Master Development Drainage Plan

Hancock Commons

Colorado Springs, Colorado

Prepared for:

ROS CONSULTING
P.O. Box 60325
Colorado Springs, CO 80960

Prepared by:
PRC Engineering, Inc.

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September 2022

ENGINEER'S STATEMENT:

This report and plan for the drainage design of Hancock Commons was prepared by me (or 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.

Signature: ______________________ Date: September 06, 2022

Raymond E. Perez, III, PE
Registered Professional Engineer State of Colorado No. 37173

COLORADO REGISTERED RAYMOND E. PEREZ III 37173 PROFESSIONAL ENGINEER

DEVELOPER'S STATEMENT:

ROS Consulting hereby certifies that the drainage facilities for Hancock Commons 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 ROS Consulting, guarantee that final drainage design review will absolve ROS Consulting 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.

Name of Developer: HC20, LLC

Authorized Signature: ______________________ Date: 9-27-2022

Printed Name: Ray O'Sullivan

Title: Manager

Address: 17 S Wahsatch Ave., Colorado Springs, CO 80907

CITY OF COLORADO SPRINGS STATEMENT:

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

Heidi M. McMacken ______________________ 09/30/2022

For the City Engineer Heidi McMacken — Date

Conditions:

Final channel improvement report and plans must be provided. Final Drainage Report must be provided. Documentation provided in this report is not sufficient for construction of any portion of the site. The City of Colorado Springs approves these plans based upon the non-jurisdictional status of the facility. It is the design engineer's responsibility to follow up with the State Division of Water Resources for jurisdictional determination. If upon State review the classification changes to Jurisdictional, additional City review and approval will be necessary.

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I. INTRODUCTION

A. Purpose

The purpose of this Master Development Drainage Plan for the Hancock Commons (hereinafter referred to as the "Project") is to must identify major drainageways, detention areas, locations of culverts, bridges, open channels and drainage areas contained within and adjacent to the proposed development and quantify and evaluate the impacts of stormwater runoff generated by this project and to provide adequate water quality/detention treatment and flow conveyance.

B. DBPS Related Investigations

The Peterson Field Basin has been studied numerous times in the past since 1965. For the purposes of this report, the most recent Drainage Basin Planning Study (hereinafter referred to as the "DBPS"), "Peterson Field Master Plan, 1984, URS/NES", hereinafter referred to as the Master Plan, was used as the basis for this report. The following list was taken from the DBPS:

1. Peterson Field Master Drainage Report, 1965, Karich and Weber Inc.
2. Peterson Field Master Drainage Report, 1974, NHPQ Engineers
3. Peterson Field Master Drainage Report, 1976, Department of Public Works, City of Colorado Springs

C. Stakeholder Process

To date, there has not been any public outreach or stakeholder engagement for the project. This phase of project development will run concurrently with the Development Plan process.

D. Agency Jurisdictions

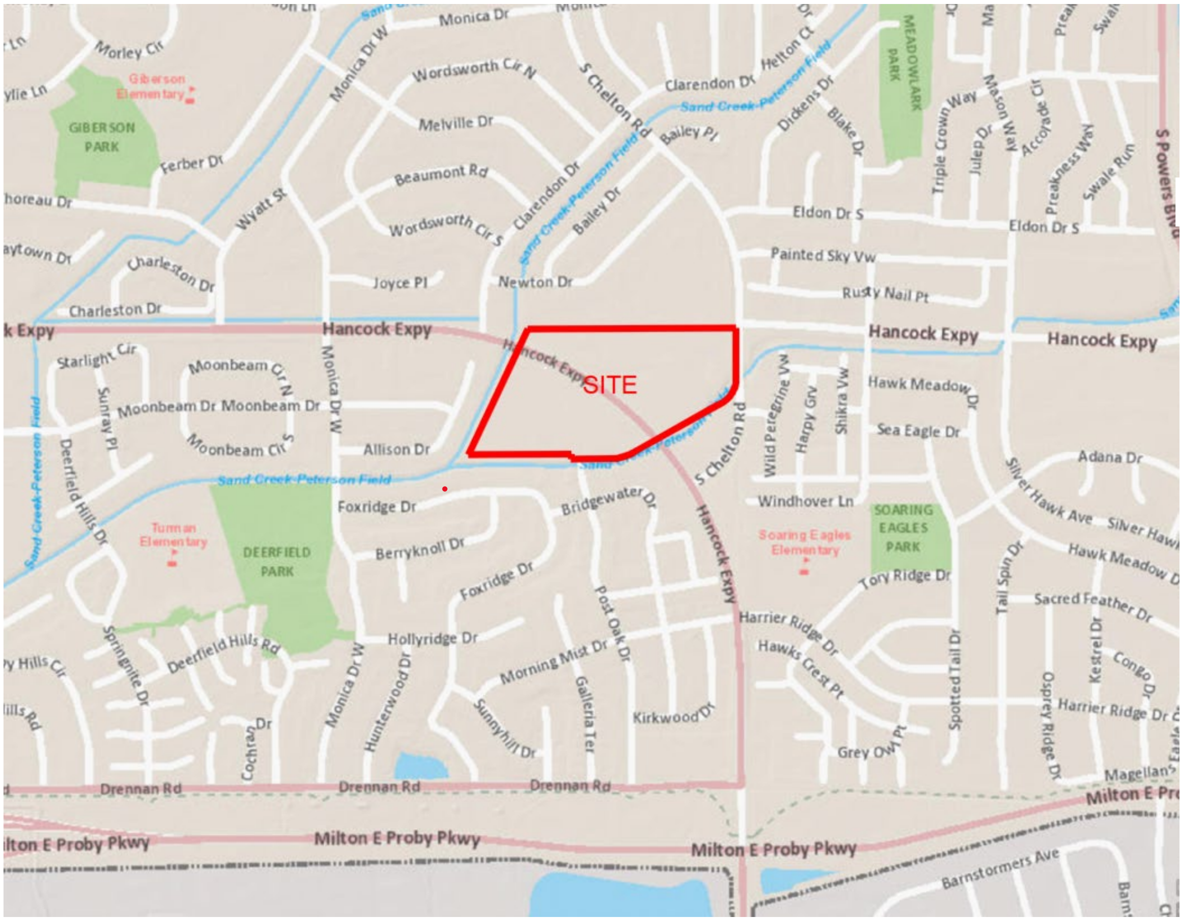
This project is located within the City of Colorado Springs and is subject to the design criteria set forth in the City of Colorado Springs Drainage Criteria Manual, Volumes I and II, dated May 2014 (rev. 2021) (DCM).

E. General Project Description

This project is in Colorado Springs, Colorado, in El Paso County. Access to the site is from Hancock Expressway. It is located in Section 35, Township 14 south, Range 66 west of the 6th Principal Meridian. A vicinity map is provided below in Figure 1.

Figure 1 – Vicinity Map

(Source: Colorado Springs Springsview GIS)



NORTH
1" = 1,200'

The Project is a 20.3-acre mixed-use development. The project will consist of a new retail center and associated site elements typical of multi-family residential development (e.g. – roadways, buildings, parking lots, walkways, parks/open space, detention/water quality ponds etc.) The proposed development area is currently vacant. The site is currently bisected by Hancock Expressway and bounded by the north by existing Hancock Expressway right-of-way (currently unimproved), to the east by Chelton Road, to the west by a canal (hereinafter referred to as the Simmelink II canal), and to the south by the Peterson Field Drainage (waterway). Per the 2009 Streamside Design Guide (2009) published by the City of Colorado Springs; the project is not within Streamside Overlay Zone

F. Data Sources

<u>General</u>

The base mapping (including topography) and structure inventory was provided by Bear Creek Surveying, Inc. (now Colorado ILC Surveying). The field survey was conducted in the fall of 2021. To date there have been no environmental or geotechnical studies performed for the Project. Soils information is provided in section II.B.

Federal Emergency Management Agency
FEMA Data Reference Data

- Community Panel Name: City of Colorado Springs, El Paso County, Colorado
- Community Identification Number: 080060, Panel 0761, G

The Federal Emergency Management Agency (hereinafter referred to as FEMA) provided several Peterson Field Drainage electronic computer models, Flood Insurance Rate Map (FIRM), and Letter of Map Revision (LOMR) documentation. Unfortunately the data provided was either incomplete or in a format that could not be understood. PRC will work closely with the PPRBD floodplain administrator and FEMA to determine the appropriate course of action for the modeling and analysis approach.

Additional data from the FEMA found on the FEMA Flood Map Service Center website

- Flood Insurance Study (FIS) Report – 08041CV003A, December 7, 2018
- Flood Insurance Rate Map – 08041C0761G, December 7, 2018

G. Applicable Criteria and Standards

The hydrologic and hydraulic analysis performed in this report utilizes The City of Colorado Springs Drainage Criteria Volumes 1 (revised January 2021) & 2 (revised December 2020), hereinafter referred to as the CSDCM. In addition to the City Criteria Manual, the Urban Storm Drainage Criteria Manual (USDCM), Volumes 1-3, published by the Mile High Flood District (MHFD), latest update, have been used to supplement the Drainage Criteria Manual for water quality capture volume (WQCV). Stormwater runoff was determined using the Rational Method and was calculated for existing and proposed conditions for the 5-yr (minor) and 100-yr (major) recurrences.

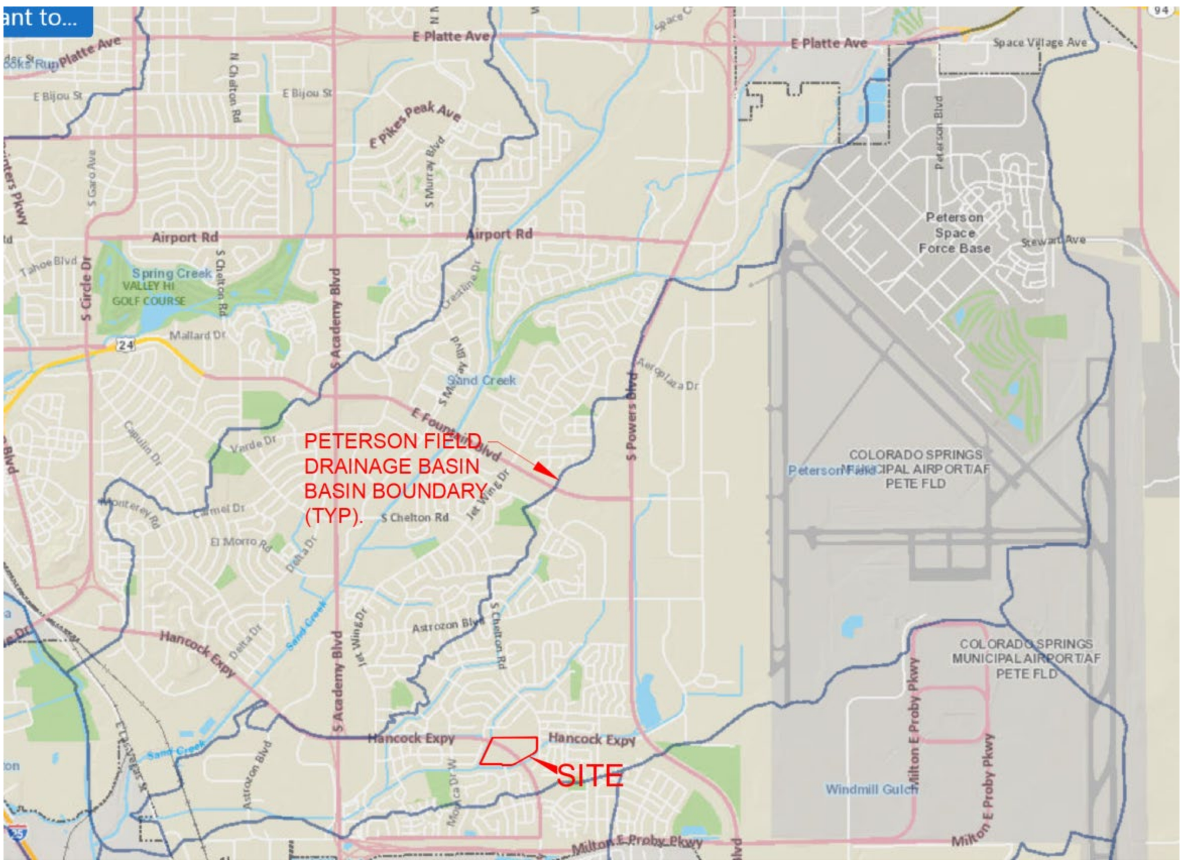
II. PROJECT CHARACTERISTICS

A. Drainage Basin Planning Study Location

Hancock Commons is located entirely within the Peterson Field Drainage Basin. The project is located at the confluence of the Peterson Field drainageway and the Simmelink II drainage channel. The Peterson Field drainage basin is approximately 8.6 square miles. The developed area for the site of 20-acres is approximately 0.4% of the total drainage area within the overall basin. Refer to figure 2 below for the location of the site within the overall basin.

Figure 2 – Peterson Field Drainage Basin – Site Location

(Source: Colorado Springs Springsview GIS)



NORTH

1" = 5,000'

B. Drainage Basin Planning Study Compliance

This study complies with the latest Master Plan study of the Peterson Field drainage basin dated 1984. All developed runoff from the site will be detained and released at pre-development peak rates, and the water quality volume will be treated. Detention and water quality were determined by the MHFD detention spreadsheet UD-Detention v4.04.

C. Land Features

1. Geology

The majority of the site is currently undeveloped and consists of natural vegetative land cover with the exception of existing Hancock Boulevard (major arterial roadway) which essentially bisects the property. The Peterson Field Drainageway (south side) and the Simmelink II drainage channel (west side) are along the edges of the property. There were no pronounced geological features discovered during any of the site visits.

2. Vegetation

Ground cover primarily consists of bare ground and sparse vegetation (shrubs and trees).

3. Soils

The general topography of the land slopes to the west. According to the Natural Resources Conservation Service (NRCS), the soils in this area consist of Blakeland loamy sand, and can be classified as a Hydrologic Soil Group (HSG) Type A. This is used to predict storm water runoff rates. Hydrologic group "A" is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. A soils map and map unit (soils type) descriptions describing the HSG and other soils properties are provided in Appendix A. For the purposes of this report an HSG type A soil has been used to define rational method runoff coefficients.

4. Environmental

To date there has not been any environmental site evaluations conducted. There has not been any geotechnical engineering analysis. Endangered species, wetland identification groundwater determination, etc. will be performed at a later date. Information found within those studies will be included in future Hancock Commons Final Drainage Report (FDR) documentation.

5. Water Quality

There are no known water quality features located on the property.

6. Utilities

Gas service to the proposed development will be provided by Colorado Springs Utilities (CSU) through the extension of the existing gas main infrastructure that currently lies within and adjacent to the site. There is an existing 20" steel gas main that is located within the existing Hancock Expressway roadway corridor. This line will remain in its current location. There is an existing sanitary sewer line in the proposed Hancock Expressway right-of-way. This line will remain in its current location. There is also an existing electric line (unknown voltage) located within the existing Hancock Expressway right-of-way. This line will remain in its current location. There are also water mains located adjacent to the site which will be used for service. It is unknown as to whether there are any communication lines located on the property.

D. Major Drainageways and Infrastructure

There are two major drainageways located adjacent to this site; the Peterson Field drainageway (concrete channel) and the Simmelink II drainage channel (concrete channel). It is unknown as to when they were constructed. It appears that the Simmelink channel was constructed all at once whereas the Peterson Field channel was constructed in phases over many years. The two drainageways are trapezoidal concrete with sides slopes ranging from 0.9:1 to 1.5:1. The Peterson Field drainage channel designs in the past yielded different geometrical variations with heights ranging from 6' to 8', bottom widths from 10' to 12'. It is unknown as to why different design sections were used. The Simmelink II drainage channel seems to be fairly consistent with a typical bottom width of ~6' and a height of ~7.5'.

There is an existing 72" RCP storm pipe beneath existing Hancock Expressway conveying the Simmelink channel flow. It was designed and constructed as an interim feature until such time as Hancock Expressway was re-aligned. This pipe will be replaced by a public 10'x6' CBC as part of this project. There is also an existing public 72" CMP storm pipe under existing Hancock Expressway conveying Peterson Field drainageway flows. This too was an interim feature, constructed to convey flow beneath Hancock Expressway until such time as it was re-aligned to the north (the current improvement scope). There is an existing dual public 7.5'x8' CBC under Post Oak Drive conveying Peterson Field drainageway flows. Two public 8' D-10-R inlets are located on top of the structure and have been constructed with the CBC as one unit. The inlets and CBC is in good condition.

E. Existing and Proposed Land Uses

Presently, the site is unplatted and consists of undeveloped land. Hancock Commons is a proposed planned unit development (PUD) which includes both residential and commercial uses. Development of utilities and internal roadways are to be included in this parcel.

III. HYDROLOGIC ANALYSIS

A. Methodology

1. Method of Analysis

   Storm sewer sizing for this project uses the Rational Method as recommended by
   the DCM for the minor and major storms for drainage basins less than 100-acres in size.
   The Rational Method uses the following equation:

   $Q=C*I*A$

   Where:
   Q = Maximum runoff rate in cubic feet per second (cfs)

C = Runoff coefficient
I = Average rainfall intensity (inches/hour)
A = Area of drainage sub-basin (acres)

2. Runoff Coefficient
   Coefficients from Table 6-6 of the DCM for developed land were utilized in the Rational Method calculations. See Appendix B for more information.

3. Time of Concentration
   The time of concentration consists of the initial time of overland flow and the travel time in a hydraulic conveyance feature to a design point or similar location of interest. A minimum time of concentration of 5 minutes is utilized for urban development.

4. Rainfall Intensity
   The hypothetical rainfall depths for the 1-hour storm duration were taken from Table 6-2 of the Colorado Springs Drainage Criteria Manual. Table 3.1. 1.50 inches for the 5-year storm and 2.52 for the 100-year storm event.

B. Basin Hydrology – Existing Conditions

This project is located in the Peterson Field major drainage basin. The project consists of one lot to be developed at this time. It is our understanding there is no Master Development Drainage Plan (MDDP) on file that encompasses this project. Therefore, this project area is considered unstudied from a master development drainage analysis perspective. Refer to the existing conditions drainage map in Appendix D.

Stormwater runoff from the project generally flows to the west, and ultimately discharges into the Peterson Field drainageway or the Simmelink II drainage channel. Five (5) basins were delineated for this analysis. Refer to the existing conditions map in Appendix D.

Basin E1 (2.84ac, Q5=1.4cfs, Q100=4.7cfs) consists of undeveloped vacant land with grass and shrubs as well as a portion of existing Hancock Expressway. This portion of Hancock Expressway right-of-way corridor will be demolished. Runoff from this basin travels overland discharging directly into the Peterson Field drainageway.

Basin E2 (7.74ac, Q5=2.8cfs, Q100=12.9cfs) consists of undeveloped vacant land with grass and shrubs as well as a portion of existing Hancock Expressway. This portion of Hancock Expressway right-of-way corridor will be demolished. Runoff from this basin travels overland discharging directly into the Simmelink II drainage channel.

Basin E3 (1.19ac, Q5=4.8cfs, Q100=9.0cfs) consists of the existing Hancock Expressway right-of-way corridor. This portion of Hancock Expressway will be demolished, and landscaping provided. Runoff from this basin travels overland discharging directly into the adjacent Simmelink II subdivision and the park on the west side of the subdivision. There is currently no curb and gutter on the south side of Hancock Expressway, therefore runoff discharges directly into those properties. Once Hancock Expressway is re-aligned, a minimal amount of flow will enter the adjacent properties to the south.

Basin E4 (17.32ac, Q5=5.4cfs, Q100=22.2cfs) consists of an undeveloped lot with grass and shrub vegetation at the northwest corner of Chelton and proposed Hancock Expressway; single family residential subdivision (Southborough Filing No. 9) and portions of the existing Hancock Expressway right-of-way corridor which will be demolished, along with on-site vacant land area. Runoff from this basin travels overland to a public 18" CMP storm culvert which conveys flow from a depression are to the west side of Clarendon Drive to an existing concrete V ditch. The culvert is undersized and flow likely overtops and enters two existing inlets at a low point in Clarendon on the north side of Hancock Expressway. Flow captured by these inlets is conveyed to the previously mentioned concrete V ditch. There is no record of the 18" CMP storm pipe in any of the Southborough reports. It is assumed this was provided as a temporary pipe to alleviate nuisance flows across Clarendon.

Basin E5 (3.1ac, Q5=1.0cfs, Q100=4.3cfs) consists of undeveloped vacant land with grass and shrubs as well as a small portion of existing Chelton Road. Runoff from this basin travels overland discharging directly into the Peterson Field drainageway.

C. Basin Hydrology – Proposed Conditions

Stormwater runoff from the project generally flows to the west, and ultimately discharges into the Peterson Field drainageway or the Simmelink II drainage channel. Proposed grading of the site will generate thirteen (13) on-site basins and four (4) off-site basins. Refer to the proposed conditions map in Appendix D.

All proposed storm piping, inlets and manholes within public right-of-way or within the drainage channel tract) will be publicly owned and maintained. All other proposed storm system elements will be privately owned and maintained. All pipes have been assumed to be RCP except for pipes 1, 6, 12 thru 15 which are small diameter private pipes which will be PVC. <u>All public storm pipes will be RCP. HDPE pipe material may be used for onsite private pipes when the final design is completed and subsequent FDR's are submitted.</u>

Design Point 1 flows are generated from onsite basin A1. Basin A1 (0.64ac, Q5=0.2cfs, Q100=1.6cfs) consists of a portion of existing Hancock Expressway right-of-way corridor, which will be demolished and established with landscaping. Basin A1 consists of proposed open space. Runoff from this basin will travel overland easterly to proposed private CDOT type C sump inlet 1. Flows will combine with roof drain runoff and will then be routed to the south via proposed private 15" PVC storm pipe 1 to proposed pond "A". There will be area drains located along the alignment to capture runoff and convey it to pond A. In the event the inlet becomes clogged, flows will overtop the depression and enter the Simmelink II drainage channel.

Design Point 2 flows are generated from onsite basin A2. Basin A2 (4.35ac, Q5=8.4cfs, Q100=18.1cfs) consists of townhomes, streets and open space. Runoff from this basin will travel overland to adjacent streets to a proposed private City standard 8' D-10-R sump inlet. Flows will then be routed to the southwest via proposed private 24" RCP storm pipe 2 to proposed pond "A". In the event the inlet becomes clogged, flow will overtop the curb and enter the pond directly.

Design Point 3 flows are generated from onsite basin A3. Basin A3 (2.56ac, Q5=5.7cfs, Q100=12.0cfs) consists of townhomes, streets and open space. Runoff from this basin will travel overland to the adjacent streets to two proposed public City standard 4' D-10-R sump inlets (inlets 3 and 4). Flows will then be routed to the south via proposed public RCP storm pipes 3 (18"), 4 (18"), and 5 (24") to design point 4, a public manhole in Post Oak Drive. In the event the inlets become clogged, flow will overtop the high point south of the intersection and will be routed to Design Point 14 where it will be captured by existing and proposed inlets.

Design Point 4 flows are generated from onsite basin A3 and A4. Basin A4 (0.55ac, Q5=1.1cfs, Q100=2.8cfs) consists of a proposed townhome and lawn areas. A small portion of runoff from this basin will travel overland westerly to proposed private CDOT type C area inlet 5. Flows will combine with roof drain runoff and will then be routed to the west via proposed private 12" PVC storm pipe 6 to a public manhole in Post Oak Drive. Flows will combine with those from basin A3 and will be conveyed westerly to pond A via private 30" RCP storm pipe 7. There will be area drains located along the alignment to capture runoff and convey it to design point 5. In the event the inlet becomes clogged, flow will overtop the curb and gutter and enter the channel directly.

Design point 5 is located in the pond and represents the location where all runoff will be routed. Refer to section 7 for pond A design information.

Design point 6 is located at the pond outfall and represents the location where all runoff will be discharged into the Simmelink II drainageway. Refer to section 7 for outfall design information.

Design Point 7 flows are generated from onsite basin B1 and off-site basins O2 and O3. Basin B1 (5.76ac, Q5=17.6cfs, Q100=34.0cfs) consists of Hancock Expressway, buildings and parking lots. Basin O2 (7.31ac, Q5=2.5cfs, Q100=18.1cfs) consists of an undeveloped lot with grass and shrub vegetation. It is assumed in this report that pond B will accommodate this off-site basin runoff until such time as the property is developed. At that time, water quality and detention will be provided, thereby releasing flows at historic rates. A public 18” RCP storm pipe will be constructed with the Hancock Commons projects improvement scope to provide a necessary outfall pipe system. This pipe will then outfall into a proposed public 10’x6’ concrete box culvert (CBC) under Hancock Expressway. Basin O3 (1.27ac, Q5=2.6cfs, Q100=5.7cfs) consists of single-family residential development. Runoff from this basin will be conveyed overland to Hancock Expressway, ultimately be conveyed via curb and gutter to design point 7. At design point 7, two public 12’ City standard D-10-R sump inlets are proposed. Flows will be conveyed to the pond via pipe 8 (30” RCP - public) and pipe 9 (42” RCP - public). In the event the inlets become clogged, flow will overtop the curb and gutter and proceed southerly entering the Simmelink II channel.

Design Point 8 flows are generated from onsite basin B2. Basin B2 (0.65ac, Q5=2,7cfs, Q100=5.0cfs) consists of commercial buildings and a parking lot. Runoff from this basin will travel overland westerly to proposed private City standard 4’ D-10-R sump inlet 8. Flows will then be routed to the west via proposed public (within the ROW)/private 18” RCP storm pipe 10 to proposed pond “B”. In the event the inlet becomes clogged, flow will overtop the parking lot curb and gutter and enter Post Oak Drive. It will then be conveyed in the southern curb line of Hancock Expressway towards Design Point 7.

Design Point 9 flows are generated from a portion of onsite basin B3. Basin B3 (1.72ac, Q5=6.3cfs, Q100=12.1cfs) consists of buildings and a parking lot. Runoff from this basin will travel overland westerly to proposed private City standard 4’ D-

10-R sump inlet 9. Flows will then be routed to the west via proposed public (within the ROW)/private 18" RCP storm pipe 11a to design point 10. In the event the inlet becomes clogged, flow will overtop the parking lot curb and gutter and enter a private drive aisle and be routed to Post Oak Drive. It will then be conveyed in the southern curb line of Hancock Expressway towards Design Point 7.

Design Point 10 flows are generated from a portion of onsite basin B3 similar to design point 9. Runoff from this basin will travel overland westerly to proposed private City standard 4' D-10-R sump inlet 10. Flows will then be routed to the west via proposed public (within ROW)/private 18" RCP storm pipe 11b to proposed pond B. In the event the inlet becomes clogged, flow will overtop the parking lot curb and gutter and enter Post Oak Drive. It will then be conveyed in the eastern curb line of towards Design Point 3.

Design point 11 is located in the pond and represents the location where all runoff will be routed. Refer to section 7 for pond B design information.

Design Point 12 flows are generated from a portion of onsite basin C (1.91ac, Q5=3.7cfs, Q100=7.9cfs) and all of basin F (0.20ac, Q5=0.9cfs, Q100=1.7cfs). Basin F consists of a small portion of Hancock Expressway. Runoff from basin F will be captured by a proposed public 4' radial inlet (inlet 17). It has been designed to be a radial inlet because flow cannot be captured to the west of the curb returns because they would not capture the flow in its entirety. Flow is then conveyed via a proposed private 18" RCP westerly, tying into inlet 11. Basin C consists of buildings, parking lot and open space. Runoff from this basin will travel easterly to proposed private City standard 4' D-10-R sump inlet 11. Flows will then be routed to the south via proposed private 12" PVC storm pipe 12 to private City standard 4' D-10-R sump inlet 12. Flows will then be routed to the south via proposed private 12" PVC storm pipe 13 to a proposed swale. At the upstream end of the swale, a riprap pad will be provided for energy dissipation. This swale will then convey runoff to a proposed private full-spectrum rain garden (pond C). Refer to section 7 for pond C design information. In the event inlet 11 becomes clogged, flow will overtop the high point in the drive aisle and route flow south towards inlet 12. In the event inlet 12 becomes clogged, flow will overtop the parking lot curb and gutter and proceed southeasterly into Chelton Road.

Design Point 13 flows are generated from onsite basin D. Basin D (1.01ac, Q5=2.6cfs, Q100=5.8cfs) consists of buildings and a parking lot. Runoff from this basin will travel overland easterly to proposed private City standard 8' D-10-R sump inlets 15 and 16. Flows will then be routed via proposed private 12" PVC storm pipes 14 and 15 to design point 13 where a proposed private full spectrum rain garden is proposed (pond D). Refer to section 7 for pond C design information. In the event inlet 15 becomes clogged, flow will overtop the parking lot curb and gutter and proceed south to inlet 5. In the event inlet 16 becomes clogged, flow will over top the parking lot curb and gutter and proceed southeast directly into the proposed channel.

Design point 14 flows are generated from off-site basin O1, Pinehurst Subdivision filings no. 4 and 5. Basin O1 (12.19ac, Q5=26,8cfs, Q100=55.8cfs) consists of residential development. Runoff from this basin will travel overland and via curb and gutter to Post Oak Drive where it routes flow to an existing low point located on top of an existing double public 7.5' x 8' concrete box culvert. There are two public 8' sump inlets located at this location and have been constructed with the CBC capturing and depositing flow directly into the top of the existing culvert. These structures are in good condition. From the Pinehurst Filings No. 4 and 5 drainage study, the 5yr and 100yr flows were calculated to be 39.7cfs and 84.7cfs respectively. Our analysis determined the flows to be 26.8cfs and 55.8cfs for the 5yr and 100yr storms respectively. The Pinehurst report flow values were calculated based on hydrologic inputs valid at that time. Since then, refined inputs have been produced and the basins flow differences are expected. It is noteworthy to mention the existing inlets appear to have been designed to accommodate the 5yr storm flows only. This may have been the approach taken when the report was prepared. Given that, two new public 8' City std type D-10-R inlets (13 and 14) are being installed adjacent to the CBC such that the additional flows can be captured and conveyed to the channel downstream of the CBC. Flows captured by the inlets will be routed to the channel via public 18" RCP storm pipe 16 and public 24" RCP storm pipe 17. In the event the inlets become clogged, flow will overtop the curb and go directly into the existing channel.

Design Point 15 flows are generated from proposed Hancock Expressway basin E. Basin E (0.96ac, Q5=4.3cfs, Q100=7.8cfs) consists of street improvements. Runoff from this basin will travel via curb and gutter westerly. Runoff from this basin cannot physically be captured and conveyed to a water quality and detention facility located on-site. Therefore, pond B will be designed to over detain and treat runoff, thereby compensating for this area.

Design Point 16 flows are generated from proposed Hancock Expressway basin G. Basin G (0.59ac, Q5=0.5cfs, Q100=1.8cfs) consists of a portion of existing Hancock Expressway that will be demolished and revegetated. Runoff from this basin will flow overland as unconcentrated sheet flow until it reaches a grass lined swale. Flow will then be routed northerly to a proposed public CDOT Type C sump inlet no.18. The runoff has been channelized in this way so as to prevent runoff from entering the development to the west. In the event the inlet become clogged, flow will be routed into the proposed concrete lined channel.

A summary of the basin runoff coefficients, peak flow rates and hydrologic analysis support calculations are provided in Appendix B.

D. Water Quality

Four-Step Process

The City of Colorado Springs requires the MHFD Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

Step 1: Runoff Reduction Practices

This development address Low Impact Development strategies primarily through the utilization of landscape buffers, located in areas adjacent to the building and parking lot areas of the site. Runoff is routed over these grass areas via unconcentrated sheet flow prior to being conveyed to water quality and detention facilities. All future FDR's associated with this site will be required to meet Runoff Reduction Criteria, including conformance with the Green Infrastructure Manual and Policy Clarification.

Step 2: Implement BMPs - Water Quality Capture Volume with Slow Release

On-site flow is directed to two private full-spectrum extended detention basins and two rain gardens. These facilities provide Water Quality Capture Volume (WQCV) required for the site by releasing flows over a longer period of time. The proposed facilities meet or exceed the DCM standards for the release rates of full-spectrum detention ponds for water quality capture volumes.

