Final Drainage Report
The Glen at Widefield Filing No. 10
El Paso County, Colorado

Prepared for:
Widefield Investment Group
3 Widefield Boulevard
Colorado Springs, Colorado 80911

Prepared by:

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
Ph: (719)630-7342

Kiowa Project No. 19016

May 27, 2020

PCD Project No. SF-1921

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STATEMENTS AND APPROVALS

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

COLORADO LICENSED ANDREW W. McCORD 25057 PROFESSIONAL ENGINEER

Andrew W. McCord (PE #25057) — February 25, 2021

For and on Behalf of Kiowa Engineering Corporation — Date

DEVELOPER'S STATEMENT:

I, the Developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By: ______________________ — Feb. 28th 2021

Date

Print Name: J. Ryan Watson, Glen Development Company

Address: 3 Widefield Boulevard
Colorado Springs, Colorado 80911

EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 & 2, El Paso County Engineering Criteria Manual, and Land Development Code, as amended.

______________________ — ______________

Jennifer Irvine, P.E. — Date

El Paso County Engineer/ECM Administrator

I. GENERAL LOCATION AND DESCRIPTION

The Glen at Widefield Filing No. 10 (Filing 10) subdivision will be developed as a single-family residential subdivision located in the Widefield area of El Paso County. The subject property is located to the west of Marksheffel Road and north of Mesa Ridge Parkway. The site is located in the southwest portion of Section 22, Township 15 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is bounded on east by Marksheffel Road, the south and west by the Glen at Widefield Filing No. 7, to the northwest by the Glen at Widefield Filing No. 8, and the north by future Glen at Widefield Filing No. 11, currently unplatted land. The property covers approximately 10.47 acres and is currently undeveloped. The property has previously been rough graded as a part of the Glen at Widefield East. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the development is in poor to fair condition with minimal grasses throughout the site. The existing ground slopes within the property range from 0.2 to 9 percent. Soils within the subject site are classified to be within Hydrologic Soils Group B as shown in the El Paso County Soils Survey. For the purposes of computing the existing and proposed hydrology for the site, Hydrologic Soil Group B was used.

Existing utilities within or adjacent to the site include a pair of thirty-inch (30") Colorado Interstate Gas (CIG) mains that run along the easterly property boundary (See Maps).

The Filing 10 area has been overlot graded. Peaceful Valley Road extends through the filing and connects to Marksheffel Road. This roadway has been constructed and will be improved further with this development with sidewalks and pedestrian ramps.

II. MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the West Fork Jimmy Camp Creek drainage basin. The majority of the overall site presently drains towards the south and southwest by a combination of overlot sheet flow along with curb gutter and pipe conveyances to the West Fork Jimmy Camp Creek just upstream of Mesa Ridge Parkway (Sub-basins EX-1 through EX-4 - See Sheet 1 of 3). The northeast portion of the site drains east and south in the same fashion to the existing roadside ditch along Marksheffel Road across from Peaceful Valley Road (Sub-basin EX-5). The remaining portion of the site, or southeast corner, drains by sheet flow to the existing roadside ditch along Marksheffel Road approximately 400 feet north of Mesa Ridge Parkway (Sub-basin EX-6). The existing drainage patterns for the site are shown on Sheet 1 provided in a map pocket at the end of this report.

The drainage reports that were reviewed in the process of preparing this drainage report are included in the References section. The Glen at Widefield East area was studied as a part of the *Master Development Drainage Plan (MDDP) for the Glen at Widefield* and the *West Fork Jimmy Camp Creek Drainage Basin Planning Study (DBPS).* A detention basin shown on the west side of the creek (DP 3101) was designed and constructed as part of the Filing No. 6 improvements. Two additional regional detention basins were identified for the site in the *MDDP*: one to serve the westerly side of the site with flows released west to the West Fork Jimmy Camp Creek (DP 3091), and the other to serve the easterly side of the site with flows released east across Marksheffel Road to a channel along the north side of Peaceful Valley Road and ultimately to the Jimmy Camp Creek main branch (DP 4021). The detention basin shown in the *MDDP* and *DBPS* at DP 3091 was designed and constructed as part of the Glen at Widefield Filing No. 7 improvements as Basin C. However, due to the proposed grading and drainage patterns north of Filing No. 7, two additional detention basins to serve the westerly side of the site were planned and constructed: one for Filing No. 8 (Basin B) and one for Filing No. 9 (Basin A), which is located just north of the Filing No. 8 area. The detention basin shown in the *MDDP* and *DBPS* at DP 4021 will be designed herein (Basin D) and constructed to serve Filing 10, and future Filings 11 and 12 within the Glen at Widefield area.

The subject property limits are shown on Flood Insurance Rate Maps (FIRMs) 08041C0956G and 08041C0957G (both with effective dates of December 7, 2018) that are included in the Appendix. The FIRMs also show that the property to be developed with buildable lots is located outside of the FEMA regulated floodplain in an unshaded Zone X area, which is described as "Area of Minimal Flood Hazard."

III. DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria Manual*. Topography for the site was compiled using a two-foot contour interval and is presented on the Drainage Plan. The hydrologic calculations were made for the historic and proposed site conditions. The Drainage Plan presents the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depth was determined from Table 6-2 of the *Drainage Criteria Manual*. These depths are shown in the runoff calculations spreadsheet. The peak flow data generated using the rational method was used to verify street capacities and to size inlets and storm sewers within the subdivision. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the sub-basins within the property. The onsite soils were assumed to be Hydrologic Soil Group B, based on the *Soil Survey* and the result of earth-moving operations. For existing conditions, runoff coefficients were determined using a land use of pasture/meadow. The land use for the proposed development will be residential with a density of approximately 4 lots per acre.

The onsite hydraulic structures were sized using the methods outlined in the *El Paso County Drainage Criteria Manual*. The hydraulic capacities of the streets and curb inlets were determined using the UD-Inlet spreadsheet developed by the UDFCD, considering the County criteria for the Minor (5-year) and Major (100-year) storms. Ramp curbs will be used throughout the development, except between curb returns, where a 6-inch vertical curb will be used. Hydraulic calculations are provided in Appendix C for the proposed streets, pipe outlet erosion protection and open channel capacities.

The on-site detention basin is planned to be an Extended Detention Basin that uses Full Spectrum Detention. The UD-Detention spreadsheets created by UDFCD were used to size and design the detention basin with water quality enhancement, per the County's recommendation. The supporting calculations associated with the sizing of the hydraulic facility for this development are included in Appendix B of this report.

IV. DRAINAGE FACILITY DESIGN

The drainage of the site will be accomplished through a combination of sheet flow, gutter flow and a temporary outflow ditch flow. Curb inlets will not be needed with this filing. Riprap outlet protection will be placed at the end of the detention basin outlet pipe to reduce erosion, as well as at the outflow ditch to the sedimentation pond (See Map Exhibit Sheet 3 of 3).

The proposed drainage patterns for the site are shown on the Final Drainage Plan for the developed condition (Sheet D-1 & D-2) provided in the map pocket at the end of this report. The hydrologic and hydraulic calculations are provided in the Appendix, refer to the Drainage Design Criteria section for additional information on the hydrologic and hydraulic calculations.

The evaluation related to the sizing of the onsite drainage improvements were carried out in accordance with the County Storm Drainage Criteria Manual. The capacities of the proposed onsite facilities were calculated in accordance with the Criteria Manual.

The primary stormwater conveyance facility will be gutter conveyance to a temporary outflow ditch conveying the runoff to the detention basin. Offsite runoff will be conveyed from upstream tributary areas by means of a temporary slope drain (See Off-Site Sheet 3 of 3).

The detention basin will include outlet structure, spillway, a trickle channel, pond shaping, and perimeter maintenance trails, along with two -foot wide temporary (Interim) riprap conveyances which will connect the discharge points to the concrete trickle channel. The trickle channel conveyed all detained flows to a three-stage outlet structure.

Fully Developed conditions at Detention Basin ‘D’ will require modification of the outfall plate. Calculations for the Interim Condition and the Ultimate Build Condition are provided in the appendix. This work is expected to be accomplished with future Glen at Widefield Filings. The detention basin will be a private facility and will be maintained by the local metro district.

The following is a description of the on-site storm sewer conveyance:

The system will begin with sheet flow at the lot areas. Some sheet flow will reach the sedimentation basin in historic fashion across unplatted and undeveloped land. However, most of the flows will begin as sheet flow on the lot areas and will be directed via overlot grades to existing and proposed street corridors. There are no inlets or pipes planned with this filing. Rather, the east-west crosspan at the intersection of Peaceful Valley Road and Pennycress Drive will direct runoff via hard surface to a temporary outflow ditch which will convey Basin D flows to the detention basin which will initially function as a sedimentation basin.

The sedimentation basin will occupy the location of Future Extended Detention Basin ‘D’. The sedimentation basin is proposed to accommodate water quality separation and emergency conveyance of flow associated with Filing 10 and is designed to function as a full-spectrum pond in the Interim Condition. Under full-build-out conditions Filing 11 and additional future areas will also be directed to Detention Basin D.

The storm sewer conveyances will provide storage and will intercept 100-year flows. The captured flow will then be conveyed to the detention basin in a temporary outflow ditch.

WATER QUALITY METHODOLOGY (4-STEP PROCESS):

STEP 1: RUNOFF REDUCTION PRACTICES

New construction will utilize existing and proposed grassed areas as buffers, allowing sediment to drop out of the storm runoff and helping to reduce runoff. The existing grassed swales along the east side of the site shall remain undisturbed. Sub-basins E-5 through a portion of E-6 are vegetated hillsides which provide some runoff reduction benefit, along with some biofiltering. Runoff Reduction calculations and *IRF Reduction Exhibit* are provided in Appendix C for the zone encompassing Sub-basins E-5 and a portion of E-6 (Zone 6). IRF Reduction Analysis for this zone resulted in a treatment value of at least 60% of the expected overall WQCV.

STEP 2: IMPLEMENT BMP’S THAT SLOWLY RELEASE THE WATER QUALITY CAPTURE VOLUME

Treatment and slow release of 40 hours of the water quality capture volume (WQCV) will be accomplished by the implementation of the proposed private extended detention basin.

STEP 3: STABILIZE DRAINAGEWAYS

There are no major drainageways affected by the development. No improvements to any downstream drainageways are required or anticipated, at this time. The project discharges into an existing underground public storm sewer system.

STEP 4: IMPLEMENT SITE SPECIFIC & SOURCE CONTROL BMP'S

There are no potential sources of contaminants that could be introduced to the City's MS4 that will not be controlled by temporary construction BMPs. Maintenance and sweeping of parking areas is recommended to limit sediment transport to new inlets, pipes and detention areas. Construction BMPs in the form of vehicle tracking control, concrete washout area, inlet protection, rock socks, and silt fences will be utilized during construction activities to protect receiving waters.

The Following is a description of the on-site drainage sub-basins:

Basin C

Sub-basins C-7, C-9, & C-18 are all partially located within Filing No. 10 but have been accounted for in the Glen at Widefield Filing No. 7 Drainage Report. Basins with a C designation are tributary to Extended Detention Basin C, and these basins are unchanged from their planned use.

Sub-basin C-7 is approximately 1.98 acres in area and is located north of Pennycress Drive and west of the Buffalo Bur Trail cul-de-sac. Runoff from this basin will sheet flow south, gutter flow south to Pennycress Drive at its high point, and gutter flow southeast along Pennycress Drive to its intersection with Alpine Daisy Drive, where it will combine with the carry-over flow from Sub-basin C-9 (DP 37).

Sub-basin C-9 is approximately 2.67 acres in area and is located south of Sub-basin C-8 and east of Alpine Daisy Drive. Runoff from this basin will sheet flow southwest, combine with runoff from Sub-basin C-8 and gutter flow south and southeast to an existing 10' curb inlet and downstream pipe system (DP 39).

Sub-basin C-18 is approximately 1.43 acres in area and is located east of Pennycress Drive, between Alpine Daisy Drive and the Buffalo Bur Trail cul-de-sac. Runoff from this basin will sheet flow west and gutter flow south from the high point in Pennycress Drive to Sub-basin C-19 (DP 51).

Basin E

The 'E' Basins are undetained basins which are located around the perimeter of the overall site where runoff cannot be captured due to physical topography. Sub-basins E-1 through E-14 drain offsite to either the West Fork Jimmy Camp Creek, Mesa Ridge Parkway or the existing roadside ditch along Marksheffel Road.

Sub-Basins E-5 & E-6 are both partially located within Filing No 10, while Sub-Basin E-4 lies between Basin D and Marksheffel Road where it will intercept the storm outfall pipe for developed conditions (See Map 3 of 3). These basins abut existing Marksheffel Road and are historically tributary to the west-side ditch for the roadway. The overall characteristics of these basins is unchanged from historic conditions. For purposes of water quality treatment, that portion of these sub-basins discharging from within the Filing No 10 Boundary was analyzed using the IRF Runoff Reduction Method. An Exhibit and MHFD Calculation Sheet (*UD-BMP_v3.07.xls*) are provided in Appendix C.

Sub-basin E-6 is approximately 4.30 acres in area and is located southeast of the site, between Sub-basins C-18, C-19 and Marksheffel Road. Undeveloped runoff from this basin will sheet flow southeast to the existing roadside ditch along Marksheffel Road (DP 100) as it does currently.

Basin D

The 'D' Basins are located in the northeast portion of the overall master-planned site. The 'D' Basins (Sub-basins D-1 though D-23) are generally bounded by Sub-basin E-1 to the north, Buffalo Bur Trail to the south, the east property boundary to the east and the 'B' and 'C' series of tributary sub-basins to the west. This area drains east and south to a low point at the Pennycress Drive and Golden Buffs Drive intersection. Future storm sewer systems are proposed along Pennycress Drive and Golden Buffs Drive that will convey captured flow to 100-year capacity curb inlets in a sump condition at DP 79, DP 81, DP 89 and DP 93, and ultimately to proposed Detention Basin 'D' (DP 94) located to the west of Pennycress Drive. Runoff from Sub-basins D-21 and D-22 will be captured in new curb & gutter of Pennycress Drive, combined with similar flows from Sub-Basin D20a and then conveyed to Detention Basin 'D' from the south via a temporary outflow ditch. Detained flow released from Detention Basin 'D' will be conveyed to the existing roadside ditch along Marksheffel Road.

Sub-basin D19.1, D20c & D23

These basins are undetained in the Interim Condition and detained in the Ultimate Condition. These basins consist of small portions of future Pennycress Drive extended north along with the emergency spillway structure. An inlet pair is planned to capture future developed flows and convey them directly to Detention Basin 'D'. In the Interim Condition, these sub-basins sheet flow east and descend along stabilized slopes of 2-25% before reaching the east property line where they are further conveyed as sheet flow at similar slopes to the existing side ditch at Markscheffel Road. The total undetained flow for these sub-basins is 0.8 cfs for the 5-year event, and 3.6 cfs for the 100-year event.

Sub-Basin D20a

Is located along the southerly margin of the site and contains portions of residential lot, along with a portion of proposed Pennycress Drive. A new crosspan will convey flows from this basin to the temporary outflow ditch and Detention Basin 'D'. Flows from this sub-basin combine with flows from Sub-basins D21 & D22 at the outflow ditch. Combined flow at the temporary outflow ditch is 6.2 cfs for the 5-year event, and 17.9 cfs for the 100-year event. Hydraulic calculations for the temporary outflow channel are provided in the appendix. Existing Report for Markscheffel Road[12] *(Final Drainage Report Marksheffel Road South - Link Road to US-24, El Paso County, CO, HDR Engineering, August 2015)*. evaluated the trapezoidal channel planned with the Markscheffel Roadway Improvements Project at a point just north of Peaceful Valley Road and provided the design value of 118.82 cfs for the 100-year event, of which we are predicting 18.8 cfs is from Detention Basin 'D' in The Interim Condition. These flows cross under Mesa Ridge Parkway within an 8'x3' Box Culvert (Q_{MAX}=175 cfs) at Invert Elevation 5650.02 (Centerline Mesa Ridge Parkway Ref: Kiowa Job #08082 for Mesa Ridge Parkway Improvements: '*WEST FORK JIMMY CAMP CREEK PROPOSED BRIDGE AND CHANNEL IMPROVEMENTS*'). No adverse impacts are expected from the detention pond discharge pipe. A channel-reinforcing riprap transition is planned at the release junction. Design calculations are provided in Appendix B.

WATER QUALITY

Storm water quality measures are required by the County in Volume 2 of the County's Drainage Criteria Manual. The water quality measures to be instituted for the development will include:

1. Water quality treatment and storage within the detention basin.
2. The outlet structure will include a water quality orifice plate and a micropool.

A. COST OF PROPOSED DRAINAGE FACILITIES

Table 2 presents a cost estimate for the construction of drainage improvements (private) for The Glen at Widefield Filing No. 10 development.

B. DRAINAGE AND BRIDGE FEES

The site lies within the West Fork Jimmy Camp Creek Drainage Basin. The current drainage basin fee associated with the West Fork Jimmy Camp Creek Drainage Basin is $12,564 per impervious acre. The current bridge fee associated with the West Fork Jimmy Camp Creek Drainage Basin is $3,717 per impervious acre. The Glen at Widefield Filing No. 10 subdivision encompasses 10.47 acres. *Table 1* details the fees due as part of this development.

V. CONCLUSIONS

The Glen at Widefield Filing No. 10 will be a single-lot family residential subdivision covering approximately 10.47 acres. Onsite drainage will include the use of surface conveyance elements such as gutter, crosspan, and a temporary outflow ditch to route the runoff from the site to two separate detention basins; Basin C (Filing 7) and Basin D (Future Filing 11). Detention Basin D serves Filing 10 along with northern tributary areas including future Filings 11 and 12. Detained runoff from the site will be conveyed to the West Fork Jimmy Camp Creek. With detention serving the site and a large portion of either side of the creek not developed, the development of the Glen at Widefield Filing No. 10 property will not adversely impact or deteriorate improvements or natural drainageways downstream of the property.

VI. REFERENCES

1) Preliminary Drainage Report, The Glen at Widefield East, prepared by Kiowa Engineering Corporation, dated December 16, 2015.

2) Final Drainage Report, The Glen at Widefield Filing No. 7, prepared by Kiowa Engineering Corporation, dated January 11, 2016.

3) Amended Master Development Drainage Plan, The Glen at Widefield, prepared by Kiowa Engineering Corporation, dated June 21, 2007.

4) Final Drainage Report, The Glen at Widefield Filing No. 6, prepared by Kiowa Engineering Corporation, dated December 6, 2007.

5) Preliminary and Final Drainage Report, Mesa Ridge Parkway Final Design, prepared by Kiowa Engineering Corporation, dated November 29, 2010.

6) Mesa Ridge Parkway Roadway Design, Autumn Glen Avenue to Marksheffel Road and Widening from Powers Boulevard to Autumn Glen Avenue, prepared by Kiowa Engineering Corporation, dated December 8, 2010.

7) Master Development Drainage Plan for the Glen at Widefield, prepared by Kiowa Engineering Corporation, dated December 10, 1999.

8) West Fork Jimmy Camp Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, dated October 17, 2003.

9) City of Colorado Springs and El Paso County Flood Insurance Study, prepared by the Federal Emergency Management Agency, dated March 1997.

10) El Paso County Drainage Criteria Manual (Volumes 1 and 2) and Engineering Criteria Manual, current editions.

11) Soil Survey of El Paso County Area, Colorado, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

12) Final Drainage Report Marksheffel Road South - Link Road to US-24, El Paso County, CO, HDR Engineering, August 2015.

APPENDIX A

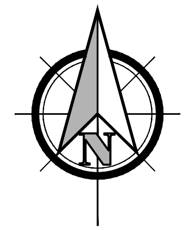
Figure 1: Vicinity Map

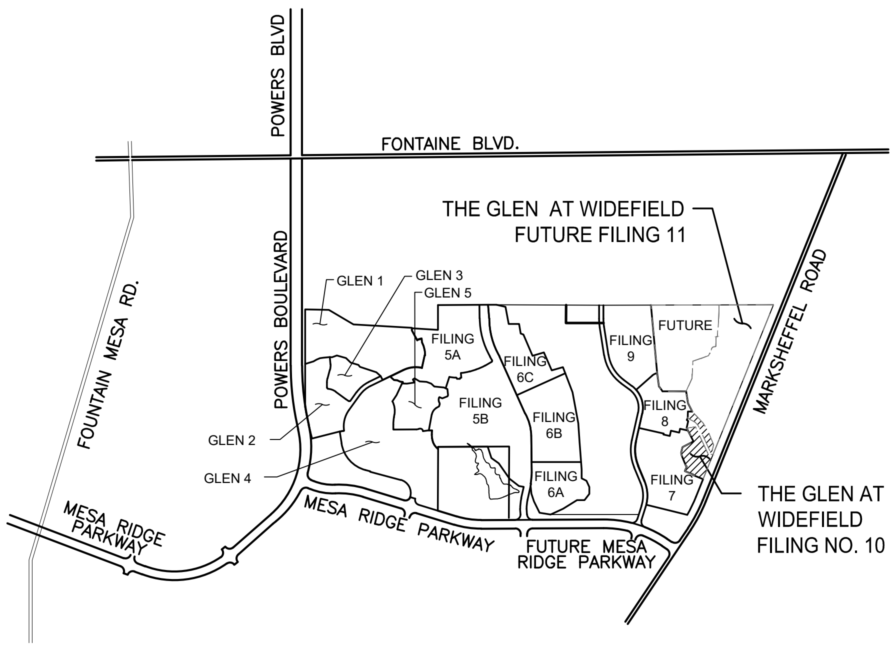
Figure 2: Soils Map

FEMA Flood Insurance Rate Map (Panels 956 and 957)

Table 1: Impervious Area and Drainage Basin & Bridge Fee Calc

Table 2: Opinion of Cost – Drainage Facilities





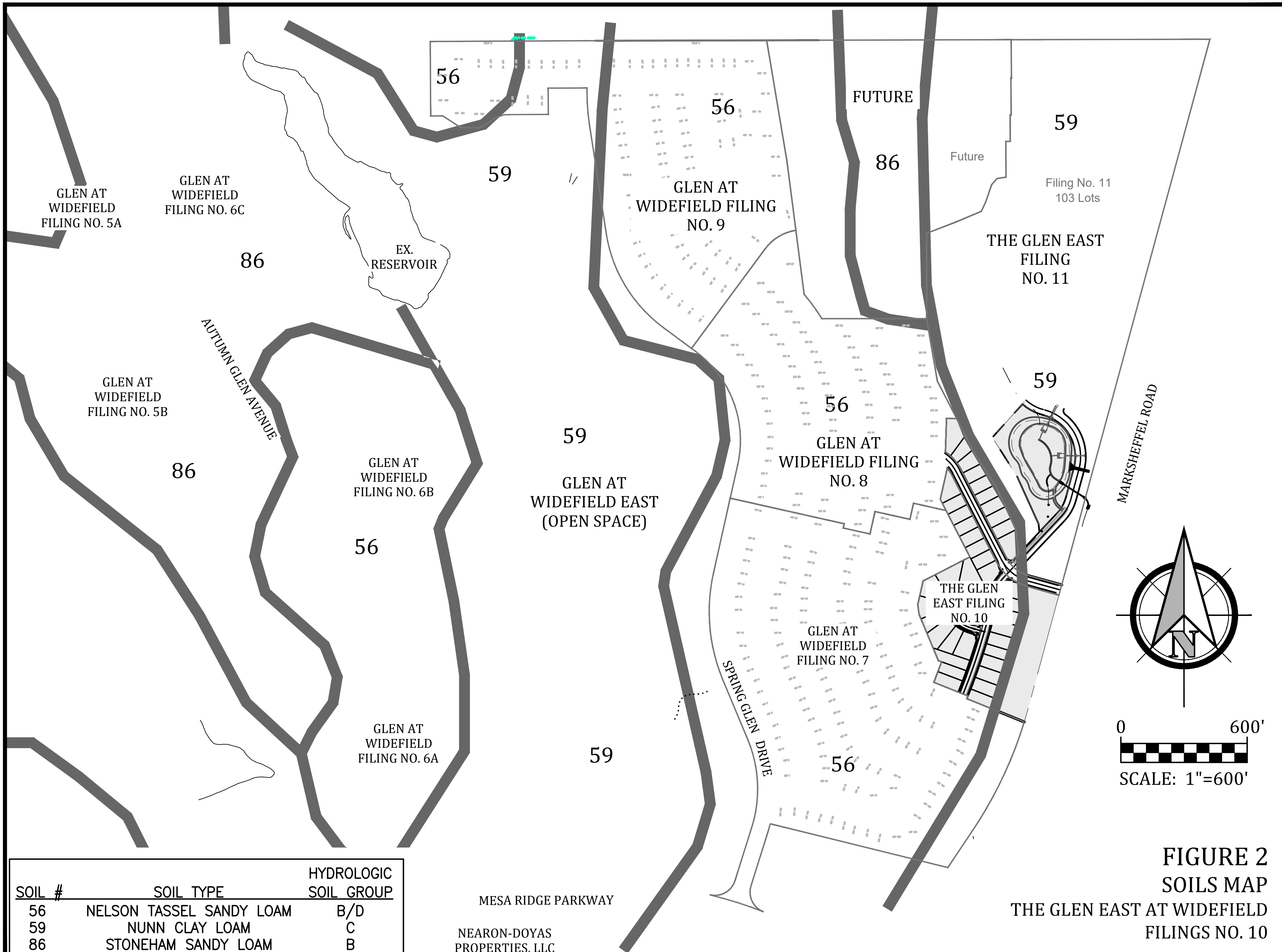
VICINITY MAP

SCALE: N.T.S.

