will be captured and enter into the proposed Pond 5 of The Sands development, as is proposed in The Sands MDDP. This basin is a portion of the basin denoted as Basin V on The Sands MDDP. The pattern proposed in that MDDP will remain and Pond 5 will provide EURV and full spectrum detention for the basin. Basin V in The Sands MDDP utilized an area of 0.87 acres and a percent impervious of 96.3%. The proposed basin B-1 is both smaller in size and lower in percent impervious. Therefore, Pond 5 is adequately sized for the proposed basin and this pattern is consistent with the approved The Sands MDDP.

Basin B-2 (0.15 AC, Q_5 = 0.7 cfs, Q_{100} = 1.2 cfs): a basin defining a portion of Larzac Drive that will be conveyed in curb & gutter north to a low point planned with The Sands project. Runoff from the basin will be captured in inlets and piped into the proposed Pond 5 of The Sands project.

Basin C-1 (0.89 AC, Q_5 = 2.4 cfs, Q_{100} = 4.7 cfs): a basin defining a future commercial development. Runoff will either be captured in future parking lot detention, shallow landscape detention, grass buffers, or grass swales to reduce the runoff being released from the basin.

Runoff will generally drain to the south where it will be captured in a future storm sewer system at DP 20. Runoff will be directed west to Pond C.

Basin C-2 (0.72 AC, Q_5 = 2.7 cfs, Q_{100} = 5.0 cfs): a basin defining a future commercial development. Runoff will generally drain to the south where parking lot detention will be provided for the basin. Runoff will be collected in a future storm sewer system at DP 21 and will be directed to Pond C.

Basin C-3 (1.04 AC, Q_5 = 3.7 cfs, Q_{100} = 6.8 cfs): a basin defining a future commercial development. Runoff will generally drain to the north. Landscape island detention will be provided for the basin at DP 22. If the landscape island detention will infiltrate, then infiltration tests will be required at the time of final design. Runoff will be collected in a future storm sewer system and will be directed to Pond C.

Basin C-4 (0.56 AC, Q_5 = 2.1 cfs, Q_{100} = 3.9 cfs): a basin defining a future commercial development. Runoff will generally drain to the north. Landscape island detention will be provided for the basin at DP 23. If the landscape island detention will infiltrate, then infiltration tests will be required at the time of final design. Runoff will be collected in a future storm sewer system and will be directed to Pond C.

Basin C-5 (0.69 AC, Q_5 = 2.6 cfs, Q_{100} = 4.9 cfs): a basin defining a future commercial development. Runoff will generally drain to the low point at Pond C at DP 25. Runoff will be captured in Pond C.

Basin C-6 (0.06 AC, Q_5 = 0.5 cfs, Q_{100} = 0.9 cfs): a basin defining a future proposed access drive. Runoff will be collected in the curb & gutter of the roadway. Runoff will then be captured in a proposed on-grade inlet at DP 24 and piped to Pond C.

Basin OS-2 (0.05 AC, Q_5 = 0.2 cfs, Q_{100} = 0.4 cfs): a basin defining a portion of the a private access drive. Runoff will be directed into the existing Constitution Ave.

Basin D-1 (0.55 AC, Q_5 = 2.1 cfs, Q_{100} = 3.9 cfs): a basin defining a portion of a future parking lot. Runoff will be directed to the west where it will be captured in Pond D at DP 30.

Basin E-1 (1.01 AC, Q_5 = 0.9 cfs, Q_{100} = 3.0 cfs): a basin defining a portion of the future access road from Marksheffel road and existing undeveloped areas in the CSU Northern Distribution System easement. Runoff will be allowed to sheet flow through the basin which will provide water quality through both grass buffer and grass swales. The *Biofiltration Swale Performance, Recommendations, and Design Considerations* report, included in Appendix A, specifies a maximum design velocity of 0.9 ft/s and a hydraulic residence time of 9 minutes for maximum water quality treatment. The swale through Basin E-1 has been designed using North American Green. Based on the input, North American Green gave a Manning's N value of 0.25, which is similar to that used in the Biofiltration Swale report. Calculations resulted in a velocity of 0.32 ft/s and a hydraulic residence time of 24 minutes, therefore exceeding the recommendations of the Biofiltration Swale report. Calculations for the swale have been included in Appendix B. Pollutants attach themselves to sediment and by providing a large residence time, sediments fall out therefore removing many of these pollutants. Additionally, the SWMM model shows no runoff leaving the basin in the water quality event (reference Appendix C). Any runoff in the other storm events will be captured in the existing area inlet at the corner of Marksheffel Road and Constitution Ave at DP 40.

D. Detention and Water Quality

There are three main ponds on the proposed site: Pond A, is located on the eastern most lot of the development; Pond C, located in the southwest corner of the development; and Pond D, located in the north west corner of the development. All three of the previously mentioned ponds will provide water quality and EURV for the entire tributary area and a portion of 100-year detention for the tributary areas except for Pond D which will provide the full 100-year detention volume for the tributary area. The water quality and EURV are provided through the use of an extended detention basin. As has been discussed parking lot detention and other various storage system or runoff reduction systems will be implemented through the development as pads develop to reduce the volume of the downstream ponds (Pond A, C and D). The use of parking lot detention or similar storage to detain portions of the100-year storm event will reduce the rates in the major storm there by reducing the required 100-year storage volume at the downstream pond. Minor storms will flow directly through the parking lot detention and will be detained at the furthest most downstream pond.

Because the system is designed as a series of detention (flood control) ponds in series a SWMM model has been prepared to verify detention and release rates. An important aspect that is required to be verified is the drain times of each pond and as well as the maximum release rates at the outfall locations. The SWMM model was utilized to check drain times as well as to verify the maximum release rates at the outfall rates in the full spectrum of storms. The SWMM model was prepared to analyze the WQ, 2, 5, 10, 25, 50, and 100 year events. The historic basins were also modeled in the SWMM model to accurately compare historic versus proposed outfall rates. The Horton infiltration values vary for the basins based on hydrologic soil type. Historic basin H-2 uses blended Horton values because it is a mixture of Type A and B soils. The results contained within this report can be utilized to recreate the SWMM model or a copy is available for use within the project site and can be obtained from Galloway or the Developer.

The storage volumes for the individual basins provided below will need to be verified with each lot as they develop. The volumes provided may increase or decrease depending on the final site plans for the individual lots. Tables of required parking lot detention volumes are provided below but are dependent upon the same area and percent impervious being tributary to the detention area. If the area or percent impervious are higher than what was approximated with this report the SWMM model should be revised to ensure that adequate detention is provided in the basin. If the area or percent impervious are lower the volume contained within this report can be used for the required detention volume in that basin.

The WQ storm will be designed to release in 40 hours while the EURV event will be designed to release within 72 hours per the City of Colorado Springs Drainage Criteria Manual. Per Colorado Statutes 97% of the 5-year event is required to release in less than 72 hours.

The main downstream ponds (Pond A, C, or D) will be required to be constructed at the time of or prior to the development of first lot within that basin. The parking lot detention will be finalized and constructed as each lot develops. The parking lot detention areas will be entirely site dependent. Approximate locations have been shown on the drainage map contained within this report.

All ponds on the site will be privately owned and maintained. Any variances required will be requested with the final drainage reports.

Because the specific site layouts are not known at this time a conservative 90% impervious was used in sizing all of the detention ponds. What is shown on the drainage map is a conceptual layout and is subject to vary at the time of development. Lots are encouraged to disconnect impervious areas as much as possible to reduce the percent impervious. The UD-BMP IRF sheet will need to be provided with the final drainage reports. A specific layout is known for Basin A-6 at this time and the percent impervious associated with this site plan has been utilized in this report.

Pond A

Pond A is located in the southeast corner of the site. It provides water quality and EURV for all "A" basins. The total tributary area for this pond is 3.71 acres. The percent impervious tributary to the pond is approximately 87.2%. A conceptual design has been included with this report. The final design and configuration will be provided in a Final Drainage Report at the time of its construction. The full spectrum detention has been sized utilizing the UDFCD UD-Detention v2.35 spreadsheet. The EURV volume will release within 72 hours while the water quality releases in 40 hours. The pond will discharge into an existing 24" storm pipe that goes under Constitution Avenue to the south and turns east outfalling into Sand Creek.

As was discussed some of the sub-basins within Basin A will require parking lot detention or some major storm storage. Below is a table of the sub-basins that require parking lot detention. The assumed area and percent imperious are included in the table as this is a pivotal assumption within the design. The table also includes the volumes and release rates that were assumed with this report. The values given can be considered the required volume for the basin if the area and percent impervious are equivalent. If at the time of development either the area or percent impervious are higher than the table, the table the SWMM model should be updated. If the area or percent impervious are lower, then the given volumes and rates can be utilized.

Basin	Area (ac)	Impervious (%)	Parking Lot Detention (cf)	Release Rate (cfs)
A-1	0.54	90	1,457	2.1
A-2	0.57	90	1,441	2.3
A-5	0.48	75	1,367	1.6
A-6	0.92	90	794	3.9

Table 2: Basin A Parking Lot Detention

The SWMM model was used to verify that the full spectrum of storm events are being controlled. Below is a table of historic versus proposed release rates at the eastern outfall from the site.

Storm Event	Historic Release Rate (cfs)	Proposed Release Rate (cfs)
WQ	0.2	0.1
2-year	0.4	0.1
5-year	0.5	0.2
10-year	0.5	0.5
25-year	0.9	1.5
50-year	1.8	3.1
100-year	3.6	3.6

Table 3: Eastern Outfall Historic vs. Proposed

Pond C

Pond C is located in the southwest corner of the site. It provides water quality and EURV for all "C" basins. The total tributary area for this pond is 3.90 acres. The percent impervious tributary to the pond is approximately 90%. It has been designed with walls around three sides of the pond. This is because the site is constrained by the CSU Northern Delivery System easement to the west. In discussions with CSU, no detention, or shallow storage of water is permissible in this easement. The full spectrum detention has been sized utilizing the UDFCD UD-Detention v2.35 spreadsheet. The EURV volume will release in 72 hours while the water quality releases in 40 hours. The release from the pond will be at or below historic rates. A pipe will be constructed from the existing area inlet at the corner of Marksheffel Road and Constitution Avenue and will connect to the outlet structure from the pond. The existing pipe is a 36" pipe and has more than adequate capacity for the development.

As was discussed, some of the sub-basins within Basin C will require parking lot detention or some major storm storage. Below is a table of the sub-basins that require parking lot detention. The assumed area and percent imperious are included in the table as this is a pivotal assumption within the design. The table also includes the volumes and release rates that were assumed with this report. The values given can be considered the required volume for the basin if the area and percent impervious are equivalent. If at the time of development either the area or percent impervious are higher than the table, the table the SWMM model should be updated. If the area or percent impervious are lower, then the given volumes and rates can be utilized.

Basin	Area (ac)	Impervious (%)	Parking Lot Detention (cf)	Release Rate (cfs)
C-1	0.89	80	2,529	2.1
C-2	0.72	90	2,578	1.9

Table 4: Basin A Parking Lot Detention

Pond D

Pond D is located in the northwest corner of the site. It provides water quality and EURV for Basin D-1. The total tributary area for this pond is 0.55 acres. The percent impervious tributary to the pond is approximately 90%. It has been designed with 4:1 side slopes. The full spectrum detention has been sized utilizing the UDFCD UD-Detention v3.07 spreadsheet. The EURV volume will release in 72 hours while the water quality releases in 40 hours. The release from the pond will be at or below historic rates. The pond will release to the west where it will sheet flow through Basin E-1 to the existing area inlet at the southwest corner of the property. Further discussion on the swale through Basin E-1 is provided in the basin description and calculations are included in Appendix B. The Pond D design from the UD-Detention spreadsheet was put into the SWMM model in order to accurately compare historic and proposed release rates at the western outfall from the site.

The SWMM model was used to verify that the full spectrum of storm events are being controlled. Below is a table of historic versus proposed release rates at the western outfall from the site.

Storm Event	Historic Release Rate (cfs)	Proposed Release Rate (cfs)
WQ	0.3	0.1
2-year	0.6	0.2
5-year	1.0	0.8
10-year	3.0	2.2
25-year	5.5	3.5
50-year	8.6	4.6
100-year	12.4	5.3

Table 5: Western Outfall Historic vs. Proposed

VI. Drainage and Bridge Fees

The project is located within the Sand Creek Drainage Basin. The "2019 Drainage, Bridge and Pond Fees of Colorado Springs", effective January 1, 2019 table identifies the following fees associated with the basin. These fees are due at the time of platting.

Basin Fees 2019	Basin Fee (per Acre)
Drainage Fee	$12,645
Bridge Fee	$761
Pond Fee - Land	$1,070
Pond Fee - Facility	$3,676

Table 6: Drainage and Basin Fees

VII. Conclusions

This report for Sand Hill Filing No. 1 has been prepared using the criteria and methods as described in the City of Colorado Springs Drainage Criteria Manual Volumes 1 & 2. The proposed ponds will adequately provide water quality and full spectrum detention for the proposed development and will ensure that the 100-year discharge from the site does not exceed the pre-developed conditions in accordance with the DCM. The downstream facilities within Sand Creek are adequate to protect the runoff proposed from the site. The runoff will not adversely affect the downstream and surrounding developments.

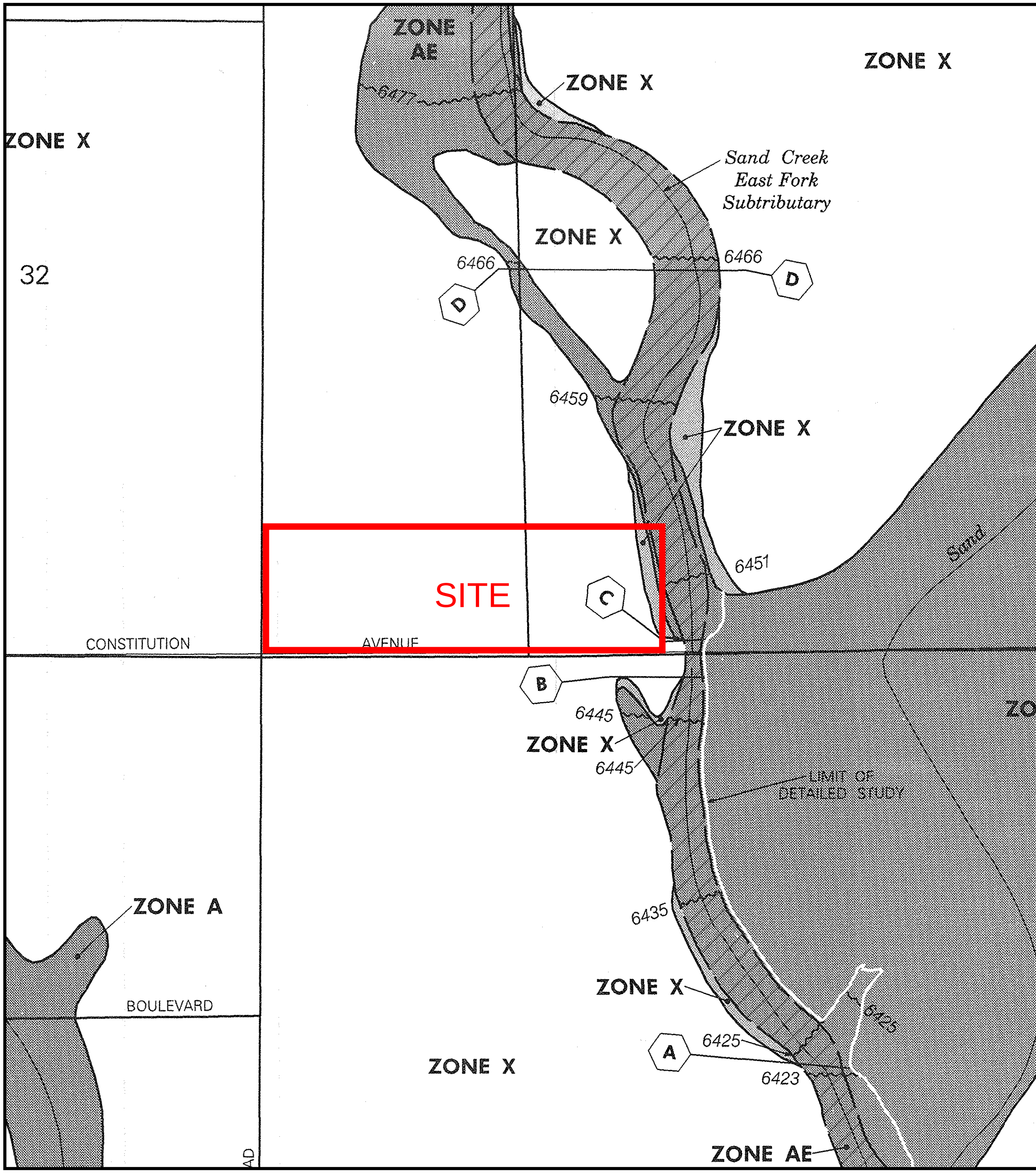
VIII. References

1) *Drainage Criteria Manual Volumes 1 & 2*, City of Colorado Springs, most recent version.
2) *Streamside Design Guidelines,* City of Colorado Springs, Revised 2009.
3) *Urban Storm Drainage and Criteria Manual,* Urban Drainage and Flood Control District, most recent version.
4) *Sand Creek Drainage Basin Planning Study*, March 1996, by Kiowa Engineering.
5) *Master Development Drainage Plan (MDDP) for the Sands and Preliminary Drainage Report*, March 2018, M&C Civil Consultants.
6) *Biofiltration Swale Performance, Recommendations, and Design Considerations*, October 5, 1992, Municipality of Metropolitan Seattle Water Pollution Control Department.

Appendix A
Figures and Exhibits

Galloway
Planning. Architecture. Engineering.

VICINITY MAP – SAND HILL



APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 756 OF 1300

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

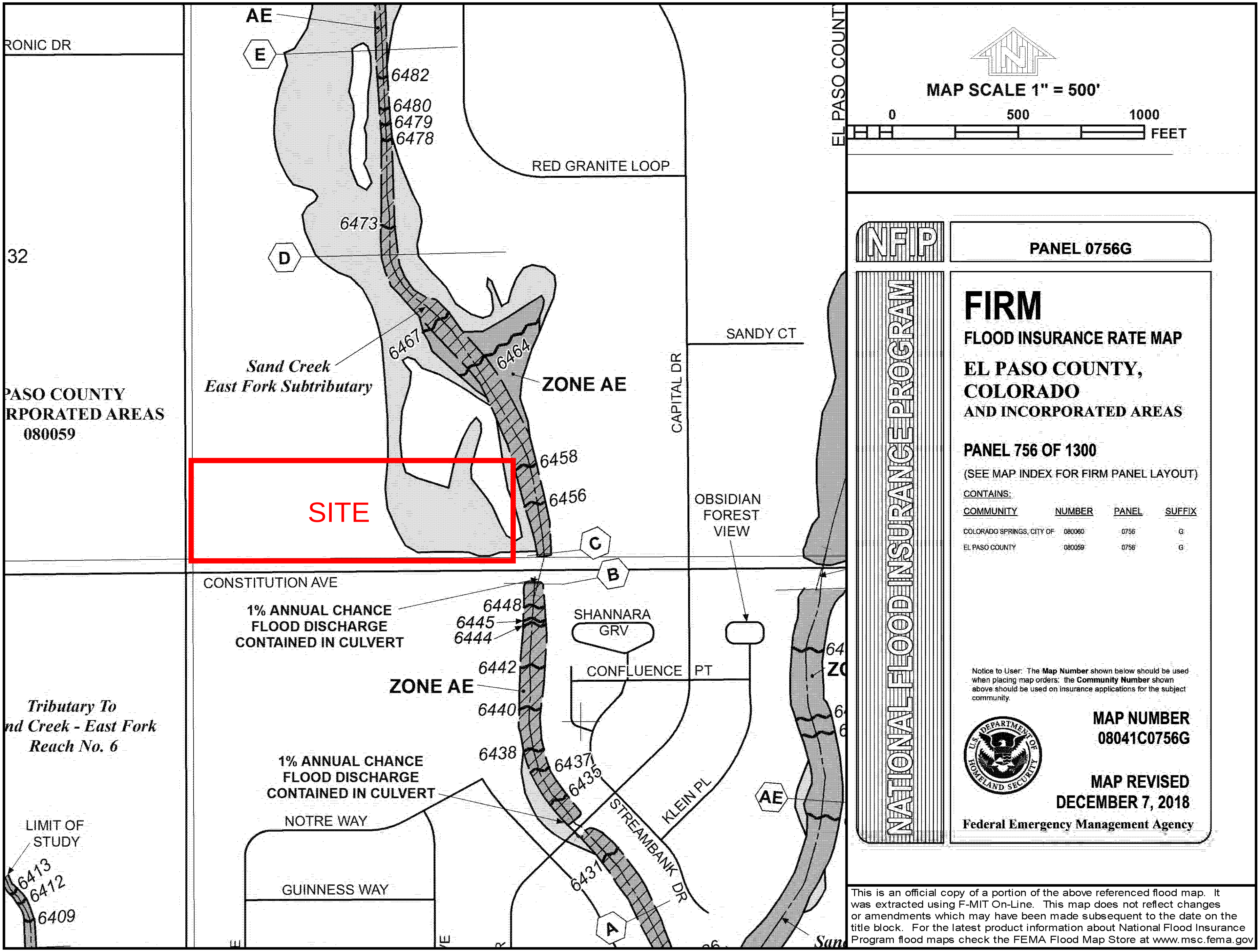
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0756	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0756	F

MAP NUMBER
08041C0756 F

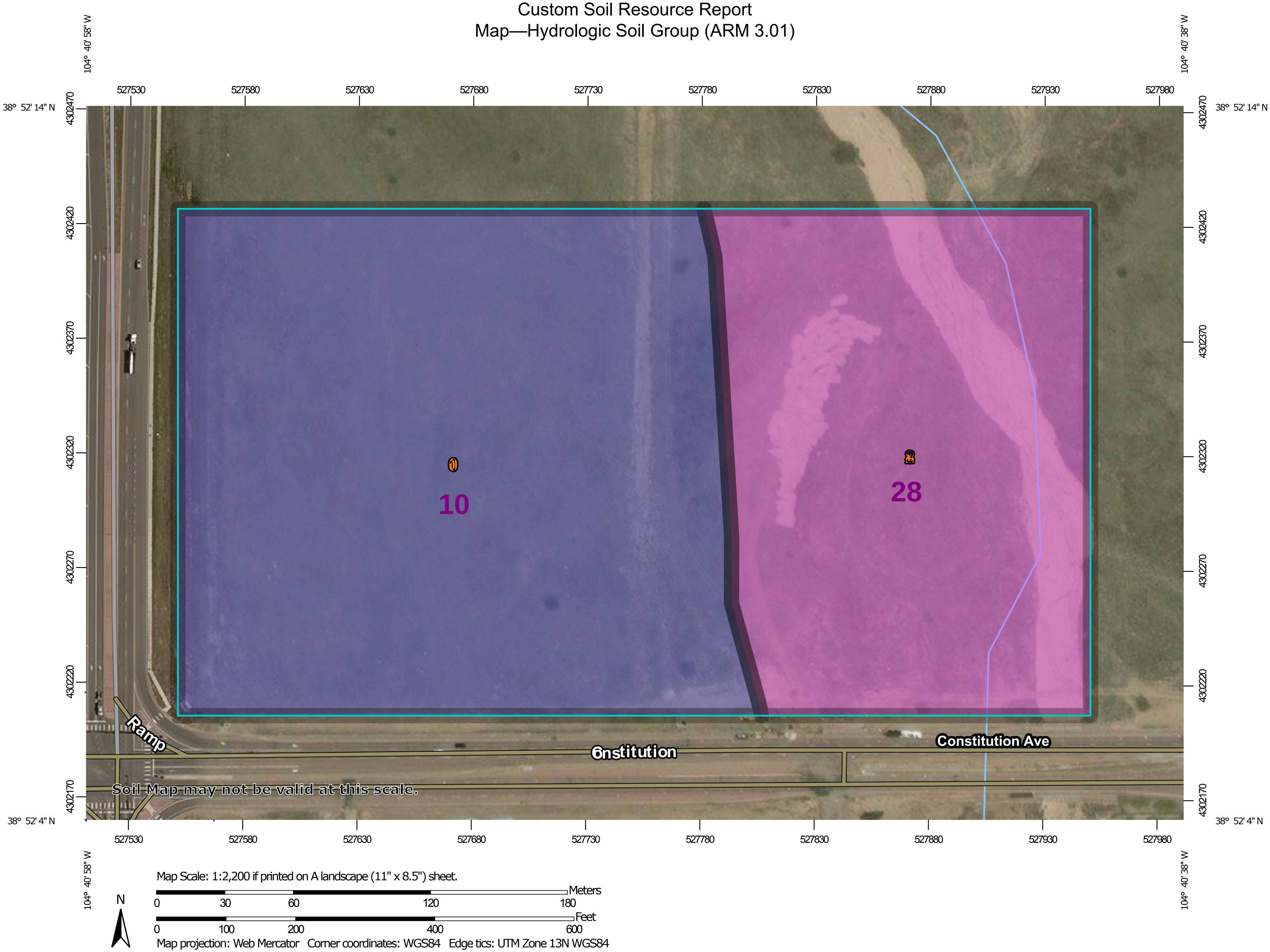
EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


AE
E
D
C
B
A
6482
6480
6479
6478
6473
6467
6464
6458
6456
6448
6445
6444
6442
6440
6438
6437
6435
6431
6413
6412
6409
RONIC DR
32
RED GRANITE LOOP
SANDY CT
EL PASO COUNTY
CAPITAL DR
Sand Creek
East Fork Subtributary
ZONE AE
PASO COUNTY
RPORATED AREAS
080059
SITE
OBSIDIAN
FOREST
VIEW
CONSTITUTION AVE
1% ANNUAL CHANCE
FLOOD DISCHARGE
CONTAINED IN CULVERT
SHANNARA
GRV
CONFLUENCE PT
ZONE AE
Tributary To
nd Creek - East Fork
Reach No. 6
1% ANNUAL CHANCE
FLOOD DISCHARGE
CONTAINED IN CULVERT
NOTRE WAY
KLEIN PL
STREAMBANK DR
LIMIT OF
STUDY
GUINNESS WAY
AE
MAP SCALE 1" = 500'
0
500
1000
FEET
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0756G
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS
PANEL 756 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
COLORADO SPRINGS, CITY OF 080060 0756 G
EL PASO COUNTY 080059 0756 G
Notice to User: The Map Number shown below should be used when placing map orders: the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
08041C0756G
MAP REVISED
DECEMBER 7, 2018
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Custom Soil Resource Report
Map—Hydrologic Soil Group (ARM 3.01)



Map Scale: 1:2,200 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 30, 60, 120, 180

Feet: 0, 100, 200, 400, 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

Date(s) aerial images were photographed: Apr 15, 2011—Mar 9, 2017

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.

Table—Hydrologic Soil Group (ARM 3.01)

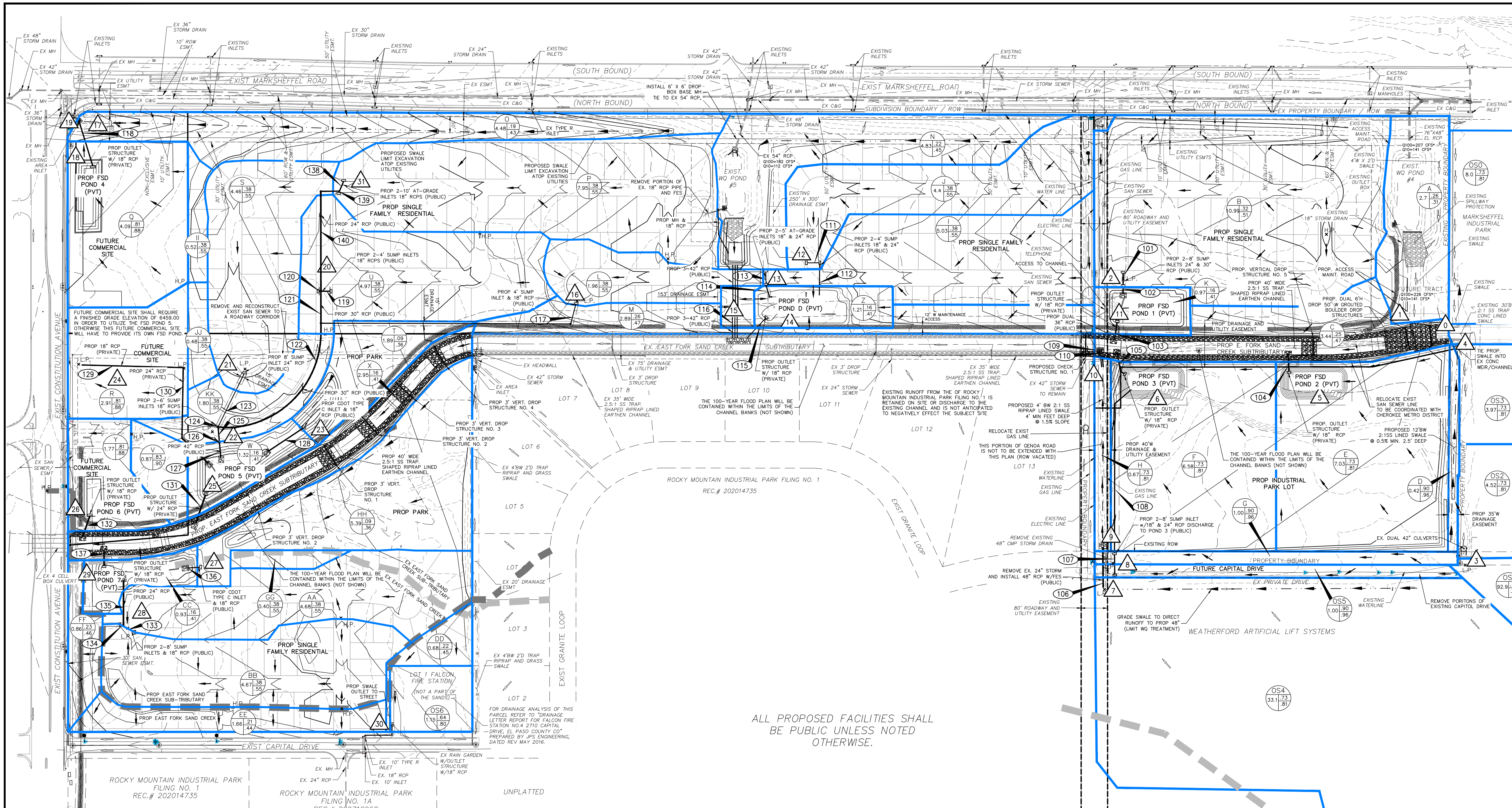
Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
10	Blendon sandy loam, 0 to 3 percent slopes	B	13.2	60.3%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	8.7	39.7%
Totals for Area of Interest			**21.9**	**100.0%**

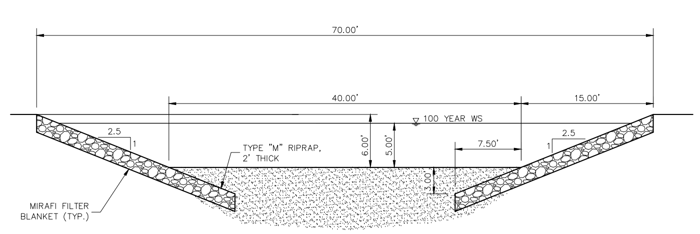
Rating Options—Hydrologic Soil Group (ARM 3.01)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

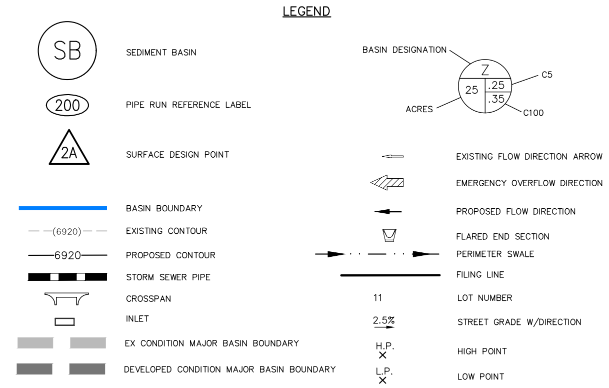
Tie-break Rule: Higher





TYPICAL SECTION EAST FORK SAND CREEK SUB-TRIBUTARY
SCALE: 3/8" = 1'

LEGEND



BASIN SUMMARY			
BASIN	AREA (ACRES)	Q5	Q100
A	38.50	141.0	226.0
B	10.99	11.6	31.1
C	3.44	4.0	12.5
D	0.42	2.0	3.5
E	7.03	21.4	39.8
F	6.58	20.0	37.2
G	1.00	3.8	6.7
H	0.67	2.5	4.7
I	5.03	6.6	15.9
J	4.40	5.8	14.1
K	0.97	0.7	2.8
L	1.96	2.8	6.8
EXF	36.59	90.2	180.3
M	2.89	3.0	9.3
N	4.83	3.6	12.1
O	4.48	2.6	9.9
P	7.95	9.8	23.8
Q	4.09	16.3	29.8
R	2.91	8.9	16.2
S	4.46	6.0	14.5
T	1.89	0.6	4.2

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q5	Q100
U	4.97	6.8	16.6
V	0.87	3.7	6.8
W	1.32	0.8	3.5
X	2.95	1.5	6.6
Y	1.77	7.3	13.3
Z	1.21	0.7	3.2
AA	4.68	6.1	14.8
BB	4.67	6.1	14.9
CC	0.93	0.6	2.7
DD	0.68	0.6	2.1
EE	1.66	1.4	5.0
FF	0.86	0.8	2.7
GG	0.40	0.6	1.6
HH	5.39	1.7	11.2
II	0.52	0.9	2.2
JJ	0.48	0.8	2.0
KK	1.80	2.7	6.6
OS0	7.99	19.9	37.1
OS1	92.92	77.2	206.5
OS2	4.52	13.6	25.4
OS3	3.97	12.3	22.9
OS4	33.11	67.4	125.5
OS5	1.00	3.8	6.7
OS6	1.15	3.8	8.0

DESIGN POINT SUMMARY		
DESIGN POINT	Q5	Q100
0	19.9	37.1
1	141.0	226.0
2	11.6	31.1
3	77.2	206.5
4	80.7	203.9
5	21.4	39.8
6	27.5	50.6
7	67.4	125.5
8	7.5	13.5
9	67.4	125.4
10	62.6	116.7
11	12.1	33.3
12	5.8	14.1
13	6.6	15.9
14	13.0	32.8
15	88.5	181.9

DESIGN POINT SUMMARY		
DESIGN POINT	Q5	Q100
16	2.8	6.8
17	2.6	9.9
18	16.1	30.0
19	3.0	13.8
20	6.8	16.6
21	6.0	14.5
22	9.4	21.3
23	0.6	4.2
24	9.5	17.8
25	41.8	99.2
26	7.3	13.3
27	2.2	12.5
28	12.2	29.5
29	14.8	44.1
30	0.6	2.1
31	9.8	23.8

STORM SEWER SUMMARY			
PIPE RUN	Q5	Q100	PIPE SIZE
101	6.0	16.0	24" RCP
102	11.9	32.0	30" RCP
103	0.2	13.8	18" RCP
104	1.0	4.9	18" RCP
105	1.2	6.0	18" RCP
106	67.4	125.5	48" RCP
107	3.8	6.7	18" RCP
108	7.5	13.5	24" RCP
109	31.3	58.3	36" RCP
110	31.3	58.3	36" RCP
111	2.9	7.1	18" RCP
112	5.8	14.1	24" RCP
113	3.3	8.0	18" RCP
114	6.6	15.9	24" RCP
115	0.3	10.5	18" RCP
116	88.5	181.9	3~42" RCP
117	2.8	6.8	18" RCP
118	0.7	3.2	18" RCP
119	3.4	8.3	18" RCP

STORM SEWER SUMMARY			
PIPE RUN	Q5	Q100	PIPE SIZE
120	3.4	8.3	18" RCP
121	15.9	38.7	30" RCP
122	18.4	44.6	30" RCP
123	6.0	14.5	24" RCP
124	4.7	10.7	18" RCP
125	28.1	67.6	42" RCP
126	4.7	10.7	18" RCP
127	32.4	77.2	42" RCP
128	0.6	4.2	18" RCP
129	4.4	8.1	18" RCP
130	9.5	17.8	24" RCP
131	0.7	38.6	24" RCP
132	7.3	13.3	18" RCP
133	6.1	14.8	18" RCP
134	6.1	14.8	18" RCP
135	12.2	29.5	24" RCP
136	2.2	12.5	18" RCP
137	0.4	16.2	18" RCP
138	4.9	11.9	18" RCP
139	4.9	11.9	18" RCP
140	9.8	23.8	24" RCP

1" = 120'
0 60 120 240
Scale in Feet

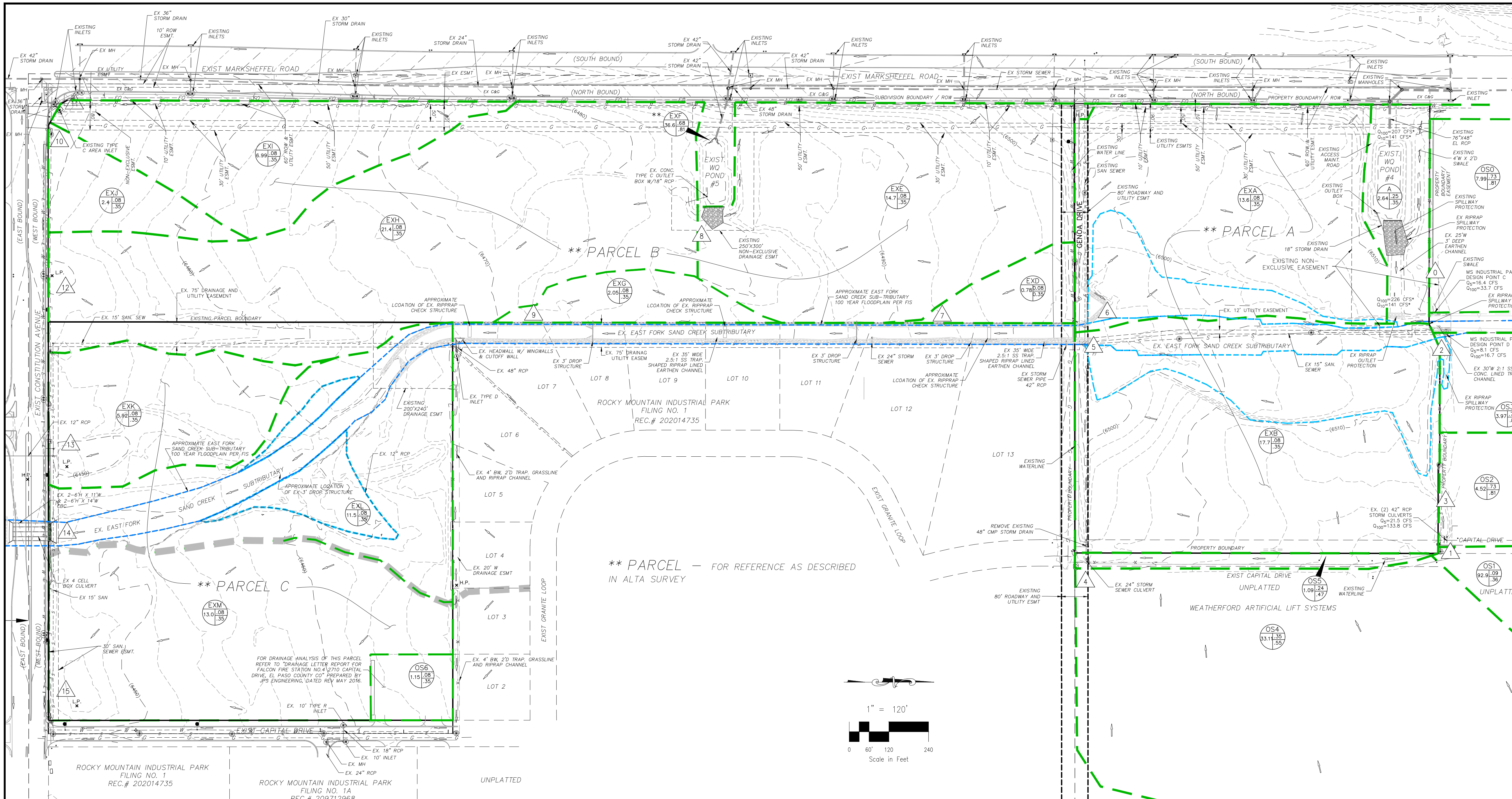
THE SANDS
PROPOSED CONDITIONS DRAINAGE MAP
PROJECT NO. 43-089
DATE: 12-15-17
SCALE: HORIZONTAL: 1"=120' VERTICAL: N/A
DESIGNED BY: DLM
DRAWN BY: JMP
CHECKED BY: VAS
SHEET 1 OF 1
PCDM-1

M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

VIRGIL A. SANCHEZ, COLORADO P.E. NO. 37160
FOR AND ON BEHALF OF M&S CIVIL CONSULTANTS, INC.

