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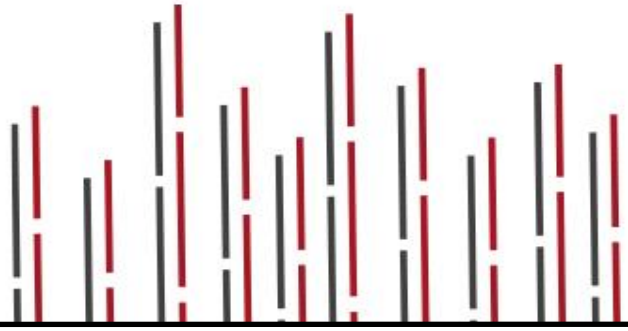

December 2019
Preliminary Drainage Report

ACM High Point Well Pad
Aurora, Colorado

Prepared for:

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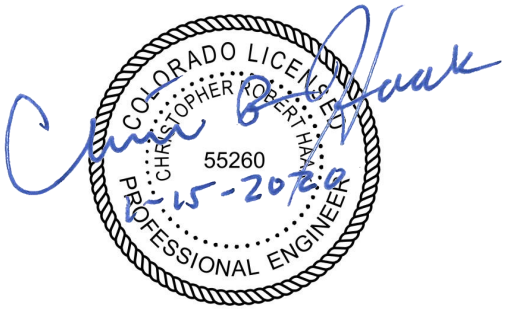
Project No. 0218003.11

Approved For One Year From This Date	
City Engineer	**Date**
Water Department	**Date**

CERTIFICATION

I, Chris Haak, PE #55260 hereby affirm that this report and plan for the Preliminary drainage design for the ACM High Point Pad site was prepared by me, or under my direct supervision, for the owners (Axis Exploration, LLC) thereof, in accordance with the provisions of City of Aurora Standards and Specifications for the Design and Construction of Public and Private Improvements and the Urban Drainage and Flood Control District Criteria Manual, and approved variances and exceptions thereto. I understand that the City of Aurora does not and will not assume liability for drainage facilities designed by others.



Chris Haak, PE
State of Colorado Registration No. 55260
For and on behalf of Lamp Rynearson

PRELIMINARY DRAINAGE REPORT
ACM HIGH POINT WELL PAD
Aurora, Colorado

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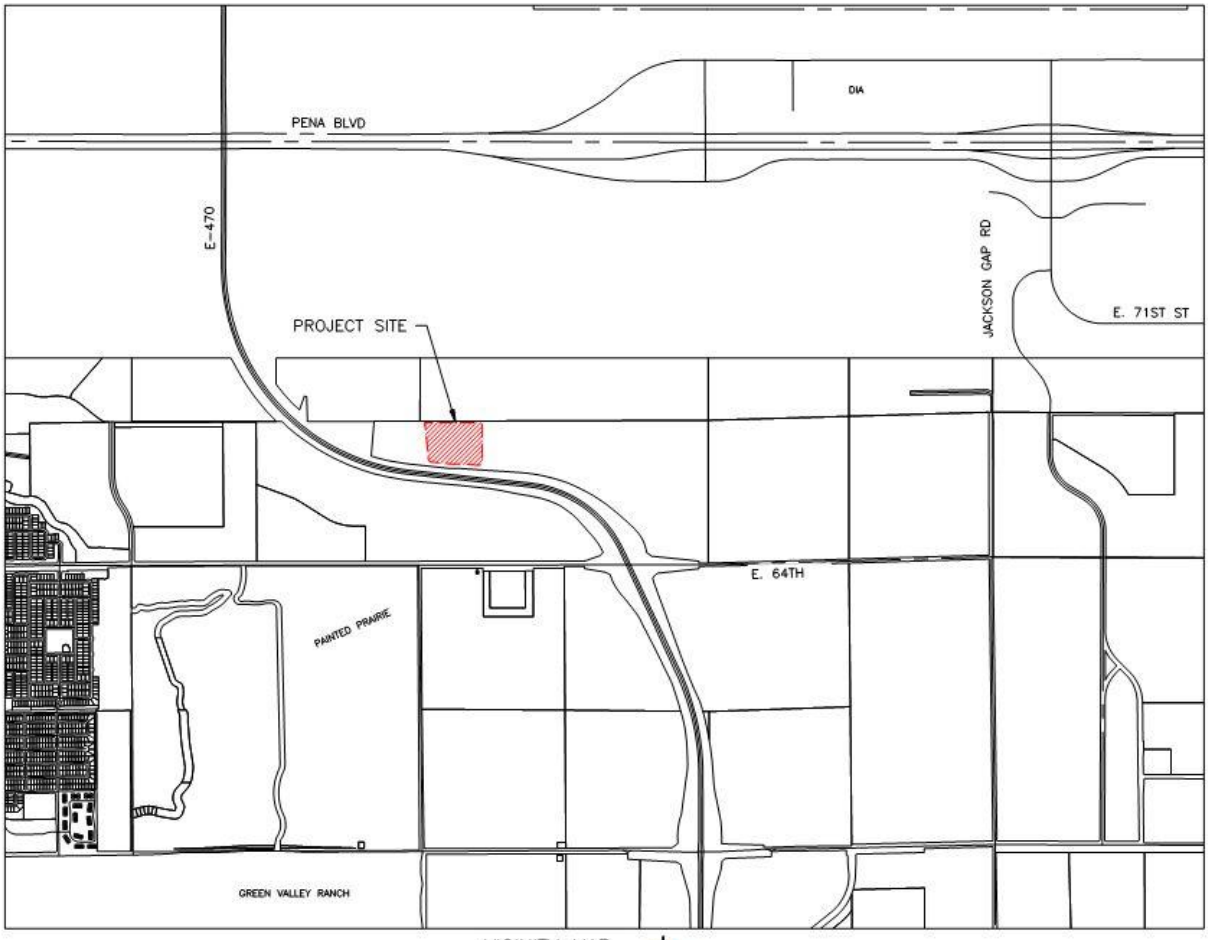
PRELIMINARY DRAINAGE REPORT
ACM HIGH POINT WELL PAD
AURORA, COLORADO

A. INTRODUCTION

This drainage report contains the details for the overall drainage design for the ACM High Point Well Pad site. The report also includes information on the historic drainage patterns for the site. The drainage design information for the proposed site considers the developed site draining to a proposed sediment pond during the drilling phase and a detention pond during the interim phase. Flows will be released below historical rates and ultimately discharging to Second Creek to the north.

1. Location

The project site is located in Section 1, Township 3 South, Range 66 West of the 6th Principal Meridian within City of Aurora, Adams County, Colorado. More specifically, the site is located northwest of the East 64th Avenue and E-470 intersection.



VICINITY MAP
1"=2000'

2. Proposed Development

The property is currently undeveloped and consists of moderately dense weeds and grasses. In general, the pad site slopes from south to northeast, at slopes ranging from about 0.3% to 6.0%.

According to the NRCS website, the site consists of Type C soils and are classified as Platner loam. (See Appendix A for soils data).

The proposed project is a multiple oil and gas well pad located in the northwest corner of the property and will be operated by Axis Exploration, LLC. The proposed project will utilize undeveloped land to extract oil and gas in advance of surface development. The proposed ACM High Point facility will consist of 32 horizontally drilled wells, 32 separators, 1 ECD, 1 fuel gas scrubber, 4 compressors, 1 maintenance vessel, 1 electric pad, 1 meter skid and other associated equipment. During the well pad drilling phase, 3 modular large volume fresh water tanks (MLVT) will be used. As a result of the required secondary containment, all stormwater that falls within the limits of the proposed separators will be retained within the containment panel and hauled off-site for disposal. Flows that fall within the separators have been fully accounted for all stormwater calculations within this report. The remaining runoff from the site flows to the proposed sediment and detention ponds in the northeast of the production & drilling pads, before discharging offsite into historical flow paths, and eventually into Second Creek. The proposed composite percent impervious for the finished site is 31% (See Appendix B for Calculations).

The site will be phased to provide necessary operational area during the time of drilling. The project site will have a 6-month Drilling Phase which can be viewed as a time of construction. After the drilling is complete the site heads into the interim reclaimed phase. At this time the space necessary for the drill rig is no longer needed and room can be made for permanent drainage facilities. The areas that are no longer needed are reclaimed and designed to go back to the predevelopment state.

Due to oil and gas site needs, the pad site is graded at 0.5% slopes. This allows for precision drilling in a safe and repeatable manner.

B. HISTORIC DRAINAGE

1. Basin Description

The site is located in the Second Creek Basin (See Appendix C). Historically, drainage from the site traveled northerly into existing drainage ways and ultimately discharged into Second Creek. According to the Flood Insurance Rate Map (FIRM) Map No. 08001C0665J with an effective date of February 17, 2017, the proposed development is located completely outside any flood hazard areas (See Appendix A).

2. Existing Drainage Patterns

The historic runoff from the project area flows north and northeast into existing drainage ways, then ultimately into Second Creek. Offsite runoff from the surrounding properties flow to the north and northeast, with the exception of E-470 to the south of the site. E-470 intercepts the overland flow from the south and directs the flow to culverts crossing E-470 which discharges the flow into existing drainage ways to the east of the proposed pad site (See Appendix D for drainage).

3. Outfalls

Historically the site flows north and northeast into existing drainage ways and ultimately discharged into Second Creek. The final detention basin outlet pipe is designed to outfall to a flow path that will run offsite along the proposed access road and eventually to Second Creek.

C. DESIGN CRITERIA

1. References

- City of Aurora Storm Drainage Design and Technical Criteria (SDDTC), 9.2010
- *The Urban Storm Drainage Criteria Manual* (USDCM), Volumes 1 and 3, published by the Urban Drainage and Flood Control District (UDFCD), Denver, Colorado, updated January 2016.

(Please reference Appendix B).

2. Hydrologic Criteria

The USDCM data within Figures 5-1 through 5-6 for site specific rainfall was used to obtain rainfall data for the 2, 5, 10 and 100-year storms of 0.97, 1.39, 1.63, and 2.63 respectively. Since the basins are less than 90 acres, the Rational Method was used to calculate developed stormwater runoff. Composite impervious values for each basin were calculated based on site layout. Runoff coefficient "C" values were taken from Table 1 of the City of Aurora's Storm Drainage Design and Technical Criteria (SDDTC). The detention basin and outlet structure has been design for "full spectrum detention," to capture and convey the Water quality capture volume (WQCV), Excess urban runoff volume (EURV) and the 100-yr Volume as outlined by the SDDTC of 100-yr + ½ EURV. (See Appendix B).

3. Hydraulic Criteria

Calculations to determine the water surface elevation & capacity for culverts and channels were computed within the Hydraflow software.

The stormwater facilities and outlet structures were designed using techniques developed or adopted by the City's SDDTC and the USDCM Criteria.

Due to the temporary nature of the drilling phase, it is most reasonable to capture only the difference between historic and proposed conditions. This phase can be considered a part of the construction phase and thus, the stormwater conveyance systems during the drilling phase were designed to capture and convey 100-year storm volume. In addition to the temporary nature of the drilling phase, quick stabilization erosion control measures will be installed immediately before site disturbance, assuring the full mitigation of sediment. The site will be fully stabilized within 1-2 weeks with gravel surfacing. Quick stabilization assures that sedimentation will be limited, reducing the size of the sediment basin.

WQCV, EURV designs were done using the UDFCD's UD-Detention v3.07spreadsheet program. Release rates for the ponds are fully dependent on drain time and is accounted for within the UD-Detention spreadsheet. The results of the detailed calculations are provided in Appendix B.

During the interim reclaimed condition, the sediment pond from the drilling phase will be re-constructed to allow for the 100-yr + ½ the EURV per city requirements. The volume for this detention pond was calculated in a separate spreadsheet utilizing the City's requirements as laid out in the SDDTC while the outlet structure was designed utilizing the UD-Detention spreadsheet. The maximum outfall was calculated utilizing the City's SDDTC "Allowable release rates for detention ponds" table for Type "C" soils. This value is 0.30 cfs/acre for the 10-yr storm and 1.00 cfs/acre for the 100-yr. Applied to our site, these values result in a maximum allowable release rate of 5.19 cfs for the 10-yr storm and 17.30 cfs for the 100-yr storm.

Allowable release rates for detention ponds - CFS/ACRE

	SCS Hydrologic Soil Group		
Storm Frequency	A	B	C&D
10-year	0.13	0.23	0.30
100-year	0.50	0.85	1.00

The predominant soil group for the total basin area tributary to the detention pond shall be used for determining the allowable release rate.

D. DRAINAGE PLAN

1. General Concept

The site has been divided into sub-basins, each representing a specific discharge point for the site. The sub-basins for the proposed development were determined and flows were calculated to establish key stormwater discharge points within the development. Runoff values were calculated using the Rational Method (See information provided in Appendix A). The imperviousness is determined based on site layout with the imperviousness values obtained from Table 1 of the City's SDDTC. The runoff coefficients corresponding to weighted average basin imperviousness and hydrologic soil groups were calculated using the Lamp Rynearson's Rational Method Spreadsheet that was created to be fully in accordance with Aurora's SDDTC.

During the drilling phase, a sediment pond is proposed along the northeast side of the drilling pad. Due to site grading constraints, a portion of the off-site flows will enter onto the site and will be directed into these ponds. The overflow spillway has been sized to allow both on-site developed flows and the assumed off-site developed flows to be released at incoming rates. The goal of the proposed drainage design is to capture the water quality volume and the excess urban runoff volume in the ponds and release at allowable rates. The sediment pond is currently sized for a 100-year storm event (See Appendix B).

As described in previous sections of this report, the site will be phased to provide necessary operational area during the time of drilling. The first phase will be a 6-month drilling phase considered to be temporary in nature. During this time the sediment pond will be constructed. After drilling is complete, the site enters an interim reclaimed condition. During this phase, the pad area to the east and the MLVT tank area will be fully reclaimed back to existing conditions. This includes the sediment pond. This reduction in pad size accommodates the construction of a new extended detention pond to allow for the capture of the SDDTC required 100-yr+1/2 EURV with 1' of freeboard.

A hydraulic analysis was completed based on calculated discharges to determine the sizes of the proposed channels that convey stormwater to the ponds.

2. Specific Details

BASIN B1

Basin B1 (17.30 acres during Drilling Phase and 13.50 acres during Interim Phase) makes up the entire proposed site and contains both the drilling and production pad and associated facilities. The base for these facilities will be constructed of gravel, while the stormwater conveyance systems and ponds will be landscaped. Due to site grading constraints, some off-site flows enter the pad from the south, joining on-site flows. The combined flows sheet flow northeast across the pad at 0.5%. Flows are then either captured by a channel on the east side or the channel on the north side, and then conveyed to the detention pond. All flows from the B1 basin are routed to the pond's outlet structure at the northeast corner of the pond (See Appendix D, Design Point B1).

To assure adequate capacity of the on-site channels that run along the north and east portion of the basin, sub basins B1a and B1b were created. The sub basins delineate the area that flow to the channels that convey to the detention pond. Design points CH1 and CH2 are located where the highest flow will occur in the channel and includes the flow that would go directly to the pond. Refer to the drainage maps for basin boundaries.

Offsite Basin Details

Sub-basin OS1 (3.44 acres) consists of undeveloped land directly south of the pad. Currently, the majority of these flows will follow historic patterns and flow to the north towards the proposed pad site then onto Second Creek. Sub-basin OS1c is what is left of the offsite basin that is not included in the Interim C1 Basin (See Appendix D).

a. Rational Method Calculations

Runoff from the proposed basin was calculated using the Rational Method as it is less than 90 acres. The Rational Method values were used for the sizing of channels (see Appendix B). The 10-year and 100-year criteria were used for the minor and major storm events. Impervious values for the on-site and off-site basins were assumed based off of the SDDTC requirements. The results of the Rational Method analysis for the developed conditions can be found in Appendix A.

b. Channels

Two channels are proposed to convey stormwater runoff through the site into the sediment and detention pond. Channels were designed to convey the 100-year peak flows safely. The channel designs considered a maximum allowable velocity of 5.0 feet per second and a maximum Froude Number of 0.8 for the 100-year storm event, meeting or exceeding the City Criteria. All permanent channels have a trapezoid shape with 4H:1V maximum side slopes. Channels that are less than 2% slope will have underdrains. A summary of the final channel parameters is provided in Table 1 below:

Table 1 – Channel Parameters (100-Year Storm)

Swale ID	Flows (cfs)	Maximum Flow Depth (ft)	Maximum Velocity (fps)	Maximum Froude Number
Drilling: CH1	13.74	0.80	2.24	0.44
Drilling: CH2	18.42	0.61	2.89	0.65
Interim: CH1	13.94	0.64	1.88	0.41
Interim: CH2	7.43	0.35	1.97	0.59

c. Sediment Pond (Drilling Phase) /Detention Pond (Interim Reclaimed Phase)

Stormwater quality will be mitigated onsite during construction with the use of sediment control logs, vehicle tracking devices and inlet/outlet protection devices. During the drilling phase, additional treatment will occur by routing the runoff into the sediment pond. The sediment pond has been sized to capture historic flows. The water will be released meeting state requirements under the maximum of 72-hour release rate.