FIGURE 1

VICINITY MAP

THE GLEN AT WIDEFIELD FILING NO. 10



SOIL #	SOIL TYPE	HYDROLOGIC SOIL GROUP
56	NELSON TASSEL SANDY LOAM	B/D
59	NUNN CLAY LOAM	C
86	STONEHAM SANDY LOAM	B

FIGURE 2
SOILS MAP
THE GLEN EAST AT WIDEFIELD
FILINGS NO. 10

National Flood Hazard Layer FIRMette

FEMA

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
- 8 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 9/26/2019 at 12:16:52 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.

Table 1: Impervious Area and Drainage Basin & Bridge Fee Calculation

Total Lots =	40 lots
Total Development Area =	10.470 ac
Total Undeveloped Acres =	2.125 ac
Total Developed Area =	**8.3 ac**
Building/Patio/Drive Per Lot =	2,500 sf
Total Building/Patio/Drive Area =	2.296 ac
Total Street/Sidewalk Area =	1.000 ac
Total Impervious Area =	3.296 ac
% Impervious Area =	**39.49 %**

West Fork Jimmy Camp Creek Drainage Basin

Drainage Basin Fee and Bridge Fee Calculations			
Drainage Basin Fee =	$12,564 / ac	**Drainage Basin Fee =**	**$ 41,406.98**
Bridge Fee =	$3,717 / ac	**Bridge Fee =**	**$ 12,250.06**

Less Previous Drainage Fee Credit (Carry Over from Glen at Widefield Filing No. 7)	**$0.00**	$ 0.00
Drainage Basin Fee Reimbursement	**$0.00**	
Total Drainage Basin Fee Credit Available	**$0.00**	

	Drainage Basin	**Bridge**
Total Fees Due for the Glen at Widefield Filing No. 10	**$41,406.98**	**$ 12,250.06**

Table 2: Opinion of Cost - Public Drainage Facilities

Item	Quantity	Unit	Unit Cost	**Item Total**
Drainage Structures				
30" Reinforced Concrete Pipe	124	LF	$ 94.00	$ 11,618.40
Flared End Section (FES) RCP 30"	1	EA	$ 1,000.00	$ 1,000.00
Geotextile (Erosion Control)	337	SY	$ 6.00	$ 2,022.00
Rip Rap, d50 Size from 6" to 24"	22	CY	$ 95.00	$ 2,090.00
Rip Rap, Grouted	0	CY	$ 215.00	$ 0.00
Drainage Channel Construction, Size (W x H)	35	LF	$ 0.00	$ 0.00
Channel Lining, Rip Rap	16	CY	$ 112.00	$ 1,792.00
Channel Lining, Grass	0	AC	$ 1,287.00	$ 0.00
Detention Outlet Structure	1	EA	$ 12,000.00	$ 12,000.00
Detention Emergency Spillway	1	EA	$ 18,300.00	$ 18,300.00
Channel Lining, Concrete (Trickle Channel)	19	CY	$ 450.00	$ 8,550.00
Channel Lining, Rip Rap	36	CY	$ 98.00	$ 3,528.00
Gravel Maintenance Access Trail	1,500	SY	$ 20.00	$ 30,000.00
Type II Bedding	28	CY	$ 35.00	$ 980.00
Detention Basin Seeding and Mulch	3	AC	$ 520.00	$ 1,528.80
			Estimated Storm Drainage Facilities Cost	**$ 93,409.20**
			Engineering 10%	$ 9,340.92
			Contingency 5%	$ 4,670.46
			Total Estimated Cost	**$ 107,420.58**

158625.2158
3.64153388

APPENDIX B

Hydrologic Calculations

- **Existing Condition – Runoff Co-eff, Time of Concentration and Runoff Calcs**
    - **Excerpts from Markscheffel Road Improvements Project**
        - **South - Link Road to US-24**
- **Developed Condition – Runoff Co-eff, Time of Concentration and Runoff Calcs**

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 1 OF 2

CALCULATED BY CJC DATE 4/24/15

CHECKED BY DATE

SCALE

RUNOFF COEFF. CALC'S. - EXISTING CONDITION

USE UNDEVELOPED - "PASTURE/MEADOW" LAND USE :

B SOILS - $C_5 = 0.08$ $C_{100} = 0.35$

B/D SOILS - $C_5 = 0.15$ $C_{100} = 0.50$ (ASSUME C/D SOILS)

C SOILS - $C_5 = 0.15$ $C_{100} = 0.50$

BASIN EX-1 : TYPE C AND B/D SOILS

AREA = 48.60 AC (AREAS FROM CAD, TYP.)

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-2 : TYPE C AND B/D SOILS

AREA = 33.12 AC

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-3 : TYPE C AND B/D SOILS

AREA = 61.01 AC

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-4 : TYPE C AND B/D SOILS

AREA = 10.51 AC

$C_5 = 0.15$

$C_{100} = 0.50$

BASIN EX-5 : TYPE B SOIL - 12.2 AC ±
TYPE C SOIL - 39.3 AC ±
TYPE B/D SOIL - 23.2 AC ±
} FROM SOILS MAP

AREA = 74.74 AC

$$C_{5,WTD} = \frac{0.08(12.2) + 0.15(39.3 + 23.2)}{74.74} = 0.14$$

$$C_{100,WTD} = \frac{0.35(12.2) + 0.50(39.3 + 23.2)}{74.74} = 0.48$$

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 2 OF 2

CALCULATED BY CJC DATE 4/24/15

CHECKED BY ___ DATE ___

SCALE ___

BASIN EX-6 = TYPE C AND B/D SOILS

AREA = 8.83 AC

$C_5 = 0.15$

$C_{100} = 0.50$

TIME OF CONCENTRATION CALC'S. – EXISTING CONDITION

BASIN OS-1 : FROM MDDP, HEC-1 MODEL INPUT : BASIN 3060

BASIN AREA (BA) = 0.119 SQ.mi. × 640 = 76.2 AC

SCS CURVE NO. (LS) = 79

SCS LAG TIME (UD) = 0.257 HRS. = $0.6\ t_c$

$t_c = 1.6\,(0.257)(60\ \text{min/hr}) = 24.7\ \text{min.}$

BASIN OS-2 = BA = 0.19 SQ.mi. × 640 = 121.6 AC (BASIN 4010)

LS = 86

UD = 0.497 HRS.

$t_c = 1.6\,(0.497)(60) = 47.7\ \text{min.}$

The Glen at Widefield

Existing Condition

Runoff Coefficient and Percent Impervious Calculation

				PV	Area 1 Land Use			HI	Area 2 Land Use			US1	Area 3 Land Use			US2	Area 4 Land Use			RO	Area 5 Land Use				Basin Runoff	
Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	Basin % Imperv	C_5	C_{100}
EX-1	2,117,068 sf	48.60ac	C	100%		0%	0%	0%	48.60ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-2	1,442,826 sf	33.12ac	C	100%		0%	0%	0%	33.12ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-3	2,657,513 sf	61.01ac	C	100%		0%	0%	0%	61.01ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-4	457,877 sf	10.51ac	C	100%		0%	0%	0%	10.51ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**
EX-5	3,255,509 sf	74.74ac	C	100%		0%	0%	0%	74.74ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.14**	**0.48**
EX-6	384,815 sf	8.83ac	C	100%		0%	0%	0%	8.83ac	100%	0%	85%		0%	0%	78%		0%	0%	90%		0%	0%	**0.0%**	**0.15**	**0.50**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation								
Runoff Coefficients and Percents Impervious								
Hydrologic Soil Type:	**C**		**Runoff Coef Calc Method**					**%Imp**
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.80	0.82	0.84	0.87	0.89	0.89
Drives and Walks	DR	90%	0.73	0.75	0.77	0.80	0.83	0.83
Streets - Gravel (Packed)	GR	40%	0.28	0.35	0.42	0.50	0.55	0.58
Undevelop-Pasture/Meadow	HI	0%	0.04	0.15	0.25	0.37	0.44	0.50
Lawns	LA	0%	0.04	0.15	0.25	0.37	0.44	0.50
Off-site flow-Undeveloped	OF	45%	0.31	0.37	0.44	0.51	0.56	0.59
Park	PA	7%	0.09	0.19	0.29	0.40	0.47	0.52
Playground	PL	13%	0.13	0.23	0.32	0.42	0.49	0.54
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.96	0.96
Roofs	RO	90%	0.73	0.75	0.77	0.80	0.83	0.83
User Input 1	US1	85%	0.66	0.68	0.71	0.75	0.78	0.79
User Input 2	US2	78%	0.57	0.60	0.64	0.68	0.72	0.73

Weighted
%Imp
A
B
C
D

Equations (% Impervious Calculation):

$C_A = K_A+(1.31\ i^3 - 1.44\ i^2 + 1.135\ i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD}+(0.858\ i^3 - 0.786\ i^2 + 0.774\ i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

- K_A (2-yr)= 0
- K_A (5-yr)= -0.08i + 0.09
- K_A (10-yr)= -0.14i + 0.17
- K_A (25-yr)= -0.19i + 0.24
- K_A (50-yr)= -0.22i + 0.28
- K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

- K_{CD} (2-yr)= 0
- K_{CD} (5-yr)= -0.10i + 0.11
- K_{CD} (10-yr)= -0.18i + 0.21
- K_{CD} (25-yr)= -0.28i + 0.33
- K_{CD} (50-yr)= -0.33i + 0.40
- K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Existing Condition
Time of Concentration Calculation

Sub-Basin Data				Time of Concentration Estimate												
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.		
Basin / Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c		Final t_c	Notes
EX-1		48.60ac	0.15	300lf	5.3%	17.3 min.	2200lf	1.9%	GW	15	2.1 ft/sec	17.7 min.	35.0 min.		**35.0 min.**	
EX-2		33.12ac	0.15	300lf	4.8%	17.9 min.	1370lf	3.2%	GW	15	2.7 ft/sec	8.5 min.	26.4 min.		**26.4 min.**	
EX-3		61.01ac	0.15			0.0 min.	2500lf	0.9%	GW	15	1.4 ft/sec	29.3 min.	29.3 min.		**29.3 min.**	
EX-4		10.51ac	0.15	300lf	4.0%	19.0 min.	900lf	4.9%	GW	15	3.3 ft/sec	4.5 min.	23.5 min.		**23.5 min.**	
EX-5		74.74ac	0.14	300lf	5.7%	17.0 min.	3250lf	1.0%	GW	15	1.5 ft/sec	36.1 min.	53.2 min.		**53.2 min.**	
EX-6		8.83ac	0.15	150lf	0.5%	26.8 min.	630lf	5.5%	GW	15	3.5 ft/sec	3.0 min.	29.8 min.		**29.8 min.**	
DP 1	OS-1	76.20ac	--	--	--	--	--	--		--	--	--	24.7 min.		**24.7 min.**	DP 3060 from MDDP
DP 2	OS-1, EX-1	124.80ac	0.15			0.0 min.	1000lf	1.0%	GW	15	1.5 ft/sec	11.1 min.	11.1 min.		**35.8 min.**	DP 1 routed to DP 2
DP 3	EX-2	33.12ac	0.15	300lf	4.8%	17.9 min.	1370lf	3.2%	GW	15	2.7 ft/sec	8.5 min.	26.4 min.		**26.4 min.**	
DP 4	OS-1, EX-1, EX-2	157.92ac	0.15			0.0 min.	300lf	0.5%	GW	15	1.1 ft/sec	4.7 min.	5.0 min.		**40.8 min.**	DP 2 and DP 3 routed to DP 4
DP 5	OS-1, EX-1, EX-2, EX-3	218.93ac	0.15			0.0 min.	800lf	1.3%	GW	15	1.7 ft/sec	7.8 min.	7.8 min.		**48.6 min.**	DP 4 routed to DP 5
DP 6	EX-4	10.51ac	0.15	300lf	4.0%	19.0 min.	900lf	4.9%	GW	15	3.3 ft/sec	4.5 min.	23.5 min.		**23.5 min.**	
DP 7	OS-1, EX-1, EX-2, EX-3, EX-4	229.44ac	0.15			0.0 min.	200lf	0.3%	GW	15	0.8 ft/sec	4.1 min.	5.0 min.		**53.6 min.**	DP 5 and DP 6 routed to DP 7
DP 8	OS-2	121.60ac	--	--	--	--	--	--		--	--	--	47.7 min.		**47.7 min.**	DP 4011 from MDDP
DP 9	OS-2, EX-5	196.34ac	0.15			0.0 min.	1550lf	0.6%	GW	15	1.1 ft/sec	23.2 min.	23.2 min.		**70.9 min.**	DP 8 routed to DP 9
DP 10	EX-6	8.83ac	0.15	150lf	0.5%	26.8 min.	630lf	5.5%	GW	15	3.5 ft/sec	3.0 min.	29.8 min.		**29.8 min.**	

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$
C_5 = Runoff coefficient for 5-year
L = Length of overland flow (ft)
S = Slope of flow path (ft/ft)
tc Check = (L/180)+10 (Developed Cond. Only)
L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$
Cv = Conveyance Coef (see Table)
S = Watercourse slope (ft/ft)

Land Surface Type	Land Type
Grassed Waterway	GW
Heavy Meadow	HM
Nearly Bare Ground	NBG
Paved Area	PV
Riprap (Not Buried)	RR
Short Pasture/Lawns	SP
Tillage/Fields	TF

The Glen at Widefield
Existing Condition
Runoff Calculation

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	i_{100}	**Runoff Q_5**	**Q_{100}**	**Basin / DP**	Notes
EX-1		48.60 ac	0.15	0.50	35.0 min.	2.2 in/hr	3.8 in/hr	**16.4 cfs**	**91.7 cfs**	EX-1	
EX-2		33.12 ac	0.15	0.50	26.4 min.	2.7 in/hr	4.5 in/hr	**13.3 cfs**	**74.3 cfs**	EX-2	
EX-3		61.01 ac	0.15	0.50	29.3 min.	2.5 in/hr	4.2 in/hr	**23.0 cfs**	**128.9 cfs**	EX-3	
EX-4		10.51 ac	0.15	0.50	23.5 min.	2.8 in/hr	4.8 in/hr	**4.5 cfs**	**25.1 cfs**	EX-4	
EX-5		74.74 ac	0.14	0.48	53.2 min.	1.6 in/hr	2.7 in/hr	**17.0 cfs**	**97.7 cfs**	EX-5	
EX-6		8.83 ac	0.15	0.50	29.8 min.	2.5 in/hr	4.2 in/hr	**3.3 cfs**	**18.5 cfs**	EX-6	
DP 1	OS-1	76.20 ac	--	--	24.7 min.	2.8 in/hr	4.7 in/hr	**48 cfs**	**163 cfs**	DP 1	DP 3060 from MDDP
DP 2	OS-1, EX-1	124.80 ac	0.15	0.50	35.8 min.	2.2 in/hr	3.7 in/hr	**41 cfs**	**232 cfs**	DP 2	
DP 3	EX-2	33.12 ac	0.15	0.50	26.4 min.	2.7 in/hr	4.5 in/hr	**13 cfs**	**74 cfs**	DP 3	
DP 4	OS-1, EX-1, EX-2	157.92 ac	0.15	0.50	40.8 min.	2.0 in/hr	3.4 in/hr	**48 cfs**	**268 cfs**	DP 4	
DP 5	OS-1, EX-1, EX-2, EX-3	218.93 ac	0.15	0.50	48.6 min.	1.8 in/hr	2.9 in/hr	**58 cfs**	**323 cfs**	DP 5	
DP 6	EX-4	10.51 ac	0.15	0.50	23.5 min.	2.8 in/hr	4.8 in/hr	**4 cfs**	**25 cfs**	DP 6	
DP 7	OS-1, EX-1, EX-2, EX-3, EX-4	229.44 ac	0.15	0.50	53.6 min.	1.6 in/hr	2.7 in/hr	**55 cfs**	**310 cfs**	DP 7	
DP 8	OS-2	121.60 ac	--	--	47.7 min.	1.8 in/hr	3.0 in/hr	**38 cfs**	**153 cfs**	DP 8	DP 4011 from MDDP
DP 9	OS-2, EX-5	196.34 ac	0.15	0.50	70.9 min.	1.2 in/hr	2.0 in/hr	**35 cfs**	**196 cfs**	DP 9	
DP 10	EX-6	8.83 ac	0.15	0.50	29.8 min.	2.5 in/hr	4.2 in/hr	**3 cfs**	**18 cfs**	DP 10	

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST
SHEET NO. 1 OF 2
CALCULATED BY CJC DATE 5/19/15
CHECKED BY ____ DATE ____
SCALE ____

RUNOFF COEFFICIENT CALC'S. - DEVELOPED CONDITION
(RESIDENTIAL AREAS)

A-BASINS: A = 10.17 AC. / 33 LOTS > 3.24 LOTS/AC.
A = 7.98 AC. / 30 LOTS > 3.76 LOTS/AC.
> 3.5 LOTS/AC.

BY INTERPOLATING FROM TABLE 6-6, I = 35%

⇒ $C_5 = 0.33$
$C_{100} = 0.57$
> SOIL GROUP C

B-BASINS: A = 20.05 AC. / 81 LOTS > 4.04 LOTS/AC.
A = 6.86 AC. / 30 LOTS > 4.37 LOTS/AC.
> 4.2 LOTS/AC.

FROM TABLE 6-6, I = 41%

⇒ $C_5 = 0.35$
$C_{100} = 0.58$
> SOIL GROUP C

C-BASINS: A = 46.12 AC. / 200 LOTS > 4.34 LOTS/AC.
A = 35.29 AC. / 148 LOTS > 4.19 LOTS/AC.
> 4.3 LOTS/AC.

FROM TABLE 6-6, I = 42%

⇒ $C_5 = 0.31$
$C_{100} = 0.50$
> SOIL GROUP B

KIOWA ENGINEERING CORPORATION

JOB 14044 - GLEN AT WIDEFIELD EAST

SHEET NO. 2 OF 2

CALCULATED BY CJC DATE 5/19/15

CHECKED BY ______ DATE ______

SCALE ______

RUNOFF COEFFICIENT CALC'S. - DEVELOPED CONDITION (CONT'D.):

(RESIDENTIAL AREAS)

D- BASINS: A = 38.97 AC., 147 LOTS > 3.77 LOTS/AC.
A = 3.52 AC., 13 LOTS > 3.69 LOTS/AC.
> 3.7 LOTS/AC.