REVISIONS: NO. | DATE | BY | DESCRIPTION | APPR'D. BY | DATE

File: O:\43089\MS Rd-Cond Ave\dwg\Dev Plan\MDDP\43089-PCDM.dwg Plotstamp: 3/5/2018 4:13 PM



BASIN SUMMARY			
BASIN	AREA (ACRES)	Q5	Q100
OS0	7.99	19.9	37.1
OS1	92.92	21.5	133.8
OS2	4.52	13.7	25.4
OS3	3.97	12.3	22.9
OS4	33.11	32.6	85.4
OS5	1.09	0.8	2.5
EXA	13.61	3.2	23.4
EXB	17.68	4.1	30.0
EXD	0.78	0.2	1.6
EXE	14.72	3.9	27.1
**EXF	36.59	81.3	159.9
EXG	2.05	0.5	3.4
EXH	21.40	4.6	33.5
EXI	6.99	1.6	11.5
EXJ	2.40	0.6	4.5
EXK	5.92	1.3	9.7
EXL	11.49	2.6	19.1
EXM	12.99	2.9	21.6
***EXN	1.15	0.4	2.6

DESIGN POINT SUMMARY			
DESIGN POINT	Q5	Q100	BASIN
DP0	19.9	37.1	OS0
DP1	21.5	133.8	OS1
DP2	12.3	22.9	OS3
DP3	29.9	148.4	DP1, OS2
DP4	33.3	87.8	OS4, OS5
DP5	72.3	304.8	EXB, DP3, DP4
DP6	3.2	23.4	EXA
DP7	0.2	1.6	EXD
DP8	79.9	167.8	EXE, **EXF WQ #5
DP9	0.5	3.4	EXG
DP10	0.6	4.5	EXJ
DP11	2.1	15.5	EXI, DP10
DP12	68.6	176.2	EXH, DP8
DP13	1.3	9.7	EXK
DP14	77.1	341.2	EXL,DP5,DP6,DP7,DP9
DP15	2.9	21.6	EXM

**EXF WQ POND #5 EXISTING C VALUES AND INTENSITY'S AS STUDIED IN THE "FINAL DRAINAGE REPORT FOR MARKSHEFFEL RD. FROM CONSTITUTION AVE. TO DUBLIN RD." PREPARED BY CHSM HILL, DATED 2008

***REFER TO "DRAINAGE LETTER REPORT FOR FALCON FIRE STATION NO.4 2710 CAPITAL DRIVE, EL PASO COUNTY CO" PREPARED BY JPS ENGINEERING, DATED REV MAY 2016.

LEGEND

- BASIN DESIGNATION (Z; ACRES 25; C5 .25; C100 .35)
- EXISTING FLOW DIRECTION ARROW
- EMERGENCY OVERFLOW DIRECTION
- FLARED END SECTION
- PERIMETER SWALE
- FILING LINE
- 2.5% STREET GRADE W/DIRECTION
- H.P. HIGH POINT
- L.P. LOW POINT
- 2A SURFACE DESIGN POINT
- BASIN BOUNDARY
- 100 YEAR FLOODPLAIN
- 5 YEAR FLOODPLAIN
- 6920 EXISTING CONTOUR
- STORM SEWER PIPE
- INLET

THE SANDS
PREDEVELOPED CONDITIONS DRAINAGE MAP

PROJECT NO. 43-089
DATE: 12-14-17
SCALE: HORIZONTAL: 1"=120' VERTICAL: NA
SHEET 1 OF 1
ECDM-1
DESIGNED BY: DLM
DRAWN BY: JWP
CHECKED BY: VAS

M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

VIRGIL A. SANCHEZ, COLORADO P.E. NO. 37160
FOR AND ON BEHALF OF M&S CIVIL CONSULTANTS, INC.

REVISIONS: NO. | DATE | BY | DESCRIPTION | APPR'D. BY | DATE

THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS.

CAUTION

Publication 657
October 5, 1992

BIOFILTRATION SWALE PERFORMANCE, RECOMMENDATIONS, AND DESIGN CONSIDERATIONS

Funded in part by the Washington Department of
Ecology's Centennial Clean Water Fund
Grant Tax No. 89-136

Municipality of Metropolitan Seattle
Water Pollution Control Department
821 Second Avenue
Seattle, Washington 98104-1598

SECTION 1
REPORT HIGHLIGHTS

Recently, biofiltration swales have been increasingly used to manage the quality of stormwater runoff from roads and other impervious surfaces associated with urban development. This study was conducted to determine the pollutant removal effectiveness of a grassy swale designed specifically for its water treatment benefits. In addition, the study sought to measure effectiveness of two swale configurations differing in length and water residence time. The two configurations are referred to as the 200-foot and 100-foot configurations. The 200-foot configuration was found to have a hydraulic residence time of approximately 9 minutes; the 100-foot configuration, 4.6 minutes. In addition, the Manning's roughness coefficient, referred to as Manning's n, was also measured in the 200-foot configuration.

RESULTS

Major findings of the study are summarized below.

Pollutant Removal Performance

The biofiltration swale studied (which was designed according to criteria given in Horner, 1988) was seen to consistently remove particulate pollutants such as total suspended solids (83 percent removal), turbidity (65 percent) and metals of largely particulate character, such as lead, zinc, iron and aluminum (63 percent to 72 percent). Materials which adhere to the grass surfaces, such as oil and grease and total petroleum hydrocarbons (TPH) are also effectively removed (about 74 percent).

Metals of less particulate character, such as copper; and dissolved metals were generally less consistently removed. Dissolved zinc removal averaged 30 percent for the 200-foot configuration. Dissolved copper, iron, and aluminum removals were negative on average, although for some events positive removals were seen. Dissolved lead was always below the detection level, so conclusions about removal could only be inferred from the behavior of other similar metals.

Nutrients were removed to varying degrees, with best removals seen for bio-available phosphorus (40 percent), followed by total phosphorus (29 percent). Poor or negative removals were seen, on average, for dissolved nutrients, such as ortho phosphorus (ortho-P) and nitrate+nitrite-nitrogen (nitrate+nitrite-N).

The removal of fecal coliform bacteria was highly variable. Some of the data showed good removals, while other data showed elevated concentrations in the outflow. These increased loadings were probably caused by external sources (such as pet wastes) and bacterial multiplication on the swale bottom and on the wooden flume bottom. Figure 1-1 summarizes the pollutant removals associated with the 200-foot swale configuration ranked in order of treatment effectiveness. The figure represents the average of removals seen for each event.

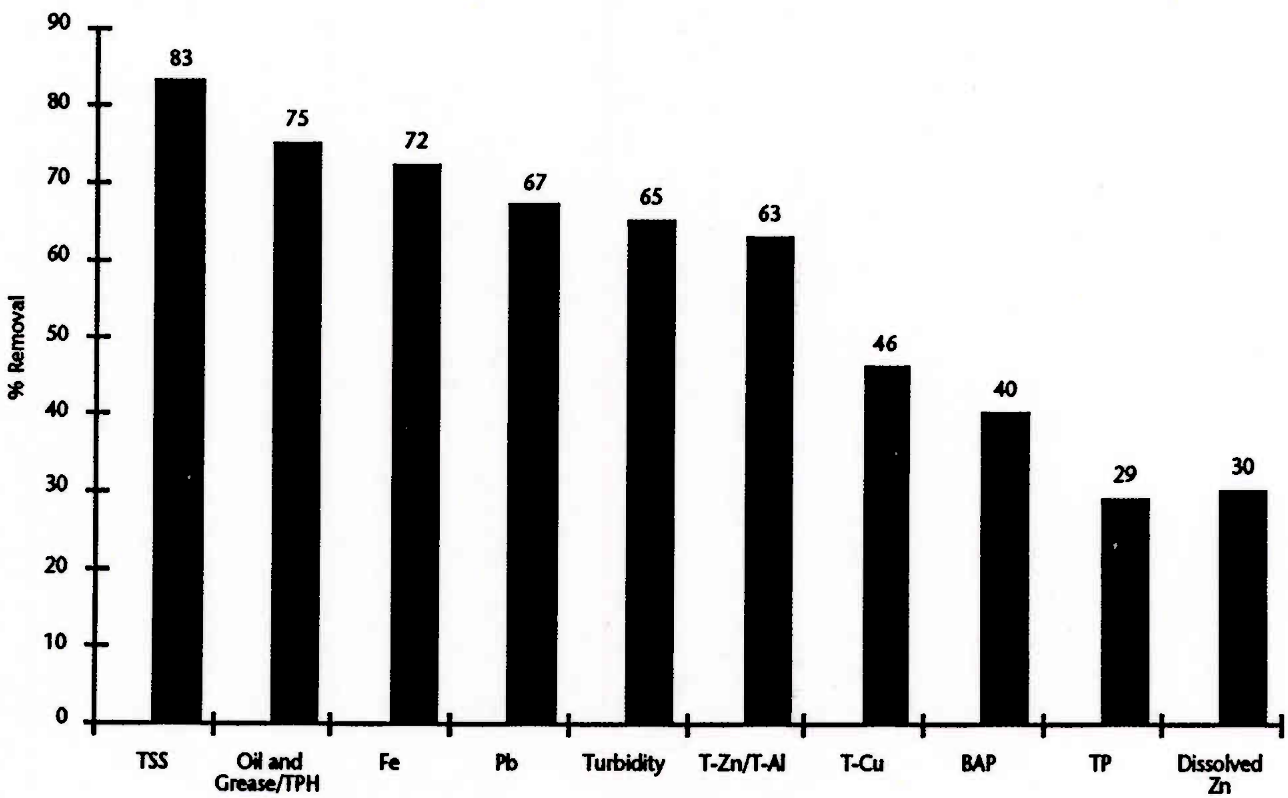


Figure 1-1. Pollutant Removal of a 200-Foot Swale (9-minute Average Hydraulic Residence Time)

Hydraulic Residence Time

A hydraulic residence time of about 9 minutes (at the 200-foot length configuration) resulted in good removal of particulate pollutants, oil and grease, and TPH. This residence time is recommended as a basis for design for most biofiltration swale applications. Longer residence times are recommended if solids removal in excess of about 80 percent is desired.

When the hydraulic residence time was reduced to an average of 4.6 minutes (at the 100-foot length configuration) visual observations and performance data for zinc and iron indicated that pollutant removal performance was poorer than for the 9-minute, 200-foot configuration. Because of a high variance in average removal for the 100-foot configuration, data for parameters other than zinc and iron could not be shown to be significantly different from those observed for the longer detention time configuration. However, it is suggested that a residence time of 4 to 5 minutes is not adequate to assure consistently good pollutant removals, particularly for storms with significant rainfall peaks. More work is needed before a residence time of less than 9 minutes can be recommended with confidence as adequate for biofiltration swale design.

Manning's n Value

This study has shown that Manning's n did not vary significantly with changes in slope between 3 and 4 percent, but did vary with flow rate. Variation was also seen with grass height (6 inches vs. 12 inches). For a grass height of 6 inches and a flow rate of 0.51 feet per second, the Manning's n values observed were between 0.192 to 0.198 (dimensionless). Considering uncertainties involved in this study, and erring on the conservative side, a Manning's n of 0.20 is recommended for swale design for stormwater treatment applications.

In applying this information, the user should be aware that the Manning's n of 0.20 was measured for grass having blade densities averaging from 600 to 1,600 blades/ft^2. The swale had infrequent maintenance (mowing and other lawn maintenance activities such as aeration and fertilization). For regularly mowed and maintained swales, grass is likely to be denser, and hence the Manning's n value may be higher than the 0.20. Therefore, it is recommended that the Manning's n value of 0.20 found in this study be adopted as the *minimum* value for biofiltration swale design. More work should be done to investigate Manning's n for regularly mowed grass.

Before mowing, when grass was about 12 inches, the Manning's n determined for the same swale was 0.24. It is reasonable to apply this higher Manning's n value in situations where swales can only be infrequently maintained, such as for rural roads. However, in general, regular mowing of swales is recommended.

RECOMMENDATIONS FOR PLANNING, DESIGN, INSTALLATION, AND MAINTENANCE

Based on the collective experience of the Biofiltration Project team, recommendations were made in the areas of landscaping, design parameters, installation, maintenance, and enforcement. These recommendations supplement the primary data on pollutant removal effectiveness and Manning's n values collected during the project. Highlights are summarized:

- Landscaping can be integrated into water quality swales, but precautions are needed to prevent shading and leaf drop, which can kill the grass, and transport of soil from the planting beds into the swale.
- Uniform spreading of flow at the head of the swale is important for effective pollutant removal.
- Maximum design velocity should not exceed 0.9 feet per second to prevent exceedance of the treatment capability of the swale.
- A hydraulic residence time of 9 minutes is recommended for pollutant removals of about 80 percent of total suspended solids. If higher levels of performance are desired, longer residence times are recommended.
- Swale width should be limited to about 7 to 8 feet (the width of a typical backhoe loader) unless special measures are provided to assure an even level of the swale bottom, uniform flow spreading, and management of flows to prevent formation of low-flow channels.
- No specific swale length is recommended, but the recommended hydraulic residence time and width will result in a minimum length for a particular set of geometric and vegetation characteristics. In the case of the 200-foot swale studied, application of these residence time and width criteria would result in a minimum length of 125 feet.
- Swale slopes should be between 2 and 4 percent. Underdrains should be installed if slopes are less than 2 percent. If standing water is likely for prolonged periods (for example, several weeks) due to low gradients or interception of the water table or base flow, wetland vegetation should be used rather than grass.
- Water depth should be limited to no greater than one half the height of the grass up to a maximum of 3 inches of water depth. For taller grass, water depth should be less than or equal to one third the grass height.
- Regular mowing is strongly recommended. Not only does regular mowing encourage thicker, healthier grass, but leaves, litter, and

other obstructions to good flow spreading are removed in the process of mowing.

- Regular maintenance of swales is key to assuring good water quality performance. Specifying mowing frequencies, regular inspection and repair on site plans is recommended. Establishing performance bonds retained through the first year of operation has also been effective in assuring early problems are addressed.

SECTION 2

INTRODUCTION

In the last two decades, uncontrolled storm runoff that accompanies development has posed a substantial and pervasive threat to the quality of the nation's lakes, rivers, and streams (Meybeck & Helmer, 1987; National Research Council, 1987, Rogers & Rosenthal, 1988). Initially stormwater managers tried simply to control the volume or quantity of storm runoff. However, significant impacts were still occurring in many water bodies. Recently, degradation of water quality caused by nonpoint source pollution, including urban stormwater runoff, has been acknowledged as a major unfinished agenda in meeting the country's clean water goals (USEPA, 1989, General Accounting Office, 1987, 1989, Davis & Simon, 1989, Thompson, 1989).

In order to reduce the impacts of the relatively dilute pollutant loads carried by urban runoff cost-effectively, stormwater managers have advocated the use of passive, technically simple, and relatively flexible methods for treating urban runoff, termed best management practices (BMPs) (Roesner et al., 1989, De Groot, 1982). Wet detention ponds, infiltration basins, constructed wetlands, as well as biofiltration devices such as filter strips and grassy swales are some of the BMPs that have been suggested or required for stormwater quality management, both locally and nationally (*King County Surface Water Design Manual*, 1990, *Washington State Department of Ecology Draft Stormwater Manual*, 1991, *Water Quality Best Management Practices Manual*, 1989, *Water Quality Design Manual*, 1991, Schueler, 1988).

Unfortunately, good data on the pollution removal performance of these systems is still relatively scarce. One major exception is the study of wet detention ponds done through the Nationwide Urban Runoff Program (NURP) (Athayde et al., 1983). The NURP report also provided design criteria for wet ponds to meet specific water quality objectives. Similar performance data for other stormwater treatment alternatives is far less comprehensive, though equally important.

This report provides information on the pollutant removal effectiveness of a grassy swale located in Mountlake Terrace, Washington, in treating runoff from a small suburban drainage basin. The Project team believes information of this kind is critically important. By providing better information about the kind of water quality treatment biofiltration swales can and cannot provide, better decisions can be made about how to protect water bodies, and scarce dollar resources can be allocated most effectively. It does little good to require that land development projects provide biofiltration for stormwater treatment if in reality the biofiltration is not effectively removing the pollutants of concern. In this case, other control methods need to be identified. On the other hand, if biofilters work well, they could be used more frequently and in more varied situations to control pollution from urban runoff.

In addition to studying the treatment efficiency of a particular swale, this report investigates the value of the Manning's roughness coefficient for grassy swales used for stormwater treatment applications. It also collects the experience of the Project team to provide general recommendations for the application and management of biofiltration swales.

In order to meet the challenging task of protecting lakes, streams, and marine waters in the face of rapid population growth, resource managers need accurate, relevant, and reliable information. We must know what the identified management tools can be expected to do, as well as how to keep those tools operating at peak efficiency, and how to fix them should they need repair. Given this information, we will be able to spend society's limited resource protection money more wisely.

It is our hope then, that this report will provide some of the information necessary to increase the effectiveness and efficiency with which stormwater managers are able to protect aquatic resources through the appropriate use of grassy swales and other biofiltration mechanisms.

SECTION 3

PROJECT GOALS AND OBJECTIVES

Biofiltration is a general term referring to the physical ability of vegetation to remove pollutants from water. Grassy swales, as their name implies, are shallow, typically broad-bottomed ditches in which a dense growth of grass is established. The use of vegetated swales is not new, but their application to water pollution control objectives is relatively recent.

Pollutant removal in a biofiltration swale depends most fundamentally on the time that water remains in the swale (the residence time) and the extent of its contact with vegetation and soil surface. Good vegetation and soil contact is required to promote the operation of the various mechanisms that capture and transform pollutants. Spreading flow in minimal depth over a wide swale is best from this standpoint. Water residence time depends on the volume of runoff, the velocity at which it travels, and the length over which it flows. Velocity, in turn, is a function of the cross-sectional area of the flow (the width and depth), the channel slope, and the friction imparted by the vegetation. Therefore, biofilter performance depends on a number of geometric, hydrologic, and hydraulic variables, namely the following:

- Swale width and length
- Flow depth
- Volumetric flow rate
- Slope
- Vegetation characteristics

Any or all of these variables can theoretically be manipulated to maximize water residence time and contact and achieve a desired level of performance, provided adequate data are available to relate performance to swale characteristics.

With thorough understanding of these relationships, a designer could increase residence time by, for instance, increasing depth or width, diverting some flow to another biofilter or other treatment system to reduce flow rate, decreasing slope, providing for a denser grass stand, or any other combination of these options. There are, on the other hand, reasons for restricting flexibility in some of these areas. For example, Horner (1988) observed standing water, sometimes resulting in poor grass growth, in flatly sloped swales, especially those sloping longitudinally less than 1 percent. Similarly, obtaining a very dense stand of grass could imply heavy fertilization, which would conflict with nutrient removal objectives.

A general objective of this project was to assemble as much information as possible to aid in choosing ranges of the crucial variables that would produce effectively operating biofiltration swales. To this end, the report presents recommendations derived from the experience of team members about the effective application and management of swales. Good design must be accompanied by effective implementation—good planning and proper installation, operation, and maintenance—for the full water quality benefits of swales to be realized.

The project also had three specific objectives:

1. To determine the types and amounts of pollutants that are removed from stormwater, during typical storm events, by a grassy swale designed according to Phase I design criteria (Horner, 1988)
2. To determine whether equivalent pollutant removal performance could be achieved in a grassy swale with length less than 200 feet if a proportionate increase in width was provided
3. To measure Manning's n, the coefficient of roughness in the Manning's Equation, in a functioning grassy swale

Although a number of other questions were of interest to the Project team, these three objectives were identified as the most valuable for investigation, considering cost, sampling difficulty and the overall state of knowledge about the performance of grassy swales.

Although the Project team attempted to explore objective 2, whether equivalent pollutant removal performance could be achieved with a wider but shorter swale, problems were encountered in finding a satisfactory field application that could address the question directly. In the end, this objective was modified to explore the question of performance under two different residence times. One residence times was associated with a 200-foot swale and the other with a 100-foot swale with a modified flow regime. Specifics are discussed further in Section 5.

In investigating the question of performance for two different residence times, the study was at the same time able to gather information on the effectiveness of a typical 200-foot configuration (objective 1), because it was needed for comparison to the modified swale. This basic information on swale performance was also important in its own right. Few sources of data on the effectiveness of grassy swales under Pacific Northwest rainfall and runoff conditions are available, other than studies done by Wang et al. (1981). Additional data were sought through this study to increase certainty that the pollutant removal performance seen in the University of Washington study would be provided in other urban/suburban grassy swale applications, and to judge the treatment performance for additional parameters of concern.

For instance, one area of interest was the performance of swales in removing nutrients from stormwater. Excess nutrients have the potential to contribute to serious water quality degradation. Phosphorus enrichment can lead to excess algae growth in lakes and other water bodies, especially those with poor circulation and long residence times. Several Puget Sound area lakes are phosphorus sensitive, including Lake Ballinger, Green Lake, and Lake Sammamish. Knowing the removal efficiency of phosphorus from monitoring data is, then, important in order for stormwater managers to use biofilters efficiently in achieving water quality objectives for specific water bodies.

The Project team wanted to establish a value for Manning's n based on field measurement since a wide variety of values are currently in use for swale design (*Guidebook, Water Quality Swales*, 1990). Because the value of Manning's n significantly affects the size of swales, information on this coefficient is of interest to both resource managers and land developers.

By having a better understanding of the pollutants that swales can and cannot remove, and by understanding critical aspects of design and implementation, a more realistic assessment of the appropriateness of using grassy swales in specific pollution control situations is possible. The next section provides background information about previous research in the area of biofiltration and provides a basis for further discussions of experimental design.

Appendix B
Hydrologic Calculations

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator
LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: Scott Brown
Company: Galloway & Co.
Date: February 19, 2019
Project: The Sands Retail Buildings
Location: Colorado Springs, CO

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	A-1	A-2	A-3	A-4	A-5	A-6	A-7							
Receiving Pervious Area Soil Type	Loamy Sand	Sand	Sand	Sand	Loamy Sand	Loamy Sand	Sand							
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.540	0.570	0.320	0.190	0.450	0.760	0.880							
Directly Connected Impervious Area (DCIA, acres)	0.486	0.513	0.300	0.190	0.405	0.548	0.792							
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
Receiving Pervious Area (RPA, acres)	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
Separate Pervious Area (SPA, acres)	0.054	0.057	0.020	0.000	0.045	0.212	0.088							
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V	V	V							

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.540	0.570	0.320	0.190	0.450	0.760	0.880							
Directly Connected Impervious Area (DCIA, %)	90.0%	90.0%	93.9%	100.0%	90.0%	72.1%	90.0%							
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%							
Receiving Pervious Area (RPA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%							
Separate Pervious Area (SPA, %)	10.0%	10.0%	6.1%	0.0%	10.0%	27.9%	10.0%							
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
I_a Check	1.000	1.000	1.000	1.000	1.000	1.000	1.000							
f / I for WQCV Event:	3.2	9.8	9.8	9.8	3.2	3.2	9.8							
f / I for 5-Year Event:	0.5	0.6	0.6	0.6	0.5	0.5	0.6							
f / I for 100-Year Event:	0.4	0.6	0.6	0.6	0.4	0.4	0.6							
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
IRF for 5-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	90.0%	90.0%	93.9%	100.0%	90.0%	72.1%	90.0%							
Effective Imperviousness for WQCV Event:	90.0%	90.0%	93.9%	100.0%	90.0%	72.1%	90.0%							
Effective Imperviousness for 5-Year Event:	90.0%	90.0%	93.9%	100.0%	90.0%	72.1%	90.0%							
Effective Imperviousness for 100-Year Event:	90.0%	90.0%	93.9%	100.0%	90.0%	72.1%	90.0%							
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	87.2%
Total Site Effective Imperviousness for WQCV Event:	87.2%
Total Site Effective Imperviousness for 5-Year Event:	87.2%
Total Site Effective Imperviousness for 100-Year Event:	87.2%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input	
Calculated cells	

Designer:	Scott Brown
Company:	Galloway & Co.
Date:	February 19, 2019
Project:	The Sands Retail Buildings
Location:	Colorado Springs, CO

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	B-1	B-2												
Receiving Pervious Area Soil Type	Sand	Sand												
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.790	0.150												
Directly Connected Impervious Area (DCIA, acres)	0.711	0.150												
Unconnected Impervious Area (UIA, acres)	0.000	0.000												
Receiving Pervious Area (RPA, acres)	0.000	0.000												
Separate Pervious Area (SPA, acres)	0.079	0.000												
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V												

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.790	0.150												
Directly Connected Impervious Area (DCIA, %)	90.0%	100.0%												
Unconnected Impervious Area (UIA, %)	0.0%	0.0%												
Receiving Pervious Area (RPA, %)	0.0%	0.0%												
Separate Pervious Area (SPA, %)	10.0%	0.0%												
A_R (RPA / UIA)	0.000	0.000												
I_a Check	1.000	1.000												
f / I for WQCV Event:	9.8	9.8												
f / I for 5-Year Event:	0.6	0.6												
f / I for 100-Year Event:	0.6	0.6												
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00	0.00												
IRF for 5-Year Event:	1.00	1.00												
IRF for 100-Year Event:	1.00	1.00												
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	90.0%	100.0%												
Effective Imperviousness for WQCV Event:	90.0%	100.0%												
Effective Imperviousness for 5-Year Event:	90.0%	100.0%												
Effective Imperviousness for 100-Year Event:	90.0%	100.0%												
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.3%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	91.6%
Total Site Effective Imperviousness for WQCV Event:	91.6%
Total Site Effective Imperviousness for 5-Year Event:	91.6%
Total Site Effective Imperviousness for 100-Year Event:	91.6%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: Scott Brown
Company: Galloway & Co.
Date: February 26, 2019
Project: The Sands Retail Buildings
Location: Colorado Springs, CO

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	C-1	C-2	C-3	C-4	C-5	C-6
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.890	0.720	1.040	0.560	0.690	0.060
Directly Connected Impervious Area (DCIA, acres)	0.801	0.648	0.936	0.504	0.621	0.060
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000	0.000	0.000	0.000
Receiving Pervious Area (RPA, acres)	0.000	0.016	0.016	0.000	0.000	0.000
Separate Pervious Area (SPA, acres)	0.089	0.056	0.088	0.056	0.069	0.000
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V	V

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.890	0.720	1.040	0.560	0.690	0.060
Directly Connected Impervious Area (DCIA, %)	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Receiving Pervious Area (RPA, %)	0.0%	2.2%	1.5%	0.0%	0.0%	0.0%
Separate Pervious Area (SPA, %)	10.0%	7.8%	8.5%	10.0%	10.0%	0.0%
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000	0.000
I_a Check	1.000	1.000	1.000	1.000	1.000	1.000
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2	3.2
f / I for 5-Year Event:	0.5	0.5	0.5	0.5	0.5	0.5
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4	0.4
f / I for Optional User Defined Storm CUHP:						
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00
IRF for 5-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00
IRF for Optional User Defined Storm CUHP:						
Total Site Imperviousness: I_{total}	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Effective Imperviousness for WQCV Event:	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Effective Imperviousness for 5-Year Event:	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Effective Imperviousness for 100-Year Event:	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%
Effective Imperviousness for Optional User Defined Storm CUHP:						

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	0.0%	0.0%	0.1%	0.0%	0.4%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	90.2%
Total Site Effective Imperviousness for WQCV Event:	90.2%
Total Site Effective Imperviousness for 5-Year Event:	90.2%
Total Site Effective Imperviousness for 100-Year Event:	90.2%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

Designer:	Scott Brown
Company:	Galloway & Co.
Date:	February 12, 2019
Project:	The Sands Retail Buildings
Location:	Colorado Springs, CO

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	D-1
Receiving Pervious Area Soil Type	Loamy Sand
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.550
Directly Connected Impervious Area (DCIA, acres)	0.495
Unconnected Impervious Area (UIA, acres)	0.000
Receiving Pervious Area (RPA, acres)	0.000
Separate Pervious Area (SPA, acres)	0.055
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.550
Directly Connected Impervious Area (DCIA, %)	90.0%
Unconnected Impervious Area (UIA, %)	0.0%
Receiving Pervious Area (RPA, %)	0.0%
Separate Pervious Area (SPA, %)	10.0%
A_R (RPA / UIA)	0.000
I_a Check	1.000
f / I for WQCV Event:	3.2
f / I for 5-Year Event:	0.5
f / I for 100-Year Event:	0.4
f / I for Optional User Defined Storm CUHP:	
IRF for WQCV Event:	0.00
IRF for 5-Year Event:	1.00
IRF for 100-Year Event:	1.00
IRF for Optional User Defined Storm CUHP:	
Total Site Imperviousness: I_{total}	90.0%
Effective Imperviousness for WQCV Event:	90.0%
Effective Imperviousness for 5-Year Event:	90.0%
Effective Imperviousness for 100-Year Event:	90.0%
Effective Imperviousness for Optional User Defined Storm CUHP:	

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	90.0%
Total Site Effective Imperviousness for WQCV Event:	90.0%
Total Site Effective Imperviousness for 5-Year Event:	90.0%
Total Site Effective Imperviousness for 100-Year Event:	90.0%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

Designer:	Scott Brown
Company:	Galloway & Co.
Date:	February 26, 2019
Project:	The Sands Retail Buildings
Location:	Colorado Springs, CO

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	E-1													
Receiving Pervious Area Soil Type	Loamy Sand													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	1.010													
Directly Connected Impervious Area (DCIA, acres)	0.000													
Unconnected Impervious Area (UIA, acres)	0.174													
Receiving Pervious Area (RPA, acres)	0.836													
Separate Pervious Area (SPA, acres)	0.000													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	1.010													
Directly Connected Impervious Area (DCIA, %)	0.0%													
Unconnected Impervious Area (UIA, %)	17.2%													
Receiving Pervious Area (RPA, %)	82.8%													
Separate Pervious Area (SPA, %)	0.0%													
A_R (RPA / UIA)	4.805													
I_a Check	0.170													
f / I for WQCV Event:	3.2													
f / I for 5-Year Event:	0.5													
f / I for 100-Year Event:	0.4													
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.37													
IRF for 5-Year Event:	0.71													
IRF for 100-Year Event:	0.73													
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	17.2%													
Effective Imperviousness for WQCV Event:	6.3%													
Effective Imperviousness for 5-Year Event:	12.3%													
Effective Imperviousness for 100-Year Event:	12.7%													
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	56.8%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	29.6%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	17.2%
Total Site Effective Imperviousness for WQCV Event:	6.3%
Total Site Effective Imperviousness for 5-Year Event:	12.3%
Total Site Effective Imperviousness for 100-Year Event:	12.7%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: The Sands Retail Buildings
Location: CO, Colorado Springs

Project Name: The Sands Retail Buildings
Project No.: ACD003
Calculated By: BHB
Checked By: SMB
Date: 2/26/19

Basin ID	Total Area (ac)	Paved Roads			Lawns			Roofs			Basins Total Weighted % Imp.
		% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	% Imp.	Area (ac)	Weighted % Imp.	
A-1	0.54										90.0
A-2	0.57										90.0
A-3	0.32	100	0.30	93.8	2	0.02	0.1	90	0.00	0.0	93.9
A-4	0.19	100	0.19	100.0	2	0.00	0.0	90	0.00	0.0	100.0
A-5	0.45										90.0
A-6	0.76	100	0.48	63.2	2	0.21	0.6	90	0.07	8.3	72.1
A-7	0.88										90.0
B-1	0.79										90.0
B-2	0.15										100.0
C-1	0.89										80.0
C-2	0.72										90.0
C-3	1.04										90.0
C-4	0.56										90.0
C-5	0.69										90.0
C-6	0.06										100.0
D-1	0.55										90.0
E-1	1.01	100	0.17	16.8	2	0.84	1.7	90	0.00	0.0	18.5
OS-1	0.07										100.0
OS-2	0.05										100.0
H-1	2.30										2.0
H-2	2.01										2.0
H-3	2.71										2.0
H-4	3.98										2.0

COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: The Sands Retail Buildings
Location: CO, Colorado Springs

Project Name: The Sands Retail Buildings
Project No.: ACD003
Calculated By: BHB
Checked By: SMB
Date: 2/26/19

Basin ID	Total Area (ac)	Paved Roads			Lawns/Undeveloped			Roofs			Composite C_5	Composite C_{100}
		C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)		
A-3	0.32	0.90	0.96	0.30	0.09	0.36	0.02	0.73	0.81	0.00	0.85	0.92
A-4	0.19	0.90	0.96	0.19	0.09	0.36	0.00	0.73	0.81	0.00	0.90	0.96
A-6	0.76	0.90	0.96	0.48	0.09	0.36	0.21	0.73	0.81	0.07	0.66	0.78
E-1	1.01	0.90	0.96	0.17	0.09	0.36	0.84	0.73	0.81	0.00	0.23	0.46

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: The Sands Retail Buildings
Location: CO, Colorado Springs

Project Name: The Sands Retail Buildings
Project No.: ACD003
Calculated By: BHB
Checked By: SMB
Date: 2/26/19