The emergency spillways will drain the uncontrolled, on-site and off-site 100-year flows through the pond in a safe manner. The spillway has been designed to conduct the 100-yr flow with no negative impact to existing off-site drainage patterns.

Table 2 – Parameter for Sediment Pond

Parameter	Sediment Pond
WQCV (ac-ft)	0.214
EURV (ac-ft)	0.240
Water Surface Elevation at WQCV (ft)	5390.69
Water Surface Elevation at EURV (ft)	5390.77
Storage Capacity (ac-ft)	1.231
Minimum Freeboard (ft)	1.0
Maximum Pond Depth (Bottom to spillway crest) (ft)	3.0
Pond Embankment Elevation (Top of spillway) (ft)	5394.0
Minimum Effective Pond Elevation (Bottom Elevation) (ft)	5390.0
Outlet Pipe Diameter (in)	4
Maximum Pond Outlet Release Rate (cfs)	17.3
Spillway Crest Elevation (ft)	5393.0
Spillway Crest Length (ft)	29.0
Spillway Outflow (cfs)	38.0*

*The spillway outflow was calculated from proposed on-site flows + historic off-site flows for basin OS1.

After the Drilling Phase, the site will enter the Interim Reclaimed phase. During this time areas of the pad and its sediment pond will be removed and reclaimed back to existing site characteristics. Basin B1's area will be reduced in size but will allow for the construction of a new detention pond. The detention basin will allow for the full, required capture volume of the 100-yr + ½ EURV with one foot of freeboard. The required volume was calculated utilizing

WQCV & EURV values obtained from the UD-Detention spreadsheet while the full volume was calculated using a separate Design Basin spreadsheet. This spreadsheet can be found within Appendix B and meets the city's standards. The spillway crest will be placed at the freeboard elevation and will accommodate flows from an extreme rainfall event. The spillway will be riprapped and will release flows to historic drainage paths and ultimately to Second Creek, following historic patterns. The outlet structure will be sized to allow for the required 10-yr and 100-yr release rates. The calculations for the sediment ponds, detention pond and spillways, along with pond stage-volume information are included in Appendix B. Table 3 below provides a summary of the detention pond parameters. As shown in the below table the detention pond has enough capacity to detain more than the required 100-yr + ½ EURV. Due to the site being within the 10,000' critical area for the Denver International Airport Wildlife Attractant zone, the detention pond outlet will be sized to release the 100-year storm as close to the recommended 40 hours as possible.

Table 3 – Parameters for Detention Ponds

Parameter	Pond 1
WQCV (ac-ft)	0.167
EURV (ac-ft)	0.355
100-yr (ac-ft)	0.570
100-yr +1/2 EURV (ac-ft)	0.748
Storage Capacity (ac-ft) (Not including 1' freeboard)	0.956
Storage Capacity (ac-ft) (Including 1' freeboard)	1.527
Water Surface Elevation at WQCV (ft)	5391.19
Water Surface Elevation at EURV (ft)	5391.72
Water Surface Elevation at 100 yr + ½ EURV (ft)	5392.59
Minimum Freeboard (ft)	1.0
Maximum Pond Depth (Bottom to spillway crest) (ft)	3.0
Pond Embankment Elevation (Top of spillway) (ft)	5394.0
Minimum Effective Pond Elevation (Bottom Elevation) (ft)	5390.0
Outlet Pipe Diameter (in)	24
Outlet Pipe Restrictor Plate Height (in)	14.0
10-yr Outlet Maximum Release Rate (cfs)	5.19
100-yr Outlet Maximum Release Rate (cfs)	17.30
10-yr Pond Outlet Release Rate (cfs)	4.72
100-yr Pond Outlet Release Rate (cfs)	13.70
Spillway Crest Elevation (ft)	5393.0
Spillway Crest Length (ft)	38
Spillway Outflow (cfs)	25.0

d. Erosion Control

Based on the channel size calculations provided in Appendix B, the average flow velocities for the 100-year storm event are well below the eroding velocity of 5 feet per second; therefore, lining the channels with native vegetation/grass is sufficient to provide protection against any potential erosion and there is no need to provide any hard lining such as riprap for swales.

The sediment and detention pond during all phases of the process will be protected with riprap.

e. Construction Phasing

The construction and use of the site will be phased. Phasing will be broken down into a drilling ("Construction") Phase and an Interim Reclaimed ("Production") Phase. Please reference sections prior for description of phasing regarding stormwater.

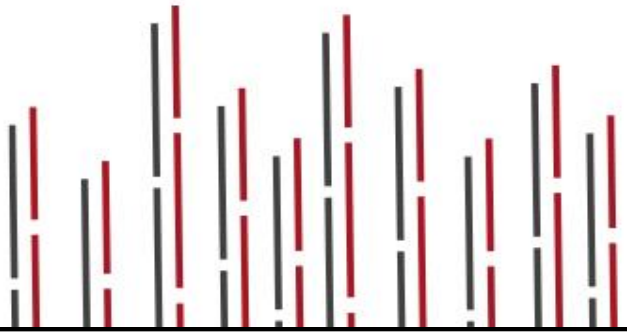
E. CONCLUSIONS

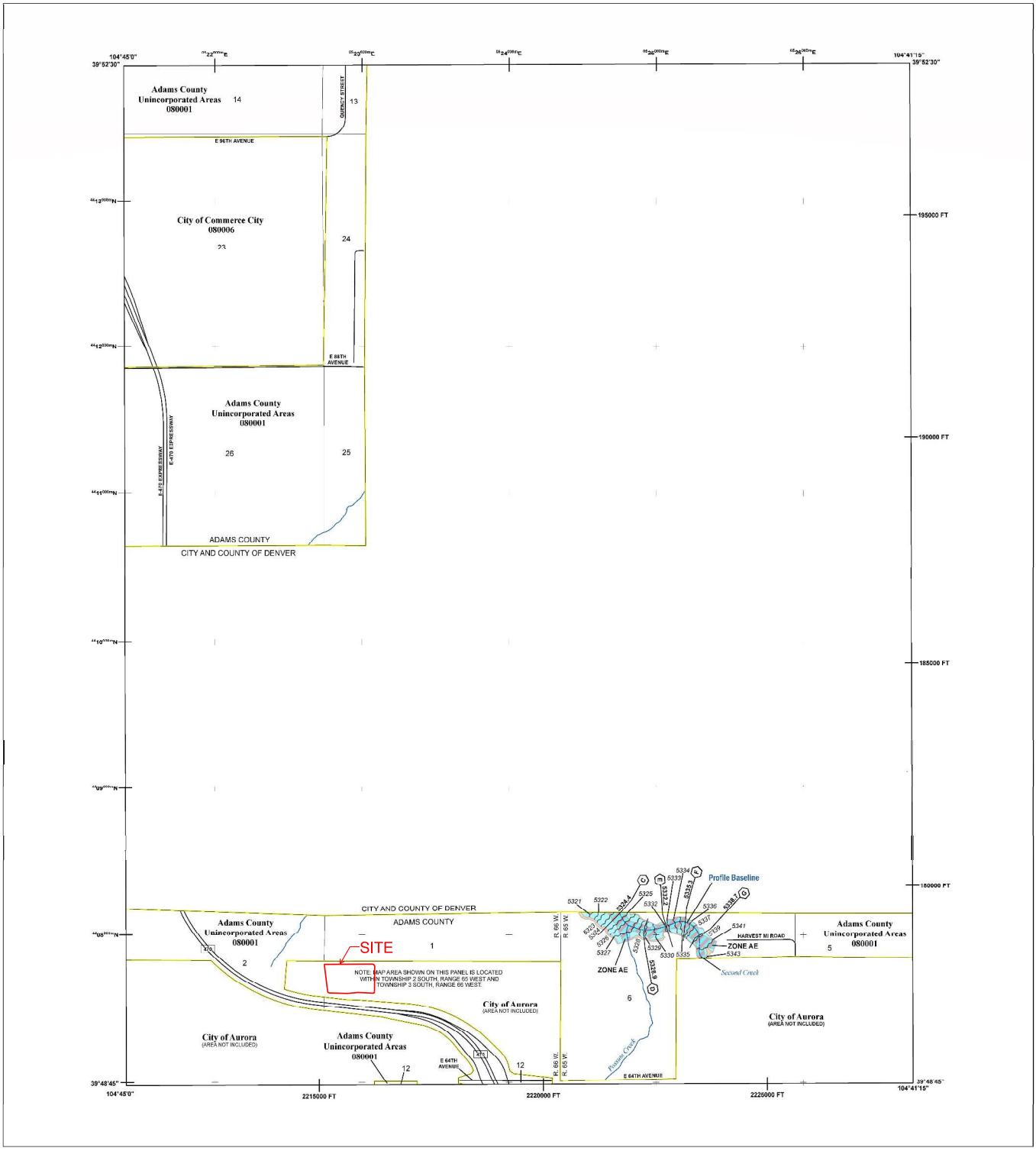
When developed, the site's runoff will increase and be detained, thereby reducing released flows back to historic values. The proposed channels will capture the runoff from the site and route the storm flows to the proposed sediment/detention pond and eventually to Second Creek. All drainage design considerations contained in this drainage report are in general accordance with the City of Aurora *Storm Drainage Design & Technical Criteria* and the Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manuals*. In general, the design presented in this report serves to provide a safe and adequate drainage system for the ACM High Point Well Pad development.

F. REFERENCES

1. City of Aurora *Storm Drainage Design & Technical Criteria,* October 2010.
2. Sand Creek Major Drainageway Plan, RESPEC, September 2017 & April 2018.
3. Flood Insurance Rate Map, Arapaho County, Colorado and Incorporated Areas, Panel 206 of 725, Number 0800110206L, FEMA, February 2017.
4. Hydrologic Soil Group – Arapaho County, Colorado USDA Natural Resources Conservation Service, August 2018.
5. *The Urban Storm Drainage Criteria Manual* (USDCM), Volumes 1 and 3, published by the Urban Drainage and Flood Control District (UDFCD), Denver, Colorado, updated January 2016.

Appendix A





FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

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*
	NO SCREEN Areas of Minimal Flood Hazard *Zone X*
OTHER AREAS	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
	18.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	8 Coastal Transect
	Coastal Transect Baseline
OTHER FEATURES	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided by the Adams County and Commerce City GIS departments. The coordinate system used for the production of the digital FIRM is Universal Transverse Mercator, Zone 13N, referenced to North American Datum of 1983 and the GRS 1980 spheroid. Western Hemisphere.

SCALE

Map Projection:
NAD83 UTM Zone 13N
Western Hemisphere. Vertical Datum: NAVD88

1 inch = 1,000 feet 1:12,000

0 1,000 2,000 4,000 Feet

0 250 500 1,000 Meters

PANEL LOCATOR

* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

ADAMS COUNTY, COLORADO
And Incorporated Areas

PANEL 655 OF 1150

FEMA

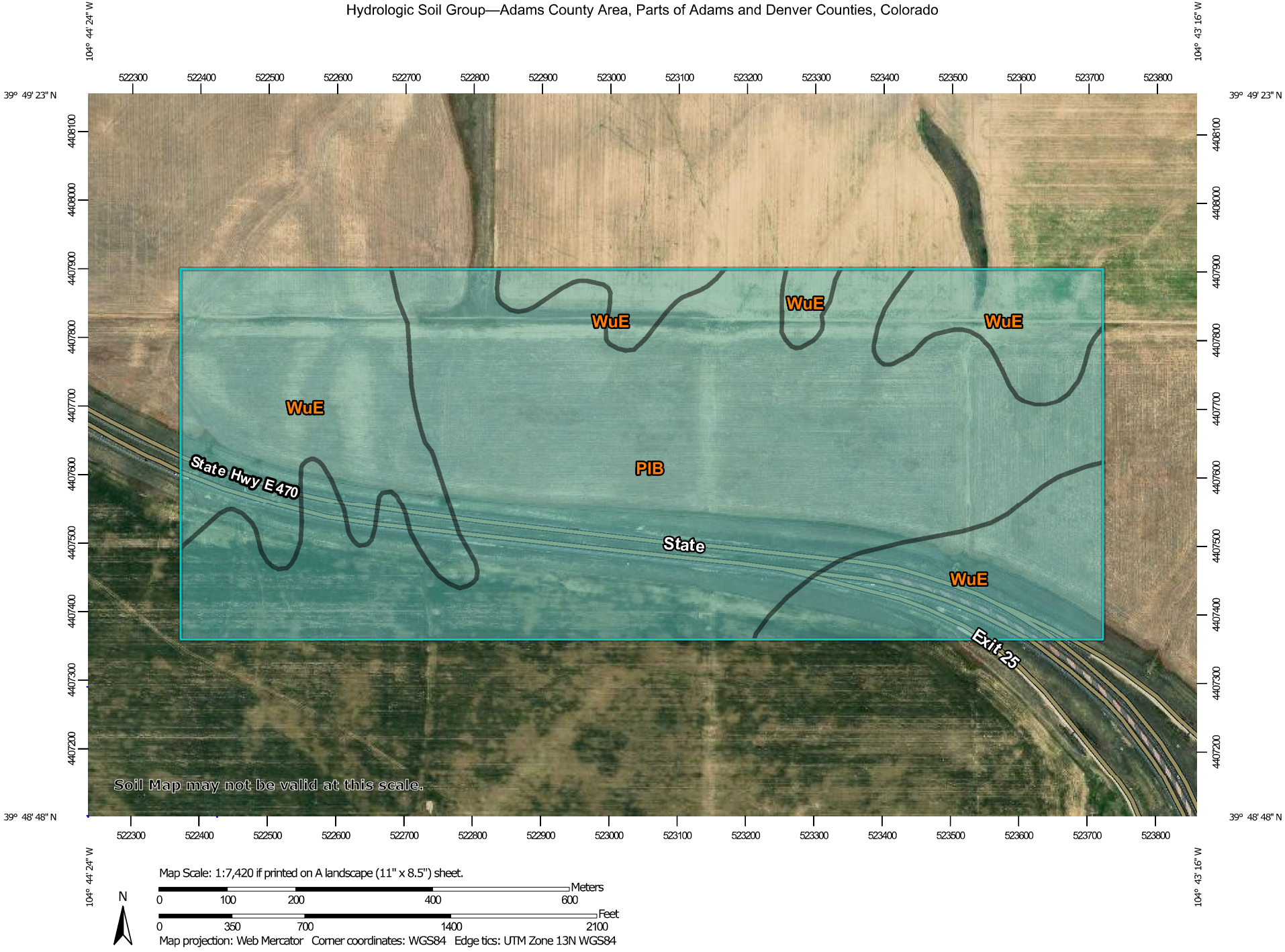
Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0655	J
COMMERCE CITY, CITY OF	080006	0655	J

VERSION NUMBER
2.3.3.2

MAP NUMBER
08001C0655J

MAP REVISED
FEBRUARY 17, 2017



Map Scale: 1:7,420 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 100 200 400 600

Feet
0 350 700 1400 2100

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 15, Sep 13, 2018

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

Date(s) aerial images were photographed: Jul 17, 2015—Oct 2, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PlB	Platner loam, 0 to 3 percent slopes	C	111.9	61.8%
WuE	Wiley-Adena-Renohill complex, 3 to 20 percent slopes	C	69.1	38.2%
Totals for Area of Interest			**181.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