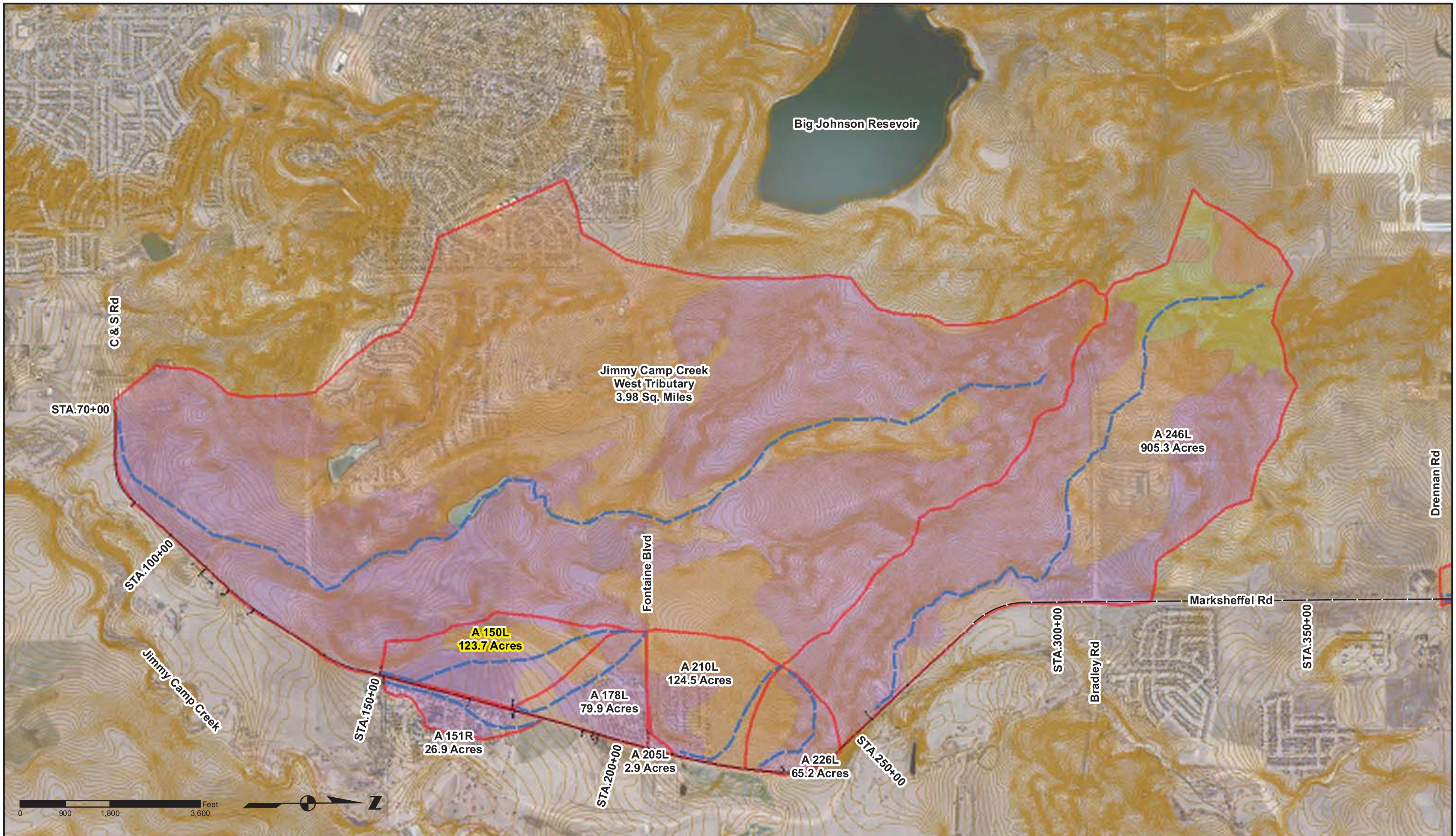
FROM TABLE 6-6, I = 37%

⇒ C_5 = 0.34, C_{100} = 0.58 > SOIL GROUP C

E- BASINS: A = 2.81 AC., 7 LOTS > 2.49 LOTS/AC.
A = 1.6 AC., 4 LOTS > 2.5 LOTS/AC.
> 2.5 LOTS/AC.

FROM TABLE 6-6, I = 28%

⇒ C_5 = 0.30, C_{100} = 0.56 > SOIL GROUP C



Print Date:	10/14/2014		
File Name:	Basins_BL_20141009.mxd		
Horiz. Scale:		Vert. Scale:	None
Unit Information		Unit Leader Initials	

HDR Engineering, Inc. PARSONS BRINCKERHOFF

EL PASO COUNTY COLORADO

PPRTA

As Constructed
No Revisions:
Revised:
Void:

MARKSHEFFEL ROAD
DRAINAGE BASIN

Designer:	E. Staten	Structure Numbers	
Detailer:	M.Johnson		
Sheet Subset:	BASIN	Subset Sheets:	1 of 3

Project No./Code

Sheet Number 1

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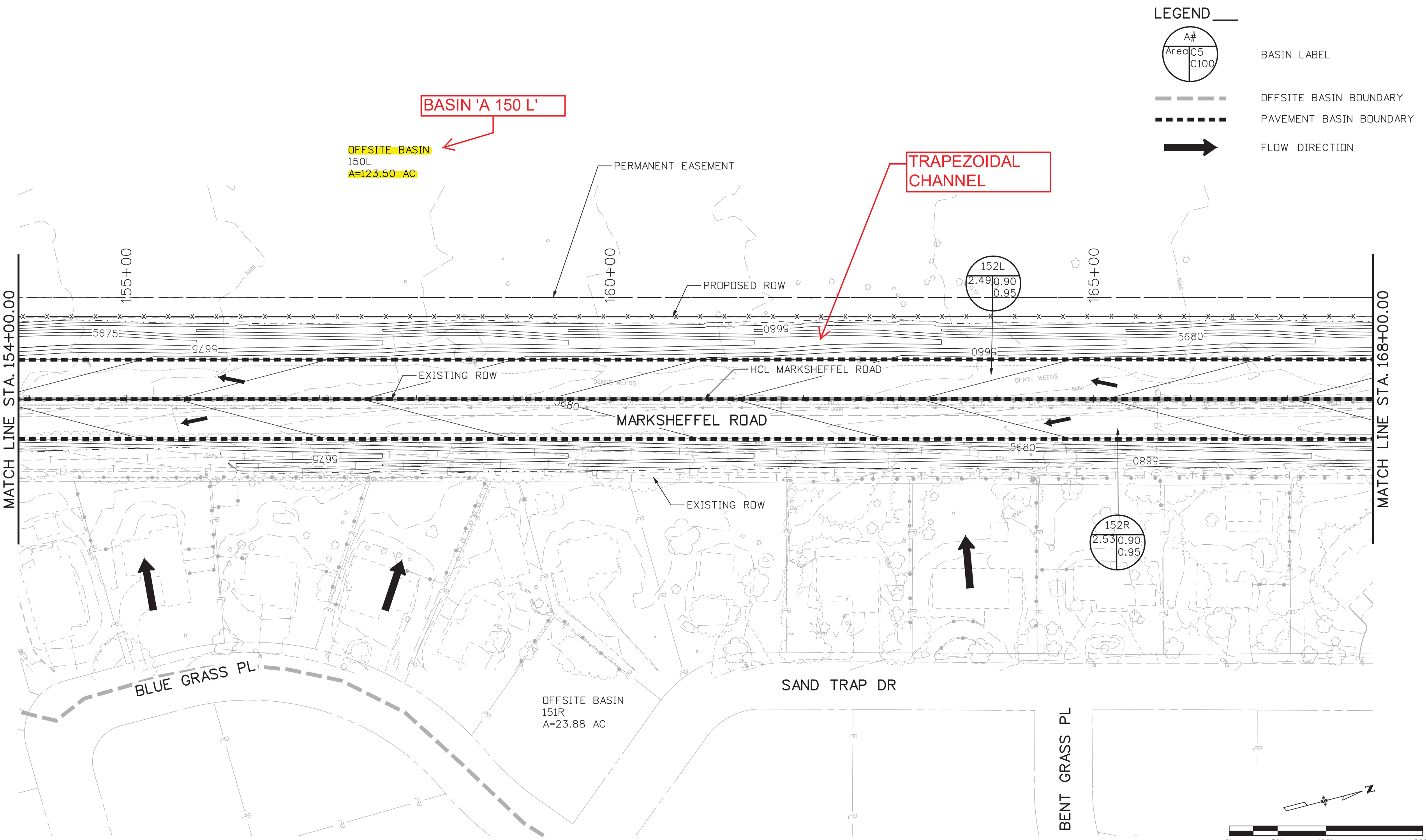

Print Date: 4/2/2015
File Name: North-Marksheffel_BASINS_Plan007.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Unit Information Unit Leader Initials

HDR PARSONS BRINCKERHOFF

Sheet Revisions		
Date:	Comments	Init.

EL PASO COUNTY COLORADO

PPRTA

As Constructed
No Revisions:
Revised:
Void:

MARKSHEFFEL ROAD
DRAINAGE BASINS PLAN
154+00.00 TO 168+00.00

Designer: E. STATEN
Detailer: D. MADDOCK
Sheet Subset: BASINS
Structure Numbers
Subset Sheets: 7 of 36

Project No./Code
....
....
7

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Standard Form SF-1 . Time of Concentration

Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

SUB-BASIN DATA				INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)							Total
									Type of Land Surface					
Basin ID	Description	C_5	Area (ac)	Length (ft)	Slope (ft/ft)	t_i (min)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v)	Velocity (ft/s)	Travel Time (min)	$t_c = t_i + t_t$ (min)
ZONE 3														
A 256L	Sta 256+30 to 264+29	0.90	0.77	57	0.05263	1.63	190	0.0090	5	Grassed waterway	15.00	1.42	2.23	5.00
A 256R	Sta 256+30 to 264+30	0.90	0.77	63	0.06349	1.61	190	0.0090	5	Grassed waterway	15.00	1.42	2.23	5.00
A 247L	Sta. 246+00 to 256+30	0.90	0.96	56	0.07143	1.46	1020	0.0199	5	Grassed waterway	15.00	2.11	8.04	9.50
A 246R	Sta. 246+00 to 256+30	0.90	1.01	56	0.07143	1.46	1020	0.0199	5	Grassed waterway	15.00	2.11	8.04	9.50
A 246L	Sta 246+00 to No Work Zone	0.25	905.26	300	0.01667	23.23	9985	0.00951	3	Short pasture and lawns	7.00	0.68	243.73	266.96
A 229R	Sta. 229+00 to 232+00	0.90	0.31	56	0.05357	1.61	300	0.00953	5	Grassed waterway	15.00	1.46	3.41	5.02
A 226L	Sta. 226+00 to 246+00	0.28	65.23	300	0.03667	17.31	2440	0.02254	3	Short pasture and lawns	7.00	1.05	38.69	56.00
A 212L	Sta. 212+00 to 229+00	0.90	1.55	61	0.06557	1.57	1640	0.0083	5	Grassed waterway	15.00	1.37	20.00	21.57
A 212R	Sta. 212+00 to 229+00	0.90	1.55	57	0.07018	1.48	1640	0.0083	5	Grassed waterway	15.00	1.37	20.00	21.49
A 210L	Sta. 210+60 to 226+00	0.31	124.50	300	0.02667	18.43	2868	0.0258	5	Grassed waterway	15.00	2.41	19.84	38.27
A 210L_S1	Sta. 212+00 to 229+00	0.31	56.88	300	0.02667	18.51	2868	0.0258	5	Grassed waterway	15.00	2.41	19.84	38.34
A 208R	Sta. 207+60 to 212+00	0.90	0.44	57	0.07018	1.48	453	0.01044	5	Grassed waterway	15.00	1.53	4.93	6.41
A 206L	Sta. 205+00 to 212+00	0.90	0.74	61	0.06557	1.57	660	0.01045	5	Grassed waterway	15.00	1.53	7.17	8.74
A 205L	Sta 205+00 to 210+60	0.25	2.87	100	0.01	15.90	550	0.00364	5	Grassed waterway	15.00	0.90	10.13	26.03
A 178L	Sta. 179+00 to 205+00	0.34	79.92	300	0.01667	20.79	2880	0.01181	3	Short pasture and lawns	7.00	0.76	63.11	83.90
A 178R	Sta. 178+00 to 207+00	0.90	3.32	54	0.07407	1.42	2865	0.00999	5	Grassed waterway	15.00	1.50	31.86	33.27
A 152L	Sta. 152+00 to 178+00	0.90	2.49	53	0.0566	1.54	2600	0.00527	5	Grassed waterway	15.00	1.09	39.80	41.33
A 152R	Sta. 152+00 to 178+00	0.90	2.53	54	0.05556	1.56	2610	0.00523	5	Grassed waterway	15.00	1.09	40.09	41.65
A 151R	Sta. 152+00 to 170+50	0.42	39.34	300	0.01	22.03	2978	0.00168	5	Grassed waterway	15.00	0.61	80.75	102.78
A 150L	Sta. 150+00 to 179+00	0.25	123.68	300	0.02	21.88	4718	0.00763	3	Short pasture and lawns	7.00	0.61	128.60	150.48
A 148L	Sta. 148+00 to 152+00	0.90	0.41	54	0.05556	1.56	400	0.00183	5	Grassed waterway	15.00	0.64	10.40	11.96
A 148R	Sta. 147+80 to 152+00	0.90	0.55	55	0.07273	1.44	470	0.00145	5	Grassed waterway	15.00	0.57	13.73	15.17
ZONE 4														
A 125R	Sta. 124+50 to 137+50	0.90	1.08	44	0.09091	1.20	1285	0.00987	5	Grassed waterway	15.00	1.49	14.37	15.57
A 103L	Sta. 103+00 to148+00	0.90	4.65	100	0.06	2.07	4386	0.00876	5	Grassed waterway	15.00	1.40	52.06	54.13
A 103R	Sta. 100+00 to 114+00	0.90	0.57	37	0.08108	1.14	1090	0.00758	5	Grassed waterway	15.00	1.31	13.91	15.05
A 92L	Sta. 92+00 to 103+00	0.90	0.53	36	0.11111	1.01	1143	0.00725	5	Grassed waterway	15.00	1.28	14.91	15.93
A 92R	Sta. 92+00 to 103+00	0.90	0.58	36	0.11111	1.01	1150	0.0071	5	Grassed waterway	15.00	1.26	15.16	16.17
A 70L	Sta. 70+38 to 92+00	0.90	1.72	55	0.07273	1.44	2087	0.00631	5	Grassed waterway	15.00	1.19	29.19	30.63
A 70R	Sta. 70+38 to 78+00	0.90	0.27	33	0.12121	0.94	717	0.00904	5	Grassed waterway	15.00	1.43	8.38	9.32

Notes:

t_i= (1.87*(1.1-C_5)*(L^0.5))/(S^0.33), from COS DCM page 5-11

Velocity from V = C_v*S_w^0.5, from UDFCD Eqn RO-4, C_v from Table R0-2 (See Sheet Design Info)

t_t=L/60V

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

Design Storm: 5-yr

	LOCATION	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
			AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																						
1	Sta 256+30 to 264+29		A 256L	0.77	0.90	5.00	0.69	3.55	2.46													
2	Sta 256+30 to 264+30		A 256R	0.77	0.90	5.00	0.69	3.55	2.46													
3	Sta. 246+00 to 256+30		A 247L	0.96	0.90	9.50	0.86	2.79	2.41													
4	Sta. 246+00 to 256+30		A 246R	1.01	0.90	9.50	0.91	2.79	2.54													
5	Sta 246+00 to No Work Zone		A 246L	905.26	0.25	266.96	227.44	0.45	101.89													
6	Sta. 229+00 to 232+00		A 229R	0.31	0.90	5.02	0.28	3.55	0.99													
7	Sta. 226+00 to 246+00		A 226L	65.23	0.28	56.00	18.23	1.08	19.69													
8	Sta. 212+00 to 229+00		A 212L	1.55	0.90	21.57	1.40	1.90	2.65													
9	Sta. 212+00 to 229+00		A 212R	1.55	0.90	21.49	1.40	1.90	2.65													
10	Sta. 210+60 to 226+00		A 210L	124.50	0.31	38.27	39.03	1.42	55.43													
	Sta. 212+00 to 229+00		A 210L_S1	56.88	0.31	38.34	17.65	1.42	25.06													
11	Sta. 207+60 to 212+00		A 208R	0.44	0.90	6.41	0.40	3.36	1.33													
12	Sta. 205+00 to 212+00		A 206L	0.74	0.90	8.74	0.67	2.98	1.99													
13	Sta 205+00 to 210+60		A 205L	2.87	0.25	26.03	0.72	1.72	1.23													
14	Sta. 179+00 to 205+00		A 178L	79.92	0.34	83.90	27.19	0.86	23.38													
15	Sta. 178+00 to 207+00		A 178R	3.32	0.90	33.27	2.99	1.51	4.51													
16	Sta. 152+00 to 178+00		A 152L	2.49	0.90	41.33	2.24	1.36	3.05													
17	Sta. 152+00 to 178+00		A 152R	2.53	0.90	41.65	2.28	1.36	3.10													
18	Sta. 152+00 to 170+50		A 151R	39.34	0.42	102.78	16.52	0.74	12.22													
19	Sta. 150+00 to 179+00		A 150L	123.68	0.25	150.48	31.04	0.53	16.45													
20	Sta. 148+00 to 152+00		A 148L	0.41	0.90	11.96	0.37	2.50	0.92													
21	Sta. 147+80 to 152+00		A 148R	0.55	0.90	15.17	0.50	2.12	1.05													
ZONE 4																						
22	Sta. 124+50 to 137+50		A 125R	1.08	0.90	15.57	0.97	2.12	2.06													
23	Sta. 103+00 to148+00		A 103L	4.65	0.90	54.13	4.19	1.12	4.69													
24	Sta. 100+00 to 114+00		A 103R	0.57	0.90	15.05	0.51	2.12	1.09													
25	Sta. 92+00 to 103+00		A 92L	0.53	0.90	15.93	0.48	2.12	1.01													
26	Sta. 92+00 to 103+00		A 92R	0.58	0.90	16.17	0.52	2.08	1.09													
27	Sta. 70+38 to 92+00		A 70L	1.72	0.90	30.63	1.55	1.57	2.43													
28	Sta. 70+38 to 78+00		A 70R	0.27	0.90	9.32	0.24	2.79	0.68													

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

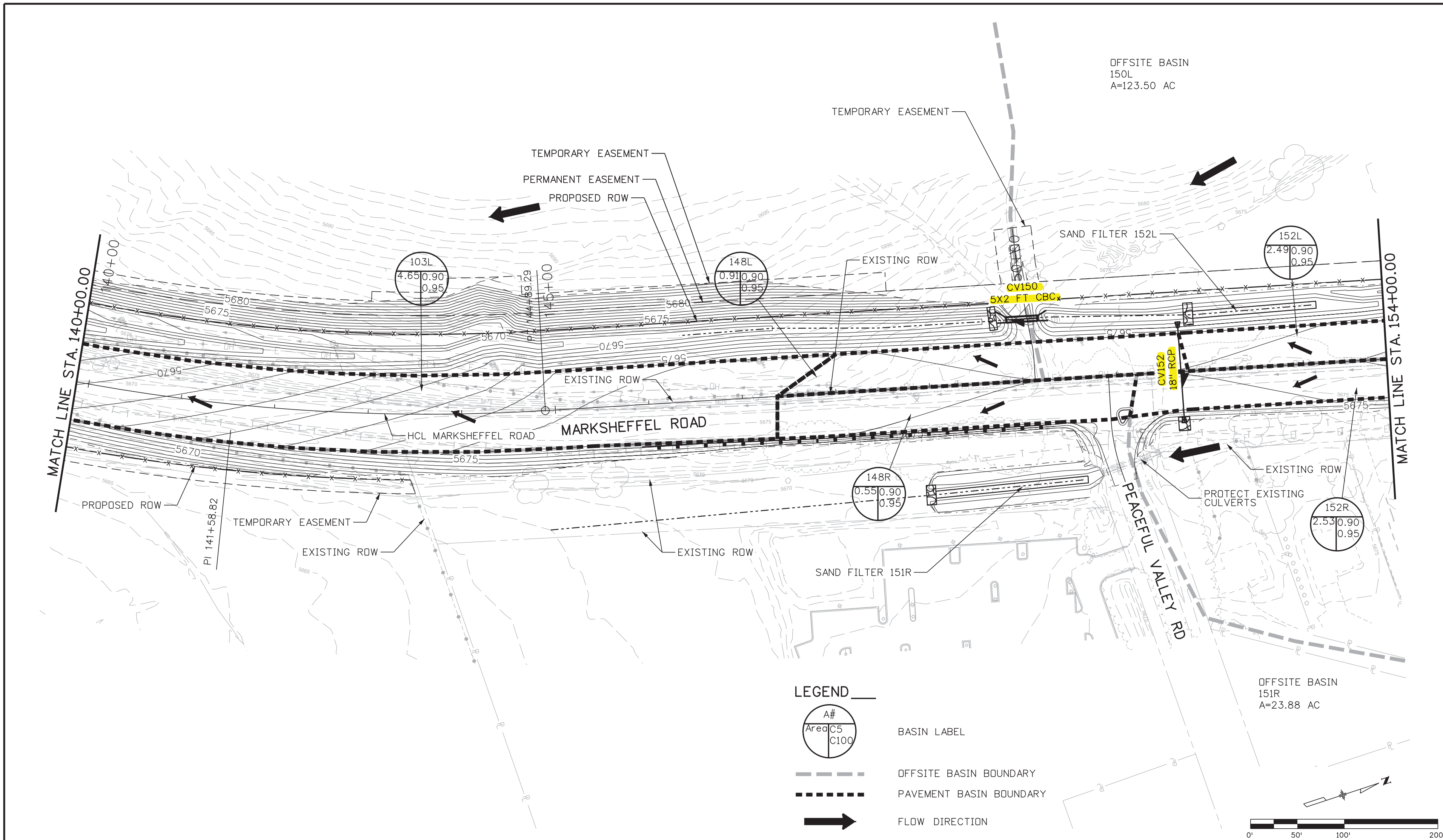
Corridor / Design Package: Marksheffel
System Name: South

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

Design Storm: 100-yr

			DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	LOCATION	DESIGN POINT	AREA DESIGN	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																						
1	Sta 256+30 to 264+29		A 256L	0.77	0.95	5.00	0.73	9.53	6.97													
2	Sta 256+30 to 264+30		A 256R	0.77	0.95	5.00	0.73	9.53	6.97													
3	Sta. 246+00 to 256+30		A 247L	0.96	0.95	9.50	0.91	7.49	6.83													
4	Sta. 246+00 to 256+30		A 246R	1.01	0.95	9.50	0.96	7.49	7.19													
5	Sta 246+00 to No Work Zone		A 246L	905.26	0.35	266.96	317.88	1.25	397.35													
6	Sta. 229+00 to 232+00		A 229R	0.31	0.95	5.02	0.29	9.53	2.81													
7	Sta. 226+00 to 246+00		A 226L	65.23	0.38	56.00	24.61	2.95	72.59													
8	Sta. 212+00 to 229+00		A 212L	1.55	0.95	21.57	1.47	5.08	7.48													
9	Sta. 212+00 to 229+00		A 212R	1.55	0.95	21.49	1.47	5.08	7.48													
10	Sta. 210+60 to 226+00		A 210L	124.50	0.43	38.27	53.71	3.82	205.15													
	Sta. 212+00 to 229+00		A 210L_S1	56.88	0.42	38.34	24.11	3.82	92.09													
11	Sta. 207+60 to 212+00		A 208R	0.44	0.95	6.41	0.42	9.02	3.77													
12	Sta. 205+00 to 212+00		A 206L	0.74	0.95	8.74	0.70	8.00	5.63													
13	Sta 205+00 to 210+60		A 205L	2.87	0.35	26.03	1.00	4.59	4.61													
14	Sta. 179+00 to 205+00		A 178L	79.92	0.46	83.90	36.89	2.36	87.06													
										83.90	36.89	2.36	87.06						2753	4.14	11.08	
15	Sta. 178+00 to 207+00		A 178R	3.32	0.95	33.27	3.15	4.06	12.81													
16	Sta. 152+00 to 178+00		A 152L	2.49	0.95	41.33	2.37	3.67	8.68													
17	Sta. 152+00 to 178+00		A 152R	2.53	0.95	41.65	2.40	3.67	8.82													
18	Sta. 152+00 to 170+50		A 151R	39.34	0.56	102.78	21.87	2.03	44.39													
19	Sta. 150+00 to 179+00		A 150L	123.68	0.35	150.48	43.39	1.48	64.22													
		1	150L,178L							150.48	80.28	1.48	118.82									CV150
20	Sta. 148+00 to 152+00		A 148L	0.41	0.95	11.96	0.39	6.72	2.62													
21	Sta. 147+80 to 152+00		A 148R	0.55	0.95	15.17	0.52	5.67	2.96													
ZONE 4																						
22	Sta. 124+50 to 137+50		A 125R	1.08	0.95	15.57	1.03	5.67	5.82													
23	Sta. 103+00 to148+00		A 103L	4.65	0.95	54.13	4.42	3.05	13.47													
24	Sta. 100+00 to 114+00		A 103R	0.57	0.95	15.05	0.54	5.67	3.07													
25	Sta. 92+00 to 103+00		A 92L	0.53	0.95	15.93	0.50	5.67	2.85													
26	Sta. 92+00 to 103+00		A 92R	0.58	0.95	16.17	0.55	5.57	3.07													
27	Sta. 70+38 to 92+00		A 70L	1.72	0.95	30.63	1.63	4.20	6.86													
28	Sta. 70+38 to 78+00		A 70R	0.27	0.95	9.32	0.26	7.49	1.92													

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to C-Value Sheet
(7) =Column 4 x Column 5
(8) =28.5*P/(10+Column 6)^0.786
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the Basin Areas (7) to get the combined basin AC
(12) =28.5*P/(10+Column 10)^0.786
(13) Sum of Qs
(14) Additonal Street Overland Flow
(15) Additonal Street Overland Flow
(16) Design Pipe Flow
(17) Pipe Slope
(18) Pipe Size
(19) Additional Flow Length
(20) Velocity
(21) =Column 19 / Column 20 / 60



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Print Date: 4/2/2015	
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Horiz. Scale: 1:100	Vert. Scale: As Noted
Unit Information	Unit Leader Initials

HDR
PARSONS BRINCKERHOFF

Sheet Revisions		
Date:	Comments	Init.