Step 3: Stabilize Drainageways

All the flows generated from impervious portions of this site will be routed to private water quality and detention facilities. These flows will combine with flows from other areas adjacent to the site and discharge into the Peterson Field drainageway and the Simmelink II drainage channel. Channel improvements are being proposed with this development. This will consist of a trapezoidal concrete channel replacing an existing ditch between Chelton Road and existing Hancock Expressway. Channel improvement details, including HEC-RAS modeling, will be provided in the future FDR. The channel will be publicly owned and maintained. Based on the available topographical data for the site, the existing concrete channels have slopes ranging from of approximately 0.75% to 1.75%. Field investigations of the site appear to show the concrete channels are stable. The FEMA Q100 of 2475cfs necessitates a design slope for channel improvements to be 0.50% to ensure flow velocities are below 20fps. No drop structures are proposed for the new reach of concrete channel.

Step 4 – Implement Site Specific and Other Source Control BMPs
To adhere to the City's Municipal Separate Storm Sewer System (MS4) requirements, temporary construction BMP's and permanent post construction BMP's will be implemented to reduce the potential of pollutants entering the creek. The implementation of these BMP's will be provided in the Grading, Erosion and Stormwater Quality Control Plan and Stormwater Management Plan for the site. The Stormwater Management Plan also addresses structural and procedural source control BMP's such as materials storage and spill prevention, containment, and control, etc. during construction to protect downstream receiving waters. Refer to the Stormwater Management Plan for this site for additional source control BMP information specific to this site. If deemed necessary, site specific source controls including covering storage/handling areas and spill containment will be used.

1. Water Quality Improvements

The proposed full-spectrum extended detention basins and full-spectrum rain gardens have been analyzed in this study based on the proposed site conditions as shown on the Proposed Conditions Drainage Map, sheet D2.

Full Spectrum Extended Detention Basin – Pond A
For the purpose of this report, a detailed pond design was not conducted. This will be provided in future FDR's. As such, the MHFD UD-Detention spreadsheet was used for preliminary sizing. A private full spectrum extended detention basin (EDB) is proposed for this portion of the site. The proposed on-site imperviousness contributing to this pond has been calculated to be 48.6%. The ponds' tributary area (basins A1 thru A5) equals 10.52 acres. The pond facility will provide ~1.0acre-ft of detention volume and ~0.2acre-ft WQCV. The EDB will have forebays, maintenance access road, concrete trickle channel, micropool an outlet structure.

The full-spectrum EDB will have a rip rap emergency overflow spillway that will drain the 100yr peak flows in the event the outlet structure becomes entirely clogged and another 100yr event passes. The spillway will be constructed of soil rip rap. A minimum of 1.0' of freeboard will be provided. The spillway will be situated such that any overflow will be directed into the Peterson Field drainageway. Refer to the design calculations in Appendix B for additional information.

Full-Spectrum Extended Detention Basin – Pond B
As mentioned prior, a detailed pond design was not conducted. This will be provided in future FDR's. The MHFD UD-Detention spreadsheet was used for preliminary sizing. A private full spectrum extended detention basin (EDB) is

proposed for this portion of the site. To compensate for basin E flow, which is not collected or treated with this project, the proposed pond will over detain and under release. Over detaining is performed by adding the acreage and imperviousness of basin E into the pond input. Under release is accomplished by means of releasing the amount of flow as if basin E was not included, thereby ensuring the release is not calculated based on the falsely high pre-development peak flow rates.

Basin O2 is tributary to pond B. In the interim period until such time as the property is developed, the pond has been designed to accept and treat its runoff. Once the site is developed, runoff will not enter Hancock Expressway as it will need to be treated and detained according to MS4 permit requirements. Both scenarios have been modeled in this report to ensure the largest volume is provided.

The proposed on-site imperviousness contributing to this pond has been calculated to be 70.3%. The ponds' tributary area (basins B1 thru B4, O2, O3 and E) equals 12.09 acres. The pond facility will provide ~1.6 acre-ft of detention volume and ~0.3 acre-ft WQCV. The EDB will have forebays, maintenance access road, concrete trickle channel, micropool and an outlet structure.

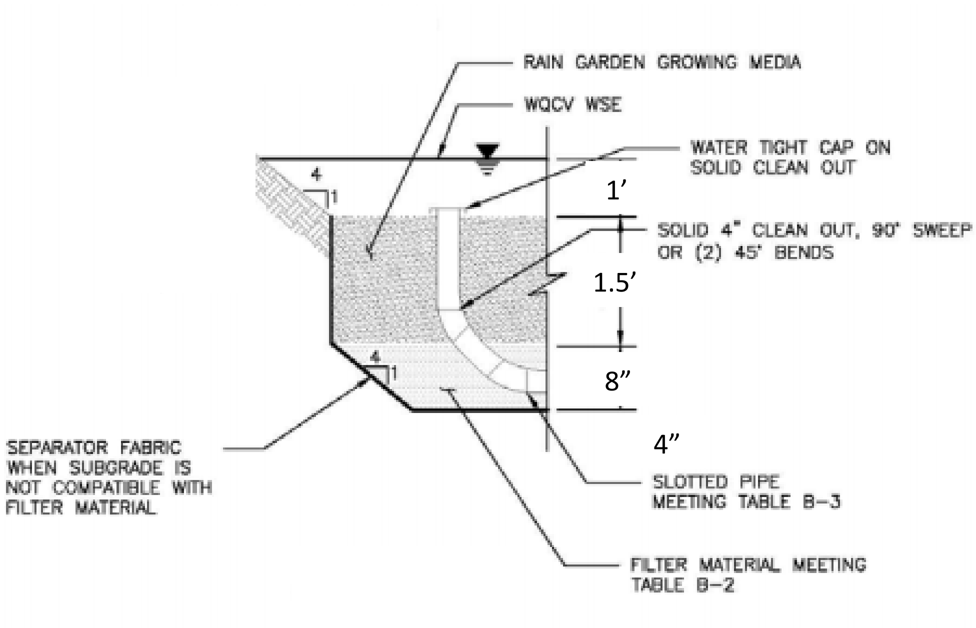
The full-spectrum EDB will have a rip rap emergency overflow spillway that will drain the 100yr peak flows in the event the outlet structure becomes entirely clogged and another 100yr event passes. The spillway will be constructed of soil rip rap. A minimum of 1.0' of freeboard will be provided. The spillway will be situated such that any overflow will be directed to the west. If overtopping does occur, flow will be routed to westerly eventually drain into the Simmelink II drainage channel as unconcentrated sheet flow. The pond will outfall into the proposed public 10'x6' CBC under Hancock Expressway. The peak flow rate released will be minimized so as to not overload the culvert. Any additional flow will be taken into consideration when the CBC is designed. Refer to the design calculations in Appendix B for additional information.

Full-Spectrum Rain Garden – Pond C

The proposed private full spectrum rain garden (aka – Bioretention Pond) has been analyzed in this study based on the proposed site conditions as shown on the Developed Conditions Drainage Map, sheet D3.

The facility will utilize a 1.5' thick growing media. The rain garden will utilize a 4" diameter slotted pipe within an 8" thick filter media. (see Figure 1 below)

IV. Figure 1 (per UDFCD Bioretention T-3)



The rain garden provides a water quality capture volume (WQCV) of 0.033 ac-ft and a 100yr detention volume of 0.229ac-ft. The facility will release the WQCV over a 40hr period. Outflows from the proposed facility are released via a proposed 4" slotted pipe with a reducer fitting located at the downstream end as well as an outlet structure and outfall pipe. The facility will have a maintenance access road. The facility will have an emergency overflow system that will route the 100yr peak flows, away from the facility directly into the Peterson Field drainageway via an overflow spillway. 1.0' of freeboard minimum will be provided. Depending on the infiltration rate of the existing soils, a full infiltration facility may be used. This will be determined once a final sub-surface soils investigation is prepared. Refer to Appendix B for support calculations.

Full-Spectrum Rain Garden – Pond D

The private full-spectrum rain garden provides a water quality capture volume (WQCV) of 0.021 ac-ft and a 100yr detention volume of 0.148ac-ft. The facility will release the WQCV over a 40hr period. Outflows from the proposed facility are released via a proposed 4" slotted pipe with a reducer fitting located at the downstream end as well as an outlet structure and outfall pipe. The facility will have a maintenance access road. The facility will have an emergency overflow system that will route the 100yr peak flows, away from the facility directly into the Peterson Field drainageway via an overflow spillway. 1.0' of freeboard minimum will be provided. Depending on the infiltration rate of the existing soils, a full infiltration facility may be used. This will be determined once a final sub-surface soils investigation is prepared. Refer to Appendix B for support calculations.

IV. HYDRAULIC ANALYSIS

A. Methodology

The following MHFD hydraulic software were used in this report:

- MHFD UD-Channels v1.00 – Concrete Channels
- MHFD UD-Culvert v4.00 – Pipe Calculations

B. Major Drainageways

Seven (7) cross sections were modeled along both channel reaches. Five (5) along Peterson Field drainageway (cross sections 1 thru 5) and two (2) along the Simmelink channel (cross sections 6 and 7). Per the FEMA FIS and associated LOMR's and floodplain analyzes, the Peterson Field channel conveys 2,475cfs during the 100yr storm event. The FIS does not include 100yr storm event flow values for the Simmelink II channel. Per the Master Plan, the design flow for the Peterson Field channel is 5,390cfs while the Simmelink channel is 850cfs during the 100yr storm event. Therefore, as can be seen in table 1 below, there is adequate freeboard provided in each case because the computations below were modeled using the FEMA flow value. These do not reflect backwater effects so they are intended to serve as a preliminary analysis only. A HEC-RAS analysis will be conducted in the FDR with a proposed design consisting of a concrete trapezoidal channel replacing the unlined reach between existing Hancock Expressway and the Chelton CBC's.

Table 1 – Open Channel Flow Calculation Summary – Existing Conditions (see note* below)

Cross Section	Channel Height (ft)	Flow Depth (ft)	Freeboard (ft)	Bottom Width (ft)	Side Slopes R & L (Z)	Velocity (fps)
1	8.3	5.6	2.7	9.4	1.6,1.8	23.4
2	8.0	5.2	2.8	9.6	1.5,1.5	27.7
3	6.2	4.7	1.6	11.8	1.5,1.2	29.5
4	6.2	4.6	1.6	11.3	1.4,1.7	29.1
5*	7.5	6.5	1.0	12.0	1.5,1.5	17.6
6	7.5	5.1	2.4	5.7	1.0,1.0	15.6
7	7.6	6.4	1.2	5.9	1.0,1.0	10.9

* Note – Cross Section 5 has been modeled assuming a new concrete channel is constructed between existing Hancock Expressway and Chelton Road.

C. Structure Characteristics/Deficiencies/Need Improvements

The only deficiencies known on this project are the one existing public 72” RCP and one public 72” CMP pipe beneath existing Hancock Expressway. They were designed and constructed as interim features until such time as Hancock Expressway was re-aligned. As mentioned prior, the public 72” RCP conveying Simmelink II channel flow will be replaced by a public 10’x6’ CBC. The existing public 72” CMP conveying the Peterson Field flows will be removed entirely and will be replaced with a concrete channel up to the existing dual 12’x8’ CBC’s under Chelton Road. Existing capacity calculations for these pipes will be provided in subsequent FDR’s. The 72” RCP is in good condition while the CMP is in fair condition.

D. Floodplains – Peterson Field Drainageway

Per the Flood Insurance Rate Map (FIRM) 08041C0761G, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), a portion of Hancock Commons lies within the designated 100year floodplain of the Peterson Field drainageway. A FIRMette of the project area is included in Appendix A. Per City of Colorado Springs regulations, when land is developed adjacent to a major drainageway, channel improvements will be required. The reaches of the Peterson Field drainageway that run along the Hancock Commons site are specified on the FIRM as sections X-X thru Z-Z. In the Master Plan this reach is delineated as 9J.

The Master Plan recommends channel improvements to include a concrete lined channel for the reach adjacent to the site. The dimensions in the report state a bottom width of 11’, a depth of 8’ and 1000’ of improvements. The actual channel design will differ from the Master Plan recommendations and will follow the current governing channel design criteria. A Conditional Letter of Map Revision (CLOMR)/Letter of Map Revision (LOMR) process will be required once channel improvements are triggered in order to show the revised extent of the regulatory floodplain through the site. The channel and improvements will be located within a tract or easement and will be owned and maintained by the City of Colorado Springs. Maintenance access to the channel will also be provided in accordance with criteria.

It is the intent of the map revision to remove the site from being in the floodplain. Currently the existing public 72” CMP pipe under existing Hancock Expressway chokes the flow and causes backwater effects that pushes flow to the north and west. See appendix A FIRMette. Once the improvements are made to the channel, the flow should be contained within the existing and proposed channel, thereby removing the site from the floodplain.

V. ENVIRONMENTAL EVALUATIONS

A. Wetland and Riparian Areas

A wetland identification process has not been performed to date. Future Final Drainage Reports (FDR's) will include this information.

B. Stormwater Quality

Refer to section III E for water quality provided for this project.

C. Permitting Requirements

A USACE 404 permit and PPRBD floodplain development permit are anticipated permits which will be required along with the proposed channel improvements.

VI. ALTERNATIVES EVALUATION

An alternatives evaluation was not conducted for this project. The Master Plan outlined improvements that have since been constructed by others (developers and the City Public Works division).

VII. SELECTED PLAN (IMPLEMENTATION OF THE MASTER PLAN)

A. Plan Hydrology

The Master Plan does not show the basin boundaries on any of the exhibits/maps. Our assumption is that this may have been done in earlier DBPS versions but are not available from the City's web site. It also does not explain the land use assumptions that were made at that time. The proposed 20-acre development lies entirely within the Peterson Field drainage basin. Per the Master Plan the watershed at this location is approximately 7 square miles in size.

Per the MHFD modeling of the proposed full-spectrum detention/water quality ponds, detention from this project will either be equal to or reduce the major storm (100yr event) discharge from the site from the pre-development. As the proposed development is not projected to increase runoff from the site, there should not be any additional impact to downstream infrastructure.

B. System Improvements

Proposed improvements to the Peterson Field drainageway adjacent to this site are in conformance with the Master Plan. Improvements to the Simmelink II channel crossing replacement under existing Hancock Expressway are not called out or addressed in anyway in the Master Plan. However, plans found on the City's design plan index web site include the original plans for the crossing and call out the future public 10'x6' CBC.

C. System Priorities/Phasing

No phasing of the development is known at this time. Once development of any portion of the site begins, the owner will be responsible for providing full-spectrum detention and water quality in accordance with this MDDP. Developed runoff cannot be released from the site until full-spectrum water quality and detention has been provided. With regard to the proposed Peterson Field drainageway concrete channel, it is unknown at this time when it will be constructed. Subsequent Final Drainage Reports (FDR's) will establish the timing of such improvements.

D. Deficiency Costs

The only deficiencies known on this project are the two existing public 72" pipes (one is an RCP and the other is a CMP) beneath existing Hancock Expressway. They were designed and constructed as interim features until such time as Hancock Expressway was re-aligned. The cost of the replacement of this feature is unknown at this time. A cost opinion is provided in the appendix.

E. Reimbursable Costs

Due to the ambiguity of the Master Plan improvement cost listings, discussions with SWENT will be required to determine what improvements will be reimbursable. At this time, it is anticipated the proposed concrete box structure under re-aligned Hancock Expressway as well as the proposed Peterson Field concrete channel will be reimbursable.

F. Governing Agencies Requirements

A United States Army Corps of Engineers (USACE) 404 permit will be required for this project. A Pikes Peak Regional Building Department (PPRBD) floodplain development permit will be required. There are no external governmental agency requirements for this development. Final Drainage Reports for each future phase of development will be presented to the city with the development of the construction documents.

G. Maintenance Requirements

Regular maintenance of stormwater facilities is essential to ensure long term functionality and effectiveness. The proposed pipes, inlets, manholes, along with the full-spectrum detention and water quality facilities should be inspected regularly, and after significant rainstorms, to verify functionality, document erosion, and remove sediment and debris. Refer to the project's Inspection and Maintenance (IM) Plan for additional information.

The following is a list of recommendations regarding drainage around structures:

- Maintain positive drainage away from all structures at all locations.
- Adhere to guidelines outlined in the geotechnical report (if one has been completed); otherwise refer to the latest International Residential Code (IRC) book.
- Avoid grading low points adjacent to any structures.

The on-site full-spectrum ponds and storm sewer outlined in this report shall be owned and maintained by the metropolitan district or homeowners' association (HOA). The proposed storm sewer facilities located within street right-of-way outlined in this report shall be owned and maintained by the City of Colorado Springs.

H. Implementation Recommendation

Development of the site requires the implementation of full-spectrum detention and water quality procedures that have been detailed in this report. The developed conditions will produce runoff lower than existing conditions, which allows adherence to Master Plan. This ensures no additional impacts will be result downstream as a result of development of this site.

I. Grading and Erosion Control Plans

Grading and Erosion Control Plans will be submitted separately.

VIII. FEE DEVELOPMENT

A. Reimbursable Drainage and Bridge Costs

Due to the ambiguity of the Master Plan improvement cost listings, discussions with SWENT will be required to determine what improvements will be reimbursable. At this time, it is anticipated the proposed concrete box structure under re-aligned Hancock Expressway as well as the proposed Peterson Field concrete channel will be reimbursable.

B. Fee Calculations

This project is located in the Peterson Field drainage basin. The Peterson Field drainage basin is a fee basin. Drainage or bridge fees are due for this project at the time of platting. 2022 drainage fees are $14,886/acre. Therefore, for this project $302,185 ($14,886 x 20.3 acres). 2022 bridge fees are $686/acre. Therefore, for this project $13,926 ($686 x 20.3 acres) is due prior to plat recordation.

IX. SUMMARY

The Master Development Drainage Plan for Hancock Commons was prepared using the City of Colorado Springs Drainage Criteria Manuals and MHFD Urban Storm Drainage Criteria Manuals. Stormwater quality is provided by proposed private full spectrum extended detention basin facilities located on-site. Site runoff, storm drain, channelization, and associated appurtenances will not adversely affect the downstream and surrounding developments. This report is in general conformance with the Master Plan drainage report for the basin and all other previously approved reports which included this site.

X. REFERENCES

1. Drainage Criteria Manual, Volume I (revised January 2021) and Volume II (revised December 2020), City of Colorado Springs
2. Urban Storm Drainage Criteria Manual, Volumes I-III, Mile High Flood District (MHFD).
3. Peterson Field Master Plan, 1984, URS/NES
4. Canyon Springs at Soaring Eagles, Preliminary & Final Drainage Report, 2007, JPS Engineering
5. Canyon Springs at Soaring Eagles, Drainage Report Addendum No. 1, 2007, JPS Engineering
6. Foxhill Subdivision Filing No. 1, Drainage Report, 1979, Weiss Consulting Engineers
7. Pinehurst Subdivision Filing No. 4 & 5, Drainage Report, 1984, Leigh Whitehead
8. Pinehurst Subdivision Filing No. 7, Drainage Report, 1985, Leigh Whitehead
9. Silverhawk Subdivision Filing No. 1 Final Drainage Report, 2004 Obering Wurth
10. Simmelink II, Drainage Report, 1983 Weiss Consulting Engineers
11. Southborough Subdivision Filing No. 7, Drainage Report, 1973, R. Keith Hook
12. Southborough Subdivision Filing No. 8, Drainage Report, 1973, R. Keith Hook
13. Southborough Subdivision Filing No. 9, Drainage Report, 1979, R. Keith Hook
14. Flood Insurance Rate Map Number 08041C0761G, City of Colorado Springs, El Paso County, Colorado, Revised December 7, 2018, Federal Emergency Management Agency (FEMA)
15. Streamside Design Manual, 2009, City of Colorado Springs
16. Web Soil Survey, Natural Resources Conservation Service (NRCS),

XI. APPENDICES

A. Stakeholder Meeting Summary

To date there have been no stakeholder or public meetings conducted for this site. Once meetings have been conducted, this information will be included in subsequent Final Drainage Reports for the project.

B. Hydrology

The following hydrologic calculations are located in appendix B:

- Percent Impervious
- Composite Runoff Coefficients
- Basin Runoff Summary
- Surface Routing Summary

C. Hydraulics – Pipes, Inlets and Ponds

The following hydraulic calculations are located in appendix B:

- Inlets
- Pipes
- Full-spectrum Rain Gardens
- Full-spectrum Extended Detention and Water Quality ponds

Hydraulic Grade Lines (HGL) for the minor (5yr) and major (100yr) storm event will be provided for each storm sewer pipe in subsequent FDR's.

D. Hydraulic Structure Capacity Calculations - Channels

Open channel calculations are located in appendix B.

E. Drainage Maps

Existing and proposed drainage maps are located in appendix D.

F. Unit Costs/Cost Estimate

A conceptual cost estimate of the proposed stormwater infrastructure is included in this report in appendix C. A more refined cost estimate will be provided in subsequent Final Drainage Reports.

Appendix A – Maps

United States Department of Agriculture

NRCS

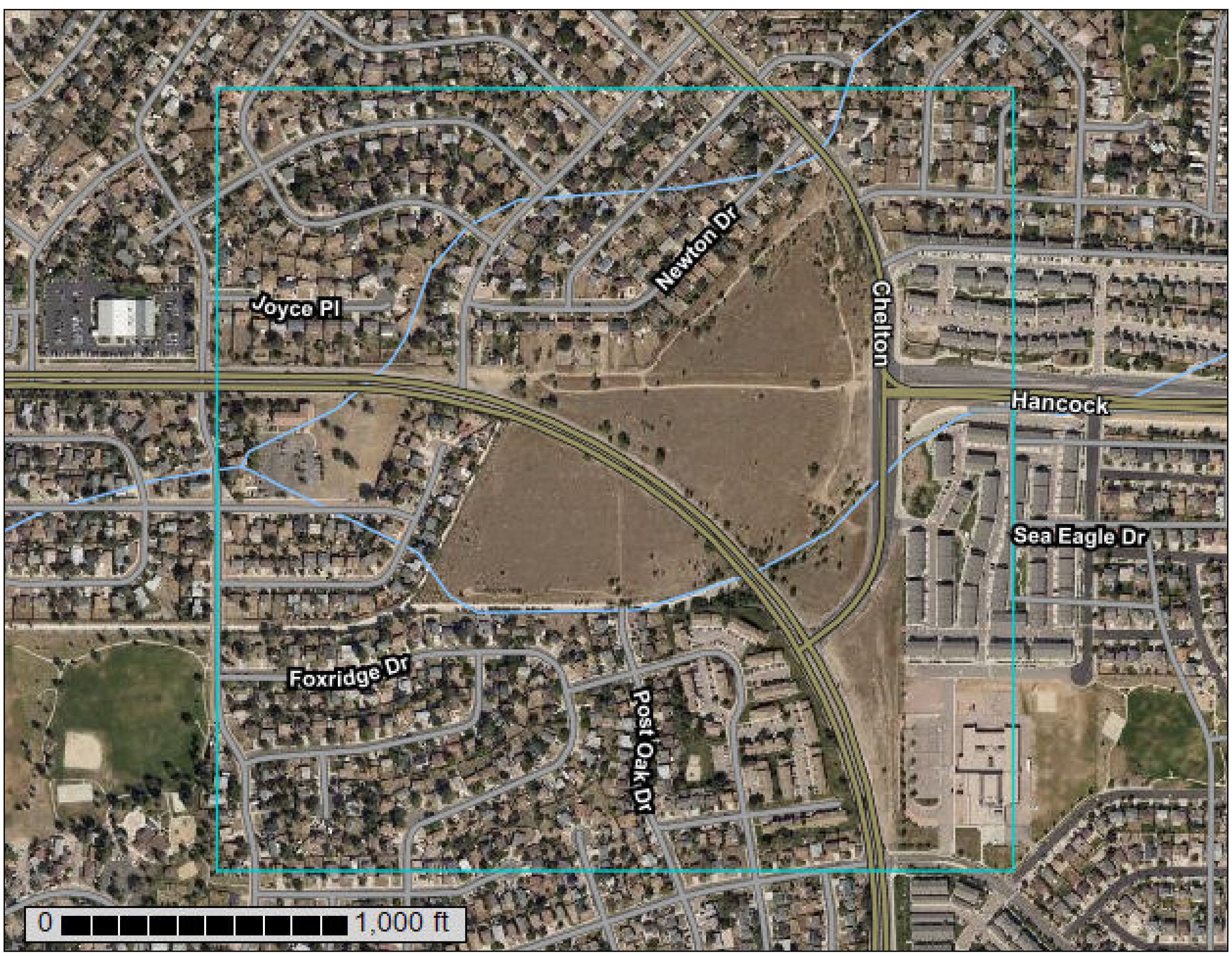
Natural Resources Conservation Service

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

Custom Soil Resource Report for

El Paso County Area, Colorado

Hancock Commons

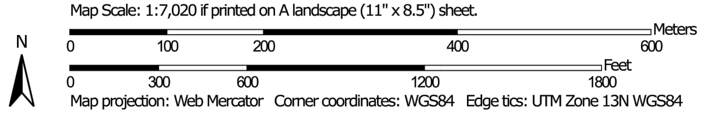


February 20, 2022

Contents

Soil Map

Map Scale: 1:7,020 if printed on A landscape (11" x 8.5") sheet.



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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	160.0	92.2%
95	Truckton loamy sand, 1 to 9 percent slopes	12.7	7.3%
96	Truckton sandy loam, 0 to 3 percent slopes	0.8	0.5%
Totals for Area of Interest		**173.6**	**100.0%**

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

95—Truckton loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2yvrm
Elevation: 5,800 to 7,100 feet
Mean annual precipitation: 12 to 19 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 90 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Truckton and similar soils: 87 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Fan remnants, interfluves
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind re-worked alluvium derived from arkose

Typical profile

A - 0 to 4 inches: loamy sand
Bt1 - 4 to 12 inches: sandy loam
Bt2 - 12 to 19 inches: sandy loam
C - 19 to 80 inches: sandy loam

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Blakeland

Percent of map unit: 5 percent
Landform: Hills, interfluves
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Bresser

Percent of map unit: 5 percent
Landform: Terraces, interfluves
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Urban land

Percent of map unit: 2 percent
Hydric soil rating: No

Ellicott, occasionally flooded

Percent of map unit: 1 percent
Landform: Drainageways, flood plains
Down-slope shape: Linear
Across-slope shape: Concave, linear
Ecological site: R067BY031CO - Sandy Bottomland
Hydric soil rating: No

96—Truckton sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2yvrd
Elevation: 5,400 to 7,000 feet
Mean annual precipitation: 14 to 23 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 90 to 155 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Truckton and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Interfluves, fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind re-worked alluvium derived from arkose

Typical profile

A - 0 to 4 inches: sandy loam
Bt1 - 4 to 12 inches: sandy loam
Bt2 - 12 to 19 inches: sandy loam
C - 19 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Blakeland

Percent of map unit: 5 percent
Landform: Interfluves, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Bresser

Percent of map unit: 5 percent
Landform: Interfluves, terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Pleasant, frequently ponded

Percent of map unit: 2 percent
Landform: Closed depressions
Down-slope shape: Concave, linear
Across-slope shape: Concave
Ecological site: R067BY010CO - Closed Upland Depression
Hydric soil rating: Yes

Urban land

Percent of map unit: 2 percent
Hydric soil rating: No

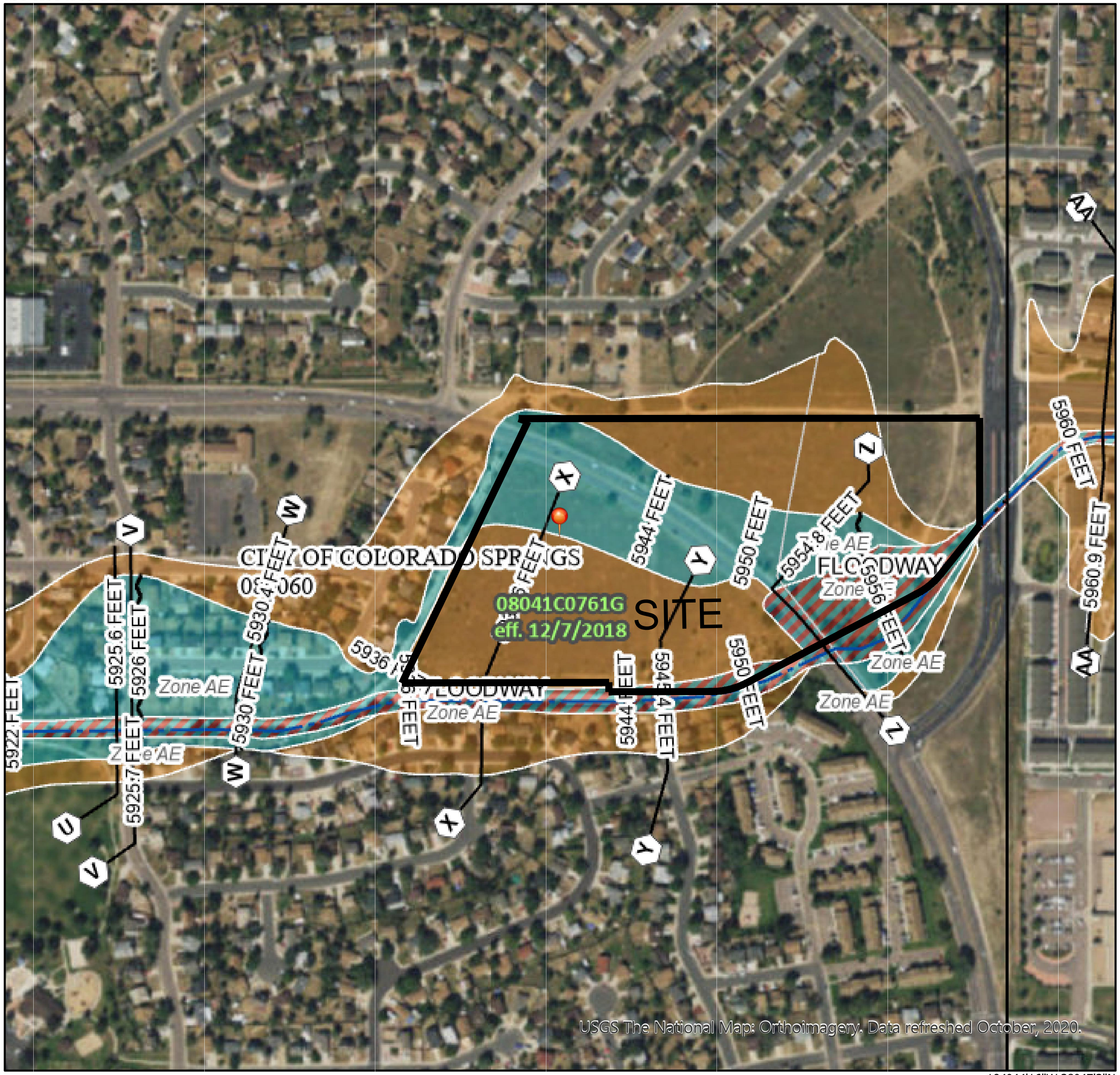
Ellicott, occasionally flooded

Percent of map unit: 1 percent
Landform: Flood plains, drainageways
Down-slope shape: Linear
Across-slope shape: Concave, linear
Ecological site: R067BY031CO - Sandy Bottomland
Hydric soil rating: No

National Flood Hazard Layer FIRMette

FEMA

104°44'54"W 38°47'31"N



Feet

0 250 500 1,000 1,500 2,000

1:6,000

104°44'16"W 38°47'3"N

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/19/2020 at 4:57 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix B – Calculations

HANCOCK COMMONS
MASTER DEVELOPMENT DRAINAGE PLAN
(Percent Impervious) - Existing

Basin	***Area (acres)***					***% Imp***
	Paved	***Drives/Walks***	***Res 1/8ac***	***Lawn/Meadow***	***TOTAL***	
E1	0.53	0.00	0.00	2.31	2.84	18.62
E2	0.64	0.00	0.00	7.10	7.74	8.27
E3	1.01	0.00	0.00	0.18	1.19	84.53
E4	0.73	0.00	1.40	15.19	17.32	9.47
E5	0.29	0.00	0.00	2.80	3.10	9.50