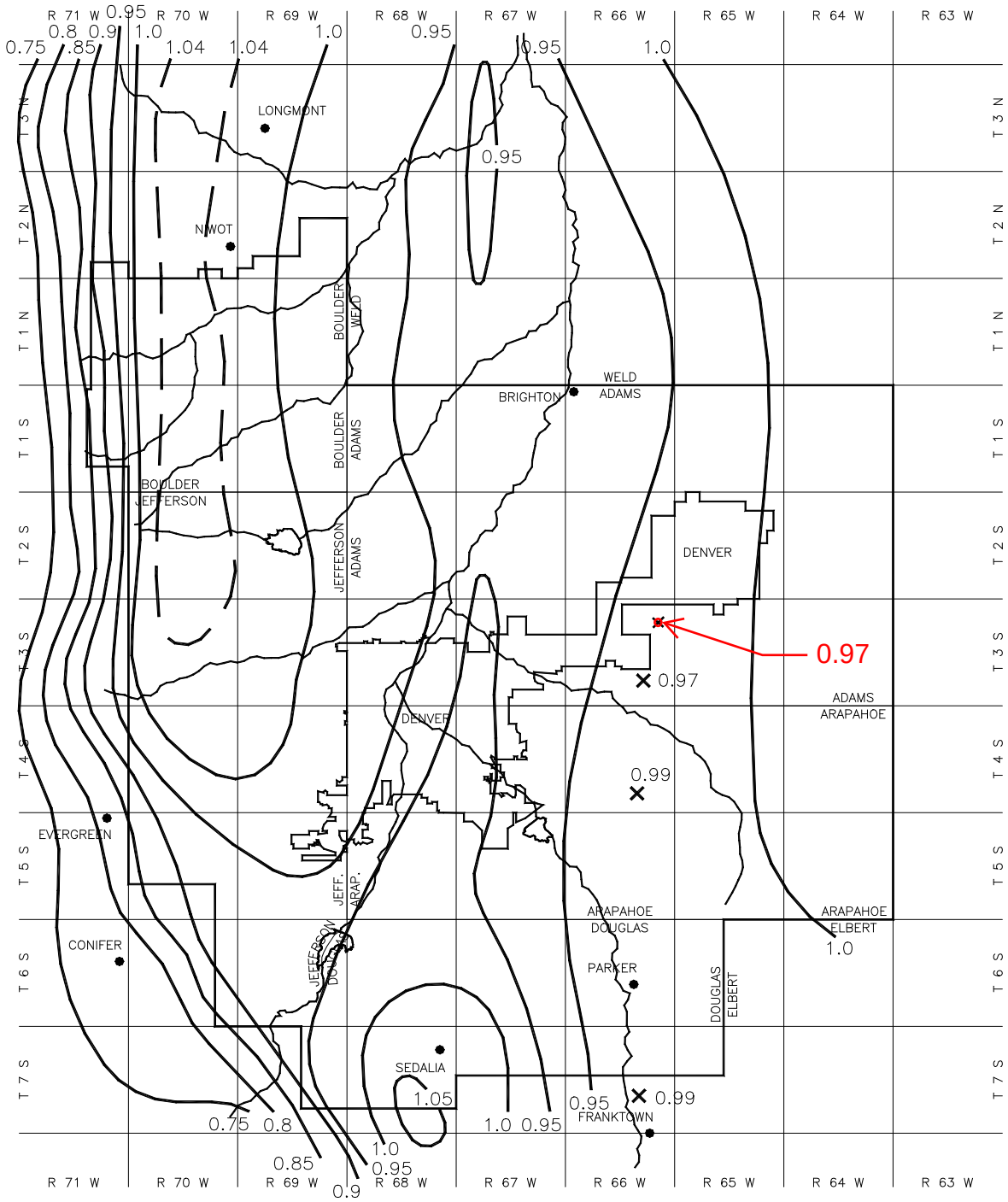


Figure 5-1. Rainfall depth-duration-frequency: 2-year, 1-hour rainfall

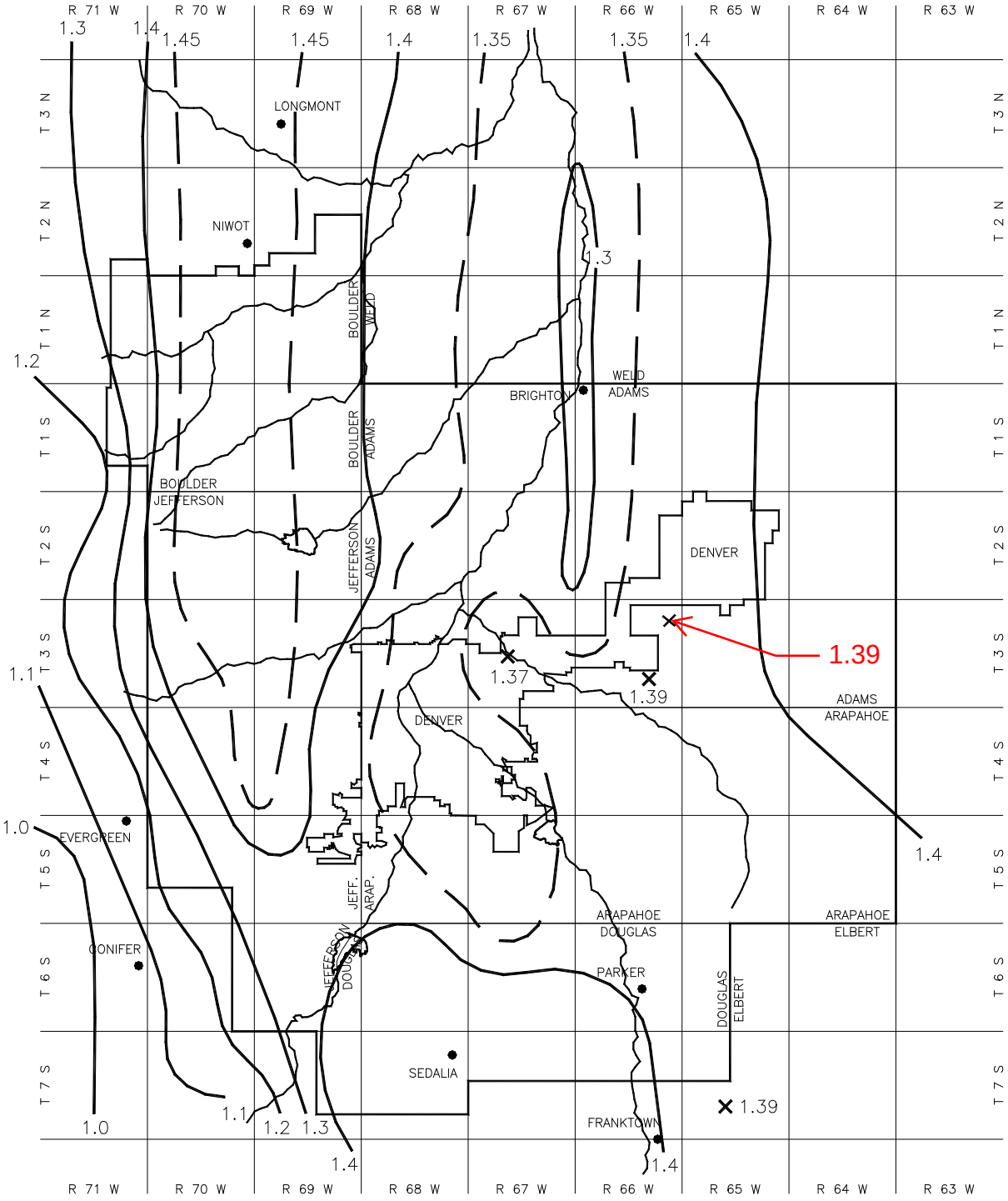


Figure 5-2. Rainfall depth-duration-frequency: 5-year, 1-hour rainfall

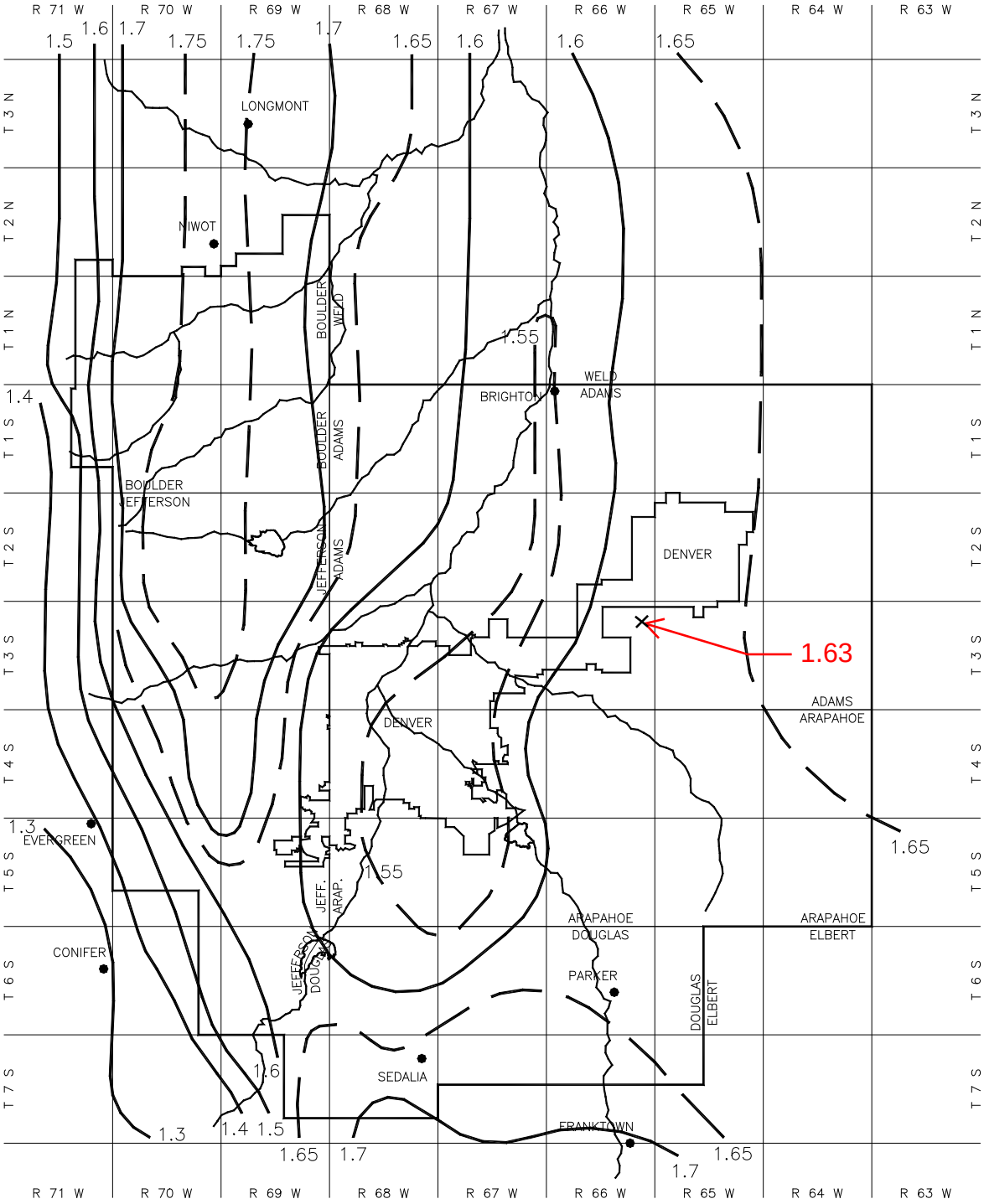


Figure 5-3. Rainfall depth-duration-frequency: 10-year, 1-hour rainfall

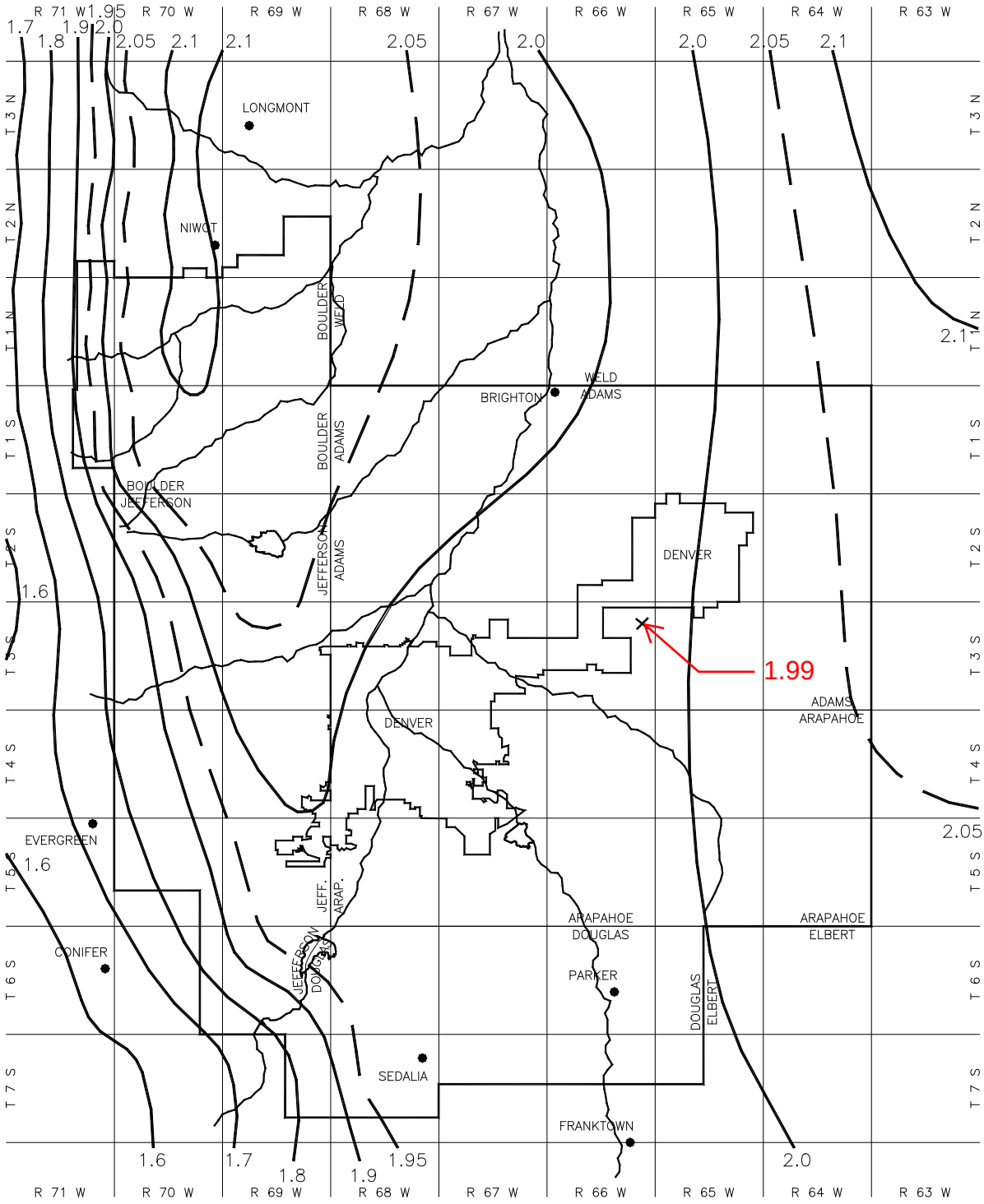


Figure 5-4. Rainfall depth-duration-frequency: 25-Year, 1-hour rainfall

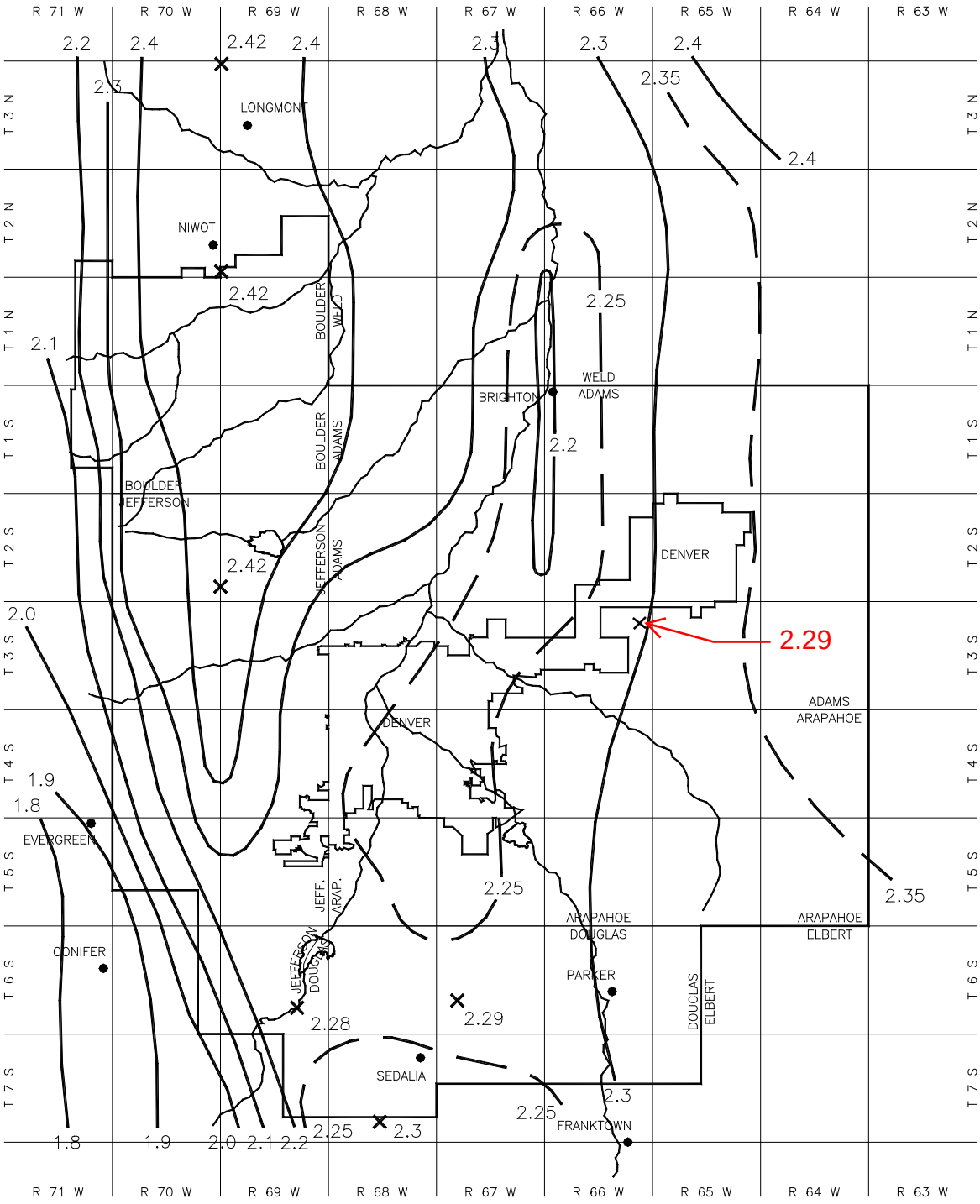


Figure 5-5. Rainfall depth-duration-frequency: 50-year, 1-hour rainfall

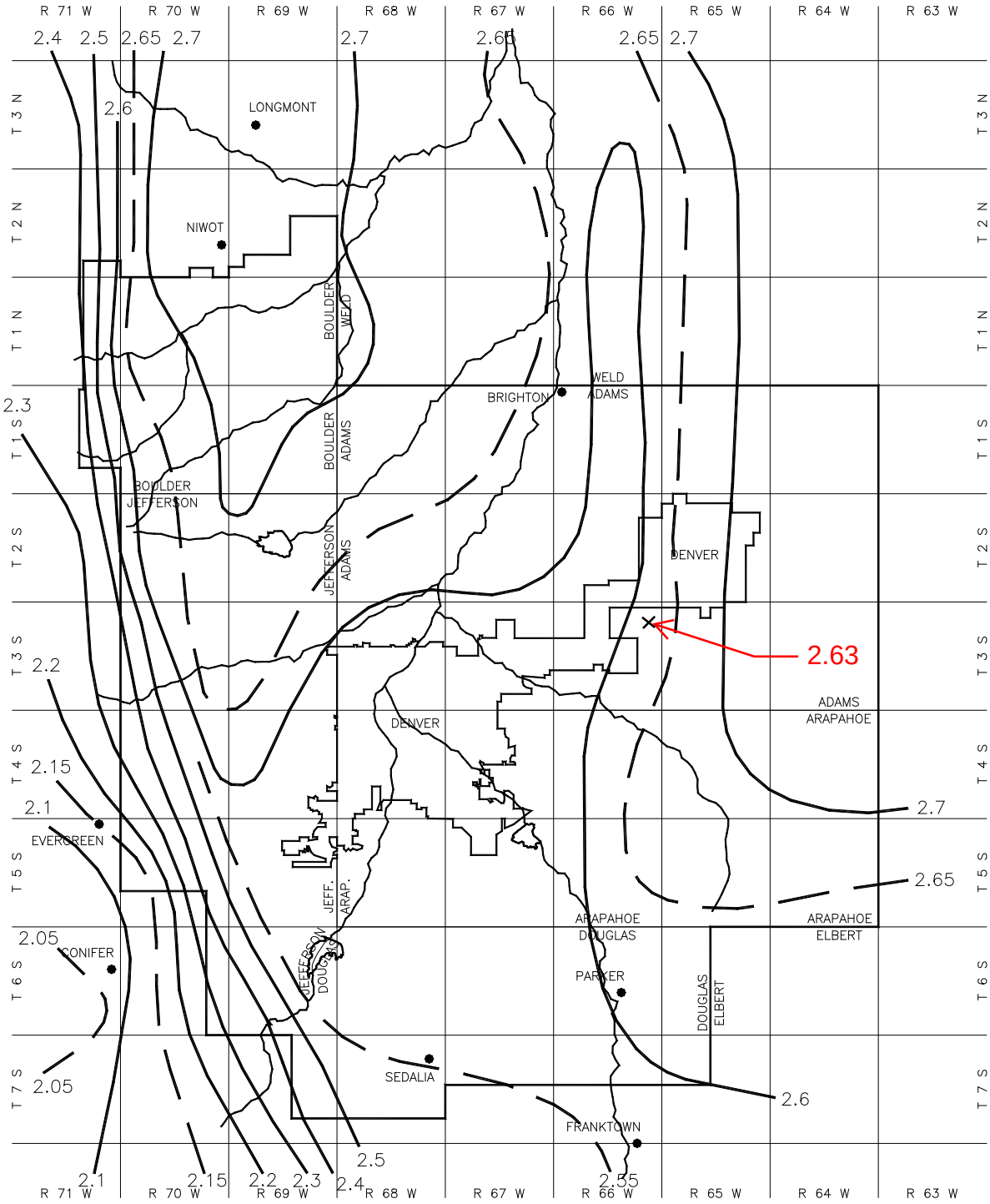


Figure 5-6. Rainfall depth-duration-frequency: 100-year, 1-hour rainfall

TABLE 1
RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	85	.60	.65	.70	.80
Residential:					
Single-Family (**)	(*)	.40	.45	.50	.60
Multi-Unit (detached)	60	.45	.50	.60	.70
Multi-Unit (attached)	75	.60	.65	.70	.80
1/2 Acre Lot or Larger	(*)	.30	.35	.40	.60
Apartments	80	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Areas	90	.80	.80	.85	.90
Parks, Cemeteries	5	.10	.10	.35	.60
Playgrounds	10	.15	.25	.35	.65
Schools	50	.45	.50	.60	.70
Railroad Yard Areas	15	.40	.45	.50	.60
Undeveloped Areas:					
Historic Flow Analysis, Greenbelts, Agricultural	2	(See "Lawns")			
Off-Site Flow Analysis (when land use not defined)	45	.43	.47	.55	.65

TABLE 1 (continued)

RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Streets:					
Paved	100	.87	.88	.90	.93
Gravel	40	.15	.25	.35	.65
Concrete Drive and Walks	96	.87	.87	.88	.89
Roofs	90	.80	.85	.90	.90
Lawns, Sandy Soil (A and B Soils):	2				
2% Slope		.05	.06	.08	.10
2-7% Slope		.10	.11	.13	.15
>7% Slope		.15	.16	.18	.20
Lawns, Clay Soil (C and D Soils):	5				
2% Slope		.13	.14	.15	.17
2-7% Slope		.18	.19	.20	.22
>7% Slope		.25	.27	.30	.35

NOTE: These Rational Formula coefficients may not be valid for large basins

(*)See Figures *RO-3 through RO-5* of USDCM Volume 1 for percent impervious.

(**)Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

.

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Composite C-Values

XOG- ACM HIGHPOINT

Input Parameters

Basin(s)	Design Point	Type of Development	NRCS Hydrologic Soil Group	Asphalt Area (acres) (i = 100)	Concrete Area (acres) (i = 100)	Gravel/Future Land Use (acres) (i = 40)	Roofs (acres) (i= 90)	Lawns (acres) (i= 2-5)	Total Area (Acres)	Percent Impervious (%)	(2-YR) Runoff Coefficient	(5-YR) Runoff Coefficient	(10-YR) Runoff Coefficient	(100-YR) Runoff Coefficent
Existing														
E1	B1	Rural	C	0.00	0.00	0.00	0.00	17.30	17.30	2%	0.01	0.05	0.15	0.49
OS1	E1	Rural	C	0.00	0.00	0.00	0.00	3.44	3.44	2%	0.01	0.05	0.15	0.49
Developed-Drilling Phase														
B1	B1	Rural	C	0.00	0.00	13.26	0.00	4.04	17.30	31%	0.22	0.29	0.36	0.61
B1a	CH1	Rural	C	0.00	0.00	6.68	0.00	1.27	7.95	34%	0.25	0.31	0.38	0.62
B1b	CH2	Rural	C	0.00	0.00	6.58	0.00	2.77	9.35	29%	0.20	0.27	0.34	0.60
OS1	E1	Rural	C	0.00	0.00	0.00	0.00	3.44	3.44	2%	0.01	0.05	0.15	0.49
Developed-Interim & Final Phase														
C1	C1	Rural	C	0.00	0.00	7.81	0.00	5.69	13.50	24%	0.17	0.23	0.31	0.58
C1a	CH1	Rural	C	0.00	0.00	6.44	0.00	2.24	8.68	30%	0.22	0.28	0.36	0.61
C1b	CH2	Rural	C	0.00	0.00	1.38	0.00	3.44	4.82	13%	0.08	0.14	0.23	0.54
OS1C	E1	Rural	C	0.00	0.00	0.00	0.00	1.35	1.35	2%	0.01	0.05	0.15	0.49

Notes:

Runoff Coefficient, C values obtained from Table 1 Aurora Storm Drainage Design and Technical Criteria

Percent Impervious Values per Table 1, Aurora Storm Drainage Design and Technical Criteria

TABLE 1 (continued)

RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Streets:					
Paved	100	.87	.88	.90	.93
Gravel	40	.15	.25	.35	.65
Concrete Drive and Walks	96	.87	.87	.88	.89
Roofs	90	.80	.85	.90	.90
Lawns, Sandy Soil (A and B Soils):	2				
2% Slope		.05	.06	.08	.10
2-7% Slope		.10	.11	.13	.15
>7% Slope		.15	.16	.18	.20
Lawns, Clay Soil (C and D Soils):	5				
2% Slope		.13	.14	.15	.17
2-7% Slope		.18	.19	.20	.22
>7% Slope		.25	.27	.30	.35

NOTE: These Rational Formula coefficients may not be valid for large basins