EL PASO COUNTY
COLORADO
PPRTA

As Constructed
No Revisions:
Revised:
Void:

MARKSHEFFEL ROAD
DRAINAGE BASINS PLAN
140+00.00 TO 154+00.00

Designer:	E. STATEN	Structure Numbers
Detailer:	D. MADDOCK	
Sheet Subset:	BASINS	Subset Sheets: 6 of 36

Project No./Code
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6

Culvert Calculator Report
CV150

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	5,676.34 ft	Headwater Depth/Height	2.36
Computed Headwater Elevation	5,676.32 ft	Discharge	118.82 cfs
Inlet Control HW Elev.	5,676.32 ft	Tailwater Elevation	5,671.50 ft
Outlet Control HW Elev.	5,675.71 ft	Control Type	Inlet Control

Grades			
Upstream Invert	5,671.60 ft	Downstream Invert	5,671.50 ft
Length	35.00 ft	Constructed Slope	0.002857 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	2.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	2.00 ft
Velocity Downstream	9.90 ft/s	Critical Slope	0.011013 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	6.00 ft
Section Size	6 x 2 ft	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	5,675.71 ft	Upstream Velocity Head	1.52 ft
Ke	0.20	Entrance Loss	0.30 ft

Inlet Control Properties			
Inlet Control HW Elev.	5,676.32 ft	Flow Control	Submerged
Inlet Type	90° headwall w 45° bevels	Area Full	12.0 ft²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Calculator Report
CV152

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	5,675.19 ft	Headwater Depth/Height	1.27
Computed Headwater Elevation	5,673.97 ft	Discharge	8.68 cfs
Inlet Control HW Elev.	5,673.89 ft	Tailwater Elevation	5,671.52 ft
Outlet Control HW Elev.	5,673.97 ft	Control Type	Outlet Control

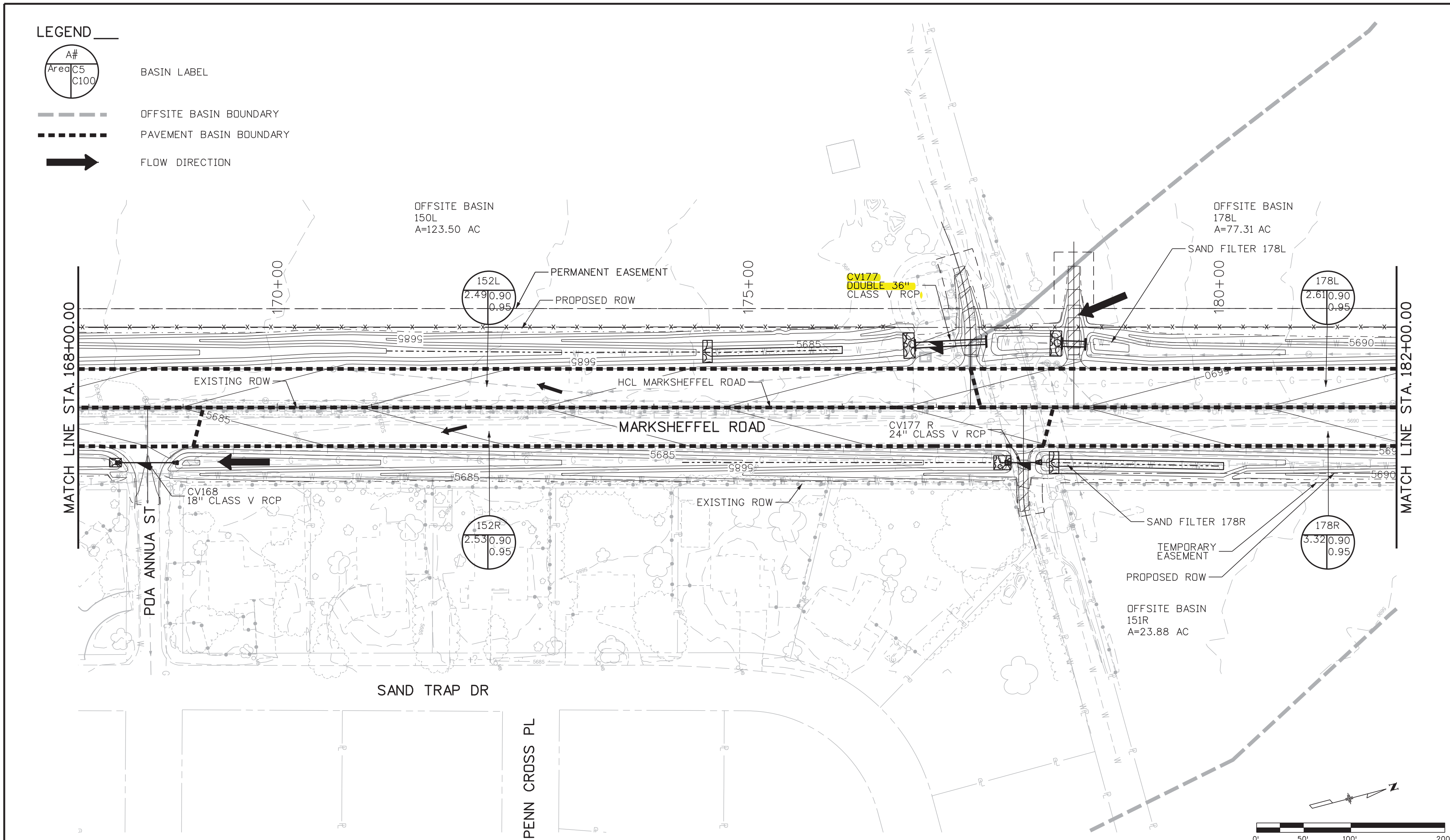
Grades			
Upstream Invert	5,672.06 ft	Downstream Invert	5,671.52 ft
Length	108.00 ft	Constructed Slope	0.005000 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.14 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.14 ft
Velocity Downstream	6.02 ft/s	Critical Slope	0.007955 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	5,673.97 ft	Upstream Velocity Head	0.38 ft
Ke	0.20	Entrance Loss	0.08 ft

Inlet Control Properties			
Inlet Control HW Elev.	5,673.89 ft	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	1.8 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		



Print Date: 4/2/2015
File Name: North-Marksheffel_BASINS_Plan008.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Unit Information Unit Leader Initials

HDR PARSONS BRINCKERHOFF

Sheet Revisions		
Date:	Comments	Init.

EL PASO COUNTY COLORADO

PPRTA

As Constructed
No Revisions:
Revised:
Void:

MARKSHEFFEL ROAD
DRAINAGE BASINS PLAN
168+00.00 TO 182+00.00

Designer: E. STATEN
Detailer: D. MADDOCK
Structure Numbers
Sheet Subset: BASINS
Subset Sheets: 8 of 36

Project No./Code
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8

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Culvert Calculator Report
CV177

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	5,688.70 ft	Headwater Depth/Height	1.13
Computed Headwater Elevation	5,688.17 ft	Discharge	87.06 cfs
Inlet Control HW Elev.	5,688.06 ft	Tailwater Elevation	5,684.52 ft
Outlet Control HW Elev.	5,688.17 ft	Control Type	Outlet Control

Grades			
Upstream Invert	5,684.78 ft	Downstream Invert	5,684.52 ft
Length	77.00 ft	Constructed Slope	0.003377 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	2.15 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	2.15 ft
Velocity Downstream	8.03 ft/s	Critical Slope	0.005723 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	5,688.17 ft	Upstream Velocity Head	0.74 ft
Ke	0.20	Entrance Loss	0.15 ft

Inlet Control Properties			
Inlet Control HW Elev.	5,688.06 ft	Flow Control	Transition
Inlet Type	Beveled ring, 33.7° bevels	Area Full	14.1 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)

Corridor / Design Package: Marksheffel
System Name: South Approach Pipes

Computed: MAJ Date: 6/28/2014
Checked: EVS Date: 6/30/2014

5-YR PIPE CALCULATIONS

Design Storm: 5-yr

	LOCATION	DESIGN POINT	DIRECT RUNOFF: AREA DESIGN (name)	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	TOTAL RUNOFF: t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	STREET: SLOPE (%)	STREET FLOW (CFS)	PIPE: DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	TRAVEL TIME: LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																						
1	Onsite flow from 233+00 to 246+00		CV233	2.37	0.90	9.85	2.13	2.79	5.95													
2	Onsite flow from 207+60 to 212+00		P205	0.44	0.90	6.41	0.40	3.36	1.33													
3	Onsite flow from 205+00 to 212+00		CV205	0.84	0.90	8.74	0.76	2.98	2.25													
4	Onsite flow from 195+00 to 205+00		CV195	1.68	0.90	13.63	1.51	2.31	3.49													
5	Onsite flow from 194+00 to 205+00		CV194	1.79	0.90	14.90	1.61	2.22	3.58													
6	Onsite flow from 192+00 to 205+00		CV192	1.99	0.90	16.82	1.79	2.08	3.73													
7	Onsite & Offsite flow from 177+00 to 205+00		CV177R	5.51	0.64	35.11	3.54	1.48	5.23													
8	Onsite flow from 168+00 to 179+00		CV168	0.95	0.90	16.85	0.86	2.08	1.78													
9	Onsite flow from 152+00 to 177+00		CV152	2.49	0.90	41.33	2.24	1.36	3.05													
ZONE 4																						
10	Onsite flow from 112+00 to 114+00		CV112	0.12	0.93	5.00	0.11	3.55	0.38													
11	Onsite flow from 109+00 to 114+00		CV109	0.27	0.90	6.61	0.24	3.36	0.82													
12	Onsite flow from 106+00 to 114+00		CV106	0.40	0.90	8.54	0.36	2.98	1.07													
13	Onsite flow from 99+00 to 103+00		CV99	0.20	0.90	5.00	0.18	3.55	0.62													

100-YR PIPE CALCULATIONS

Design Storm: 100-yr

	LOCATION	DESIGN POINT	DIRECT RUNOFF: AREA DESIGN	AREA (AC)	RUNOFF COEFF	t_c (MIN)	C.A. (AC)	I IN / HR	Q (CFS)	TOTAL RUNOFF: t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	STREET: SLOPE (%)	STREET FLOW (CFS)	PIPE: DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE	TRAVEL TIME: LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	REMARKS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
ZONE 3																						
1	Onsite flow from 233+00 to 246+00		CV233	2.37	0.95	9.85	2.25	7.49	16.87													
2	Onsite flow from 207+60 to 212+00		P205	0.44	0.95	6.41	0.42	9.02	3.77													
3	Onsite flow from 205+00 to 212+00		CV205	0.84	0.95	8.74	0.80	8.00	6.38													
4	Onsite flow from 195+00 to 205+00		CV195	1.68	0.95	13.63	1.59	6.19	9.87													
5	Onsite flow from 194+00 to 205+00		CV194	1.79	0.95	14.90	1.70	5.93	10.08													See TR-55 Peak Flow
6	Onsite flow from 192+00 to 205+00		CV192	1.99	0.95	16.82	1.89	5.57	10.53													
7	Onsite & Offsite flow from 177+00 to 205+00		CV177R	5.51	0.71	35.11	3.92	3.96	15.53													
8	Onsite flow from 168+00 to 179+00		CV168	0.95	0.95	16.85	0.90	5.57	5.03													
9	Onsite flow from 152+00 to 177+00		CV152	2.49	0.95	41.33	2.37	3.67	8.68													
ZONE 4																						
10	Onsite flow from 112+00 to 114+00		CV112	0.12	0.98	5.00	0.11	9.53	1.07													See TR-55 Peak Flow
11	Onsite flow from 109+00 to 114+00		CV109	0.27	0.95	6.61	0.26	9.02	2.31													
12	Onsite flow from 106+00 to 114+00		CV106	0.40	0.95	8.54	0.38	8.00	3.04													
13	Onsite flow from 99+00 to 103+00		CV99	0.20	0.95	5.00	0.19	9.53	1.77													

(1) Basin Description linked to C-Value Sheet
(2) Basin Design Point
(3) Enter the Basin Name from C Value Sheet
(4) Basin Area linked to C-Value Sheet
(5) Composite C linked to C-Value Sheet
(6) Time of Concentration linked to C-Value Sheet
(7) =Column 4 x Column 5
(8) =28.5*P/(10+Column 6)^0.786
(9) =Column 7 x Column 8
(10) =Column 6 + Column 21
(11) Add the Basin Areas (7) to get the combined basin AC
(12) =28.5*P/(10+Column 10)^0.786
(13) Sum of Qs
(14) Additonal Street Overland Flow
(15) Additonal Street Overland Flow
(16) Design Pipe Flow
(17) Pipe Slope
(18) Pipe Size
(19) Additional Flow Length
(20) Velocity
(21) =Column 19 / Column 20 / 60

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

The Glen at Widefield

Developed Condition

Runoff Coeficient and Percent Impervious Calculation

Basin	DP	Basin or DP Area (DP contributing basins)		Soil Type	PV % Imperv	Area 1 Land Use: Land Use Area	Area 1: % Area	Area 1: Comp Land Use % Imp	LA % Imperv	Area 2 Land Use: Land Use Area	Area 2: % Area	Area 2: Comp Land Use % Imp	GR % Imperv	Area 3 Land Use: Land Use Area	Area 3: % Area	Area 3: Comp Land Use % Imp	RS2 % Imperv	Area 4 Land Use: Land Use Area	Area 4: % Area	Area 4: Comp Land Use % Imp	Basin % Imperv	Basin Runoff C_5	Basin Runoff C_{100}
C-7	DP 37	86,130 sf	1.98ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	28%	1.98ac	100%	28%	28.0%	0.24	0.46
C-9		116,516 sf	2.67ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	28%	2.67ac	100%	28%	28.0%	0.24	0.46
C-18	DP 51	62,114 sf	1.43ac	B	100%		0%	0%	0%		0%	0%	40%		0%	0%	42%	1.43ac	100%	42%	42.0%	0.31	0.50
E-1	DP 95	229,727 sf	5.27ac	C	100%		0%	0%	0%	5.27ac	100%	0%	40%		0%	0%	28%		0%	0%	42.0%	0.31	0.50
E-2	DP 96	21,807 sf	0.50ac	B	100%	0.19ac	37%	37%	0%	0.09ac	19%	0%	40%		0%	0%	28%		0%	0%	42.0%	0.31	0.50
E-3	DP 97	69,766 sf	1.60ac	B	100%	0.19ac	12%	12%	0%	1.41ac	88%	0%	40%		0%	0%	28%		0%	0%	42.0%	0.31	0.50
E-4	DP 98	50,997 sf	1.17ac	C	100%	0.22ac	19%	19%	0%	0.95ac	81%	0%	40%		0%	0%	28%		0%	0%	18.7%	0.25	0.55
E-5	DP 99	57,314 sf	1.32ac	C	100%	0.10ac	8%	8%	0%	1.08ac	82%	0%	40%		0%	0%	28%	0.14ac	11%	3%	10.6%	0.21	0.53
E-6	DP 100	187,508 sf	4.30ac	C	100%		0%	0%	0%	4.30ac	100%	0%	40%		0%	0%	28%		0%	0%	0.0%	0.15	0.50

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation								
Runoff Coefficients and Percents Impervious								
Hydrologic Soil Type:	**B**	**Runoff Coef Calc Method**						%Imp
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81
Residential: 1/4 Acre	RS1	40%	0.23	0.30	0.36	0.42	0.46	0.50
Residential: 4.3 Lots/Acre	RS2	28%	0.16	0.24	0.31	0.38	0.43	0.46

Equations (% Impervious Calculation):

$C_A = K_A+(1.31\ i^3 - 1.44\ i^2 + 1.135\ i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD}+(0.858\ i^3 - 0.786\ i^2 + 0.774\ i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

K_A (2-yr)= 0

K_A (5-yr)= -0.08i + 0.09

K_A (10-yr)= -0.14i + 0.17

K_A (25-yr)= -0.19i + 0.24

K_A (50-yr)= -0.22i + 0.28

K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

K_{CD} (2-yr)= 0

K_{CD} (5-yr)= -0.10i + 0.11

K_{CD} (10-yr)= -0.18i + 0.21

K_{CD} (25-yr)= -0.28i + 0.33

K_{CD} (50-yr)= -0.33i + 0.40

K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Developed Condition
Time of Concentration Calculation

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		Final t_c
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
C-7	DP 37		1.98ac	0.24	100lf	0.8%	17.0 min.	690lf	1.3%	PV	20	2.3 ft/sec	5.0 min.	22.0 min.	790lf	14.4 min.	**14.4 min.**
C-9			2.67ac	0.24	100lf	2.0%	12.5 min.	660lf	1.2%	PV	20	2.2 ft/sec	5.0 min.	17.5 min.	760lf	14.2 min.	**14.2 min.**
C-18	DP 51		1.43ac	0.31	100lf	3.3%	9.7 min.	400lf	1.0%	PV	20	2.0 ft/sec	3.3 min.	13.1 min.	500lf	12.8 min.	**12.8 min.**
E-1	DP 95		5.27ac	0.15	100lf	2.3%	13.2 min.	1800lf	1.9%	GW	15	2.1 ft/sec	14.5 min.	27.7 min.	1900lf	20.6 min.	**20.6 min.**
E-2	DP 96		0.50ac	0.28	100lf	1.5%	13.0 min.	675lf	0.8%	PV	20	1.8 ft/sec	6.3 min.	19.3 min.	775lf	14.3 min.	**14.3 min.**
E-3	DP 97		1.60ac	0.15	70lf	1.2%	13.7 min.	260lf	0.5%	PV	20	1.4 ft/sec	3.1 min.	16.8 min.	330lf	11.8 min.	**11.8 min.**
E-4	DP 98		1.17ac	0.21	50lf	2.4%	8.6 min.	160lf	1.9%	PV	20	2.8 ft/sec	1.0 min.	9.6 min.	210lf	11.2 min.	**9.6 min.**
E-5	DP 99		1.32ac	0.21	100lf	4.0%	10.2 min.	200lf	1.9%	PV	20	2.8 ft/sec	1.2 min.	11.4 min.	300lf	11.7 min.	**11.4 min.**
E-6	DP 100		4.30ac	0.15			0.0 min.	300lf	5.5%	GW	15	3.5 ft/sec	1.4 min.	5.0 min.	300lf	11.7 min.	**5.0 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see Table)

S = Watercourse slope (ft/ft)

Land Surface Type	Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

The Glen at Widefield
Developed Condition
Runoff Calculation

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
C-7	DP 37		1.98 ac	0.31	0.50	14.4 min.	3.6 in/hr	6.0 in/hr	**2.2 cfs**	**6.0 cfs**	C-7
C-9			2.67 ac	0.31	0.50	14.2 min.	3.6 in/hr	6.0 in/hr	**3.0 cfs**	**8.1 cfs**	C-9
C-18	DP 51		1.43 ac	0.31	0.50	12.8 min.	3.8 in/hr	6.3 in/hr	**1.6 cfs**	**4.5 cfs**	C-18
E-1	DP 95		5.27 ac	0.15	0.50	20.6 min.	3.0 in/hr	5.1 in/hr	**2.4 cfs**	**13.5 cfs**	E-1
E-2	DP 96		0.50 ac	0.28	0.49	14.3 min.	3.6 in/hr	6.0 in/hr	**0.5 cfs**	**1.5 cfs**	E-2
E-3	DP 97		1.60 ac	0.15	0.41	11.8 min.	3.9 in/hr	6.5 in/hr	**0.9 cfs**	**4.3 cfs**	E-3
E-4	DP 98		1.17 ac	0.21	0.53	9.6 min.	4.2 in/hr	7.0 in/hr	**0.9 cfs**	**3.8 cfs**	E-4
E-5	DP 99		1.32 ac	0.21	0.53	11.4 min.	3.9 in/hr	6.6 in/hr	**1.1 cfs**	**4.6 cfs**	E-5
E-6	DP 100		4.30 ac	0.15	0.50	5.0 min.	5.2 in/hr	8.7 in/hr	**3.3 cfs**	**18.7 cfs**	E-6

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

The Glen at Widefield
Developed Condition
Runoff Calculation

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	**Runoff Q_5**	**Runoff Q_{100}**	**Basin / DP**
C-7	DP 37		1.98 ac	0.31	0.50	14.4 min.	3.6 in/hr	6.0 in/hr	**2.2 cfs**	**6.0 cfs**	C-7
C-9			2.67 ac	0.31	0.50	14.2 min.	3.6 in/hr	6.0 in/hr	**3.0 cfs**	**8.1 cfs**	C-9
C-18	DP 51		1.43 ac	0.31	0.50	12.8 min.	3.8 in/hr	6.3 in/hr	**1.6 cfs**	**4.5 cfs**	C-18
E-1	DP 95		5.27 ac	0.15	0.50	20.6 min.	3.0 in/hr	5.1 in/hr	**2.4 cfs**	**13.5 cfs**	E-1
E-2	DP 96		0.50 ac	0.28	0.49	14.3 min.	3.6 in/hr	6.0 in/hr	**0.5 cfs**	**1.5 cfs**	E-2
E-3	DP 97		1.60 ac	0.15	0.41	11.8 min.	3.9 in/hr	6.5 in/hr	**0.9 cfs**	**4.3 cfs**	E-3
E-4	DP 98		1.17 ac	0.21	0.53	9.6 min.	4.2 in/hr	7.0 in/hr	**0.9 cfs**	**3.8 cfs**	E-4
E-5	DP 99		1.32 ac	0.21	0.53	11.4 min.	3.9 in/hr	6.6 in/hr	**1.1 cfs**	**4.6 cfs**	E-5
E-6	DP 100		4.30 ac	0.15	0.50	5.0 min.	5.2 in/hr	8.7 in/hr	**3.3 cfs**	**18.7 cfs**	E-6