Surface	**% Impervious**
Paved	100
Drives/Walks	90
Res 1/8ac	65
Lawn/Meadow	0

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:	REP
Company:	PRC Engineering
Date:	September 5, 2022
Project:	Hancock Commons - Pond A
Location:	Colorado Springs

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	A1	A2	A3	A4	A5									
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand									
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	0.640	4.351	2.567	0.550	2.420									
Directly Connected Impervious Area (DCIA, acres)	0.000	1.612	1.456	0.241	0.315									
Unconnected Impervious Area (UIA, acres)	0.000	0.938	0.429	0.000	0.123									
Receiving Pervious Area (RPA, acres)	0.000	1.590	0.523	0.000	0.782									
Separate Pervious Area (SPA, acres)	0.640	0.211	0.159	0.309	1.200									
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V									

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	0.640	4.351	2.567	0.550	2.420									
Directly Connected Impervious Area (DCIA, %)	0.0%	37.0%	56.7%	43.8%	13.0%									
Unconnected Impervious Area (UIA, %)	0.0%	21.6%	16.7%	0.0%	5.1%									
Receiving Pervious Area (RPA, %)	0.0%	36.5%	20.4%	0.0%	32.3%									
Separate Pervious Area (SPA, %)	100.0%	4.8%	6.2%	56.2%	49.6%									
A_R (RPA / UIA)	0.000	1.695	1.219	0.000	6.358									
I_a Check	1.000	0.370	0.450	1.000	0.140									
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2									
f / I for 10-Year Event:	0.6	0.6	0.6	0.6	0.6									
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4									
f / I for Optional User Defined Storm CUHP:	0.39	0.39	0.39	0.39	0.39									
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00									
IRF for 10-Year Event:	1.00	0.79	0.82	1.00	0.49									
IRF for 100-Year Event:	1.00	0.87	0.90	1.00	0.55									
IRF for Optional User Defined Storm CUHP:	1.00	0.87	0.90	1.00	0.55									
Total Site Imperviousness: I_{total}	0.0%	58.6%	73.4%	43.8%	18.1%									
Effective Imperviousness for WQCV Event:	0.0%	37.0%	56.7%	43.8%	13.0%									
Effective Imperviousness for 10-Year Event:	0.0%	54.1%	70.4%	43.8%	15.5%									
Effective Imperviousness for 100-Year Event:	0.0%	55.8%	71.7%	43.8%	15.8%									
Effective Imperviousness for Optional User Defined Storm CUHP:	0.0%	55.8%	71.7%	43.8%	15.8%									

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
10-Year Event CREDIT**: Reduce Detention By:	N/A	8.1%	4.3%	0.1%	16.1%	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:	N/A	4.6%	2.2%	0.1%	14.0%	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:	0.0%	5.0%	3.2%	0.0%	8.3%									

Total Site Imperviousness:	**48.6%**
Total Site Effective Imperviousness for WQCV Event:	**34.4%**
Total Site Effective Imperviousness for 10-Year Event:	**45.4%**
Total Site Effective Imperviousness for 100-Year Event:	**46.5%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**46.5%**

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:	REP	
Company:	PRC Engineering	
Date:	September 5, 2022	
Project:	Pond B - Future (B1 thru B4, O3, Overdetain E)	
Location:	Colorado Springs	

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	B1	B2	B3	B4	O3	E
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)	5.760	0.650	1.720	1.740	1.270	0.960
Directly Connected Impervious Area (DCIA, acres)	4.312	0.616	1.248	0.000	0.000	0.960
Unconnected Impervious Area (UIA, acres)	0.348	0.000	0.196	0.221	0.606	0.000
Receiving Pervious Area (RPA, acres)	0.404	0.000	0.086	1.046	0.664	0.000
Separate Pervious Area (SPA, acres)	0.696	0.034	0.190	0.473	0.000	0.000
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V	V

CALCULATED RESULTS (OUTPUT)

	B1	B2	B3	B4	O3	E
Total Calculated Area (ac, check against input)	5.760	0.650	1.720	1.740	1.270	0.960
Directly Connected Impervious Area (DCIA, %)	74.9%	94.8%	72.6%	0.0%	0.0%	100.0%
Unconnected Impervious Area (UIA, %)	6.0%	0.0%	11.4%	12.7%	47.7%	0.0%
Receiving Pervious Area (RPA, %)	7.0%	0.0%	5.0%	60.1%	52.3%	0.0%
Separate Pervious Area (SPA, %)	12.1%	5.2%	11.0%	27.2%	0.0%	0.0%
A_R (RPA / UIA)	1.161	0.000	0.439	4.733	1.096	0.000
I_a Check	0.460	1.000	0.700	0.170	0.480	1.000
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2	3.2
f / I for 10-Year Event:	0.6	0.6	0.6	0.6	0.6	0.6
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:	0.39	0.39	0.39	0.39	0.39	0.39
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00
IRF for 10-Year Event:	0.82	1.00	0.88	0.60	0.82	1.00
IRF for 100-Year Event:	0.90	1.00	0.95	0.67	0.91	1.00
IRF for Optional User Defined Storm CUHP:	0.90	1.00	0.95	0.67	0.91	1.00
Total Site Imperviousness: I_{total}	80.9%	94.8%	84.0%	12.7%	47.7%	100.0%
Effective Imperviousness for WQCV Event:	74.9%	94.8%	72.6%	0.0%	0.0%	100.0%
Effective Imperviousness for 10-Year Event:	79.8%	94.8%	82.5%	7.6%	39.3%	100.0%
Effective Imperviousness for 100-Year Event:	80.3%	94.8%	83.4%	8.5%	43.2%	100.0%
Effective Imperviousness for Optional User Defined Storm CUHP:	80.3%	94.8%	83.4%	8.5%	43.2%	100.0%

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

	B1	B2	B3	B4	O3	E								
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
10-Year Event CREDIT**: Reduce Detention By:	1.4%	0.1%	1.8%	48.1%	18.4%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.7%	0.0%	0.6%	39.1%	9.4%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:	1.2%	0.0%	1.0%	21.0%	8.2%	0.0%								

Total Site Imperviousness:	**70.3%**
Total Site Effective Imperviousness for WQCV Event:	**59.0%**
Total Site Effective Imperviousness for 10-Year Event:	**68.0%**
Total Site Effective Imperviousness for 100-Year Event:	**68.9%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**68.9%**

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	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

Designer:	**REP**
Company:	**PRC Engineering**
Date:	**September 5, 2022**
Project:	**Pond B - Future (B1 thru B4, O3) Under Release**
Location:	**Colorado Springs**

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**B1**	**B2**	**B3**	**B4**	**O3**									
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand									
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	5.760	0.650	1.720	1.740	1.270									
Directly Connected Impervious Area (DCIA, acres)	4.312	0.616	1.248	0.000	0.000									
Unconnected Impervious Area (UIA, acres)	0.348	0.000	0.196	0.221	0.606									
Receiving Pervious Area (RPA, acres)	0.404	0.000	0.086	1.046	0.664									
Separate Pervious Area (SPA, acres)	0.696	0.034	0.190	0.473	0.000									
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	V	V	V	V									

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	5.760	0.650	1.720	1.740	1.270									
Directly Connected Impervious Area (DCIA, %)	74.9%	94.8%	72.6%	0.0%	0.0%									
Unconnected Impervious Area (UIA, %)	6.0%	0.0%	11.4%	12.7%	47.7%									
Receiving Pervious Area (RPA, %)	7.0%	0.0%	5.0%	60.1%	52.3%									
Separate Pervious Area (SPA, %)	12.1%	5.2%	11.0%	27.2%	0.0%									
A_R (RPA / UIA)	1.161	0.000	0.439	4.733	1.096									
I_a Check	0.460	1.000	0.700	0.170	0.480									
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2									
f / I for 10-Year Event:	0.6	0.6	0.6	0.6	0.6									
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4									
f / I for Optional User Defined Storm CUHP:	0.39	0.39	0.39	0.39	0.39									
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00									
IRF for 10-Year Event:	0.82	1.00	0.88	0.60	0.82									
IRF for 100-Year Event:	0.90	1.00	0.95	0.67	0.91									
IRF for Optional User Defined Storm CUHP:	0.90	1.00	0.95	0.67	0.91									
Total Site Imperviousness: I_{total}	80.9%	94.8%	84.0%	12.7%	47.7%									
Effective Imperviousness for WQCV Event:	74.9%	94.8%	72.6%	0.0%	0.0%									
Effective Imperviousness for 10-Year Event:	79.8%	94.8%	82.5%	7.6%	39.3%									
Effective Imperviousness for 100-Year Event:	80.3%	94.8%	83.4%	8.5%	43.2%									
Effective Imperviousness for Optional User Defined Storm CUHP:	80.3%	94.8%	83.4%	8.5%	43.2%									

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
10-Year Event CREDIT**: Reduce Detention By:	1.4%	0.1%	1.8%	48.1%	18.4%	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:	0.7%	0.0%	0.6%	39.1%	9.4%	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:	1.2%	0.0%	1.0%	21.0%	8.2%									

Total Site Imperviousness:	**67.7%**
Total Site Effective Imperviousness for WQCV Event:	**55.4%**
Total Site Effective Imperviousness for 10-Year Event:	**65.2%**
Total Site Effective Imperviousness for 100-Year Event:	**66.2%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**66.2%**

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

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

Designer:	**REP**
Company:	**PRC Engineering**
Date:	**September 5, 2022**
Project:	**Pond B - Proposed (B1 thru B4, O2, O3, Overdetain E)**
Location:	**Colorado Springs**

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**B1**	**B2**	**B3**	**B4**	**O2**	**O3**	**E**							
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand							
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	5.760	0.650	1.720	1.740	7.310	1.270	0.960							
Directly Connected Impervious Area (DCIA, acres)	4.312	0.616	1.248	0.000	0.000	0.000	0.960							
Unconnected Impervious Area (UIA, acres)	0.348	0.000	0.196	0.221	0.000	0.606	0.000							
Receiving Pervious Area (RPA, acres)	0.404	0.000	0.086	1.046	0.000	0.664	0.000							
Separate Pervious Area (SPA, acres)	0.696	0.034	0.190	0.473	7.310	0.000	0.000							
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)	5.760	0.650	1.720	1.740	7.310	1.270	0.960							
Directly Connected Impervious Area (DCIA, %)	74.9%	94.8%	72.6%	0.0%	0.0%	0.0%	100.0%							
Unconnected Impervious Area (UIA, %)	6.0%	0.0%	11.4%	12.7%	0.0%	47.7%	0.0%							
Receiving Pervious Area (RPA, %)	7.0%	0.0%	5.0%	60.1%	0.0%	52.3%	0.0%							
Separate Pervious Area (SPA, %)	12.1%	5.2%	11.0%	27.2%	100.0%	0.0%	0.0%							
A_R (RPA / UIA)	1.161	0.000	0.439	4.733	0.000	1.096	0.000							
I_a Check	0.460	1.000	0.700	0.170	1.000	0.480	1.000							
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2	3.2	3.2							
f / I for 10-Year Event:	0.6	0.6	0.6	0.6	0.6	0.6	0.6							
f / I for 100-Year Event:	0.4	0.4	0.4	0.4	0.4	0.4	0.4							
f / I for Optional User Defined Storm CUHP:	0.39	0.39	0.39	0.39	0.39	0.39	0.39							
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
IRF for 10-Year Event:	0.82	1.00	0.88	0.60	1.00	0.82	1.00							
IRF for 100-Year Event:	0.90	1.00	0.95	0.67	1.00	0.91	1.00							
IRF for Optional User Defined Storm CUHP:	0.90	1.00	0.95	0.67	1.00	0.91	1.00							
Total Site Imperviousness: I_{total}	80.9%	94.8%	84.0%	12.7%	0.0%	47.7%	100.0%							
Effective Imperviousness for WQCV Event:	74.9%	94.8%	72.6%	0.0%	0.0%	0.0%	100.0%							
Effective Imperviousness for 10-Year Event:	79.8%	94.8%	82.5%	7.6%	0.0%	39.3%	100.0%							
Effective Imperviousness for 100-Year Event:	80.3%	94.8%	83.4%	8.5%	0.0%	43.2%	100.0%							
Effective Imperviousness for Optional User Defined Storm CUHP:	80.3%	94.8%	83.4%	8.5%	0.0%	43.2%	100.0%							

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
10-Year Event CREDIT**: Reduce Detention By:	1.4%	0.1%	1.8%	48.1%	N/A	18.4%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.7%	0.0%	0.6%	39.1%	N/A	9.4%	0.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:	1.2%	0.0%	1.0%	21.0%	0.0%	8.2%	0.0%							

Total Site Imperviousness:	**43.8%**
Total Site Effective Imperviousness for WQCV Event:	**36.8%**
Total Site Effective Imperviousness for 10-Year Event:	**42.4%**
Total Site Effective Imperviousness for 100-Year Event:	**42.9%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**42.9%**

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:	**REP**
Company:	**PRC Engineering**
Date:	**September 5, 2022**
Project:	**Pond B - Proposed (B1 thru B4, O2, O3) Under Release**
Location:	**Colorado Springs**

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**B1**	**B2**	**B3**	**B4**	**O2**	**O3**								
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)	5.760	0.650	1.720	1.740	7.310	1.270								
Directly Connected Impervious Area (DCIA, acres)	4.312	0.616	1.248	0.000	0.000	0.000								
Unconnected Impervious Area (UIA, acres)	0.348	0.000	0.196	0.221	0.000	0.606								
Receiving Pervious Area (RPA, acres)	0.404	0.000	0.086	1.046	0.000	0.664								
Separate Pervious Area (SPA, acres)	0.696	0.034	0.190	0.473	7.310	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)	5.760	0.650	1.720	1.740	7.310	1.270								
Directly Connected Impervious Area (DCIA, %)	74.9%	94.8%	72.6%	0.0%	0.0%	0.0%								
Unconnected Impervious Area (UIA, %)	6.0%	0.0%	11.4%	12.7%	0.0%	47.7%								
Receiving Pervious Area (RPA, %)	7.0%	0.0%	5.0%	60.1%	0.0%	52.3%								
Separate Pervious Area (SPA, %)	12.1%	5.2%	11.0%	27.2%	100.0%	0.0%								
A_R (RPA / UIA)	1.161	0.000	0.439	4.733	0.000	1.096								
I_a Check	0.460	1.000	0.700	0.170	1.000	0.480								
f / I for WQCV Event:	3.2	3.2	3.2	3.2	3.2	3.2								
f / I for 10-Year Event:	0.6	0.6	0.6	0.6	0.6	0.6								
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:	0.39	0.39	0.39	0.39	0.39	0.39								
IRF for WQCV Event:	0.00	0.00	0.00	0.00	0.00	0.00								
IRF for 10-Year Event:	0.82	1.00	0.88	0.60	1.00	0.82								
IRF for 100-Year Event:	0.90	1.00	0.95	0.67	1.00	0.91								
IRF for Optional User Defined Storm CUHP:	0.90	1.00	0.95	0.67	1.00	0.91								
Total Site Imperviousness: I_{total}	80.9%	94.8%	84.0%	12.7%	0.0%	47.7%								
Effective Imperviousness for WQCV Event:	74.9%	94.8%	72.6%	0.0%	0.0%	0.0%								
Effective Imperviousness for 10-Year Event:	79.8%	94.8%	82.5%	7.6%	0.0%	39.3%								
Effective Imperviousness for 100-Year Event:	80.3%	94.8%	83.4%	8.5%	0.0%	43.2%								
Effective Imperviousness for Optional User Defined Storm CUHP:	80.3%	94.8%	83.4%	8.5%	0.0%	43.2%								

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
10-Year Event CREDIT**: Reduce Detention By:	1.4%	0.1%	1.8%	48.1%	N/A	18.4%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.7%	0.0%	0.6%	39.1%	N/A	9.4%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:	1.2%	0.0%	1.0%	21.0%	0.0%	8.2%								

Total Site Imperviousness:	**40.9%**
Total Site Effective Imperviousness for WQCV Event:	**33.5%**
Total Site Effective Imperviousness for 10-Year Event:	**39.4%**
Total Site Effective Imperviousness for 100-Year Event:	**40.0%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**40.0%**

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

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

Designer: REP
Company: PRC Engineering
Date: September 5, 2022
Project: Pond C - (Basins C and F)
Location: Colorado Springs

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	C	F												
Receiving Pervious Area Soil Type	Loamy Sand	Loamy Sand												
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	1.911	0.200												
Directly Connected Impervious Area (DCIA, acres)	0.844	0.200												
Unconnected Impervious Area (UIA, acres)	0.199	0.000												
Receiving Pervious Area (RPA, acres)	0.340	0.000												
Separate Pervious Area (SPA, acres)	0.528	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)	1.911	0.200												
Directly Connected Impervious Area (DCIA, %)	44.2%	100.0%												
Unconnected Impervious Area (UIA, %)	10.4%	0.0%												
Receiving Pervious Area (RPA, %)	17.8%	0.0%												
Separate Pervious Area (SPA, %)	27.6%	0.0%												
A_R (RPA / UIA)	1.709	0.000												
I_a Check	0.370	1.000												
f / I for WQCV Event:	3.2	3.2												
f / I for 10-Year Event:	0.6	0.6												
f / I for 100-Year Event:	0.4	0.4												
f / I for Optional User Defined Storm CUHP:	0.39	0.39												
IRF for WQCV Event:	0.00	0.00												
IRF for 10-Year Event:	0.79	1.00												
IRF for 100-Year Event:	0.87	1.00												
IRF for Optional User Defined Storm CUHP:	0.87	1.00												
Total Site Imperviousness: I_{total}	54.6%	100.0%												
Effective Imperviousness for WQCV Event:	44.2%	100.0%												
Effective Imperviousness for 10-Year Event:	52.4%	100.0%												
Effective Imperviousness for 100-Year Event:	53.2%	100.0%												
Effective Imperviousness for Optional User Defined Storm CUHP:	53.2%	100.0%												

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
10-Year Event CREDIT**: Reduce Detention By:	4.2%	0.2%	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:	2.4%	0.1%	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:	2.5%	0.0%												

Total Site Imperviousness:	**58.9%**
Total Site Effective Imperviousness for WQCV Event:	**49.5%**
Total Site Effective Imperviousness for 10-Year Event:	**56.9%**
Total Site Effective Imperviousness for 100-Year Event:	**57.7%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**57.7%**

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

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.20	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	2.52	
Max Intensity for Optional User Defined Storm	2.51496		

Designer: REP
Company: PRC Engineering
Date: September 5, 2022
Project: Pond D - (Basin D)
Location: Colorado Springs

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**D**													
Receiving Pervious Area Soil Type	Loamy Sand													
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	1.010													
Directly Connected Impervious Area (DCIA, acres)	0.623													
Unconnected Impervious Area (UIA, acres)	0.166													
Receiving Pervious Area (RPA, acres)	0.144													
Separate Pervious Area (SPA, acres)	0.077													
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V													

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	1.010													
Directly Connected Impervious Area (DCIA, %)	61.7%													
Unconnected Impervious Area (UIA, %)	16.4%													
Receiving Pervious Area (RPA, %)	14.3%													
Separate Pervious Area (SPA, %)	7.6%													
A_R (RPA / UIA)	0.867													
I_a Check	0.540													
f / I for WQCV Event:	3.2													
f / I for 10-Year Event:	0.6													
f / I for 100-Year Event:	0.4													
f / I for Optional User Defined Storm CUHP:	0.39													
IRF for WQCV Event:	0.00													
IRF for 10-Year Event:	0.84													
IRF for 100-Year Event:	0.92													
IRF for Optional User Defined Storm CUHP:	0.92													
Total Site Imperviousness: I_{total}	78.1%													
Effective Imperviousness for WQCV Event:	61.7%													
Effective Imperviousness for 10-Year Event:	75.5%													
Effective Imperviousness for 100-Year Event:	76.8%													
Effective Imperviousness for Optional User Defined Storm CUHP:	76.8%													

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
10-Year Event CREDIT**: Reduce Detention By:	3.5%	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:	1.6%	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:	2.5%													

Total Site Imperviousness:	**78.1%**
Total Site Effective Imperviousness for WQCV Event:	**61.7%**
Total Site Effective Imperviousness for 10-Year Event:	**75.5%**
Total Site Effective Imperviousness for 100-Year Event:	**76.8%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	**76.8%**

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

HANCOCK COMMONS
MASTER DEVELOPMENT DRAINAGE PLAN
(Composite Runoff Coefficients)

Existing Conditions - Basins E1 thru E5 and O1, Proposed Conditions - Basins A1 thru O3

Basin	*Total Basin Area (acres)*	*Land Use*	*Sub-Basin (5yr)*		*Composite*	*Sub-Basin (100yr)*		*Composite*
			C_5	*Area (acres)*	C_5	C_{100}	*Area (acres)*	C_{100}
E1	2.84	Streets - Paved	0.90	0.53	0.23	0.96	0.53	0.46
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	2.31		0.35	2.31	
E2	7.74	Streets - Paved	0.90	0.64	0.15	0.96	0.64	0.40
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	7.10		0.35	7.10	
E3	1.19	Streets - Paved	0.90	1.01	0.78	0.96	1.01	0.87
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.18		0.35	0.18	
E4	17.32	Streets - Paved	0.90	0.73	0.17	0.96	0.73	0.41
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	1.40		0.81	1.40	
		Lawn/Meadow	0.08	15.19		0.35	15.19	
E5	3.10	Streets - Paved	0.90	0.30	0.16	0.96	0.30	0.41
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	2.80		0.35	2.80	
A1	0.64	Streets - Paved	0.90	0.00	0.08	0.96	0.00	0.35
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.64		0.35	0.64	

Basin	Total Basin Area (acres)	Land Use	Sub-Basin (5yr) C_5	Sub-Basin (5yr) Area (acres)	Composite C_5	Sub-Basin (100yr) C_{100}	Sub-Basin (100yr) Area (acres)	Composite C_{100}
A2	4.35	Streets - Paved	0.90	1.05	0.53	0.96	1.05	0.68
		Drives/Walks	0.90	0.57		0.96	0.57	
		Roof	0.73	0.94		0.81	0.94	
		Lawn/Meadow	0.08	1.79		0.35	1.79	
A3	2.56	Streets - Paved	0.90	0.95	0.57	0.96	0.95	0.71
		Drives/Walks	0.90	0.24		0.96	0.24	
		Roof	0.73	0.43		0.81	0.43	
		Lawn/Meadow	0.08	0.94		0.35	0.94	
A4	0.55	Streets - Paved	0.90	0.05	0.39	0.96	0.05	0.58
		Drives/Walks	0.90	0.05		0.96	0.05	
		Roof	0.73	0.14		0.81	0.14	
		Lawn/Meadow	0.08	0.31		0.35	0.31	
A5	2.42	Streets - Paved	0.90	0.79	0.50	0.96	0.79	0.66
		Drives/Walks	0.90	0.12		0.96	0.12	
		Roof	0.73	0.43		0.81	0.43	
		Lawn/Meadow	0.08	1.08		0.35	1.08	
B1	5.76	Streets - Paved	0.90	3.52	0.71	0.96	3.52	0.82
		Drives/Walks	0.90	0.65		0.96	0.65	
		Roof	0.73	0.33		0.81	0.33	
		Lawn/Meadow	0.08	1.26		0.35	1.26	
B2	0.65	Streets - Paved	0.90	0.43	0.80	0.96	0.43	0.88
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.18		0.81	0.18	
		Lawn/Meadow	0.08	0.04		0.35	0.04	
B3	1.72	Streets - Paved	0.90	0.91	0.71	0.96	0.91	0.81
		Drives/Walks	0.90	0.05		0.96	0.05	
		Roof	0.73	0.45		0.81	0.45	
		Lawn/Meadow	0.08	0.31		0.35	0.31	

Basin	Total Basin Area	Land Use	Sub-Basin (5yr)		Composite	Sub-Basin (100yr)		Composite
	(acres)		C_5	Area (acres)	C_5	C_{100}	Area (acres)	C_{100}
B4	1.74	Streets - Paved	0.90	0.75	0.51	0.96	0.75	0.67
		Drives/Walks	0.90	0.03		0.96	0.03	
		Roof	0.73	0.17		0.81	0.17	
		Lawn/Meadow	0.08	0.78		0.35	0.78	
C	1.91	Streets - Paved	0.90	0.74	0.56	0.96	0.74	0.70
		Drives/Walks	0.90	0.10		0.96	0.10	
		Roof	0.73	0.35		0.81	0.35	
		Lawn/Meadow	0.08	0.72		0.35	0.72	
D	1.01	Streets - Paved	0.90	0.32	0.50	0.96	0.32	0.66
		Drives/Walks	0.90	0.04		0.96	0.04	
		Roof	0.73	0.20		0.81	0.20	
		Lawn/Meadow	0.08	0.45		0.35	0.45	
E	0.96	Streets - Paved	0.90	0.83	0.87	0.96	0.83	0.94
		Drives/Walks	0.90	0.10		0.96	0.10	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.03		0.35	0.03	
F	0.20	Streets - Paved	0.90	0.83	0.90	0.96	0.83	0.96
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.00		0.35	0.00	
G	0.59	Streets - Paved	0.90	0.10	0.22	0.96	0.10	0.45
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.49		0.35	0.49	
O1	12.19	Streets - Paved	0.90	2.05	0.53	0.96	2.05	0.65
		Res 1/8ac	0.45	10.14		0.59	10.14	
		Roof	0.73	0.00		0.59	0.00	
		Lawn/Meadow	0.08	0.00		0.35	0.00	

Basin	Total Basin Area (acres)	Land Use	Sub-Basin (5yr)		Composite	Sub-Basin (100yr)		Composite
			C_5	Area (acres)	C_5	C_{100}	Area (acres)	C_{100}
O2	7.31	Streets - Paved	0.90	0.00	0.08	0.96	0.00	0.35
		Drives/Walks	0.90	0.00		0.96	0.00	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	7.31		0.35	7.31	
O3	1.27	Streets - Paved	0.90	0.00	0.45	0.96	0.00	0.59
		Res 1/8ac	0.45	1.27		0.59	1.27	
		Roof	0.73	0.00		0.81	0.00	
		Lawn/Meadow	0.08	0.00		0.35	0.00	

HANCOCK COMMONS
MASTER DEVELOPMENT DRAINAGE PLAN
(Basin Runoff Calculations)
Existing Conditions - Basins E1 thru E5 and O1, Proposed Conditions - Basins A1 thru O3

				Overland Flow				*Channel Flow*					*Travel Time (T_t)*	*Intensity*		*Total Flows*	
Basin	*Area Total (acres)*	*C_5*	*C_{100}*	*C_5*	*Length (ft)*	*Slope (ft/ft)*	*T_C (min)*	*Length (ft)*	*Slope (ft/ft)*	*Cv*	*Velocity (fps)*	*T_t (min)*	*TOTAL* (min)*	*I_5 (in/hr)*	*I_{100} (in/hr)*	*Q_5 (c.f.s.)*	*Q_{100} (c.f.s.)*
E1	2.84	0.23	0.46	0.08	300	0.010	31.9	335	0.015	7.0	0.9	6.5	38.4	2.1	3.5	**1.4**	**4.7**
E2	7.74	0.15	0.40	0.08	200	0.017	21.9	430	0.016	7.0	0.9	8.1	30.0	2.5	4.2	**2.8**	**12.9**
E3	1.19	0.78	0.87										5.0	5.2	8.7	**4.8**	**9.0**
E4	17.32	0.17	0.41	0.08	300	0.020	25.4	1005	0.014	7.0	0.8	20.2	45.6	1.9	3.1	**5.4**	**22.2**
E5	3.10	0.16	0.41	0.08	300	0.011	30.9	392	0.009	7.0	0.7	9.8	40.7	2.0	3.4	**1.0**	**4.3**
A1	0.64	0.08	0.35	0.08	50	0.038	8.4	75	0.010	15.0	1.5	0.8	9.2	4.3	7.1	**0.2**	**1.6**
A2	4.35	0.53	0.68	0.08	100	0.040	11.7	145	0.030	7.0	1.2	2.0	13.6	3.7	6.1	**8.4**	**18.1**

				Overland Flow				Channel Flow					Travel Time (T_t)	Intensity		Total Flows	
Basin	**Area Total (acres)**	**C_5**	**C_{100}**	**C_5**	**Length (ft)**	**Slope (ft/ft)**	**T_C (min)**	**Length (ft)**	**Slope (ft/ft)**	**Cv**	**Velocity (fps)**	**T_t (min)**	**TOTAL* (min)**	**I_5 (in/hr)**	**I_{100} (in/hr)**	**Q_5 (c.f.s.)**	**Q_{100} (c.f.s.)**
A3	2.56	0.57	0.71	0.08	50	0.030	9.1	320	0.013	20.0	2.3	2.3	11.4	3.9	6.6	**5.7**	**12.0**
A4	0.55	0.39	0.58										5.0	5.2	8.7	**1.1**	**2.8**
A5	2.42	0.50	0.66	0.08	70	0.025	11.4	0	0.000	7.0	0.0	0.0	11.4	3.9	6.6	**4.8**	**10.6**
B1	5.76	0.71	0.82	0.90	30	0.020	1.6	1120	0.016	20.0	2.5	7.4	9.0	4.3	7.2	**17.6**	**34.0**
B2	0.65	0.80	0.88										5.0	5.2	8.7	**2.7**	**5.0**
B3	1.72	0.71	0.81										5.0	5.2	8.7	**6.3**	**12.1**
B4	1.74	0.51	0.67										5.0	5.2	8.7	**4.6**	**10.1**
C	1.91	0.56	0.70	0.08	100	0.020	14.7	30	0.010	7.0	0.7	0.7	15.4	3.5	5.9	**3.7**	**7.9**
D	1.01	0.50	0.66										5.0	5.2	8.7	**2.6**	**5.8**
E	0.96	0.87	0.94										5.0	5.2	8.7	**4.3**	**7.8**

				Overland Flow				Channel Flow					Travel Time (T_t)	Intensity		Total Flows	
Basin	***Area Total (acres)***	C_5	C_{100}	C_5	***Length (ft)***	***Slope (ft/ft)***	T_C ***(min)***	***Length (ft)***	***Slope (ft/ft)***	***Cv***	***Velocity (fps)***	T_t ***(min)***	***TOTAL* (min)***	I_5 ***(in/hr)***	I_{100} ***(in/hr)***	Q_5 ***(c.f.s.)***	Q_{100} ***(c.f.s.)***
F	0.20	0.90	0.96										5.0	5.2	8.7	**0.9**	**1.7**
G	0.59	0.22	0.45	0.08	65	0.052	8.6	180	0.018	15.0	2.0	1.5	10.1	4.1	6.9	**0.5**	**1.8**
O1	12.19	0.53	0.65	0.08	20	0.035	5.4	950	0.035	20.0	3.7	4.2	9.7	4.2	7.0	**26.8**	**55.8**
O2 (Undeveloped)	7.31	0.08	0.35	0.08	20	0.030	5.7	670	0.022	20.0	3.0	3.8	9.5	4.2	7.1	**2.5**	**18.1**
O3	1.27	0.45	0.59	0.08	40	0.038	7.5	0	0.000	7.0	0.0	0.0	7.5	4.6	7.7	**2.6**	**5.7**