(*)See Figures *RO-3 through RO-5* of USDCM Volume 1 for percent impervious.

(**)Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

TABLE 1
RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	85	.60	.65	.70	.80
Residential:					
Single-Family (**)	(*)	.40	.45	.50	.60
Multi-Unit (detached)	60	.45	.50	.60	.70
Multi-Unit (attached)	75	.60	.65	.70	.80
1/2 Acre Lot or Larger	(*)	.30	.35	.40	.60
Apartments	80	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Areas	90	.80	.80	.85	.90
Parks, Cemeteries	5	.10	.10	.35	.60
Playgrounds	10	.15	.25	.35	.65
Schools	50	.45	.50	.60	.70
Railroad Yard Areas	15	.40	.45	.50	.60
Undeveloped Areas:					
Historic Flow Analysis, Greenbelts, Agricultural	2	(See "Lawns")			
Off-Site Flow Analysis (when land use not defined)	45	.43	.47	.55	.65

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Individual Basin Flow Calculations

XOG-ACM HIGHPOINT

Input Parameters

Basin(s)	Design Point	Area (acres)	5-yr Composite "C5"	Initial/Overland Time			Travel Time					Final TC	Intensity (in/hr)				Basin Flows (cfs)			
				Length (ft)	Slope (%)	Ti (min)	Length (ft)	Slope (%)	Channel Type	Velocity (fps)	Tt (min)	Total TC (min)	2-yr	5-yr	10-yr	100-yr	2-yr	5-yr	10-yr	100-yr
Existing																				
E1	B1	17.30	0.05	1129	3.00	44.27	0	3.00	GW	2.60	0.00	44.27	1.20	1.72	2.01	3.25	0.21	1.53	5.11	27.65
OS1	E1	3.44	0.05	198	3.00	18.54	0	3.00	GW	2.60	0.00	18.54	1.98	2.84	3.33	5.38	0.07	0.50	1.68	9.11
Developed-Drilling Phase																				
B1	*Total*	17.30	0.29	727	0.50	49.55	733	1.00	GW	1.50	8.14	57.70	1.01	1.44	1.69	2.73	3.90	7.24	10.60	28.87
B1a	CH1	7.95	0.31	727	0.50	48.15	733	1.00	GW	1.50	8.14	56.29	1.02	1.47	1.72	2.77	2.01	3.65	5.24	13.74
B1b	CH2	9.35	0.27	465	0.50	40.59	281	1.00	GW	1.50	3.12	43.71	1.21	1.73	2.03	3.27	2.31	4.38	6.54	18.42
OS1	E1	3.44	0.05	198	3.00	18.54	0	3.00	GW	2.60	0.00	18.54	1.98	2.84	3.33	5.38	0.07	0.50	1.68	9.11
Developed-Interim & Final Phase																				
C1	*Total*	13.50	0.23	730	0.50	53.25	663	0.50	GW	1.06	10.42	63.66	0.94	1.35	1.58	2.55	2.13	4.22	6.61	20.07
C1a	CH1	8.68	0.28	730	0.50	50.12	663	0.50	GW	1.06	10.42	60.54	0.97	1.40	1.64	2.64	1.83	3.42	5.05	13.94
C1b	CH2	4.82	0.14	530	0.50	50.13	301	1.00	GW	1.50	3.34	53.47	1.06	1.52	1.78	2.87	0.42	1.03	1.95	7.43
OS1C	E1	1.35	0.05	198	3.00	18.54	0	3.00	GW	2.60	0.00	11.10	2.52	3.61	4.23	6.82	1.46	2.29	3.14	5.99

Notes:

$$t_c = t_i + t_t$$

Equation 5.2 COAA SDDTC

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{\sqrt[3]{S}} \qquad (5.3)$$

Equation 5.3 COAA SDDTC

where t_i = initial or overland flow time (minutes)
C_5 = runoff coefficient for 5-year frequency
L = length of overland flow, (ft., 500 ft. max.)
S = average basin slope (ft/ft)

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Equation 6.4 UDFCD

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

HM = Heavy Meadow, TF = Tillage/field, PL = Short pasture and lawns, BG = Nearly bare ground, GW = Grassed Waterway, PA = Paved Areas
Velocity values from Figure 3-3/Table RO-2 Estimate of Average Flow Velocity for use with the Rational Method

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

$$I = \frac{28.5\ P_1}{(10 + T_C)^{0.786}} \qquad (5.5)$$

Where:
I = rainfall intensity (inches per hour)
P_1 = one-hour rainfall depth (inches) from Figures RA-1 through RA-6 in USDCM, Volume 1
T_c = time of concentration (minutes).

Equation 5.5 COAA SDDTC

$$t_c = \frac{L'}{180} + 10 \qquad (5.4)$$

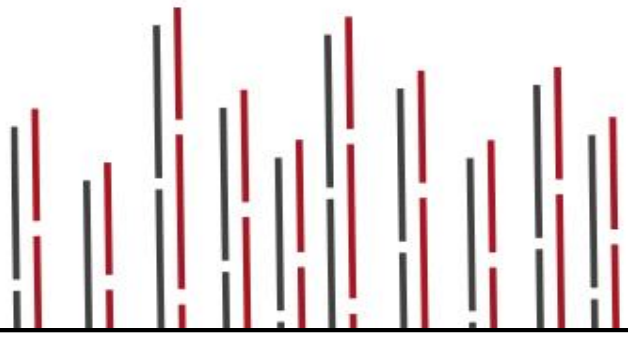
Where t_c = time of concentration (minutes)

L' = length of flow to first design point from the most remote point (feet)

Normally the above equation will govern the time of concentration in urbanized basins.

Equation 5.4 COAA SDDTC

Appendix B



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 26 2019

Drilling Phase Channel 1 - 100yr Storm

Trapezoidal

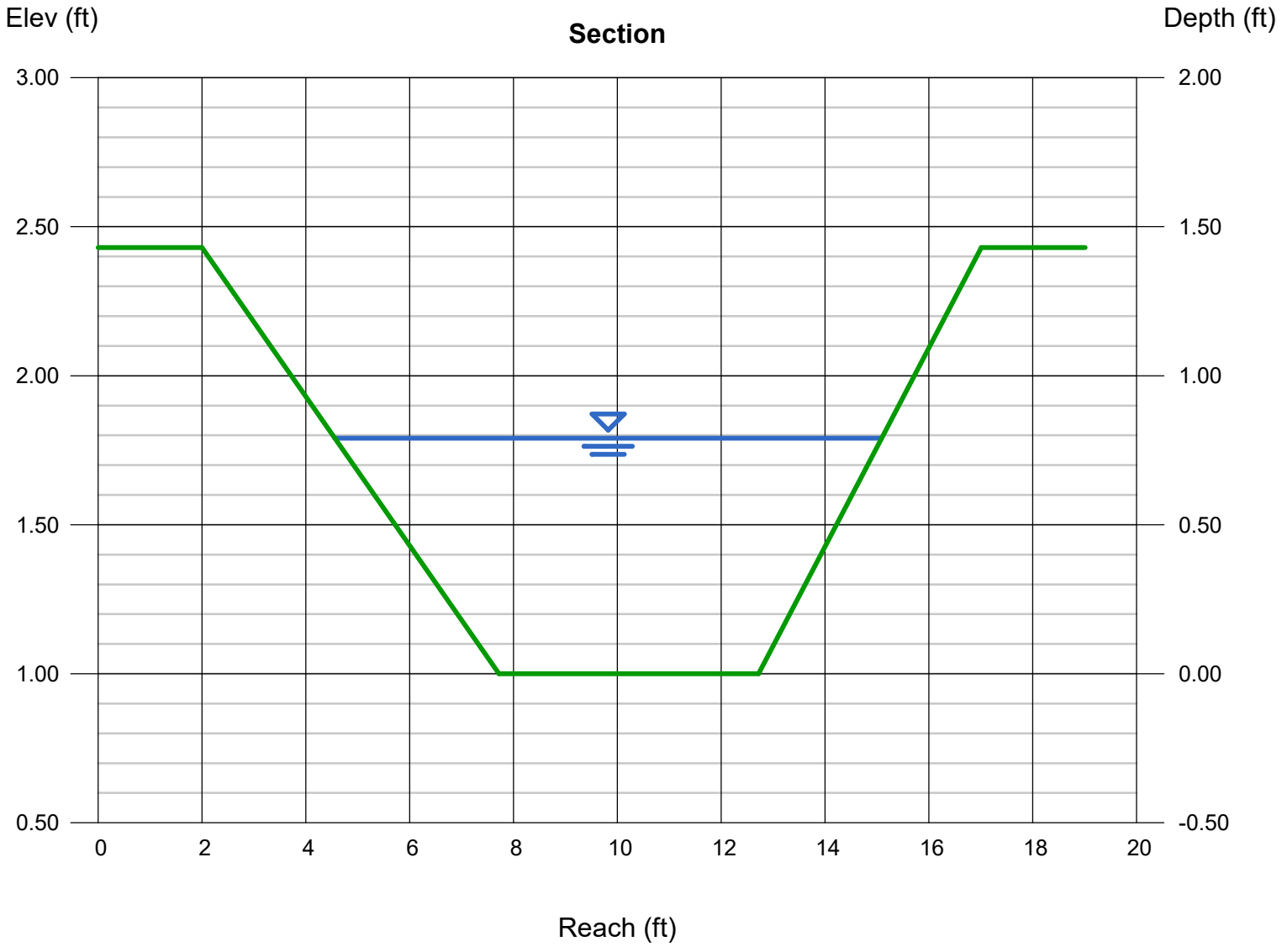
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.43
Invert Elev (ft)	= 1.00
Slope (%)	= 1.00
N-Value	= 0.045