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (AC)	Hydrologic Soils Group	Impervious (%)	C_{100}	C_5	L (FT)	S (%)	T_i (MIN)	L (FT)	S (%)	Cv	VEL. (FPS)	T_t (MIN)	COMP. T_c (MIN)	TOTAL LENGTH(FT)	Urbanized T_c (MIN)	T_c (MIN)
A-1	0.54	B	90.00	0.81	0.73	30	1.5	3.2	65	1.5	20.0	2.4	0.4	3.7	95.0	10.5	5.0
A-2	0.57	B	90.00	0.81	0.73	30	1.5	3.2	50	1.5	20.0	2.4	0.3	3.6	80.0	10.4	5.0
A-3	0.32	B	93.90	0.92	0.85	30	2.0	2.0	220	1.0	20.0	2.0	1.8	3.8	250.0	11.4	5.0
A-4	0.19	B	100.00	0.96	0.90	30	2.0	1.6	160	1.0	20.0	2.0	1.3	2.9	190.0	11.1	5.0
A-5	0.45	B	90.00	0.81	0.73	30	1.0	3.7	110	1.0	20.0	2.0	0.9	4.6	140.0	10.8	5.0
A-6	0.76	B	72.10	0.78	0.66	30	1.0	4.4	130	1.0	20.0	2.0	1.1	5.5	160.0	10.9	5.5
A-7	0.88	B	90.00	0.81	0.73	30	2.0	2.9	100	2.0	20.0	2.8	0.6	3.5	130.0	10.7	5.0
B-1	0.79	B	90.00	0.81	0.73	100	1.0	6.8	60	1.0	20.0	2.0	0.5	7.3	160.0	10.9	7.3
B-2	0.15	B	100.00	0.96	0.90	25	2.0	1.5	60	1.0	20.0	2.0	0.5	2.0	85.0	10.5	5.0
C-1	0.89	B	80.00	0.70	0.59	100	2.0	7.4	60	2.0	20.0	2.8	0.4	7.8	160.0	10.9	7.8
C-2	0.72	B	90.00	0.81	0.73	100	2.5	5.0	40	2.5	20.0	3.2	0.2	5.2	140.0	10.8	5.2
C-3	1.04	B	90.00	0.81	0.73	100	1.5	5.9	50	2.0	20.0	2.8	0.3	6.2	150.0	10.8	6.2
C-4	0.56	B	90.00	0.81	0.73	50	1.5	4.2	50	2.0	20.0	2.8	0.3	4.5	100.0	10.6	5.0
C-5	0.69	B	90.00	0.81	0.73	50	2.0	3.8	50	2.0	20.0	2.8	0.3	4.1	100.0	10.6	5.0
C-6	0.06	B	100.00	0.96	0.90	10	1.0	1.2	55	4.0	20.0	4.0	0.2	1.4	65.0	10.4	5.0
D-1	0.55	B	90.00	0.81	0.73	60	3.0	3.6						3.6	60.0	10.3	5.0
E-1	1.01	B	18.50	0.46	0.23	100	2.0	12.7	385	2.0	20.0	2.8	2.3	15.0	485.0	12.7	12.7
OS-1	0.07	B	100.00	0.96	0.90	45	2.0	1.9						1.9	45.0	10.3	5.0
OS-2	0.05	B	100.00	0.96	0.90	10	1.0	1.2	55	4.0	20.0	4.0	0.2	1.4	65.0	10.4	5.0
H-1	2.30	B	2.00	0.36	0.09	300	1.5	28.0	60	1.5	20.0	2.4	0.4	28.4	360.0	12.0	12.0
H-2	2.01	B	2.00	0.36	0.09	300	2.0	25.4	25	2.0	20.0	2.8	0.1	25.6	325.0	11.8	11.8
H-3	2.71	B	2.00	0.36	0.09	300	3.0	22.2	60	3.0	20.0	3.5	0.3	22.5	360.0	12.0	12.0
H-4	3.98	B	2.00	0.36	0.09	300	2.5	23.6	200	2.5	20.0	3.2	1.1	24.7	500.0	12.8	12.8

NOTES:

T_i = (0.395*(1.1 - C_5)*(L)^0.5)/((S)^0.33), S in ft/ft
T_t=L/60V (Velocity From Fig. 501)
Velocity V=Cv*S^0.5, S in ft/ft
Tc Check = 10+L/180
For Urbanized basins a minimum T_c of 5.0 minutes is required.
For non-urbanized basins a minimum T_c of 10.0 minutes is required

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Project Name: The Sands Retail Buildings
Subdivision: The Sands Retail Buildings
Project No.: ACD003
Location: CO, Colorado Springs
Calculated By: BHB
Design Storm: 5-Year
Checked By: SMB
Date: 2/26/19

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
Historic Calculations																					
		H-1	2.30	0.09	12.0	0.21	3.86	0.8				0.8									
		H-2	2.01	0.09	11.8	0.18	3.88	0.7				0.7									
		H-2							12.0	0.39	3.86	1.5									
		H-3	2.71	0.09	12.0	0.24	3.86	0.9				0.9									
		H-4	3.98	0.09	12.8	0.36	3.76	1.4				1.4									
		H-4							12.8	0.60	3.76	2.3									

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Project Name: The Sands Retail Buildings
Subdivision: The Sands Retail Buildings
Project No.: ACD003
Location: CO, Colorado Springs
Calculated By: BHB
Design Storm: 5-Year
Checked By: SMB
Date: 2/26/19

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	REMARKS
Proposed Calculations																					
	1	A-1	0.54	0.73	5.0	0.39	5.17	2.0							2.0	0.5	18				Future Lot, runoff conveyed to parking lot detention Piped to DP 2
	2	A-2	0.57	0.73	5.0	0.42	5.17	2.2													Future Lot, runoff conveyed to parking lot detention
	2								5.0	0.81	5.17	4.2			4.2	0.5	18				Piped to Pond A DP 7
	3	A-5	0.45	0.73	5.0	0.33	5.17	1.7							1.7	0.5	18				Future Lot, runoff conveyed to parking lot detention Piped to DP 4
	4	A-6	0.76	0.66	5.5	0.50	5.03	2.5													Future Lot, runoff conveyed to parking lot detention
	4								5.5	0.83	5.03	4.2			4.2	0.5	24				Piped to DP 5
	5	A-3	0.32	0.85	5.0	0.27	5.17	1.4													Ongrade D-10-R Inlet
	5								5.5	1.10	5.03	5.5			5.5	0.5	24				Piped to DP 6
	6	A-4	0.19	0.90	5.0	0.17	5.17	0.9													Ongrade D-10-R Inlet
	6								5.5	1.27	5.03	6.4			6.4	0.5	24				Piped to Pond A DP 7
	7	A-7	0.88	0.73	5.0	0.64	5.17	3.3													
	7								5.5	2.72	5.03	13.7									Total runoff in Pond A
	10	B-1	0.79	0.73	7.3	0.58	4.61	2.7													Runoff convetyed to The Sands Pond 5
	11	B-2	0.15	0.90	5.0	0.13	5.17	0.7													Street flows North to The Sands Pond 5
	20	C-1	0.89	0.59	7.8	0.53	4.51	2.4				2.4									Sheet flows to Design Point 20
	21	C-2	0.72	0.73	5.2	0.53	5.11	2.7				2.7									Sheet flows to inlet at Design Point 21
	22	C-3	1.04	0.73	6.2	0.76	4.84	3.7				3.7									Sheet flows to inlet at Design Point 22
	23	C-4	0.56	0.73	5.0	0.41	5.17	2.1				2.1									Sheet flows to inlet at Design Point 23
	23								7.8	2.23	4.51	10.1									Combines with runoff from Basin C-1, C-2, & C-3 Piped to Pond C
	24	C-6	0.06	0.90	5.0	0.05	5.17	0.3				0.3									Ongrade D-10-R Inlet
	25	C-5	0.69	0.73	5.0	0.50	5.17	2.6				2.6									Sheet flows to Pond C
	25								7.8	2.78	4.51	12.5									Total runoff in Pond C
	30	D-1	0.55	0.73	5.0	0.40	5.17	2.1				2.1									Runoff conveyed to Pond D
	40	E-1	1.01	0.23	12.7	0.23	3.77	0.9				0.9									Sheet flows to Design Point 40
		OS-1	0.07	0.90	5.0	0.06	5.17	0.3				0.3									Runoff from Larzac Drive Sheet flows south to Constitution Ave.
		OS-2	0.05	0.90	5.0	0.04	5.17	0.2				0.2									Runoff from Private Drive Sheet flows south to Constitution Ave.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Project Name: The Sands Retail Buildings
Subdivision: The Sands Retail Buildings
Project No.: ACD003
Location: CO, Colorado Springs
Calculated By: BHB
Design Storm: 100-Year
Checked By: SMB
Date: 2/26/19

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
Historic Calculations																					
		H-1	2.30	0.36	12.0	0.83	6.47	5.4				5.4									
		H-2	2.01	0.36	11.8	0.72	6.51	4.7				4.7									
		H-2							12.0	1.55	6.47	10.0									
		H-3	2.71	0.36	12.0	0.98	6.47	6.3				6.3									
		H-4	3.98	0.36	12.8	1.43	6.31	9.0				9.0									
		H-4							12.8	2.41	6.31	15.2									

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Project Name: The Sands Retail Buildings
Subdivision: The Sands Retail Buildings
Project No.: ACD003
Location: CO, Colorado Springs
Calculated By: BHB
Design Storm: 100-Year
Checked By: SMB
Date: 2/26/19

STREET		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
Proposed Calculations																					
	1	A-1	0.54	0.81	5.0	0.44	8.68	3.8							3.8	0.5	18				Future Lot, runoff conveyed to parking lot detention Piped to DP 2
	2	A-2	0.57	0.81	5.0	0.46	8.68	4.0													Future Lot, runoff conveyed to parking lot detention
	2								5.0	0.90	8.68	7.8			7.8	0.5	18				Piped to Pond A DP 7
	3	A-5	0.45	0.81	5.0	0.36	8.68	3.1							3.1	0.5	18				Future Lot, runoff conveyed to parking lot detention Piped to DP 4
	4	A-6	0.76	0.78	5.5	0.59	8.44	5.0													Future Lot, runoff conveyed to parking lot detention
	4								5.5	0.95	8.44	8.0			8.0	0.5	24				Piped to DP 5
	5	A-3	0.32	0.92	5.0	0.30	8.68	2.6													Ongrade D-10-R Inlet
	5								5.5	1.25	8.44	10.6			10.6	0.5	24				Piped to DP 6
	6	A-4	0.19	0.96	5.0	0.18	8.68	1.6													Ongrade D-10-R Inlet
	6								5.5	1.43	8.44	12.1			12.1	0.5	24				Piped to Pond A DP 7
	7	A-7	0.88	0.81	5.0	0.71	8.68	6.2													
	7								5.5	3.04	8.44	25.7									Total runoff in Pond A
	10	B-1	0.79	0.81	7.3	0.64	7.73	4.9													Runoff convetyed to The Sands Pond 5
	11	B-2	0.15	0.96	5.0	0.14	8.68	1.2													Street flows North to The Sands Pond 5
	20	C-1	0.89	0.70	7.8	0.62	7.57	4.7				4.7									Sheet flows to Design Point 20
	21	C-2	0.72	0.81	5.2	0.58	8.58	5.0				5.0									Sheet flows to inlet at Design Point 21
	22	C-3	1.04	0.81	6.2	0.84	8.13	6.8				6.8									Sheet flows to inlet at Design Point 22
	23	C-4	0.56	0.81	5.0	0.45	8.68	3.9				3.9									Sheet flows to inlet at Design Point 23
	23								7.8	2.49	7.57	18.8									Combines with runoff from Basin C-1, C-2, & C-3 Piped to Pond C
	24	C-6	0.06	0.96	5.0	0.06	8.68	0.5				0.5									Ongrade D-10-R Inlet
	25	C-5	0.69	0.81	5.0	0.56	8.68	4.9				4.9									Sheet flows to Pond C
	25								7.8	3.11	7.57	23.5									Total runoff in Pond C
	30	D-1	0.55	0.81	5.0	0.45	8.68	3.9				3.9									Runoff conveyed to Pond D
	40	E-1	1.01	0.46	12.7	0.47	6.33	3.0				3.0									Sheet flows to Design Point 40
		OS-1	0.07	0.96	5.0	0.07	8.68	0.6				0.6									Runoff from Larzac Drive Sheet flows south to Constitution Ave.
		OS-2	0.05	0.96	5.0	0.05	8.68	0.4				0.4									Runoff from Private Drive Sheet flows south to Constitution Ave.

North American Green
5401 St. Wendel-Cynthiana Rd.
Poseyville, Indiana 47633
Tel. 800.772.2040
>Fax 812.867.0247
www.nagreen.com
ECMDS v6.0

ANALYSIS COMPUTATIONS

> > > >View Computation

Project Parameters	
Specify Manning's n:	0.25
Discharge:	2.8
Peak Flow Period:	0.5
Channel Slope:	0.0235
Bottom Width:	0
Left Side Slope:	50
Right Side Slope:	50
Existing Channel Bend:	
Bend Coefficient (Kb):	1
Channel Radius :	
Retardance Class (A - E):	C 6-12 in
Vegetation Type:	Bunch Type
Vegetation Density:	Fair 50-75%
Soil Type:	Sandy Loam
Channel Lining Options	
Protection Type	Permanent

Material Type	
Matting Type	Unreinforced Vegetation
Manning's N value for selected Product	0.25
Cross-Sectional Area (A)	
$A = A_L + A_B + A_R =$	8.74
$A_L = (1/2) * Depth^2 * Z_L =$	4.37
$A_B =$ Bottom Width * Depth =	0
$A_R = (1/2) * Depth^2 * Z_R =$	4.37
Wetted Perimeter (P)	
$P = P_L + P_B + P_R =$	41.81
$P_L = Depth * (Z_L^2 + 1)^{0.5} =$	20.9
$P_B =$ Channel Bottom Width =	0
$P_R = Depth * (Z_R^2 + 1)^{0.5}$	20.9
Hydraulic Radius (R)	
R = A / P =	0.21
Flow (Q)	
$Q = 1.486 / n * A * R^{2/3} * S^{1/2} =$	2.8
Velocity (V)	
V = Q / A =	0.32
Channel Shear Stress (T_e)	
$T_d = 62.4 * Depth * Slope =$	0.61
Channel Safety Factor = (T_p / T_d)	6.85
Effective Stress on Blanket(T_{db})	
$T_e = T_d * (1\text{-}CF) * (n_s/n)^2 =$	
CF =	
$n_s =$	
Soil Safety Factor	
Allowable Soil Shear (T_a) =	
Soil Safety Factor = $T_a / T_e =$	
Bend Shear Stress (T_{db})	

T_{db} =	
Bend Safety Factor	
T_{db} =	
Effective Stress on Blanket in Bend $T_{(eb)}$	
$T_{eb} = T_{db} * (1\text{-}CF) * (n_s / n)^2$ =	
Soil Safety Factor in Bend	
Soil Safety Factor = T_a / T_e =	
Conclusion: Stability of Mat	STABLE
Conclusion: Stability of Underlying soil	STABLE
Conclusion: Stability of Mat (Bend)	
Conclusion: Stability of Underlying Soil (Bend)	
Material Type	
Matting Type	Unreinforced Vegetation
Manning's N value for selected Product	0
Cross-Sectional Area (A)	
$A = A_L + A_B + A_R$ =	8.74
$A_L = (1/2) * Depth^2 * Z_L$ =	4.37
A_B = Bottom Width * Depth =	0
$A_R = (1/2) * Depth^2 * Z_R$ =	4.37
Wetted Perimeter (P)	
$P = P_L + P_B + P_R$ =	41.81
$P_L = Depth * (Z_L^2 + 1)^{0.5}$ =	20.9
P_B = Channel Bottom Width =	0
$P_R = Depth * (Z_R^2 + 1)^{0.5}$	20.9
Hydraulic Radius (R)	
R = A / P =	0.21
Flow (Q)	
$Q = 1.486 / n * A * R^{2/3} * S^{1/2}$ =	2.8
Velocity (V)	
V = Q / A =	0.32
Channel Shear Stress (T_e)	
T_d = 62.4 * Depth * Slope =	0.61
Channel Safety Factor = (T_p / T_d)	6.85
Effective Stress on Blanket(T_{db})	
$T_e = T_d * (1\text{-}CF) * (n_s/n)^2$ =	
CF =	
n_s =	
Soil Safety Factor	
Allowable Soil Shear (T_a) =	
Soil Safety Factor = T_a / T_e =	
Bend Shear Stress (T_{db})	
T_{db} =	
Bend Safety Factor	
T_{db} =	
Effective Stress on Blanket in Bend $T_{(eb)}$	
$T_{eb} = T_{db} * (1\text{-}CF) * (n_s / n)^2$ =	
Soil Safety Factor in Bend	
Soil Safety Factor = T_a / T_e =	
Conclusion: Stability of Mat	STABLE
Conclusion: Stability of Underlying soil	STABLE
Conclusion: Stability of Mat (Bend)	
Conclusion: Stability of Underlying Soil (Bend)	

Galloway

Date: 1/8/19

Subject: Sand Hill West WQ swale

velocity (V) = 0.32 ft/s (from North American Green calc)

Length (L) = 460 ft

Time of concentration (t_c) = $\frac{L}{V}$ = $\frac{460 \text{ ft}}{0.32 \text{ ft/s}}$ = 1437.5 sec = **24 min.**

Pollutants attach themselves to sediment and by providing a large time of concentration, sediments fall out therefore removing many of these pollutants. Additionally, the SWMM model shows no runoff leaving the basin (E-1) in the water quality event (reference Appendix C).

Appendix C
Pond Calculations

Detention Pond Tributary Areas

Subdivision:	The Sands Retail Buildings	**Project Name:**	The Sands Retail Buildings
Location:	CO, Colorado Springs	**Project No.:**	ACD003
		Calculated By:	BHB
		Checked By:	SMB
		Date:	2/26/19

Pond A

Basin	Area	% Imp
A-1	0.54	90
A-2	0.57	90
A-3	0.32	93.9
A-4	0.19	100
A-5	0.45	90
A-6	0.76	72.1
A-7	0.88	90
Total	**3.71**	**87.2**

WQ Required

WQCV =	0.38	in	From Eqn 3-1
WQCV =	**0.12**	**ac-ft**	

Pond C

Basin	Area	% Imp
C-1	0.89	80
C-2	0.72	90
C-3	1.04	90
C-4	0.56	90
C-5	0.69	90
C-6	0.06	100
Total	**3.96**	**87.9**

Pond D

Basin	Area	% Imp
D-1	0.55	90
Total	**0.55**	**90.0**

POND VOLUME CALCULATIONS

Subdivision	The Sands Retail Buildings	**Project Name:**	
Location	CO, Colorado Springs	**Project No.**	ACD003
		By:	BHB
		Checked By:	SMB
		Date:	2/26/19

Volume=1/3 x Depth x (A+B+(A*B)^0.5)
A - Upper Surface
B - Lower Surface

Pond A

Stage	**Stage Elevation**	**Stage Surface Area** (square feet)	**Stage Volume** (cubic feet)	**Cumulative Volume** (cubic feet)	**Cumulative Volume** (acre feet)
0.00	6447.25	0	0	0	0.00
0.75	6448.00	1,237	309	309	0.01
1.75	6449.00	5,155	2,972	3,281	0.08
2.75	6450.00	5,633	5,392	8,673	0.20
3.75	6451.00	5,987	5,809	14,482	0.33
4.75	6452.00	6,347	6,166	20,648	0.47
5.75	6453.00	6,734	6,540	27,188	0.62

Volume (acre feet)	**Volume**	**Water Surface Elevation**	**Stage**
WQCV	0.13	6449.45	2.20
EURV Required	0.49	6452.11	4.86
EURV Provided	0.50	6452.15	4.90
100-Year Detention	0.59	6452.78	5.53

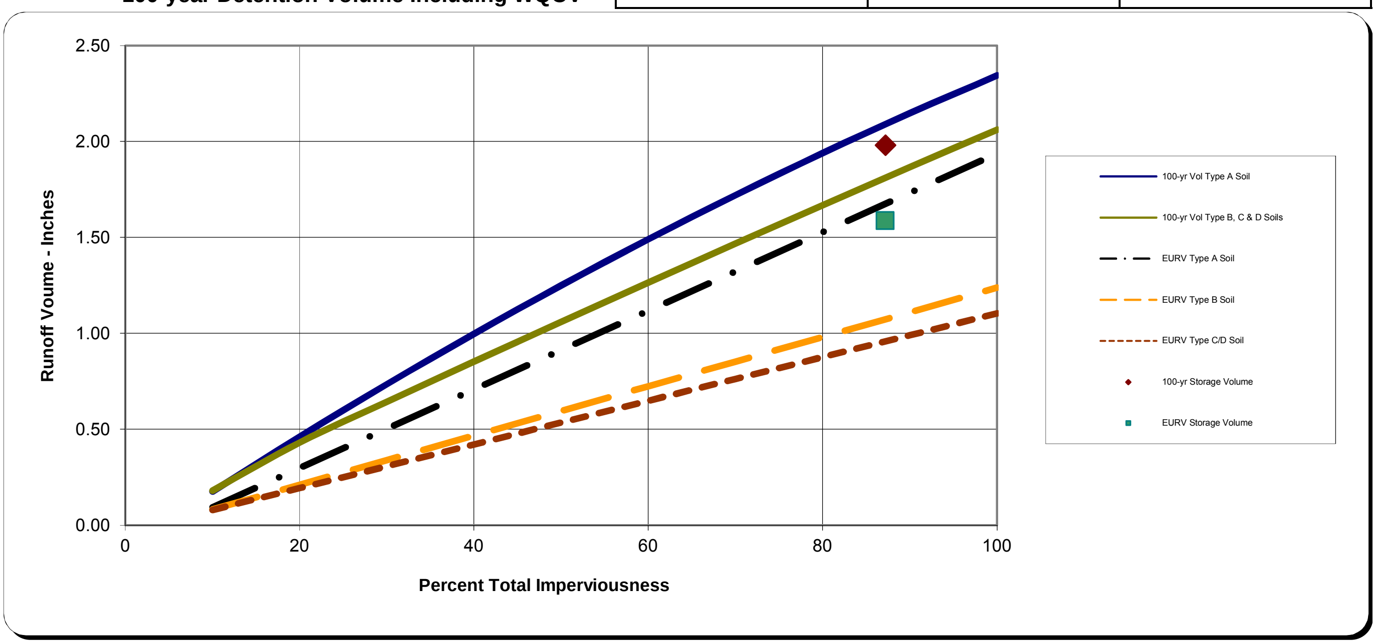
DETENTION VOLUME BY THE FULL SPECTRUM METHOD

Project: **Sand Hill**
Basin ID: **Pond A**

			* User input data shown in blue.
Area of Watershed (acres)	3.71		
Subwatershed Imperviousness	87.2%		
Level of Minimizing Directly Connected Impervious Area (MDCIA)	0	0	
Effective Imperviousness[1]	87.2%		
Hydrologic Soil Type	**Percentage of Area**	**Area (acres)**	
Type A	61.0%	2.3	
Type B	39.0%	1.4	
Type C or D		0.0	

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		**Decay Coefficient--α**
Initial--f_i	**Final--*fo***	
4.805	0.8	0.0011

	Detention Volumes [2,5]		**Maximum Allowable Release Rate, cfs**[3]
	(watershed inches)	**(acre-feet)**	
Excess Urban Runoff Volume[4]	1.59	0.49	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	~~1.98~~	~~0.61~~	2.36



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
4) EURV approximates the difference between developed and pre-developed runoff volume.
5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

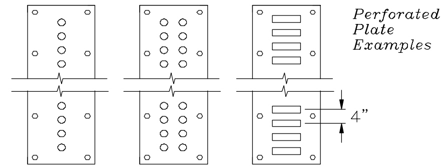
Project: Sand Hill
Basin ID: Pond A

WQCV Design Volume (Input):

Catchment Imperviousness, I_a =	87.2	percent			
Catchment Area, A =	3.71	acres	Diameter of holes, D =	1.135	inches
Depth at WQCV outlet above lowest perforation, H =	5	feet	Number of holes per row, N =	1	
Vertical distance between rows, h =	20.00	inches		**OR**	
Number of rows, NL =	3.00				
Orifice discharge coefficient, C_o =	0.65		Height of slot, H =		inches
Slope of Basin Trickle Channel, S =	0.010	ft / ft	Width of slot, W =		inches
Time to Drain the Pond =	72	hours			

Watershed Design Information (Input):

Percent Soil Type A =	61	%
Percent Soil Type B =	39	%
Percent Soil Type C/D =		%



Outlet Design Information (Output):

Excess Urban Runoff Volume (From 'Full-Spectrum Sheet')	1.585	watershed inches
	N/A	
Excess Urban Runoff Volume (From 'Full-Spectrum Sheet')	**0.490**	**acre-feet**
Outlet area per row, Ao =	1.79	square inches
Total opening area at each row based on user-input above, Ao =	1.01	square inches
Total opening area at each row based on user-input above, Ao =	0.007	square feet

3

	Central Elevations of Rows of Holes in feet																							
	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13	Row 14	Row 15	Row 16	Row 17	Row 18	Row 19	Row 20	Row 21	Row 22	Row 23	Row 23	Σ Flow
	0.00	1.67	3.33																						
	Collection Capacity for Each Row of Holes in cfs																								
0.00	0.0000	0.0000	0.0000																						**0.00**
0.25	0.0183	0.0000	0.0000																						**0.02**
0.50	0.0259	0.0000	0.0000																						**0.03**
0.75	0.0317	0.0000	0.0000																						**0.03**
1.00	0.0367	0.0000	0.0000																						**0.04**
1.25	0.0410	0.0000	0.0000																						**0.04**
1.50	0.0449	0.0000	0.0000																						**0.04**
1.75	0.0485	0.0104	0.0000																						**0.06**
2.00	0.0518	0.0211	0.0000																						**0.07**
2.25	0.0550	0.0279	0.0000																						**0.08**
2.50	0.0579	0.0334	0.0000																						**0.09**
2.75	0.0608	0.0381	0.0000																						**0.10**
3.00	0.0635	0.0423	0.0000																						**0.11**
3.25	0.0661	0.0461	0.0000																						**0.11**
3.50	0.0686	0.0496	0.0151																						**0.13**
3.75	0.0710	0.0529	0.0238																						**0.15**
4.00	0.0733	0.0559	0.0300																						**0.16**
4.25	0.0756	0.0589	0.0352																						**0.17**
4.50	0.0777	0.0617	0.0396																						**0.18**
4.60	0.0786	0.0627	0.0413																						**0.18**
4.75	0.0799	0.0643	0.0437																						**0.19**
5.00	0.0820	0.0669	0.0474																						**0.20**
5.25	0.0840	0.0693	0.0508																						**0.20**
5.50	0.0860	0.0717	0.0540																						**0.21**
5.75	0.0879	0.0740	0.0570																						**0.22**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
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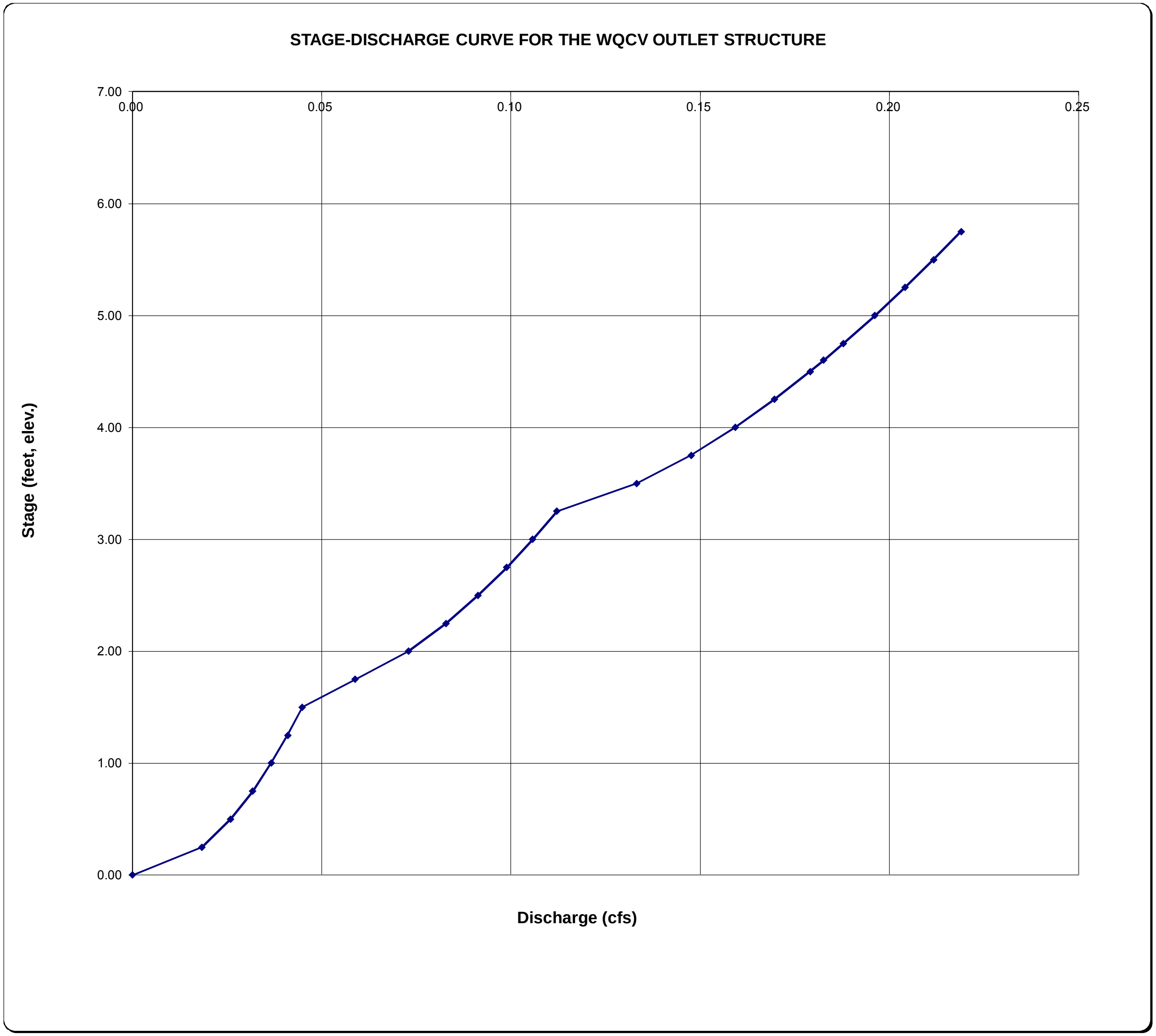
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**

Override Area Row 1	Override Area Row 2	Override Area Row 3	Override Area Row 4	Override Area Row 5	Override Area Row 6	Override Area Row 7	Override Area Row 8	Override Area Row 9	Override Area Row 10	Override Area Row 11	Override Area Row 12	Override Area Row 13	Override Area Row 14	Override Area Row 15	Override Area Row 16	Override Area Row 17	Override Area Row 18	Override Area Row 19	Override Area Row 20	Override Area Row 21	Override Area Row 22	Override Area Row 23	Override Area Row 24

STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: Sand Hill
Basin ID: Pond A

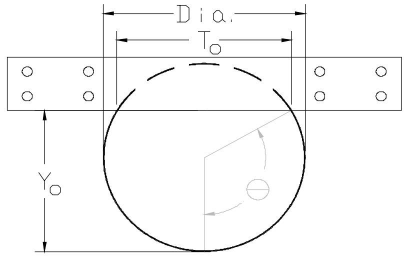


RESTRICTOR PLATE SIZING FOR CIRCULAR VERTICAL ORIFICES

Project: Sand Hill

Basin ID: Pond A

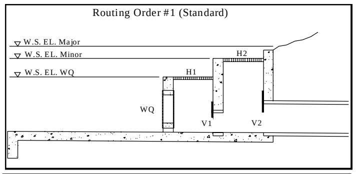
X

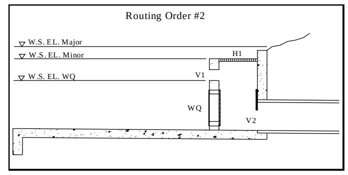


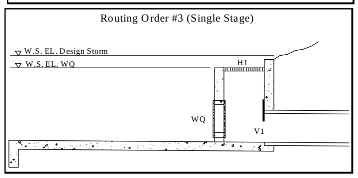
		#1 Vertical Orifice	#2 Vertical Orifice	
Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)				
Water Surface Elevation at Design Depth	Elev: WS =	5.20		feet
Pipe/Vertical Orifice Entrance Invert Elevation	Elev: Invert =	-0.58		feet
Required Peak Flow through Orifice at Design Depth	Q =	3.50		cfs
Pipe/Vertical Orifice Diameter (inches)	Dia =	24.0		inches
Orifice Coefficient	C_o =	0.65		
Full-flow Capacity (Calculated)				
Full-flow area	Af =	3.14		sq ft
Half Central Angle in Radians	Theta =	3.14		rad
Full-flow capacity	Qf =	35.8		cfs
	Percent of Design Flow =	1024%		
Calculation of Orifice Flow Condition				
Half Central Angle (0<Theta<3.1416)	Theta =	0.78		rad
Flow area	A_o =	0.28		sq ft
Top width of Orifice (inches)	T_o =	16.93		inches
Height from Invert of Orifice to Bottom of Plate (feet)	Y_o =	0.29		feet
Elevation of Bottom of Plate	Elev Plate Bottom Edge =	-0.29		feet
Resultant Peak Flow Through Orifice at Design Depth	Q_o =	3.5		cfs
Width of Equivalent Rectangular Vertical Orifice	**Equivalent Width =**	**0.97**		**feet**
Centroid Elevation of Equivalent Rectangular Vertical Orifice	**Equiv. Centroid El. =**	**-0.44**		**feet**

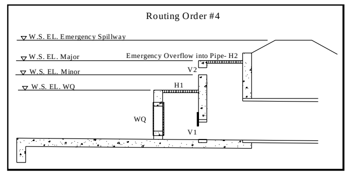
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Sand Hill
Basin ID: Pond A









Current Routing Order is #3

Design Information (Input):

			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =					inches
OR							
Rectangular Opening:	Width in Feet	W =	2.92		0.97		ft.
	Length (Height for Vertical)	L or H =	5.83		0.29		ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	70		100		%
	Orifice Coefficient	C_o =	0.65		0.65		
	Weir Coefficient	C_w =	3.00				
	Orifice Elevation (Bottom for Vertical)	E_o =	4.90		-0.58		ft.

Calculation of Collection Capacity:

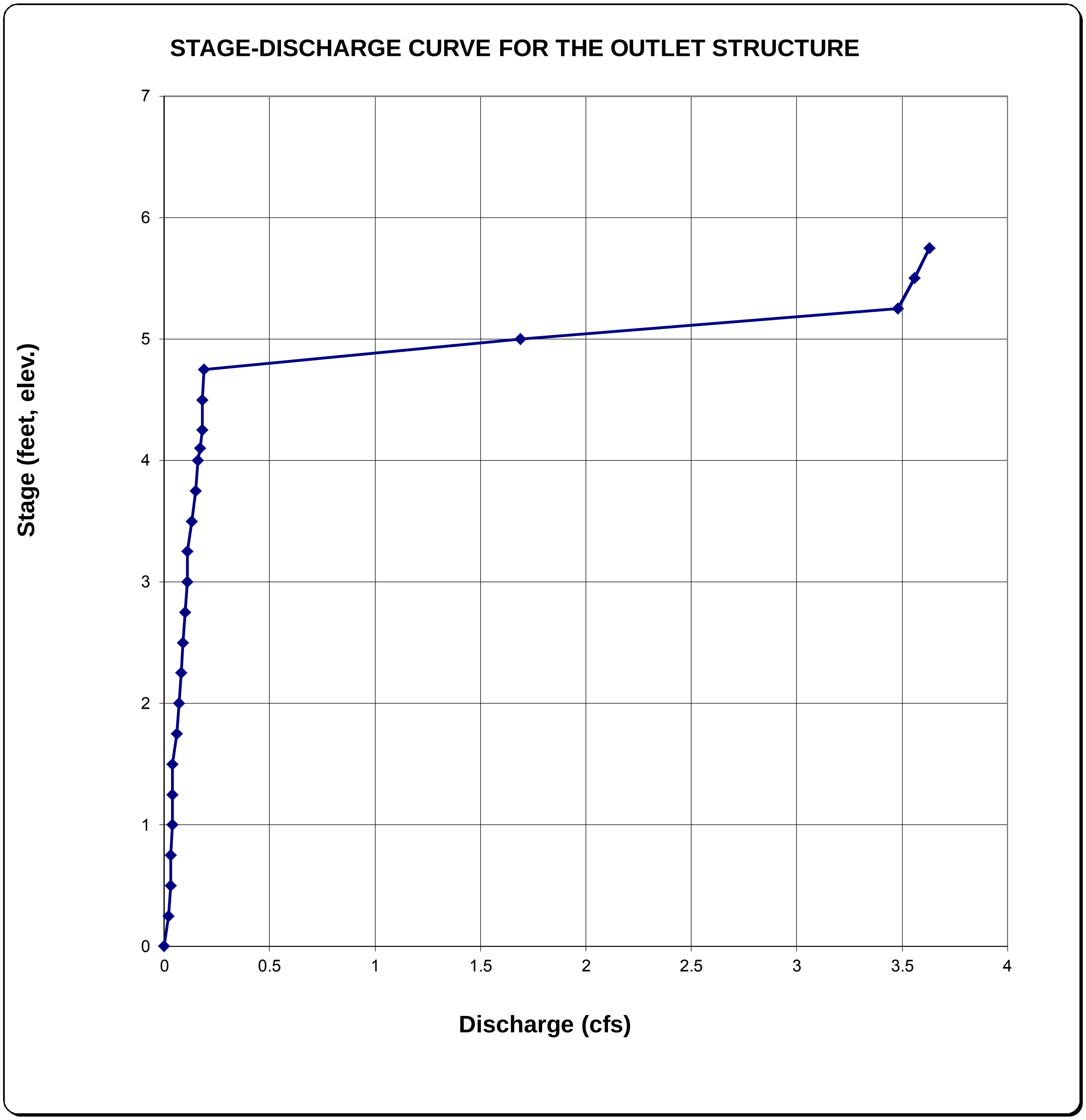
		#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Net Opening Area (after Trash Rack Reduction)	A_o =	11.92		0.28		sq. ft.
OPTIONAL: User-Overide Net Opening Area	A_o =					sq. ft.
Perimeter as Weir Length	L_w =	15.75	ft.			
OPTIONAL: User-Overide Weir Length	L_w =		ft.			
Top Elevation of Vertical Orifice Opening, Top =				-0.29		ft.
Center Elevation of Vertical Orifice Opening, Cen =				-0.44		ft.

Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	**Total Collection Capacity cfs (output)**	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	**0.00**	
	0.25	0.02	0.00	0.00	0.00	0.00	1.21	0.00	**0.02**	
	0.50	0.03	0.00	0.00	0.00	0.00	1.41	0.00	**0.03**	
	0.75	0.03	0.00	0.00	0.00	0.00	1.59	0.00	**0.03**	
	1.00	0.04	0.00	0.00	0.00	0.00	1.75	0.00	**0.04**	
	1.25	0.04	0.00	0.00	0.00	0.00	1.90	0.00	**0.04**	
	1.50	0.04	0.00	0.00	0.00	0.00	2.03	0.00	**0.04**	
	1.75	0.06	0.00	0.00	0.00	0.00	2.16	0.00	**0.06**	
	2.00	0.07	0.00	0.00	0.00	0.00	2.28	0.00	**0.07**	
	2.25	0.08	0.00	0.00	0.00	0.00	2.39	0.00	**0.08**	
	2.50	0.09	0.00	0.00	0.00	0.00	2.50	0.00	**0.09**	
	2.75	0.10	0.00	0.00	0.00	0.00	2.61	0.00	**0.10**	
	3.00	0.11	0.00	0.00	0.00	0.00	2.71	0.00	**0.11**	
	3.25	0.11	0.00	0.00	0.00	0.00	2.80	0.00	**0.11**	
	3.50	0.13	0.00	0.00	0.00	0.00	2.90	0.00	**0.13**	
	3.75	0.15	0.00	0.00	0.00	0.00	2.99	0.00	**0.15**	
	4.00	0.16	0.00	0.00	0.00	0.00	3.08	0.00	**0.16**	
	4.10	0.17	0.00	0.00	0.00	0.00	3.11	0.00	**0.17**	
	4.25	0.18	0.00	0.00	0.00	0.00	3.16	0.00	**0.18**	
	4.50	0.18	0.00	0.00	0.00	0.00	3.24	0.00	**0.18**	
	4.75	0.19	0.00	0.00	0.00	0.00	3.33	0.00	**0.19**	
	5.00	0.20	1.49	19.66	0.00	0.00	3.40	0.00	**1.69**	
	5.25	0.20	9.78	36.77	0.00	0.00	3.48	0.00	**3.48**	
	5.50	0.21	21.96	48.15	0.00	0.00	3.56	0.00	**3.56**	
	5.75	0.22	37.02	57.31	0.00	0.00	3.63	0.00	**3.63**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	

STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Sand Hill
Basin ID: Pond A



DETENTION VOLUME BY THE FULL SPECTRUM METHOD

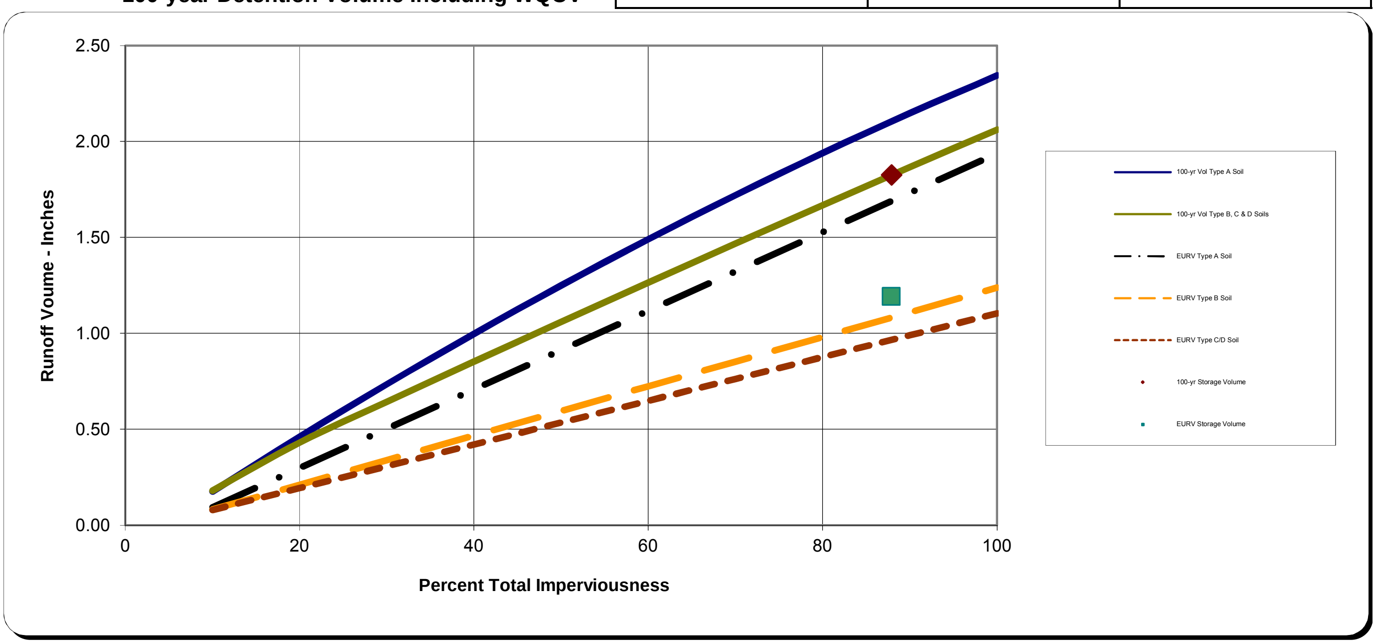
Project: Sand Hill
Basin ID: Pond C

* User input data shown in blue.

Area of Watershed (acres)	3.96	
Subwatershed Imperviousness	87.9%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	0	0
Effective Imperviousness[1]	87.9%	
Hydrologic Soil Type	**Percentage of Area**	**Area (acres)**
Type A		0.0
Type B	100.0%	4.0
Type C or D		0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient--α
Initial--f_i	Final--fo	
4.5	0.6	0.0018

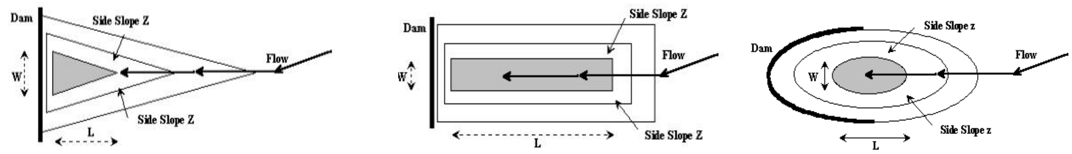
	Detention Volumes [2,5]		Maximum Allowable Release Rate, cfs[3]
	(watershed inches)	(acre-feet)	
Excess Urban Runoff Volume[4]	1.19	0.39	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	~~1.83~~	~~0.60~~	3.37



Notes:
1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
4) EURV approximates the difference between developed and pre-developed runoff volume.
5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

STAGE-STORAGE SIZING FOR DETENTION BASINS

Project: Sand Hill
Basin ID: Pond C



Design Information (Input):

Width of Basin Bottom, W = ______ ft
Length of Basin Bottom, L = ______ ft
Dam Side-slope (H:V), Z_d = ______ ft/ft

Check Basin Shape

Right Triangle ______ OR…
Isosceles Triangle ______ OR…
Rectangle ______ OR…
Circle / Ellipse ______ OR…
Irregular ______ (Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':	0.39	0.60	acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Water Surface Elevation ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Basin Width at Stage ft (output)	Basin Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
6647	0.00					0		0.000	0.000	
6648	1.00		0.00	0.00		2,347	1,174	0.054	0.027	
6649	2.00		0.00	0.00		2,835	3,765	0.065	0.086	
6650	3.00		0.00	0.00		3,286	6,825	0.075	0.157	
6651	4.00		0.00	0.00		3,755	10,346	0.086	0.238	
6652	5.00		0.00	0.00		4,189	14,318	0.096	0.329	EURV = 5.63
6653	6.00		0.00	0.00		4,770	18,797	0.110	0.432	
							#N/A		#N/A	
							#N/A		#N/A	
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							#N/A		#N/A	
							#N/A		#N/A	
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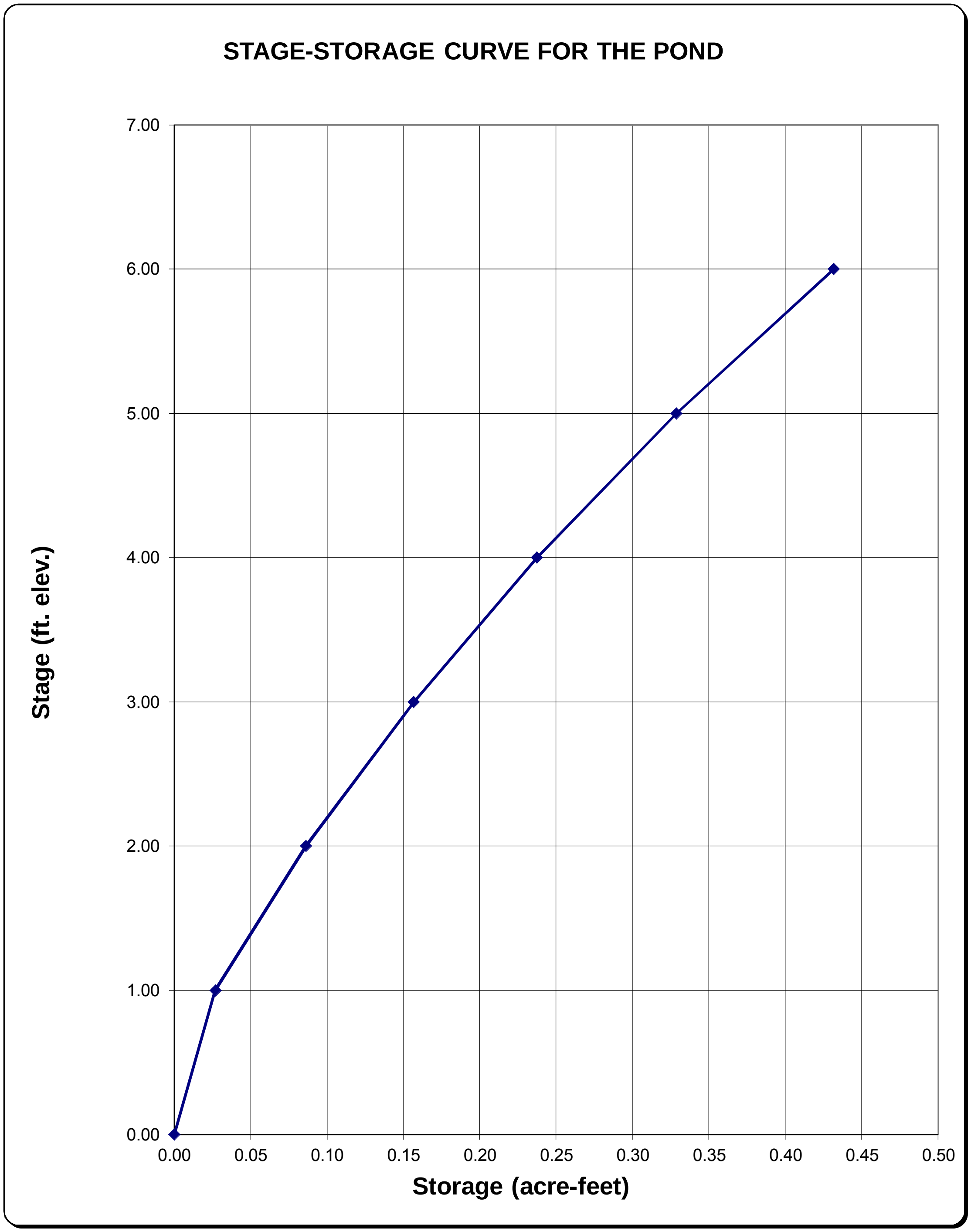
STAGE-STORAGE SIZING FOR DETENTION BASINS

Project:
Basin ID:



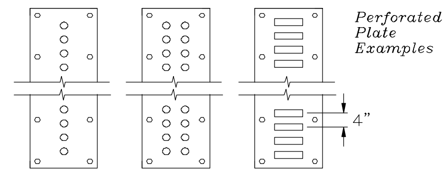
STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: Sand Hill
Basin ID: Pond C

WQCV Design Volume (Input):

Catchment Imperviousness, I_a = 87.9 percent
Catchment Area, A = 3.96 acres
Depth at WQCV outlet above lowest perforation, H = 6 feet
Vertical distance between rows, h = 22.00 inches
Number of rows, NL = 3.00
Orifice discharge coefficient, C_o = 0.65
Slope of Basin Trickle Channel, S = 0.010 ft / ft
Time to Drain the Pond = 72 hours

Diameter of holes, D = 1.063 inches
Number of holes per row, N = 1
OR
Height of slot, H = inches
Width of slot, W = inches



Watershed Design Information (Input):

Percent Soil Type A = %
Percent Soil Type B = 100 %
Percent Soil Type C/D = %

Outlet Design Information (Output):

Excess Urban Runoff Volume (From 'Full-Spectrum Sheet') 1.191 watershed inches
N/A
Excess Urban Runoff Volume (From 'Full-Spectrum Sheet') 0.393 acre-feet
Outlet area per row, Ao = 1.52 square inches
Total opening area at each row based on user-input above, Ao = 0.89 square inches
Total opening area at each row based on user-input above, Ao = 0.006 square feet

3

Central Elevations of Rows of Holes in feet

	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13	Row 14	Row 15	Row 16	Row 17	Row 18	Row 19	Row 20	Row 21	Row 22	Row 23	Row 23	Σ Flow
	0.00	1.83	3.67																						
	Collection Capacity for Each Row of Holes in cfs																								
0.00	0.0000	0.0000	0.0000																						**0.00**
1.00	0.0321	0.0000	0.0000																						**0.03**
2.00	0.0454	0.0132	0.0000																						**0.06**
3.00	0.0556	0.0347	0.0000																						**0.09**
4.00	0.0642	0.0473	0.0185																						**0.13**
5.00	0.0718	0.0572	0.0370																						**0.17**
6.00	0.0787	0.0656	0.0490																						**0.19**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
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	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
	#N/A	#N/A	#N/A																						**#N/A**
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	#N/A	#N/A	#N/A																						**#N/A**
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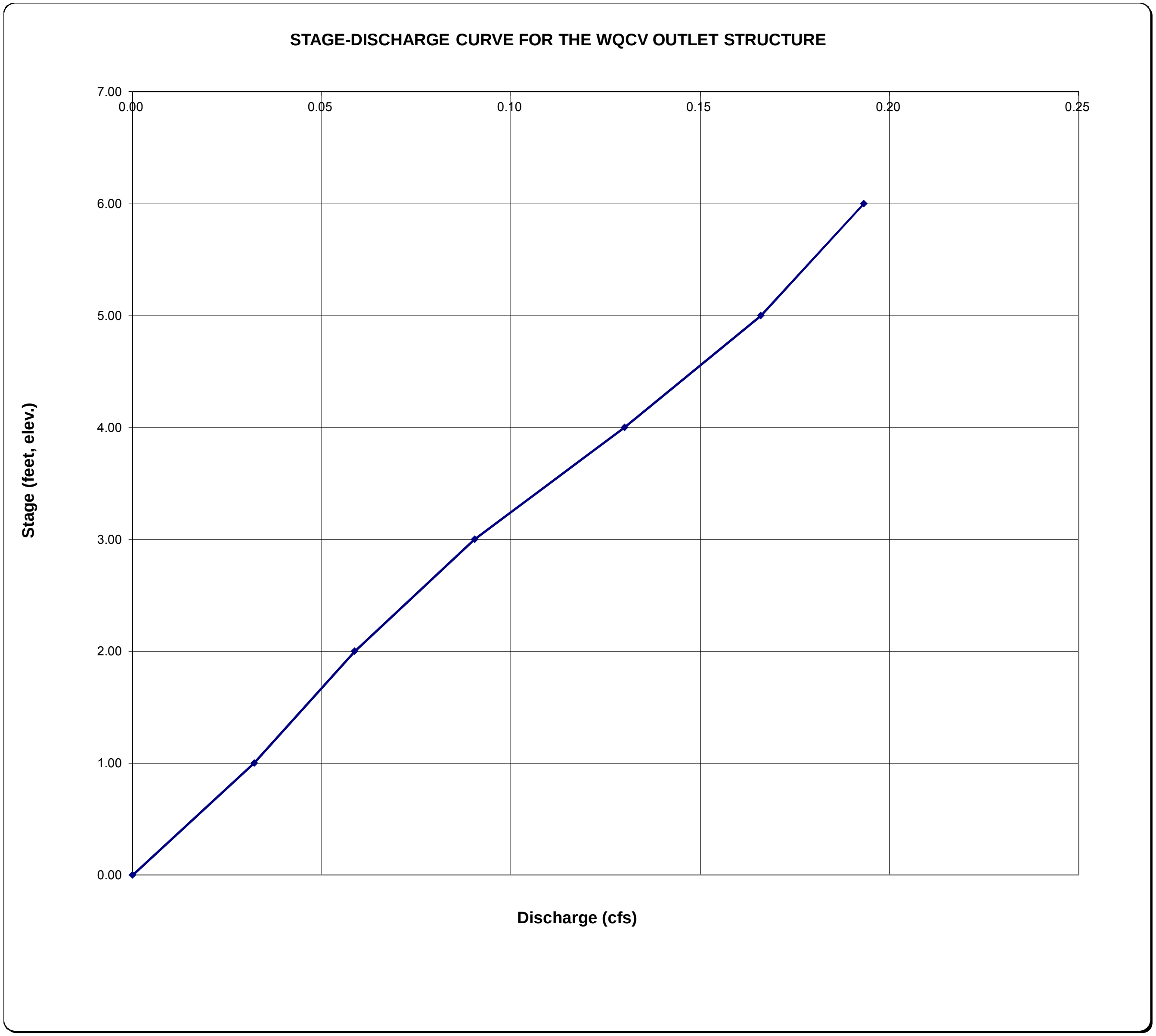
	#N/A	#N/A	#N/A																						**#N/A**

Override Area Row 1	Override Area Row 2	Override Area Row 3	Override Area Row 4	Override Area Row 5	Override Area Row 6	Override Area Row 7	Override Area Row 8	Override Area Row 9	Override Area Row 10	Override Area Row 11	Override Area Row 12	Override Area Row 13	Override Area Row 14	Override Area Row 15	Override Area Row 16	Override Area Row 17	Override Area Row 18	Override Area Row 19	Override Area Row 20	Override Area Row 21	Override Area Row 22	Override Area Row 23	Override Area Row 24

STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: Sand Hill
Basin ID: Pond C

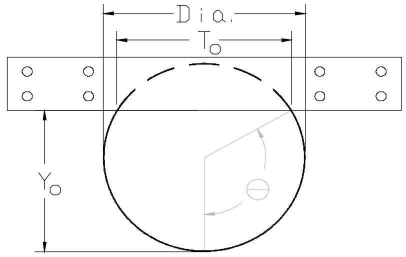


RESTRICTOR PLATE SIZING FOR CIRCULAR VERTICAL ORIFICES

Project: Sand Hill

Basin ID: Pond C

X



Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)

		#1 Vertical Orifice	#2 Vertical Orifice	
Water Surface Elevation at Design Depth	Elev: WS =	6.00		feet
Pipe/Vertical Orifice Entrance Invert Elevation	Elev: Invert =	0.00		feet
Required Peak Flow through Orifice at Design Depth	Q =	10.64		cfs
Pipe/Vertical Orifice Diameter (inches)	Dia =	18.0		inches
Orifice Coefficient	C_o =	0.65		

Full-flow Capacity (Calculated)

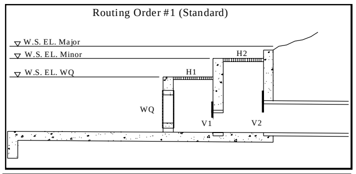
Full-flow area	Af =	1.77		sq ft
Half Central Angle in Radians	Theta =	3.14		rad
Full-flow capacity	Qf =	21.1		cfs
	Percent of Design Flow =	198%		

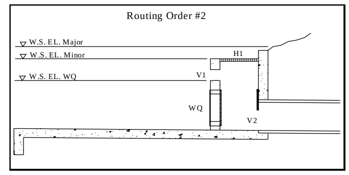
Calculation of Orifice Flow Condition

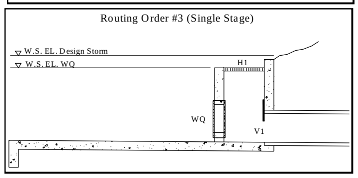
Half Central Angle (0<Theta<3.1416)	Theta =	1.55		rad
Flow area	A_o =	0.86		sq ft
Top width of Orifice (inches)	T_o =	18.00		inches
Height from Invert of Orifice to Bottom of Plate (feet)	Y_o =	0.73		feet
Elevation of Bottom of Plate	Elev Plate Bottom Edge =	0.73		feet
Resultant Peak Flow Through Orifice at Design Depth	Q_o =	10.7		cfs
Width of Equivalent Rectangular Vertical Orifice	**Equivalent Width =**	**1.18**		**feet**

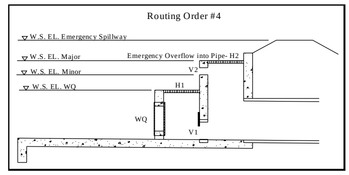
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Sand Hill
Basin ID: Pond c









Current Routing Order is #3

Design Information (Input):			#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =					inches
OR							
Rectangular Opening:	Width in Feet	W =	4.00		1.18		ft.
	Length (Height for Vertical)	L or H =	2.92		0.73		ft.
	Percentage of Open Area After Trash Rack Reduction	% open =	70		100		%
	Orifice Coefficient	C_o =	0.65		0.65		
	Weir Coefficient	C_w =	3.00				
	Orifice Elevation (Bottom for Vertical)	E_o =	5.76		0.00		ft.
Calculation of Collection Capacity:							
	Net Opening Area (after Trash Rack Reduction)	A_o =	8.18		0.86		sq. ft.
	OPTIONAL: User-Overide Net Opening Area	A_o =					sq. ft.
	Perimeter as Weir Length	L_w =	11.44	ft.			
	OPTIONAL: User-Overide Weir Length	L_w =		ft.			
	Top Elevation of Vertical Orifice Opening, Top =				0.73		ft.
	Center Elevation of Vertical Orifice Opening, Cen =				0.37		ft.

Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	**Total Collection Capacity cfs (output)**	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	
	1.00	0.03	0.00	0.00	0.00	0.00	3.57	0.00	**0.03**	
	2.00	0.06	0.00	0.00	0.00	0.00	5.74	0.00	**0.06**	
	3.00	0.09	0.00	0.00	0.00	0.00	7.28	0.00	**0.09**	
	4.00	0.13	0.00	0.00	0.00	0.00	8.55	0.00	**0.13**	
	5.00	0.17	0.00	0.00	0.00	0.00	9.66	0.00	**0.17**	
	6.00	0.19	4.04	20.89	0.00	0.00	10.65	0.00	**4.23**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	
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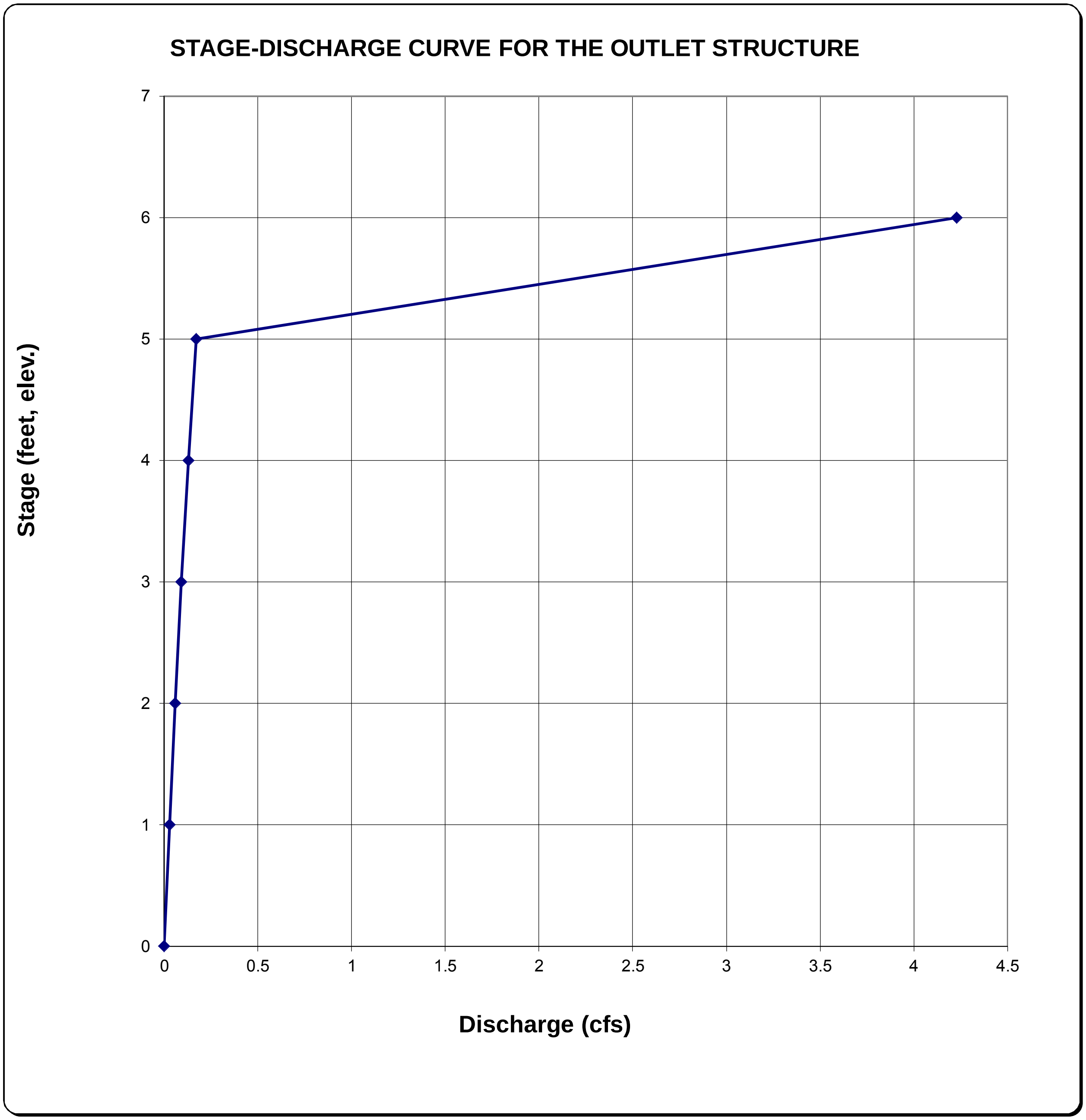
		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00	**#N/A**	

STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Sand Hill
Basin ID: Pond c

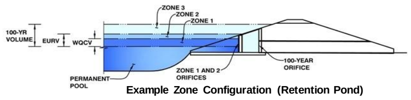


Project:

UD-Detention, Version 3.07 (February 2017)

Project: Sand Hill

Basin ID: Pond D



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**				
Watershed Area =	0.55	acres			
Watershed Length =	400	ft			
Watershed Slope =	0.010	ft/ft			
Watershed Imperviousness =	90.00%	percent			
Percentage Hydrologic Soil Group A =	0.0%	percent			
Percentage Hydrologic Soil Group B =	100.0%	percent			
Percentage Hydrologic Soil Groups C/D =	0.0%	percent			
Desired WQCV Drain Time =	40.0	hours			
Location for 1-hr Rainfall Depths =	User Input				
Water Quality Capture Volume (WQCV) =	0.018	acre-feet	Optional User Override 1-hr Precipitation		
Excess Urban Runoff Volume (EURV) =	0.055	acre-feet			
2-yr Runoff Volume (P1 = 1.19 in.) =	0.047	acre-feet	1.19	inches	
5-yr Runoff Volume (P1 = 1.5 in.) =	0.062	acre-feet	1.50	inches	
10-yr Runoff Volume (P1 = 1.75 in.) =	0.075	acre-feet	1.75	inches	
25-yr Runoff Volume (P1 = 2 in.) =	0.089	acre-feet	2.00	inches	
50-yr Runoff Volume (P1 = 2.25 in.) =	0.100	acre-feet	2.25	inches	
100-yr Runoff Volume (P1 = 2.52 in.) =	0.114	acre-feet	2.52	inches	
500-yr Runoff Volume (P1 = 3.68 in.) =	0.171	acre-feet	3.68	inches	
Approximate 2-yr Detention Volume =	0.044	acre-feet			
Approximate 5-yr Detention Volume =	0.058	acre-feet			
Approximate 10-yr Detention Volume =	0.071	acre-feet			
Approximate 25-yr Detention Volume =	0.076	acre-feet			
Approximate 50-yr Detention Volume =	0.079	acre-feet			
Approximate 100-yr Detention Volume =	0.082	acre-feet			

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.018	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.037	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.027	acre-feet
Total Detention Basin Volume =	0.082	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	1.00	--	--	--	1,042	0.024	511	0.012
	--	2.00	--	--	--	1,734	0.040	1,892	0.043
	--	3.00	--	--	--	2,525	0.058	4,038	0.093
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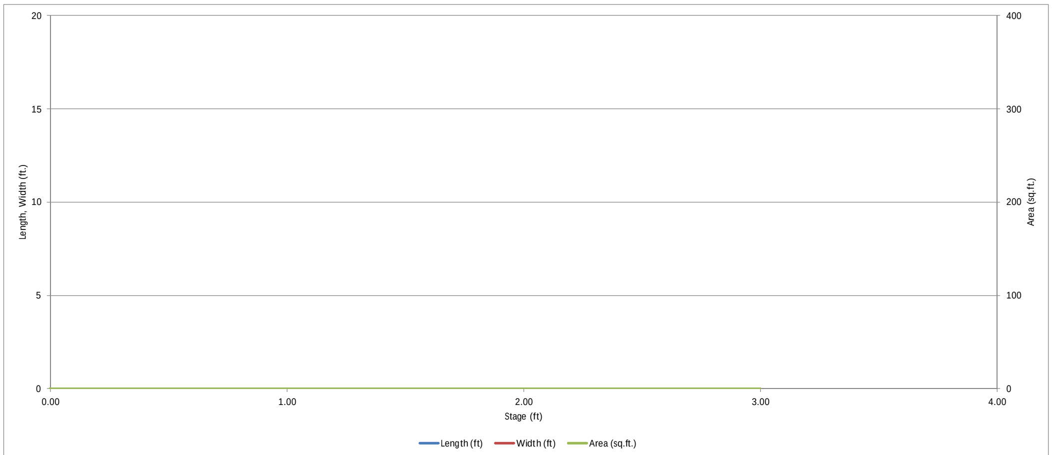
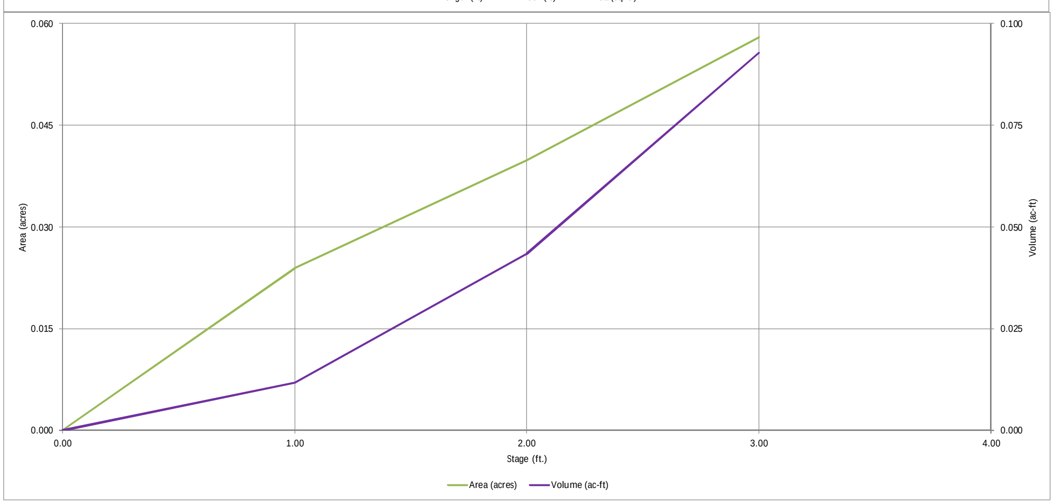
Project:

UD-Detention, Version 3.07 (February 2017)

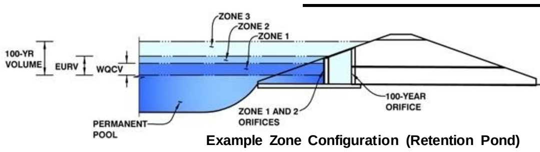




Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Sand Hill
Basin ID: Pond D



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.25	0.018	Orifice Plate
Zone 2 (EURV)	2.28	0.037	Orifice Plate
Zone 3 (100-year)	2.82	0.027	Weir&Pipe (Restrict)
		0.082	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.28	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	9.10	inches
Orifice Plate: Orifice Area per Row =	0.16	sq. inches (diameter = 7/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.111E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.76	1.52					
Orifice Area (sq. inches)	0.16	0.16	0.16					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.28	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.28	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	117.97	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	5.97	N/A	ft^2
Overflow Grate Open Area w/ Debris =	2.98	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	1.20		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.05	N/A	ft^2
Outlet Orifice Centroid =	0.06	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.52	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	0.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

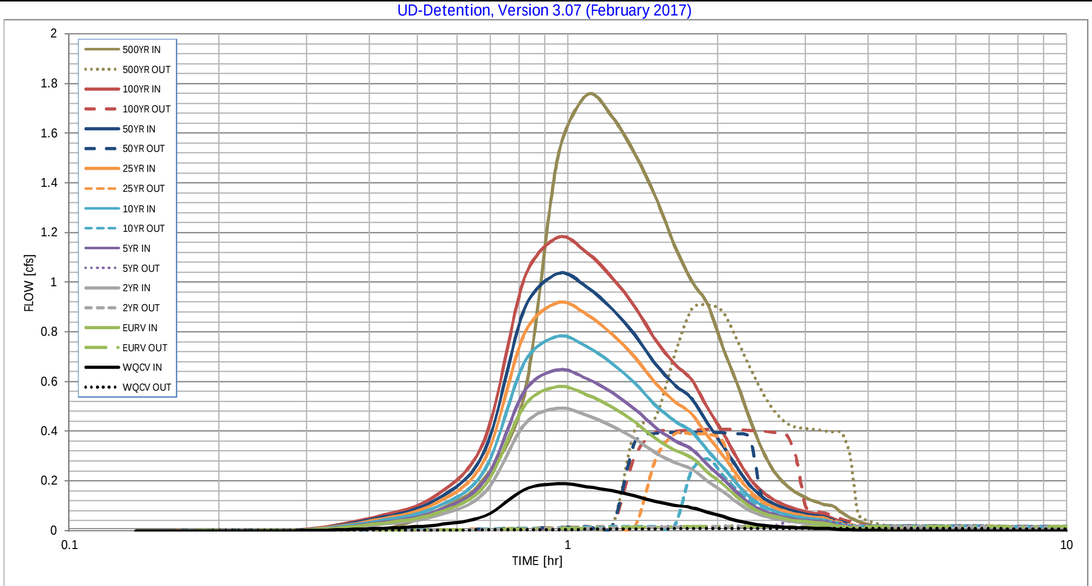
Spillway Design Flow Depth=	0.43	feet
Stage at Top of Freeboard =	4.13	feet
Basin Area at Top of Freeboard =	0.06	acres