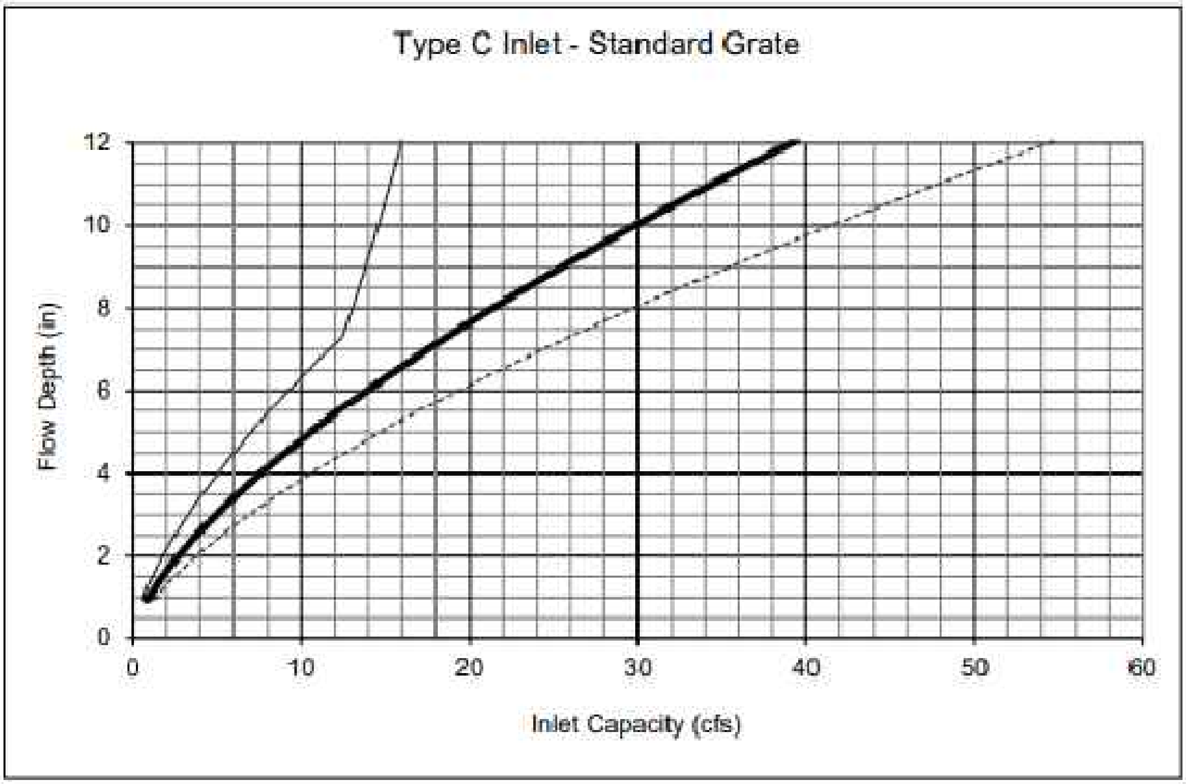
* 5 MINUTE TIME OF CONCENTRATION - MINIMUM

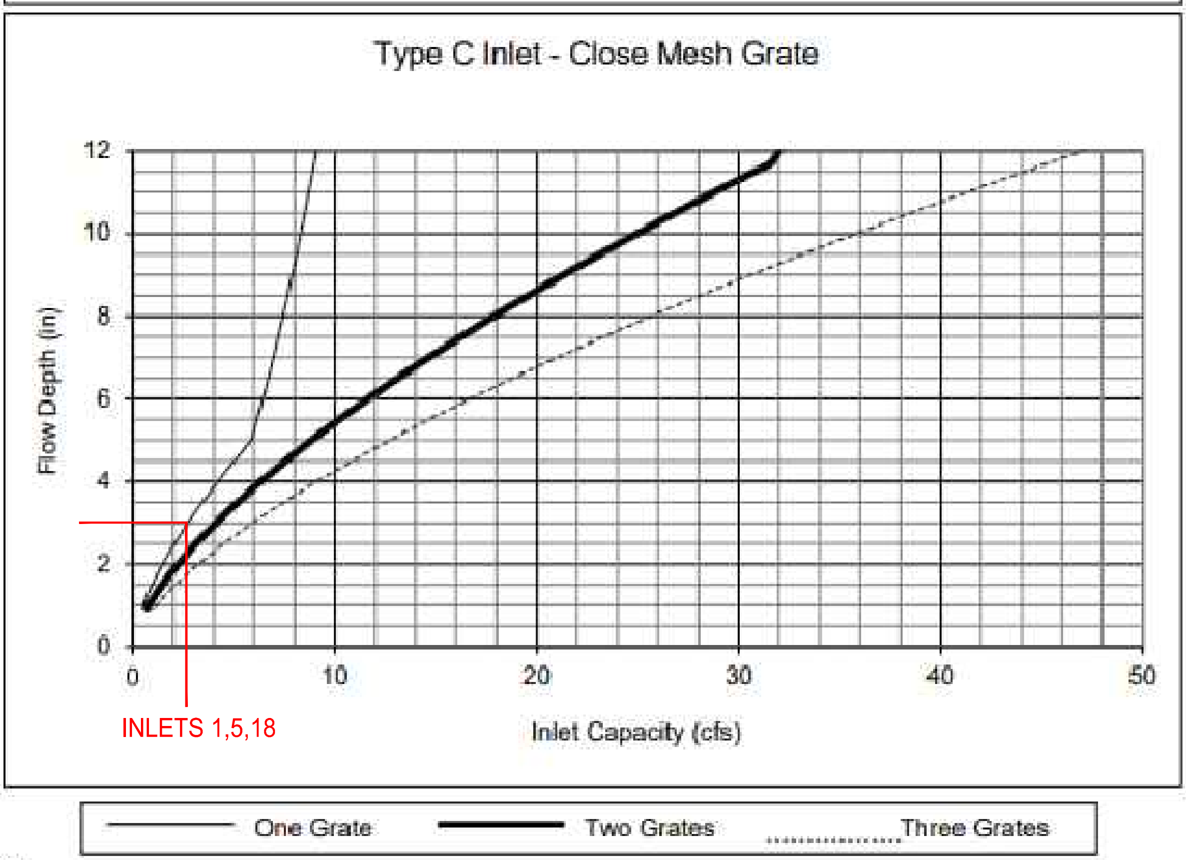
HANCOCK COMMONS
MASTER DEVELOPMENT DRAINAGE PLAN
(Surface Routing Summary)
Proposed Conditions

					Intensity		Flow		
Design Point	Contributing Basins	Equivalent CA_5	Equivalent CA_{100}	Routed T_C	I_5	I_{100}	Q_5	Q_{100}	Comments
1	A1	0.05	0.22	9.2	4.3	7.1	**0.2**	**1.6**	flow to Type C inlet 1
2	A2	2.29	2.94	13.6	3.7	6.1	**8.4**	**18.1**	flow to 8' Type D-10-R sump inlet 2
3	A3	1.46	1.82	11.4	3.9	6.6	**5.7**	**12.0**	flow to 2-4' Type d-10-R sump inlets 3 & 4
4	A4	0.22	0.32	5.0	5.2	8.7	**1.1**	**2.8**	flow to Type C inlet 5 and basin A4 roof and lawn runoff
5	A1,A2,A3,A4	4.02	5.30	13.6	3.7	6.1	**14.7**	**32.6**	flow into pond (basins A1,A2,A3,A4)
6	A1,A2,A3,A4,A5	5.24	6.90	13.6	3.7	6.1	**19.2**	**42.5**	total flow to pond
7	B1, O2 (Undeveloped), O3	5.25	8.02	9.0	4.3	7.2	**22.6**	**57.8**	flow to 2-12' Type D-10-R sump inlets 6 & 7
8	B2	0.52	0.57	5.0	5.2	8.7	**2.7**	**5.0**	flow to 4' Type D-10-R sump inlet 8
9	B3 (40%)	0.49	0.56	5.0	5.2	8.7	**2.5**	**4.8**	flow to 4' Type D-10-R sump inlet 9
10	B3 (60%)	0.73	0.84	5.0	5.2	8.7	**3.8**	**7.3**	flow to 4' Type D-10-R sump inlet 10
11	B1,B2,B3,B4,O2 (Undeveloped), O3	7.88	11.15	9.0	4.3	7.2	**33.9**	**80.4**	total flow to pond
12	C	1.07	1.34	15.4	3.5	5.9	**3.7**	**7.9**	flow to inlets 11 & 12
13	D	0.51	0.67	5.0	5.2	8.7	**2.6**	**5.8**	flow to inlets 15 & 16
14	O1	6.41	7.95	9.7	4.2	7.0	**26.8**	**55.8**	flow to 2-8' exist.Type D-10-R sump inlets (existing) and 2-4' Type D-10-R sump inlets 13 & 14
15	E	0.84	0.90	5.0	5.2	8.7	**4.3**	**7.8**	flow to west in Hancock
16	G	0.13	0.27	10.1	4.1	6.9	**0.5**	**1.8**	flow to Type C inlet 18

Figure 8-12. Inlet Capacity Chart Sump Conditions, Curb Opening (D-10-R) Inlet

Figure 8-10. Inlet Capacity Chart Sump Conditions, Area (Type C) Inlet





Notes:

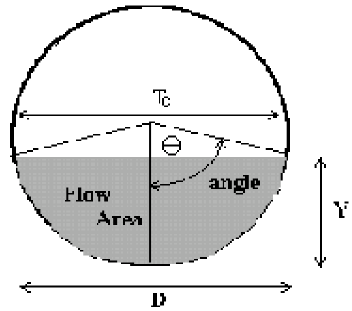
1. The standard inlet parameters must apply to use these charts.

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 1 - Proposed Conditions



Design Information (Input)			
Pipe Invert Slope	So =	0.0050	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	15.00	inches
Design discharge	Q =	4.50	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.23	sq ft
Full-flow wetted perimeter	Pf =	3.93	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	6.62	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.78	radians
Flow area	An =	0.78	sq ft
Top width	Tn =	1.22	ft
Wetted perimeter	Pn =	2.23	ft
Flow depth	Yn =	0.76	ft
Flow velocity	Vn =	5.80	fps
Discharge	Qn =	4.50	cfs
Percent of Full Flow	Flow =	68.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.28	supercritical

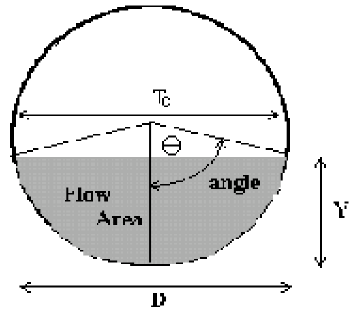
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.96	radians
Critical flow area	Ac =	0.90	sq ft
Critical top width	Tc =	1.16	ft
Critical flow depth	Yc =	0.86	ft
Critical flow velocity	Vc =	5.00	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 2 - Proposed Conditions



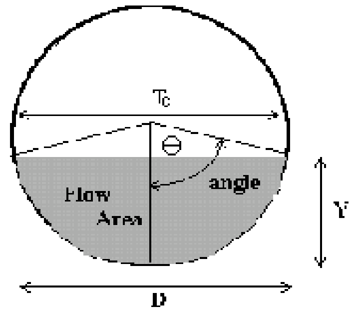
Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	18.10	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	32.08	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.65	radians
Flow area	An =	1.72	sq ft
Top width	Tn =	1.99	ft
Wetted perimeter	Pn =	3.29	ft
Flow depth	Yn =	1.08	ft
Flow velocity	Vn =	10.52	fps
Discharge	Qn =	18.10	cfs
Percent of Full Flow	Flow =	56.4%	of full flow
Normal Depth Froude Number	Fr_n =	2.00	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.13	radians
Critical flow area	Ac =	2.58	sq ft
Critical top width	Tc =	1.69	ft
Critical flow depth	Yc =	1.53	ft
Critical flow velocity	Vc =	7.01	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 3 - Proposed Conditions



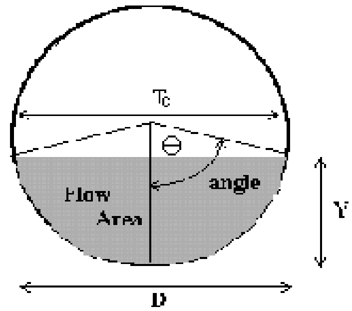
Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	6.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.65	radians
Flow area	An =	0.98	sq ft
Top width	Tn =	1.50	ft
Wetted perimeter	Pn =	2.48	ft
Flow depth	Yn =	0.81	ft
Flow velocity	Vn =	6.15	fps
Discharge	Qn =	6.00	cfs
Percent of Full Flow	Flow =	57.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.34	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.84	radians
Critical flow area	Ac =	1.17	sq ft
Critical top width	Tc =	1.45	ft
Critical flow depth	Yc =	0.95	ft
Critical flow velocity	Vc =	5.11	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 4 - Proposed Conditions

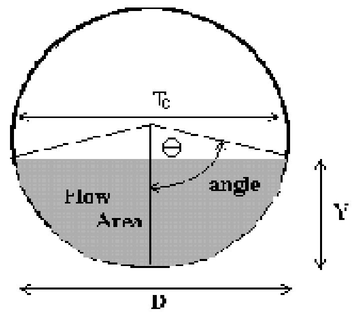


Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	6.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.65	radians
Flow area	An =	0.98	sq ft
Top width	Tn =	1.50	ft
Wetted perimeter	Pn =	2.48	ft
Flow depth	Yn =	0.81	ft
Flow velocity	Vn =	6.15	fps
Discharge	Qn =	6.00	cfs
Percent of Full Flow	Flow =	57.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.34	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.84	radians
Critical flow area	Ac =	1.17	sq ft
Critical top width	Tc =	1.45	ft
Critical flow depth	Yc =	0.95	ft
Critical flow velocity	Vc =	5.11	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 5 - Proposed Conditions



Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	12.00	cfs

Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	27.78	cfs

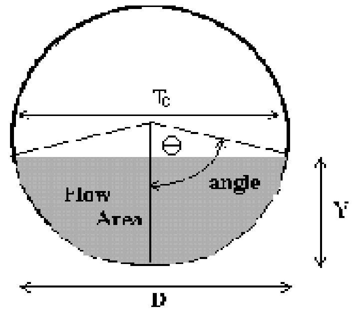
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.49	radians
Flow area	An =	1.41	sq ft
Top width	Tn =	1.99	ft
Wetted perimeter	Pn =	2.98	ft
Flow depth	Yn =	0.92	ft
Flow velocity	Vn =	8.52	fps
Discharge	Qn =	12.00	cfs
Percent of Full Flow	Flow =	43.2%	of full flow
Normal Depth Froude Number	Fr_n =	1.79	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.82	radians
Critical flow area	Ac =	2.05	sq ft
Critical top width	Tc =	1.94	ft
Critical flow depth	Yc =	1.24	ft
Critical flow velocity	Vc =	5.84	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 6 - Proposed Conditions



Design Information (Input)			
Pipe Invert Slope	So =	0.0095	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	2.80	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	5.03	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.64	radians
Flow area	An =	0.43	sq ft
Top width	Tn =	1.00	ft
Wetted perimeter	Pn =	1.64	ft
Flow depth	Yn =	0.53	ft
Flow velocity	Vn =	6.58	fps
Discharge	Qn =	2.80	cfs
Percent of Full Flow	Flow =	55.7%	of full flow
Normal Depth Froude Number	Fr_n =	1.77	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.02	radians
Critical flow area	Ac =	0.60	sq ft
Critical top width	Tc =	0.90	ft
Critical flow depth	Yc =	0.72	ft
Critical flow velocity	Vc =	4.64	fps
Critical Depth Froude Number	Fr_c =	1.00	

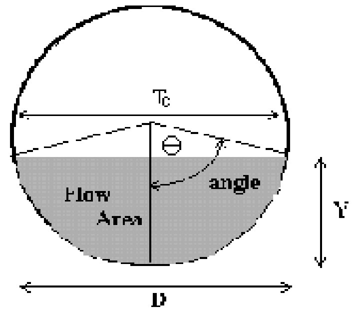
*** Unexpected value for Manning's n**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 7 - Proposed Conditions



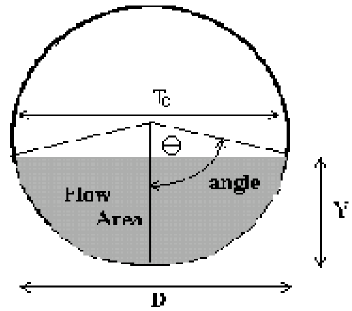
Design Information (Input)			
Pipe Invert Slope	So =	0.0190	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	30.00	inches
Design discharge	Q =	32.60	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	56.69	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.66	radians
Flow area	An =	2.73	sq ft
Top width	Tn =	2.49	ft
Wetted perimeter	Pn =	4.15	ft
Flow depth	Yn =	1.36	ft
Flow velocity	Vn =	11.95	fps
Discharge	Qn =	32.60	cfs
Percent of Full Flow	Flow =	57.5%	of full flow
Normal Depth Froude Number	Fr_n =	2.01	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.16	radians
Critical flow area	Ac =	4.09	sq ft
Critical top width	Tc =	2.08	ft
Critical flow depth	Yc =	1.94	ft
Critical flow velocity	Vc =	7.96	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 8 - Proposed Conditions

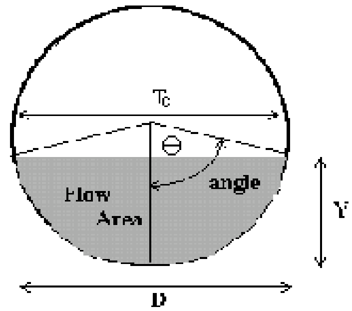


Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	30.00	inches
Design discharge	Q =	29.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	58.16	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.57	radians
Flow area	An =	2.45	sq ft
Top width	Tn =	2.50	ft
Wetted perimeter	Pn =	3.92	ft
Flow depth	Yn =	1.25	ft
Flow velocity	Vn =	11.84	fps
Discharge	Qn =	29.00	cfs
Percent of Full Flow	Flow =	49.9%	of full flow
Normal Depth Froude Number	Fr_n =	2.11	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.06	radians
Critical flow area	Ac =	3.86	sq ft
Critical top width	Tc =	2.21	ft
Critical flow depth	Yc =	1.84	ft
Critical flow velocity	Vc =	7.51	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 9 - Proposed Conditions

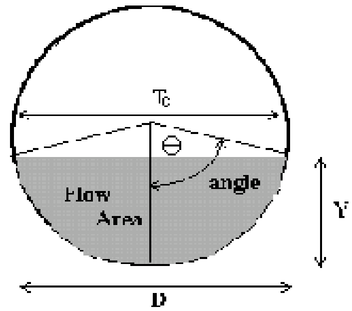


Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	42.00	inches
Design discharge	Q =	57.80	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	9.62	sq ft
Full-flow wetted perimeter	Pf =	11.00	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	100.88	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.66	radians
Flow area	An =	5.33	sq ft
Top width	Tn =	3.49	ft
Wetted perimeter	Pn =	5.80	ft
Flow depth	Yn =	1.90	ft
Flow velocity	Vn =	10.84	fps
Discharge	Qn =	57.81	cfs
Percent of Full Flow	Flow =	57.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.54	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.94	radians
Critical flow area	Ac =	6.97	sq ft
Critical top width	Tc =	3.26	ft
Critical flow depth	Yc =	2.38	ft
Critical flow velocity	Vc =	8.29	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 10 - Proposed Conditions



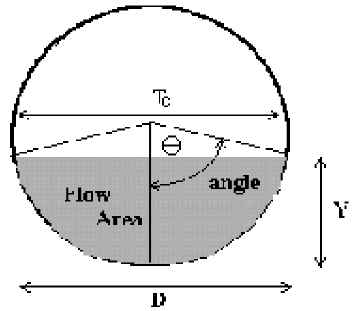
Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	5.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.54	radians
Flow area	An =	0.85	sq ft
Top width	Tn =	1.50	ft
Wetted perimeter	Pn =	2.31	ft
Flow depth	Yn =	0.73	ft
Flow velocity	Vn =	5.88	fps
Discharge	Qn =	5.00	cfs
Percent of Full Flow	Flow =	47.5%	of full flow
Normal Depth Froude Number	Fr_n =	1.38	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.72	radians
Critical flow area	Ac =	1.05	sq ft
Critical top width	Tc =	1.48	ft
Critical flow depth	Yc =	0.86	ft
Critical flow velocity	Vc =	4.77	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 11 - Proposed Conditions

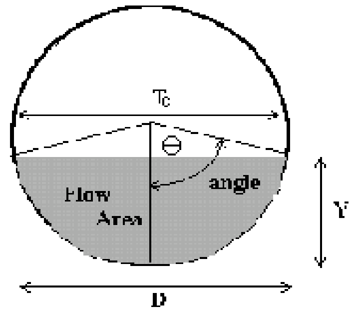


Design Information (Input)			
Pipe Invert Slope	So =	0.0180	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	4.80	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	14.13	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.37	radians
Flow area	An =	0.66	sq ft
Top width	Tn =	1.47	ft
Wetted perimeter	Pn =	2.06	ft
Flow depth	Yn =	0.60	ft
Flow velocity	Vn =	7.23	fps
Discharge	Qn =	4.80	cfs
Percent of Full Flow	Flow =	34.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.90	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.69	radians
Critical flow area	Ac =	1.02	sq ft
Critical top width	Tc =	1.49	ft
Critical flow depth	Yc =	0.84	ft
Critical flow velocity	Vc =	4.70	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 12 - Proposed Conditions



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	2.90	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	5.16	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.64	radians
Flow area	An =	0.43	sq ft
Top width	Tn =	1.00	ft
Wetted perimeter	Pn =	1.64	ft
Flow depth	Yn =	0.54	ft
Flow velocity	Vn =	6.76	fps
Discharge	Qn =	2.90	cfs
Percent of Full Flow	Flow =	56.2%	of full flow
Normal Depth Froude Number	Fr_n =	1.82	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.05	radians
Critical flow area	Ac =	0.61	sq ft
Critical top width	Tc =	0.89	ft
Critical flow depth	Yc =	0.73	ft
Critical flow velocity	Vc =	4.72	fps
Critical Depth Froude Number	Fr_c =	1.00	

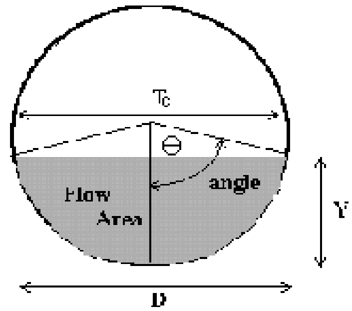
*** Unexpected value for Manning's n**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 13 - Proposed Conditions



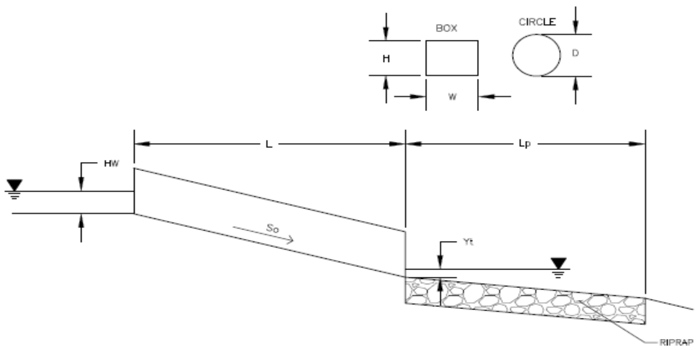
Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	5.20	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	7.30	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.82	radians
Flow area	An =	0.52	sq ft
Top width	Tn =	0.97	ft
Wetted perimeter	Pn =	1.82	ft
Flow depth	Yn =	0.62	ft
Flow velocity	Vn =	10.09	fps
Discharge	Qn =	5.20	cfs
Percent of Full Flow	Flow =	71.3%	of full flow
Normal Depth Froude Number	Fr_n =	2.44	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.59	radians
Critical flow area	Ac =	0.76	sq ft
Critical top width	Tc =	0.52	ft
Critical flow depth	Yc =	0.93	ft
Critical flow velocity	Vc =	6.85	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
ID: Pipe 13 Riprap Outfall Pad



Soil Type:
Choose One:
◉ Sandy
○ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	3.5	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)		Square Edge with Headwall	
OR:			
Box Culvert:		OR	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	101.9	ft
Outlet Elevation **OR** Slope	Elev OUT =	100	ft
Culvert Length	L =	93	ft
Manning's Roughness	n =	0.009	For concrete, this value is typically no les
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	0.79	ft^2
Culvert Normal Depth	Y_n =	0.48	ft
Culvert Critical Depth	Y_c =	0.80	ft
Froude Number	Fr =	2.66	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.39	
Sum of All Loss Coefficients	k_s =	2.89	ft
Headwater:			
Inlet Control Headwater	HW_I =	1.45	ft
Outlet Control Headwater	HW_O =	N/A	ft
Design Headwater Elevation	**HW =**	**103.35**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.45**	

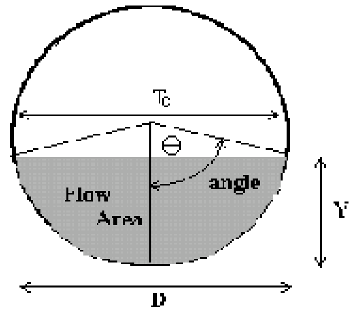
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.50	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.40	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	3.94	
Flow Area at Max Channel Velocity	A_t =	0.70	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**3**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**2**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	0.74	ft
Minimum Theoretical Riprap Size	d_{50} min=	3	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 14 - Proposed Conditions



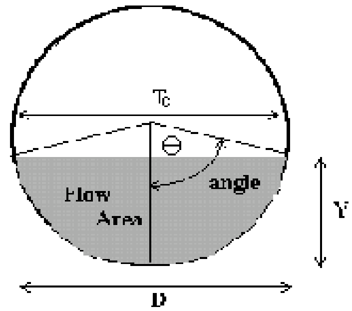
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	2.90	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	6.32	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.76	radians
Flow area	An =	0.49	sq ft
Top width	Tn =	0.98	ft
Wetted perimeter	Pn =	1.76	ft
Flow depth	Yn =	0.59	ft
Flow velocity	Vn =	8.60	fps
Discharge	Qn =	4.19	cfs
Percent of Full Flow	Flow =	66.3%	of full flow
Normal Depth Froude Number	Fr_n =	2.15	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.05	radians
Critical flow area	Ac =	0.61	sq ft
Critical top width	Tc =	0.89	ft
Critical flow depth	Yc =	0.73	ft
Critical flow velocity	Vc =	4.72	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 15 - Proposed Conditions



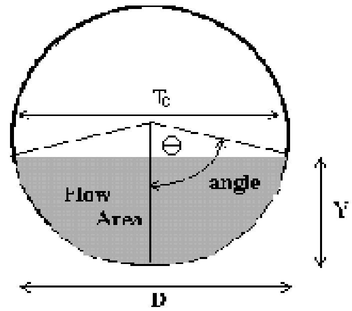
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0090	*
Pipe Diameter	D =	12.00	inches
Design discharge	Q =	2.90	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	6.32	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.76	radians
Flow area	An =	0.49	sq ft
Top width	Tn =	0.98	ft
Wetted perimeter	Pn =	1.76	ft
Flow depth	Yn =	0.59	ft
Flow velocity	Vn =	8.60	fps
Discharge	Qn =	4.19	cfs
Percent of Full Flow	Flow =	66.3%	of full flow
Normal Depth Froude Number	Fr_n =	2.15	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.05	radians
Critical flow area	Ac =	0.61	sq ft
Critical top width	Tc =	0.89	ft
Critical flow depth	Yc =	0.73	ft
Critical flow velocity	Vc =	4.72	fps
Critical Depth Froude Number	Fr_c =	1.00	

*** Unexpected value for Manning's n**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 16 - Proposed Conditions



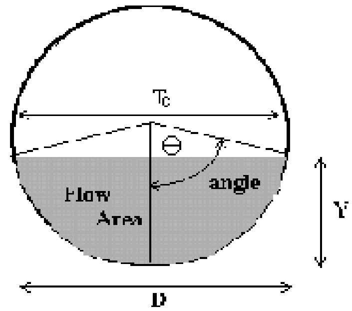
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	10.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	12.90	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.40	radians
Flow area	An =	0.69	sq ft
Top width	Tn =	1.48	ft
Wetted perimeter	Pn =	2.10	ft
Flow depth	Yn =	0.62	ft
Flow velocity	Vn =	6.70	fps
Discharge	Qn =	4.64	cfs
Percent of Full Flow	Flow =	36.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.73	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.70	radians
Critical flow area	Ac =	1.03	sq ft
Critical top width	Tc =	1.49	ft
Critical flow depth	Yc =	0.85	ft
Critical flow velocity	Vc =	9.70	fps
Critical Depth Froude Number	Fr_c =	2.05	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons

Pipe ID: 17 - Proposed Conditions

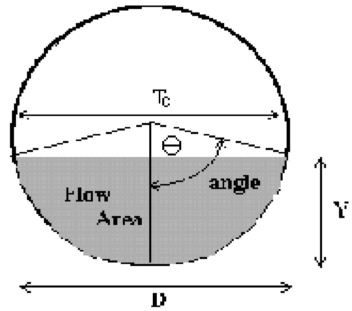


Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	20.00	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	32.08	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.72	radians
Flow area	An =	1.86	sq ft
Top width	Tn =	1.98	ft
Wetted perimeter	Pn =	3.43	ft
Flow depth	Yn =	1.14	ft
Flow velocity	Vn =	10.77	fps
Discharge	Qn =	20.00	cfs
Percent of Full Flow	Flow =	62.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.96	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.22	radians
Critical flow area	Ac =	2.70	sq ft
Critical top width	Tc =	1.59	ft
Critical flow depth	Yc =	1.61	ft
Critical flow velocity	Vc =	7.40	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Hancock Commons
Pipe ID: 18 - Proposed Conditions

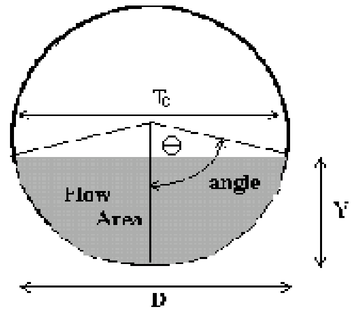


Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	1.70	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.10	radians
Flow area	An =	0.39	sq ft
Top width	Tn =	1.33	ft
Wetted perimeter	Pn =	1.64	ft
Flow depth	Yn =	0.41	ft
Flow velocity	Vn =	4.38	fps
Discharge	Qn =	1.70	cfs
Percent of Full Flow	Flow =	16.1%	of full flow
Normal Depth Froude Number	Fr_n =	1.43	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.22	radians
Critical flow area	Ac =	0.50	sq ft
Critical top width	Tc =	1.41	ft
Critical flow depth	Yc =	0.49	ft
Critical flow velocity	Vc =	3.39	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

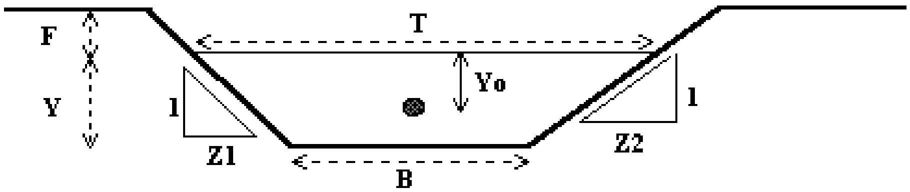
Project: Hancock Commons
Pipe ID: 19 - Proposed Conditions



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	1.80	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.11	radians
Flow area	An =	0.40	sq ft
Top width	Tn =	1.35	ft
Wetted perimeter	Pn =	1.67	ft
Flow depth	Yn =	0.42	ft
Flow velocity	Vn =	4.45	fps
Discharge	Qn =	1.80	cfs
Percent of Full Flow	Flow =	17.1%	of full flow
Normal Depth Froude Number	Fr_n =	1.43	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.24	radians
Critical flow area	Ac =	0.52	sq ft
Critical top width	Tc =	1.42	ft
Critical flow depth	Yc =	0.50	ft
Critical flow velocity	Vc =	3.45	fps
Critical Depth Froude Number	Fr_c =	1.00	

Normal Flow Analysis - Trapezoidal Channel

Project: **Hancock Commons**
Channel ID: **Main Channel - Cross Section 1 (8.3' Channel)**