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{25}=-2.00 ln(T_c) + 10.111

i_{50}=-2.25 ln(T_c) + 11.375

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

The Glen at Widefield
Developed Condition
Runoff Coeficient and Percent Impervious Calculation

Filing 10 - Interim Condition

Basin	DP	Basin or DP Area (DP contributing basins)		Soil Type	PV % Imperv	Area 1 Land Use: Land Use Area	% Area	Comp Land Use % Imp	LA % Imperv	Area 2 Land Use: Land Use Area	% Area	Comp Land Use % Imp	RS2 % Imperv	Area 3 Land Use: Land Use Area	% Area	Comp Land Use % Imp	RS1 % Imperv	Area 4 Land Use: Land Use Area	% Area	Comp Land Use % Imp	HI % Imperv	Area 5 Land Use: Land Use Area	% Area	Comp Land Use % Imp	Basin % Imperv	C_5	C_{100}
D-1	DP 68	61,148 sf	1.40ac	B	100%		0%	0%	0%	1.40ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-2		63,184 sf	1.45ac	B	100%		0%	0%	0%	1.45ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-3	DP 70	73,555 sf	1.69ac	B	100%		0%	0%	0%	1.69ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-4		90,208 sf	2.07ac	C	100%		0%	0%	0%	2.07ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-5	DP 72	68,122 sf	1.56ac	C	100%		0%	0%	0%	1.56ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-6	DP 73	18,040 sf	0.41ac	C	100%		0%	0%	0%	0.41ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-7		130,015 sf	2.98ac	C	100%		0%	0%	0%	2.98ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-8		70,452 sf	1.62ac	C	100%		0%	0%	0%	1.62ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-9	DP 77	91,788 sf	2.11ac	B	100%		0%	0%	0%	2.11ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-10		130,320 sf	2.99ac	C	100%		0%	0%	0%	2.99ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-11	DP 80	172,355 sf	3.96ac	C	100%		0%	0%	0%	3.96ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-12		60,400 sf	1.39ac	C	100%		0%	0%	0%	1.39ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-13		89,754 sf	2.06ac	C	100%		0%	0%	0%	2.06ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-14		143,954 sf	3.30ac	C	100%		0%	0%	0%	3.30ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-15	DP 84	122,155 sf	2.80ac	B	100%		0%	0%	0%	2.80ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
D-16		98,963 sf	2.27ac	C	100%		0%	0%	0%	2.27ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-16.1		90,495 sf	2.08ac	C	100%		0%	0%	0%	2.08ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-17		150,208 sf	3.45ac	C	100%		0%	0%	0%	3.45ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-18		92,997 sf	2.13ac	C	100%		0%	0%	0%	2.13ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-19		129,215 sf	2.97ac	C	100%		0%	0%	0%	2.97ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-19.1	**DP89**	7,235 sf	0.17ac	C	100%		0%	0%	0%	0.17ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-20a	DP 92a	35,151 sf	0.81ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	0.81ac	100%	37%	2%		0%	0%	37.0%	0.28	0.49
D-20b	DP 92b	20,481 sf	0.47ac	C	100%	0.20ac	43%	43%	0%	0.27ac	57%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	42.5%	0.36	0.59
D-20c	**DP 92d**	15,896 sf	0.36ac	C	100%		0%	0%	0%	0.36ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
D-21	DP 91	175,102 sf	4.02ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.02ac	100%	37%	2%		0%	0%	37.0%	0.28	0.49
D-22	DP 90	50,194 sf	1.15ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.15ac	100%	37%	2%		0%	0%	37.0%	0.28	0.49
D-23	**DP92e**	12,393 sf	0.28ac	C	100%	0.04ac	14%	14%	0%	0.24ac	84%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	14.1%	0.23	0.54
D-24		443,273 sf	10.18ac	C	100%		0%	0%	0%	8.18ac	80%	0%	46%		0%	0%	37%	2.00ac	20%	7%	2%		0%	0%	7.3%	0.20	0.52
Combined Design Point Summary																											
	DP 69	D1, D2	2.85ac	B	100%		0%	0%	0%	2.85ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
	DP 71	D3, D4	3.76ac	B	100%		0%	0%	0%	3.76ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
	DP 74	D3, D4, D6	4.17ac	C	100%		0%	0%	0%	4.17ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 75	D1-D4, D6, D7	10.01ac	C	100%		0%	0%	0%	10.01ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 76	D1-D4, D6-D8	11.63ac	C	100%		0%	0%	0%	11.63ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 78	D1-D4, D6-D9	13.74ac	C	100%		0%	0%	0%	13.74ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 79	D1-D4, D6-D10	16.73ac	C	100%		0%	0%	0%	16.73ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 81	D11, D12	5.34ac	C	100%		0%	0%	0%	5.34ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 82	D5, D13	3.62ac	B	100%		0%	0%	0%	3.62ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
	DP 83	D5, D13, D14	6.93ac	B	100%		0%	0%	0%	6.93ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.08	0.35
	DP 85	D15,D16, D16.1	7.15ac	C	100%		0%	0%	0%	7.15ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 86	D15 - D17	10.60ac	C	100%		0%	0%	0%	10.60ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 87	D15 - D18	12.74ac	C	100%		0%	0%	0%	12.74ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 88	D15 - D19	15.70ac	C	100%		0%	0%	0%	15.70ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP 92c	D20a,D21, D22	5.98ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	5.98ac	100%	37%	2%		0%	0%	37.0%	0.28	0.49
	DP 93a	D1-D19	44.70ac	C	100%		0%	0%	0%	44.70ac	100%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	0.0%	0.15	0.50
	DP93b	**D19.1, D20c, D23**	**0.82ac**	C	100%	0.04ac	5%	5%	0%	0.78ac	96%	0%	46%		0%	0%	37%		0%	0%	2%		0%	0%	4.9%	0.18	0.52
D1-24	DP 94	D1-24 Summ:	62.15ac	C	100%	0.24ac	0%	0%	0%	53.92ac	87%	0%	46%		0%	0%	37%	7.98ac	13%	5%	2%		0%	0%	5.1%	0.18	0.52
		Detained*:	**61.33ac**	C	100%	0.24ac	0%	0%	0%	53.73ac	88%	0%	46%		0%	0%	37%	7.98ac	13%	5%	2%		0%	0%	5.2%	0.18	0.52

***Sub-basins D-19.1, D-20c & D-23 are Undetained In The Interim Condition (Future Pennycress Dr).**

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation

Runoff Coefficients and Percents Impervious

Hydrologic Soil Type: B — **Runoff Coef Calc Method** %Imp

Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81
Residential: 3.7 Lots/Acre	RS1	37%	0.22	0.28	0.35	0.41	0.45	0.49
Residential: 1/5 Acre	RS2	46%	0.27	0.33	0.39	0.45	0.48	0.51

Equations (% Impervious Calculation):

$C_A = K_A + (1.31 i^3 - 1.44 i^2 + 1.135 i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD} + (0.858 i^3 - 0.786 i^2 + 0.774 i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

K_A (2-yr)= 0

K_A (5-yr)= -0.08i + 0.09

K_A (10-yr)= -0.14i + 0.17

K_A (25-yr)= -0.19i + 0.24

K_A (50-yr)= -0.22i + 0.28

K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

K_{CD} (2-yr)= 0

K_{CD} (5-yr)= -0.10i + 0.11

K_{CD} (10-yr)= -0.18i + 0.21

K_{CD} (25-yr)= -0.28i + 0.33

K_{CD} (50-yr)= -0.33i + 0.40

K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield

Developed Condition

Runoff Coeficient and Percent Impervious Calculation

Filings 10-12 Ultimate Condition					PV	Area 1 Land Use			LA	Area 2 Land Use			RS2	Area 3 Land Use			RS1	Area 4 Land Use				Basin Runoff Coeficient	
Basin	DP	Basin or DP Area (DP contributing basins)		Soil Type	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	Basin % Imperv	C_5	C_{100}
D-1	DP 68	61,148 sf	1.40ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.40ac	100%	37%	37.0%	0.28	0.49
D-2		63,184 sf	1.45ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.45ac	100%	37%	37.0%	0.28	0.49
D-3	DP 70	73,555 sf	1.69ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.69ac	100%	37%	37.0%	0.28	0.49
D-4		90,208 sf	2.07ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.07ac	100%	37%	37.0%	0.34	0.58
D-5	DP 72	68,122 sf	1.56ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.56ac	100%	37%	37.0%	0.34	0.58
D-6	DP 73	18,040 sf	0.41ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	0.41ac	100%	37%	37.0%	0.34	0.58
D-7		130,015 sf	2.98ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.98ac	100%	37%	37.0%	0.34	0.58
D-8		70,452 sf	1.62ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.62ac	100%	37%	37.0%	0.34	0.58
D-9	DP 77	91,788 sf	2.11ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.11ac	100%	37%	37.0%	0.28	0.49
D-10		130,320 sf	2.99ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.99ac	100%	37%	37.0%	0.34	0.58
D-11	DP 80	172,355 sf	3.96ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.96ac	100%	37%	37.0%	0.34	0.58
D-12		60,400 sf	1.39ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.39ac	100%	37%	37.0%	0.34	0.58
D-13		89,754 sf	2.06ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.06ac	100%	37%	37.0%	0.34	0.58
D-14		143,954 sf	3.30ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.30ac	100%	37%	37.0%	0.34	0.58
D-15	DP 84	122,155 sf	2.80ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.80ac	100%	37%	37.0%	0.28	0.49
D-16		98,963 sf	2.27ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.27ac	100%	37%	37.0%	0.34	0.58
D-16.1		90,495 sf	2.08ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.08ac	100%	37%	37.0%	0.34	0.58
D-17		150,208 sf	3.45ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.45ac	100%	37%	37.0%	0.34	0.58
D-18		92,997 sf	2.13ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.13ac	100%	37%	37.0%	0.34	0.58
D-19		129,215 sf	2.97ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.97ac	100%	37%	37.0%	0.34	0.58
D-19.1	DP89	7,235 sf	0.17ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	0.17ac	102%	38%	37.9%	0.34	0.58
D-20a	DP 92a	35,151 sf	0.81ac	C	100%	0.34ac	42%	42%	0%	0.37ac	46%	0%	46%		0%	0%	37%	0.10ac	12%	4%	46.6%	0.38	0.60
D-20b	DP 92b	20,481 sf	0.47ac	C	100%	0.40ac	85%	85%	0%	0.07ac	15%	0%	46%		0%	0%	37%		0%	0%	85.1%	0.68	0.79
D-20c	DP 92d	15,896 sf	0.36ac	C	100%	0.17ac	47%	47%	0%	0.19ac	52%	0%	46%		0%	0%	37%		0%	0%	46.6%	0.38	0.60
D-21	DP 91	175,102 sf	4.02ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.02ac	100%	37%	37.0%	0.28	0.49
D-22	DP 90	50,194 sf	1.15ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	1.15ac	100%	37%	37.0%	0.28	0.49
D-23	DP92e	12,393 sf	0.28ac	C	100%	0.24ac	84%	84%	0%	0.04ac	16%	0%	46%		0%	0%	37%		0%	0%	84.4%	0.67	0.78
D-24		443,273 sf	10.18ac	C	100%		0%	0%	0%	7.78ac	76%	0%	46%		0%	0%	37%	2.40ac	24%	9%	8.7%	0.20	0.53
Combined Design Point Summary																							
	DP 69	D1, D2	2.85ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.85ac	100%	37%	37.0%	0.28	0.49
	DP 71	D3, D4	3.76ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.76ac	100%	37%	37.0%	0.28	0.49
	DP 74	D3, D4, D6	4.17ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	4.17ac	100%	37%	37.0%	0.34	0.58
	DP 75	D1-D4, D6, D7	10.01ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	10.01ac	100%	37%	37.0%	0.34	0.58
	DP 76	D1-D4, D6-D8	11.63ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	11.63ac	100%	37%	37.0%	0.34	0.58
	DP 78	D1-D4, D6-D9	13.74ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	13.74ac	100%	37%	37.0%	0.34	0.58
	DP 79	D1-D4, D6-D10	16.73ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	16.73ac	100%	37%	37.0%	0.34	0.58
	DP 81	D11, D12	5.34ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	5.34ac	100%	37%	37.0%	0.34	0.58
	DP 82	D5, D13	3.62ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	3.62ac	100%	37%	37.0%	0.28	0.49
	DP 83	D5, D13, D14	6.93ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	6.93ac	100%	37%	37.0%	0.28	0.49
	DP 85	D15,D16, D16.1	7.15ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	7.15ac	100%	37%	37.0%	0.34	0.58
	DP 86	D15 - D17	10.60ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	10.60ac	100%	37%	37.0%	0.34	0.58
	DP 87	D15 - D18	12.74ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	12.74ac	100%	37%	37.0%	0.34	0.58
	DP 88	D15 - D19	15.70ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	15.70ac	100%	37%	37.0%	0.34	0.58
	DP 92c	D20a-c, D21, D22	7.10ac	B	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	2.94ac	41%	15%	15.3%	0.17	0.42
	DP 93a	D1-D19.1	44.87ac	C	100%		0%	0%	0%		0%	0%	46%		0%	0%	37%	44.87ac	100%	37%	37.0%	0.34	0.58
	DP 93b	D20b, D20c, D23	1.12ac	C	100%	0.56ac	50%	50%	0%	0.30ac	27%	0%	46%		0%	0%	37%		0%	0%	50.0%	0.40	0.60
D1-24	DP 94	ULTIMATE	62.15ac	C	100%	1.15ac	2%	2%	0%	8.45ac	14%	0%	46%		0%	0%	37%	52.54ac	85%	31%	33.1%	0.32	0.57

Basin Runoff Coefficient is based on UDFCD % Imperviousness Calculation								
Runoff Coefficients and Percents Impervious								
Hydrologic Soil Type:	B						Runoff Coef Calc Method	%Imp
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Commercial Area	CO	95%	0.79	0.81	0.83	0.85	0.87	0.88
Drives and Walks	DR	90%	0.71	0.73	0.75	0.78	0.80	0.81
Streets - Gravel (Packed)	GR	40%	0.23	0.30	0.36	0.42	0.46	0.50
Historic Flow Analysis	HI	2%	0.03	0.08	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.51
Park	PA	7%	0.05	0.12	0.20	0.29	0.34	0.39
Playground	PL	13%	0.07	0.16	0.24	0.32	0.37	0.42
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81
Residential: 3.7 Lots/Acre	RS1	37%	0.22	0.28	0.35	0.41	0.45	0.49
Residential: 1/5 Acre	RS2	46%	0.27	0.33	0.39	0.45	0.48	0.51

Equations (% Impervious Calculation):

$C_A = K_A+(1.31\, i^3 - 1.44\, i^2 + 1.135\, i - 0.12)$ [Eqn RO-6]

$C_{CD} = K_{CD}+(0.858\, i^3 - 0.786\, i^2 + 0.774\, i + 0.04)$ [Eqn RO-7]

$C_B = (C_A + C_{CD}) / 2$

I = % imperviousness/100 as a decimal (See Table RO-3)

C_A = Runoff coefficient for NRCS Type A Soils

C_B = Runoff coefficient for NRCS Type B Soils

C_{CD} = Runoff coefficient for NRCS Type C and D Soils

Correction Factors - Table RO-4

K_A = For Type A Soils

K_A (2-yr)= 0

K_A (5-yr)= -0.08i + 0.09

K_A (10-yr)= -0.14i + 0.17

K_A (25-yr)= -0.19i + 0.24

K_A (50-yr)= -0.22i + 0.28

K_A (100-yr)= -0.25i + 0.32

K_{CD}=For Type C & D Soils

K_{CD} (2-yr)= 0

K_{CD} (5-yr)= -0.10i + 0.11

K_{CD} (10-yr)= -0.18i + 0.21

K_{CD} (25-yr)= -0.28i + 0.33

K_{CD} (50-yr)= -0.33i + 0.40

K_{CD} (100-yr)= -0.39i + 0.46

The Glen at Widefield
Developed Condition
Runoff Coeficient and Percent Impervious Calculation

Filing 10 - Interim Condition

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		Final t_c*
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total	t_c Check	
D-1	DP 68		1.40ac	0.08	100lf	2.4%	14.0 min.	600lf	3.5%	NBG	10	1.9 ft/sec	5.3 min.	19.4 min.	700lf	13.9 min.	19.4 min.
D-2			1.45ac	0.08	85lf	1.5%	15.1 min.	655lf	0.9%	NBG	10	0.9 ft/sec	11.5 min.	26.6 min.	740lf	14.1 min.	26.6 min.
D-3	DP 70		1.69ac	0.08	100lf	2.4%	14.0 min.	600lf	3.5%	NBG	10	1.9 ft/sec	5.3 min.	19.4 min.	700lf	13.9 min.	19.4 min.
D-4			2.07ac	0.15	50lf	1.0%	12.3 min.	610lf	0.9%	NBG	10	0.9 ft/sec	10.7 min.	23.0 min.	660lf	13.7 min.	23.0 min.
D-5	DP 72		1.56ac	0.15	60lf	2.0%	10.7 min.	790lf	0.5%	NBG	10	0.7 ft/sec	18.6 min.	29.3 min.	850lf	14.7 min.	29.3 min.
D-6	DP 73		0.41ac	0.15	90lf	1.0%	16.5 min.	140lf	0.8%	NBG	10	0.9 ft/sec	2.6 min.	19.1 min.	230lf	11.3 min.	19.1 min.
D-7			2.98ac	0.15	100lf	1.5%	15.2 min.	430lf	1.3%	NBG	10	1.1 ft/sec	6.3 min.	21.5 min.	530lf	12.9 min.	21.5 min.
D-8			1.62ac	0.15	100lf	1.0%	17.4 min.	330lf	1.5%	NBG	10	1.2 ft/sec	4.5 min.	21.9 min.	430lf	12.4 min.	21.9 min.
D-9	DP 77		2.11ac	0.08	100lf	2.0%	14.9 min.	300lf	1.3%	NBG	10	1.1 ft/sec	4.4 min.	19.3 min.	400lf	12.2 min.	19.3 min.
D-10			2.99ac	0.15	100lf	1.5%	15.2 min.	660lf	1.1%	NBG	10	1.0 ft/sec	10.5 min.	25.7 min.	760lf	14.2 min.	25.7 min.
D-11	DP 80		3.96ac	0.15	70lf	1.5%	12.7 min.	1095lf	1.2%	NBG	10	1.1 ft/sec	16.7 min.	29.4 min.	1165lf	16.5 min.	29.4 min.
D-12			1.39ac	0.15	100lf	1.3%	15.9 min.	450lf	1.2%	NBG	10	1.1 ft/sec	6.8 min.	22.8 min.	550lf	13.1 min.	22.8 min.
D-13			2.06ac	0.15	55lf	1.0%	12.9 min.	660lf	0.6%	NBG	10	0.8 ft/sec	14.2 min.	27.1 min.	715lf	14.0 min.	27.1 min.
D-14			3.30ac	0.15	100lf	1.8%	14.3 min.	980lf	1.6%	NBG	10	1.3 ft/sec	12.9 min.	27.2 min.	1080lf	16.0 min.	27.2 min.
D-15	DP 84		2.80ac	0.08	100lf	2.0%	14.9 min.	185lf	2.0%	NBG	10	1.4 ft/sec	2.2 min.	17.1 min.	285lf	11.6 min.	17.1 min.
D-16			2.27ac	0.15	100lf	2.0%	13.8 min.	660lf	0.8%	NBG	10	0.9 ft/sec	12.3 min.	26.1 min.	760lf	14.2 min.	26.1 min.
D-16.1			2.08ac	0.15	100lf	1.4%	15.5 min.	360lf	0.8%	NBG	10	0.9 ft/sec	6.7 min.	22.3 min.	460lf	12.6 min.	22.3 min.
D-17			3.45ac	0.15	100lf	1.5%	15.2 min.	410lf	1.5%	NBG	10	1.2 ft/sec	5.6 min.	20.8 min.	510lf	12.8 min.	20.8 min.
D-18			2.13ac	0.15	116lf	1.5%	16.4 min.	510lf	2.2%	NBG	10	1.5 ft/sec	5.7 min.	22.1 min.	626lf	13.5 min.	22.1 min.
D-19			2.97ac	0.15	100lf	2.6%	12.7 min.	510lf	1.1%	NBG	10	1.0 ft/sec	8.1 min.	20.8 min.	610lf	13.4 min.	20.8 min.
D-19.1	DP89		0.17ac	0.15	75lf	1.6%	12.9 min.	23lf	1.0%	NBG	10	1.0 ft/sec	0.4 min.	13.3 min.	98lf	10.5 min.	13.3 min.
D-20a	DP 92a		0.81ac	0.28	100lf	3.3%	10.0 min.	300lf	0.8%	PV	20	1.8 ft/sec	2.8 min.	12.8 min.	400lf	12.2 min.	12.2 min.
D-20b	DP 92b		0.47ac	0.36	80lf	3.3%	8.1 min.	10lf	6.0%	NBG	10	2.4 ft/sec	0.1 min.	8.2 min.	90lf	10.5 min.	10.5 min.
D-20c	DP 92d		0.36ac	0.15	14lf	25.0%	2.2 min.	243lf	1.0%	PV	20	2.0 ft/sec	2.0 min.	5.0 min.	257lf	11.4 min.	11.4 min.
D-21	DP 91		4.02ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	13.7 min.
D-22	DP 90		1.15ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	11.9 min.
D-23	DP92e		0.28ac	0.23	10lf	2.5%	3.7 min.	230lf	1.0%	GW	15	1.5 ft/sec	2.6 min.	6.3 min.	240lf	11.3 min.	11.3 min.
D-24			10.18ac	0.20	100lf	4.9%	9.8 min.	800lf	0.5%	GW	15	1.1 ft/sec	12.6 min.	22.3 min.	900lf	15.0 min.	22.3 min.
Combined Design Point Summary																	
	DP 69	D1, D2	2.85ac	0.08	100lf	2.4%	14.0 min.	1385lf	2.0%	NBG	10	1.4 ft/sec	16.3 min.	30.3 min.	1485lf	18.3 min.	30.3 min.
	DP 71	D3, D4	3.76ac	0.08	100lf	2.4%	14.0 min.	1370lf	2.0%	NBG	10	1.4 ft/sec	16.1 min.	30.2 min.	1470lf	18.2 min.	30.2 min.
	DP 74	D3, D4, D6	4.17ac	0.15	100lf	2.4%	13.0 min.	1370lf	2.0%	NBG	10	1.4 ft/sec	16.1 min.	29.1 min.	1470lf	18.2 min.	29.1 min.
	DP 75	D1-D4, D6, D7	10.01ac	0.15	100lf	2.4%	13.0 min.	1970lf	1.8%	NBG	10	1.3 ft/sec	24.5 min.	37.5 min.	2070lf	21.5 min.	37.5 min.
	DP 76	D1-D4, D6-D8	11.63ac	0.15	100lf	2.4%	13.0 min.	2110lf	1.8%	NBG	10	1.3 ft/sec	26.2 min.	39.2 min.	2210lf	22.3 min.	39.2 min.
	DP 78	D1-D4, D6-D9	13.74ac	0.15	100lf	2.4%	13.0 min.	2110lf	1.8%	NBG	10	1.3 ft/sec	26.2 min.	39.2 min.	2210lf	22.3 min.	39.2 min.
	DP 79	D1-D4, D6-D10	16.73ac	0.15	100lf	2.4%	13.0 min.	2770lf	1.6%	NBG	10	1.3 ft/sec	36.5 min.	49.5 min.	2870lf	25.9 min.	49.5 min.
	DP 81	D11, D12	5.34ac	0.15	70lf	1.5%	12.7 min.	1545lf	1.2%	NBG	10	1.1 ft/sec	23.5 min.	36.2 min.	1615lf	19.0 min.	36.2 min.
	DP 82	D5, D13	3.62ac	0.08	60lf	2.0%	11.5 min.	1590lf	0.6%	NBG	10	0.7 ft/sec	35.4 min.	47.0 min.	1650lf	19.2 min.	47.0 min.
	DP 83	D5, D13, D14	6.93ac	0.08	60lf	2.0%	11.5 min.	2640lf	0.9%	NBG	10	0.9 ft/sec	46.4 min.	57.9 min.	2700lf	25.0 min.	57.9 min.
	DP 85	D15,D16, D16.1	7.15ac	0.15	100lf	2.0%	13.8 min.	1035lf	0.8%	NBG	10	0.9 ft/sec	19.3 min.	33.1 min.	1135lf	16.3 min.	33.1 min.
	DP 86	D15 - D17	10.60ac	0.15	100lf	2.0%	13.8 min.	1320lf	0.7%	NBG	10	0.8 ft/sec	26.3 min.	40.1 min.	1420lf	17.9 min.	40.1 min.
	DP 87	D15 - D18	12.74ac	0.15	100lf	2.0%	13.8 min.	2080lf	1.0%	NBG	10	1.0 ft/sec	34.7 min.	48.5 min.	2180lf	22.1 min.	48.5 min.
	DP 88	D15 - D19	15.70ac	0.15	100lf	2.0%	13.8 min.	2580lf	1.0%	NBG	10	1.0 ft/sec	43.0 min.	56.8 min.	2680lf	24.9 min.	56.8 min.
	DP 92c	D20a,D21, D22	5.98ac	0.28	100lf	2.0%	11.9 min.	564lf	1.0%	NBG	10	1.0 ft/sec	9.4 min.	21.3 min.	664lf	13.7 min.	13.7 min.
	DP 93a	D1-D19	44.70ac	0.28	100lf	2.0%	11.9 min.	2820lf	1.0%	NBG	10	1.0 ft/sec	47.0 min.	58.9 min.	2920lf	26.2 min.	58.9 min.
	DP 93b	**D19.1, D20c, D23**	**0.82ac**	0.15	14lf	2.0%	5.2 min.	56lf	1.6%	NBG	10	1.3 ft/sec	0.7 min.	5.9 min.	70lf	10.4 min.	10.4 min.
	DP 94	**D1-24 Summ:**	**62.15ac**	**0.18**	**100lf**	**2.4%**	**12.5 min.**	**3110lf**	**1.6%**	**NBG**	**10**	**1.3 ft/sec**	**41.0 min.**	**53.5 min.**	**3210lf**	**27.8 min.**	**56.8 min.**