Calculations

Compute by:	Known Q
Known Q (cfs)	= 13.74

Highlighted

Depth (ft)	= 0.79
Q (cfs)	= 13.74
Area (sqft)	= 6.13
Velocity (ft/s)	= 2.24
Wetted Perim (ft)	= 10.76
Crit Depth, Yc (ft)	= 0.55
Top Width (ft)	= 10.53
EGL (ft)	= 0.87



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jan 8 2020

Drilling Phase Channel 2 - 100yr Storm

Trapezoidal

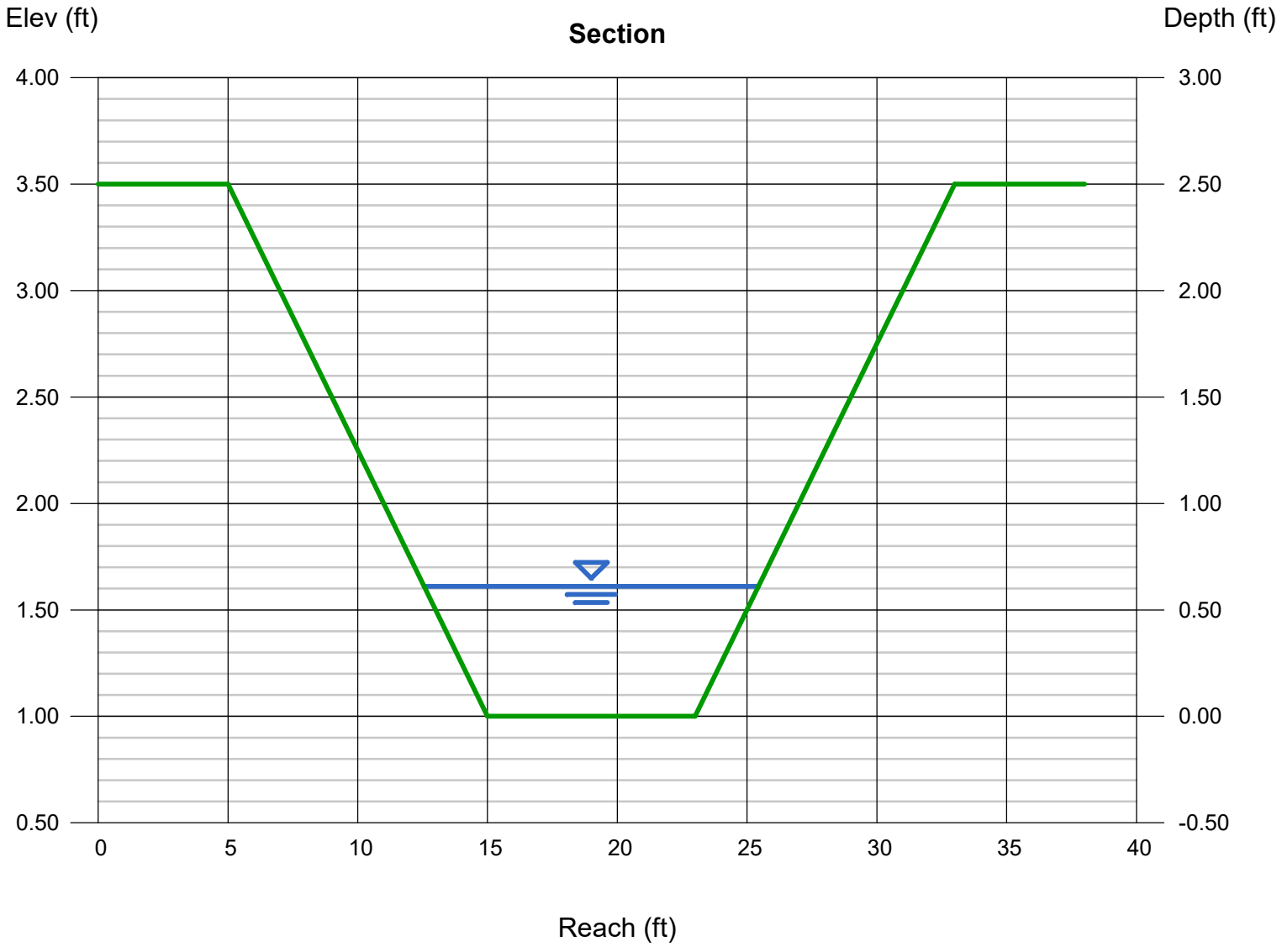
Bottom Width (ft)	= 8.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 1.00
Slope (%)	= 2.00
N-Value	= 0.045

Calculations

Compute by:	Known Q
Known Q (cfs)	= 18.42

Highlighted

Depth (ft)	= 0.61
Q (cfs)	= 18.42
Area (sqft)	= 6.37
Velocity (ft/s)	= 2.89
Wetted Perim (ft)	= 13.03
Crit Depth, Yc (ft)	= 0.51
Top Width (ft)	= 12.88
EGL (ft)	= 0.74



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Jan 10 2020

Interim Phase Channel 1 - 100yr Storm

Trapezoidal

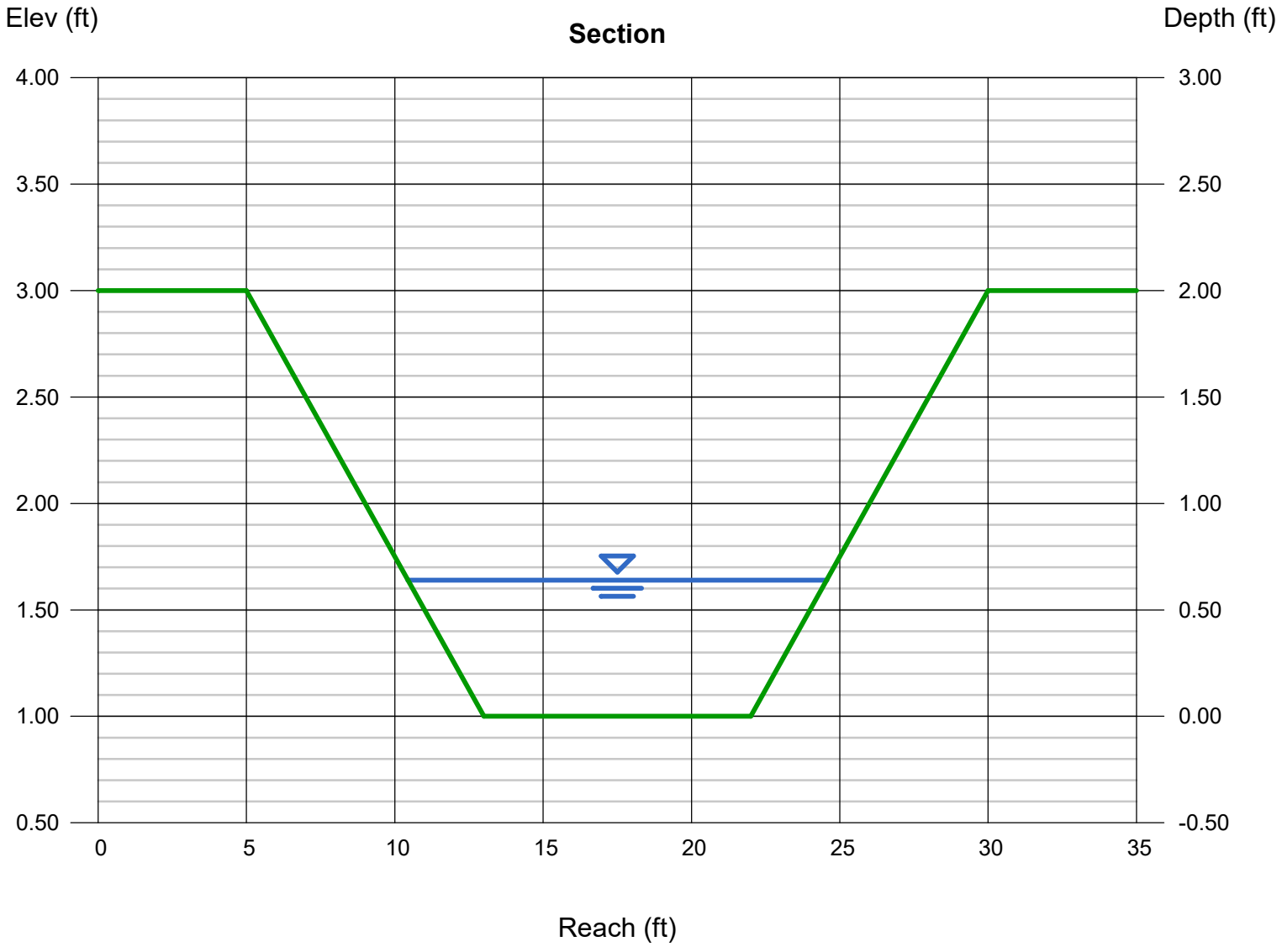
Bottom Width (ft)	= 9.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.80
N-Value	= 0.045

Calculations

Compute by:	Known Q
Known Q (cfs)	= 13.94

Highlighted

Depth (ft)	= 0.64
Q (cfs)	= 13.94
Area (sqft)	= 7.40
Velocity (ft/s)	= 1.88
Wetted Perim (ft)	= 14.28
Crit Depth, Yc (ft)	= 0.40
Top Width (ft)	= 14.12
EGL (ft)	= 0.70



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Jan 10 2020

Interim Phase Channel 2 - 100yr Storm

Trapezoidal

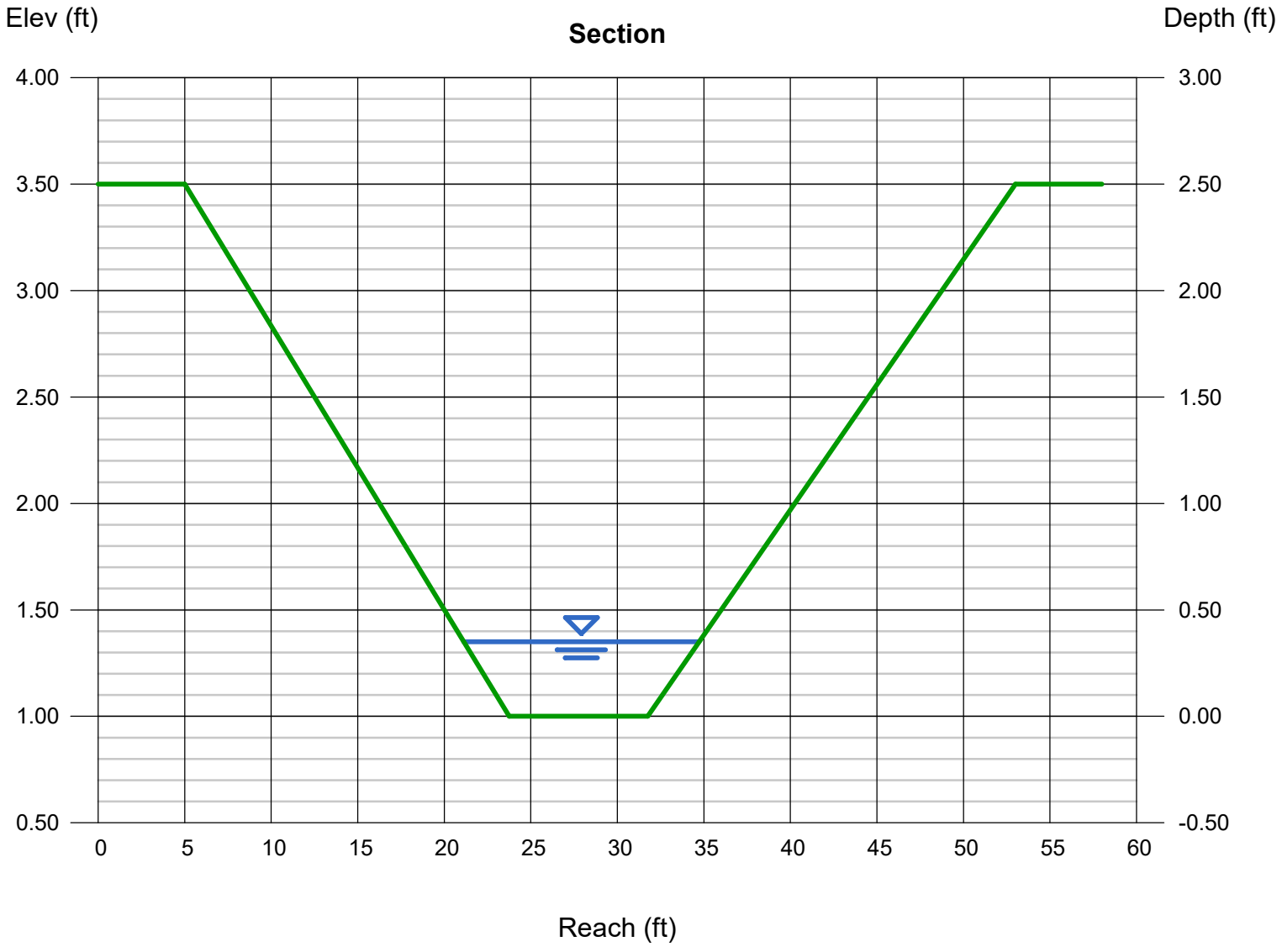
Bottom Width (ft)	= 8.00
Side Slopes (z:1)	= 7.50, 8.50
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 1.00
Slope (%)	= 2.08
N-Value	= 0.045

Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.43

Highlighted

Depth (ft)	= 0.35
Q (cfs)	= 7.430
Area (sqft)	= 3.78
Velocity (ft/s)	= 1.97
Wetted Perim (ft)	= 13.64
Crit Depth, Yc (ft)	= 0.28
Top Width (ft)	= 13.60
EGL (ft)	= 0.41

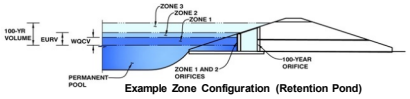


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ACM Drilling Phase - Sediment Pond

Basin ID: Developed Drilling- Phase



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	No BMP	Flood Control Only	
Watershed Area =	17.30	acres	
Watershed Length =	1,460	ft	
Watershed Slope =	0.005	ft/ft	
Watershed Imperviousness =	29.00%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	100.0%	percent	
Desired WQCV Drain Time =	N/A	hours	
Location for 1-hr Rainfall Depths =	Denver - Capitol Building		
Water Quality Capture Volume (WQCV) =	0.214	acre-feet	
Excess Urban Runoff Volume (EURV) =	0.454	acre-feet	
2-yr Runoff Volume (P1 = 0.97 in.) =	0.339	acre-feet	
5-yr Runoff Volume (P1 = 1.39 in.) =	0.644	acre-feet	
10-yr Runoff Volume (P1 = 1.63 in.) =	0.935	acre-feet	
25-yr Runoff Volume (P1 = 1.99 in.) =	1.592	acre-feet	
50-yr Runoff Volume (P1 = 2.29 in.) =	2.057	acre-feet	
100-yr Runoff Volume (P1 = 2.63 in.) =	2.666	acre-feet	
500-yr Runoff Volume (P1 = 3.14 in.) =	3.585	acre-feet	
Approximate 2-yr Detention Volume =	0.317	acre-feet	
Approximate 5-yr Detention Volume =	0.608	acre-feet	
Approximate 10-yr Detention Volume =	0.711	acre-feet	
Approximate 25-yr Detention Volume =	0.856	acre-feet	
Approximate 50-yr Detention Volume =	0.916	acre-feet	
Approximate 100-yr Detention Volume =	1.156	acre-feet	