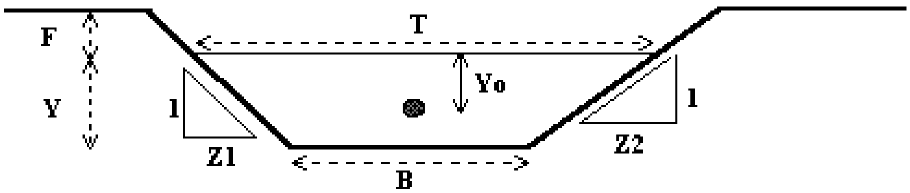


Design Information (Input)			
Channel Invert Slope	So =	0.0110	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	9.4	ft
Left Side Slope	Z1 =	1.6	ft/ft
Right Side Slope	Z2 =	1.8	ft/ft
Freeboard Height	F =	2.7	ft
Design Water Depth	Y =	**5.60**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2,481.5**	cfs
Froude Number	**Fr =**	**2.14**	
Flow Velocity	**V =**	**23.4**	fps
Flow Area	A =	106.1	sq ft
Top Width	T =	28.5	ft
Wetted Perimeter	P =	31.5	ft
Hydraulic Radius	R =	3.4	ft
Hydraulic Depth	D =	3.7	ft
Specific Energy	Es =	14.1	ft
Centroid of Flow Area	Yo =	2.3	ft
Specific Force	Fs =	128.0	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Hancock Commons
Channel ID: Main Channel - Cross Section 2 (8.0' Channel)

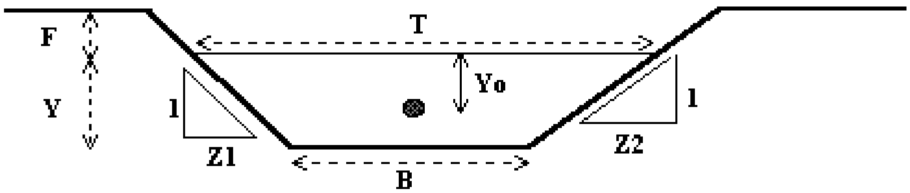


Design Information (Input)			
Channel Invert Slope	So =	0.0166	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	9.6	ft
Left Side Slope	Z1 =	1.5	ft/ft
Right Side Slope	Z2 =	1.5	ft/ft
Freeboard Height	F =	2.8	ft
Design Water Depth	Y =	**5.17**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2,481.7**	cfs
Froude Number	**Fr =**	**2.58**	
Flow Velocity	**V =**	**27.7**	fps
Flow Area	A =	89.7	sq ft
Top Width	T =	25.1	ft
Wetted Perimeter	P =	28.2	ft
Hydraulic Radius	R =	3.2	ft
Hydraulic Depth	D =	3.6	ft
Specific Energy	Es =	17.0	ft
Centroid of Flow Area	Yo =	2.2	ft
Specific Force	Fs =	145.4	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Hancock Commons**
Channel ID: **Main Channel - Cross Section 3 (6.2' Channel)**

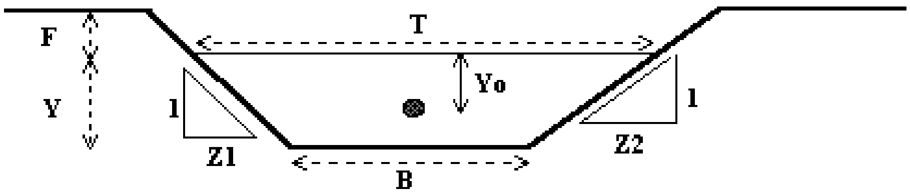


Design Information (Input)			
Channel Invert Slope	So =	0.0198	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	11.8	ft
Left Side Slope	Z1 =	1.5	ft/ft
Right Side Slope	Z2 =	1.2	ft/ft
Freeboard Height	F =	1.6	ft
Design Water Depth	Y =	**4.65**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2,477.9**	cfs
Froude Number	**Fr =**	**2.80**	
Flow Velocity	**V =**	**29.5**	fps
Flow Area	A =	84.1	sq ft
Top Width	T =	24.4	ft
Wetted Perimeter	P =	27.4	ft
Hydraulic Radius	R =	3.1	ft
Hydraulic Depth	D =	3.5	ft
Specific Energy	Es =	18.1	ft
Centroid of Flow Area	Yo =	2.1	ft
Specific Force	Fs =	152.5	kip

Normal Flow Analysis - Trapezoidal Channel

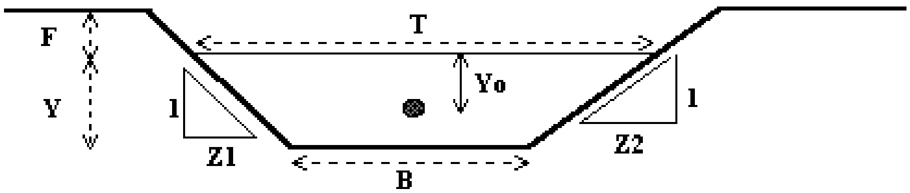
Project: **Hancock Commons**
Channel ID: **Main Channel - Cross Section 4 (6.2' Channel)**



Design Information (Input)			
Channel Invert Slope	So =	0.0198	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	11.3	ft
Left Side Slope	Z1 =	1.4	ft/ft
Right Side Slope	Z2 =	1.7	ft/ft
Freeboard Height	F =	1.6	ft
Design Water Depth	Y =	**4.62**	ft
Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2,483.8**	cfs
Froude Number	**Fr =**	**2.81**	
Flow Velocity	**V =**	**29.1**	fps
Flow Area	A =	85.3	sq ft
Top Width	T =	25.6	ft
Wetted Perimeter	P =	28.4	ft
Hydraulic Radius	R =	3.0	ft
Hydraulic Depth	D =	3.3	ft
Specific Energy	Es =	17.8	ft
Centroid of Flow Area	Yo =	2.0	ft
Specific Force	Fs =	151.0	kip

Normal Flow Analysis - Trapezoidal Channel

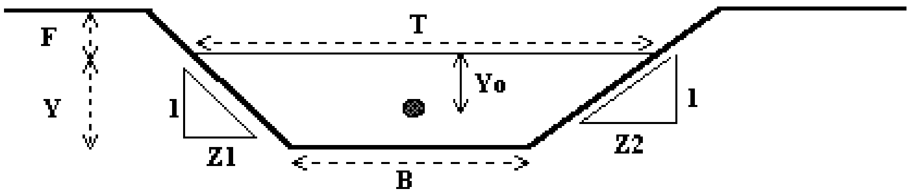
Project: **Hancock Commons**
Channel ID: **Main Channel - Cross Section 5 (7.5' Channel) - PROPOSED**



Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	12.0	ft
Left Side Slope	Z1 =	1.5	ft/ft
Right Side Slope	Z2 =	1.5	ft/ft
Freeboard Height	F =	1.0	ft
Design Water Depth	Y =	**6.48**	ft
Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**2,482.7**	cfs
Froude Number	**Fr =**	**1.47**	
Flow Velocity	**V =**	**17.6**	fps
Flow Area	A =	140.7	sq ft
Top Width	T =	31.4	ft
Wetted Perimeter	P =	35.4	ft
Hydraulic Radius	R =	4.0	ft
Hydraulic Depth	D =	4.5	ft
Specific Energy	Es =	11.3	ft
Centroid of Flow Area	Yo =	2.7	ft
Specific Force	Fs =	109.1	kip

Normal Flow Analysis - Trapezoidal Channel

Project: **Hancock Commons**
Channel ID: **Simmelink II Channel - Cross Section 6 (7.5' Channel)**

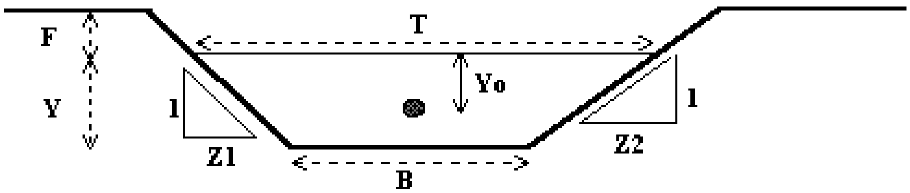


Design Information (Input)			
Channel Invert Slope	So =	0.0065	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	5.7	ft
Left Side Slope	Z1 =	1.0	ft/ft
Right Side Slope	Z2 =	1.0	ft/ft
Freeboard Height	F =	2.4	ft
Design Water Depth	Y =	**5.08**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**854.7**	cfs
Froude Number	**Fr =**	**1.48**	
Flow Velocity	**V =**	**15.6**	fps
Flow Area	A =	54.7	sq ft
Top Width	T =	15.9	ft
Wetted Perimeter	P =	20.1	ft
Hydraulic Radius	R =	2.7	ft
Hydraulic Depth	D =	3.5	ft
Specific Energy	Es =	8.9	ft
Centroid of Flow Area	Yo =	2.1	ft
Specific Force	Fs =	33.2	kip

Normal Flow Analysis - Trapezoidal Channel

Project: Hancock Commons
Channel ID: Simmelink II Channel - Cross Section 7 (7.6' Channel)



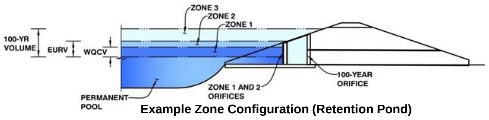
Design Information (Input)			
Channel Invert Slope	So =	0.0025	ft/ft
Channel Manning's N	N =	0.015	
Bottom Width	B =	5.9	ft
Left Side Slope	Z1 =	1.0	ft/ft
Right Side Slope	Z2 =	1.0	ft/ft
Freeboard Height	F =	1.2	ft
Design Water Depth	Y =	**6.36**	ft
Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**852.1**	cfs
Froude Number	**Fr =**	**0.94**	
Flow Velocity	**V =**	**10.9**	fps
Flow Area	A =	78.0	sq ft
Top Width	T =	18.6	ft
Wetted Perimeter	P =	23.9	ft
Hydraulic Radius	R =	3.3	ft
Hydraulic Depth	D =	4.2	ft
Specific Energy	Es =	8.2	ft
Centroid of Flow Area	Yo =	2.6	ft
Specific Force	Fs =	30.8	kip

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond A - Proposed Conditions**



Example Zone Configuration (Retention Pond)

Depth Increement = [ ] ft

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	10.52	acres		
Watershed Length =	820	ft		
Watershed Length to Centroid =	440	ft		
Watershed Slope =	0.023	ft/ft		
Watershed Imperviousness =	48.60%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.177	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.585	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.427	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.568	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.681	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.863	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.040	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.267	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.756	acre-feet		inches
Approximate 2-yr Detention Volume =	0.376	acre-feet		
Approximate 5-yr Detention Volume =	0.495	acre-feet		
Approximate 10-yr Detention Volume =	0.605	acre-feet		
Approximate 25-yr Detention Volume =	0.741	acre-feet		
Approximate 50-yr Detention Volume =	0.828	acre-feet		
Approximate 100-yr Detention Volume =	0.937	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.177	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.407	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.352	acre-feet
Total Detention Basin Volume =	0.937	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

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	--	--	--	1,868	0.043		
32	--	0.50	--	--	--	17,550	0.403	4,854	0.111
33	--	1.50	--	--	--	24,826	0.570	26,042	0.598
34	--	2.50	--	--	--	32,102	0.737	54,506	1.251
35	--	3.50	--	--	--	35,612	0.818	88,363	2.029
36	--	4.50	--	--	--	39,141	0.899	125,740	2.887
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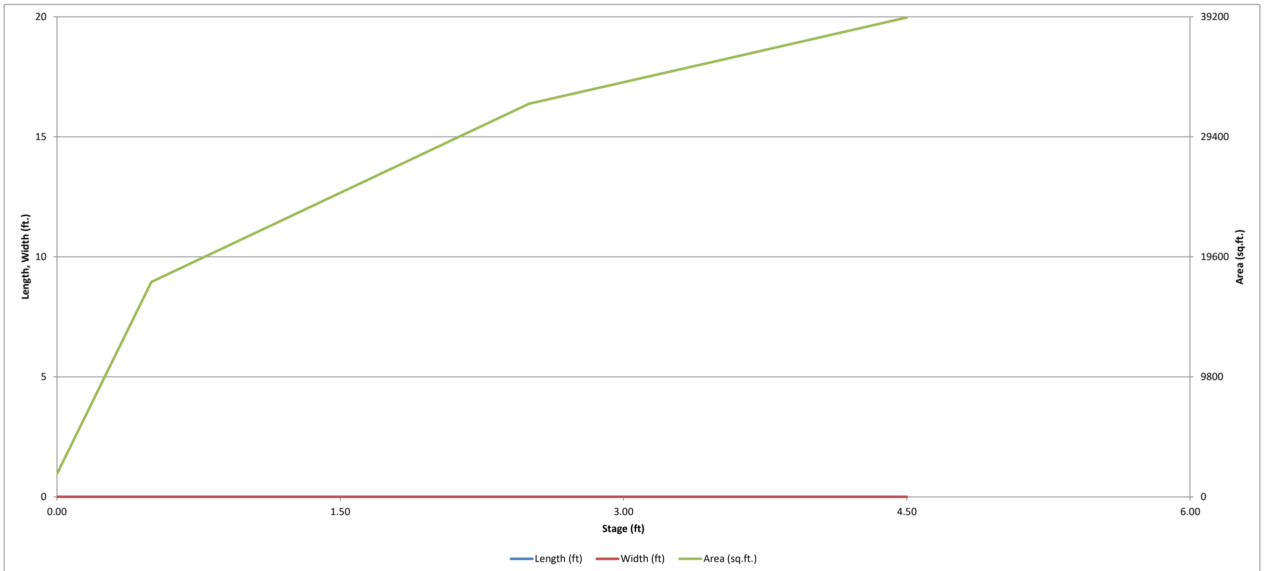
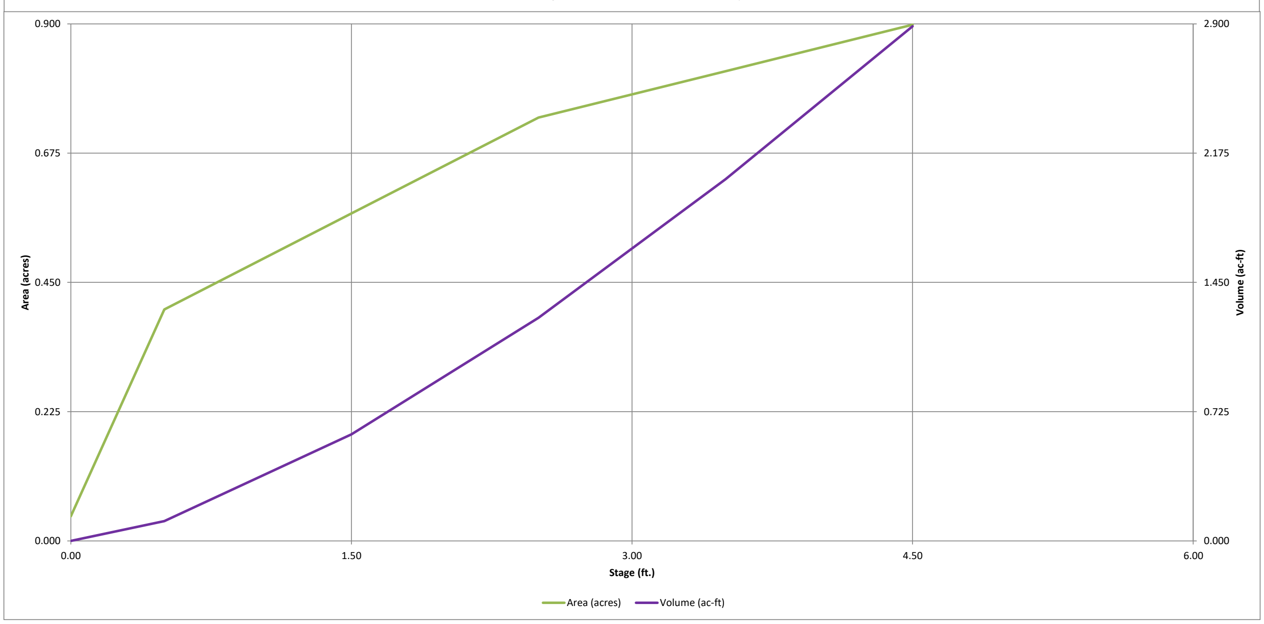
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



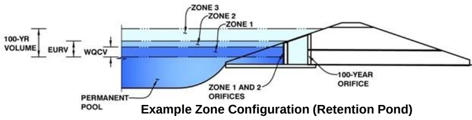


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond B Future OVER DETAIN**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		**Note: L / W Ratio < 1**	
Watershed Area =	12.09	acres	**L / W Ratio = 0.8**	
Watershed Length =	650	ft		
Watershed Length to Centroid =	270	ft		
Watershed Slope =	0.035	ft/ft		
Watershed Imperviousness =	70.30%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.278	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.078	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.712	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.930	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.105	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.323	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.537	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.793	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.355	acre-feet		inches
Approximate 2-yr Detention Volume =	0.704	acre-feet		
Approximate 5-yr Detention Volume =	0.918	acre-feet		
Approximate 10-yr Detention Volume =	1.103	acre-feet		
Approximate 25-yr Detention Volume =	1.320	acre-feet		
Approximate 50-yr Detention Volume =	1.450	acre-feet		
Approximate 100-yr Detention Volume =	1.579	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.278	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.800	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.501	acre-feet
Total Detention Basin Volume =	1.579	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	--	--	--	25	0.001		
36	--	0.50	--	--	--	450	0.010	119	0.003
37	--	1.50	--	--	--	1,206	0.028	947	0.022
38	--	2.50	--	--	--	20,742	0.476	11,921	0.274
39	--	3.50	--	--	--	22,624	0.519	33,604	0.771
40	--	4.50	--	--	--	25,941	0.596	57,886	1.329
41	--	5.50	--	--	--	28,456	0.653	85,085	1.953
42	--	6.50	--	--	--	31,944	0.733	115,284	2.647
43	--	7.50	--	--	--	34,687	0.796	148,600	3.411
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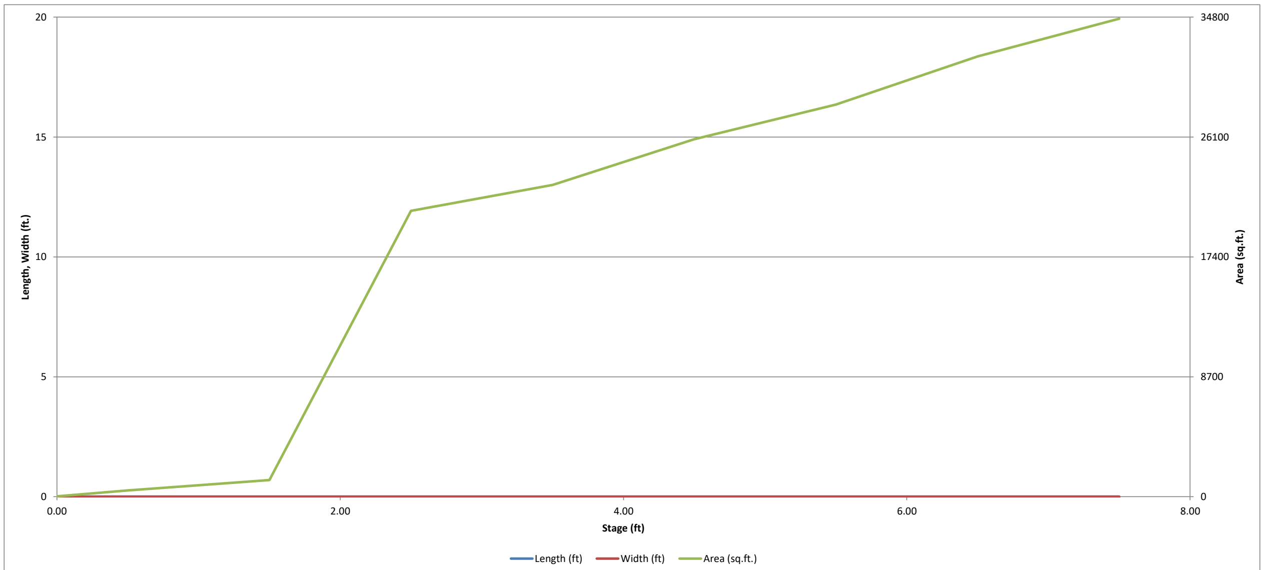
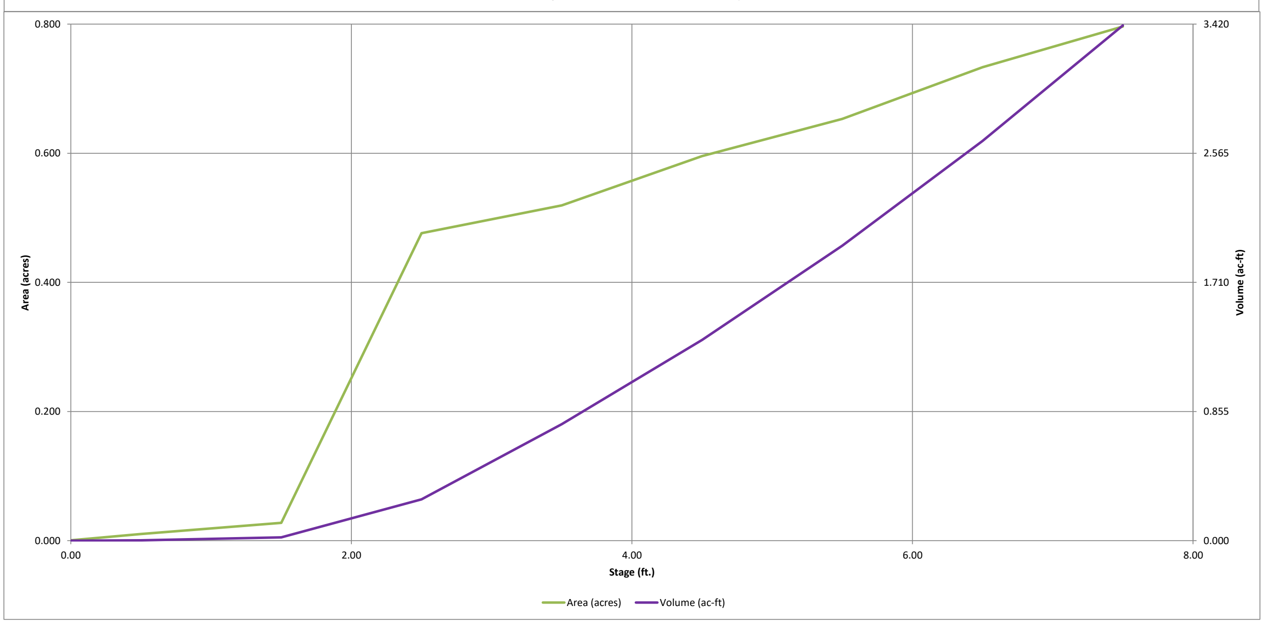
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

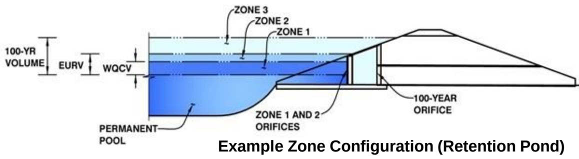




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**
Basin ID: **Pond B Future OVER DETAIN**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.52	0.278	Orifice Plate
Zone 2 (EURV)	4.07	0.800	Orifice Plate
Zone 3 (100-year)	4.92	0.501	Weir&Pipe (Restrict)
Total (all zones)		1.579	

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

				Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)		Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches		Underdrain Orifice Centroid =		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)

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	4.20	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	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	1.40	2.80	3.30	3.80			
Orifice Area (sq. inches)	1.16	1.16	12.00	12.00	12.00			

	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		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.20	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.20	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.50	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =		N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =		N/A	ft^2
Overflow Grate Type =		N/A		Overflow Grate Open Area w/ Debris =		N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	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 Orifice Area =	4.91	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	1.25	N/A	feet
Restrictor Plate Height Above Pipe Invert =	30.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.62	feet
Spillway Crest Length =	30.00	feet	Stage at Top of Freeboard =	7.12	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.77	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	3.11	acre-ft

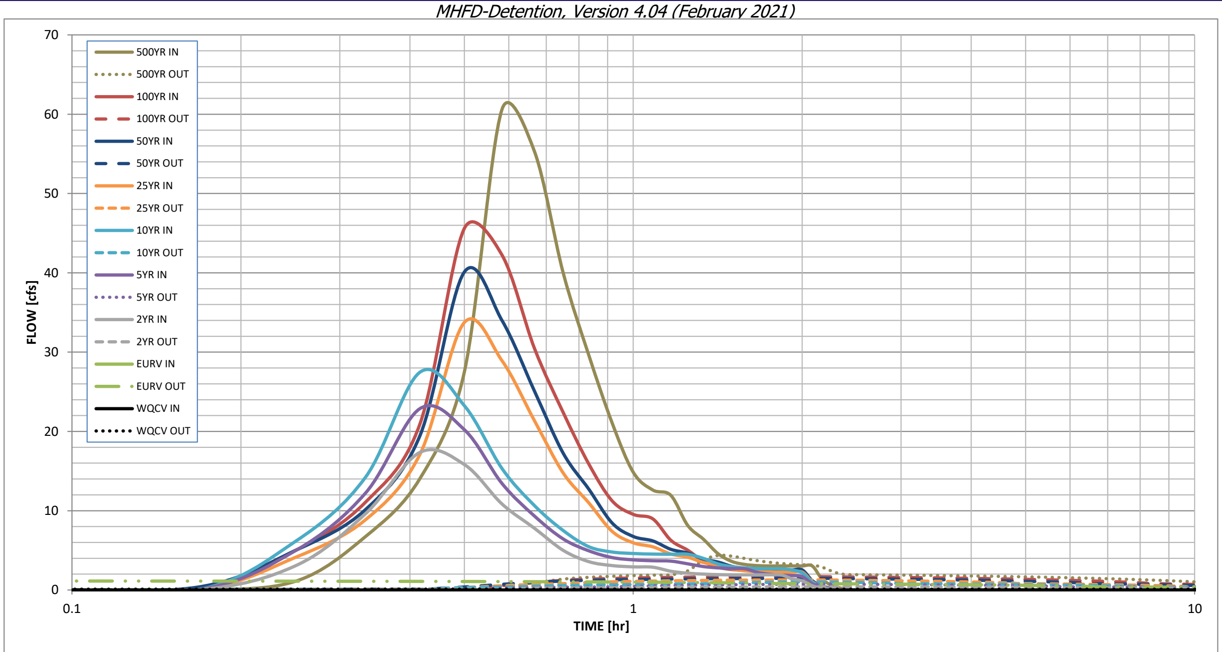
Routed Hydrograph Results

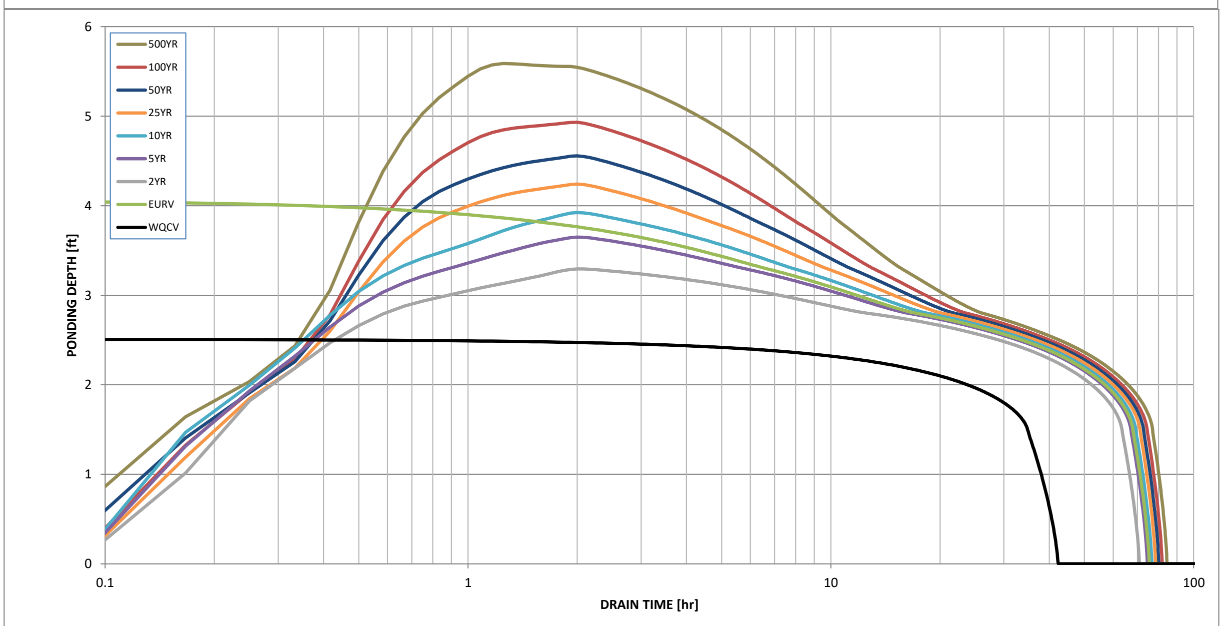
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

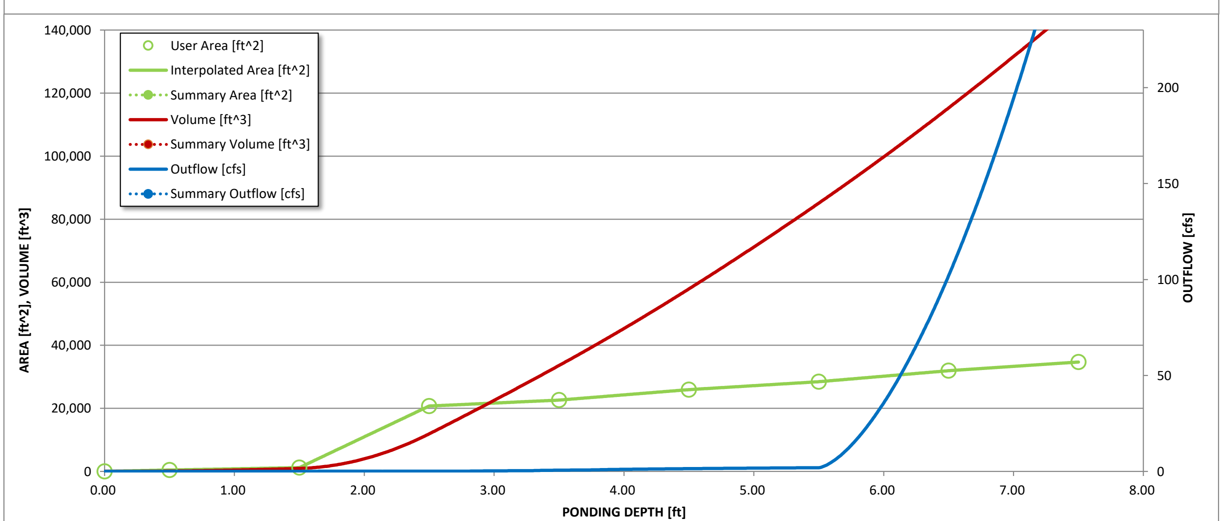
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.278	1.078	0.712	0.930	1.105	1.323	1.537	1.793	2.355
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.712	0.930	1.105	1.323	1.537	1.793	2.355
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.3	0.4	4.0	7.6	12.3	21.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.04	0.33	0.63	1.02	1.79
Peak Inflow Q (cfs) =	N/A	N/A	17.4	22.9	27.5	33.7	40.1	45.6	60.6
Peak Outflow Q (cfs) =	0.1	1.1	0.4	0.7	1.0	1.3	1.5	1.7	4.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.3	2.3	0.3	0.2	0.1	0.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	39	66	64	66	67	68	69	69	69
Time to Drain 99% of Inflow Volume (hours) =	**41**	71	68	71	72	73	74	75	77
Maximum Ponding Depth (ft) =	2.51	4.07	3.29	3.65	3.92	4.24	4.56	4.93	5.59
Area at Maximum Ponding Depth (acres) =	0.48	0.56	0.51	0.53	0.55	0.58	0.60	0.62	0.66
Maximum Volume Stored (acre-ft) =	0.278	1.080	0.663	0.845	0.996	1.177	1.359	1.590	2.006