***Red Indicates Sub-basins are non-urbanized In The Interim Condition.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see Table RO-2)

S = Watercourse slope (ft/ft)

Land Surface Type	Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

The Glen at Widefield

Developed Condition

Runoff Coeficient and Percent Impervious Calculation

Filings 10-12 Ultimate Condition

Sub-Basin Data					Time of Concentration Estimate										Min. Tc in Urban		
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		Final t_c
Basin	Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
D-1	DP 68		1.40ac	0.28	100lf	2.4%	11.2 min.	600lf	3.5%	PV	20	3.7 ft/sec	2.7 min.	13.9 min.	700lf	13.9 min.	**13.9 min.**
D-2			1.45ac	0.28	85lf	1.5%	12.1 min.	655lf	0.9%	PV	20	1.9 ft/sec	5.8 min.	17.8 min.	740lf	14.1 min.	**14.1 min.**
D-3	DP 70		1.69ac	0.28	100lf	2.4%	11.2 min.	600lf	3.5%	PV	20	3.7 ft/sec	2.7 min.	13.9 min.	700lf	13.9 min.	**13.9 min.**
D-4			2.07ac	0.34	50lf	1.0%	9.9 min.	610lf	0.9%	PV	20	1.9 ft/sec	5.4 min.	15.3 min.	660lf	13.7 min.	**13.7 min.**
D-5	DP 72		1.56ac	0.34	60lf	2.0%	8.6 min.	790lf	0.5%	PV	20	1.4 ft/sec	9.3 min.	17.9 min.	850lf	14.7 min.	**14.7 min.**
D-6	DP 73		0.41ac	0.34	90lf	1.0%	13.3 min.	140lf	0.8%	PV	20	1.8 ft/sec	1.3 min.	14.6 min.	230lf	11.3 min.	**11.3 min.**
D-7			2.98ac	0.34	100lf	1.5%	12.2 min.	430lf	1.3%	PV	20	2.3 ft/sec	3.1 min.	15.4 min.	530lf	12.9 min.	**12.9 min.**
D-8			1.62ac	0.34	100lf	1.0%	14.0 min.	330lf	1.5%	PV	20	2.4 ft/sec	2.2 min.	16.2 min.	430lf	12.4 min.	**12.4 min.**
D-9	DP 77		2.11ac	0.28	100lf	2.0%	11.9 min.	300lf	1.3%	PV	20	2.3 ft/sec	2.2 min.	14.1 min.	400lf	12.2 min.	**12.2 min.**
D-10			2.99ac	0.34	100lf	1.5%	12.2 min.	660lf	1.1%	PV	20	2.1 ft/sec	5.2 min.	17.5 min.	760lf	14.2 min.	**14.2 min.**
D-11	DP 80		3.96ac	0.34	70lf	1.5%	10.2 min.	1095lf	1.2%	PV	20	2.2 ft/sec	8.3 min.	18.6 min.	1165lf	16.5 min.	**16.5 min.**
D-12			1.39ac	0.34	100lf	1.3%	12.8 min.	450lf	1.2%	PV	20	2.2 ft/sec	3.4 min.	16.3 min.	550lf	13.1 min.	**13.1 min.**
D-13			2.06ac	0.34	55lf	1.0%	10.4 min.	660lf	0.6%	PV	20	1.5 ft/sec	7.1 min.	17.5 min.	715lf	14.0 min.	**14.0 min.**
D-14			3.30ac	0.34	100lf	1.8%	11.5 min.	980lf	1.6%	PV	20	2.5 ft/sec	6.5 min.	18.0 min.	1080lf	16.0 min.	**16.0 min.**
D-15	DP 84		2.80ac	0.28	100lf	2.0%	11.9 min.	185lf	2.0%	PV	20	2.8 ft/sec	1.1 min.	13.0 min.	285lf	11.6 min.	**11.6 min.**
D-16			2.27ac	0.34	100lf	2.0%	11.1 min.	660lf	0.8%	PV	20	1.8 ft/sec	6.1 min.	17.3 min.	760lf	14.2 min.	**14.2 min.**
D-16.1			2.08ac	0.34	100lf	1.4%	12.5 min.	360lf	0.8%	PV	20	1.8 ft/sec	3.4 min.	15.9 min.	460lf	12.6 min.	**12.6 min.**
D-17			3.45ac	0.34	60lf	1.5%	9.5 min.	410lf	1.5%	PV	20	2.4 ft/sec	2.8 min.	12.3 min.	470lf	12.6 min.	**12.3 min.**
D-18			2.13ac	0.34	60lf	1.5%	9.5 min.	510lf	2.2%	PV	20	3.0 ft/sec	2.9 min.	12.3 min.	570lf	13.2 min.	**12.3 min.**
D-19			2.97ac	0.34	100lf	2.6%	10.2 min.	510lf	1.1%	PV	20	2.1 ft/sec	4.1 min.	14.2 min.	610lf	13.4 min.	**13.4 min.**
D-19.1	DP89		0.17ac	0.34	75lf	1.6%	10.3 min.	23lf	1.1%	PV	20	2.1 ft/sec	0.2 min.	10.5 min.	98lf	10.5 min.	**10.5 min.**
D-20a	DP 92a		0.81ac	0.38	100lf	3.3%	8.8 min.	300lf	0.8%	PV	20	1.8 ft/sec	2.8 min.	11.6 min.	400lf	12.2 min.	**11.6 min.**
D-20b	DP 92b		0.47ac	0.68	80lf	3.3%	4.6 min.	10lf	6.0%	PV	20	4.9 ft/sec	0.0 min.	5.0 min.	90lf	10.5 min.	**5.0 min.**
D-20c	DP 92d		0.36ac	0.38	80lf	3.3%	7.9 min.	10lf	6.0%	PV	20	4.9 ft/sec	0.0 min.	7.9 min.	90lf	10.5 min.	**7.9 min.**
D-21	DP 91		4.02ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	**11.9 min.**
D-22	DP 90		1.15ac	0.28	50lf	2.0%	8.4 min.	610lf	2.1%	PV	20	2.9 ft/sec	3.5 min.	11.9 min.	660lf	13.7 min.	**11.9 min.**
D-23	DP92e		0.28ac	0.67	10lf	2.5%	1.8 min.	230lf	1.0%	PV	20	2.0 ft/sec	1.9 min.	5.0 min.	240lf	11.3 min.	**5.0 min.**
D-24			10.18ac	0.20	100lf	4.9%	9.7 min.	800lf	0.5%	GW	15	1.1 ft/sec	12.6 min.	22.2 min.	900lf	15.0 min.	**15.0 min.**
Combined Design Point Summary																	
	DP 69	D1, D2	2.85ac	0.28	100lf	2.4%	11.2 min.	1385lf	2.0%	PV	20	2.8 ft/sec	8.2 min.	19.3 min.	1485lf	18.3 min.	**18.3 min.**
	DP 71	D3, D4	3.76ac	0.28	100lf	2.4%	11.2 min.	1370lf	2.0%	PV	20	2.8 ft/sec	8.1 min.	19.3 min.	1470lf	18.2 min.	**18.2 min.**
	DP 74	D3, D4, D6	4.17ac	0.34	100lf	2.4%	10.5 min.	1370lf	2.0%	PV	20	2.8 ft/sec	8.1 min.	18.5 min.	1470lf	18.2 min.	**18.2 min.**
	DP 75	D1-D4, D6, D7	10.01ac	0.34	100lf	2.4%	10.5 min.	1970lf	1.8%	PV	20	2.7 ft/sec	12.2 min.	22.7 min.	2070lf	21.5 min.	**21.5 min.**
	DP 76	D1-D4, D6-D8	11.63ac	0.34	100lf	2.4%	10.5 min.	2110lf	1.8%	PV	20	2.7 ft/sec	13.1 min.	23.6 min.	2210lf	22.3 min.	**22.3 min.**
	DP 78	D1-D4, D6-D9	13.74ac	0.34	100lf	2.4%	10.5 min.	2110lf	1.8%	PV	20	2.7 ft/sec	13.1 min.	23.6 min.	2210lf	22.3 min.	**22.3 min.**
	DP 79	D1-D4, D6-D10	16.73ac	0.34	100lf	2.4%	10.5 min.	2770lf	1.6%	PV	20	2.5 ft/sec	18.2 min.	28.7 min.	2870lf	25.9 min.	**25.9 min.**
	DP 81	D11, D12	5.34ac	0.34	70lf	1.5%	10.2 min.	1545lf	1.2%	PV	20	2.2 ft/sec	11.8 min.	22.0 min.	1615lf	19.0 min.	**19.0 min.**
	DP 82	D5, D13	3.62ac	0.28	60lf	2.0%	9.2 min.	1590lf	0.6%	PV	20	1.5 ft/sec	17.7 min.	26.9 min.	1650lf	19.2 min.	**19.2 min.**
	DP 83	D5, D13, D14	6.93ac	0.28	60lf	2.0%	9.2 min.	2640lf	0.9%	PV	20	1.9 ft/sec	23.2 min.	32.4 min.	2700lf	25.0 min.	**25.0 min.**
	DP 85	D15,D16, D16.1	7.15ac	0.34	100lf	2.0%	11.1 min.	1035lf	0.8%	PV	20	1.8 ft/sec	9.6 min.	20.8 min.	1135lf	16.3 min.	**16.3 min.**
	DP 86	D15 - D17	10.60ac	0.34	100lf	2.0%	11.1 min.	1320lf	0.7%	PV	20	1.7 ft/sec	13.1 min.	24.3 min.	1420lf	17.9 min.	**17.9 min.**
	DP 87	D15 - D18	12.74ac	0.34	100lf	2.0%	11.1 min.	2080lf	1.0%	PV	20	2.0 ft/sec	17.3 min.	28.4 min.	2180lf	22.1 min.	**22.1 min.**
	DP 88	D15 - D19	15.70ac	0.34	100lf	2.0%	11.1 min.	2580lf	1.0%	PV	20	2.0 ft/sec	21.5 min.	32.6 min.	2680lf	24.9 min.	**24.9 min.**
	DP 92c	D20a-c, D21, D22	7.10ac	0.17	50lf	2.0%	9.6 min.	546lf	1.6%	PV	20	2.5 ft/sec	3.6 min.	13.2 min.	596lf	13.3 min.	**13.2 min.**
	DP 93a	D1-D19.1	44.87ac	0.34	100lf	2.4%	10.5 min.	2820lf	1.6%	PV	20	2.5 ft/sec	18.6 min.	29.0 min.	2920lf	26.2 min.	**26.2 min.**
	DP 93b	D20b, D20c, D23	1.12ac	0.40	14lf	2.4%	3.6 min.	56lf	1.6%	PV	20	2.5 ft/sec	0.4 min.	5.0 min.	70lf	10.4 min.	**5.0 min.**
	DP 94	**ULTIMATE**	**62.15ac**	**0.32**	**100lf**	**2.4%**	**10.7 min.**	**3110lf**	**1.0%**	**PV**	**20**	**2.0 ft/sec**	**25.9 min.**	**36.6 min.**	**3210lf**	**27.8 min.**	**27.8 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see Table RO-2)

S = Watercourse slope (ft/ft)

Land Surface Type	Type	Cv
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

The Glen at Widefield

Developed Condition

Runoff Coeficient and Percent Impervious Calculation

Filing 10 - Interim Condition

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
D-1	DP 68		1.40 ac	0.08	0.35	19.4 min.	3.1 in/hr	5.3 in/hr	**0.3 cfs**	**2.6 cfs**	D-1
D-2			1.45 ac	0.08	0.35	26.6 min.	2.7 in/hr	4.5 in/hr	**0.3 cfs**	**2.3 cfs**	D-2
D-3	DP 70		1.69 ac	0.08	0.35	19.4 min.	3.1 in/hr	5.3 in/hr	**0.4 cfs**	**3.1 cfs**	D-3
D-4			2.07 ac	0.15	0.50	23.0 min.	2.9 in/hr	4.8 in/hr	**0.9 cfs**	**5.0 cfs**	D-4
D-5	DP 72		1.56 ac	0.15	0.50	29.3 min.	2.5 in/hr	4.2 in/hr	**0.6 cfs**	**3.3 cfs**	D-5
D-6	DP 73		0.41 ac	0.15	0.50	19.1 min.	3.2 in/hr	5.3 in/hr	**0.2 cfs**	**1.1 cfs**	D-6
D-7			2.98 ac	0.15	0.50	21.5 min.	3.0 in/hr	5.0 in/hr	**1.3 cfs**	**7.5 cfs**	D-7
D-8			1.62 ac	0.15	0.50	21.9 min.	3.0 in/hr	5.0 in/hr	**0.7 cfs**	**4.0 cfs**	D-8
D-9	DP 77		2.11 ac	0.08	0.35	19.3 min.	3.1 in/hr	5.3 in/hr	**0.5 cfs**	**3.9 cfs**	D-9
D-10			2.99 ac	0.15	0.50	25.7 min.	2.7 in/hr	4.6 in/hr	**1.2 cfs**	**6.8 cfs**	D-10
D-11	DP 80		3.96 ac	0.15	0.50	29.4 min.	2.5 in/hr	4.2 in/hr	**1.5 cfs**	**8.3 cfs**	D-11
D-12			1.39 ac	0.15	0.50	22.8 min.	2.9 in/hr	4.9 in/hr	**0.6 cfs**	**3.4 cfs**	D-12
D-13			2.06 ac	0.15	0.50	27.1 min.	2.6 in/hr	4.4 in/hr	**0.8 cfs**	**4.6 cfs**	D-13
D-14			3.30 ac	0.15	0.50	27.2 min.	2.6 in/hr	4.4 in/hr	**1.3 cfs**	**7.3 cfs**	D-14
D-15	DP 84		2.80 ac	0.08	0.35	17.1 min.	3.3 in/hr	5.6 in/hr	**0.7 cfs**	**5.5 cfs**	D-15
D-16			2.27 ac	0.15	0.50	26.1 min.	2.7 in/hr	4.5 in/hr	**0.9 cfs**	**5.1 cfs**	D-16
D-16.1			2.08 ac	0.15	0.50	22.3 min.	2.9 in/hr	4.9 in/hr	**0.9 cfs**	**5.1 cfs**	D-16.1
D-17			3.45 ac	0.15	0.50	20.8 min.	3.0 in/hr	5.1 in/hr	**1.6 cfs**	**8.8 cfs**	D-17
D-18			2.13 ac	0.15	0.50	22.1 min.	2.9 in/hr	4.9 in/hr	**0.9 cfs**	**5.3 cfs**	D-18
D-19			2.97 ac	0.15	0.50	20.8 min.	3.0 in/hr	5.1 in/hr	**1.3 cfs**	**7.6 cfs**	D-19
D-19.1	DP89		0.17 ac	0.15	0.50	13.3 min.	3.7 in/hr	6.2 in/hr	**0.1 cfs**	**0.5 cfs**	D-19.1
D-20a	DP 92a		0.81 ac	0.28	0.49	12.2 min.	3.8 in/hr	6.4 in/hr	**0.9 cfs**	**2.5 cfs**	D-20a
D-20b	DP 92b		0.47 ac	0.36	0.59	10.5 min.	4.1 in/hr	6.8 in/hr	**0.7 cfs**	**1.9 cfs**	D-20b
D-20c	DP 92d		0.36 ac	0.15	0.50	11.4 min.	3.9 in/hr	6.6 in/hr	**0.2 cfs**	**1.2 cfs**	D-20c
D-21	DP 91		4.02 ac	0.28	0.49	13.7 min.	3.7 in/hr	6.1 in/hr	**4.2 cfs**	**12.0 cfs**	D-21
D-22	DP 90		1.15 ac	0.28	0.49	11.9 min.	3.9 in/hr	6.5 in/hr	**1.3 cfs**	**3.6 cfs**	D-22
D-23	DP92e		0.28 ac	0.23	0.54	11.3 min.	3.9 in/hr	6.6 in/hr	**0.3 cfs**	**1.0 cfs**	D-23
D-24			10.18 ac	0.20	0.52	22.3 min.	2.9 in/hr	4.9 in/hr	**5.8 cfs**	**26.2 cfs**	D-24
Combined Design Point Summary						Direct Summation (No Lagging):			**30.4 cfs**	**149.4 cfs**	
	DP 69	D1, D2	2.85 ac	0.08	0.35	30.3 min.	2.5 in/hr	4.1 in/hr	**0.5 cfs**	**4.1 cfs**	DP 69
	DP 71	D3, D4	3.76 ac	0.08	0.35	30.2 min.	2.5 in/hr	4.2 in/hr	**0.7 cfs**	**5.5 cfs**	DP 71
	DP 74	D3, D4, D6	4.17 ac	0.15	0.50	29.1 min.	2.5 in/hr	4.2 in/hr	**1.6 cfs**	**8.8 cfs**	DP 74
	DP 75	D1-D4, D6, D7	10.01 ac	0.15	0.50	37.5 min.	2.1 in/hr	3.6 in/hr	**3.2 cfs**	**18.0 cfs**	DP 75
	DP 76	D1-D4, D6-D8	11.63 ac	0.15	0.50	39.2 min.	2.1 in/hr	3.5 in/hr	**3.6 cfs**	**20.3 cfs**	DP 76
	DP 78	D1-D4, D6-D9	13.74 ac	0.15	0.50	39.2 min.	2.1 in/hr	3.5 in/hr	**4.3 cfs**	**24.0 cfs**	DP 78
	DP 79	D1-D4, D6-D10	16.73 ac	0.15	0.50	49.5 min.	1.7 in/hr	2.9 in/hr	**4.3 cfs**	**24.3 cfs**	DP 79
	DP 81	D11, D12	5.34 ac	0.15	0.50	36.2 min.	2.2 in/hr	3.7 in/hr	**1.8 cfs**	**9.9 cfs**	DP 81
	DP 82	D5, D13	3.62 ac	0.08	0.35	47.0 min.	1.8 in/hr	3.0 in/hr	**0.5 cfs**	**3.9 cfs**	DP 82
	DP 83	D5, D13, D14	6.93 ac	0.08	0.35	57.9 min.	1.5 in/hr	2.5 in/hr	**0.8 cfs**	**6.1 cfs**	DP 83
	DP 85	D15,D16, D16.1	7.15 ac	0.15	0.50	33.1 min.	2.3 in/hr	3.9 in/hr	**2.5 cfs**	**14.0 cfs**	DP 85
	DP 86	D15 - D17	10.60 ac	0.15	0.50	40.1 min.	2.0 in/hr	3.4 in/hr	**3.3 cfs**	**18.2 cfs**	DP 86
	DP 87	D15 - D18	12.74 ac	0.15	0.50	48.5 min.	1.8 in/hr	3.0 in/hr	**3.4 cfs**	**18.8 cfs**	DP 87
	DP 88	D15 - D19	15.70 ac	0.15	0.50	56.8 min.	1.5 in/hr	2.6 in/hr	**3.6 cfs**	**20.1 cfs**	DP 88
	DP 92c	D20a,D21, D22	5.98 ac	0.28	0.49	13.7 min.	3.7 in/hr	6.1 in/hr	**6.2 cfs**	**17.9 cfs**	DP 92c
	DP 93a	D1-D19	44.70 ac	0.15	0.50	58.9 min.	1.5 in/hr	2.5 in/hr	**9.9 cfs**	**55.1 cfs**	DP 93a
	DP93b	D19.1, D20c, D23	0.82 ac	0.18	0.52	5.2 min.	5.1 in/hr	8.6 in/hr	**0.8 cfs**	**3.6 cfs**	DP93b
	DP 94	**D1-24 Summ:**	**62.15 ac**	**0.32**	**0.57**	**27.8 min.**	**2.6 in/hr**	**4.4 in/hr**	**51.3 cfs**	**154.8 cfs**	**ULTIMATE**
	DP 94	**Detained:**	**61.39 ac**	**0.18**	**0.52**	**53.5 min.**	**1.6 in/hr**	**2.7 in/hr**	**18.1 cfs**	**86.0 cfs**	**INTERIM**