Optional User Override 1-hr Precipitation

0.97	inches
1.39	inches
1.63	inches
1.99	inches
2.29	inches
2.63	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (100-year) =	1.156	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	1.156	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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	--	--	--	12,511	0.287		
5388.9	--	0.10	--	--	--	12,842	0.295	1,268	0.029
5389	--	0.20	--	--	--	13,176	0.302	2,437	0.056
5389.1	--	0.30	--	--	--	13,512	0.310	3,768	0.086
5389.2	--	0.40	--	--	--	13,851	0.318	5,133	0.118
5389.3	--	0.50	--	--	--	14,193	0.326	6,532	0.150
5389.4	--	0.60	--	--	--	14,538	0.334	7,965	0.183
5389.5	--	0.70	--	--	--	14,856	0.341	9,431	0.217
5389.6	--	0.80	--	--	--	15,236	0.350	10,932	0.251
5389.7	--	0.90	--	--	--	15,589	0.358	12,470	0.286
5389.8	--	1.00	--	--	--	15,946	0.366	14,043	0.322
5389.9	--	1.10	--	--	--	16,305	0.374	15,652	0.359
5390	--	1.20	--	--	--	16,667	0.383	17,297	0.397
5390.1	--	1.30	--	--	--	17,032	0.391	18,978	0.436
5390.2	--	1.40	--	--	--	17,399	0.399	20,696	0.475
5390.3	--	1.50	--	--	--	17,770	0.408	22,451	0.515
5390.4	--	1.60	--	--	--	18,144	0.417	24,243	0.557
5390.5	--	1.70	--	--	--	18,520	0.425	26,072	0.599
5390.6	--	1.80	--	--	--	18,900	0.434	27,939	0.641
5390.7	--	1.90	--	--	--	19,282	0.443	29,844	0.685
5390.8	--	2.00	--	--	--	19,667	0.452	31,788	0.730
5390.9	--	2.10	--	--	--	20,056	0.460	33,971	0.780
5391	--	2.20	--	--	--	20,447	0.469	35,996	0.826
5391.1	--	2.30	--	--	--	20,842	0.478	38,060	0.874
5391.2	--	2.40	--	--	--	21,239	0.488	40,164	0.922
5391.3	--	2.50	--	--	--	21,640	0.497	42,308	0.971
5391.4	--	2.60	--	--	--	22,044	0.506	44,493	1.021
5391.5	--	2.70	--	--	--	22,450	0.515	46,717	1.072
5391.6	--	2.80	--	--	--	22,861	0.525	48,983	1.124
5391.7	--	2.90	--	--	--	23,273	0.534	51,290	1.177
5391.8	--	3.00	--	--	--	23,690	0.544	53,638	1.231
5392.8	--	4.00	--	--	--	28,031	0.643	79,498	1.825

Weir Report

Drilling Phase Sediment Pond Spillway

Trapezoidal Weir

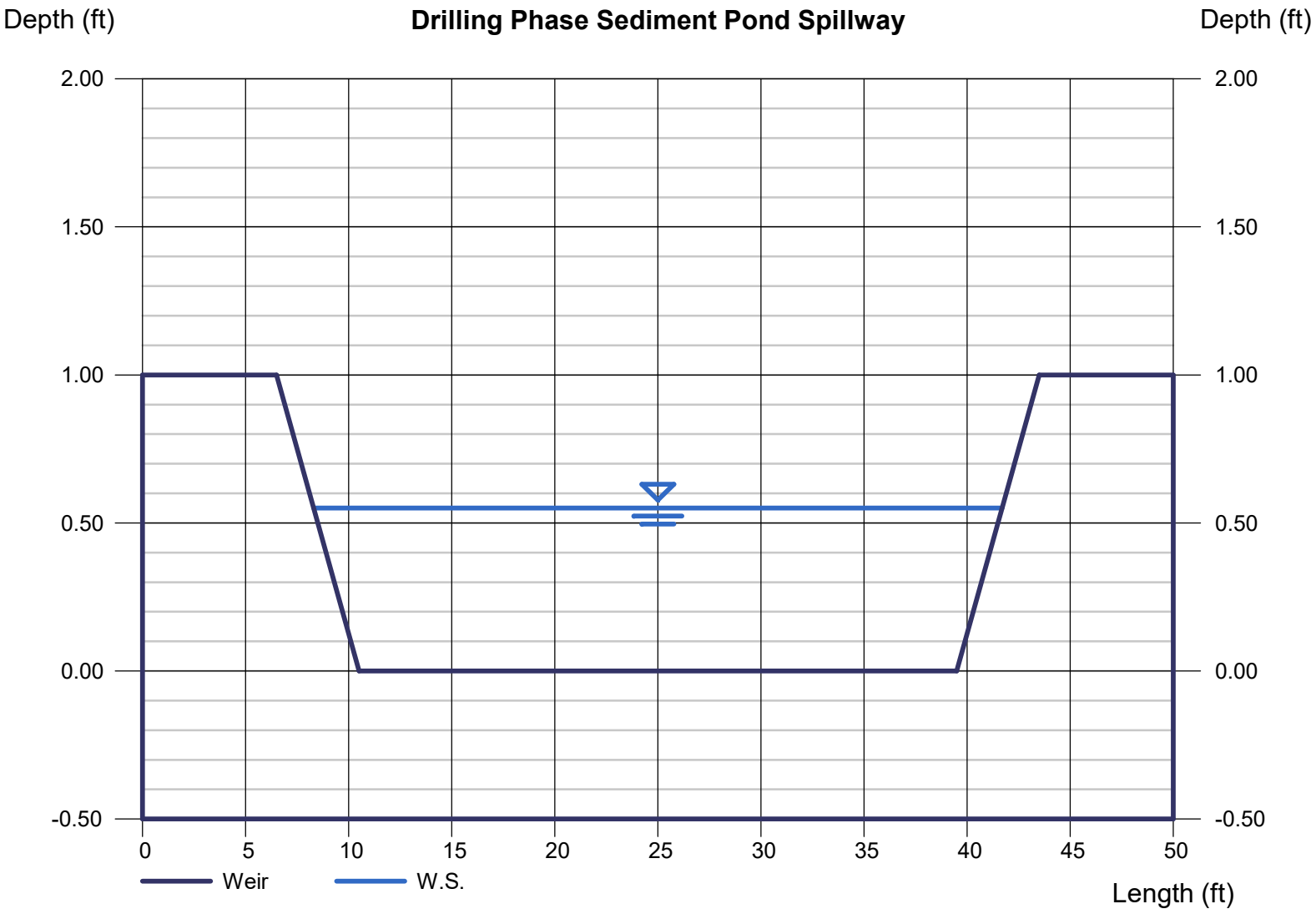
Crest	= Sharp
Bottom Length (ft)	= 29.00
Total Depth (ft)	= 1.00
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 38.00

Highlighted

Depth (ft)	= 0.55
Q (cfs)	= 38.00
Area (sqft)	= 17.16
Velocity (ft/s)	= 2.21
Top Width (ft)	= 33.40



Detention Basin Calculation-Extended Detention Basin

XOG- ACM HIGH POINT

LAMP RYNEARSON

Input Parameters

Pond Parameters	
A (Acres)	13.50
I (%)	24%
K	0.0422
WQCV (Ac-Ft)	0.167
EURV (Ac-Ft)	0.355
V100 (Ac-Ft)	0.570
Total Required Volume (Ac-Ft)	**0.748**

Equations/Notes:

WQCV & EURV are calculated from UD spreadsheet and input here.

V100=K100*A + ½*V(EURV)

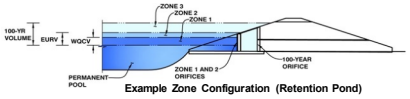
A – Area draining to the pond
K100 = (1.78*I – 0.002 *I^2 – 3.56)/900
I – Imperviousness of the area draining to the pond
V(EURV) – from UD spreadsheet.

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ACM High Point Interim Phase - Extended Dentention Pond

Basin ID: Interim- Phase (Basin B1)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	13.50	acres
Watershed Length =	1,393	ft
Watershed Slope =	0.005	ft/ft
Watershed Imperviousness =	29.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	
Water Quality Capture Volume (WQCV) =	0.167	acre-feet
Excess Urban Runoff Volume (EURV) =	0.355	acre-feet
2-yr Runoff Volume (P1 = 0.97 in.) =	0.264	acre-feet
5-yr Runoff Volume (P1 = 1.39 in.) =	0.503	acre-feet
10-yr Runoff Volume (P1 = 1.63 in.) =	0.730	acre-feet
25-yr Runoff Volume (P1 = 1.99 in.) =	1.242	acre-feet
50-yr Runoff Volume (P1 = 2.29 in.) =	1.605	acre-feet
100-yr Runoff Volume (P1 = 2.63 in.) =	2.081	acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	2.797	acre-feet
Approximate 2-yr Detention Volume =	0.248	acre-feet
Approximate 5-yr Detention Volume =	0.475	acre-feet
Approximate 10-yr Detention Volume =	0.555	acre-feet
Approximate 25-yr Detention Volume =	0.668	acre-feet
Approximate 50-yr Detention Volume =	0.715	acre-feet
Approximate 100-yr Detention Volume =	0.902	acre-feet

Optional User Override 1-hr Precipitation

0.97	inches
1.39	inches
1.63	inches
1.99	inches
2.29	inches
2.63	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.167	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.188	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.547	acre-feet
Total Detention Basin Volume =	0.902	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

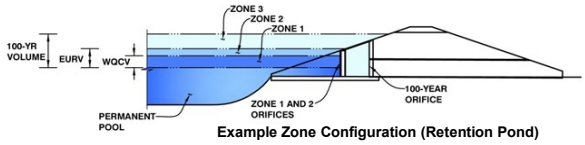
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	265	0.006		
5390.1	--	0.10	--	--	--	1,029	0.024	65	0.001
5390.2	--	0.20	--	--	--	1,972	0.045	195	0.004
5390.3	--	0.30	--	--	--	2,946	0.068	432	0.010
5390.4	--	0.40	--	--	--	3,989	0.092	768	0.018
5390.5	--	0.50	--	--	--	5,067	0.116	1,210	0.028
5390.6	--	0.60	--	--	--	6,155	0.141	1,760	0.040
5390.7	--	0.70	--	--	--	7,240	0.166	2,419	0.056
5390.8	--	0.80	--	--	--	8,324	0.191	3,186	0.073
5390.9	--	0.90	--	--	--	9,405	0.216	4,062	0.093
5391	--	1.00	--	--	--	10,488	0.241	5,046	0.116
5391.1	--	1.10	--	--	--	11,584	0.266	6,138	0.141
5391.2	--	1.20	--	--	--	12,693	0.291	7,341	0.169
5391.3	--	1.30	--	--	--	13,815	0.317	8,655	0.199
5391.4	--	1.40	--	--	--	14,939	0.343	10,082	0.231
5391.5	--	1.50	--	--	--	15,944	0.366	11,616	0.267
5391.6	--	1.60	--	--	--	16,800	0.386	13,245	0.304
5391.7	--	1.70	--	--	--	17,585	0.404	14,956	0.343
5391.8	--	1.80	--	--	--	18,294	0.420	16,743	0.384
5391.9	--	1.90	--	--	--	18,913	0.434	18,597	0.427
5392	--	2.00	--	--	--	19,232	0.442	20,501	0.471
5392.1	--	2.10	--	--	--	19,557	0.449	22,632	0.520
5392.2	--	2.20	--	--	--	19,888	0.457	24,605	0.565
5392.3	--	2.30	--	--	--	20,226	0.464	26,610	0.611
5392.4	--	2.40	--	--	--	20,571	0.472	28,650	0.658
5392.5	--	2.50	--	--	--	20,922	0.480	30,725	0.705
5392.6	--	2.60	--	--	--	21,279	0.489	32,835	0.754
5392.7	--	2.70	--	--	--	21,643	0.497	34,981	0.803
5392.8	--	2.80	--	--	--	22,014	0.505	37,164	0.853
5392.9	--	2.90	--	--	--	22,391	0.514	39,384	0.904
5393	--	3.00	--	--	--	22,775	0.523	41,642	0.956
5393.1	--	3.10	--	--	--	23,165	0.532	43,939	1.009
5393.2	--	3.20	--	--	--	23,562	0.541	46,276	1.062
5393.3	--	3.30	--	--	--	23,966	0.550	48,652	1.117
5393.4	--	3.40	--	--	--	24,376	0.560	51,069	1.172
5393.5	--	3.50	--	--	--	24,792	0.569	53,528	1.229
5393.6	--	3.60	--	--	--	25,215	0.579	56,028	1.286
5393.7	--	3.70	--	--	--	25,645	0.589	58,571	1.345
5393.8	--	3.80	--	--	--	26,081	0.599	61,157	1.404
5393.9	--	3.90	--	--	--	26,524	0.609	63,788	1.464
5394	--	4.00	--	--	--	27,750	0.637	66,501	1.527

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: ACM High Point Interim Phase - Extended Dentention Pond

Basin ID: Interim- Phase (Basin B1)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.19	0.167	Orifice Plate
Zone 2 (EURV)	1.72	0.188	Weir&Pipe (Restrict)
Zone 3 (100-year)	2.90	0.547	
		0.902	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.19	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	3.76	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	0.30	0.60	0.90				
Orifice Area (sq. inches)	1.10	1.10	1.10	1.10				

	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) and Grate (Flat or Sloped)

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.20		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00		feet
Overflow Weir Slope =	3.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.87		feet
Over Flow Weir Slope Length =	8.43		feet
Grate Open Area / 100-yr Orifice Area =	24.82		should be ≥ 4
Overflow Grate Open Area w/o Debris =	47.22		ft^2
Overflow Grate Open Area w/ Debris =	23.61		ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00		inches
Restrictor Plate Height Above Pipe Invert =	14.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	1.90		ft^2
Outlet Orifice Centroid =	0.66		feet
Half-Central Angle of Restrictor Plate on Pipe =	1.74	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	4.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	1.04	feet
Stage at Top of Freeboard =	5.04	feet
Basin Area at Top of Freeboard =	0.64	acres

Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.97	1.39	1.63	1.99	2.29	2.63	3.14
Calculated Runoff Volume (acre-ft) =	0.167	0.355	0.264	0.503	0.730	1.242	1.605	2.081	2.797
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.166	0.354	0.264	0.502	0.729	1.241	1.604	2.080	2.796
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.08	0.22	0.58	0.78	1.06	1.47
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	1.1	3.0	7.8	10.6	14.3	19.9
Peak Inflow Q (cfs) =	1.9	4.1	3.0	5.7	8.3	14.0	18.1	23.4	31.3
Peak Outflow Q (cfs) =	0.1	1.5	0.7	2.8	4.9	9.9	11.2	12.8	16.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.6	1.6	1.3	1.1	0.9	0.8
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.03	0.01	0.1	0.1	0.2	0.2	0.3	0.3
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) =	32	32	34	31	28	24	22	19	16
Time to Drain 99% of Inflow Volume (hours) =	35	37	38	36	35	32	31	29	27
Maximum Ponding Depth (ft) =	1.10	1.41	1.32	1.52	1.66	1.91	2.17	2.62	3.26
Area at Maximum Ponding Depth (acres) =	0.27	0.35	0.32	0.37	0.40	0.43	0.45	0.49	0.55
Maximum Volume Stored (acre-ft) =	0.144	0.238	0.205	0.278	0.331	0.436	0.547	0.759	1.095

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

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.