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.03	1.10
	0:15:00	0.00	0.00	3.05	4.95	6.12	4.11	4.99	4.99	6.74
	0:20:00	0.00	0.00	9.62	12.22	14.21	8.85	10.14	11.07	14.04
	0:25:00	0.00	0.00	17.35	22.87	27.46	17.10	19.44	20.92	27.46
	0:30:00	0.00	0.00	15.83	20.22	23.26	33.73	40.09	45.59	60.57
	0:35:00	0.00	0.00	10.86	13.45	15.34	28.94	34.02	42.27	55.32
	0:40:00	0.00	0.00	7.79	9.33	10.65	21.36	25.10	30.49	40.02
	0:45:00	0.00	0.00	5.00	6.44	7.51	14.77	17.26	22.40	29.61
	0:50:00	0.00	0.00	3.58	4.94	5.46	10.99	12.72	15.89	21.10
	0:55:00	0.00	0.00	3.08	4.10	4.79	7.40	8.46	11.26	14.85
	1:00:00	0.00	0.00	2.92	3.80	4.61	5.95	6.75	9.54	12.61
	1:05:00	0.00	0.00	2.88	3.69	4.53	5.45	6.19	8.97	11.94
	1:10:00	0.00	0.00	2.37	3.64	4.51	4.54	5.13	6.27	8.15
	1:15:00	0.00	0.00	2.12	3.31	4.51	4.14	4.66	5.03	6.41
	1:20:00	0.00	0.00	2.01	2.96	3.99	3.47	3.91	3.61	4.57
	1:25:00	0.00	0.00	1.94	2.79	3.28	3.13	3.52	2.87	3.59
	1:30:00	0.00	0.00	1.92	2.71	2.95	2.65	2.97	2.58	3.21
	1:35:00	0.00	0.00	1.92	2.67	2.78	2.41	2.71	2.47	3.07
	1:40:00	0.00	0.00	1.92	2.21	2.70	2.31	2.60	2.44	3.03
	1:45:00	0.00	0.00	1.92	1.99	2.68	2.27	2.55	2.44	3.03
	1:50:00	0.00	0.00	1.92	1.89	2.68	2.26	2.54	2.44	3.03
	1:55:00	0.00	0.00	1.41	1.83	2.53	2.26	2.54	2.44	3.03
	2:00:00	0.00	0.00	1.16	1.69	2.16	2.26	2.54	2.44	3.03
	2:05:00	0.00	0.00	0.54	0.79	1.00	1.06	1.19	1.14	1.42
	2:10:00	0.00	0.00	0.22	0.35	0.44	0.47	0.53	0.51	0.63
	2:15:00	0.00	0.00	0.09	0.15	0.18	0.21	0.23	0.22	0.27
	2:20:00	0.00	0.00	0.02	0.04	0.04	0.05	0.05	0.05	0.06
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft²]	Area [acres]	Volume [ft³]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

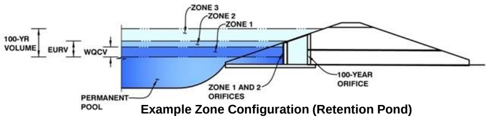
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond B Future UNDER RELEASE**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		**Note: L / W Ratio < 1**	
Watershed Area =	11.13	acres	**L / W Ratio = 0.87**	
Watershed Length =	650	ft		
Watershed Length to Centroid =	270	ft		
Watershed Slope =	0.035	ft/ft		
Watershed Imperviousness =	67.70%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.246	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.946	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.634	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.830	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.986	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.186	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.382	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.618	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.136	acre-feet		inches
Approximate 2-yr Detention Volume =	0.616	acre-feet		
Approximate 5-yr Detention Volume =	0.805	acre-feet		
Approximate 10-yr Detention Volume =	0.968	acre-feet		
Approximate 25-yr Detention Volume =	1.162	acre-feet		
Approximate 50-yr Detention Volume =	1.278	acre-feet		
Approximate 100-yr Detention Volume =	1.397	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.246	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.700	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.451	acre-feet
Total Detention Basin Volume =	1.397	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	--	--	--	25	0.001		
36	--	0.50	--	--	--	450	0.010	119	0.003
37	--	1.50	--	--	--	1,206	0.028	947	0.022
38	--	2.50	--	--	--	20,742	0.476	11,921	0.274
39	--	3.50	--	--	--	22,624	0.519	33,604	0.771
40	--	4.50	--	--	--	25,941	0.596	57,886	1.329
41	--	5.50	--	--	--	28,456	0.653	85,085	1.953
42	--	6.50	--	--	--	31,944	0.733	115,284	2.647
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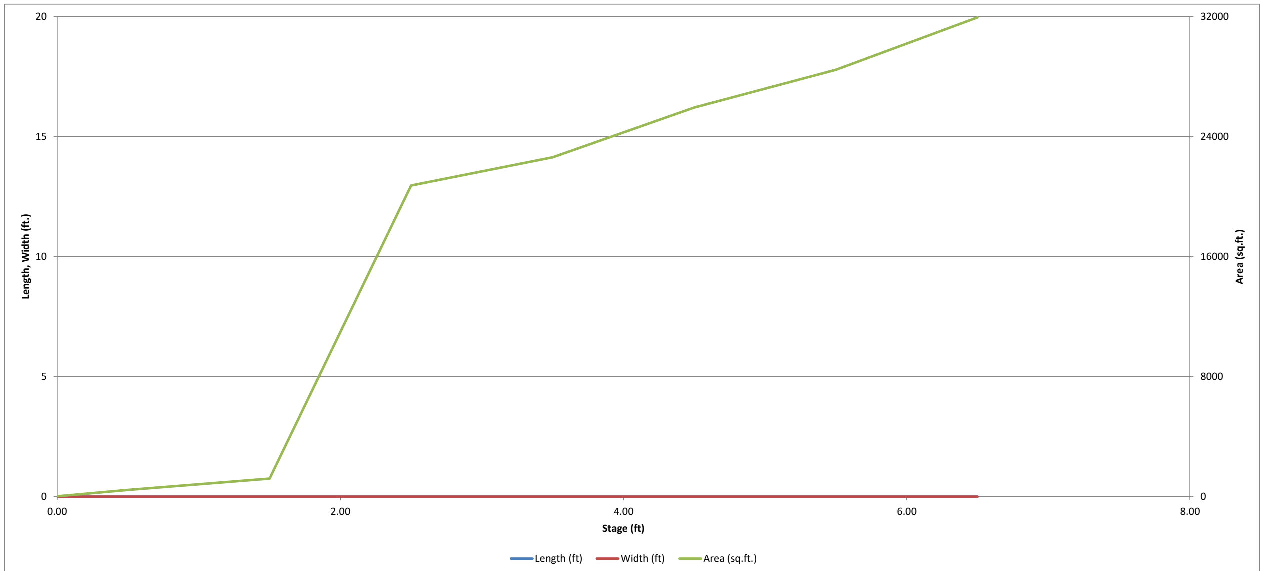
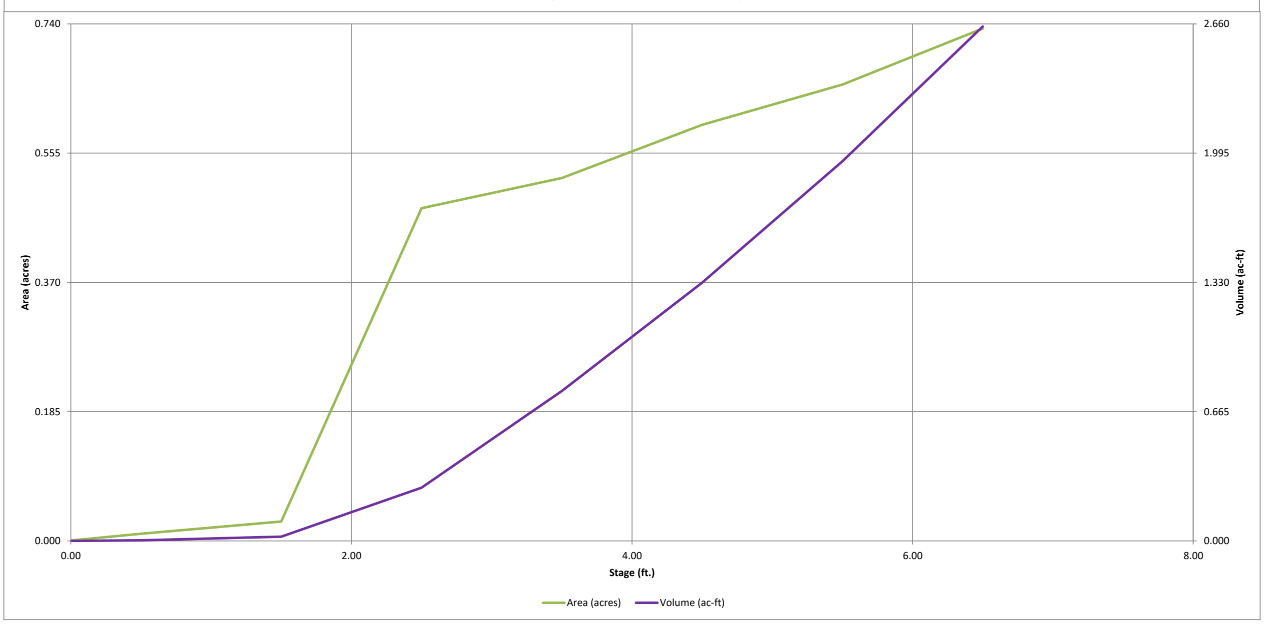
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

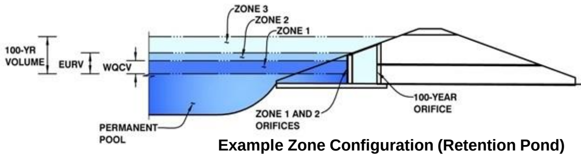




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**
Basin ID: **Pond B Future UNDER RELEASE**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.44	0.246	
Zone 2 (EURV)	3.83	0.700	
Zone 3 (100-year)	4.62	0.451	
Total (all zones)		1.397	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		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 =		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =		inches
Orifice Plate: Orifice Area per Row =		inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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 (optional)	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)								
Orifice Area (sq. inches)								

	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 =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres
Basin Volume at Top of Freeboard =		acre-ft

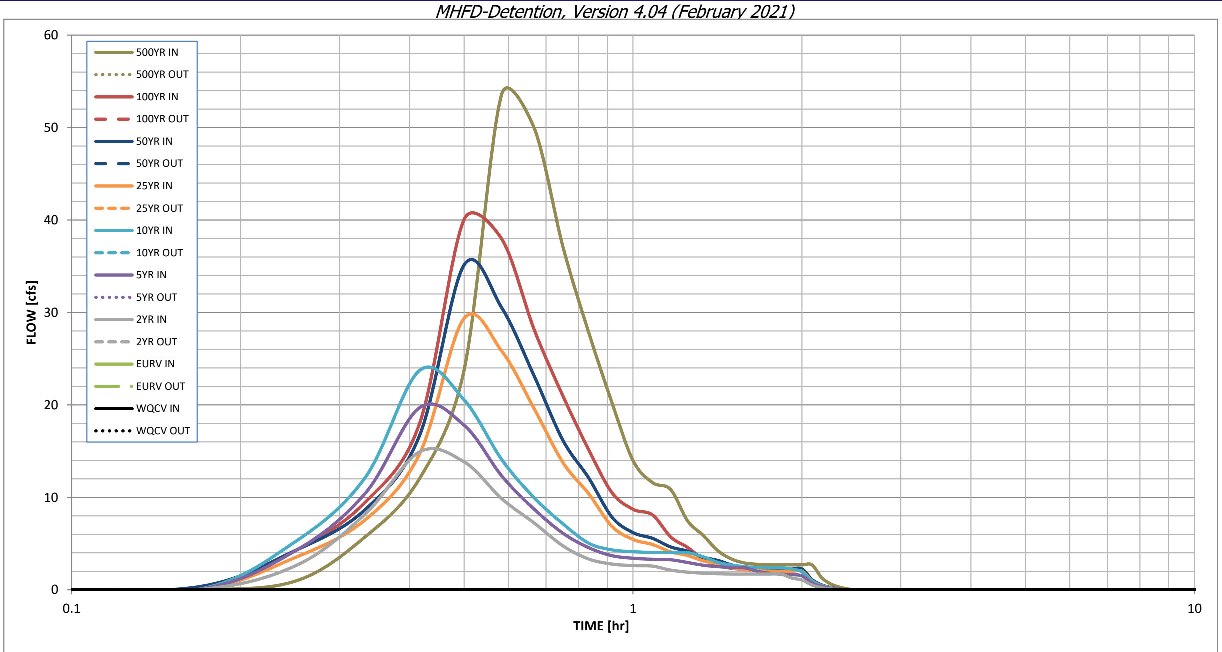
Routed Hydrograph Results

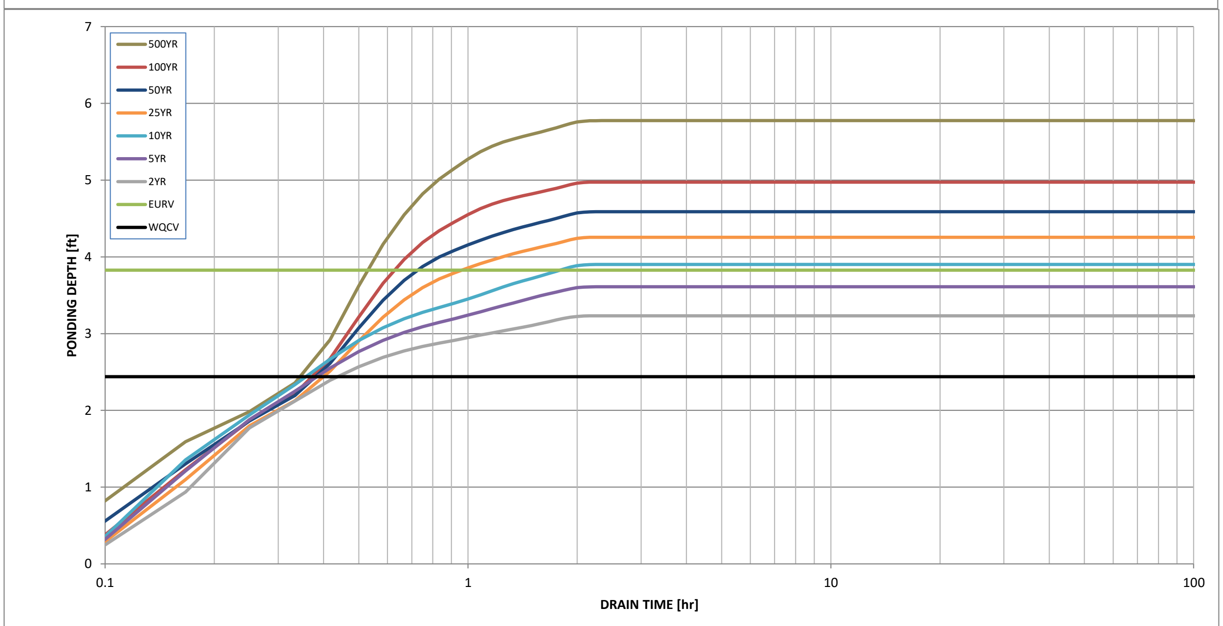
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

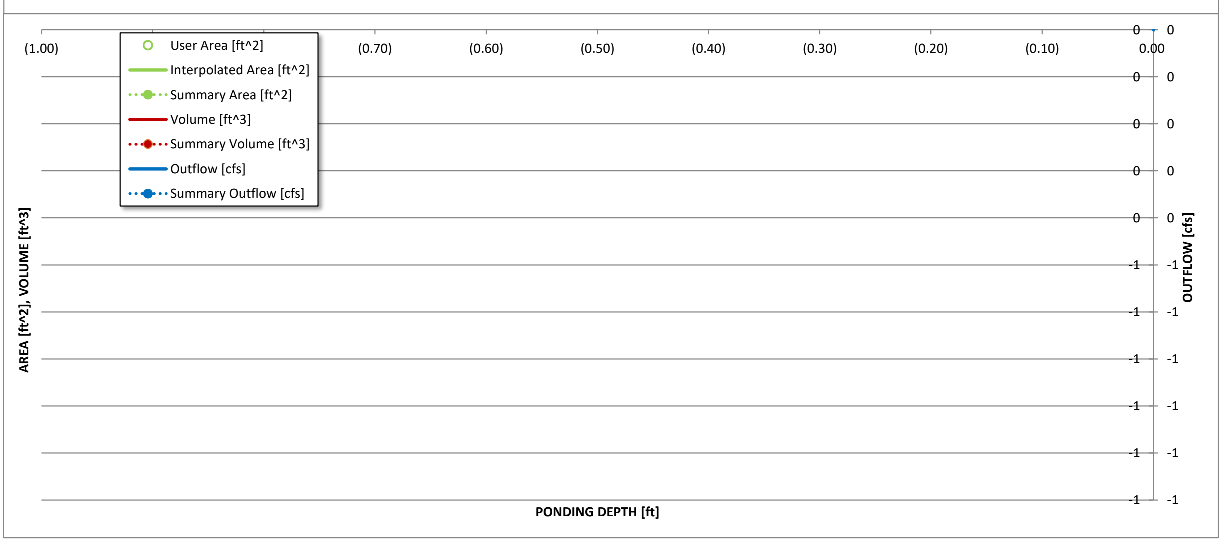
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.246	0.946	0.634	0.830	0.986	1.186	1.382	1.618	2.136
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.634	0.830	0.986	1.186	1.382	1.618	2.136
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.3	0.4	3.5	6.8	11.0	19.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.04	0.32	0.61	0.99	1.74
Peak Inflow Q (cfs) =	N/A	N/A	14.9	19.7	23.7	29.4	35.1	40.1	53.6
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.03	0.93
	0:15:00	0.00	0.00	2.58	4.20	5.20	3.49	4.24	4.24	5.74
	0:20:00	0.00	0.00	8.20	10.44	12.15	7.58	8.69	9.48	12.05
	0:25:00	0.00	0.00	14.93	19.71	23.74	14.73	16.71	18.00	23.75
	0:30:00	0.00	0.00	13.85	17.82	20.55	29.35	35.13	40.05	53.60
	0:35:00	0.00	0.00	9.86	12.33	14.10	25.84	30.53	37.97	49.95
	0:40:00	0.00	0.00	7.23	8.72	9.96	19.59	23.13	28.15	37.13
	0:45:00	0.00	0.00	4.76	6.13	7.14	13.78	16.18	20.98	27.88
	0:50:00	0.00	0.00	3.34	4.56	5.05	10.41	12.13	15.18	20.29
	0:55:00	0.00	0.00	2.79	3.70	4.32	6.88	7.89	10.54	13.98
	1:00:00	0.00	0.00	2.62	3.42	4.12	5.45	6.19	8.71	11.60
	1:05:00	0.00	0.00	2.56	3.30	4.04	4.90	5.57	8.10	10.86
	1:10:00	0.00	0.00	2.13	3.25	4.02	4.11	4.64	5.73	7.49
	1:15:00	0.00	0.00	1.91	2.96	4.02	3.72	4.19	4.60	5.89
	1:20:00	0.00	0.00	1.80	2.66	3.57	3.13	3.53	3.33	4.22
	1:25:00	0.00	0.00	1.74	2.51	2.97	2.83	3.18	2.65	3.32
	1:30:00	0.00	0.00	1.71	2.42	2.66	2.39	2.68	2.32	2.89
	1:35:00	0.00	0.00	1.71	2.38	2.50	2.17	2.44	2.22	2.76
	1:40:00	0.00	0.00	1.71	1.99	2.41	2.07	2.33	2.17	2.70
	1:45:00	0.00	0.00	1.71	1.80	2.39	2.03	2.28	2.17	2.70
	1:50:00	0.00	0.00	1.71	1.70	2.39	2.01	2.26	2.17	2.70
	1:55:00	0.00	0.00	1.28	1.64	2.26	2.01	2.26	2.17	2.70
	2:00:00	0.00	0.00	1.06	1.51	1.94	2.01	2.26	2.17	2.70
	2:05:00	0.00	0.00	0.52	0.75	0.95	0.99	1.11	1.07	1.33
	2:10:00	0.00	0.00	0.23	0.36	0.45	0.48	0.54	0.51	0.63
	2:15:00	0.00	0.00	0.09	0.16	0.20	0.22	0.24	0.23	0.29
	2:20:00	0.00	0.00	0.03	0.05	0.06	0.07	0.07	0.07	0.09
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

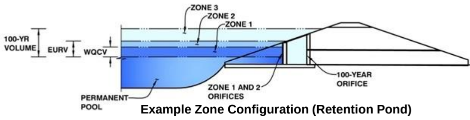
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Hancock Commons

Basin ID: Pond B Proposed OVER DETAIN



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		**Note: L / W Ratio < 1**
Watershed Area =	19.40	acres	**L / W Ratio = 0.5**
Watershed Length =	650	ft	
Watershed Length to Centroid =	270	ft	
Watershed Slope =	0.035	ft/ft	
Watershed Imperviousness =	43.80%	percent	
Percentage Hydrologic Soil Group A =	100.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.307	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.944	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.662	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.886	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.064	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.376	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.680	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.073	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.921	acre-feet		inches
Approximate 2-yr Detention Volume =	0.604	acre-feet		
Approximate 5-yr Detention Volume =	0.797	acre-feet		
Approximate 10-yr Detention Volume =	0.979	acre-feet		
Approximate 25-yr Detention Volume =	1.208	acre-feet		
Approximate 50-yr Detention Volume =	1.358	acre-feet		
Approximate 100-yr Detention Volume =	1.557	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.307	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.637	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.613	acre-feet
Total Detention Basin Volume =	1.557	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	--	--	--	25	0.001		
36	--	0.50	--	--	--	450	0.010	119	0.003
37	--	1.50	--	--	--	1,206	0.028	947	0.022
38	--	2.50	--	--	--	20,742	0.476	11,921	0.274
39	--	3.50	--	--	--	22,624	0.519	33,604	0.771
40	--	4.50	--	--	--	25,941	0.596	57,886	1.329
41	--	5.50	--	--	--	28,456	0.653	85,085	1.953
42	--	6.50	--	--	--	31,944	0.733	115,284	2.647
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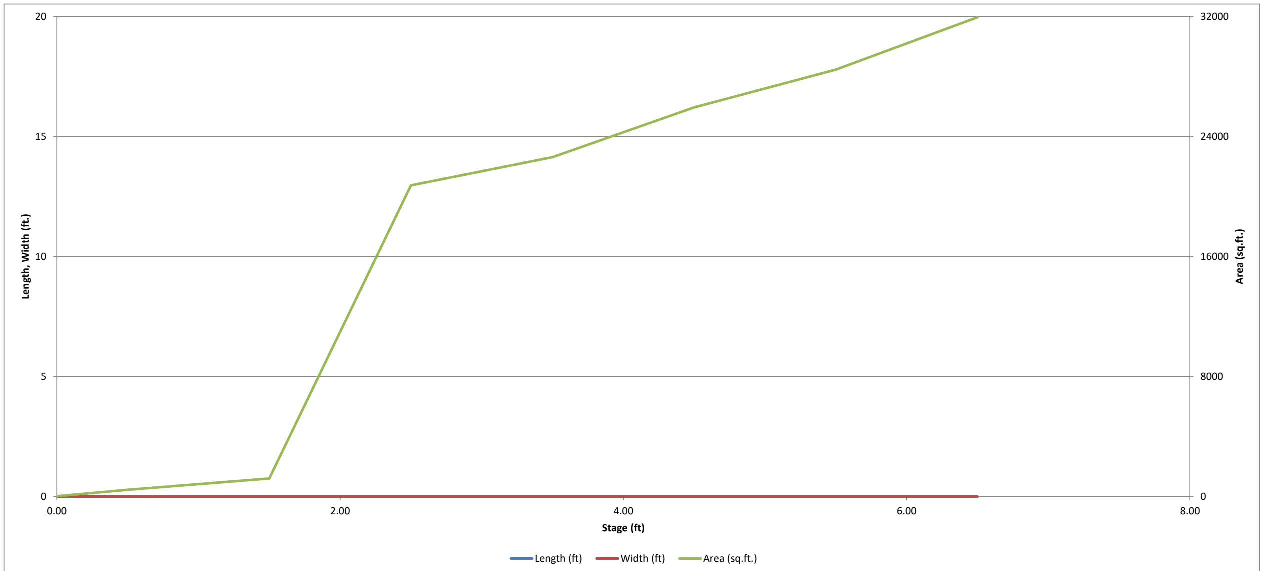
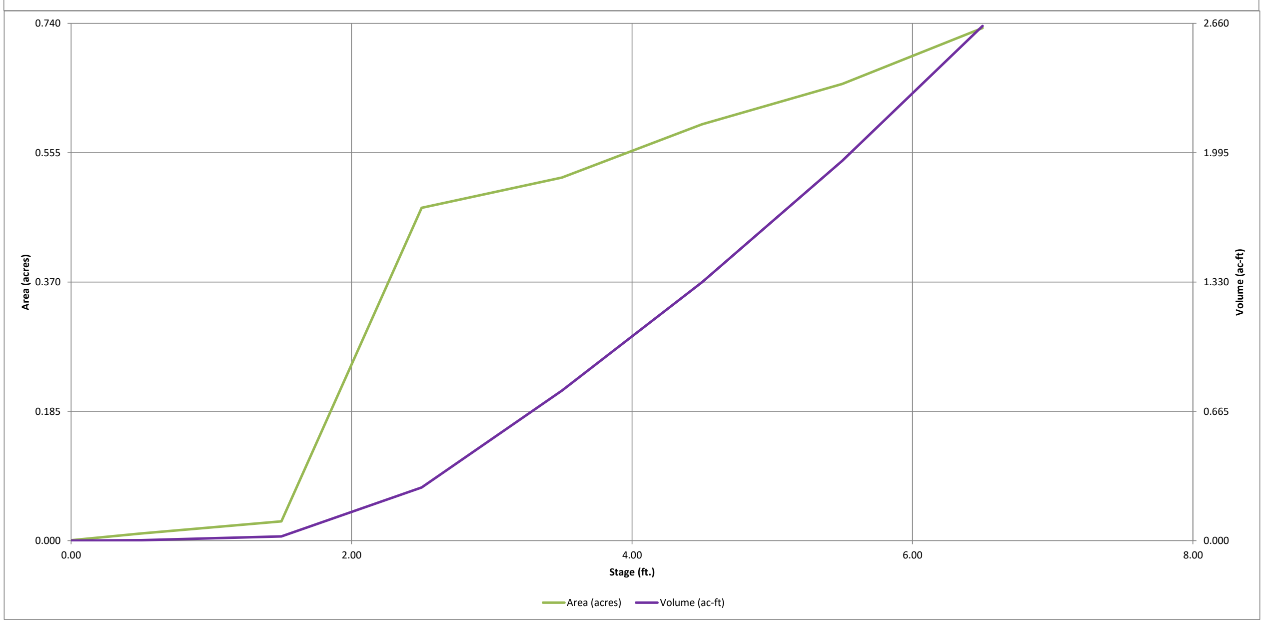
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



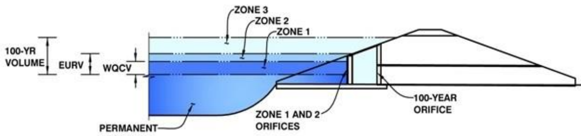


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond B Proposed OVER DETAIN**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.57	0.307	Orifice Plate
Zone 2 (EURV)	3.83	0.637	Orifice Plate
Zone 3 (100-year)	4.88	0.613	Weir&Pipe (Restrict)
Total (all zones)		1.557	

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 =	4.20	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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	1.40	2.80	3.30	3.80			
Orifice Area (sq. inches)	1.16	1.16	12.00	12.00	12.00			

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.20	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Type =		N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.20	N/A	feet
Overflow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =		N/A	
Overflow Grate Open Area w/o Debris =		N/A	ft^2
Overflow Grate Open Area w/ Debris =		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 =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	30.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.91	N/A	ft^2
Outlet Orifice Centroid =	1.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.67	feet
Stage at Top of Freeboard =	7.17	feet
Basin Area at Top of Freeboard =	0.78	acres
Basin Volume at Top of Freeboard =	3.15	acre-ft

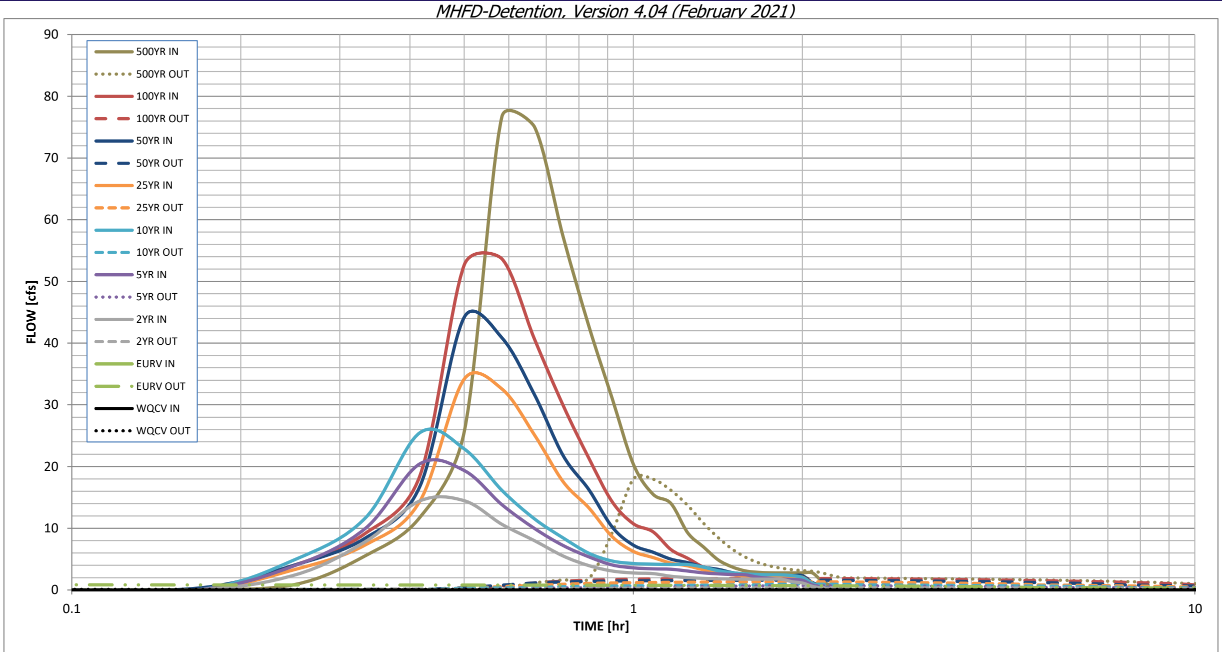
Routed Hydrograph Results

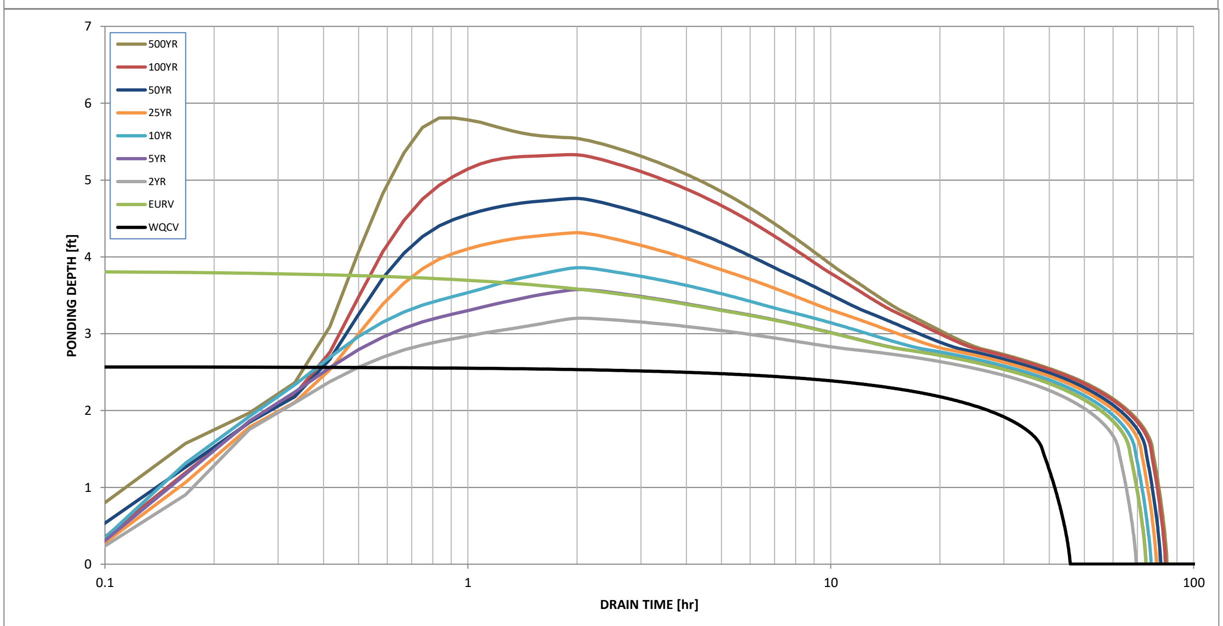
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