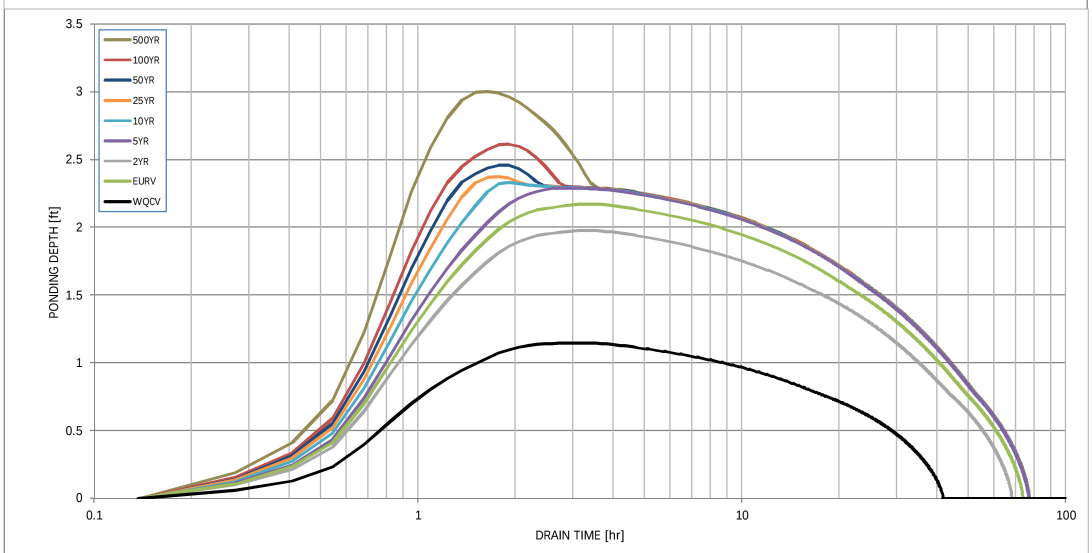
Routed Hydrograph Results

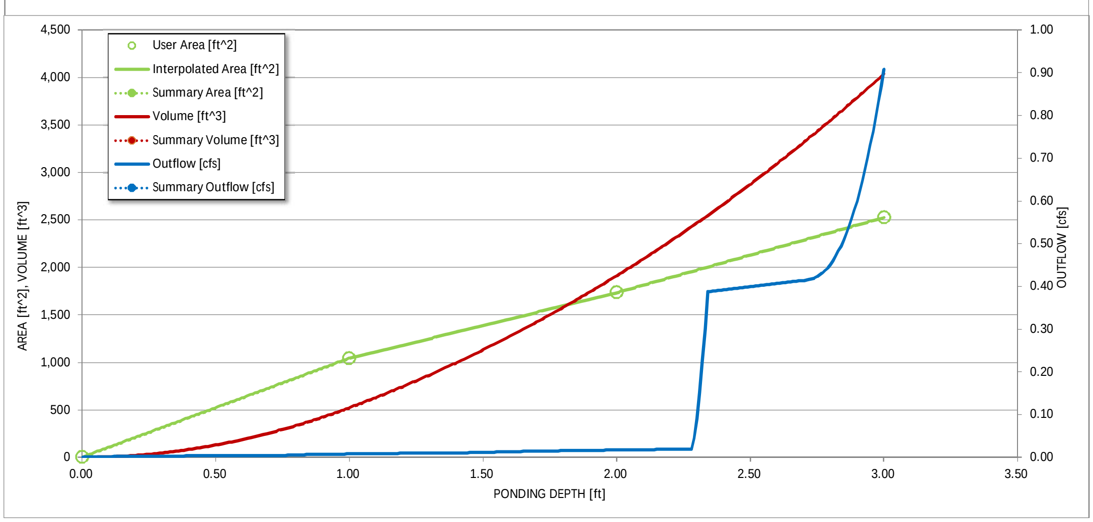
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.68
Calculated Runoff Volume (acre-ft) =	0.018	0.055	0.047	0.062	0.075	0.089	0.100	0.114	0.171
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.018	0.055	0.047	0.062	0.075	0.088	0.100	0.114	0.170
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.01	0.11	0.39	0.54	0.75	1.31
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.7
Peak Inflow Q (cfs) =	0.2	0.6	0.5	0.6	0.8	0.9	1.0	1.2	1.8
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.5	4.9	1.8	1.3	1.0	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1	0.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	66	61	68	67	65	65	63	58
Time to Drain 99% of Inflow Volume (hours) =	40	70	65	73	73	72	72	71	69
Maximum Ponding Depth (ft) =	1.15	2.17	1.98	2.29	2.33	2.38	2.46	2.62	3.00
Area at Maximum Ponding Depth (acres) =	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06
Maximum Volume Stored (acre-ft) =	0.015	0.051	0.043	0.056	0.057	0.060	0.064	0.071	0.093

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

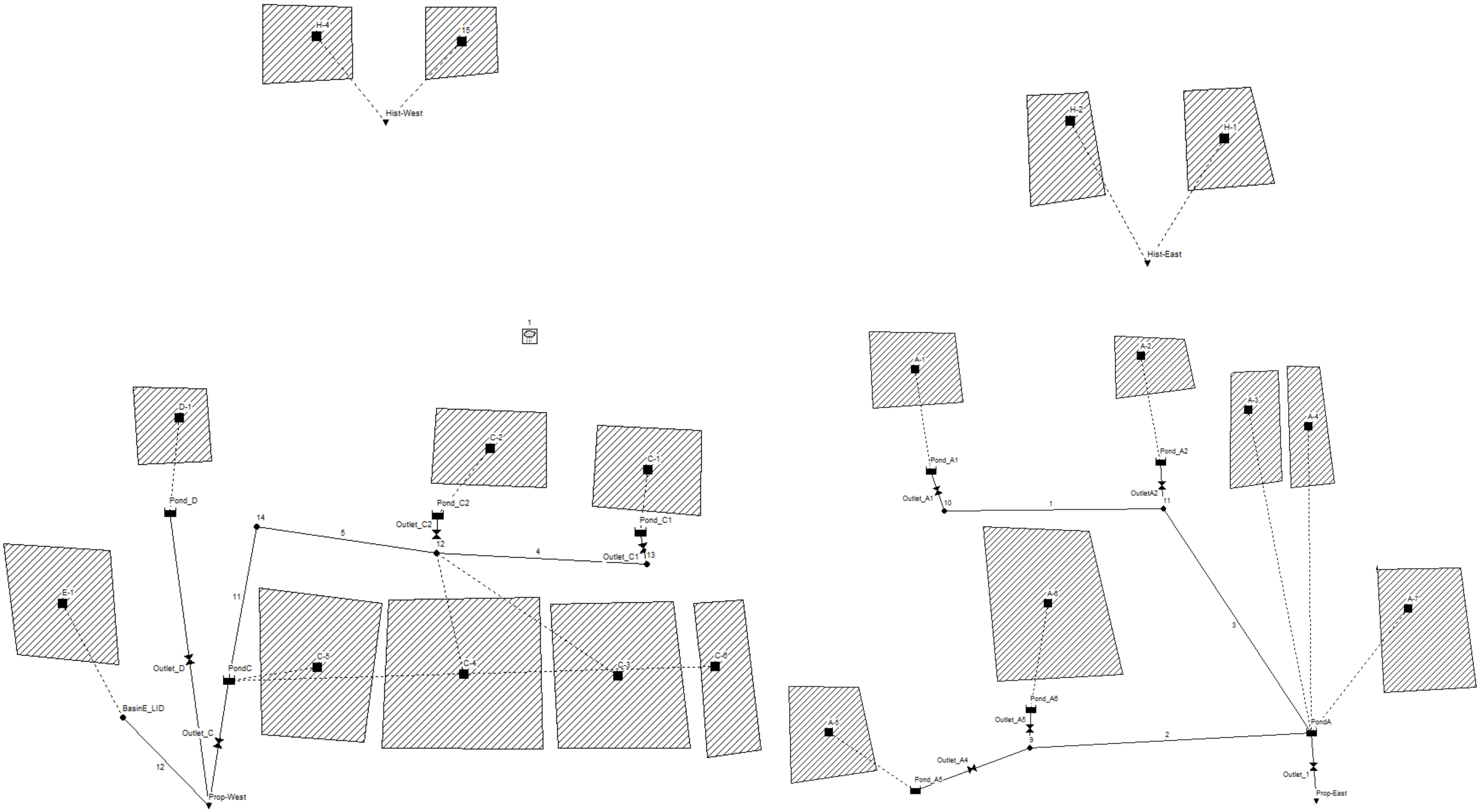






S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

SWMM Model – Sand Hill



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;;Project Title/Notes

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INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           02/19/2018
START_TIME           00:00:00
REPORT_START_DATE    02/19/2018
REPORT_START_TIME    00:00:00
END_DATE             02/22/2018
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:05:00
WET_STEP             00:05:00
DRY_STEP             72:00:00
ROUTING_STEP         0:00:30
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[RAINGAGES]
;;Name           Format    Interval SCF      Source
;;-------------- --------- ------ ------ ----------
1                CUMULATIVE 0:05     1.0      TIMESERIES CS_100-yr

[SUBCATCHMENTS]
;;Name           Rain Gage        Outlet           Area     %Imperv  Width    %Slope
CurbLen  SnowPack
```

```
;;-------------- ---------------- ---------------- -------- -------- -------- --------
-------- ----------------
A-2              1                Pond_A2          0.57     90       150      1        0
A-1              1                Pond_A1          0.54     90       165      1        0
A-6              1                Pond_A6          0.76     72.1     160      1        0
A-4              1                PondA            0.19     100      190      1        0
A-5              1                Pond_A5          0.45     90       165      1        0
C-1              1                Pond_C1          0.89     80       40       1        0
C-2              1                Pond_C2          0.72     90       75       1        0
E-1              1                BasinE_LID       1.01     17.2     50       1        0
C-3              1                12               1.04     90       20       1        0
D-1              1                Pond_D           0.55     90       20       0.5      0
A-3              1                PondA            0.32     93.9     250      1        0
A-7              1                PondA            .88      90       200      1        0
C-4              1                12               .56      90       20       1        0
C-5              1                PondC            0.69     90       20       1        0
H-2              1                Hist-East        2.01     2        367      1.5      0
H-1              1                Hist-East        2.3      2        345      2.5      0
H-4              1                Hist-West        3.98     2        416      2.5      0
15               1                Hist-West        2.71     2        343      3        0
C-6              1                PondC            0.06     100      100      0.5      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
A-2              0.011      0.24       0.1        0.35       25         OUTLET
A-1              0.011      0.24       0.1        0.35       25         OUTLET
A-6              0.011      0.24       0.1        0.35       25         OUTLET
A-4              0.011      0.24       0.1        0.35       25         OUTLET
A-5              0.011      0.24       0.1        0.34       25         OUTLET
C-1              0.011      0.24       0.1        0.35       25         OUTLET
C-2              0.011      0.24       0.1        0.35       25         OUTLET
E-1              0.011      0.24       0.1        0.35       25         PERVIOUS   100
```

```
C-3              0.011      0.24       0.1        0.35       25         OUTLET
D-1              0.011      0.24       0.1        0.35       25         OUTLET
A-3              0.011      0.24       0.1        0.35       25         OUTLET
A-7              0.011      0.24       0.1        0.35       25         OUTLET
C-4              0.011      0.24       0.1        0.35       25         OUTLET
C-5              0.011      0.24       0.1        0.35       25         OUTLET
H-2              0.011      0.13       0.1        0.35       25         OUTLET
H-1              0.011      0.13       0.1        0.35       25         OUTLET
H-4              0.011      0.13       0.1        0.35       25         OUTLET
15               0.011      0.13       0.1        0.35       25         OUTLET
C-6              0.011      0.24       0.1        0.35       25         OUTLET

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
A-2              4.5        0.6        6.48       7          0
A-1              4.5        0.6        6.48       7          0
A-6              4.5        0.6        6.48       7          0
A-4              5          1          2.52       7          0
A-5              4.5        0.6        6.48       7          0
C-1              4.5        0.6        4.68       7          0
C-2              4.5        0.6        4.68       7          0
E-1              4.5        .6         6.48       7          0
C-3              4.5        0.6        4.68       7          0
D-1              4.5        0.6        4.68       7          0
A-3              5          1          2.52       7          0
A-7              5          1          2.52       7          0
C-4              4.5        0.6        6.48       7          0
C-5              4.5        .6         6.48       7          0
H-2              4.8175     0.854      3.9654     7          0
H-1              5          1          2.52       7          0
H-4              4.5        .6         6.48       7          0
15               4.5        .6         6.48       7          0
C-6              4.5        .6         4.65       7          0

[LID_CONTROLS]
;;Name           Type/Layer Parameters
;;-------------- ---------- ----------
ParkingIsland    BC
ParkingIsland    SURFACE    24         0.1        0.1        0          5
ParkingIsland    SOIL       18         0.5        0.2        0.1        0.5        30
   3.5
ParkingIsland    STORAGE    1          0.75       0.5        0
ParkingIsland    DRAIN      0          0.5        6          6          0          0


BasinEGrassSwale VS
BasinEGrassSwale SURFACE    6          0.0        0.25       2.35       50

[LID_USAGE]
;;Subcatchment   LID Process      Number  Area       Width      InitSat    FromImp
ToPerv     RptFile                  DrainTo          FromPerv
;;-------------- ---------------- ------- ---------- ---------- ---------- ----------
---------- ------------------------ ---------------- ----------
C-3              ParkingIsland    1       580        0          0          80         0
```

```
      *                        *                80
C-4              ParkingIsland    1       580        0          0          80         0
      *                        *                80

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
9                5          0          0          0          0
10               5          0          0          0          0
11               5          0          0          0          0
12               2          0          0          0          0
13               3          0          0          0          0
14               1          0          0          0          0
BasinE_LID       0          0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
Prop-East        0          FREE                        NO
Prop-West        0          FREE                        NO
Hist-East        0          FREE                        NO
Hist-West        0          FREE                        NO

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params
N/A      Fevap    Psi      Ksat     IMD
;;-------------- -------- ---------- ----------- ---------- ----------------------------
-------- --------          -------- --------
PondA            0        5.75       0          TABULAR    Pond1_Volume                 0
      0
Pond_A1          6        0.75       0          TABULAR    PondA1_Volume                0
      0
Pond_A2          6        0.75       0          TABULAR    PondA2_Volume                0
      0
Pond_A6          6        .75        0          TABULAR    PondA5_Volume                0
      0
Pond_A5          6        0.75       0          TABULAR    PondA4_Volume                0
      0
Pond_C2          2        .75        0          TABULAR    PondB2_vol                   0
      0
Pond_C1          3        .75        0          TABULAR    PondB1_vol                   0
      0
Pond_D           1        3          0          TABULAR    PondD_Vol                    0
      0
PondC            0        6          0          TABULAR    PondC_Vol                    0
      0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset
OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
1                10               11               400        0.01       0          0
    0          0
2                9                PondA            400        0.01       0          0
```

```
    0          0
3                11               PondA            400        0.01       0          0
    0          0
4                13               12               400        0.01       0          0
    0          0
5                12               14               400        0.01       0          0
    0          0
11               14               PondC            400        0.01       0          0
    0          0
12               BasinE_LID       Prop-West        400        0.01       0          0
    0          0

[ORIFICES]
;;Name           From Node        To Node          Type         Offset     Qcoeff
Gated    CloseTime
;;-------------- ---------------- ---------------- ------------ ---------- ----------
-------- ----------
Outlet_A1        Pond_A1          10               SIDE         0          0.65       NO
    0
OutletA2         Pond_A2          11               SIDE         0          0.65       NO
    0
Outlet_A5        Pond_A6          9                SIDE         0          0.65       NO
    0
Outlet_A4        Pond_A5          9                SIDE         0          0.65       NO
    0
Outlet_C2        Pond_C2          12               SIDE         0          0.65       NO
    0
Outlet_C1        Pond_C1          13               SIDE         0          0.65       NO
    0

[OUTLETS]
;;Name           From Node        To Node          Offset     Type
QTable/Qcoeff    Qexpon     Gated
;;-------------- ---------------- ---------------- ---------- ---------------
---------------- ---------- --------
Outlet_1         PondA            Prop-East        0          TABULAR/DEPTH   Pond1_Outlet
               NO
Outlet_D         Pond_D           Prop-West        0          TABULAR/DEPTH   Outlet_D
               NO
Outlet_C         PondC            Prop-West        0          TABULAR/DEPTH   OutletPondC
               NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
----------
1                DUMMY        0                0          0          0          1

2                DUMMY        0                0          0          0          1

3                DUMMY        0                0          0          0          1

4                DUMMY        0                0          0          0          1
```

```
5                DUMMY       0                0          0          0          1

11               DUMMY       0                0          0          0          1

12               DUMMY       0                0          0          0          1

Outlet_A1        RECT_CLOSED  0.75            .9         0          0
OutletA2         RECT_CLOSED  .75             1          0          0
Outlet_A5        RECT_CLOSED  0.75            2.25       0          0
Outlet_A4        RECT_CLOSED  0.75            .7         0          0
Outlet_C2        RECT_CLOSED  0.75            .85        0          0
Outlet_C1        RECT_CLOSED  0.75            .95        0          0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
Pond1_Outlet     Rating     0.00       0.00
Pond1_Outlet                0.25       0.02
Pond1_Outlet                0.50       0.03
Pond1_Outlet                0.75       0.03
Pond1_Outlet                1.00       0.04
Pond1_Outlet                1.25       0.04
Pond1_Outlet                1.50       0.04
Pond1_Outlet                1.75       0.06
Pond1_Outlet                2.00       0.07
Pond1_Outlet                2.25       0.08
Pond1_Outlet                2.50       0.09
Pond1_Outlet                2.75       0.10
Pond1_Outlet                3.00       0.11
Pond1_Outlet                3.25       0.11
Pond1_Outlet                3.50       0.13
Pond1_Outlet                3.75       0.15
Pond1_Outlet                4.00       0.16
Pond1_Outlet                4.10       0.17
Pond1_Outlet                4.25       0.18
Pond1_Outlet                4.50       0.18
Pond1_Outlet                4.75       0.19
Pond1_Outlet                5.00       1.69
Pond1_Outlet                5.25       3.48
Pond1_Outlet                5.50       3.56
Pond1_Outlet                5.75       3.63
;
OutletPondC      Rating     0.00       0.00
OutletPondC                 1.00       0.03
OutletPondC                 2.00       0.06
OutletPondC                 3.00       0.09
OutletPondC                 4.00       0.13
OutletPondC                 5.00       0.17
OutletPondC                 6.00       4.23
;
Outlet_D         Rating     0.00       0.00
Outlet_D                    0.25       0.00
Outlet_D                    0.50       0.00
Outlet_D                    0.75       0.00
Outlet_D                    1.00       0.01
```

```
Outlet_D                    1.25       0.01
Outlet_D                    1.50       0.01
Outlet_D                    1.75       0.02
Outlet_D                    2.00       0.02
Outlet_D                    2.25       0.02
Outlet_D                    2.50       0.33
Outlet_D                    2.75       0.34
Outlet_D                    3.00       0.36
;
Pond1_Volume     Storage    0.00       0
Pond1_Volume                0.75       1237
Pond1_Volume                1.75       5155
Pond1_Volume                2.75       5633
Pond1_Volume                3.75       5987
Pond1_Volume                4.75       6347
Pond1_Volume                5.75       6734
;
PondA1_Volume    Storage    0          0
PondA1_Volume               0.25       625
PondA1_Volume               0.5        2500
PondA1_Volume               0.75       5625
;
PondA2_Volume    Storage    0          0
PondA2_Volume               0.25       625
PondA2_Volume               0.5        2500
PondA2_Volume               0.75       5625
;
PondA5_Volume    Storage    0          0
PondA5_Volume               0.25       625
PondA5_Volume               0.5        2500
PondA5_Volume               0.75       5625
;
PondA4_Volume    Storage    0          0
PondA4_Volume               0.25       625
PondA4_Volume               0.5        2500
PondA4_Volume               0.75       5625
;
PondB2_vol       Storage    0          0
PondB2_vol                  0.25       1250
PondB2_vol                  0.50       5000
PondB2_vol                  0.75       11250
;
PondB1_vol       Storage    0          0
PondB1_vol                  0.25       1250
PondB1_vol                  0.50       5000
PondB1_vol                  0.75       11250
;
PondC_Vol        Storage    0.00       0
PondC_Vol                   1          2347
PondC_Vol                   2.00       2835
PondC_Vol                   3.00       3286
PondC_Vol                   4.00       3755
PondC_Vol                   5          4189
PondC_Vol                   6          4770
;
```

```
PondD_Vol        Storage    0.00       0
PondD_Vol                   1.00       1042
PondD_Vol                   2.00       1734
PondD_Vol                   3.00       2525
;
PondB3_vol       Storage    0          3750
PondB3_vol                  1          3750

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
CS_100-yr                   0          0
CS_100-yr                   0:05       0.03528
CS_100-yr                   0:10       0.11592
CS_100-yr                   0:15       0.19908
CS_100-yr                   0:20       0.3024
CS_100-yr                   0:25       0.45108
CS_100-yr                   0:30       0.65016
CS_100-yr                   0:35       1.06092
CS_100-yr                   0:40       1.79424
CS_100-yr                   0:45       2.07648
CS_100-yr                   0:50       2.24784
CS_100-yr                   0:55       2.3562
CS_100-yr                   1:00       2.44944
CS_100-yr                   1:05       2.53008
CS_100-yr                   1:10       2.56536
CS_100-yr                   1:15       2.5956
CS_100-yr                   1:20       2.62332
CS_100-yr                   1:25       2.65104
CS_100-yr                   1:30       2.67876
CS_100-yr                   1:35       2.70144
CS_100-yr                   1:40       2.72664
CS_100-yr                   1:45       2.74932
CS_100-yr                   1:50       2.772
CS_100-yr                   1:55       2.79468
CS_100-yr                   2:00       2.81988
;
CS_WQ                       0          0
CS_WQ                       0:05       0.0084
CS_WQ                       0:10       0.0276
CS_WQ                       0:15       0.0474
CS_WQ                       0:20       0.072
CS_WQ                       0:25       0.1074
CS_WQ                       0:30       0.1548
CS_WQ                       0:35       0.2526
CS_WQ                       0:40       0.4272
CS_WQ                       0:45       0.4944
CS_WQ                       0:50       0.5352
CS_WQ                       0:55       0.561
CS_WQ                       1:00       0.5832
CS_WQ                       1:05       0.6024
CS_WQ                       1:10       0.6108
CS_WQ                       1:15       0.618
CS_WQ                       1:20       0.6246
CS_WQ                       1:25       0.6312
```

```
CS_WQ                       1:30        0.6378
CS_WQ                       1:35        0.6432
CS_WQ                       1:40        0.6492
CS_WQ                       1:45        0.6546
CS_WQ                       1:50        0.66
CS_WQ                       1:55        0.6654
CS_WQ                       2:00        0.6714
;
CS_5-yr                     0           0
CS_5-yr                     0:05        0.021
CS_5-yr                     0:10        0.069
CS_5-yr                     0:15        0.1185
CS_5-yr                     0:20        0.18
CS_5-yr                     0:25        0.2685
CS_5-yr                     0:30        0.387
CS_5-yr                     0:35        0.6315
CS_5-yr                     0:40        1.068
CS_5-yr                     0:45        1.236
CS_5-yr                     0:50        1.338
CS_5-yr                     0:55        1.4025
CS_5-yr                     1:00        1.458
CS_5-yr                     1:05        1.506
CS_5-yr                     1:10        1.527
CS_5-yr                     1:15        1.545
CS_5-yr                     1:20        1.5615
CS_5-yr                     1:25        1.578
CS_5-yr                     1:30        1.5945
CS_5-yr                     1:35        1.608
CS_5-yr                     1:40        1.623
CS_5-yr                     1:45        1.6365
CS_5-yr                     1:50        1.65
CS_5-yr                     1:55        1.6635
CS_5-yr                     2:00        1.6785
;
CS_2-yr                     0           0
CS_2-yr                     0:05        0.01666
CS_2-yr                     0:10        0.05474
CS_2-yr                     0:15        0.09401
CS_2-yr                     0:20        0.1428
CS_2-yr                     0:25        0.21301
CS_2-yr                     0:30        0.30702
CS_2-yr                     0:35        0.50099
CS_2-yr                     0:40        0.84728
CS_2-yr                     0:45        0.98056
CS_2-yr                     0:50        1.06148
CS_2-yr                     0:55        1.11265
CS_2-yr                     1:00        1.15668
CS_2-yr                     1:05        1.19476
CS_2-yr                     1:10        1.21142
CS_2-yr                     1:15        1.2257
CS_2-yr                     1:20        1.23879
CS_2-yr                     1:25        1.25188
CS_2-yr                     1:30        1.26497
CS_2-yr                     1:35        1.27568
CS_2-yr                     1:40        1.28758
```

```
CS_2-yr                     1:45       1.29829
CS_2-yr                     1:50       1.309
CS_2-yr                     1:55       1.31971
CS_2-yr                     2:00       1.33161
;
CS_10-yr                    0          0
CS_10-yr                    0:05       0.0245
CS_10-yr                    0:10       0.0805
CS_10-yr                    0:15       0.13825
CS_10-yr                    0:20       0.21
CS_10-yr                    0:25       0.31325
CS_10-yr                    0:30       0.4515
CS_10-yr                    0:35       0.73675
CS_10-yr                    0:40       1.246
CS_10-yr                    0:45       1.442
CS_10-yr                    0:50       1.561
CS_10-yr                    0:55       1.63625
CS_10-yr                    1:00       1.701
CS_10-yr                    1:05       1.757
CS_10-yr                    1:10       1.7815
CS_10-yr                    1:15       1.8025
CS_10-yr                    1:20       1.82175
CS_10-yr                    1:25       1.841
CS_10-yr                    1:30       1.86025
CS_10-yr                    1:35       1.876
CS_10-yr                    1:40       1.8935
CS_10-yr                    1:45       1.90925
CS_10-yr                    1:50       1.925
CS_10-yr                    1:55       1.94075
CS_10-yr                    2:00       1.95825
;
CS_25-yr                    0          0
CS_25-yr                    0:05       0.028
CS_25-yr                    0:10       0.092
CS_25-yr                    0:15       0.158
CS_25-yr                    0:20       0.24
CS_25-yr                    0:25       0.358
CS_25-yr                    0:30       0.516
CS_25-yr                    0:35       0.842
CS_25-yr                    0:40       1.424
CS_25-yr                    0:45       1.648
CS_25-yr                    0:50       1.784
CS_25-yr                    0:55       1.87
CS_25-yr                    1:00       1.944
CS_25-yr                    1:05       2.008
CS_25-yr                    1:10       2.036
CS_25-yr                    1:15       2.06
CS_25-yr                    1:20       2.082
CS_25-yr                    1:25       2.104
CS_25-yr                    1:30       2.126
CS_25-yr                    1:35       2.144
CS_25-yr                    1:40       2.164
CS_25-yr                    1:45       2.182
CS_25-yr                    1:50       2.2
CS_25-yr                    1:55       2.218
```

```
CS_25-yr                    2:00       2.238
;
CS_50-yr                    0          0
CS_50-yr                    0:05       0.0315
CS_50-yr                    0:10       0.1035
CS_50-yr                    0:15       0.17775
CS_50-yr                    0:20       0.27
CS_50-yr                    0:25       0.40275
CS_50-yr                    0:30       0.5805
CS_50-yr                    0:35       0.94725
CS_50-yr                    0:40       1.602
CS_50-yr                    0:45       1.854
CS_50-yr                    0:50       2.007
CS_50-yr                    0:55       2.10375
CS_50-yr                    1:00       2.187
CS_50-yr                    1:05       2.259
CS_50-yr                    1:10       2.2905
CS_50-yr                    1:15       2.3175
CS_50-yr                    1:20       2.34225
CS_50-yr                    1:25       2.367
CS_50-yr                    1:30       2.39175
CS_50-yr                    1:35       2.412
CS_50-yr                    1:40       2.4345
CS_50-yr                    1:45       2.45475
CS_50-yr                    1:50       2.475
CS_50-yr                    1:55       2.49525
CS_50-yr                    2:00       2.51775
;
CS_500-yr                   0:05       0.05152
CS_500-yr                   0:10       0.16928
CS_500-yr                   0:15       0.29072
CS_500-yr                   0:20       0.4416
CS_500-yr                   0:25       0.65872
CS_500-yr                   0:30       0.94944
CS_500-yr                   0:35       1.54928
CS_500-yr                   0:40       2.62016
CS_500-yr                   0:45       3.03232
CS_500-yr                   0:50       3.28256
CS_500-yr                   0:55       3.4408
CS_500-yr                   1:00       3.57696
CS_500-yr                   1:05       3.69472
CS_500-yr                   1:10       3.74624
CS_500-yr                   1:15       3.7904
CS_500-yr                   1:20       3.83088
CS_500-yr                   1:25       3.87136
CS_500-yr                   1:30       3.91184
CS_500-yr                   1:35       3.94496
CS_500-yr                   1:40       3.98176
CS_500-yr                   1:45       4.01488
CS_500-yr                   1:50       4.048
CS_500-yr                   1:55       4.08112
CS_500-yr                   2:00       4.11792

[REPORT]
;;Reporting Options
```

```
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
9                4148.695           2122.588
10               2809.308           5856.981
11               6248.581           5891.033
12               -3788.694          6016.151
13               -868.102           5868.102
14               -6278.600          6393.001
BasinE_LID       -8130.227          3739.546
Prop-East        8654.938           1282.633
Prop-West        -6938.089          2516.824
Hist-East        4705.882           10115.090
Hist-West        -5511.509          12007.673
PondA            8575.482           2360.953
Pond_A1          2593.644           6481.271
Pond_A2          6203.178           6628.831
Pond_A6          4160.045           2724.177
Pond_A5          2344.398           1452.282
Pond_C2          -3775.236          6541.050
Pond_C1          -962.315           6298.789
Pond_D           -7485.066          6571.087
PondC            -6668.910          4253.028

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
A-2              5525.588           8603.043
A-2              5525.588           8603.043
A-2              6576.763           8561.549
A-2              6742.739           7786.999
A-2              5511.757           7621.024
A-2              5484.094           8603.043
A-1              2968.218           8649.262
A-1              3104.427           7570.942
A-1              1685.585           7468.785
A-1              1628.831           8683.314
A-6              5079.455           5539.160
A-6              5612.940           3280.363
A-6              3637.911           3178.207
A-6              3422.247           5607.264
```

A-4	8711.691	8127.128
A-4	8938.706	6288.309
A-4	8257.662	6220.204
A-4	8200.908	8138.479
A-5	1462.656	3080.913
A-5	1739.281	1766.943
A-5	397.649	1573.306
A-5	356.155	3094.744
C-1	-114.401	7725.437
C-1	-127.860	6541.050
C-1	-1621.803	6675.639
C-1	-1554.509	7792.732
C-2	-2263.367	7970.343
C-2	-2263.367	6934.004
C-2	-3851.523	6987.840
C-2	-3784.228	8024.179
E-1	-8303.694	6062.067
E-1	-8182.563	4473.911
E-1	-9595.753	4621.960
E-1	-9784.178	6156.280
C-3	-507.199	5345.091
C-3	-264.938	3312.790
C-3	-2098.539	3315.716
C-3	-2206.066	5310.937
D-1	-6976.105	8303.465
D-1	-6976.105	8303.465
D-1	-6904.421	7299.880
D-1	-7919.952	7252.091
D-1	-7991.637	8327.360
A-3	7365.591	8040.621
A-3	7365.591	8040.621
A-3	8058.542	8064.516
A-3	8118.280	6332.139
A-3	7305.854	6212.664
A-3	7317.802	8004.779
A-7	9599.761	4934.289
A-7	9599.761	4934.289
A-7	10925.926	4958.184
A-7	11176.822	3082.437
A-7	9719.235	2998.805
A-7	9611.708	4994.026
C-4	-2353.644	5406.213
C-4	-2305.854	3303.465
C-4	-4540.024	3315.412
C-4	-4444.444	5370.370
C-5	-6206.691	3500.597
C-5	-4784.946	3405.018
C-5	-4534.050	5328.554
C-5	-6242.533	5531.661
H-2	3759.591	12391.304
H-2	3759.591	12391.304
H-2	3759.591	12391.304
H-2	3759.591	12391.304
H-2	3900.256	12416.880
H-2	4143.223	11035.806

```
H-2              3132.992           10882.353
H-2              3081.841           12378.517
H-1              6086.957           12480.818
H-1              6406.650           11189.258
H-1              5242.967           11099.744
H-1              5191.816           12429.668
H-4              -5971.867          13554.987
H-4              -5971.867          13554.987
H-4              -5959.079          12595.908
H-4              -7161.125          12531.969
H-4              -7161.125          13593.350
15               -4028.133          13554.987
15               -4002.558          12685.422
15               -4974.425          12583.120
15               -4974.425          13554.987
C-6              -141.884           4676.504
C-6              -141.884           4676.504
C-6              -221.339           5323.496
C-6              471.056            5368.899
C-6              709.421            3291.714
C-6              -28.377            3189.557
C-6              -130.533           4642.452

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
1                -2468.785          9012.486
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         1.132         0.671
```

		WQ Event
Evaporation Loss	0.000	0.000
Infiltration Loss	0.757	0.449
Surface Runoff	0.319	0.189
Final Storage	0.063	0.037
Continuity Error (%)	-0.301	

**************************	Volume	Volume
Flow Routing Continuity	acre-feet	10^6 gal
**************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.319	0.104
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.312	0.102
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.007	0.002
Continuity Error (%)	0.143	

****
Highest Flow Instability Indexes
****

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	30.00 sec
Average Time Step	:	30.00 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	1.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	1.00	0.809
A-1	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	0.97	0.809
A-6	0.67	0.00	0.00	0.19	0.44	0.00	0.44	0.01	1.07	0.648
A-4	0.67	0.00	0.00	0.00	0.60	0.00	0.60	0.00	0.40	0.897
A-5	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	0.82	0.809
C-1	0.67	0.00	0.00	0.13	0.48	0.00	0.48	0.01	0.83	0.716
C-2	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	1.04	0.807
E-1	0.67	0.00	0.00	0.66	0.10	0.00	0.00	0.00	0.00	0.000
C-3	0.67	0.00	0.00	0.38	0.53	0.00	0.16	0.00	0.12	0.235
D-1	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	0.39	0.803
A-3	0.67	0.00	0.00	0.04	0.57	0.00	0.57	0.00	0.63	0.842
A-7	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	1.52	0.809
C-4	0.67	0.00	0.00	0.38	0.53	0.00	0.11	0.00	0.10	0.157

WQ Event

C-5	0.67	0.00	0.00	0.07	0.54	0.00	0.54	0.01	0.52
0.803									
H-2	0.67	0.00	0.00	0.66	0.01	0.00	0.01	0.00	0.08
0.018									
H-1	0.67	0.00	0.00	0.66	0.01	0.00	0.01	0.00	0.10
0.018									
H-4	0.67	0.00	0.00	0.66	0.01	0.00	0.01	0.00	0.17
0.018									
15	0.67	0.00	0.00	0.66	0.01	0.00	0.01	0.00	0.11
0.018									
C-6	0.67	0.00	0.00	0.00	0.60	0.00	0.60	0.00	0.13
0.896									

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	33.89	0.00	24.46	4.03	0.00	1.80	7.21	-0.02
C-4	ParkingIsland	18.40	0.00	13.39	0.00	0.00	1.80	6.82	-0.01

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	0.79	2.29	2.29	0	02:16	2.29
Pond_A1	STORAGE	0.00	0.35	6.35	0	00:49	0.34
Pond_A2	STORAGE	0.00	0.34	6.34	0	00:49	0.34
Pond_A6	STORAGE	0.00	0.24	6.24	0	00:47	0.22
Pond_A5	STORAGE	0.00	0.35	6.35	0	00:49	0.35
Pond_C2	STORAGE	0.00	0.33	2.33	0	00:53	0.33
Pond_C1	STORAGE	0.00	0.30	3.30	0	00:55	0.30
Pond_D	STORAGE	0.86	1.36	2.36	0	03:16	1.36
PondC	STORAGE	0.68	2.28	2.28	0	02:46	2.28

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	1.48	0	00:47	0	0.0156	0.000
10	JUNCTION	0.00	0.67	0	00:49	0	0.00795	0.000
11	JUNCTION	0.00	1.40	0	00:49	0	0.0163	0.000
12	JUNCTION	0.21	1.38	0	00:53	0.00606	0.0282	0.000
13	JUNCTION	0.00	0.58	0	00:55	0	0.0116	0.000
14	JUNCTION	0.00	1.38	0	00:53	0	0.0282	0.000
BasinE_LID	JUNCTION	0.00	0.00	0	00:00	0	0	0.000 gal
Prop-East	OUTFALL	0.00	0.08	0	02:16	0	0.0529	0.000
Prop-West	OUTFALL	0.00	0.08	0	02:46	0	0.0451	0.000
Hist-East	OUTFALL	0.18	0.18	0	00:45	0.00143	0.00143	0.000
Hist-West	OUTFALL	0.28	0.28	0	00:45	0.00221	0.00221	0.000
PondA	STORAGE	2.55	5.17	0	00:45	0.021	0.0529	0.011
Pond_A1	STORAGE	0.97	0.97	0	00:45	0.00796	0.00796	0.224
Pond_A2	STORAGE	1.00	1.00	0	00:45	0.00841	0.00841	0.202
Pond_A6	STORAGE	1.07	1.07	0	00:45	0.00898	0.00898	0.227

WQ Event

Pond_A5	STORAGE	0.82	0.82	0 00:45	0.00664	0.00664	0.281
Pond_C2	STORAGE	1.04	1.04	0 00:45	0.0106	0.0106	0.314
Pond_C1	STORAGE	0.83	0.83	0 00:45	0.0116	0.0116	0.262
Pond_D	STORAGE	0.39	0.39	0 00:50	0.00805	0.00805	0.009
PondC	STORAGE	0.64	1.91	0 00:51	0.0111	0.0393	0.012

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	1.520	6	0	0	6.514	24	0 02:16	0.08
Pond_A1	0.001	0	0	0	0.173	12	0 00:48	0.67
Pond_A2	0.001	0	0	0	0.164	11	0 00:48	0.73
Pond_A6	0.000	0	0	0	0.073	5	0 00:46	0.97
Pond_A5	0.001	0	0	0	0.174	12	0 00:49	0.53
Pond_C2	0.002	0	0	0	0.308	10	0 00:53	0.60
Pond_C1	0.002	0	0	0	0.244	8	0 00:54	0.58
Pond_D	0.408	10	0	0	0.936	23	0 03:16	0.01
PondC	1.014	5	0	0	4.580	24	0 02:45	0.07

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

Outfall Node	Pcnt	CFS	CFS	WQ Event 10^6 gal
Prop-East	55.82	0.05	0.08	0.053
Prop-West	61.97	0.04	0.08	0.045
Hist-East	2.82	0.03	0.18	0.001
Hist-West	2.86	0.04	0.28	0.002
System	30.87	0.15	0.28	0.102

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	0.67	0 00:49			
2	DUMMY	1.48	0 00:47			
3	DUMMY	1.40	0 00:49			
4	DUMMY	0.58	0 00:55			
5	DUMMY	1.38	0 00:53			
11	DUMMY	1.38	0 00:53			
12	DUMMY	0.00	0 00:00			
Outlet_A1	ORIFICE	0.67	0 00:49			0.00
OutletA2	ORIFICE	0.73	0 00:49			0.00
Outlet_A5	ORIFICE	0.97	0 00:47			0.00
Outlet_A4	ORIFICE	0.53	0 00:49			0.00
Outlet_C2	ORIFICE	0.60	0 00:53			0.00
Outlet_C1	ORIFICE	0.58	0 00:55			0.00
Outlet_1	DUMMY	0.08	0 02:16			
Outlet_D	DUMMY	0.01	0 01:06			
Outlet_C	DUMMY	0.07	0 02:46			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Feb 26 14:29:51 2019
Analysis ended on: Tue Feb 26 14:29:51 2019
Total elapsed time: < 1 sec

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         2.245         1.332
```

```
Evaporation Loss .........        0.000          0.000
Infiltration Loss ........        1.472          0.873
Surface Runoff ...........        0.719          0.427
Final Storage ............        0.063          0.038
Continuity Error (%) .....       -0.266


**************************        Volume         Volume
Flow Routing Continuity         acre-feet       10^6 gal
**************************      ---------      ---------
Dry Weather Inflow .......        0.000          0.000
Wet Weather Inflow .......        0.719          0.234
Groundwater Inflow .......        0.000          0.000
RDII Inflow ..............        0.000          0.000
External Inflow ..........        0.000          0.000
External Outflow .........        0.712          0.232
Flooding Loss ............        0.000          0.000
Evaporation Loss .........        0.000          0.000
Exfiltration Loss ........        0.000          0.000
Initial Stored Volume ....        0.000          0.000
Final Stored Volume ......        0.007          0.002
Continuity Error (%) .....        0.084


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00
```