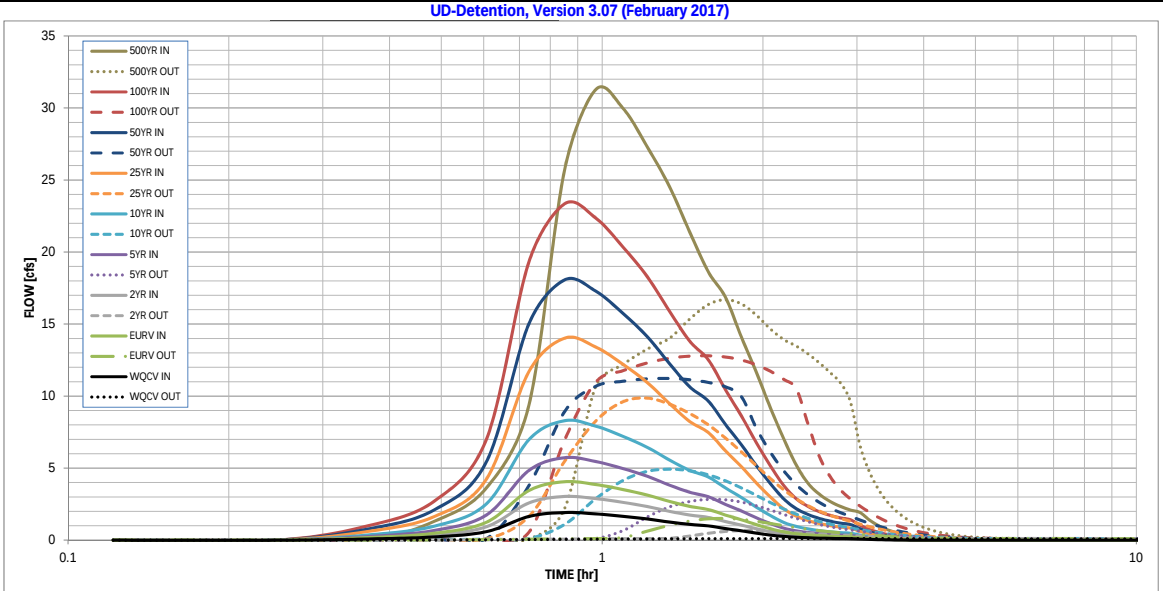
Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	265	0.006	0	0.000	0.00
WQCV	1.19	12,471	0.286	7,216	0.166	0.12
10yr Max Stage	1.66	17,192	0.395	14,262	0.327	4.72
100-Year Max Storage	2.90	22,391	0.514	39,384	0.904	13.70
Freeboard	3.00	22,775	0.523	41,642	0.956	14.00
Top of Pond	4.00	27,750	0.637	66,501	1.527	38.33

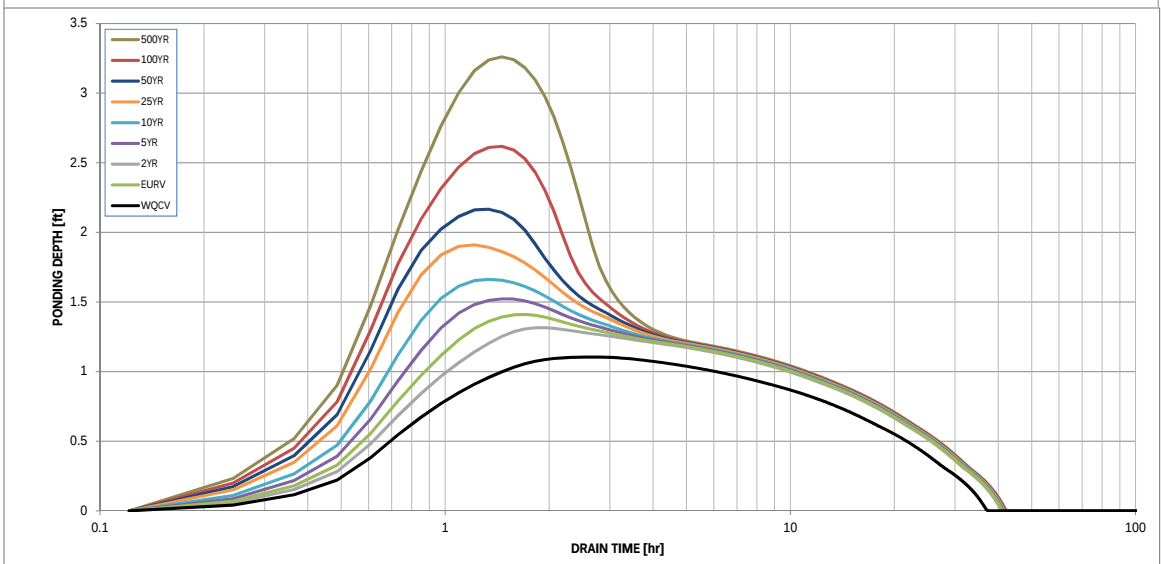
For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

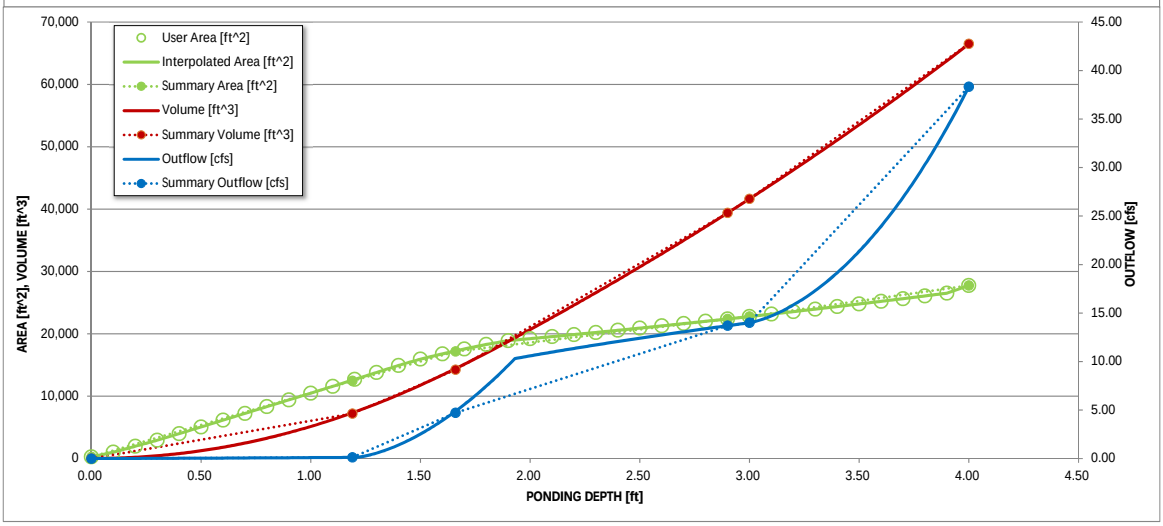
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Weir Report

Interim Phase Detention Pond Spillway - 100yr Storm

Trapezoidal Weir

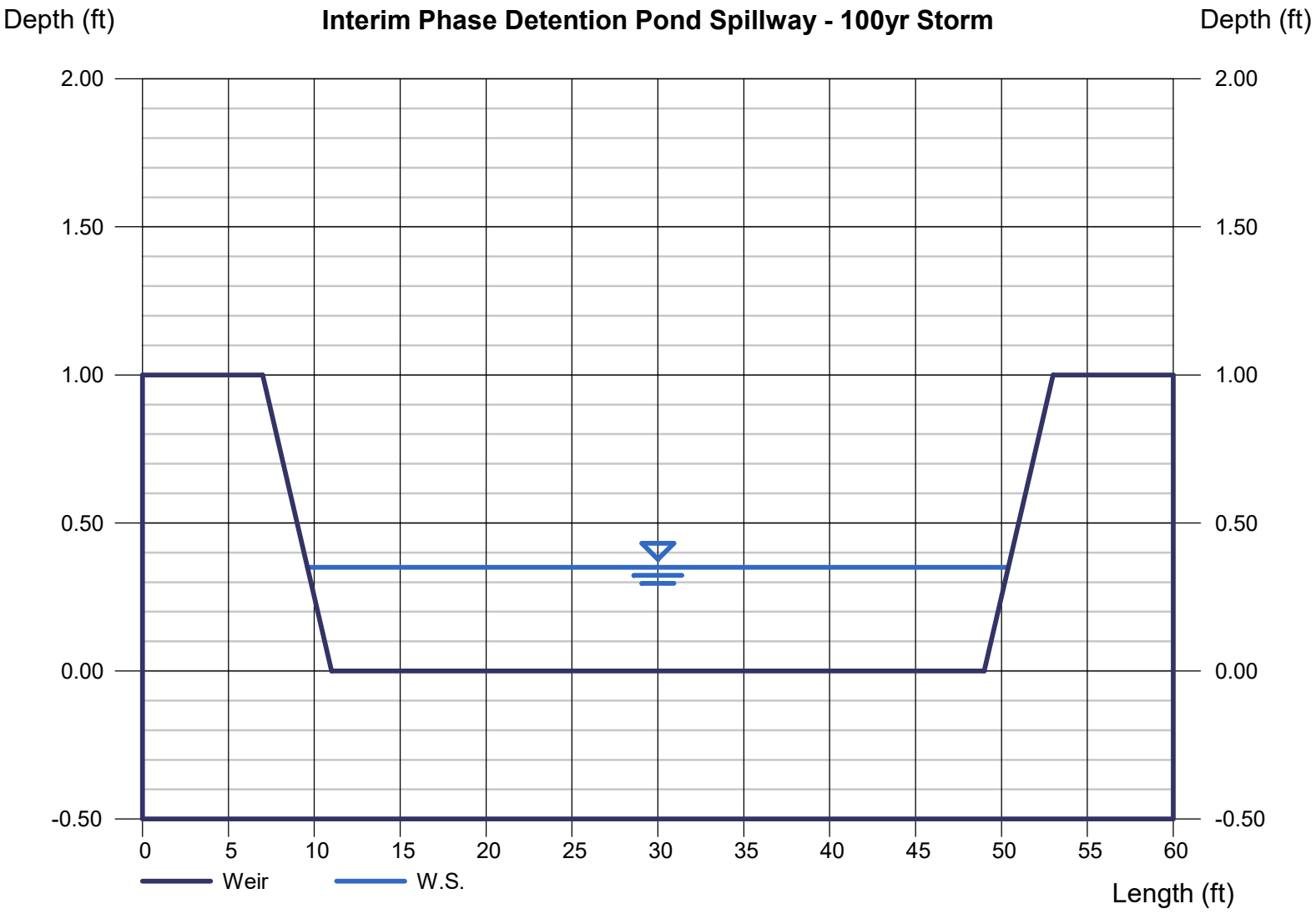
Crest	= Sharp
Bottom Length (ft)	= 38.00
Total Depth (ft)	= 1.00
Side Slope (z:1)	= 4.00

Calculations

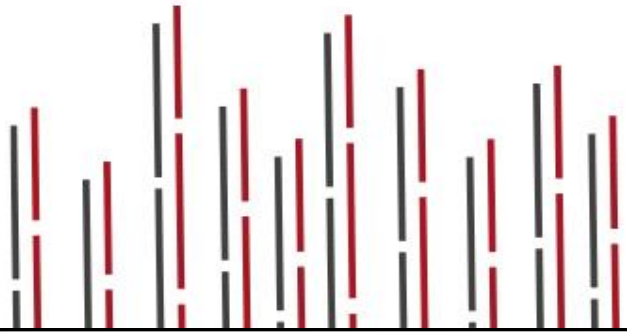
Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 25.00

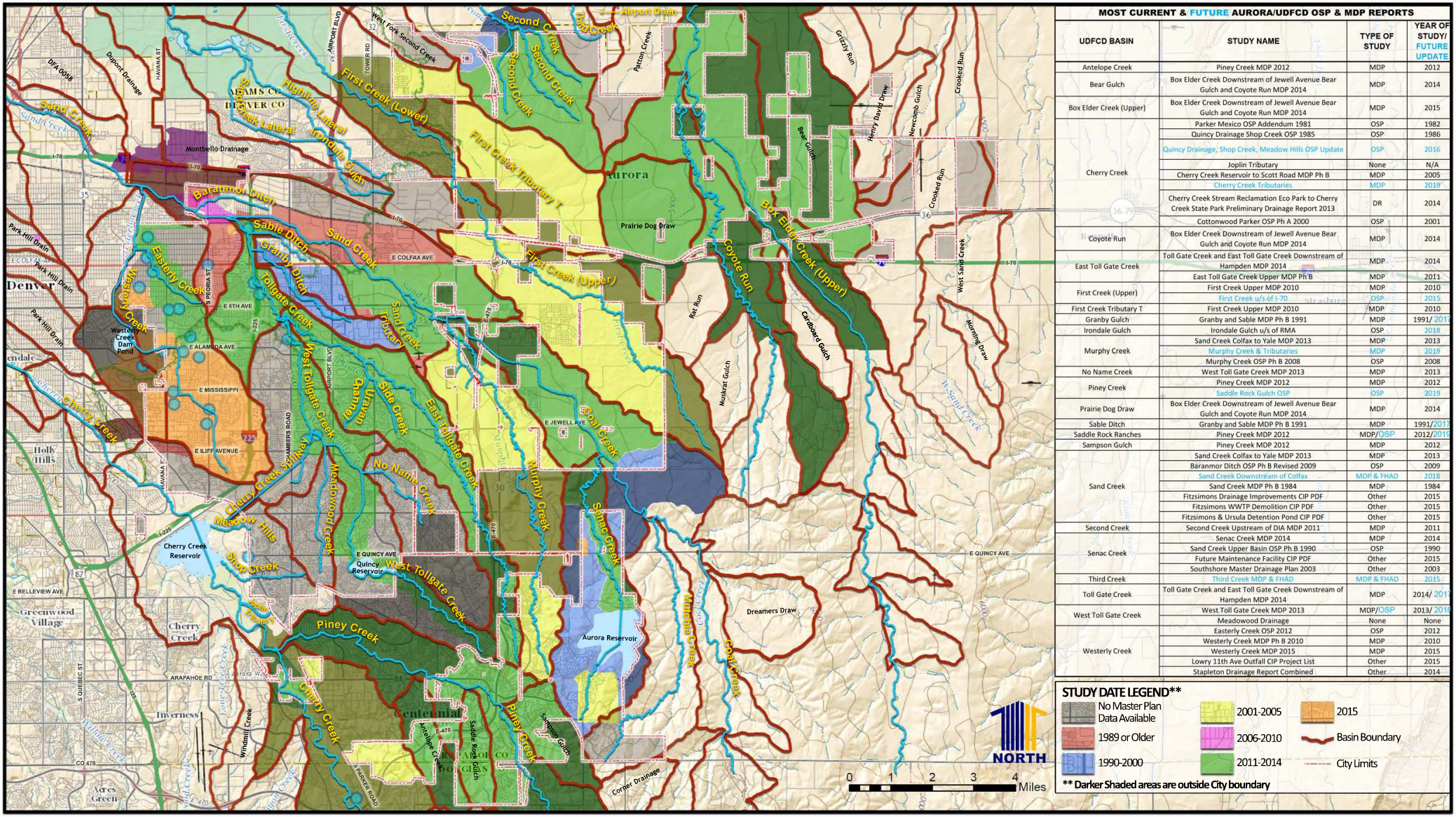
Highlighted

Depth (ft)	= 0.35
Q (cfs)	= 25.00
Area (sqft)	= 13.79
Velocity (ft/s)	= 1.81
Top Width (ft)	= 40.80



Appendix C





MOST CURRENT & FUTURE AURORA/UDFCD OSP & MDP REPORTS

UDFCD BASIN	STUDY NAME	TYPE OF STUDY	YEAR OF STUDY/ FUTURE UPDATE
Antelope Creek	Piney Creek MDP 2012	MDP	2012
Bear Gulch	Box Elder Creek Downstream of Jewell Avenue Bear Gulch and Coyote Run MDP 2014	MDP	2014
Box Elder Creek (Upper)	Box Elder Creek Downstream of Jewell Avenue Bear Gulch and Coyote Run MDP 2014	MDP	2015
Cherry Creek	Parker Mexico OSP Addendum 1981	OSP	1982
	Quincy Drainage Shop Creek OSP 1985	OSP	1986
	Quincy Drainage, Shop Creek, Meadow Hills OSP Update	OSP	2016
	Joplin Tributary	None	N/A
	Cherry Creek Reservoir to Scott Road MDP Ph B	MDP	2005
	Cherry Creek Tributaries	MDP	2019
	Cherry Creek Stream Reclamation Eco Park to Cherry Creek State Park Preliminary Drainage Report 2013	DR	2014
	Cottonwood Parker OSP Ph A 2000	OSP	2001
Coyote Run	Box Elder Creek Downstream of Jewell Avenue Bear Gulch and Coyote Run MDP 2014	MDP	2014
East Toll Gate Creek	Toll Gate Creek and East Toll Gate Creek Downstream of Hampden MDP 2014	MDP	2014
	East Toll Gate Creek Upper MDP Ph B	MDP	2011
First Creek (Upper)	First Creek Upper MDP 2010	MDP	2010
	First Creek u/s of I-70	OSP	2015
First Creek Tributary T	First Creek Upper MDP 2010	MDP	2010
Granby Gulch	Granby and Sable MDP Ph B 1991	MDP	1991/ 2017
Irondale Gulch	Irondale Gulch u/s of RMA	OSP	2018
Murphy Creek	Sand Creek Colfax to Yale MDP 2013	MDP	2013
	Murphy Creek & Tributaries	MDP	2019
	Murphy Creek OSP Ph B 2008	OSP	2008
No Name Creek	West Toll Gate Creek MDP 2013	MDP	2013
Piney Creek	Piney Creek MDP 2012	MDP	2012
	Saddle Rock Gulch OSP	OSP	2019
Prairie Dog Draw	Box Elder Creek Downstream of Jewell Avenue Bear Gulch and Coyote Run MDP 2014	MDP	2014
Sable Ditch	Granby and Sable MDP Ph B 1991	MDP	1991/2017
Saddle Rock Ranches	Piney Creek MDP 2012	MDP/OSP	2012/2019
Sampson Gulch	Piney Creek MDP 2012	MDP	2012
Sand Creek	Sand Creek Colfax to Yale MDP 2013	MDP	2013
	Baranmor Ditch OSP Ph B Revised 2009	OSP	2009
	Sand Creek Downstream of Colfax	MDP & FHAD	2018
	Sand Creek MDP Ph B 1984	MDP	1984
	Fitzsimons Drainage Improvements CIP PDF	Other	2015
	Fitzsimons WWTP Demolition CIP PDF	Other	2015
	Fitzsimons & Ursula Detention Pond CIP PDF	Other	2015
Second Creek	Second Creek Upstream of DIA MDP 2011	MDP	2011
Senac Creek	Senac Creek MDP 2014	MDP	2014
	Sand Creek Upper Basin OSP Ph B 1990	OSP	1990
	Future Maintenance Facility CIP PDF	Other	2015
	Southshore Master Drainage Plan 2003	Other	2003
Third Creek	Third Creek MDP & FHAD	MDP & FHAD	2015
Toll Gate Creek	Toll Gate Creek and East Toll Gate Creek Downstream of Hampden MDP 2014	MDP	2014/ 2019
West Toll Gate Creek	West Toll Gate Creek MDP 2013	MDP/OSP	2013/ 2019
Westerly Creek	Meadowood Drainage	None	None
	Easterly Creek OSP 2012	OSP	2012
	Westerly Creek MDP Ph B 2010	MDP	2010
	Westerly Creek MDP 2015	MDP	2015
	Lowry 11th Ave Outfall CIP Project List	Other	2015
	Stapleton Drainage Report Combined	Other	2014