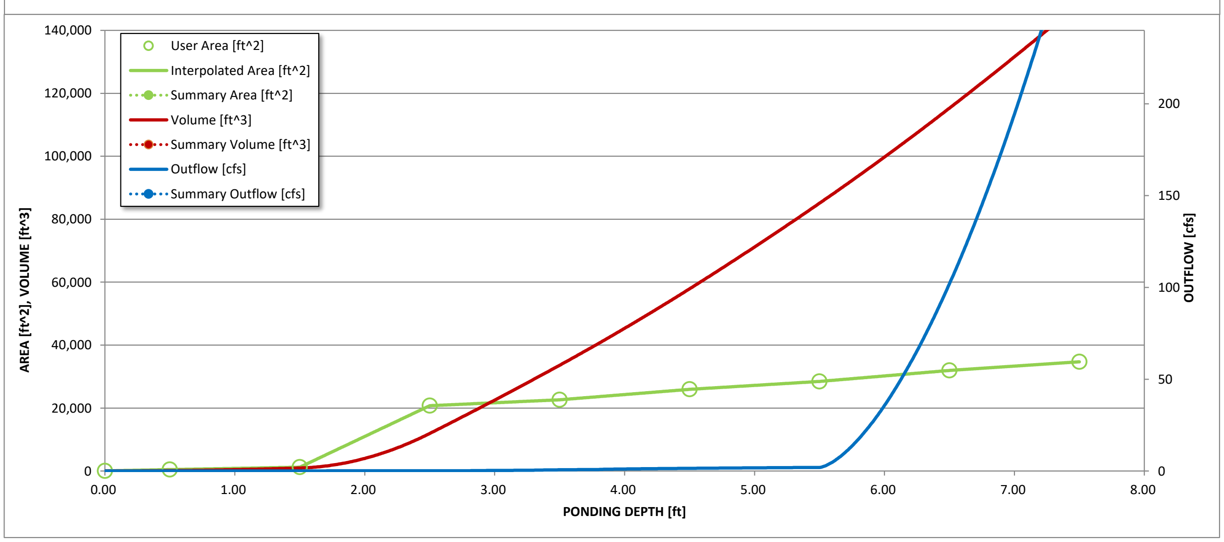
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.307	0.944	0.662	0.886	1.064	1.376	1.680	2.073	2.921
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.662	0.886	1.064	1.376	1.680	2.073	2.921
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	0.8	7.5	14.0	23.0	40.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.03	0.04	0.39	0.72	1.19	2.06
Peak Inflow Q (cfs) =	N/A	N/A	14.5	20.4	25.5	34.2	44.2	53.7	76.7
Peak Outflow Q (cfs) =	0.1	0.9	0.4	0.7	0.9	1.3	1.6	1.9	18.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.2	1.2	0.2	0.1	0.1	0.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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) =	42	65	63	66	67	68	69	70	67
Time to Drain 99% of Inflow Volume (hours) =	**44**	70	66	70	72	74	75	76	76
Maximum Ponding Depth (ft) =	2.57	3.83	3.20	3.58	3.86	4.32	4.76	5.33	5.81
Area at Maximum Ponding Depth (acres) =	0.48	0.54	0.51	0.52	0.55	0.58	0.61	0.64	0.68
Maximum Volume Stored (acre-ft) =	0.307	0.947	0.618	0.808	0.963	1.217	1.486	1.843	2.153

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.03	0.90
	0:15:00	0.00	0.00	2.45	3.98	4.95	3.34	4.07	4.08	5.56
	0:20:00	0.00	0.00	7.83	9.98	11.68	7.31	8.42	9.19	11.76
	0:25:00	0.00	0.00	14.43	20.44	25.48	14.36	16.76	18.46	25.67
	0:30:00	0.00	0.00	14.46	19.35	22.86	34.19	44.21	52.69	76.66
	0:35:00	0.00	0.00	10.65	13.83	16.15	32.58	40.87	53.67	75.06
	0:40:00	0.00	0.00	7.99	9.98	11.53	25.14	31.67	40.68	57.22
	0:45:00	0.00	0.00	5.51	7.21	8.44	17.54	21.77	29.90	42.76
	0:50:00	0.00	0.00	3.95	5.37	5.96	13.31	16.26	21.36	31.09
	0:55:00	0.00	0.00	3.08	4.06	4.69	8.65	10.23	14.32	20.41
	1:00:00	0.00	0.00	2.76	3.59	4.30	6.26	7.27	10.74	15.55
	1:05:00	0.00	0.00	2.66	3.43	4.18	5.27	6.14	9.45	14.03
	1:10:00	0.00	0.00	2.23	3.36	4.14	4.36	4.99	6.55	9.27
	1:15:00	0.00	0.00	2.01	3.07	4.13	3.91	4.44	5.13	6.98
	1:20:00	0.00	0.00	1.88	2.77	3.71	3.28	3.71	3.69	4.87
	1:25:00	0.00	0.00	1.81	2.61	3.12	2.97	3.35	2.91	3.74
	1:30:00	0.00	0.00	1.77	2.52	2.80	2.51	2.82	2.47	3.09
	1:35:00	0.00	0.00	1.76	2.46	2.61	2.28	2.56	2.31	2.87
	1:40:00	0.00	0.00	1.76	2.08	2.51	2.15	2.42	2.24	2.79
	1:45:00	0.00	0.00	1.76	1.88	2.46	2.10	2.36	2.23	2.77
	1:50:00	0.00	0.00	1.76	1.77	2.45	2.07	2.33	2.23	2.77
	1:55:00	0.00	0.00	1.35	1.71	2.33	2.06	2.32	2.23	2.77
	2:00:00	0.00	0.00	1.13	1.57	2.03	2.06	2.32	2.23	2.77
	2:05:00	0.00	0.00	0.60	0.83	1.07	1.09	1.22	1.17	1.44
	2:10:00	0.00	0.00	0.31	0.45	0.57	0.58	0.65	0.61	0.75
	2:15:00	0.00	0.00	0.14	0.22	0.27	0.28	0.31	0.30	0.36
	2:20:00	0.00	0.00	0.05	0.09	0.11	0.12	0.13	0.12	0.14
	2:25:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

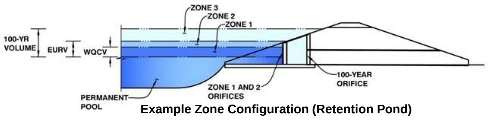
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond B Proposed UNDER RELEASE**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		**Note: L / W Ratio < 1**
Watershed Area =	18.44	acres	**L / W Ratio = 0.53**
Watershed Length =	650	ft	
Watershed Length to Centroid =	270	ft	
Watershed Slope =	0.035	ft/ft	
Watershed Imperviousness =	40.90%	percent	
Percentage Hydrologic Soil Group A =	100.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.280	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.822	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.581	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.781	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.940	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.233	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.519	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.893	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.697	acre-feet		inches
Approximate 2-yr Detention Volume =	0.524	acre-feet		
Approximate 5-yr Detention Volume =	0.693	acre-feet		
Approximate 10-yr Detention Volume =	0.854	acre-feet		
Approximate 25-yr Detention Volume =	1.058	acre-feet		
Approximate 50-yr Detention Volume =	1.195	acre-feet		
Approximate 100-yr Detention Volume =	1.383	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.280	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.542	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.561	acre-feet
Total Detention Basin Volume =	1.383	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	--	--	--	25	0.001		
36	--	0.50	--	--	--	450	0.010	119	0.003
37	--	1.50	--	--	--	1,206	0.028	947	0.022
38	--	2.50	--	--	--	20,742	0.476	11,921	0.274
39	--	3.50	--	--	--	22,624	0.519	33,604	0.771
40	--	4.50	--	--	--	25,941	0.596	57,886	1.329
41	--	5.50	--	--	--	28,456	0.653	85,085	1.953
42	--	6.50	--	--	--	31,944	0.733	115,284	2.647
43	--	7.50	--	--	--	34,687	0.796	148,600	3.411
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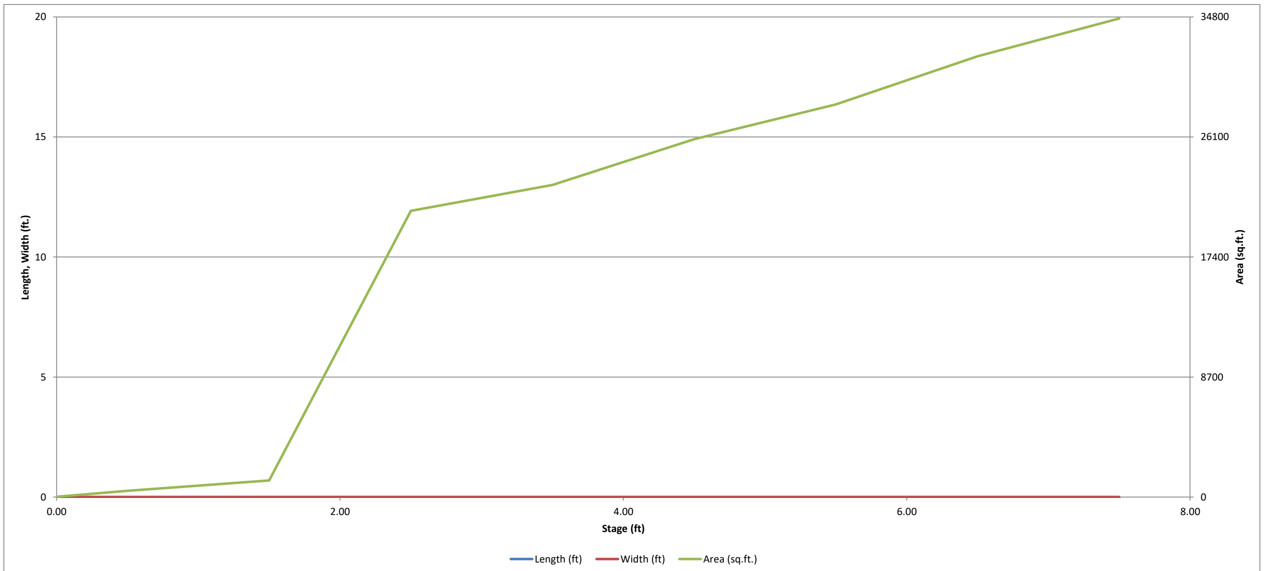
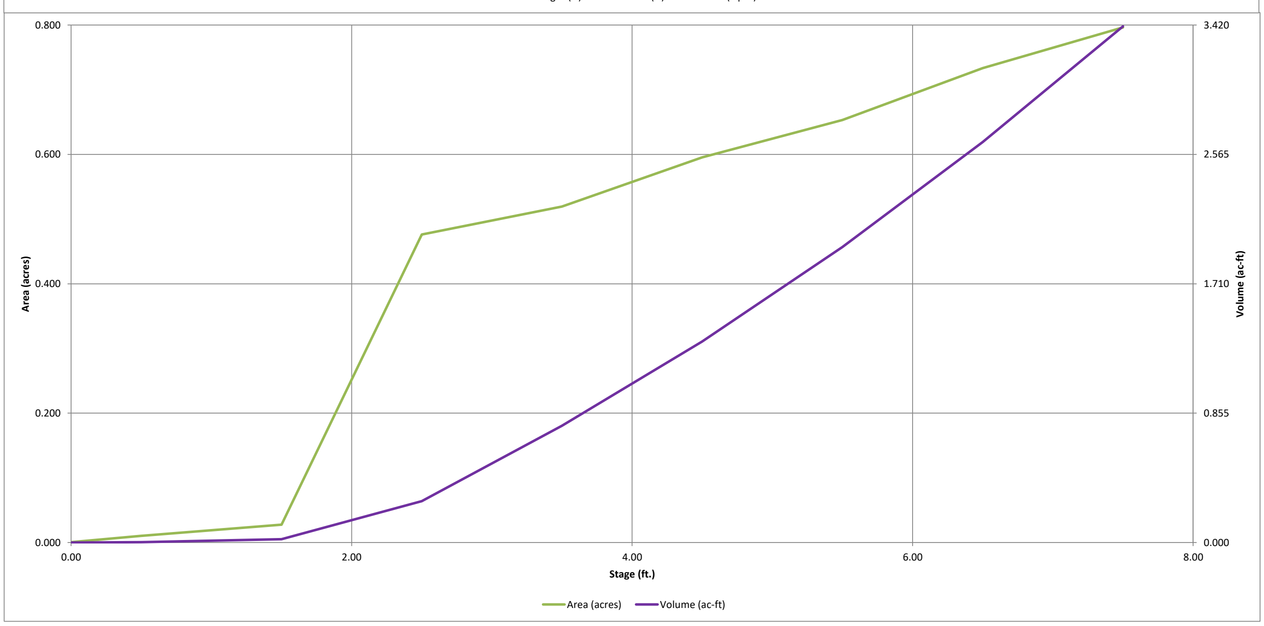
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



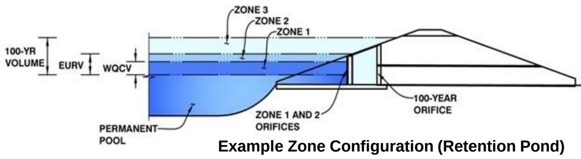


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond B Proposed UNDER RELEASE**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.52	0.280	Orifice Plate
Zone 2 (EURV)	3.60	0.542	Orifice Plate
Zone 3 (100-year)	4.60	0.561	Weir&Pipe (Restrict)
Total (all zones)		1.383	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		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 =	3.60	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.90	inches
Orifice Plate: Orifice Area per Row =		sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	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	1.20	2.40					
Orifice Area (sq. inches)	0.00	0.00	0.00					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =		N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =		N/A	feet
Overflow Weir Grate Slope =		N/A	H:V
Horiz. Length of Weir Sides =		N/A	feet
Overflow Grate Type =	Close Mesh Grate	N/A	
Debris Clogging % =		N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =		N/A	feet
Overflow Weir Slope Length =		N/A	feet
Grate Open Area / 100-yr Orifice Area =		N/A	
Overflow Grate Open Area w/o Debris =		N/A	ft^2
Overflow Grate Open Area w/ Debris =		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 =		N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =		N/A	inches
Restrictor Plate Height Above Pipe Invert =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres
Basin Volume at Top of Freeboard =		acre-ft

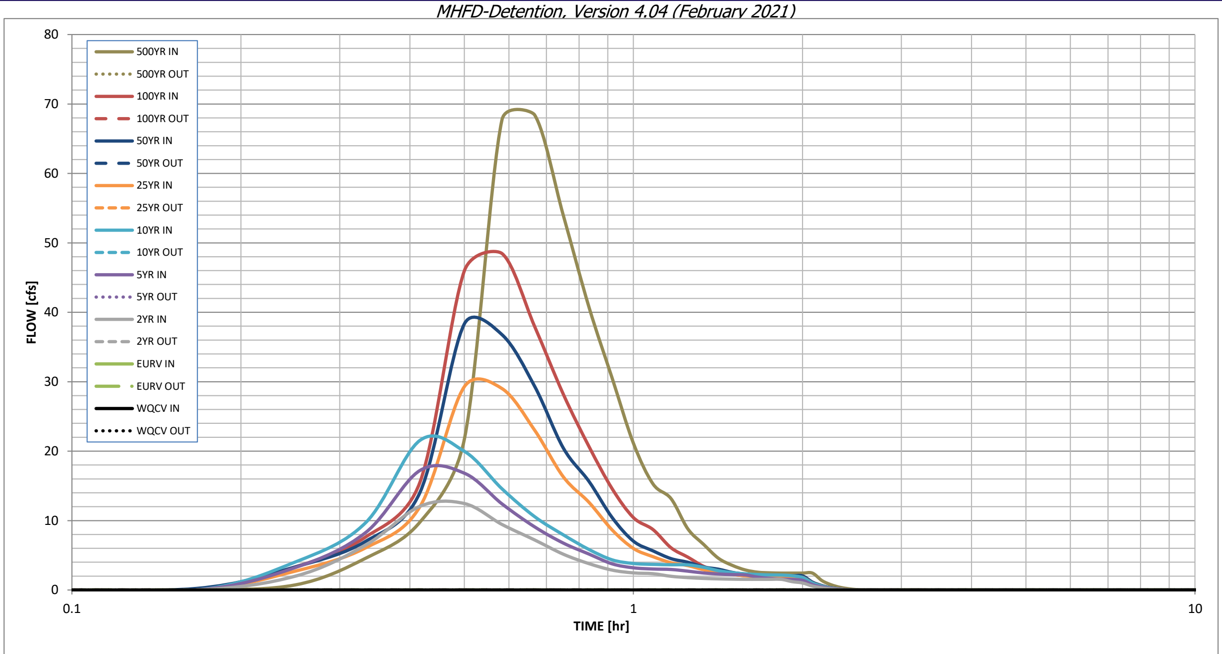
Routed Hydrograph Results

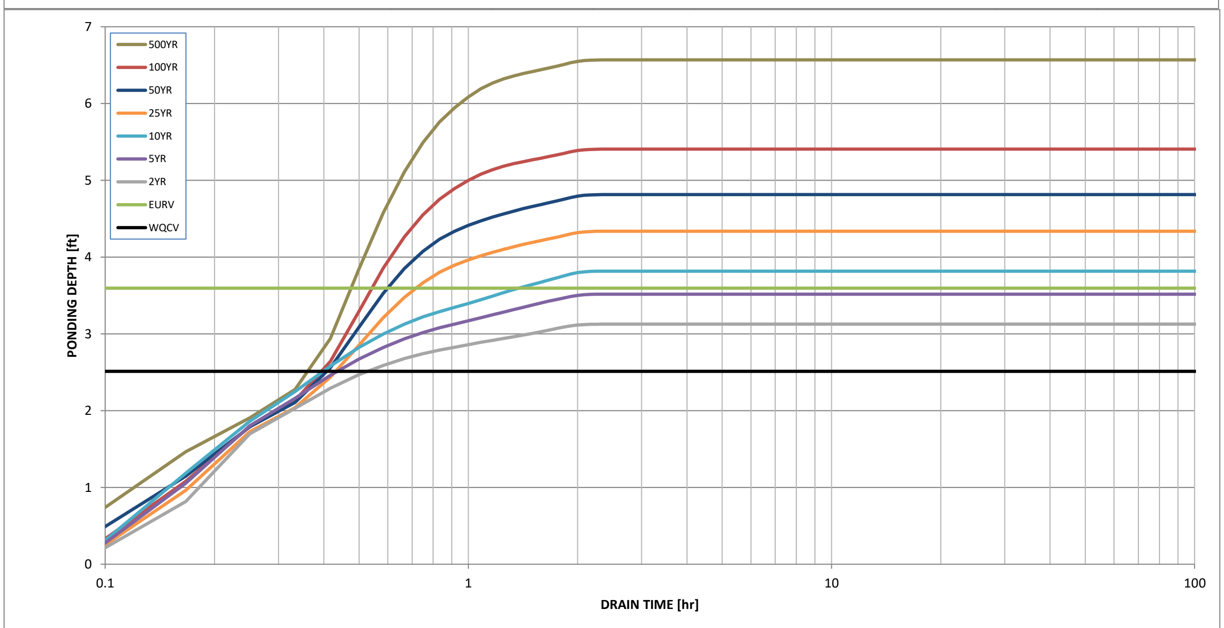
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

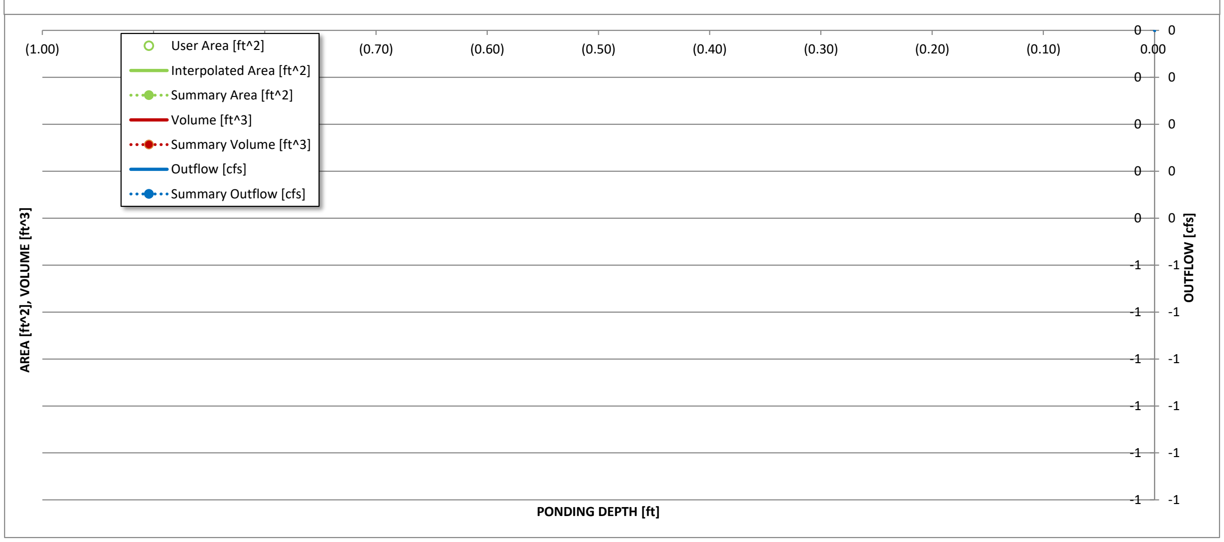
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.280	0.822	0.581	0.781	0.940	1.233	1.519	1.893	2.697
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.581	0.781	0.940	1.233	1.519	1.893	2.697
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.6	0.7	7.0	13.2	21.6	37.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.03	0.04	0.38	0.71	1.17	2.04
Peak Inflow Q (cfs) =	N/A	N/A	12.5	17.2	21.5	29.3	38.3	48.5	68.4
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.02	0.74
	0:15:00	0.00	0.00	1.99	3.24	4.03	2.72	3.33	3.33	4.57
	0:20:00	0.00	0.00	6.46	8.26	9.67	6.07	7.00	7.62	9.78
	0:25:00	0.00	0.00	12.05	17.21	21.55	12.00	14.04	15.52	21.74
	0:30:00	0.00	0.00	12.45	16.82	19.97	29.29	38.34	45.98	67.74
	0:35:00	0.00	0.00	9.44	12.41	14.57	29.01	36.78	48.46	68.44
	0:40:00	0.00	0.00	7.21	9.10	10.57	23.04	29.36	37.99	53.98
	0:45:00	0.00	0.00	5.16	6.76	7.95	16.31	20.46	28.21	40.75
	0:50:00	0.00	0.00	3.80	5.18	5.83	12.63	15.64	20.67	30.50
	0:55:00	0.00	0.00	2.86	3.76	4.34	8.64	10.42	14.57	21.13
	1:00:00	0.00	0.00	2.46	3.20	3.82	5.99	7.03	10.43	15.29
	1:05:00	0.00	0.00	2.35	3.03	3.69	4.80	5.64	8.71	13.16
	1:10:00	0.00	0.00	1.97	2.96	3.64	3.93	4.52	6.08	8.80
	1:15:00	0.00	0.00	1.78	2.71	3.62	3.51	4.00	4.73	6.57
	1:20:00	0.00	0.00	1.67	2.45	3.27	2.93	3.32	3.41	4.58
	1:25:00	0.00	0.00	1.60	2.31	2.78	2.65	3.00	2.71	3.55
	1:30:00	0.00	0.00	1.56	2.22	2.50	2.25	2.54	2.27	2.88
	1:35:00	0.00	0.00	1.54	2.17	2.33	2.03	2.29	2.05	2.56
	1:40:00	0.00	0.00	1.54	1.85	2.23	1.91	2.15	1.98	2.47
	1:45:00	0.00	0.00	1.54	1.67	2.17	1.85	2.08	1.95	2.43
	1:50:00	0.00	0.00	1.54	1.57	2.15	1.82	2.05	1.95	2.43
	1:55:00	0.00	0.00	1.21	1.51	2.05	1.81	2.04	1.95	2.43
	2:00:00	0.00	0.00	1.02	1.39	1.80	1.81	2.04	1.95	2.43
	2:05:00	0.00	0.00	0.57	0.78	1.01	1.02	1.14	1.09	1.35
	2:10:00	0.00	0.00	0.31	0.44	0.56	0.57	0.64	0.61	0.75
	2:15:00	0.00	0.00	0.15	0.23	0.29	0.29	0.33	0.31	0.38
	2:20:00	0.00	0.00	0.06	0.11	0.13	0.14	0.16	0.15	0.18
	2:25:00	0.00	0.00	0.02	0.04	0.04	0.05	0.05	0.05	0.05
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

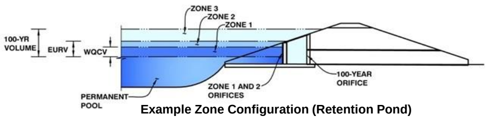
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond C**



Example Zone Configuration (Retention Pond)

Depth Increment = ft

Watershed Information

Selected BMP Type =	**RG**				
Watershed Area =	2.11	acres			
Watershed Length =	350	ft			
Watershed Length to Centroid =	175	ft			
Watershed Slope =	0.009	ft/ft			
Watershed Imperviousness =	58.90%	percent			
Percentage Hydrologic Soil Group A =	100.0%	percent			
Percentage Hydrologic Soil Group B =	0.0%	percent			
Percentage Hydrologic Soil Groups C/D =	0.0%	percent			
Target WQCV Drain Time =	40.0	hours	**Drain Time Too Long**		
Location for 1-hr Rainfall Depths =	User Input				

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.033	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.150	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.106	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.140	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.167	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.204	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.241	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.286	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.386	acre-feet		inches
Approximate 2-yr Detention Volume =	0.097	acre-feet		
Approximate 5-yr Detention Volume =	0.127	acre-feet		
Approximate 10-yr Detention Volume =	0.154	acre-feet		
Approximate 25-yr Detention Volume =	0.187	acre-feet		
Approximate 50-yr Detention Volume =	0.207	acre-feet		
Approximate 100-yr Detention Volume =	0.229	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =		acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =		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

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)
Media Surface	--	0.00	--	--	--	1,500	0.034		
	--	0.50	--	--	--	1,936	0.044	859	0.020
	--	1.00	--	--	--	2,304	0.053	1,919	0.044
	--	1.50	--	--	--	2,704	0.062	3,171	0.073
	--	2.00	--	--	--	3,136	0.072	4,631	0.106
	--	2.50	--	--	--	3,600	0.083	6,315	0.145
	--	3.00	--	--	--	4,096	0.094	8,239	0.189
	--	3.50	--	--	--	4,703	0.108	10,419	0.239
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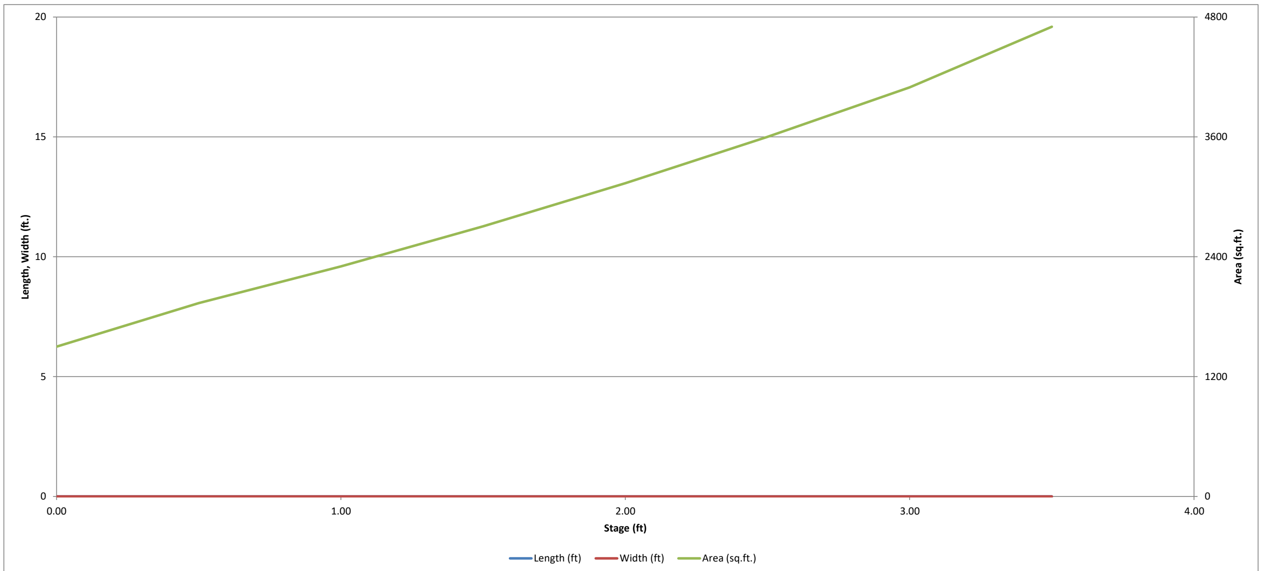
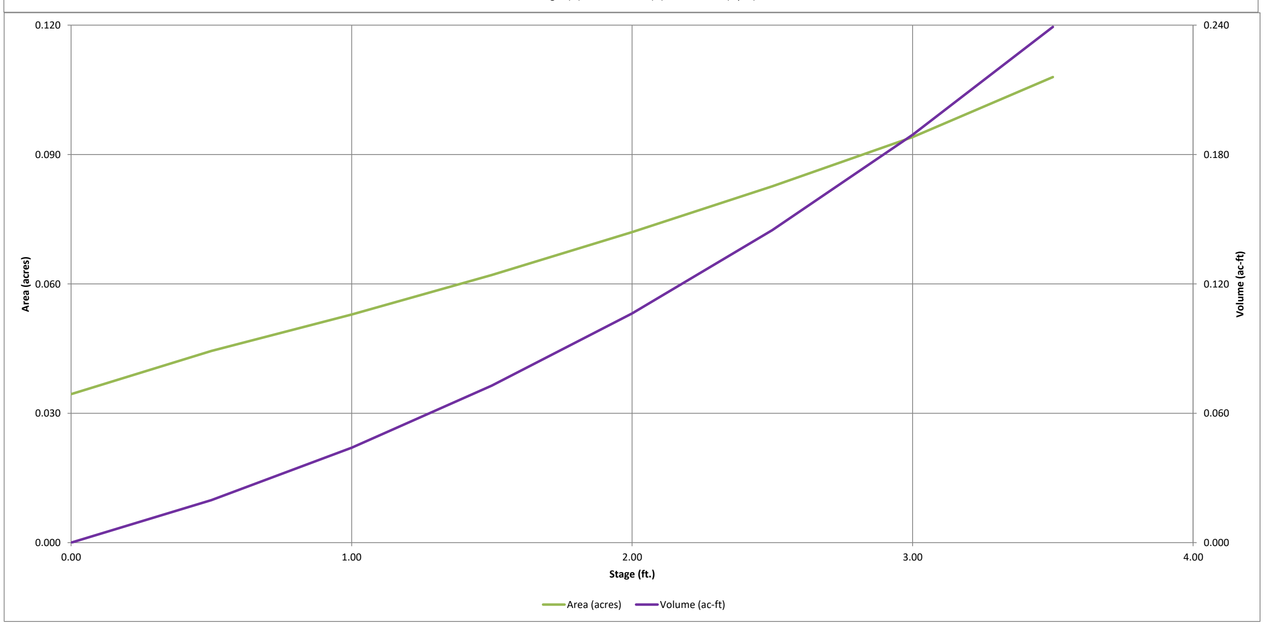
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