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

The Glen at Widefield

Developed Condition

Runoff Coeficient and Percent Impervious Calculation

Filings 10-12 Ultimate Condition

Basin	Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
D-1	DP 68		1.40 ac	0.28	0.49	13.9 min.	3.6 in/hr	6.1 in/hr	**1.4 cfs**	**4.2 cfs**	D-1
D-2			1.45 ac	0.28	0.49	14.1 min.	3.6 in/hr	6.1 in/hr	**1.5 cfs**	**4.3 cfs**	D-2
D-3	DP 70		1.69 ac	0.28	0.49	13.9 min.	3.6 in/hr	6.1 in/hr	**1.7 cfs**	**5.0 cfs**	D-3
D-4			2.07 ac	0.34	0.58	13.7 min.	3.7 in/hr	6.1 in/hr	**2.5 cfs**	**7.4 cfs**	D-4
D-5	DP 72		1.56 ac	0.34	0.58	14.7 min.	3.5 in/hr	6.0 in/hr	**1.9 cfs**	**5.4 cfs**	D-5
D-6	DP 73		0.41 ac	0.34	0.58	11.3 min.	3.9 in/hr	6.6 in/hr	**0.5 cfs**	**1.6 cfs**	D-6
D-7			2.98 ac	0.34	0.58	12.9 min.	3.7 in/hr	6.3 in/hr	**3.7 cfs**	**10.8 cfs**	D-7
D-8			1.62 ac	0.34	0.58	12.4 min.	3.8 in/hr	6.4 in/hr	**2.1 cfs**	**6.0 cfs**	D-8
D-9	DP 77		2.11 ac	0.28	0.49	12.2 min.	3.8 in/hr	6.4 in/hr	**2.3 cfs**	**6.6 cfs**	D-9
D-10			2.99 ac	0.34	0.58	14.2 min.	3.6 in/hr	6.0 in/hr	**3.6 cfs**	**10.5 cfs**	D-10
D-11	DP 80		3.96 ac	0.34	0.58	16.5 min.	3.4 in/hr	5.7 in/hr	**4.5 cfs**	**13.0 cfs**	D-11
D-12			1.39 ac	0.34	0.58	13.1 min.	3.7 in/hr	6.3 in/hr	**1.7 cfs**	**5.0 cfs**	D-12
D-13			2.06 ac	0.34	0.58	14.0 min.	3.6 in/hr	6.1 in/hr	**2.5 cfs**	**7.3 cfs**	D-13
D-14			3.30 ac	0.34	0.58	16.0 min.	3.4 in/hr	5.7 in/hr	**3.8 cfs**	**11.0 cfs**	D-14
D-15	DP 84		2.80 ac	0.28	0.49	11.6 min.	3.9 in/hr	6.6 in/hr	**3.1 cfs**	**9.0 cfs**	D-15
D-16			2.27 ac	0.34	0.58	14.2 min.	3.6 in/hr	6.0 in/hr	**2.7 cfs**	**7.9 cfs**	D-16
D-16.1			2.08 ac	0.34	0.58	12.6 min.	3.8 in/hr	6.4 in/hr	**2.6 cfs**	**7.6 cfs**	D-16.1
D-17			3.45 ac	0.34	0.58	12.3 min.	3.8 in/hr	6.4 in/hr	**4.4 cfs**	**12.8 cfs**	D-17
D-18			2.13 ac	0.34	0.58	12.3 min.	3.8 in/hr	6.4 in/hr	**2.7 cfs**	**7.9 cfs**	D-18
D-19			2.97 ac	0.34	0.58	13.4 min.	3.7 in/hr	6.2 in/hr	**3.7 cfs**	**10.6 cfs**	D-19
D-19.1	DP89a		0.17 ac	0.34	0.58	10.5 min.	4.1 in/hr	6.8 in/hr	**0.2 cfs**	**0.7 cfs**	D-19.1
D-20a	DP 89b		0.81 ac	0.38	0.60	11.6 min.	3.9 in/hr	6.6 in/hr	**1.2 cfs**	**3.1 cfs**	D-20a
D-20b	DP 89c		0.47 ac	0.68	0.79	5.0 min.	5.2 in/hr	8.7 in/hr	**1.7 cfs**	**3.2 cfs**	D-20b
D-20c	DP 89c		0.36 ac	0.38	0.60	7.9 min.	4.5 in/hr	7.5 in/hr	**0.6 cfs**	**1.6 cfs**	D-20c
D-21	DP 90		4.02 ac	0.28	0.49	11.9 min.	3.9 in/hr	6.5 in/hr	**4.4 cfs**	**12.7 cfs**	D-21
D-22	DP 91a		1.15 ac	0.28	0.49	11.9 min.	3.9 in/hr	6.5 in/hr	**1.3 cfs**	**3.6 cfs**	D-22
D-23	DP91b		0.28 ac	0.67	0.78	5.0 min.	5.2 in/hr	8.7 in/hr	**1.0 cfs**	**1.9 cfs**	D-23
D-24			10.18 ac	0.20	0.53	15.0 min.	3.5 in/hr	5.9 in/hr	**7.3 cfs**	**31.8 cfs**	D-24
Combined Design Point Summary						Direct Summation (No Lagging):			**70.8 cfs**	**212.5 cfs**	
	DP 69	D1, D2	2.85 ac	0.28	0.49	18.3 min.	3.2 in/hr	5.4 in/hr	**2.6 cfs**	**7.5 cfs**	DP 69
	DP 71	D3, D4	3.76 ac	0.28	0.49	18.2 min.	3.2 in/hr	5.4 in/hr	**3.4 cfs**	**9.9 cfs**	DP 71
	DP 74	D3, D4, D6	4.17 ac	0.34	0.58	18.2 min.	3.2 in/hr	5.4 in/hr	**4.5 cfs**	**13.1 cfs**	DP 74
	DP 75	D1-D4, D6, D7	10.01 ac	0.34	0.58	21.5 min.	3.0 in/hr	5.0 in/hr	**10.0 cfs**	**29.0 cfs**	DP 75
	DP 76	D1-D4, D6-D8	11.63 ac	0.34	0.58	22.3 min.	2.9 in/hr	4.9 in/hr	**11.4 cfs**	**33.0 cfs**	DP 76
	DP 78	D1-D4, D6-D9	13.74 ac	0.34	0.58	22.3 min.	2.9 in/hr	4.9 in/hr	**13.5 cfs**	**39.0 cfs**	DP 78
	DP 79	D1-D4, D6-D10	16.73 ac	0.34	0.58	25.9 min.	2.7 in/hr	4.5 in/hr	**15.1 cfs**	**43.8 cfs**	DP 79
	DP 81	D11, D12	5.34 ac	0.34	0.58	19.0 min.	3.2 in/hr	5.3 in/hr	**5.7 cfs**	**16.4 cfs**	DP 81
	DP 82	D5, D13	3.62 ac	0.28	0.49	19.2 min.	3.2 in/hr	5.3 in/hr	**3.2 cfs**	**9.3 cfs**	DP 82
	DP 83	D5, D13, D14	6.93 ac	0.28	0.49	25.0 min.	2.8 in/hr	4.6 in/hr	**5.4 cfs**	**15.6 cfs**	DP 83
	DP 85	D15,D16, D16.1	7.15 ac	0.34	0.58	16.3 min.	3.4 in/hr	5.7 in/hr	**8.1 cfs**	**23.6 cfs**	DP 85
	DP 86	D15 - D17	10.60 ac	0.34	0.58	17.9 min.	3.3 in/hr	5.5 in/hr	**11.6 cfs**	**33.5 cfs**	DP 86
	DP 87	D15 - D18	12.74 ac	0.34	0.58	22.1 min.	2.9 in/hr	4.9 in/hr	**12.5 cfs**	**36.3 cfs**	DP 87
	DP 88	D15 - D19	15.70 ac	0.34	0.58	24.9 min.	2.8 in/hr	4.6 in/hr	**14.5 cfs**	**42.1 cfs**	DP 88
	DP 92c	D20a-c, D21, D22	7.10 ac	0.17	0.42	13.2 min.	3.7 in/hr	6.2 in/hr	**4.5 cfs**	**18.8 cfs**	DP 92c
	DP 93a	D1-D19.1	44.87 ac	0.34	0.58	26.2 min.	2.7 in/hr	4.5 in/hr	**40.4 cfs**	**116.8 cfs**	DP 93a
	DP 93b	D20b, D20c, D23	1.12 ac	0.40	0.60	5.0 min.	5.2 in/hr	8.7 in/hr	**2.3 cfs**	**5.9 cfs**	DP 93b
	DP 94	**ULTIMATE**	**62.15 ac**	**0.32**	**0.57**	**27.8 min.**	**2.6 in/hr**	**4.4 in/hr**	**51.3 cfs**	**154.8 cfs**	**FINAL**
	DP 94	**Filing 10 - Interim**	**61.39 ac**	**0.18**	**0.52**	**53.5 min.**	**1.6 in/hr**	**2.7 in/hr**	**18.1 cfs**	**86.0 cfs**	**INTERIM**

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

APPENDIX B.1
Supporting Hydrologic Tables and Figures

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

APPENDIX B.2

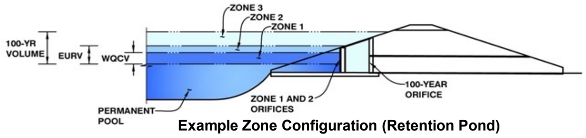
Detention Basin Calculations

- Full Spectrum Detention Basin/Extended Detention Basin
- Detention Volume and Emergency Spillway
- Outlet Structure Calculations
- Trash Rack and Safety Grate Sizing
- Trickle Channel and Open Channel Calculations

UD-Detention, Version 3.07 (February 2017)

Project: The Glen at Widefield Filings No. 10-12 Ultimate Build-Out Condition

Basin ID: Detention Basin "D" 'Interim' Condition (Filing 10 Only with off-site tributary areas as undeveloped land)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	61.33	acres		
Watershed Length =	1,660	ft		
Watershed Slope =	0.017	ft/ft		
Watershed Imperviousness =	5.20%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	17.5%	percent		
Percentage Hydrologic Soil Groups C/D =	82.5%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.192	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.257	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.206	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.604	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.572	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.916	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.451	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	7.431	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	11.340	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	0.192	acre-feet		
Approximate 5-yr Detention Volume =	0.579	acre-feet		
Approximate 10-yr Detention Volume =	0.932	acre-feet		
Approximate 25-yr Detention Volume =	1.150	acre-feet		
Approximate 50-yr Detention Volume =	1.163	acre-feet		
Approximate 100-yr Detention Volume =	1.687	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.192	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.066	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	1.525	acre-feet
Total Detention Basin Volume =	1.783	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	--	--	--	26	0.001		
5671	--	0.33	--	--	--	84	0.002	17	0.000
5672	--	1.33	--	--	--	5,906	0.136	2,954	0.068
5673	--	2.33	--	--	--	31,084	0.714	21,508	0.494
5674	--	3.33	--	--	--	63,050	1.447	68,575	1.574
5675	--	4.33	--	--	--	69,093	1.586	134,646	3.091
5676	--	5.33	--	--	--	74,861	1.719	206,623	4.743
5677	--	6.33	--	--	--	81,249	1.865	284,678	6.535
5678	--	7.33	--	--	--	88,132	2.023	369,369	8.480
5679	--	8.33	--	--	--	96,541	2.216	461,705	10.599
5679.14	--	8.47	--	--	--	98,509	2.261	475,359	10.913
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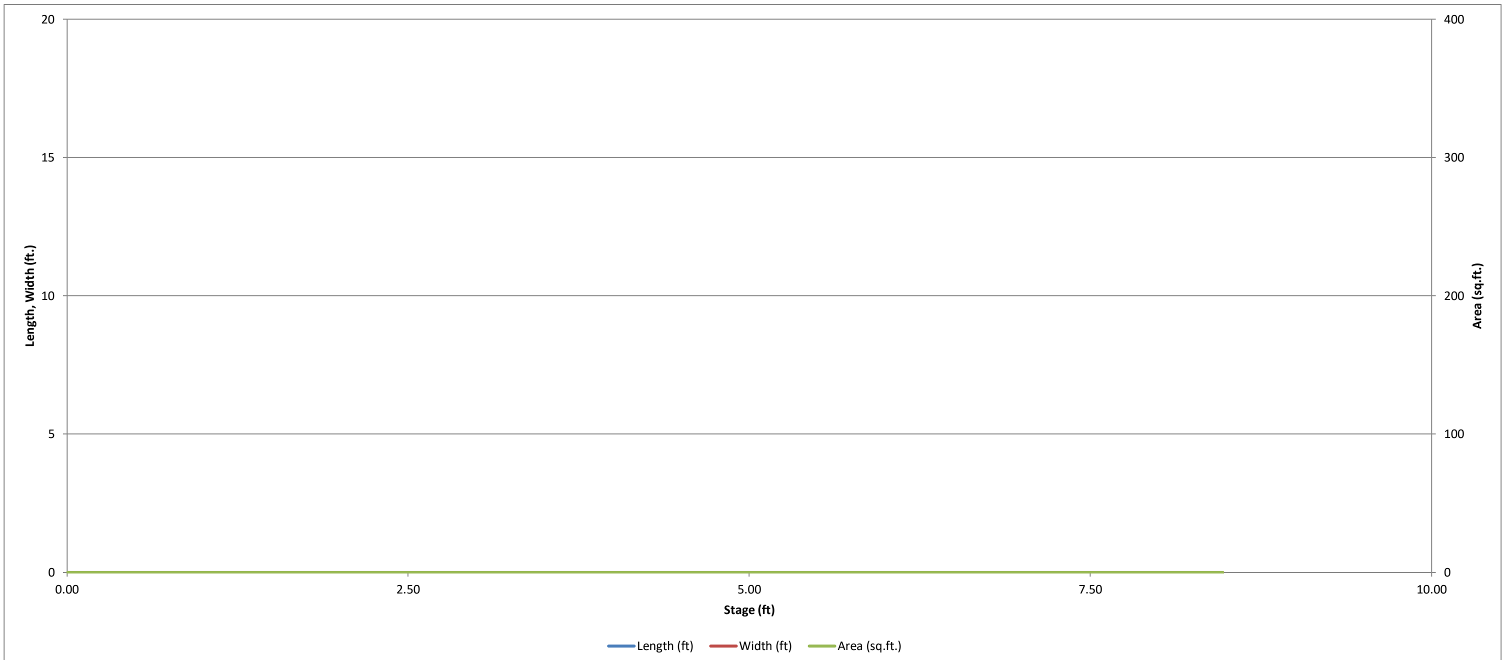
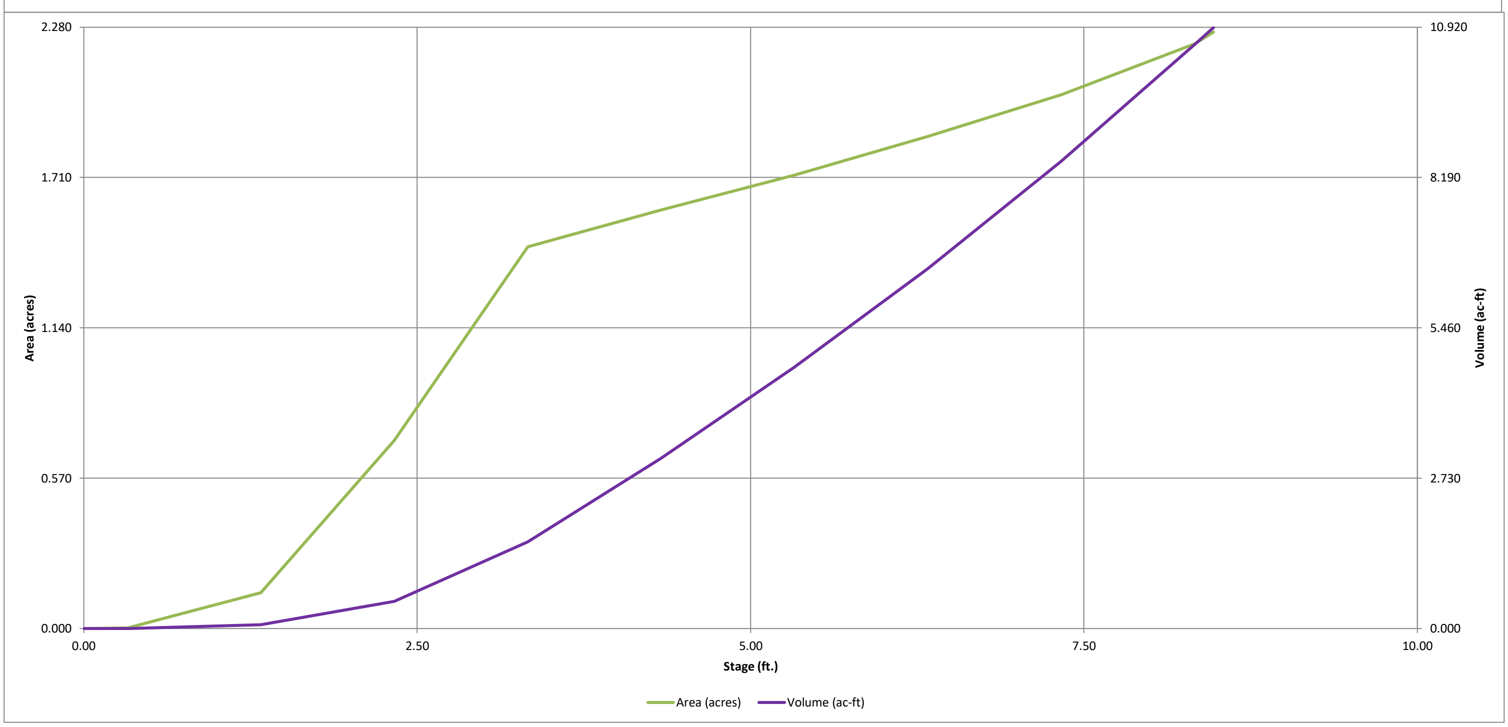


Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)



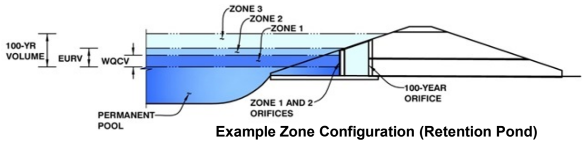
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: The Glen at Widefield Filing 10 - 'Interim' Condition

Basin ID: Full Spectrum Detention Basin 'D' 'Interim' Condition (Filings 10 Only with All Off-Site Tributary Land as Undeveloped)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.79	0.192	Orifice Plate
Zone 2 (EURV)	1.94	0.066	Not Utilized
(100+1/2WQCV)	3.48	1.525	Weir&Pipe (Restrict)
		1.783	Total

0

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 =	1.94	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	0.50	1.00	1.50	2.00	2.50		
Orifice Area (sq. inches)	0.50	0.50	0.50	8.00	8.00	8.00		

	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) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.58	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.83	N/A	feet
Over Flow Weir Slope Length =	5.15	N/A	feet
Grate Open Area / 100-yr Orifice Area =	17.70	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	28.86	N/A	ft^2
Overflow Grate Open Area w/ Debris =	14.43	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 =	0.33	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 =	11.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.63	N/A	ft^2
Outlet Orifice Centroid =	0.54	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.30	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.33	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	46.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

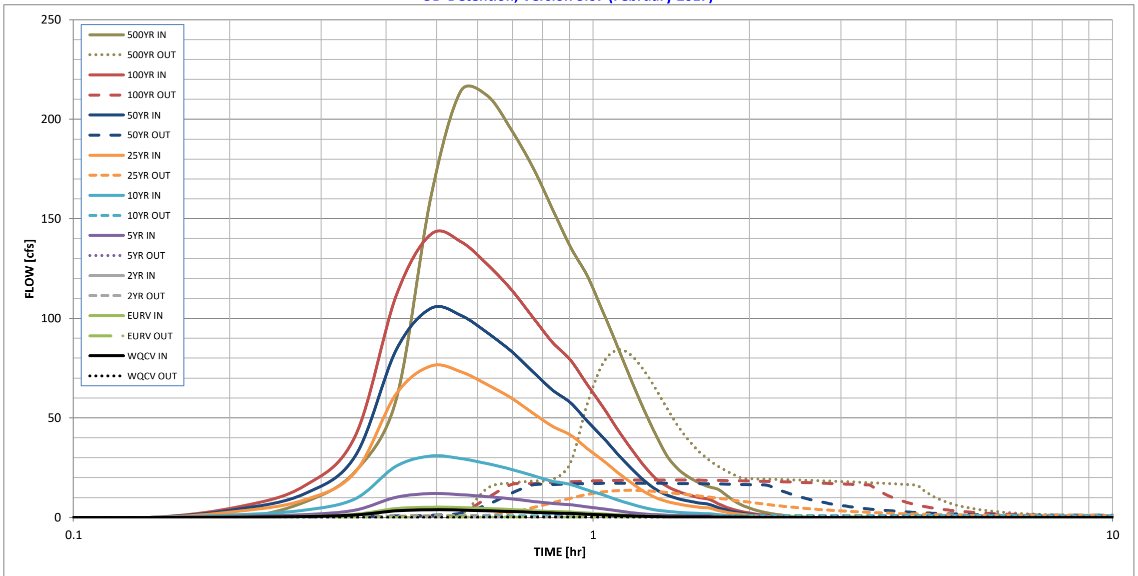
Spillway Design Flow Depth=	1.14	feet
Stage at Top of Freeboard =	8.47	feet
Basin Area at Top of Freeboard =	2.26	acres