STUDY DATE LEGEND**

- No Master Plan Data Available
- 1989 or Older
- 1990-2000
- 2001-2005
- 2006-2010
- 2011-2014
- 2015
- Basin Boundary
- City Limits

** Darker Shaded areas are outside City boundary

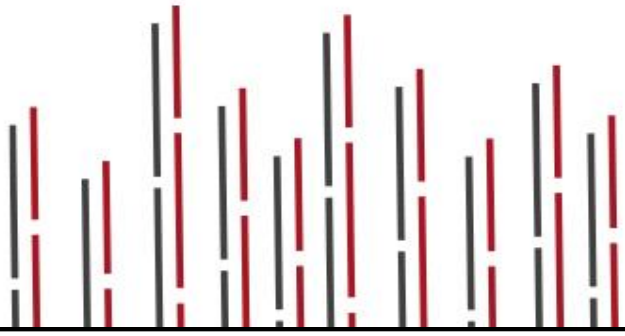
AURORA STORMWATER PROGRAM MASTER PLAN

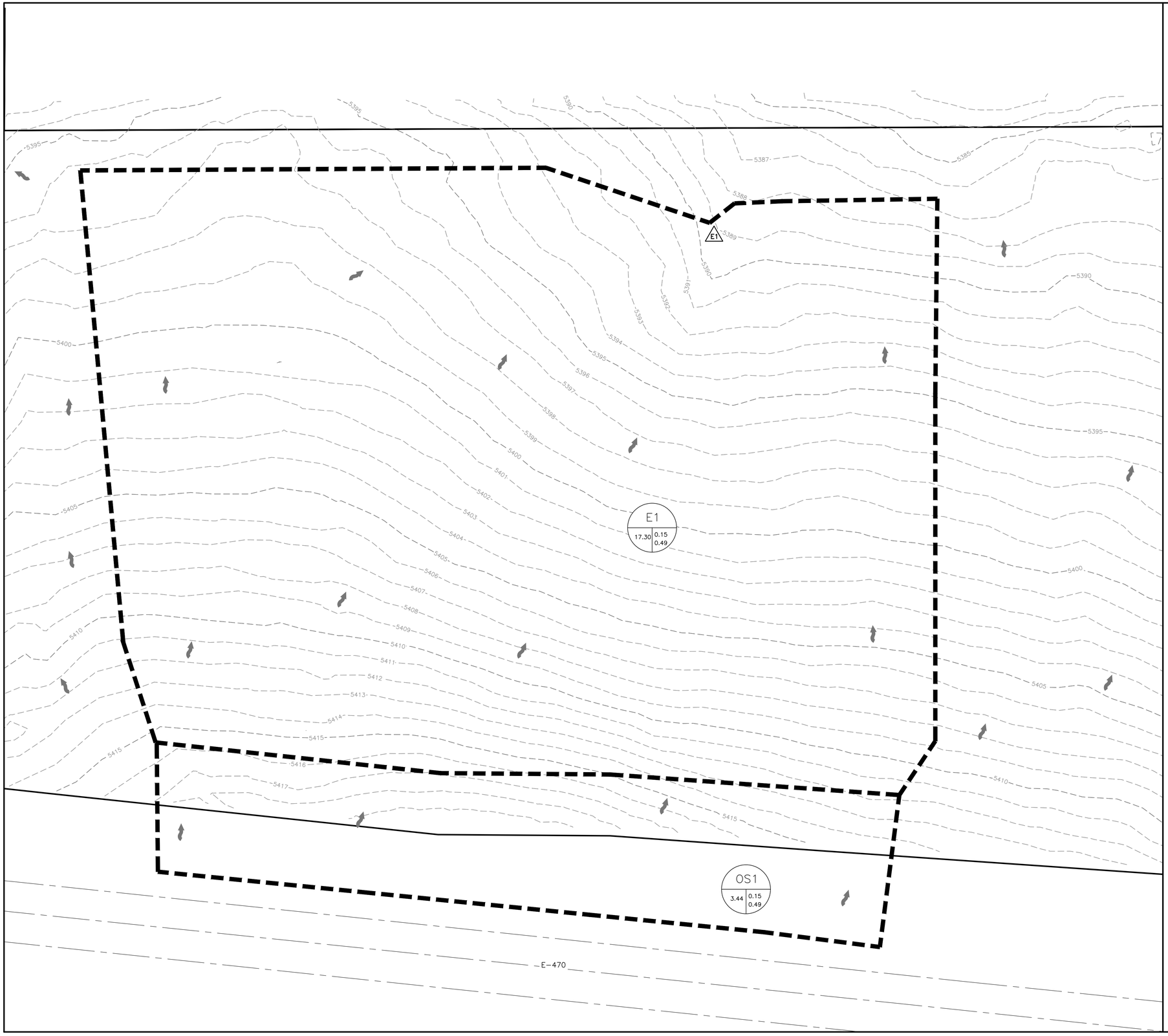
MOST CURRENT MAJOR BASIN STUDY LIMITS

MAP LEGEND

- Proposed Land Acquisition
- Creek Flowlines
- Highline Canal
- Point Subject to Localized 100-YR Flooding

Appendix D





60 0 60 120

SCALE: 1"= 60'

DRAINAGE LEGEND:

- DRAINAGE SUBBASIN BOUNDARY
- B1 — DRAINAGE BASIN DESIGN POINT
- B1 (4.34 / 0.15 / 0.49) — DRAINAGE SUBBASIN NAME; DRAINAGE BASIN AREA; 10-YEAR RUNOFF COEFFICIENT; 100-YEAR RUNOFF COEFFICIENT
- OVERLAND FLOW ARROW
- 1100 — EXISTING CONTOUR

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DRAINAGE MAP
EXISTING CONDITIONS

ACM HIGH POINT MULTI-WELL PAD
NW/4, SW/4, SEC 1 T3S R66W

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DESIGNER / DRAFTER
TJS
DATE
11/27/2019
PROJECT NUMBER
0218003.08
BOOK AND PAGE

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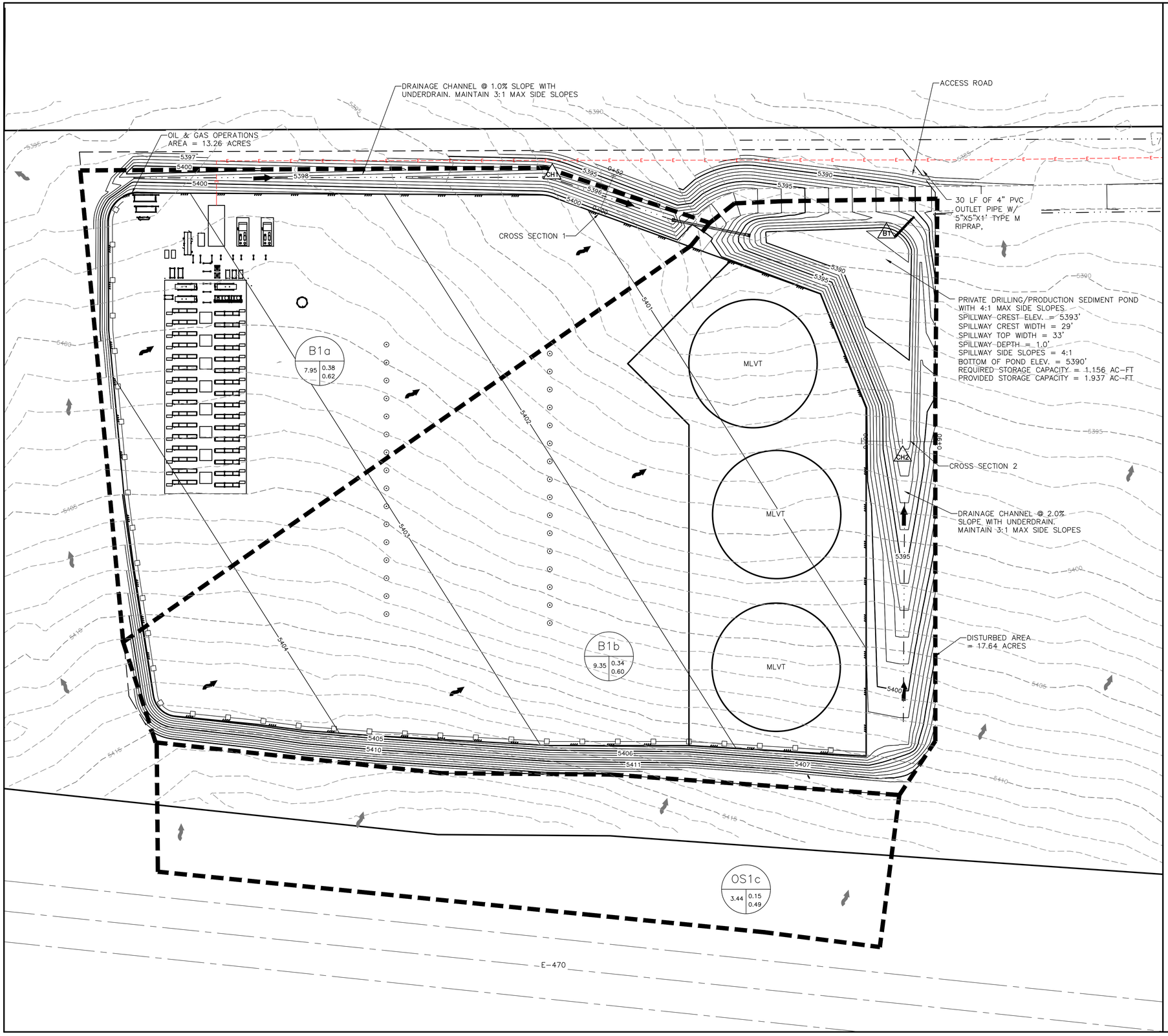
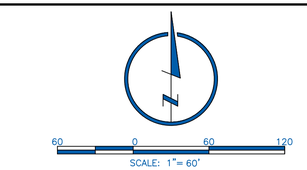
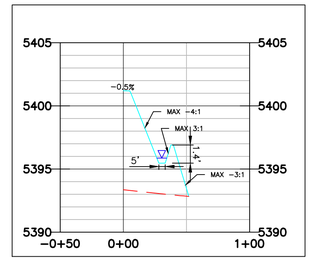




DRAINAGE LEGEND:

- DRAINAGE SUBBASIN BOUNDARY
- B1 — DRAINAGE BASIN DESIGN POINT
- B1 (4.37 / 0.38 / 0.62) — DRAINAGE SUBBASIN NAME; DRAINAGE BASIN AREA; 10-YEAR RUNOFF COEFFICIENT; 100-YEAR RUNOFF COEFFICIENT
- CHANNEL FLOW ARROW
- OVERLAND FLOW ARROW
- 100 — PROPOSED CONTOUR
- 100 — EXISTING CONTOUR
- PROPOSED DRAINAGE PATH



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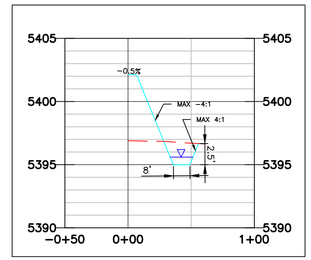

CHANNEL 2 CROSS SECTION

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DRAINAGE MAP
DRILLING PHASE

ACM HIGH POINT MULTI-WELL PAD
NW/4, SW/4, SEC 1 T3S R66W

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PROJECT NUMBER
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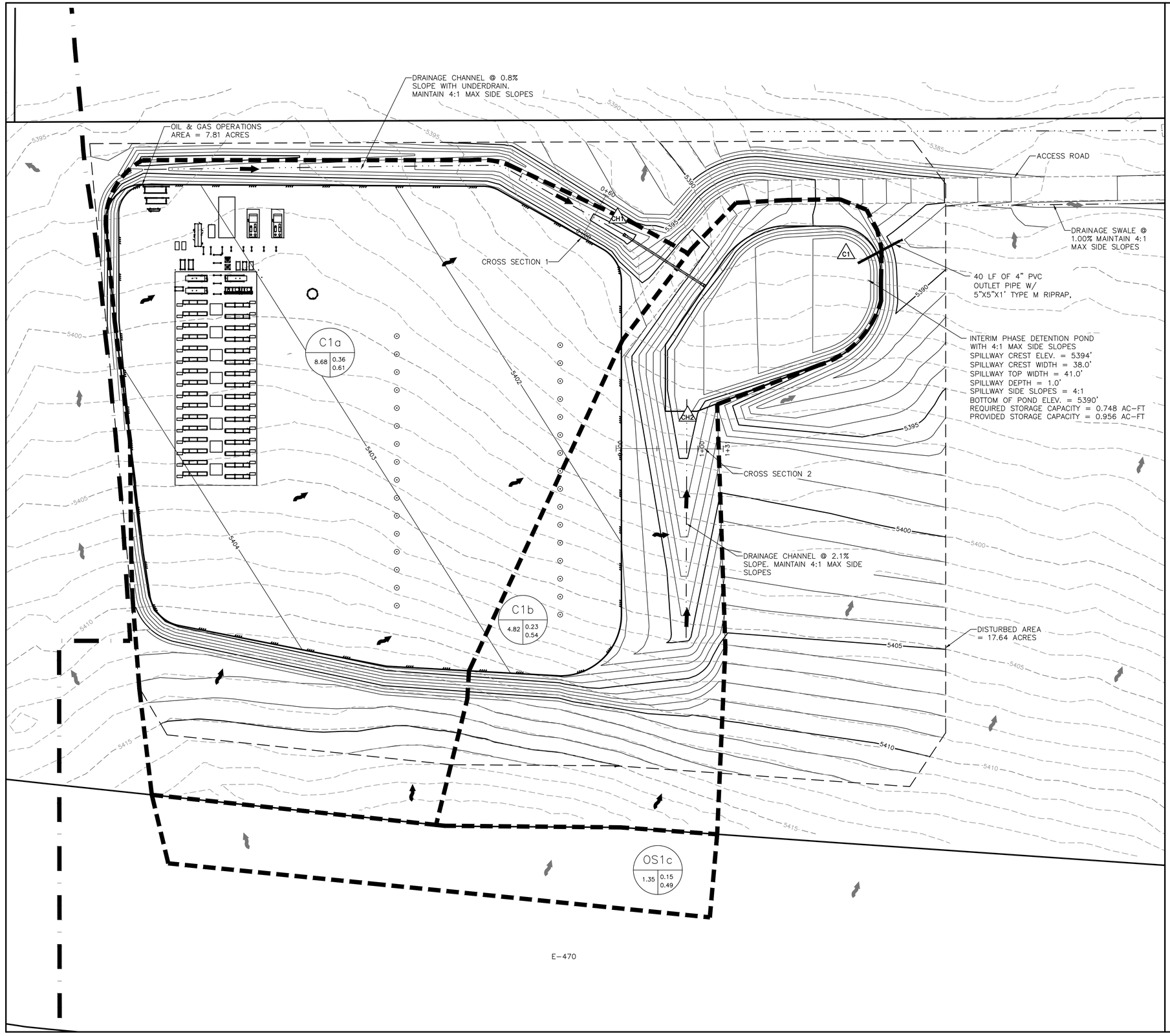

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SCALE: 1"= 60'

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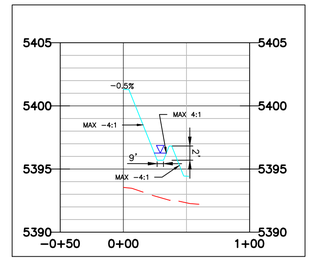
- DRAINAGE SUBBASIN NAME, DRAINAGE BASIN AREA, 10-YEAR RUNOFF COEFFICIENT, 100-YEAR RUNOFF COEFFICIENT
- CHANNEL FLOW ARROW
- OVERLAND FLOW ARROW
- PROPOSED CONTOUR
- EXISTING CONTOUR
- PROPOSED DRAINAGE PATH



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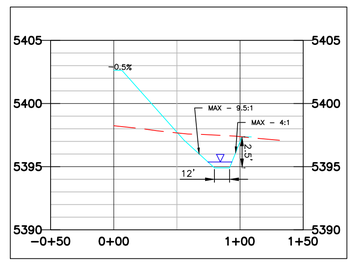

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DRAINAGE MAP INTERIM PHASE

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