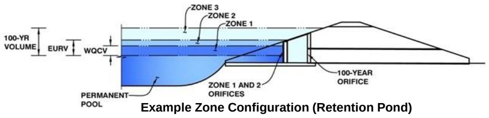


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: **Hancock Commons**

Basin ID: **Pond D**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**RG**		**Note: L / W Ratio < 1**
Watershed Area =	1.01	acres	**L / W Ratio = 0.45**
Watershed Length =	140	ft	
Watershed Length to Centroid =	70	ft	
Watershed Slope =	0.008	ft/ft	
Watershed Imperviousness =	78.10%	percent	
Percentage Hydrologic Soil Group A =	100.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	**Drain Time Too Long**
Location for 1-hr Rainfall Depths =	User Input		

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.021	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.103	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.064	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.084	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.099	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.117	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.135	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.156	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.202	acre-feet		inches
Approximate 2-yr Detention Volume =	0.068	acre-feet		
Approximate 5-yr Detention Volume =	0.088	acre-feet		
Approximate 10-yr Detention Volume =	0.105	acre-feet		
Approximate 25-yr Detention Volume =	0.125	acre-feet		
Approximate 50-yr Detention Volume =	0.137	acre-feet		
Approximate 100-yr Detention Volume =	0.148	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =		acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =		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)
Media Surface	--	0.00	--	--	--	900	0.021		
	--	0.50	--	--	--	1,156	0.027	514	0.012
	--	1.00	--	--	--	1,444	0.033	1,164	0.027
	--	1.50	--	--	--	1,764	0.040	1,966	0.045
	--	2.00	--	--	--	2,116	0.049	2,936	0.067
	--	2.50	--	--	--	2,500	0.057	4,090	0.094
	--	3.00	--	--	--	4,096	0.094	5,739	0.132
	--	3.50	--	--	--	4,783	0.110	7,959	0.183
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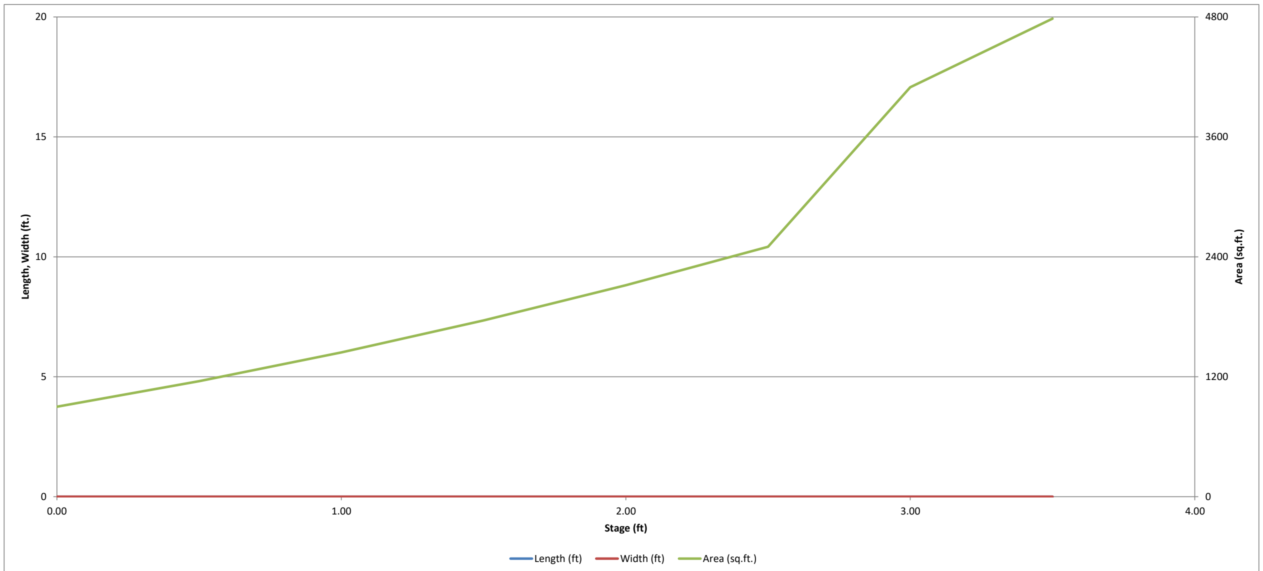
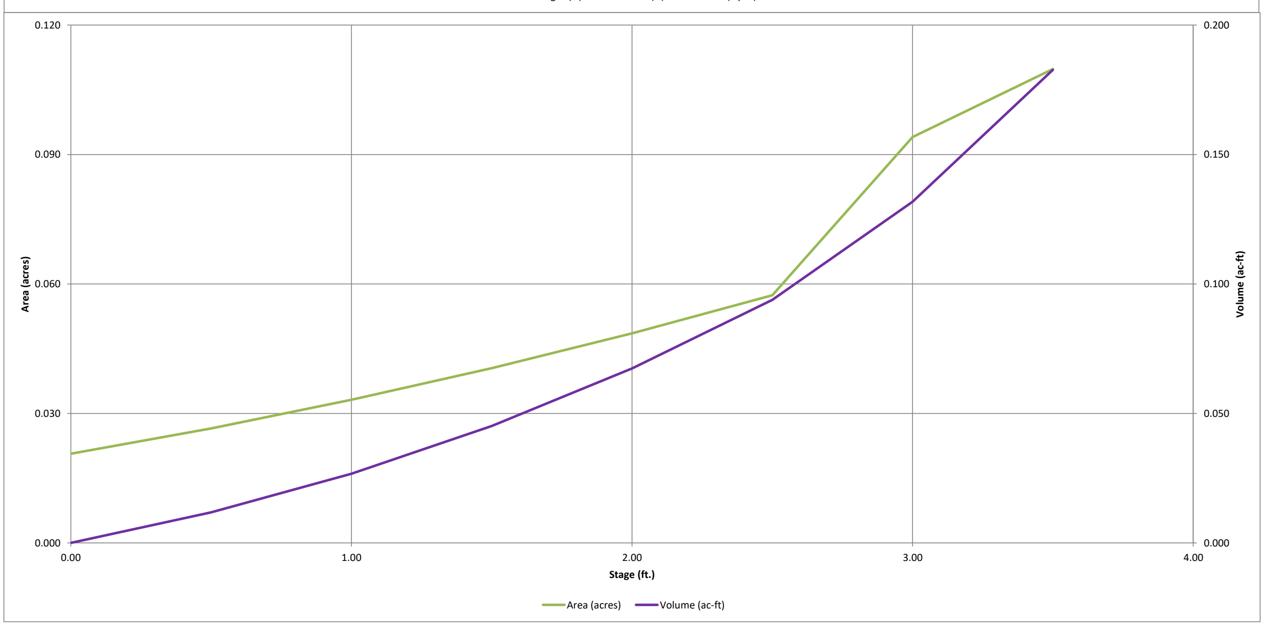
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)





Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: REP
Company: Prc Engineering
Date: September 5, 2022
Project: Hancock Commons
Location: Pond C

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 58.9 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.589
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.19 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 91,912 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.60 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 1,988 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 1083 sq ft
D) Actual Flat Surface Area	A_{Actual} = 2486 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 4703 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 3,595 cu ft
3. Growing Media	Choose One: ◉ 18" Rain Garden Growing Media; ○ Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: ◉ YES; ○ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 1,988 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 1 in

Design Procedure Form: Rain Garden (RG)

Designer:	**REP**
Company:	**Prc Engineering**
Date:	**September 5, 2022**
Project:	**Hancock Commons**
Location:	**Pond C**

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ◉ Sheet Flow- No Energy Dissipation Required ○ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ◉ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ◉ NO

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: REP
Company: Prc Engineering
Date: September 5, 2022
Project: Hancock Commons
Location: Pond D

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 78.1 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.781
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.25 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 43,996 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.60 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 1,297 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 687 sq ft
D) Actual Flat Surface Area	A_{Actual} = 1318 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 4392 sq ft
F) Rain Garden Total Volume ($V_T= ((A_{Top} + A_{Actual}) / 2) * Depth$)	V_T= 2,855 cu ft
3. Growing Media	Choose One ◉ 18" Rain Garden Growing Media ○ Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One ◉ YES ○ NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 1,297 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 13/16 in

Design Procedure Form: Rain Garden (RG)

Designer: REP
Company: Prc Engineering
Date: September 5, 2022
Project: Hancock Commons
Location: Pond D

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ◉ Sheet Flow- No Energy Dissipation Required ○ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ◉ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ◉ NO

Notes:

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Appendix C – Cost Estimate

Storm Sewer System (Non-reimbursable) - Private				
Item	Unit	Quantity	Unit Price	Extended Cost
12" PVC	LF	825	$35	$ 28,875
15" PVC	LF	420	$45	$ 18,900
18" RCP	LF	350	$70	$ 24,500
24" RCP	LF	105	$85	$ 8,925
30" RCP	LF	80	$105	$ 8,400
42" RCP	LF	45	$175	$ 7,875
CDOT Type C (Sump)	EA	2	$5,100	$ 10,200
4' D-10-R (Sump)	EA	5	$5,500	$ 27,500
8' D-10-R (Sump)	EA	3	$8,500	$ 25,500
Type II Manhole	EA	5	$6,600	$ 33,000
			Sub-total	$ 193,675
			Contingency 10%	$ 19,368
			Total	$ 213,043

Storm Sewer System (Non-reimbursable) - Public				
Item	Unit	Quantity	Unit Price	Extended Cost
18" RCP	LF	170	$70	$ 11,900
24" RCP	LF	730	$85	$ 62,050
30" RCP	LF	505	$105	$ 53,025
42" RCP	LF	240	$175	$ 42,000
4' D-10-R (Sump)	EA	2	$5,500	$ 11,000
8' D-10-R (Sump)	EA	2	$8,500	$ 17,000
12' D-10-R (Sump)	EA	2	$11,200	$ 22,400
4' D-10-R (Radial)	EA	1	$6,400	$ 6,400
Type II Manhole	EA	4	$6,600	$ 26,400
			Sub-total	$ 252,175
			Contingency 10%	$ 25,218
			Total	$ 277,393

Permanent BMP (Non-reimbursable) - Private				
Item	Unit	Quantity	Unit Price	Extended Cost
18" RCP	LF	55	$70	$ 3,850
24" RCP	LF	290	$85	$ 24,650
Earthworks	CY	10850	$8	$ 86,800
Concrete Forebay	EA	6	$7,500	$ 45,000
Trickle Channel	LF	645	$65	$ 41,925
Outlet Structure	EA	4	$6,700	$ 26,800
Riprap Spillway	CY	195	$125	$ 24,375
			Sub-total	$ 253,400
			Contingency 10%	$ 25,340
			Total	$ 278,740

Storm Sewer System/Channel (Reimbursable) - Public				
Item	Unit	Quantity	Unit Price	Extended Cost
10'x6' CBC	LF	205	$825	$ 169,125
Concrete Lined Channel	CY	450	$750	$ 337,500
			Sub-total	$ 506,625
			Contingency 10%	$ 50,663
			Total	$ 557,288

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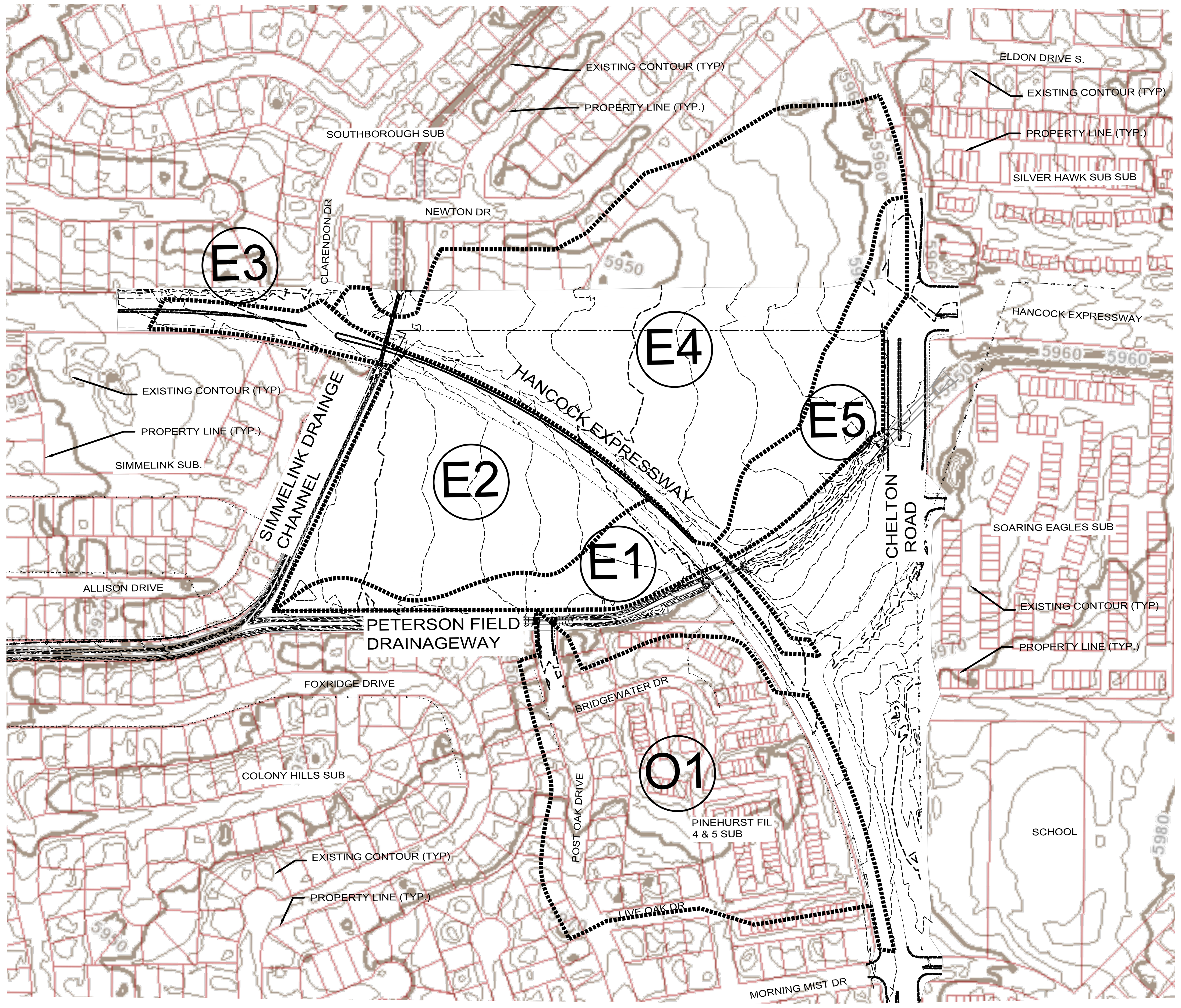
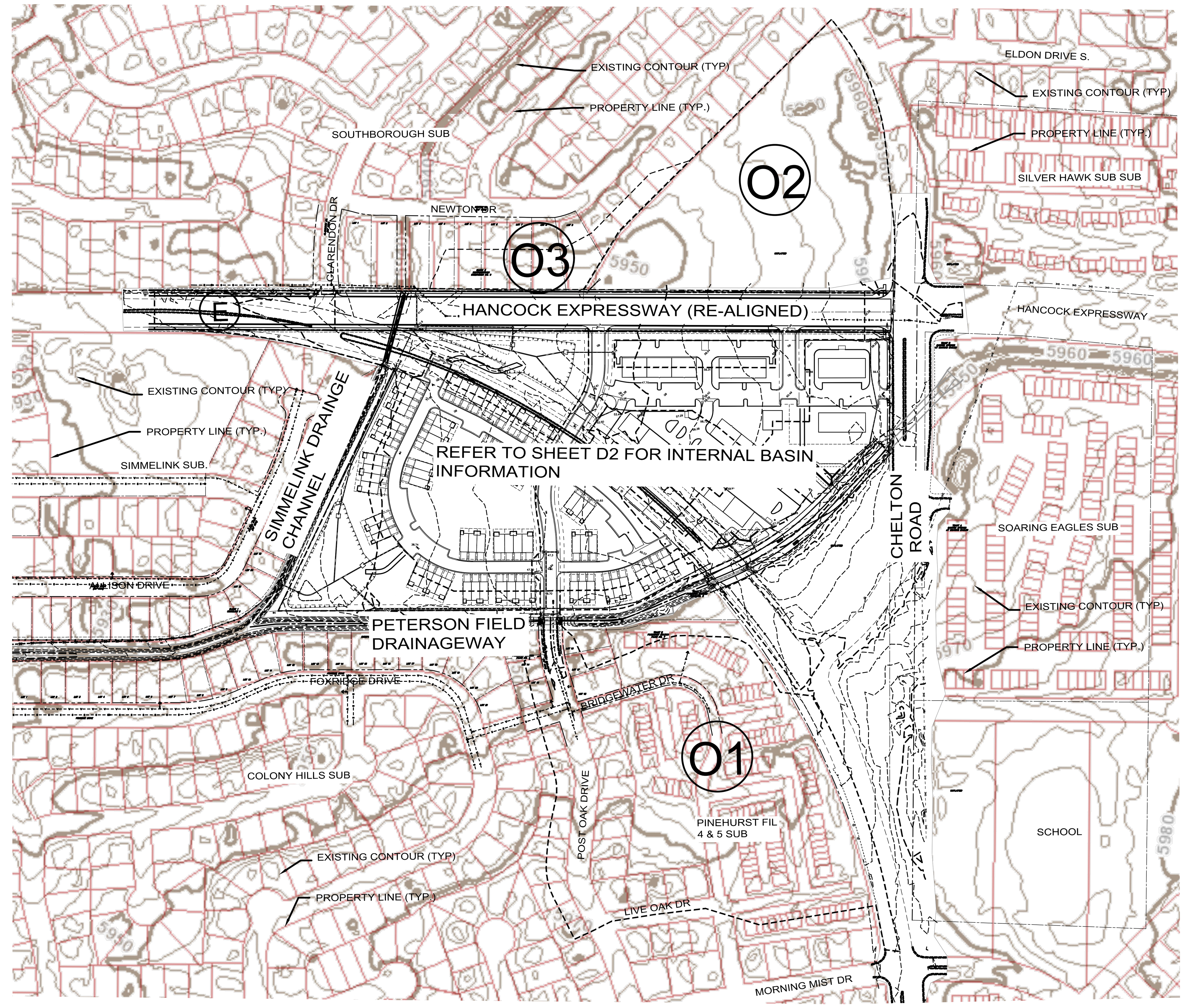
Appendix D – Drainage Maps

EXISTING CONDITIONS (OVERALL)



PROPOSED CONDITIONS (OVERALL)



Surface Routing Summary

Design Point	Flow Q_5	Flow Q_{100}	Comments
1	0.2	1.6	flow to Type C inlet 1
2	8.4	18.1	flow to 8' Type D-10-R sump inlet 2
3	5.7	12.0	flow to 2-4' Type d-10-R sump inlets 3 & 4
4	1.1	2.8	flow to Type C inlet 5 and basin A4 roof and lawn runoff
5	14.7	32.6	flow into pond (basins A1,A2,A3,A4)
6	19.2	42.5	total flow to pond
7	22.6	57.8	flow to 2-12' Type D-10-R sump inlets 6 & 7
8	2.7	5.0	flow to 4' Type D-10-R sump inlet 8
9	2.5	4.8	flow to 4' Type D-10-R sump inlet 9
10	3.8	7.3	flow to 4' Type D-10-R sump inlet 10
11	33.9	80.4	total flow to pond
12	4.6	9.6	flow to inlets 11, 12 & 17
13	2.6	5.8	flow to inlets 15 & 16
14	26.8	55.8	flow to 2-8' exist.Type D-10-R sump inlets (existing) and 2-4' Type D-10-R sump inlets 13 & 14
15	4.3	7.8	flow to west in Hancock
16	0.5	1.8	flow to Type C inlet 18

Basin Runoff Summary

Basin	Area Total (acres)	C_5	C_{100}	Total Flows Q_5 (c.f.s.)	Total Flows Q_{100} (c.f.s.)
E1	2.84	0.23	0.46	1.4	4.7
E2	7.74	0.15	0.40	2.8	12.9
E3	1.19	0.78	0.87	4.8	9.0
E4	17.32	0.17	0.41	5.4	22.2
E5	3.10	0.16	0.41	1.0	4.3
A1	0.64	0.08	0.35	0.2	1.6
A2	4.35	0.53	0.68	8.4	18.1
A3	2.56	0.57	0.71	5.7	12.0
A4	0.55	0.39	0.58	1.1	2.8

Basin Runoff Summary cont'd

A5	2.42	0.50	0.66	4.8	10.6
B1	5.76	0.71	0.82	17.6	34.0
B2	0.65	0.80	0.88	2.7	5.0
B3	1.72	0.71	0.81	6.3	12.1
B4	1.74	0.51	0.67	4.6	10.1
C	1.91	0.56	0.70	3.7	7.9
D	1.01	0.50	0.66	2.6	5.8
E	0.96	0.53	0.94	2.6	7.8
F	2.11	0.90	0.96	0.9	1.7
G	0.59	0.22	0.45	0.5	1.8
O1	12.19	0.53	0.65	26.8	55.8
O2 (Undeveloped)	7.31	0.08	0.35	2.5	18.1
O3	1.27	0.45	0.59	2.6	5.7

Storm System Summary Table

REFER TO REPORT FOR PUBLIC VERSUS PRIVATE DESIGNATION

I#		P#	
1	CDOT TYPE C (SUMP)	1	15" PVC
2	8' D-10-R (SUMP)	2	24" RCP
3	4' D-10-R (SUMP)	3	18" RCP
4	4' D-10-R (SUMP)	4	18" RCP
5	CDOT TYPE C (SUMP)	5	24" RCP
6	12' D-10-R (SUMP)	6	12" PVC
7	12' D-10-R (SUMP)	7	30" RCP
8	4' D-10-R (SUMP)	8	30" RCP
9	4' D-10-R (SUMP)	9	42" RCP
10	4' D-10-R (SUMP)	10	18" RCP
11	4' D-10-R (SUMP)	11	18" RCP
12	4' D-10-R (SUMP)	12	12" PVC
13	8' D-10-R (SUMP)	13	12" PVC
14	8' D-10-R (SUMP)	14	12" PVC
15	8' D-10-R (SUMP)	15	12" PVC
16	8' D-10-R (SUMP)	16	18" RCP
17	4' D-10-R (RADIAL)	17	24" RCP
18	CDOT TYPE C (SUMP)	18	18" RCP
		19	18" RCP

NOTE: HDPE PIPE MATERIAL MAY BE USED INSTEAD OF RCP FOR FINAL DESIGN OF PRIVATE PIPES.

NORTH

0 100 200 400

LEGEND

- A — BASIN ID
- 1 — DESIGN POINT
- I# — INLET ID
- P# — PIPE ID

EXISTING	(E)
PROPOSED	(P)
FUTURE	(F)
CURB AND GUTTER	C&G
EASEMENT	ESMT
PUBLIC	PUB
PRIVATE	PVT
UTILITY	UT

BASIN BOUNDARY
RIGHT-OF-WAY/PROPERTY LINE (FIMS LABELED ON EACH SHEET)
(E) CONTOUR, INDEX (FIMS LABELED ON EACH SHEET) — 5930
(E) CONTOUR (FIMS LABELED ON EACH SHEET) — 5930
(E) OVERHEAD UTILITY
(E) SANITARY MAIN, MH
(E) WATER MAIN, VALVE, FH
(P) SANITARY MAIN, MH
(P) WATER MAIN, VALVE
(P) CONTOUR, INDEX — 5930
(P) CONTOUR
(P) STORM SEWER, INLET, MH
SURFACE FLOW DIRECTION

PRC ENGINEERING, INC.
4465 NORTHPARK DRIVE, SUITE 400A
COLORADO SPRINGS, CO 80907
PRC ENGINEERING

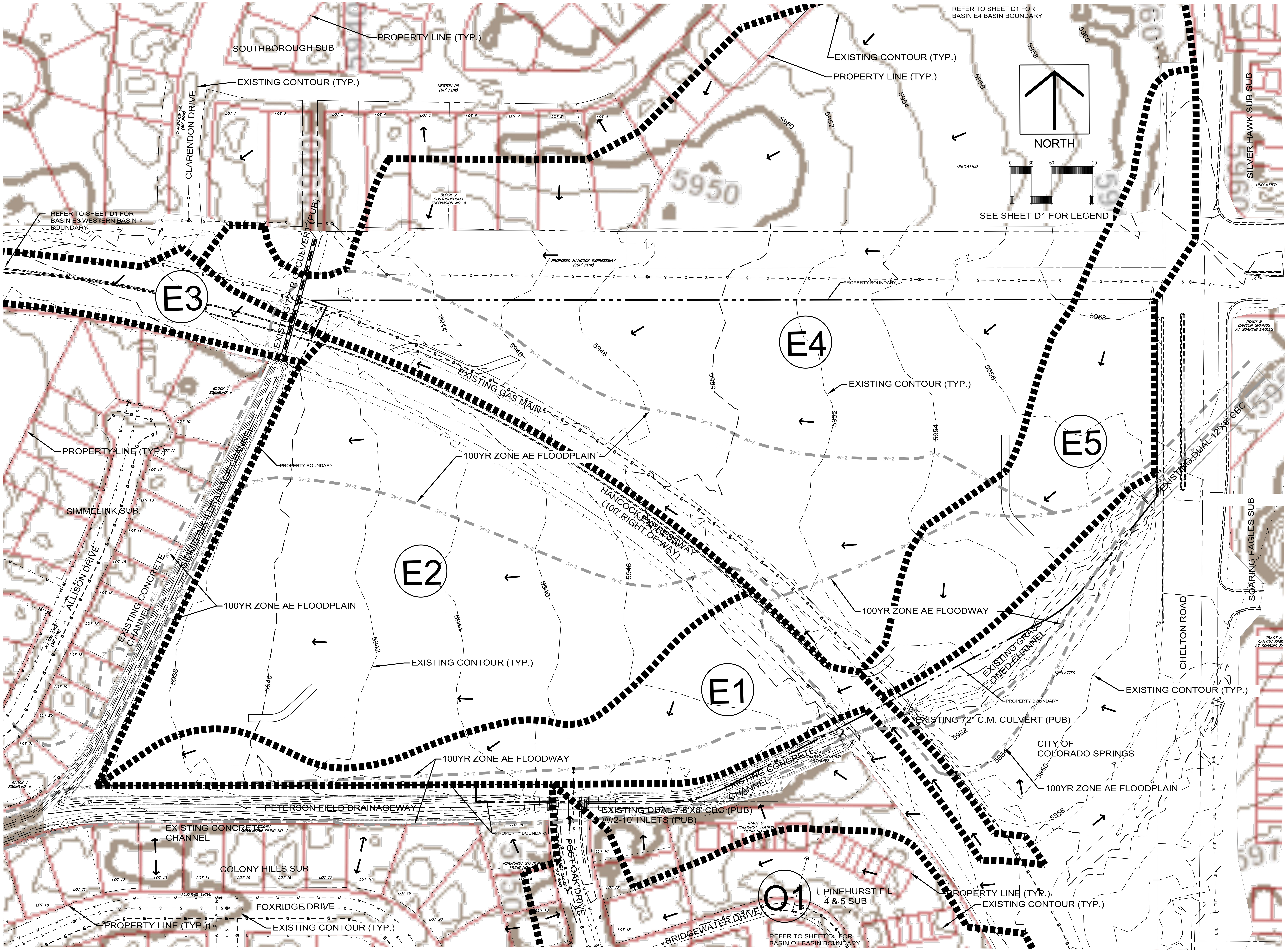
HANCOCK COMMONS

City Of Colorado Springs
El Paso County, CO

DRAINAGE PLAN:
OVERALL EXISTING CONDITIONS AND PROPOSED OVERALL CONDITIONS

issued 9/4/22

D1
sheet number



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DRAINAGE PLAN:
EXISTING CONDITIONS

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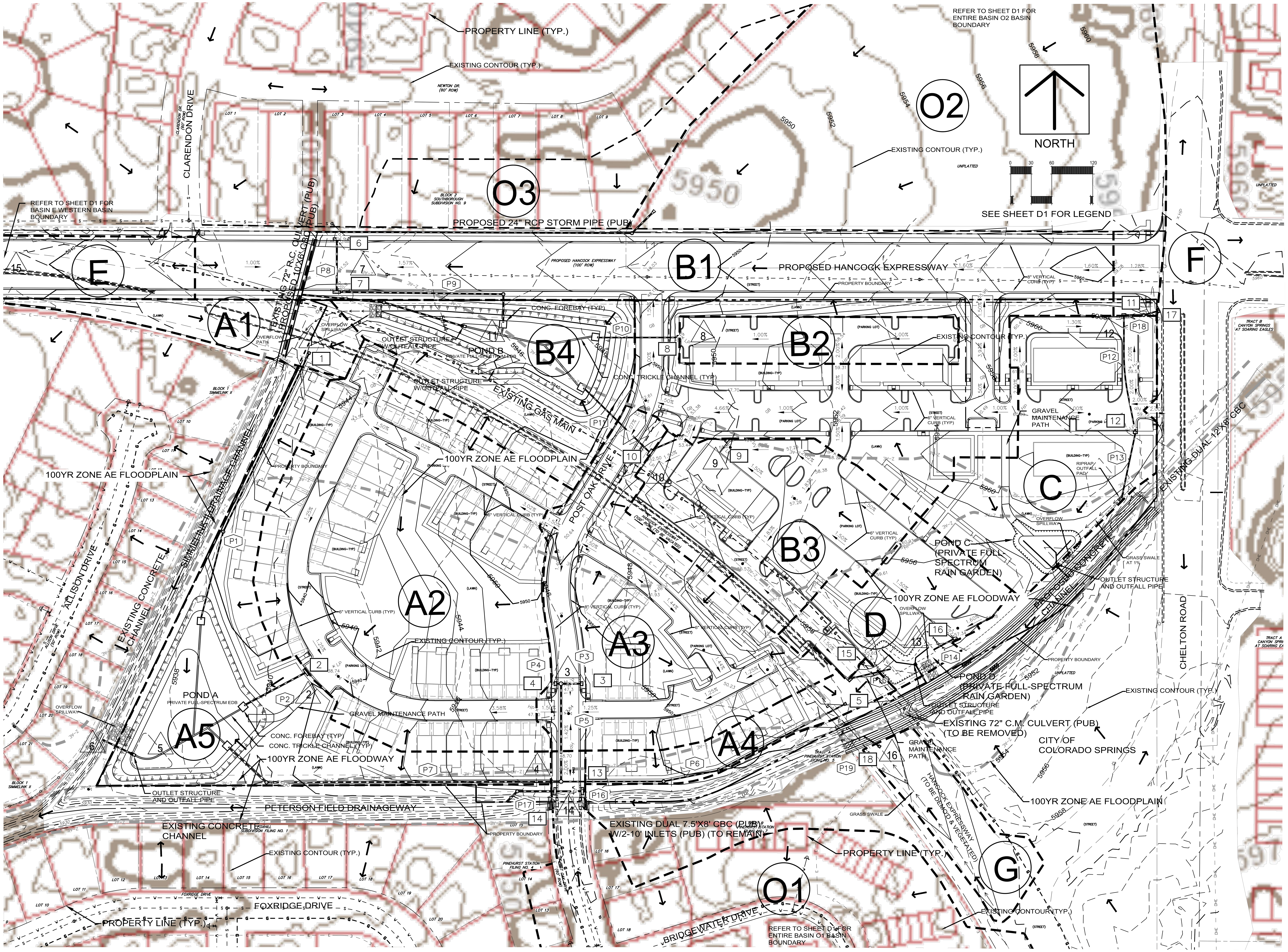
D2
sheet number



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