****

Subcatchment Runoff Summary

****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.02	2.08	0.857
A-1	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.02	1.99	0.857
A-6	1.33	0.00	0.00	0.37	0.91	0.00	0.91	0.02	2.22	0.687
A-4	1.33	0.00	0.00	0.00	1.27	0.00	1.27	0.01	0.80	0.950
A-5	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.01	1.67	0.857
C-1	1.33	0.00	0.00	0.27	1.01	0.00	1.01	0.02	2.14	0.760
C-2	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.02	2.36	0.857
E-1	1.33	0.00	0.00	1.32	0.22	0.00	0.00	0.00	0.01	0.002
C-3	1.33	0.00	0.00	0.45	1.12	0.00	0.75	0.02	1.36	0.561
D-1	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.02	1.10	0.854
A-3	1.33	0.00	0.00	0.08	1.19	0.00	1.19	0.01	1.26	0.893
A-7	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.03	3.18	0.857
C-4	1.33	0.00	0.00	0.67	1.11	0.00	0.48	0.01	0.41	0.357

C-5	1.33	0.00	0.00	0.13	1.14	0.00	1.14	0.02	1.47	0.854
H-2	1.33	0.00	0.00	1.30	0.03	0.00	0.03	0.00	0.17	0.019
H-1	1.33	0.00	0.00	1.30	0.03	0.00	0.03	0.00	0.19	0.019
H-4	1.33	0.00	0.00	1.30	0.03	0.00	0.03	0.00	0.33	0.019
15	1.33	0.00	0.00	1.30	0.03	0.00	0.03	0.00	0.23	0.019
C-6	1.33	0.00	0.00	0.00	1.27	0.00	1.27	0.00	0.25	0.950

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	71.39	0.00	25.15	40.81	0.00	1.80	7.24	-0.00
C-4	ParkingIsland	38.71	0.00	22.76	10.64	0.00	1.80	7.12	-0.01

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	1.63	3.61	3.61	0	02:16	3.61
Pond_A1	STORAGE	0.01	0.50	6.50	0	00:49	0.50
Pond_A2	STORAGE	0.01	0.50	6.50	0	00:49	0.50
Pond_A6	STORAGE	0.00	0.37	6.37	0	00:47	0.34
Pond_A5	STORAGE	0.01	0.50	6.50	0	00:50	0.50
Pond_C2	STORAGE	0.01	0.49	2.49	0	00:54	0.49
Pond_C1	STORAGE	0.01	0.47	3.47	0	00:55	0.47
Pond_D	STORAGE	1.15	2.07	3.07	0	02:55	2.07
PondC	STORAGE	1.64	4.41	4.41	0	02:36	4.41

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	2.72	0 00:47	0	0.0328	0.000
10	JUNCTION	0.00	1.18	0 00:49	0	0.0167	0.000
11	JUNCTION	0.00	2.47	0 00:49	0	0.0344	0.000
12	JUNCTION	1.51	3.70	0 00:55	0.0283	0.075	0.000
13	JUNCTION	0.00	1.13	0 00:55	0	0.0244	0.000
14	JUNCTION	0.00	3.70	0 00:55	0	0.075	0.000
BasinE_LID	JUNCTION	0.01	0.01	0 01:00	5.8e-05	5.8e-05	0.000
Prop-East	OUTFALL	0.00	0.14	0 02:16	0	0.111	0.000
Prop-West	OUTFALL	0.00	0.17	0 02:36	0	0.113	0.000
Hist-East	OUTFALL	0.36	0.36	0 00:45	0.00295	0.00295	0.000
Hist-West	OUTFALL	0.56	0.56	0 00:45	0.00458	0.00458	0.000
PondA	STORAGE	5.23	9.90	0 00:45	0.0441	0.111	0.010
Pond_A1	STORAGE	1.99	1.99	0 00:45	0.0167	0.0167	0.098
Pond_A2	STORAGE	2.08	2.08	0 00:45	0.0177	0.0177	0.084
Pond_A6	STORAGE	2.22	2.22	0 00:45	0.0189	0.0189	0.023

2-year

Pond_A5	STORAGE	1.67	1.67	0	00:45	0.0139	0.0139	0.163
Pond_C2	STORAGE	2.36	2.36	0	00:45	0.0223	0.0223	0.250
Pond_C1	STORAGE	2.14	2.14	0	00:45	0.0245	0.0245	0.235
Pond_D	STORAGE	1.10	1.10	0	00:45	0.017	0.017	0.010
PondC	STORAGE	1.72	4.75	0	00:55	0.0234	0.0983	0.013

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	4.444	16	0	0	14.014	51	0 02:15	0.14
Pond_A1	0.002	0	0	0	0.477	32	0 00:49	1.18
Pond_A2	0.002	0	0	0	0.463	31	0 00:49	1.29
Pond_A6	0.001	0	0	0	0.207	14	0 00:47	1.85
Pond_A5	0.002	0	0	0	0.463	31	0 00:49	0.90
Pond_C2	0.007	0	0	0	0.882	30	0 00:53	1.07
Pond_C1	0.006	0	0	0	0.794	27	0 00:55	1.13
Pond_D	0.756	19	0	0	2.038	50	0 02:55	0.02
PondC	3.386	18	0	0	11.939	64	0 02:35	0.15

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

Outfall Node	Pcnt	CFS	CFS	2-year 10^6 gal
Prop-East	83.37	0.07	0.14	0.111
Prop-West	89.24	0.07	0.17	0.113
Hist-East	2.86	0.05	0.36	0.003
Hist-West	2.87	0.08	0.56	0.005
System	44.58	0.27	0.56	0.232

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	1.18	0 00:49			
2	DUMMY	2.72	0 00:47			
3	DUMMY	2.47	0 00:49			
4	DUMMY	1.13	0 00:55			
5	DUMMY	3.70	0 00:55			
11	DUMMY	3.70	0 00:55			
12	DUMMY	0.01	0 01:00			
Outlet_A1	ORIFICE	1.18	0 00:49			0.00
OutletA2	ORIFICE	1.29	0 00:49			0.00
Outlet_A5	ORIFICE	1.85	0 00:47			0.00
Outlet_A4	ORIFICE	0.90	0 00:50			0.00
Outlet_C2	ORIFICE	1.07	0 00:54			0.00
Outlet_C1	ORIFICE	1.13	0 00:55			0.00
Outlet_1	DUMMY	0.14	0 02:16			
Outlet_D	DUMMY	0.02	0 01:12			
Outlet_C	DUMMY	0.15	0 02:36			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Feb 26 14:30:05 2019
Analysis ended on: Tue Feb 26 14:30:05 2019
Total elapsed time: < 1 sec

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         2.830         1.679
```

```
Evaporation Loss .........        0.000         0.000
Infiltration Loss ........        1.809         1.073
Surface Runoff ...........        0.970         0.575
Final Storage ............        0.063         0.038
Continuity Error (%) .....       -0.305


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......        0.000         0.000
Wet Weather Inflow .......        0.970         0.316
Groundwater Inflow .......        0.000         0.000
RDII Inflow ..............        0.000         0.000
External Inflow ..........        0.000         0.000
External Outflow .........        0.962         0.314
Flooding Loss ............        0.000         0.000
Evaporation Loss .........        0.000         0.000
Exfiltration Loss ........        0.000         0.000
Initial Stored Volume ....        0.000         0.000
Final Stored Volume ......        0.007         0.002
Continuity Error (%) .....        0.074


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	1.68	0.00	0.00	0.16	1.46	0.01	1.47	0.02	2.65	0.874
A-1	1.68	0.00	0.00	0.16	1.45	0.01	1.47	0.02	2.53	0.874
A-6	1.68	0.00	0.00	0.45	1.17	0.02	1.19	0.02	2.83	0.707
A-4	1.68	0.00	0.00	0.00	1.61	0.00	1.61	0.01	1.00	0.961
A-5	1.68	0.00	0.00	0.15	1.45	0.01	1.47	0.02	2.13	0.875
C-1	1.68	0.00	0.00	0.34	1.29	0.00	1.29	0.03	2.85	0.770
C-2	1.68	0.00	0.00	0.17	1.46	0.00	1.46	0.03	3.05	0.867
E-1	1.68	0.00	0.00	1.60	0.28	0.07	0.07	0.00	0.10	0.039
C-3	1.68	0.00	0.00	0.49	1.43	0.00	1.06	0.03	2.17	0.631
D-1	1.68	0.00	0.00	0.17	1.45	0.00	1.45	0.02	1.52	0.864
A-3	1.68	0.00	0.00	0.10	1.52	0.00	1.52	0.01	1.58	0.903
A-7	1.68	0.00	0.00	0.17	1.46	0.00	1.46	0.03	4.05	0.867
C-4	1.68	0.00	0.00	0.70	1.42	0.00	0.79	0.01	0.94	0.471

C-5	1.68	0.00	0.00	0.16	1.45	0.00	1.46	0.03	2.01
0.867									
H-2	1.68	0.00	0.00	1.64	0.03	0.00	0.03	0.00	0.21
0.019									
H-1	1.68	0.00	0.00	1.64	0.03	0.00	0.03	0.00	0.24
0.019									
H-4	1.68	0.00	0.00	1.60	0.03	0.04	0.07	0.01	0.54
0.045									
15	1.68	0.00	0.00	1.60	0.03	0.05	0.08	0.01	0.45
0.050									
C-6	1.68	0.00	0.00	0.00	1.61	0.00	1.61	0.00	0.32
0.962									

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	91.11	0.00	25.30	60.37	0.00	1.80	7.25	-0.00
C-4	ParkingIsland	49.55	0.00	22.94	21.28	0.00	1.80	7.12	-0.01

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	2.02	4.27	4.27	0	02:15	4.27
Pond_A1	STORAGE	0.01	0.57	6.57	0	00:50	0.57
Pond_A2	STORAGE	0.01	0.56	6.56	0	00:49	0.56
Pond_A6	STORAGE	0.00	0.42	6.42	0	00:47	0.40
Pond_A5	STORAGE	0.01	0.56	6.56	0	00:50	0.56
Pond_C2	STORAGE	0.01	0.55	2.55	0	00:54	0.55
Pond_C1	STORAGE	0.01	0.54	3.54	0	00:55	0.54
Pond_D	STORAGE	1.25	2.31	3.31	0	02:09	2.31
PondC	STORAGE	1.95	5.14	5.14	0	01:56	5.14

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	3.34	0	00:48	0	0.0424	0.000
10	JUNCTION	0.00	1.42	0	00:50	0	0.0215	0.000
11	JUNCTION	0.00	2.97	0	00:50	0	0.0442	0.000
12	JUNCTION	2.73	5.38	0	00:55	0.0419	0.101	0.000
13	JUNCTION	0.00	1.37	0	00:55	0	0.0312	0.000
14	JUNCTION	0.00	5.38	0	00:55	0	0.101	0.000
BasinE_LID	JUNCTION	0.10	0.10	0	01:05	0.00181	0.00181	0.000
Prop-East	OUTFALL	0.00	0.18	0	02:05	0	0.143	0.000
Prop-West	OUTFALL	0.00	0.83	0	01:57	0	0.153	0.000
Hist-East	OUTFALL	0.46	0.46	0	00:45	0.00381	0.00381	0.000
Hist-West	OUTFALL	0.98	0.98	0	00:55	0.0143	0.0143	0.000
PondA	STORAGE	6.64	12.27	0	00:45	0.0563	0.143	0.011
Pond_A1	STORAGE	2.53	2.53	0	00:45	0.0215	0.0215	0.049
Pond_A2	STORAGE	2.65	2.65	0	00:45	0.0227	0.0227	0.032
Pond_A6	STORAGE	2.83	2.83	0	00:45	0.0245	0.0245	-0.003

Pond_A5	STORAGE	2.13	2.13	0	00:45	0.0179	0.0179	0.129
Pond_C2	STORAGE	3.05	3.05	0	00:45	0.0285	0.0285	0.246
Pond_C1	STORAGE	2.85	2.85	0	00:45	0.0312	0.0312	0.228
Pond_D	STORAGE	1.52	1.52	0	00:45	0.0217	0.0217	0.009
PondC	STORAGE	2.33	6.93	0	00:50	0.0299	0.131	0.027

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	6.075	22	0	0	18.019	65	0 02:15	0.18
Pond_A1	0.003	0	0	0	0.667	45	0 00:49	1.42
Pond_A2	0.003	0	0	0	0.651	44	0 00:49	1.55
Pond_A6	0.001	0	0	0	0.303	20	0 00:47	2.29
Pond_A5	0.004	0	0	0	0.641	43	0 00:50	1.08
Pond_C2	0.010	0	0	0	1.221	41	0 00:53	1.28
Pond_C1	0.009	0	0	0	1.134	38	0 00:55	1.37
Pond_D	0.904	22	0	0	2.482	61	0 02:09	0.09
PondC	4.266	23	0	0	14.911	79	0 01:55	0.74

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

Outfall Node	Pcnt	CFS	CFS	5-year 10^6 gal
Prop-East	93.03	0.08	0.18	0.143
Prop-West	95.16	0.08	0.83	0.153
Hist-East	2.87	0.07	0.46	0.004
Hist-West	2.87	0.26	0.98	0.014
System	48.48	0.49	0.98	0.314

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	1.42	0 00:50			
2	DUMMY	3.34	0 00:48			
3	DUMMY	2.97	0 00:50			
4	DUMMY	1.37	0 00:55			
5	DUMMY	5.38	0 00:55			
11	DUMMY	5.38	0 00:55			
12	DUMMY	0.10	0 01:05			
Outlet_A1	ORIFICE	1.42	0 00:50			0.00
OutletA2	ORIFICE	1.55	0 00:49			0.00
Outlet_A5	ORIFICE	2.29	0 00:47			0.00
Outlet_A4	ORIFICE	1.08	0 00:50			0.00
Outlet_C2	ORIFICE	1.28	0 00:54			0.00
Outlet_C1	ORIFICE	1.37	0 00:55			0.00
Outlet_1	DUMMY	0.18	0 02:05			
Outlet_D	DUMMY	0.09	0 02:09			
Outlet_C	DUMMY	0.74	0 01:56			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Feb 26 14:30:15 2019
Analysis ended on: Tue Feb 26 14:30:15 2019
Total elapsed time: < 1 sec

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         3.301         1.958
```

```
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         2.006         1.190
Surface Runoff ...........         1.250         0.741
Final Storage ............         0.063         0.038
Continuity Error (%) .....        -0.415


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         1.250         0.407
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         1.242         0.405
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.007         0.002
Continuity Error (%) .....         0.093


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	1.96	0.00	0.00	0.16	1.71	0.04	1.75	0.03	3.18	0.892
A-1	1.96	0.00	0.00	0.16	1.71	0.04	1.75	0.03	3.03	0.892
A-6	1.96	0.00	0.00	0.47	1.37	0.08	1.45	0.03	3.40	0.738
A-4	1.96	0.00	0.00	0.00	1.90	0.00	1.90	0.01	1.17	0.969
A-5	1.96	0.00	0.00	0.16	1.71	0.04	1.75	0.02	2.56	0.893
C-1	1.96	0.00	0.00	0.38	1.52	0.01	1.53	0.04	3.44	0.780
C-2	1.96	0.00	0.00	0.18	1.71	0.01	1.72	0.03	3.63	0.880
E-1	1.96	0.00	0.00	1.77	0.33	0.18	0.18	0.00	0.21	0.091
C-3	1.96	0.00	0.00	0.51	1.68	0.00	1.32	0.04	2.67	0.673
D-1	1.96	0.00	0.00	0.19	1.70	0.01	1.71	0.03	1.87	0.873
A-3	1.96	0.00	0.00	0.12	1.78	0.00	1.78	0.02	1.85	0.909
A-7	1.96	0.00	0.00	0.20	1.71	0.00	1.71	0.04	4.76	0.873
C-4	1.96	0.00	0.00	0.72	1.67	0.02	1.06	0.02	1.36	0.540

C-5	1.96	0.00	0.00	0.18	1.71	0.02	1.72	0.03	2.48	0.880
H-2	1.96	0.00	0.00	1.92	0.04	0.00	0.04	0.00	0.25	0.020
H-1	1.96	0.00	0.00	1.92	0.04	0.00	0.04	0.00	0.28	0.019
H-4	1.96	0.00	0.00	1.74	0.04	0.19	0.23	0.02	1.67	0.116
15	1.96	0.00	0.00	1.71	0.04	0.21	0.25	0.02	1.37	0.129
C-6	1.96	0.00	0.00	0.00	1.90	0.00	1.90	0.00	0.37	0.969

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	107.31	0.00	25.33	76.53	0.00	1.80	7.25	-0.01
C-4	ParkingIsland	58.68	0.00	23.05	30.31	0.00	1.80	7.13	-0.01

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	2.33	4.80	4.80	0	02:09	4.80
Pond_A1	STORAGE	0.01	0.62	6.62	0	00:50	0.62
Pond_A2	STORAGE	0.01	0.61	6.61	0	00:50	0.61
Pond_A6	STORAGE	0.00	0.47	6.47	0	00:48	0.45
Pond_A5	STORAGE	0.01	0.61	6.61	0	00:50	0.61
Pond_C2	STORAGE	0.01	0.59	2.59	0	00:54	0.59
Pond_C1	STORAGE	0.01	0.58	3.58	0	00:56	0.58
Pond_D	STORAGE	1.26	2.39	3.39	0	01:37	2.39
PondC	STORAGE	1.96	5.42	5.42	0	01:34	5.42

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	3.86	0 00:48	0	0.0512	0.000
10	JUNCTION	0.00	1.61	0 00:50	0	0.0256	0.000
11	JUNCTION	0.00	3.37	0 00:50	0	0.0526	0.000
12	JUNCTION	4.03	6.90	0 00:50	0.0533	0.124	0.000
13	JUNCTION	0.00	1.56	0 00:56	0	0.0369	0.000
14	JUNCTION	0.00	6.90	0 00:50	0	0.124	0.000
BasinE_LID	JUNCTION	0.21	0.21	0 01:05	0.00488	0.00488	0.000
Prop-East	OUTFALL	0.00	0.46	0 02:09	0	0.17	0.000
Prop-West	OUTFALL	0.00	2.17	0 01:34	0	0.187	0.000
Hist-East	OUTFALL	0.53	0.53	0 00:45	0.00448	0.00448	0.000
Hist-West	OUTFALL	3.04	3.04	0 00:55	0.043	0.043	0.000
PondA	STORAGE	7.78	14.18	0 00:45	0.0661	0.17	0.011
Pond_A1	STORAGE	3.03	3.03	0 00:45	0.0256	0.0256	0.047
Pond_A2	STORAGE	3.18	3.18	0 00:45	0.027	0.027	0.041
Pond_A6	STORAGE	3.40	3.40	0 00:45	0.0298	0.0298	-0.009

Pond_A5	STORAGE	2.56	2.56	0	00:45	0.0214	0.0214	0.113
Pond_C2	STORAGE	3.63	3.63	0	00:45	0.0337	0.0337	0.229
Pond_C1	STORAGE	3.44	3.44	0	00:45	0.0369	0.0369	0.221
Pond_D	STORAGE	1.87	1.87	0	00:45	0.0255	0.0255	0.025
PondC	STORAGE	2.85	9.02	0	00:50	0.0354	0.159	0.095

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	7.441	27	0	0	21.321	77	0 02:09	0.46
Pond_A1	0.005	0	0	0	0.847	57	0 00:49	1.61
Pond_A2	0.004	0	0	0	0.830	56	0 00:49	1.76
Pond_A6	0.001	0	0	0	0.401	27	0 00:47	2.67
Pond_A5	0.005	0	0	0	0.811	55	0 00:50	1.22
Pond_C2	0.013	0	0	0	1.525	51	0 00:54	1.44
Pond_C1	0.012	0	0	0	1.438	48	0 00:55	1.56
Pond_D	0.913	23	0	0	2.644	65	0 01:37	0.19
PondC	4.313	23	0	0	16.122	86	0 01:34	1.87

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

Outfall Node	Pcnt	CFS	CFS	10-year 10^6 gal
Prop-East	99.63	0.09	0.46	0.170
Prop-West	95.27	0.10	2.17	0.187
Hist-East	2.87	0.08	0.53	0.004
Hist-West	2.87	0.77	3.04	0.043
System	50.16	1.04	3.04	0.405

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	1.61	0 00:50			
2	DUMMY	3.86	0 00:48			
3	DUMMY	3.37	0 00:50			
4	DUMMY	1.56	0 00:56			
5	DUMMY	6.90	0 00:50			
11	DUMMY	6.90	0 00:50			
12	DUMMY	0.21	0 01:05			
Outlet_A1	ORIFICE	1.61	0 00:50			0.00
OutletA2	ORIFICE	1.76	0 00:50			0.00
Outlet_A5	ORIFICE	2.67	0 00:48			0.00
Outlet_A4	ORIFICE	1.22	0 00:50			0.00
Outlet_C2	ORIFICE	1.44	0 00:54			0.00
Outlet_C1	ORIFICE	1.56	0 00:56			0.00
Outlet_1	DUMMY	0.46	0 02:09			
Outlet_D	DUMMY	0.19	0 01:37			
Outlet_C	DUMMY	1.87	0 01:34			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Feb 26 14:30:26 2019
Analysis ended on: Tue Feb 26 14:30:26 2019
Total elapsed time: < 1 sec

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... YES
  Ponding Allowed .... NO
  Water Quality .... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date 02/19/2018 00:00:00
Ending Date 02/22/2018 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:00:00
Routing Time Step .... 30.00 sec

************************** Runoff Quantity Continuity **************************	Volume acre-feet	Depth inches
Initial LID Storage	0.004	0.002
Total Precipitation	3.773	2.238

Evaporation Loss	0.000	0.000
Infiltration Loss	2.165	1.284
Surface Runoff	1.568	0.930
Final Storage	0.063	0.038
Continuity Error (%)	-0.507	

************************* Flow Routing Continuity *************************	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.568	0.511
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	1.560	0.508
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.007	0.002
Continuity Error (%)	0.112	

****
Highest Flow Instability Indexes
****

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	30.00 sec
Average Time Step	:	30.00 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	1.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	2.24	0.00	0.00	0.17	1.96	0.06	2.02	0.03	3.72	0.905
A-1	2.24	0.00	0.00	0.17	1.96	0.06	2.03	0.03	3.55	0.905
A-6	2.24	0.00	0.00	0.49	1.57	0.14	1.71	0.04	4.02	0.764
A-4	2.24	0.00	0.00	0.00	2.17	0.00	2.17	0.01	1.34	0.972
A-5	2.24	0.00	0.00	0.17	1.96	0.07	2.03	0.02	2.99	0.906
C-1	2.24	0.00	0.00	0.41	1.74	0.04	1.78	0.04	4.05	0.796
C-2	2.24	0.00	0.00	0.19	1.96	0.03	2.00	0.04	4.25	0.893
E-1	2.24	0.00	0.00	1.90	0.37	0.33	0.33	0.01	0.36	0.146
C-3	2.24	0.00	0.00	0.53	1.93	0.02	1.58	0.04	3.16	0.707
D-1	2.24	0.00	0.00	0.20	1.96	0.02	1.98	0.03	2.24	0.884
A-3	2.24	0.00	0.00	0.14	2.04	0.00	2.04	0.02	2.11	0.913
A-7	2.24	0.00	0.00	0.22	1.96	0.00	1.96	0.05	5.46	0.877
C-4	2.24	0.00	0.00	0.73	1.91	0.04	1.33	0.02	1.84	0.594

C-5	2.24	0.00	0.00	0.19	1.96	0.04	2.00	0.04	2.96	0.892
H-2	2.24	0.00	0.00	2.14	0.04	0.06	0.11	0.01	0.57	0.048
H-1	2.24	0.00	0.00	2.19	0.04	0.00	0.04	0.00	0.32	0.019
H-4	2.24	0.00	0.00	1.83	0.04	0.38	0.42	0.05	3.05	0.188
15	2.24	0.00	0.00	1.79	0.04	0.41	0.46	0.03	2.53	0.204
C-6	2.24	0.00	0.00	0.00	2.17	0.00	2.17	0.00	0.42	0.972

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	124.01	0.00	25.36	93.20	0.00	1.80	7.25	-0.00
C-4	ParkingIsland	67.95	0.00	23.13	39.49	0.00	1.80	7.13	-0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	2.34	4.97	4.97	0	01:22	4.97
Pond_A1	STORAGE	0.01	0.66	6.66	0	00:50	0.66
Pond_A2	STORAGE	0.01	0.66	6.66	0	00:50	0.66
Pond_A6	STORAGE	0.00	0.52	6.52	0	00:48	0.50
Pond_A5	STORAGE	0.01	0.65	6.65	0	00:50	0.65
Pond_C2	STORAGE	0.01	0.64	2.64	0	00:55	0.64
Pond_C1	STORAGE	0.01	0.63	3.63	0	00:56	0.63
Pond_D	STORAGE	1.26	2.49	3.49	0	01:24	2.49
PondC	STORAGE	1.97	5.68	5.68	0	01:27	5.68

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	4.39	0	00:48	0	0.06	0.000
10	JUNCTION	0.00	1.79	0	00:50	0	0.0297	0.000
11	JUNCTION	0.00	3.75	0	00:50	0	0.061	0.000
12	JUNCTION	5.00	8.19	0	00:50	0.0649	0.147	0.000
13	JUNCTION	0.00	1.74	0	00:56	0	0.043	0.000
14	JUNCTION	0.00	8.19	0	00:50	0	0.147	0.000
BasinE_LID	JUNCTION	0.36	0.36	0	01:05	0.00897	0.00897	0.000
Prop-East	OUTFALL	0.00	1.52	0	01:22	0	0.197	0.000
Prop-West	OUTFALL	0.00	3.49	0	01:26	0	0.224	0.000
Hist-East	OUTFALL	0.87	0.87	0	00:45	0.00853	0.00853	0.000
Hist-West	OUTFALL	5.55	5.55	0	00:50	0.079	0.079	0.000
PondA	STORAGE	8.91	16.08	0	00:45	0.0759	0.197	0.057
Pond_A1	STORAGE	3.55	3.55	0	00:45	0.0297	0.0297	0.046
Pond_A2	STORAGE	3.72	3.72	0	00:45	0.0313	0.0313	0.056
Pond_A6	STORAGE	4.02	4.02	0	00:45	0.0353	0.0353	-0.026

25-year

Pond_A5	STORAGE	2.99	2.99	0	00:45	0.0248	0.0248	0.106
Pond_C2	STORAGE	4.25	4.25	0	00:45	0.0391	0.0391	0.224
Pond_C1	STORAGE	4.05	4.05	0	00:45	0.043	0.043	0.212
Pond_D	STORAGE	2.24	2.24	0	00:45	0.0295	0.0295	0.061
PondC	STORAGE	3.38	10.65	0	00:50	0.0409	0.188	0.114

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	7.509	27	0	0	22.449	81	0 01:22	1.52
Pond_A1	0.006	0	0	0	1.040	70	0 00:50	1.79
Pond_A2	0.005	0	0	0	1.020	69	0 00:49	1.97
Pond_A6	0.002	0	0	0	0.514	35	0 00:48	3.08
Pond_A5	0.006	0	0	0	0.987	67	0 00:50	1.35
Pond_C2	0.017	1	0	0	1.853	62	0 00:54	1.59
Pond_C1	0.016	1	0	0	1.771	60	0 00:56	1.74
Pond_D	0.920	23	0	0	2.856	71	0 01:24	0.32
PondC	4.351	23	0	0	17.295	92	0 01:27	2.93

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

25-year

Outfall Node	Pcnt	CFS	CFS	10^6 gal
Prop-East	99.77	0.10	1.52	0.197
Prop-West	95.35	0.12	3.49	0.224
Hist-East	2.87	0.15	0.87	0.009
Hist-West	2.89	1.41	5.55	0.079
System	50.22	1.78	5.55	0.508

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	1.79	0 00:50			
2	DUMMY	4.39	0 00:48			
3	DUMMY	3.75	0 00:50			
4	DUMMY	1.74	0 00:56			
5	DUMMY	8.19	0 00:50			
11	DUMMY	8.19	0 00:50			
12	DUMMY	0.36	0 01:05			
Outlet_A1	ORIFICE	1.79	0 00:50			0.00
OutletA2	ORIFICE	1.97	0 00:50			0.00
Outlet_A5	ORIFICE	3.08	0 00:48			0.00
Outlet_A4	ORIFICE	1.35	0 00:50			0.00
Outlet_C2	ORIFICE	1.59	0 00:55			0.00
Outlet_C1	ORIFICE	1.74	0 00:56			0.00
Outlet_1	DUMMY	1.52	0 01:22			
Outlet_D	DUMMY	0.32	0 01:24			
Outlet_C	DUMMY	2.93	0 01:27			

****
Conduit Surcharge Summary
****

```
No conduits were surcharged.


Analysis begun on:  Tue Feb 26 14:30:37 2019
Analysis ended on:  Tue Feb 26 14:30:37 2019
Total elapsed time: < 1 sec
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         4.245         2.518
```

```
Evaporation Loss .........         0.000          0.000
Infiltration Loss ........         2.289          1.358
Surface Runoff ...........         1.921          1.139
Final Storage ............         0.063          0.038
Continuity Error (%) .....        -0.582


**************************        Volume         Volume
Flow Routing Continuity         acre-feet       10^6 gal
**************************      ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         1.921          0.626
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........         0.000          0.000
External Outflow .........         1.912          0.623
Flooding Loss ............         0.000          0.000
Evaporation Loss .........         0.000          0.000
Exfiltration Loss ........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......         0.007          0.002
Continuity Error (%) .....         0.124


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	2.52	0.00	0.00	0.17	2.21	0.09	2.30	0.04	4.26	0.913
A-1	2.52	0.00	0.00	0.17	2.21	0.09	2.30	0.03	4.07	0.914
A-6	2.52	0.00	0.00	0.51	1.77	0.20	1.98	0.04	4.67	0.785
A-4	2.52	0.00	0.00	0.00	2.45	0.00	2.45	0.01	1.51	0.973
A-5	2.52	0.00	0.00	0.17	2.21	0.09	2.30	0.03	3.42	0.914
C-1	2.52	0.00	0.00	0.43	1.97	0.07	2.04	0.05	4.68	0.812
C-2	2.52	0.00	0.00	0.20	2.22	0.06	2.27	0.04	4.88	0.903
E-1	2.52	0.00	0.00	2.00	0.42	0.51	0.51	0.01	0.52	0.201
C-3	2.52	0.00	0.00	0.54	2.18	0.03	1.85	0.05	3.84	0.736
D-1	2.52	0.00	0.00	0.21	2.21	0.04	2.25	0.03	2.62	0.894
A-3	2.52	0.00	0.00	0.15	2.30	0.01	2.32	0.02	2.42	0.920
A-7	2.52	0.00	0.00	0.25	2.21	0.01	2.22	0.05	6.21	0.883
C-4	2.52	0.00	0.00	0.74	2.16	0.06	1.60	0.02	2.10	0.637

C-5	2.52	0.00	0.00	0.19	2.21	0.06	2.27	0.04	3.46	0.902
H-2	2.52	0.00	0.00	2.28	0.05	0.20	0.25	0.01	1.31	0.100
H-1	2.52	0.00	0.00	2.45	0.05	0.03	0.08	0.00	0.63	0.030
H-4	2.52	0.00	0.00	1.89	0.05	0.59	0.64	0.07	4.74	0.253
15	2.52	0.00	0.00	1.85	0.05	0.63	0.68	0.05	3.89	0.270
C-6	2.52	0.00	0.00	0.00	2.45	0.00	2.45	0.00	0.48	0.973

****

LID Performance Summary

****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	140.99	0.00	25.39	110.16	0.00	1.80	7.25	-0.00
C-4	ParkingIsland	77.27	0.00	23.20	48.75	0.00	1.80	7.13	-0.01

****

Node Depth Summary

****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	2.35	5.19	5.19	0	01:16	5.19
Pond_A1	STORAGE	0.01	0.70	6.70	0	00:50	0.70
Pond_A2	STORAGE	0.01	0.70	6.70	0	00:50	0.70
Pond_A6	STORAGE	0.01	0.56	6.56	0	00:48	0.54
Pond_A5	STORAGE	0.01	0.69	6.69	0	00:51	0.69
Pond_C2	STORAGE	0.01	0.67	2.67	0	00:55	0.67
Pond_C1	STORAGE	0.01	0.67	3.67	0	00:57	0.67
Pond_D	STORAGE	1.27	2.64	3.64	0	01:25	2.64
PondC	STORAGE	1.98	5.92	5.92	0	01:23	5.92

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	4.90	0	00:48	0	0.0689	0.000
10	JUNCTION	0.00	1.96	0	00:50	0	0.0337	0.000
11	JUNCTION	0.00	4.11	0	00:50	0	0.0693	0.000
12	JUNCTION	5.76	9.24	0	00:50	0.0767	0.17	0.000
13	JUNCTION	0.00	1.91	0	00:57	0	0.0493	0.000
14	JUNCTION	0.00	9.24	0	00:50	0	0.17	0.000
BasinE_LID	JUNCTION	0.52	0.52	0	01:00	0.0139	0.0139	0.000
Prop-East	OUTFALL	0.00	3.07	0	01:16	0	0.224	0.000
Prop-West	OUTFALL	0.00	4.64	0	01:22	0	0.262	0.000
Hist-East	OUTFALL	1.79	1.79	0	00:45	0.0184	0.0184	0.000
Hist-West	OUTFALL	8.63	8.63	0	00:50	0.119	0.119	0.000
PondA	STORAGE	10.14	18.05	0	00:45	0.0859	0.224	0.108
Pond_A1	STORAGE	4.07	4.07	0	00:45	0.0337	0.0337	0.061
Pond_A2	STORAGE	4.26	4.26	0	00:45	0.0356	0.0356	0.056
Pond_A6	STORAGE	4.67	4.67	0	00:45	0.0408	0.0408	0.051

50-year

Pond_A5	STORAGE	3.42	3.42	0	00:45	0.0281	0.0281	0.092
Pond_C2	STORAGE	4.88	4.88	0	00:45	0.0445	0.0445	0.217
Pond_C1	STORAGE	4.68	4.68	0	00:45	0.0494	0.0494	0.201
Pond_D	STORAGE	2.62	2.62	0	00:45	0.0336	0.0336	0.086
PondC	STORAGE	3.93	12.37	0	00:46	0.0465	0.217	0.103

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	7.546	27	0	0	23.885	87	0 01:16	3.07
Pond_A1	0.007	0	0	0	1.237	83	0 00:50	1.96
Pond_A2	0.007	0	0	0	1.219	82	0 00:50	2.16
Pond_A6	0.002	0	0	0	0.640	43	0 00:48	3.46
Pond_A5	0.008	1	0	0	1.168	79	0 00:50	1.48
Pond_C2	0.021	1	0	0	2.196	74	0 00:54	1.74
Pond_C1	0.020	1	0	0	2.127	72	0 00:56	1.91
Pond_D	0.929	23	0	0	3.170	79	0 01:25	0.34
PondC	4.384	23	0	0	18.421	98	0 01:23	3.91

****
Outfall Loading Summary
****

	Flow Freq	Avg Flow	Max Flow	Total Volume

Outfall Node	Pcnt	CFS	CFS	50-year 10^6 gal
Prop-East	99.83	0.12	3.07	0.224
Prop-West	95.43	0.14	4.64	0.262
Hist-East	2.87	0.33	1.79	0.018
Hist-West	2.89	2.12	8.63	0.119
System	50.25	2.71	8.63	0.623

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	1.96	0 00:50			
2	DUMMY	4.90	0 00:48			
3	DUMMY	4.11	0 00:50			
4	DUMMY	1.91	0 00:57			
5	DUMMY	9.24	0 00:50			
11	DUMMY	9.24	0 00:50			
12	DUMMY	0.52	0 01:00			
Outlet_A1	ORIFICE	1.96	0 00:50			0.00
OutletA2	ORIFICE	2.16	0 00:50			0.00
Outlet_A5	ORIFICE	3.46	0 00:48			0.00
Outlet_A4	ORIFICE	1.48	0 00:51			0.00
Outlet_C2	ORIFICE	1.74	0 00:55			0.00
Outlet_C1	ORIFICE	1.91	0 00:57			0.00
Outlet_1	DUMMY	3.07	0 01:16			
Outlet_D	DUMMY	0.34	0 01:25			
Outlet_C	DUMMY	3.91	0 01:23			

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Feb 26 14:30:48 2019
Analysis ended on: Tue Feb 26 14:30:49 2019
Total elapsed time: 00:00:01

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 12

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 02/19/2018 00:00:00
Ending Date .............. 02/22/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:00:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Initial LID Storage ......         0.004         0.002
Total Precipitation ......         4.754         2.820
```

Evaporation Loss	0.000	0.000
Infiltration Loss	2.390	1.418
Surface Runoff	2.334	1.385
Final Storage	0.063	0.038
Continuity Error (%)	-0.623	

************************** Flow Routing Continuity **************************	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	2.334	0.761
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	2.298	0.749
Flooding Loss	0.027	0.009
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.007	0.002
Continuity Error (%)	0.113	

****
Highest Flow Instability Indexes
****

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	30.00 sec
Average Time Step	:	30.00 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	1.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
A-2	2.82	0.00	0.00	0.18	2.49	0.11	2.60	0.04	4.84	0.921
A-1	2.82	0.00	0.00	0.18	2.49	0.11	2.60	0.04	4.62	0.921
A-6	2.82	0.00	0.00	0.52	1.99	0.27	2.27	0.05	5.40	0.804
A-4	2.82	0.00	0.00	0.00	2.76	0.00	2.76	0.01	1.69	0.977
A-5	2.82	0.00	0.00	0.18	2.48	0.11	2.60	0.03	3.88	0.921
C-1	2.82	0.00	0.00	0.45	2.21	0.12	2.33	0.06	5.38	0.827
C-2	2.82	0.00	0.00	0.20	2.49	0.08	2.57	0.05	5.57	0.912
E-1	2.82	0.00	0.00	2.09	0.48	0.72	0.72	0.02	0.72	0.255
C-3	2.82	0.00	0.00	0.55	2.45	0.06	2.15	0.06	5.11	0.762
D-1	2.82	0.00	0.00	0.22	2.49	0.06	2.55	0.04	3.04	0.903
A-3	2.82	0.00	0.00	0.15	2.59	0.03	2.62	0.02	2.76	0.928
A-7	2.82	0.00	0.00	0.26	2.49	0.03	2.52	0.06	7.08	0.892
C-4	2.82	0.00	0.00	0.74	2.43	0.09	1.90	0.03	2.64	0.674

C-5	2.82	0.00	0.00	0.20	2.49	0.08	2.57	0.05	4.01	0.911
H-2	2.82	0.00	0.00	2.39	0.06	0.39	0.45	0.02	2.28	0.159
H-1	2.82	0.00	0.00	2.66	0.06	0.12	0.17	0.01	1.38	0.062
H-4	2.82	0.00	0.00	1.95	0.06	0.83	0.89	0.10	6.83	0.315
15	2.82	0.00	0.00	1.90	0.06	0.88	0.93	0.07	5.52	0.331
C-6	2.82	0.00	0.00	0.00	2.76	0.00	2.76	0.00	0.53	0.978

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
C-3	ParkingIsland	159.53	0.00	25.42	128.66	0.00	1.80	7.25	-0.00
C-4	ParkingIsland	87.40	0.00	23.26	58.81	0.00	1.80	7.14	-0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
9	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
10	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
11	JUNCTION	0.00	0.00	5.00	0 00:00	0.00
12	JUNCTION	0.00	0.00	2.00	0 00:00	0.00
13	JUNCTION	0.00	0.00	3.00	0 00:00	0.00
14	JUNCTION	0.00	0.00	1.00	0 00:00	0.00

BasinE_LID	JUNCTION	0.00	0.00	0.00	0	00:00	0.00
Prop-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Prop-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-East	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
Hist-West	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
PondA	STORAGE	2.36	5.47	5.47	0	01:17	5.46
Pond_A1	STORAGE	0.01	0.74	6.74	0	00:50	0.74
Pond_A2	STORAGE	0.01	0.74	6.74	0	00:50	0.74
Pond_A6	STORAGE	0.01	0.60	6.60	0	00:48	0.59
Pond_A5	STORAGE	0.01	0.73	6.73	0	00:51	0.73
Pond_C2	STORAGE	0.01	0.71	2.71	0	00:55	0.71
Pond_C1	STORAGE	0.01	0.71	3.71	0	00:57	0.71
Pond_D	STORAGE	1.28	2.82	3.82	0	01:27	2.82
PondC	STORAGE	1.99	6.00	6.00	0	01:24	6.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
9	JUNCTION	0.00	5.44	0	00:49	0	0.0785	0.000
10	JUNCTION	0.00	2.13	0	00:50	0	0.0381	0.000
11	JUNCTION	0.00	4.48	0	00:50	0	0.0782	0.000
12	JUNCTION	7.75	10.82	0	00:45	0.0896	0.196	0.000
13	JUNCTION	0.00	2.09	0	00:57	0	0.0562	0.000
14	JUNCTION	0.00	10.82	0	00:45	0	0.196	0.000
BasinE_LID	JUNCTION	0.72	0.72	0	01:00	0.0197	0.0197	0.000
Prop-East	OUTFALL	0.00	3.55	0	01:17	0	0.254	0.000
Prop-West	OUTFALL	0.00	5.27	0	01:10	0	0.295	0.000
Hist-East	OUTFALL	3.58	3.58	0	00:50	0.0354	0.0354	0.000
Hist-West	OUTFALL	12.35	12.35	0	00:50	0.165	0.165	0.000
PondA	STORAGE	11.53	20.16	0	00:45	0.0971	0.254	0.100
Pond_A1	STORAGE	4.62	4.62	0	00:45	0.0381	0.0381	0.067
Pond_A2	STORAGE	4.84	4.84	0	00:45	0.0402	0.0402	0.055
Pond_A6	STORAGE	5.40	5.40	0	00:45	0.0468	0.0468	0.034

100-year

Pond_A5	STORAGE	3.88	3.88	0 00:45	0.0317	0.0317	0.101
Pond_C2	STORAGE	5.57	5.57	0 00:45	0.0503	0.0503	0.224
Pond_C1	STORAGE	5.38	5.38	0 00:45	0.0563	0.0563	0.208
Pond_D	STORAGE	3.04	3.04	0 00:45	0.038	0.038	0.086
PondC	STORAGE	4.54	15.36	0 00:45	0.0526	0.249	0.100

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Volume 1000 ft3
PondC	0.26	2.74	0 01:10	0.009	0.000

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
PondA	7.588	28	0	0	25.691	93	0 01:16	3.55
Pond_A1	0.009	1	0	0	1.457	98	0 00:50	2.13
Pond_A2	0.008	1	0	0	1.441	97	0 00:50	2.35
Pond_A6	0.003	0	0	0	0.794	53	0 00:48	3.88
Pond_A5	0.009	1	0	0	1.367	92	0 00:50	1.60
Pond_C2	0.025	1	0	0	2.578	87	0 00:55	1.89
Pond_C1	0.025	1	0	0	2.529	85	0 00:57	2.09
Pond_D	0.946	23	0	0	3.595	89	0 01:27	0.35
PondC	4.412	23	0	0	18.797	100	0 01:09	4.23

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
Prop-East	99.86	0.13	3.55	0.254
Prop-West	95.49	0.16	5.27	0.295
Hist-East	2.87	0.64	3.58	0.035
Hist-West	2.91	2.92	12.35	0.165
System	50.28	3.85	12.35	0.749

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	DUMMY	2.13	0 00:50			
2	DUMMY	5.44	0 00:49			
3	DUMMY	4.48	0 00:50			
4	DUMMY	2.09	0 00:57			
5	DUMMY	10.82	0 00:45			
11	DUMMY	10.82	0 00:45			
12	DUMMY	0.72	0 01:00			
Outlet_A1	ORIFICE	2.13	0 00:50			0.00
OutletA2	ORIFICE	2.35	0 00:50			0.00
Outlet_A5	ORIFICE	3.88	0 00:48			0.00
Outlet_A4	ORIFICE	1.60	0 00:51			0.00
Outlet_C2	ORIFICE	1.89	0 00:55			0.00
Outlet_C1	ORIFICE	2.09	0 00:57			0.00
Outlet_1	DUMMY	3.55	0 01:17			
Outlet_D	DUMMY	0.35	0 01:27			

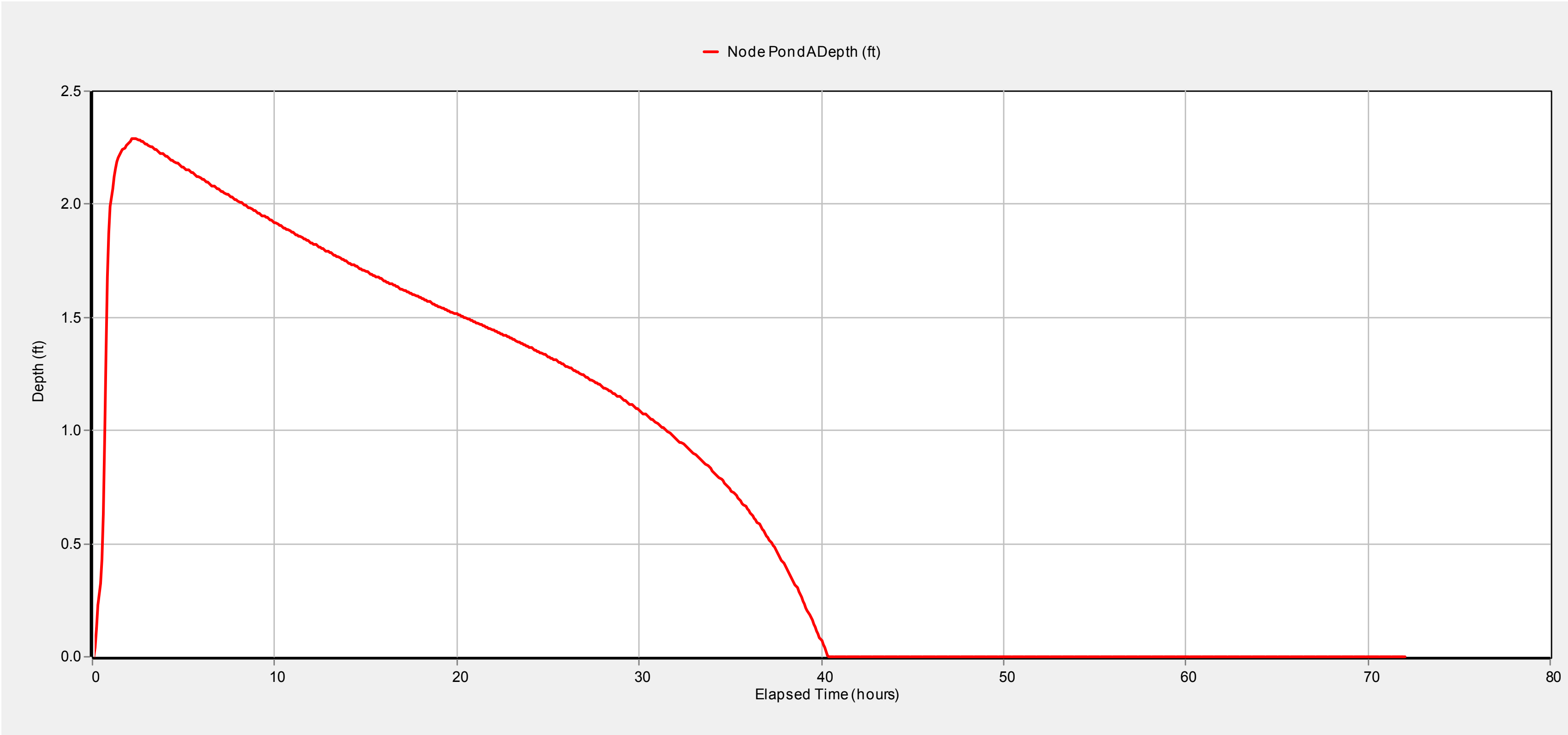
```
Outlet_C              DUMMY        4.23     0  01:24


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.

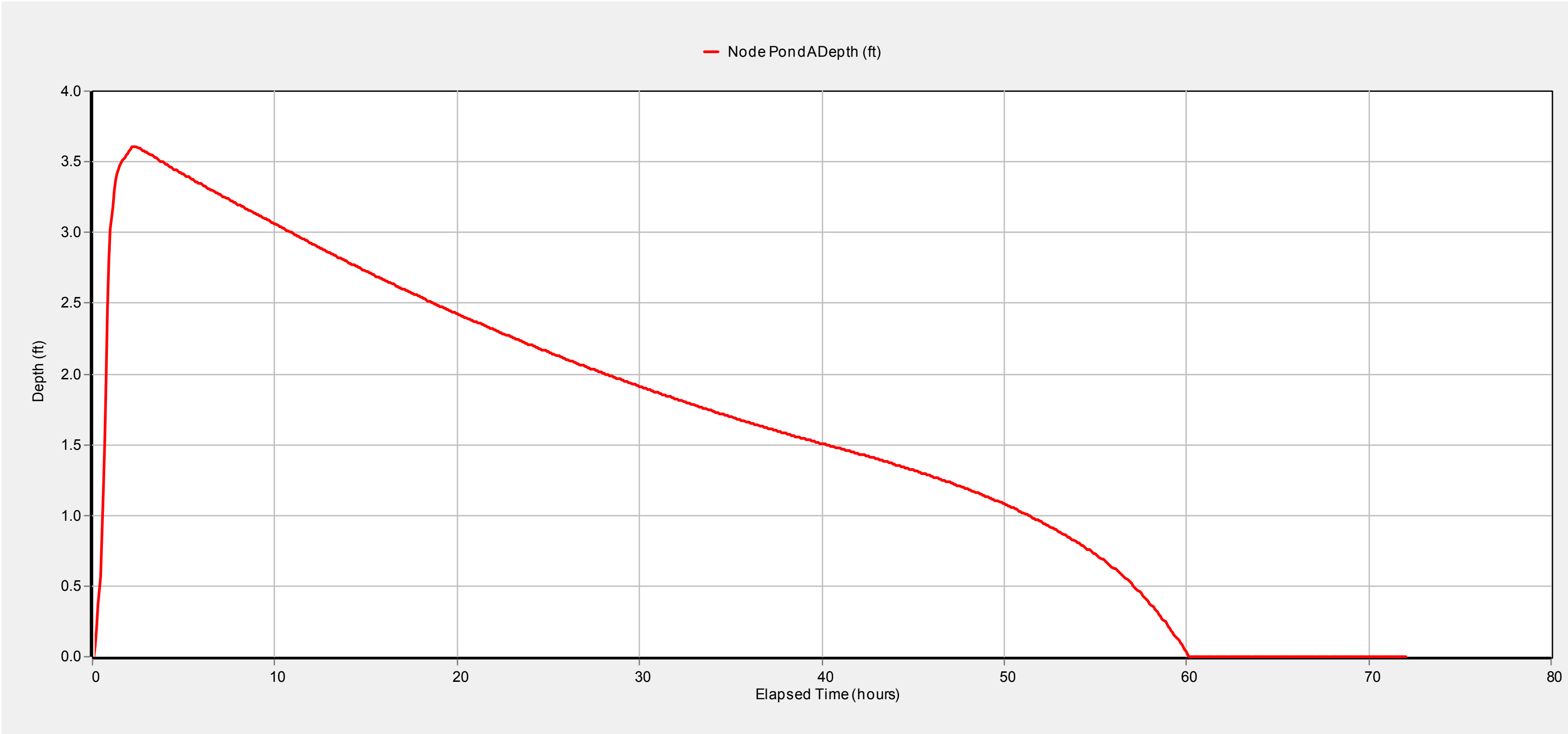

Analysis begun on:  Tue Feb 26 14:31:00 2019
Analysis ended on:  Tue Feb 26 14:31:00 2019
Total elapsed time: < 1 sec
```

Pond A - WQ



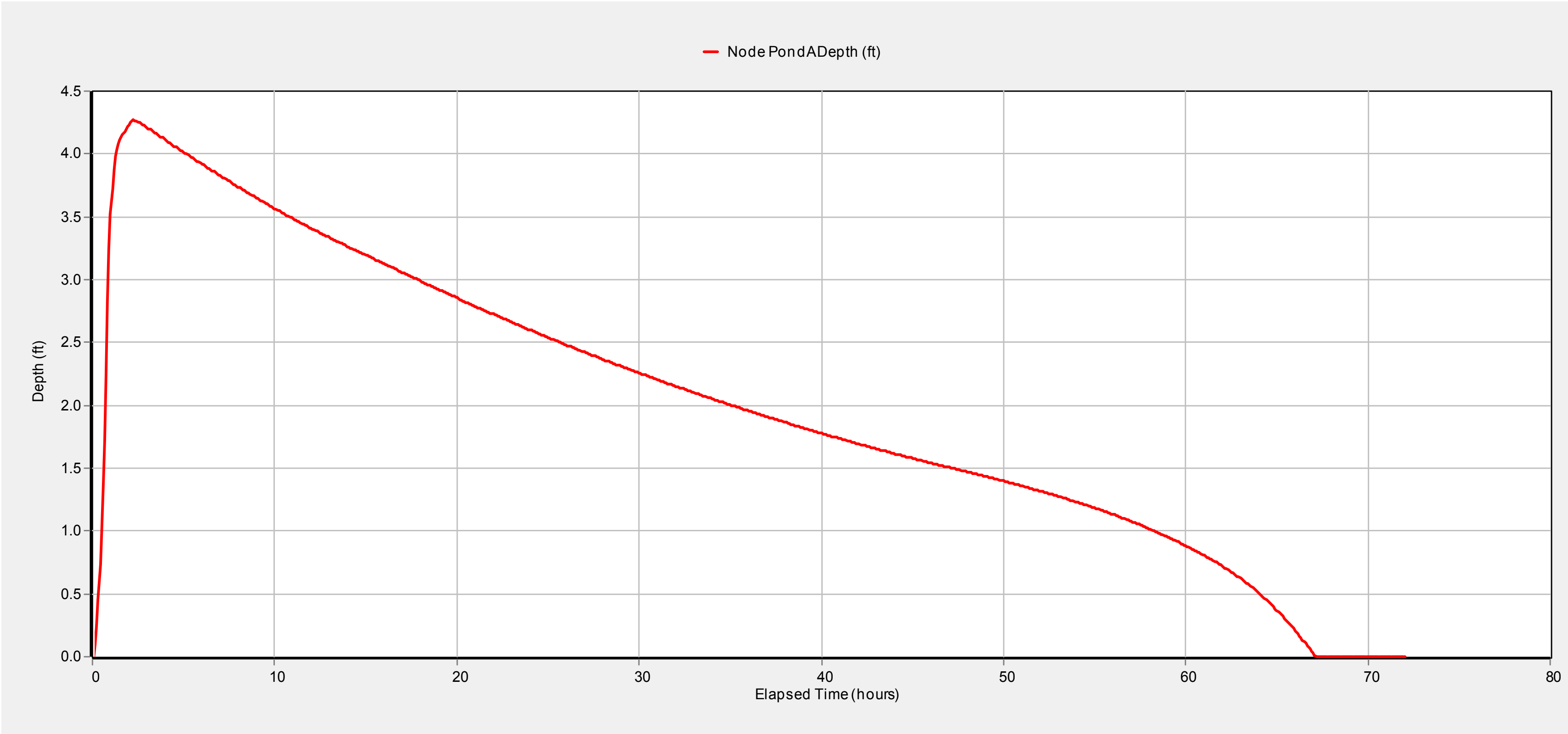
Node PondADepth (ft)
Depth (ft)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

Pond A - 2 year



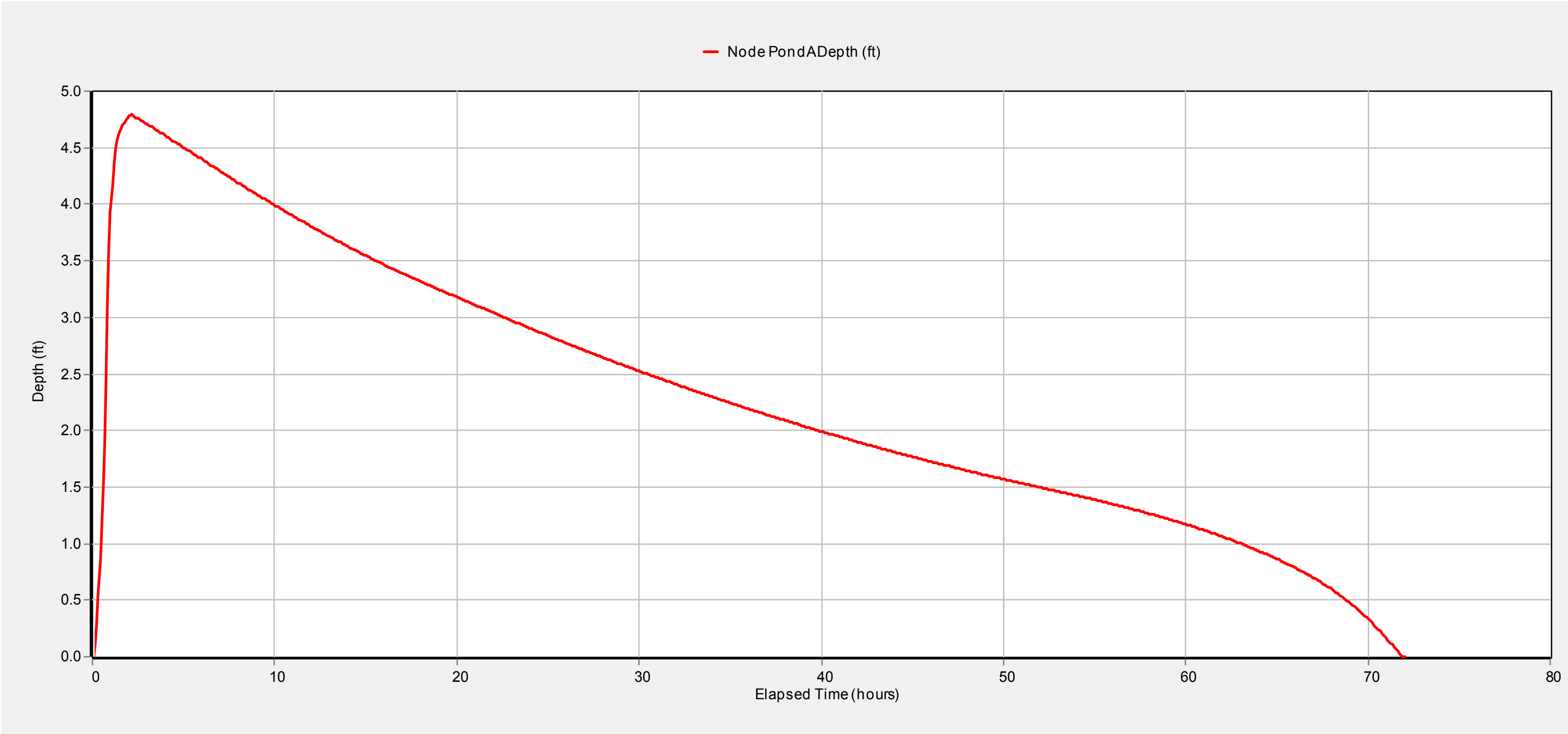
Node PondADepth (ft)
Depth (ft)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

Pond A - 5 year

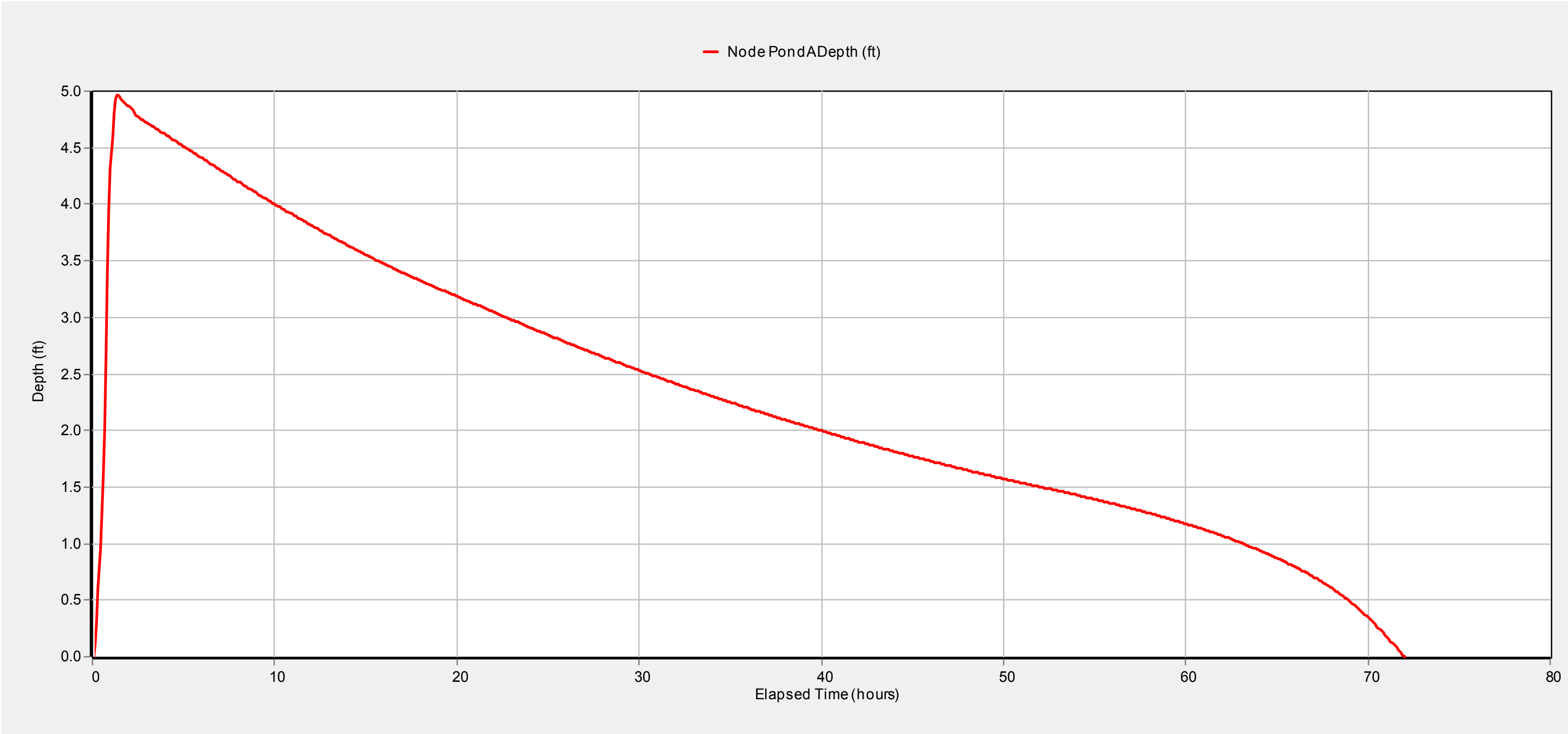


Node PondADepth (ft)
Depth (ft)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

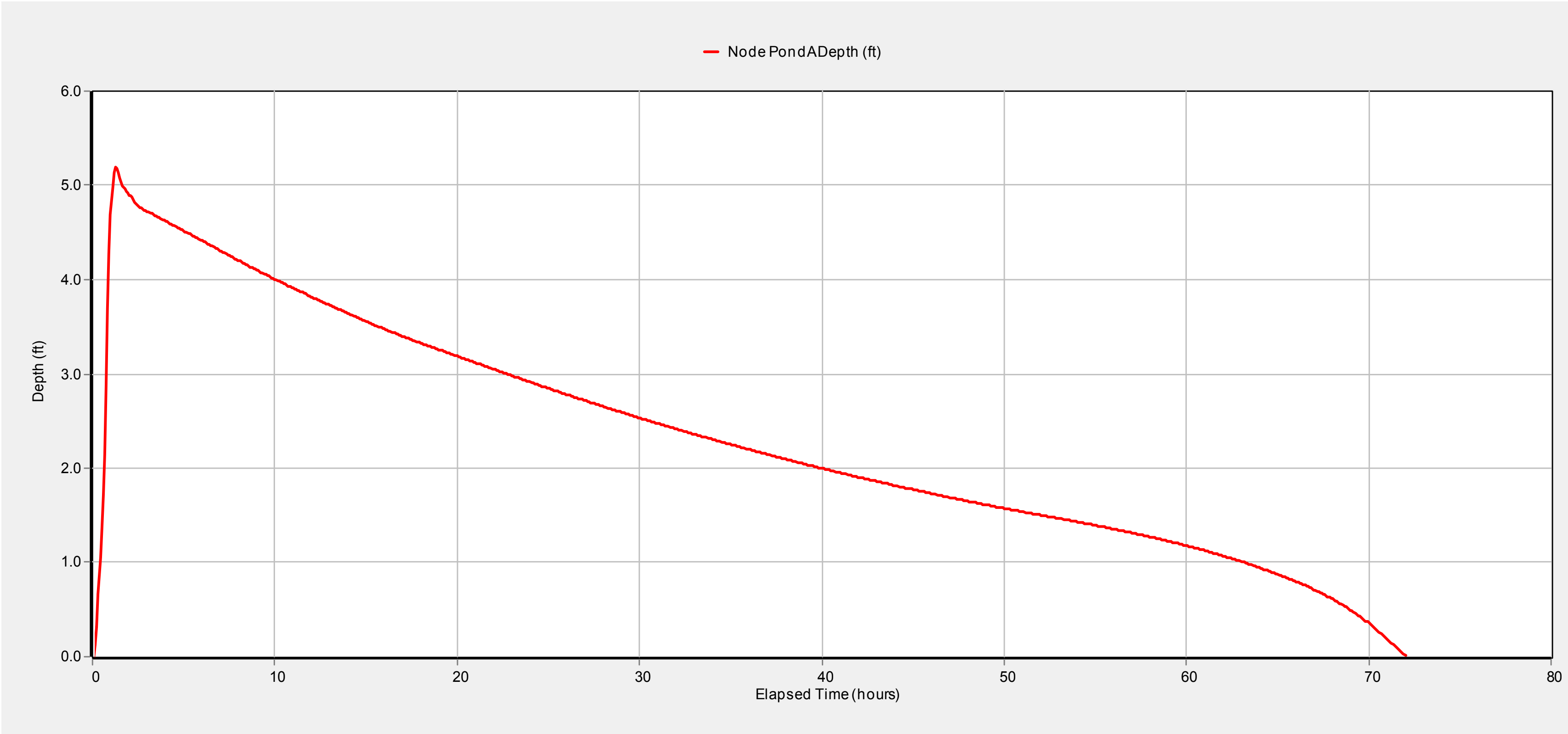
Pond A - 10 year



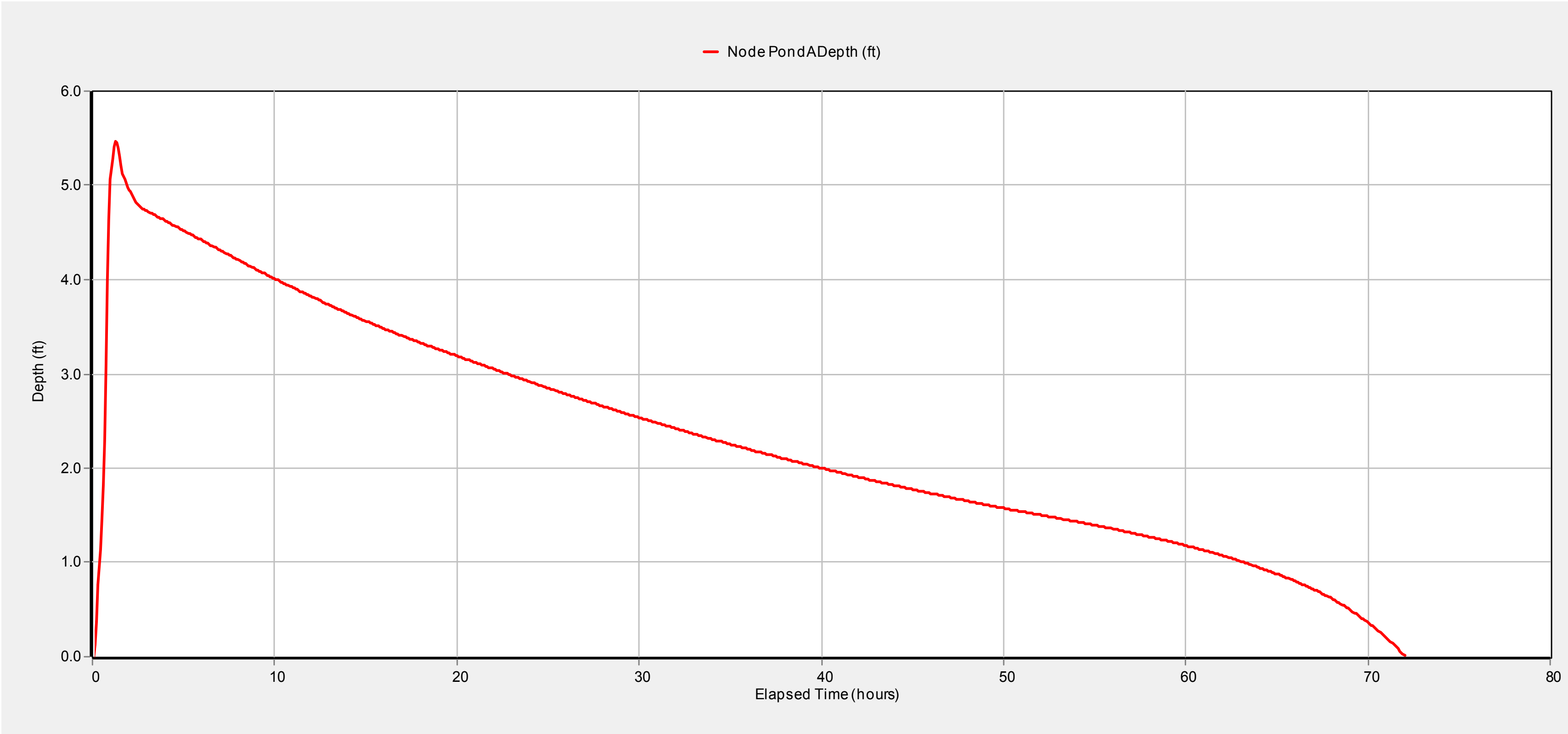
Pond A - 25 year



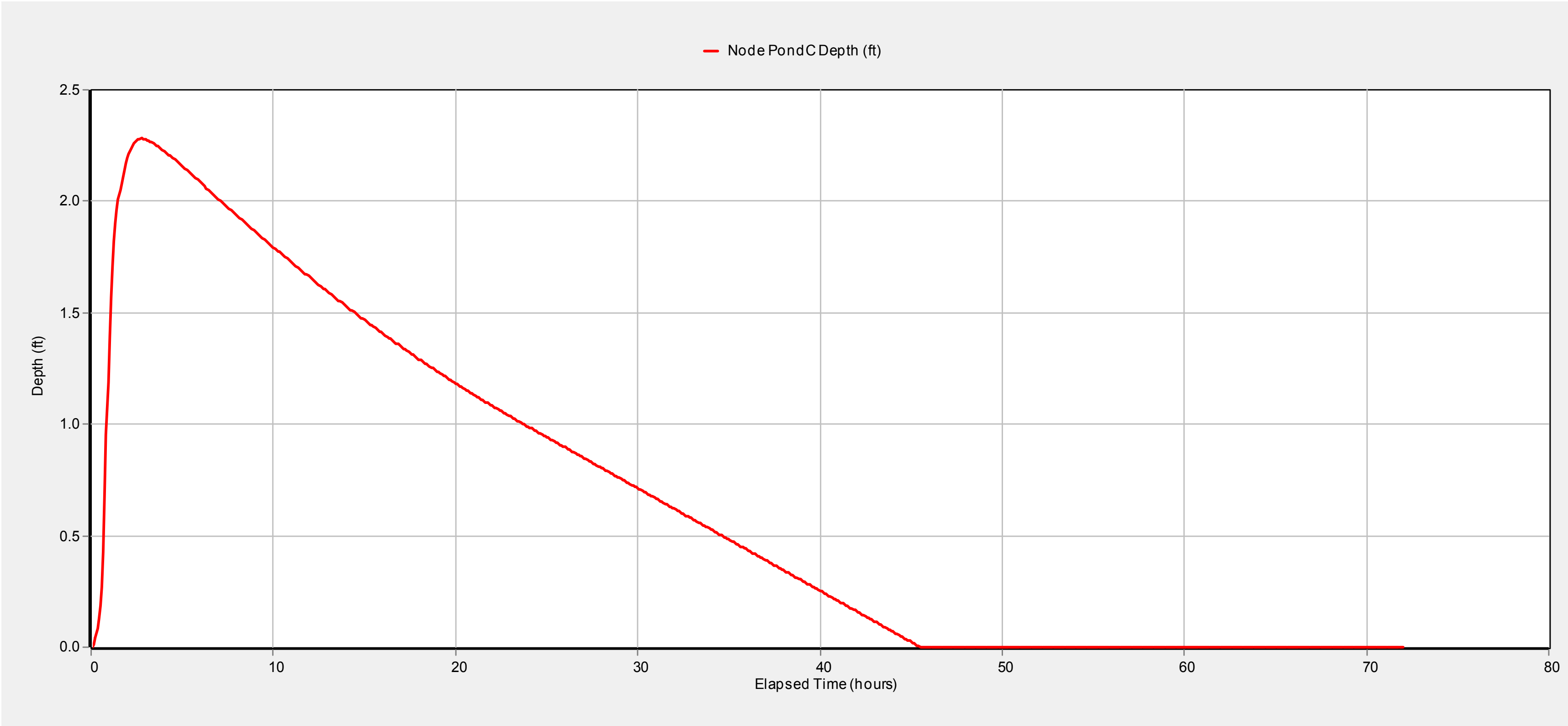
Pond A - 50 year



Pond A - 100 year

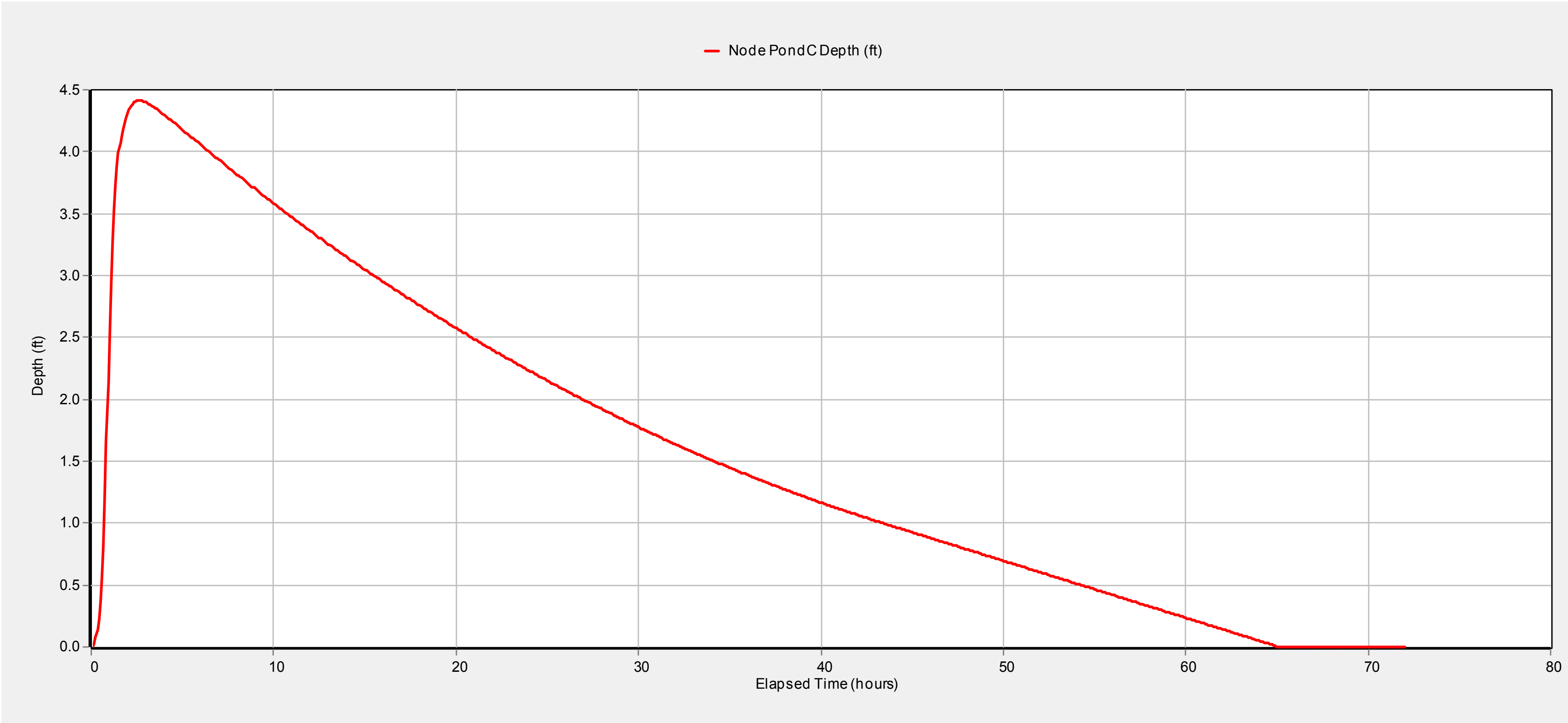


Pond C - 2 year

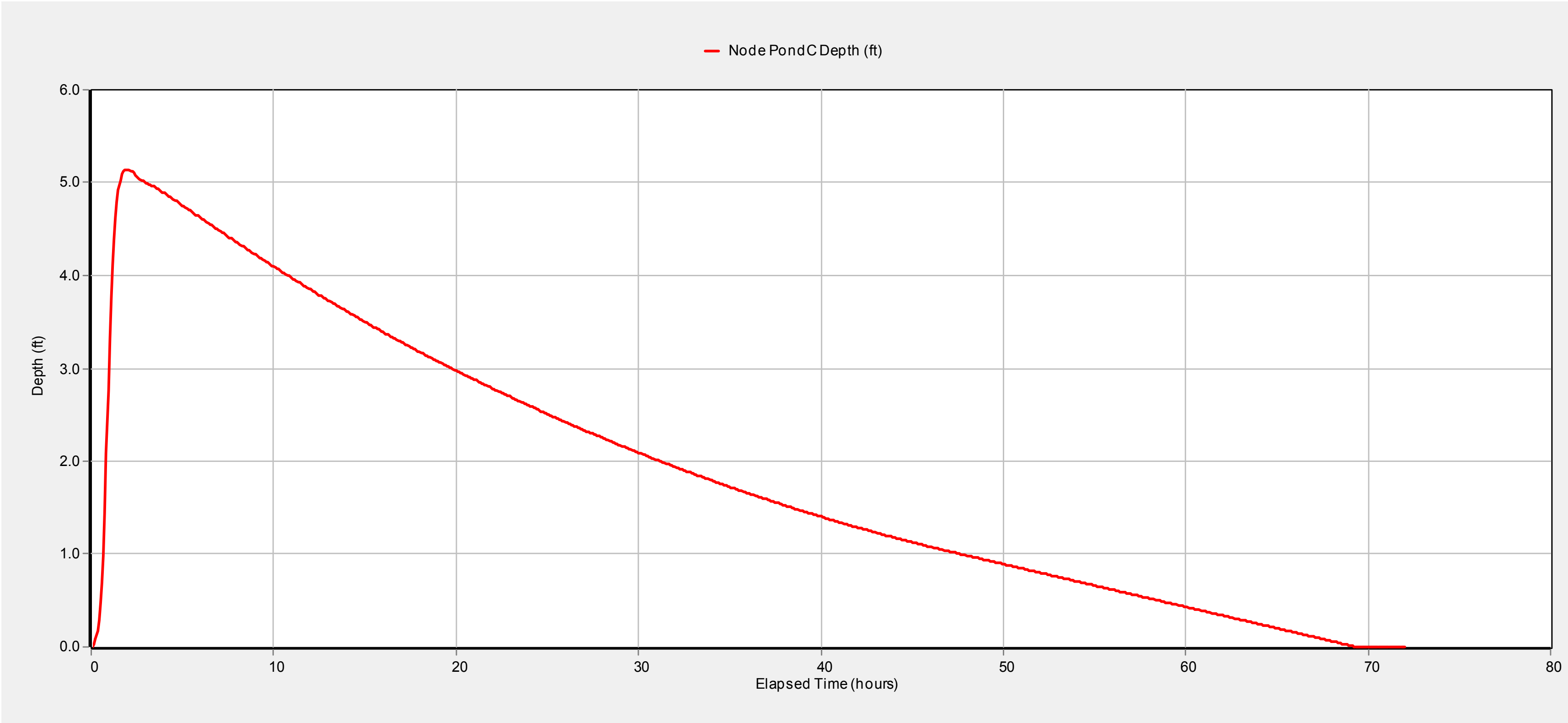


Node PondC Depth (ft)
Depth (ft)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

Pond C - 2 year

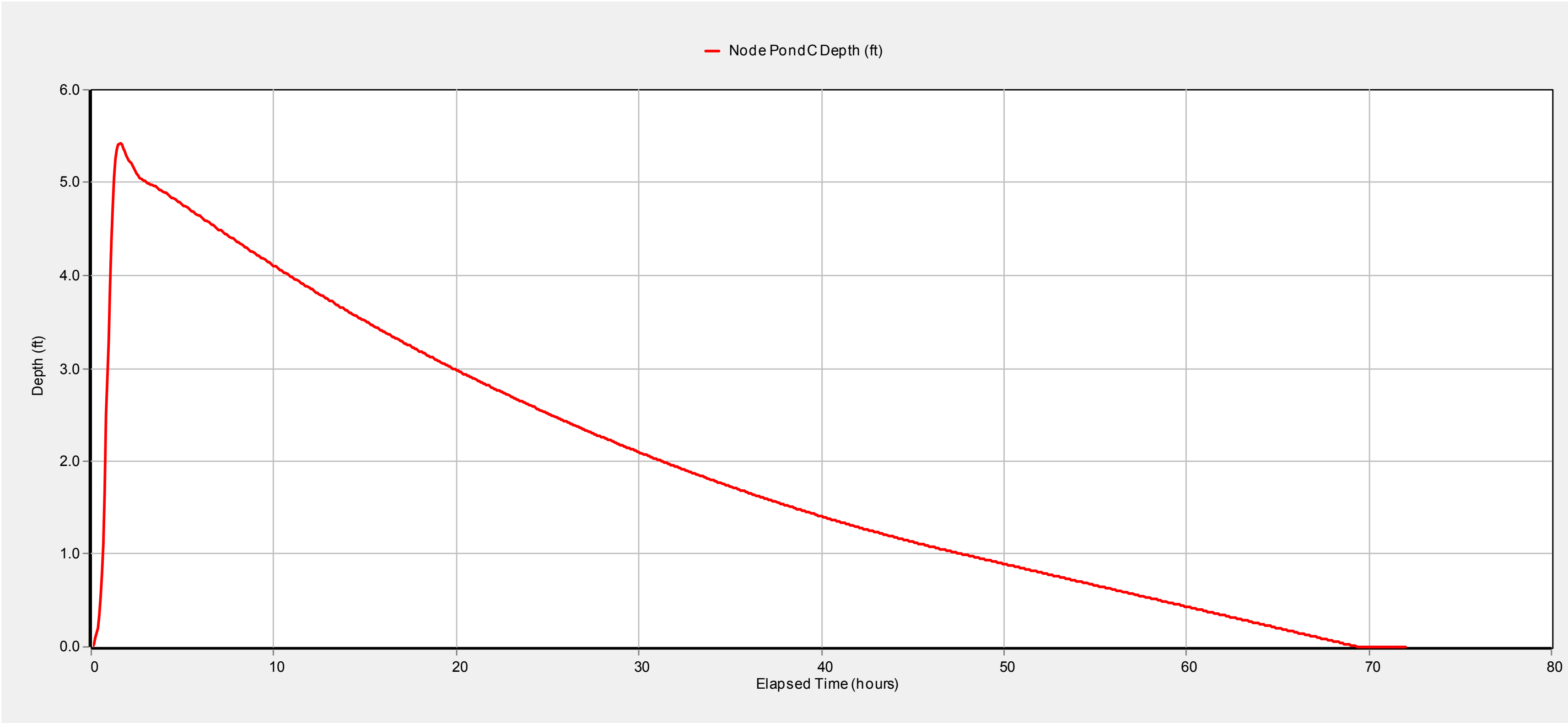

Node PondC Depth (ft)
Depth (ft)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

Pond C - 5 year

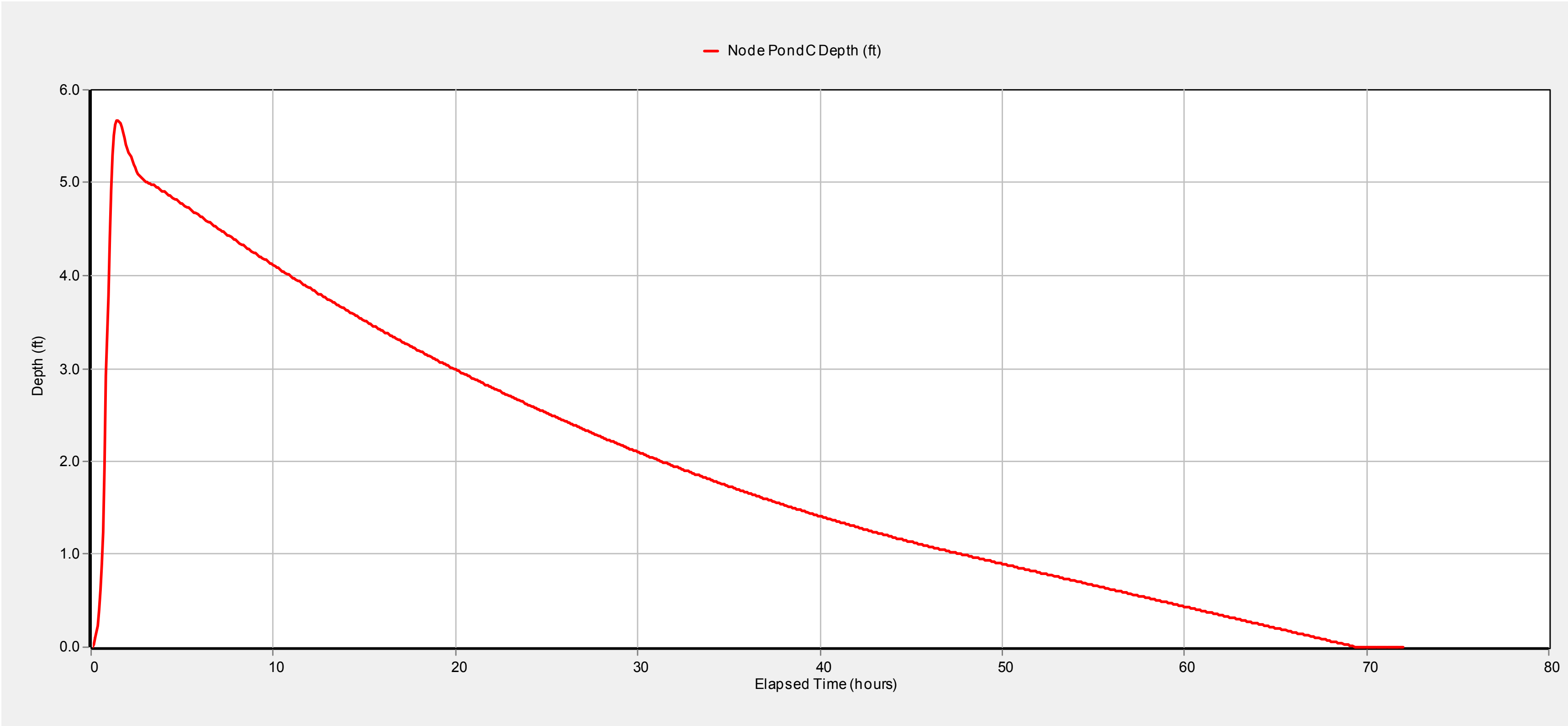


Node PondC Depth (ft)
Depth (ft)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
70
80
Elapsed Time (hours)

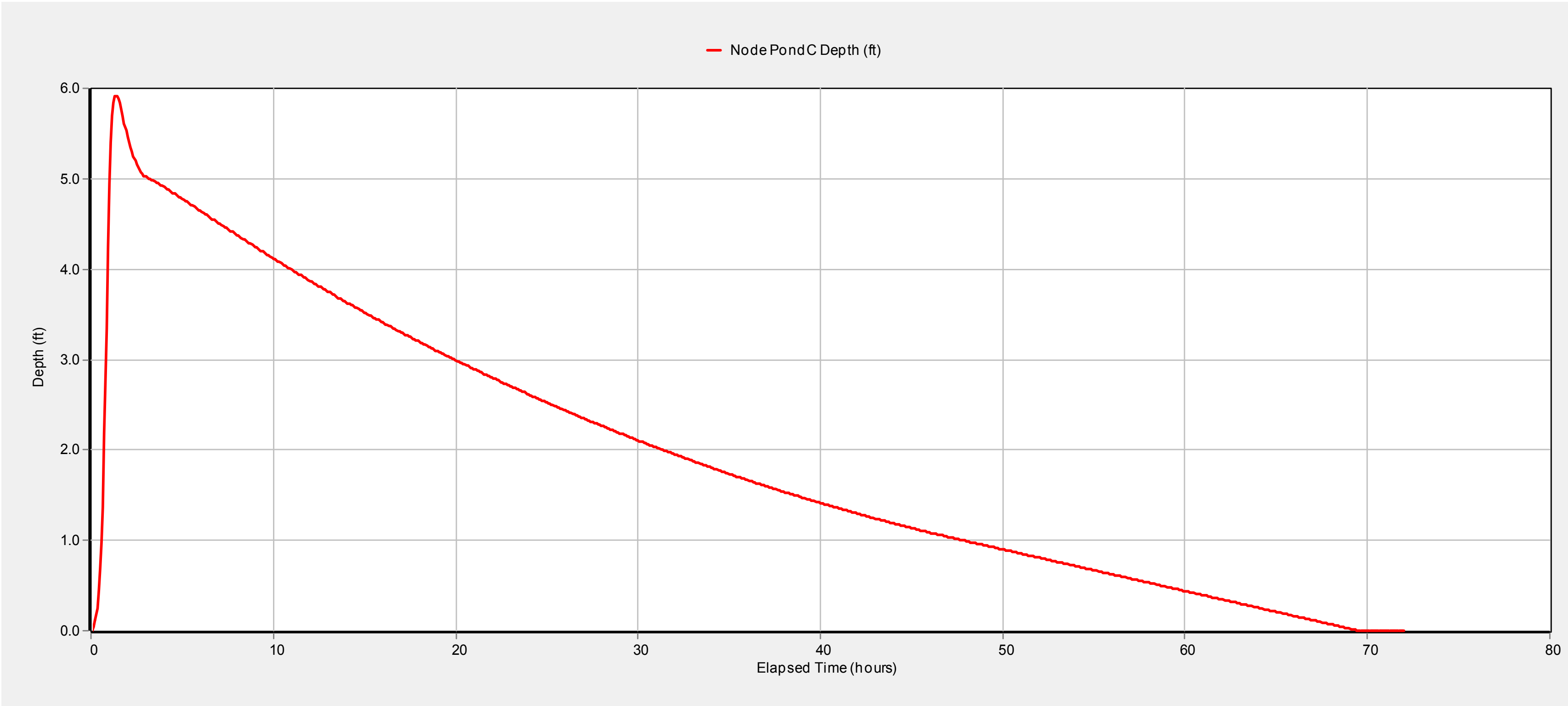
Pond C - 10 year



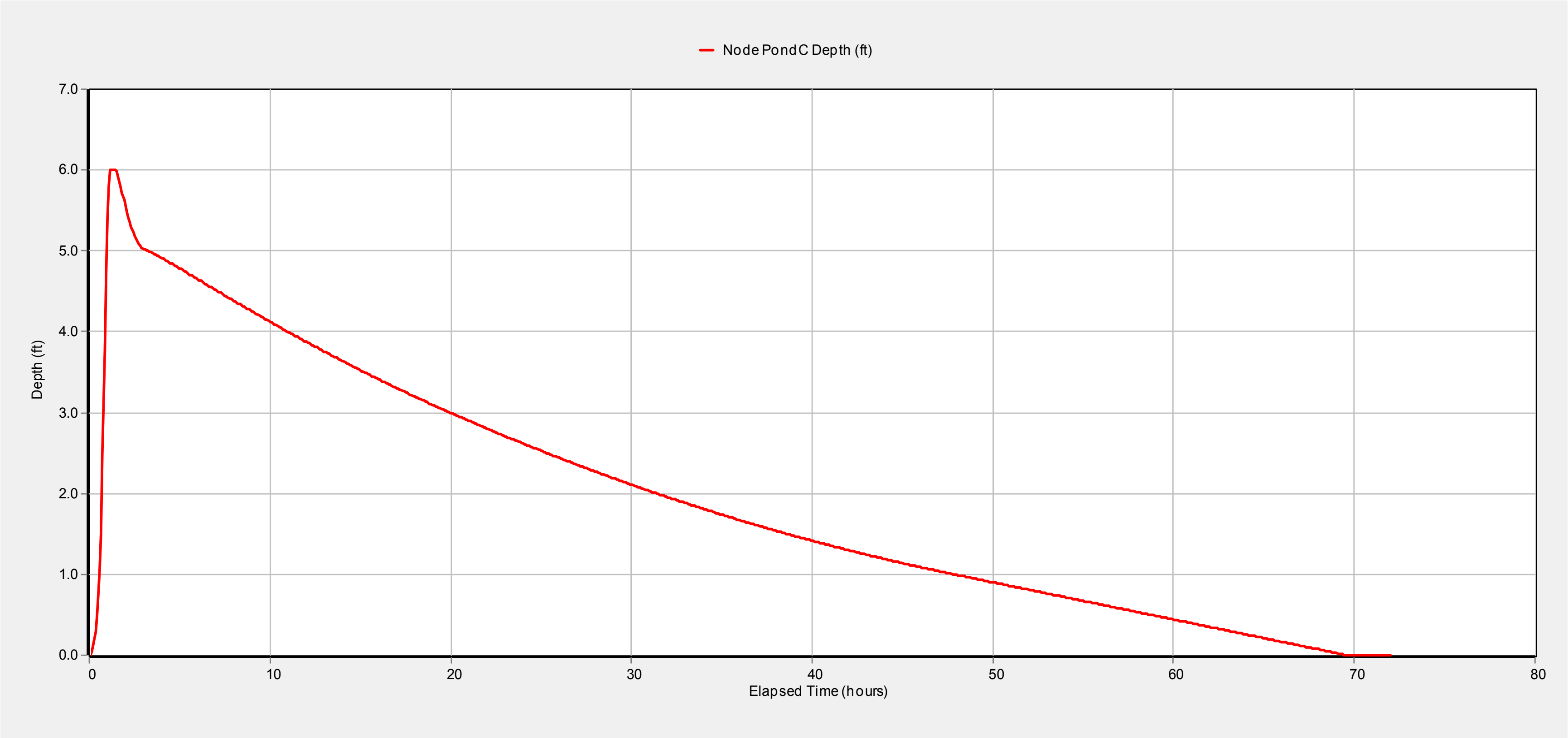
Pond C - 25 year



Pond C - 50 year



Pond C - 100 year



Appendix D
Drainage Map

Galloway
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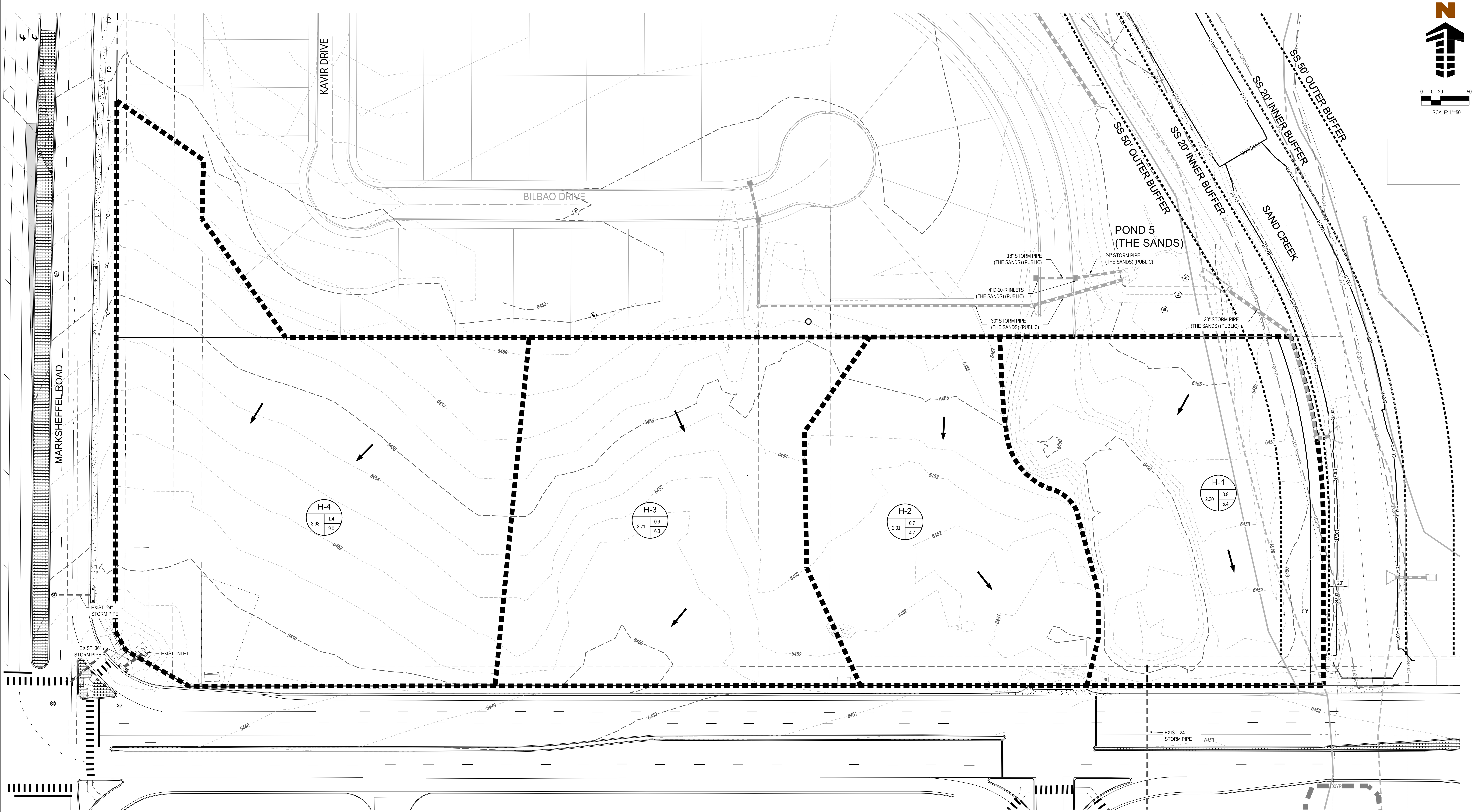
Colorado Springs, Co 80920
719.900.7220 O
www.gallowayUS.com



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SCOTT MICHAEL BROWN
45900
PROFESSIONAL ENGINEER
04/12/2019

THE SANDS RETAIL BUILDINGS MDDP AMENDMENT HISTORIC DRAINAGE MAP

COLORADO SPRINGS, CO

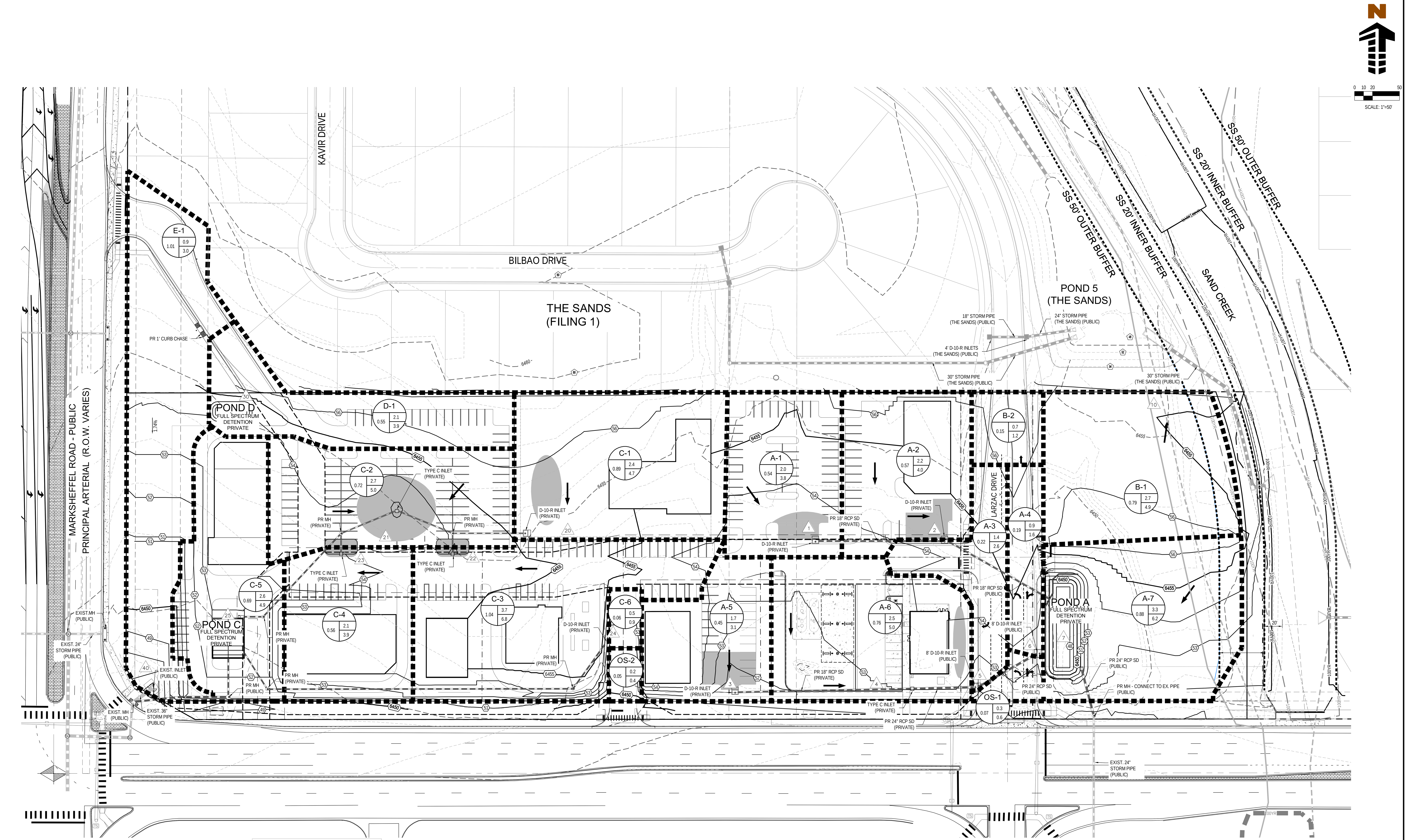
#	Date	Issue / Description	Init.

DRAINAGE LEGEND

4850	EXISTING CONTOUR
	MAJOR BASIN BOUNDARY LINE
H-1	BASIN DESIGNATION
1.7	5-YEAR RUNOFF IN CUBIC FEET PER SECOND
3.2	100-YEAR RUNOFF IN CUBIC FEET PER SECOND
.49	BASIN AREA IN ACRES
	PROPOSED STORM SEWER
DRAINAGE ARROW	PROPOSED FLOW DIRECTION ARROW
	EFFECTIVE 100-YR FLOODPLAIN
	EFFECTIVE 100-YR FLOODWAY
100YR	FEMA PENDING 100-YR FLOODPLAIN
FDWY	FEMA PENDING 100-YR FLOODWAY
100YR	CLOMR 100-YR FLOODPLAIN
	STREAMSIDE OVERLAYS

Project No:	ACD3.01
Drawn By:	BHB
Checked By:	SMB
Date:	JULY 2018

HISTORIC DRAINAGE MAP



DRAINAGE LEGEND

4850	EXISTING CONTOUR
6450	PROPOSED CONTOUR
	MAJOR BASIN BOUNDARY LINE
A-1, .49, 1.7, 3.2	BASIN DESIGNATION; 5-YEAR RUNOFF IN CUBIC FEET PER SECOND; 100-YEAR RUNOFF IN CUBIC FEET PER SECOND; BASIN AREA IN ACRES
	PROPOSED STORM SEWER
DESIGN POINT	DESIGN POINT LABEL
DRAINAGE ARROW	PROPOSED FLOW DIRECTION ARROW
	PROPOSED PARKING LOT DETENTION
	EFFECTIVE 100-YR FLOODPLAIN
	EFFECTIVE 100-YR FLOODWAY
100YR	FEMA PENDING 100-YR FLOODPLAIN
FDWY	FEMA PENDING 100-YR FLOODWAY
100YR	CLOMR 100-YR FLOODPLAIN
	STREAMSIDE OVERLAYS

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Q_5 (cfs)	Q_{100} (cfs)
A-1	0.54	2.0	3.8
A-2	0.57	2.2	4.0
A-3	0.32	1.4	2.6
A-4	0.19	0.9	1.6
A-5	0.45	1.7	3.1
A-6	0.76	2.5	5.0
A-7	0.88	3.3	6.2
B-1	0.79	2.7	4.9
B-2	0.15	0.7	1.2
C-1	0.89	2.4	4.7
C-2	0.72	2.7	5.0
C-3	1.04	3.7	6.8
C-4	0.56	2.1	3.9
C-5	0.69	2.6	4.9
C-6	0.06	0.3	0.5
D-1	0.55	2.1	3.9
E-1	1.01	0.9	3.0
OS-1	0.07	0.3	0.6
OS-2	0.05	0.2	0.4

DESIGN POINT SUMMARY TABLE

Design Point	Q_5 (cfs)	Q_{100} (cfs)
1	2.0	3.8
2	4.2	7.8
3	1.7	3.1
4	4.2	8.0
5	5.5	10.6
6	6.4	12.1
7	13.7	25.7
10	2.7	4.9
11	0.7	1.2
20	2.4	4.7
21	2.7	5.0
22	3.7	6.8
23	10.1	18.8
24	0.3	0.5
25	12.5	23.5
30	2.1	3.9
40	0.9	3.0

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PROFESSIONAL ENGINEER
04/12/2019

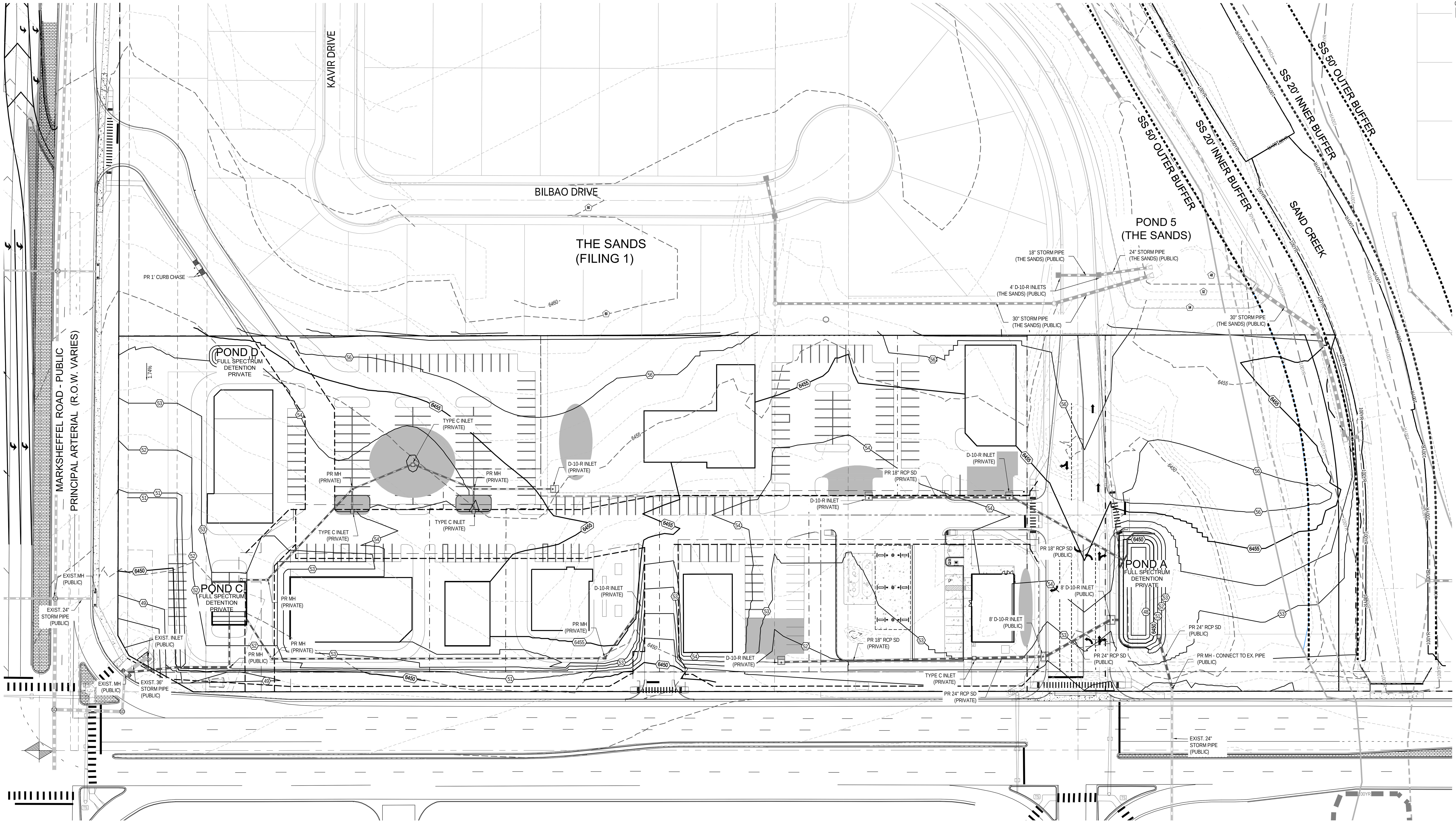
THE SANDS RETAIL BUILDINGS
MDDP AMENDMENT
PROPOSED DRAINAGE MAP

COLORADO SPRINGS, CO

#	Date	Issue / Description	Init.

Project No:	ACD3.01
Drawn By:	BHB
Checked By:	SMB
Date:	FEBRUARY 2019

PROPOSED DRAINAGE MAP



DRAINAGE LEGEND

4850	EXISTING CONTOUR
6450	PROPOSED CONTOUR
	PROPOSED STORM SEWER
DRAINAGE ARROW	PROPOSED FLOW DIRECTION ARROW
	PROPOSED PARKING LOT DETENTION
	EFFECTIVE 100-YR FLOODPLAIN
	EFFECTIVE 100-YR FLOODWAY
100YR	FEMA PENDING 100-YR FLOODPLAIN
FDWY	FEMA PENDING 100-YR FLOODWAY
100YR	CLOMR 100-YR FLOODPLAIN
	STREAMSIDE OVERLAYS

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COLORADO LICENSED SCOTT MICHAEL BROWN 45900 PROFESSIONAL ENGINEER
04/12/2019

THE SANDS RETAIL BUILDINGS MDDP AMENDMENT PROPOSED STORM DRAIN

COLORADO SPRINGS, CO

#	Date	Issue / Description	Init.

Project No:	ACD3.01
Drawn By:	BHB
Checked By:	SMB
Date:	FEBRUARY 2019

PROPOSED STORM DRAIN