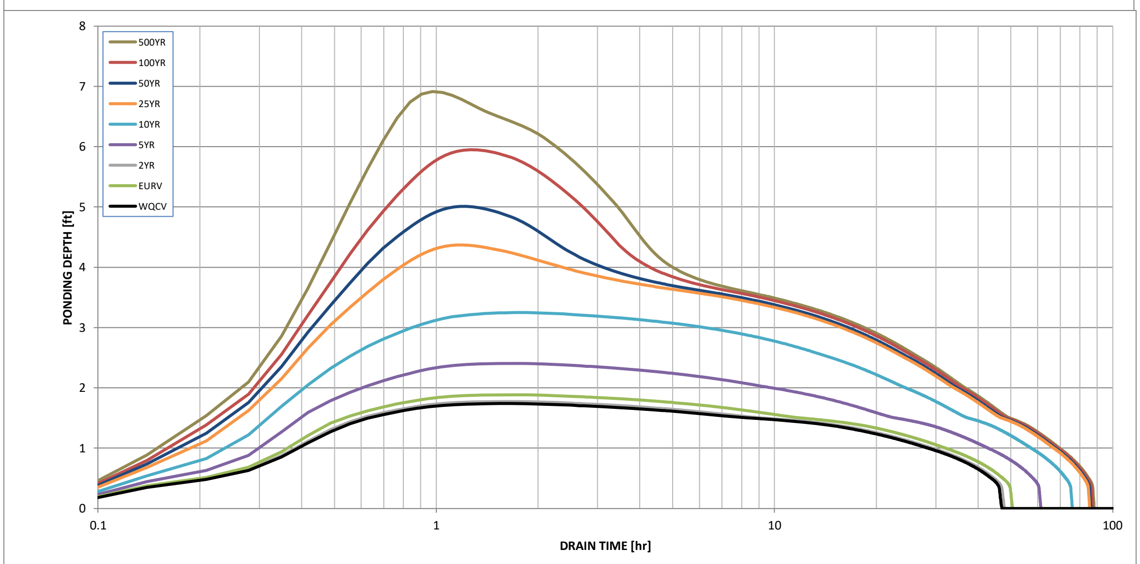
Routed Hydrograph Results

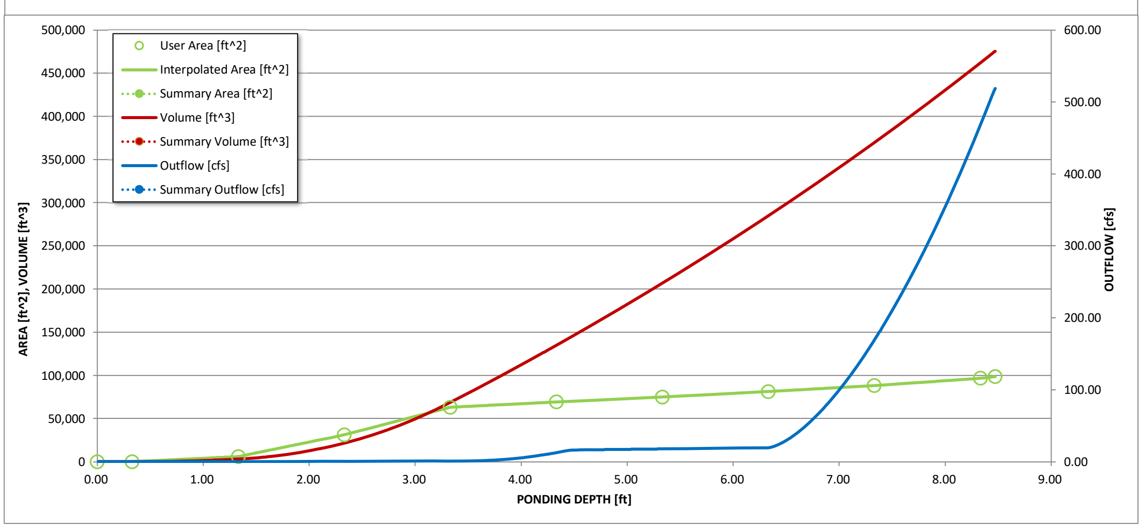
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.192	0.257	0.206	0.604	1.572	3.916	5.451	7.431	11.340
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.191	0.257	0.206	0.604	1.573	3.919	5.448	7.439	11.353
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.14	0.40	0.95	1.26	1.64	2.41
Predevelopment Peak Q (cfs) =	0.0	0.0	1.1	8.3	24.5	58.1	77.2	100.3	148.1
Peak Inflow Q (cfs) =	3.9	5.2	4.1	12.0	30.9	76.1	105.0	142.2	214.3
Peak Outflow Q (cfs) =	0.2	0.2	0.2	0.5	1.0	13.6	17.2	18.8	84.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.2	0.2	0.2	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	0.5	0.6	0.6
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	44	42	49	52	45	42	39	35
Time to Drain 99% of Inflow Volume (hours) =	45	47	45	56	65	64	60	56	48
Maximum Ponding Depth (ft) =	1.74	1.89	1.77	2.41	3.25	4.37	5.01	5.95	6.91
Area at Maximum Ponding Depth (acres) =	0.37	0.45	0.39	0.76	1.38	1.59	1.68	1.81	1.96
Maximum Volume Stored (acre-ft) =	0.170	0.231	0.185	0.546	1.447	3.155	4.200	5.837	7.644

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			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

Time Interval	
4.18 min	
Hydrograph Constant	1.198

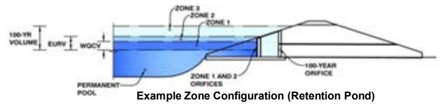
SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:08:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:12:32	0.18	0.23	0.19	0.53	1.34	3.17	4.24	5.51	7.67
0:16:43	0.47	0.62	0.50	1.43	3.64	8.79	11.94	15.82	22.90
0:20:54	1.20	1.60	1.29	3.68	9.36	22.57	30.65	40.63	58.86
0:25:05	3.30	4.41	3.54	10.13	25.70	61.90	83.97	111.19	160.74
0:29:16	3.86	5.17	4.14	12.01	30.91	76.05	104.97	142.22	214.27
0:33:26	3.67	4.92	3.94	11.46	29.58	73.11	101.48	138.52	211.60
0:37:37	3.33	4.48	3.58	10.43	26.93	66.56	92.62	126.81	194.64
0:41:48	2.96	3.98	3.18	9.31	24.15	59.96	83.48	114.36	175.70
0:45:59	2.53	3.41	2.72	8.04	20.96	52.43	73.17	100.47	154.87
0:50:10	2.21	2.98	2.38	7.00	18.21	45.76	63.95	87.92	135.67
0:54:20	2.00	2.70	2.15	6.35	16.52	41.32	57.61	78.99	121.39
0:58:31	1.63	2.20	1.76	5.23	13.75	34.61	48.44	66.71	103.27
1:02:42	1.32	1.79	1.42	4.27	11.32	28.67	40.19	55.44	85.97
1:06:53	0.99	1.35	1.07	3.29	8.84	22.70	31.98	44.33	69.20
1:11:04	0.72	0.99	0.78	2.44	6.70	17.52	24.79	34.50	54.11
1:15:14	0.53	0.73	0.57	1.77	4.90	13.07	18.61	26.02	41.06
1:19:25	0.42	0.57	0.45	1.37	3.74	9.81	13.89	19.33	30.28
1:23:36	0.34	0.47	0.37	1.13	3.05	7.90	11.12	15.40	23.96
1:27:47	0.29	0.40	0.32	0.96	2.58	6.65	9.35	12.92	20.05
1:31:58	0.26	0.35	0.28	0.84	2.26	5.79	8.12	11.20	17.33
1:36:08	0.23	0.32	0.25	0.76	2.03	5.17	7.25	9.99	15.42
1:40:19	0.22	0.29	0.23	0.70	1.86	4.74	6.64	9.12	14.06
1:44:30	0.16	0.22	0.17	0.51	1.37	3.53	4.98	6.93	10.87
1:48:41	0.12	0.16	0.13	0.38	1.00	2.56	3.60	5.00	7.83
1:52:52	0.09	0.12	0.09	0.28	0.74	1.89	2.67	3.71	5.81
1:57:02	0.06	0.08	0.07	0.20	0.54	1.41	1.98	2.75	4.31
2:01:13	0.04	0.06	0.05	0.15	0.39	1.03	1.46	2.03	3.19
2:05:24	0.03	0.04	0.03	0.10	0.28	0.74	1.05	1.47	2.31
2:09:35	0.02	0.03	0.02	0.07	0.20	0.54	0.76	1.06	1.67
2:13:46	0.01	0.02	0.01	0.05	0.14	0.37	0.53	0.75	1.19
2:17:56	0.01	0.01	0.01	0.03	0.09	0.24	0.35	0.49	0.79
2:22:07	0.00	0.00	0.00	0.01	0.05	0.14	0.20	0.29	0.48
2:26:18	0.00	0.00	0.00	0.00	0.02	0.06	0.09	0.14	0.24
2:30:29	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.04	0.08
2:34:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:38:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:43:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:47:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:51:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:55:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:59:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:03:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:08:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:12:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:16:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:24:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:29:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:33:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:37:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:41:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:45:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:49:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:54:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:58:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:02:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:06:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:10:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:14:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:19:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:23:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:27:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:31:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:44:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:48:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:52:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:56:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: The Glen at Widefield Filings No. 10-12 Ultimate Build-Out Condition

Basin ID: Detention Basin "D" Ultimate Condition (Filings 10-12)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	62.15	acres		
Watershed Length =	1,660	ft		
Watershed Slope =	0.017	ft/ft		
Watershed Imperviousness =	33.10%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	17.5%	percent		
Percentage Hydrologic Soil Groups C/D =	82.5%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.833	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	1.926	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	1.719	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.725	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.850	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.953	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.437	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	9.325	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	13.260	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	1.610	acre-feet		
Approximate 5-yr Detention Volume =	2.570	acre-feet		
Approximate 10-yr Detention Volume =	3.070	acre-feet		
Approximate 25-yr Detention Volume =	3.440	acre-feet		
Approximate 50-yr Detention Volume =	3.597	acre-feet		
Approximate 100-yr Detention Volume =	4.321	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.833	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.093	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	2.811	acre-feet
Total Detention Basin Volume =	4.737	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	--	--	--	26	0.001		
5671	--	0.33	--	--	--	84	0.002	17	0.000
5672	--	1.33	--	--	--	5,906	0.136	2,954	0.068
5673	--	2.33	--	--	--	31,084	0.714	21,508	0.494
5674	--	3.33	--	--	--	63,050	1.447	68,575	1.574
5675	--	4.33	--	--	--	69,093	1.586	134,646	3.091
5676	--	5.33	--	--	--	74,861	1.719	206,623	4.743
5677	--	6.33	--	--	--	81,249	1.865	284,678	6.535
5678	--	7.33	--	--	--	88,132	2.023	369,369	8.480
5679	--	8.33	--	--	--	96,541	2.216	461,705	10.599
5679.14	--	8.47	--	--	--	98,509	2.261	475,359	10.913
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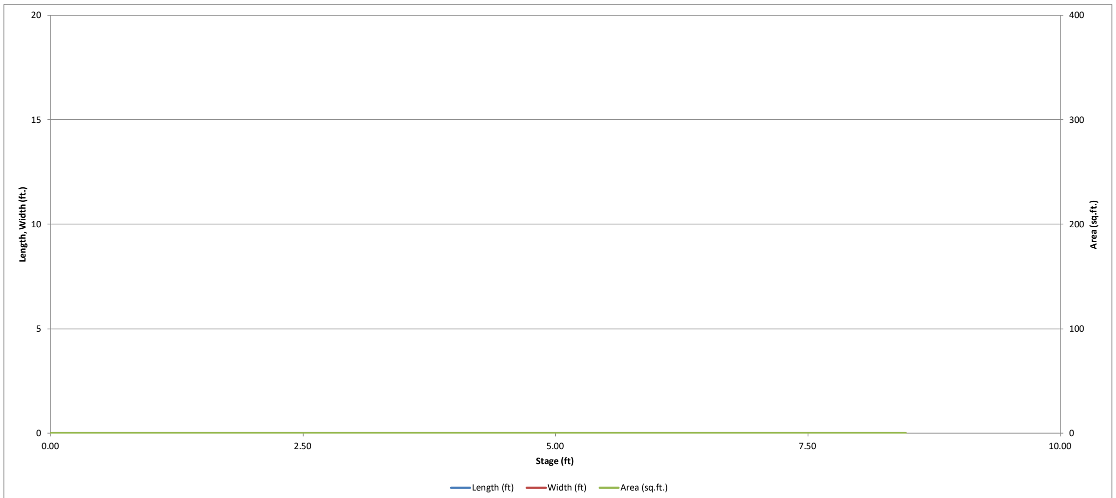
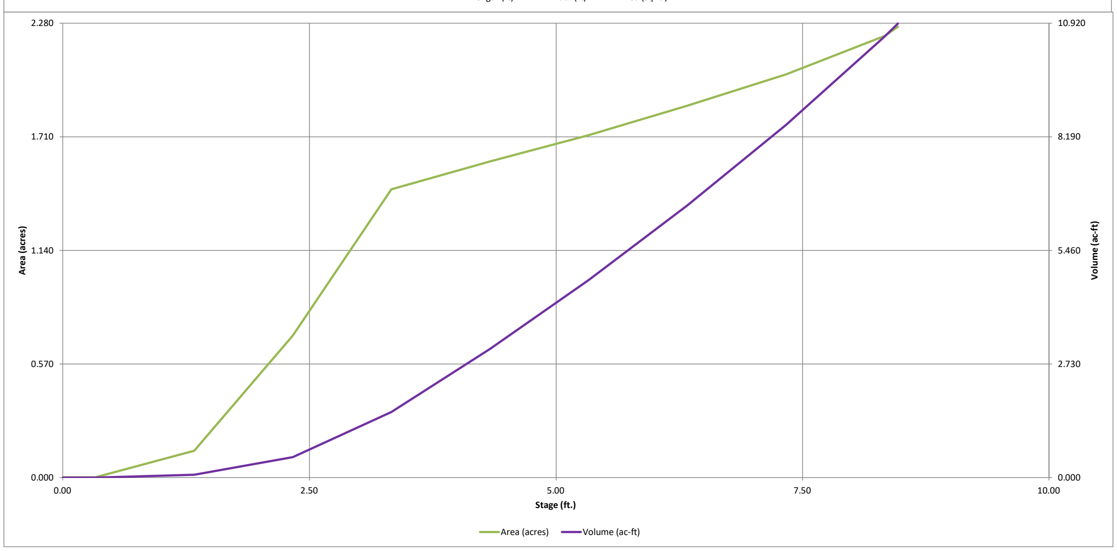
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



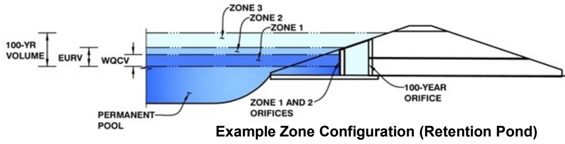


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: The Glen at Widefield Filings 10-12 Ultimate Build-Out Condition

Basin ID: Full Spectrum Detention Basin 'D' Ultimate Build-Out Condition (Filings 10-12)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	2.73	0.833	Orifice Plate	
Zone 2 (EURV)	3.58	1.093	Rectangular Orifice	
(100+1/2WQCV)	5.33	2.811	Weir&Pipe (Restrict)	
		4.737	Total	0

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 =	3.58	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	0.50	1.00	1.50	2.00	2.50		
Orifice Area (sq. inches)	1.00	1.00	1.00	3.00	4.00			

	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)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.73	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.58	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	8.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.11	N/A	ft^2
Vertical Orifice Centroid =	0.08	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.58	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.83	N/A	feet
Over Flow Weir Slope Length =	5.15	N/A	feet
Grate Open Area / 100-yr Orifice Area =	7.86	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	28.86	N/A	ft^2
Overflow Grate Open Area w/ Debris =	14.43	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 =	0.33	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 =	21.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.67	N/A	ft^2
Outlet Orifice Centroid =	0.98	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.98	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.33	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	46.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

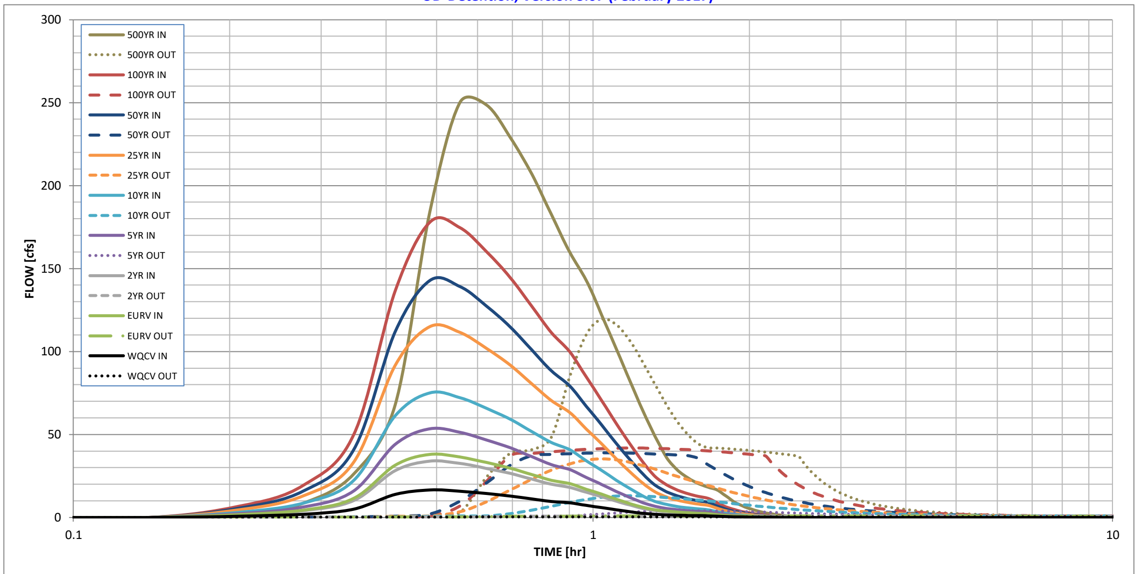
Spillway Design Flow Depth=	1.14	feet
Stage at Top of Freeboard =	8.47	feet
Basin Area at Top of Freeboard =	2.26	acres

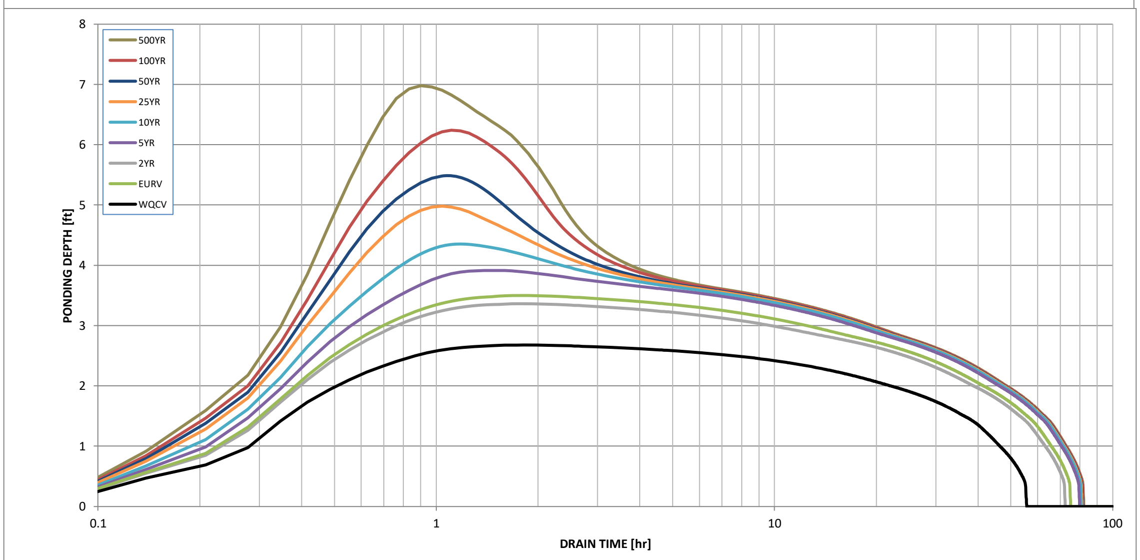
Routed Hydrograph Results

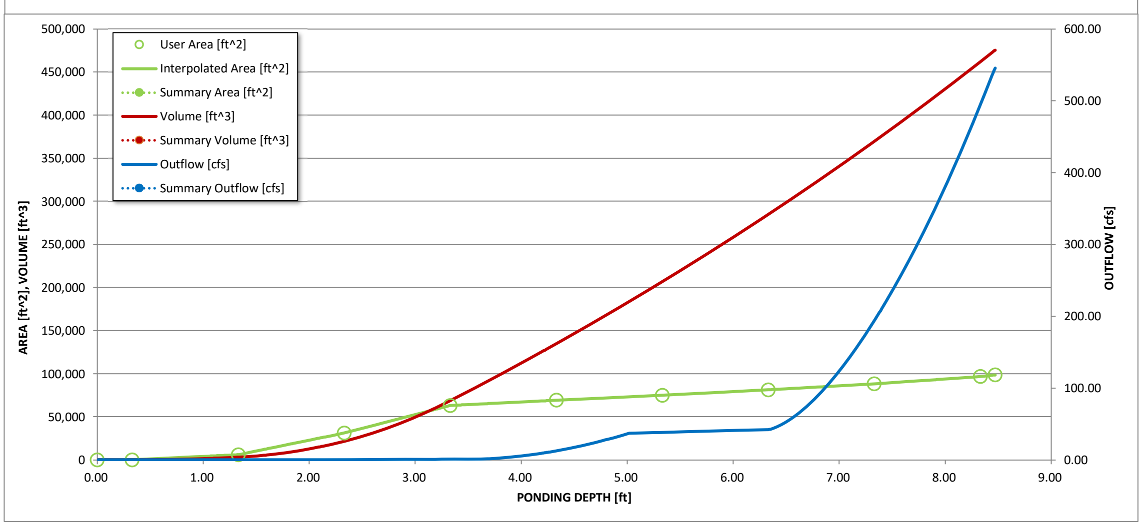
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.833	1.926	1.719	2.725	3.850	5.953	7.437	9.325	13.260
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.832	1.927	1.720	2.726	3.851	5.955	7.434	9.328	13.263
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.14	0.40	0.95	1.27	1.64	2.43
Predevelopment Peak Q (cfs) =	0.0	0.0	1.1	8.4	24.9	59.2	78.7	102.2	150.8
Peak Inflow Q (cfs) =	16.6	38.0	33.9	53.4	75.1	115.0	142.8	178.0	250.1
Peak Outflow Q (cfs) =	0.4	0.9	0.9	4.0	13.0	35.3	38.9	41.8	119.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.5	0.6	0.5	0.4	0.8
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 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	N/A	N/A	0.1	0.4	1.2	1.3	1.4	1.5
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) =	48	62	60	63	60	55	52	49	43
Time to Drain 99% of Inflow Volume (hours) =	52	69	67	72	70	67	66	64	60
Maximum Ponding Depth (ft) =	2.68	3.50	3.36	3.91	4.35	4.98	5.49	6.24	6.98
Area at Maximum Ponding Depth (acres) =	0.96	1.47	1.45	1.53	1.59	1.67	1.74	1.85	1.97
Maximum Volume Stored (acre-ft) =	0.779	1.808	1.618	2.437	3.123	4.150	5.003	6.350	7.761

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			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

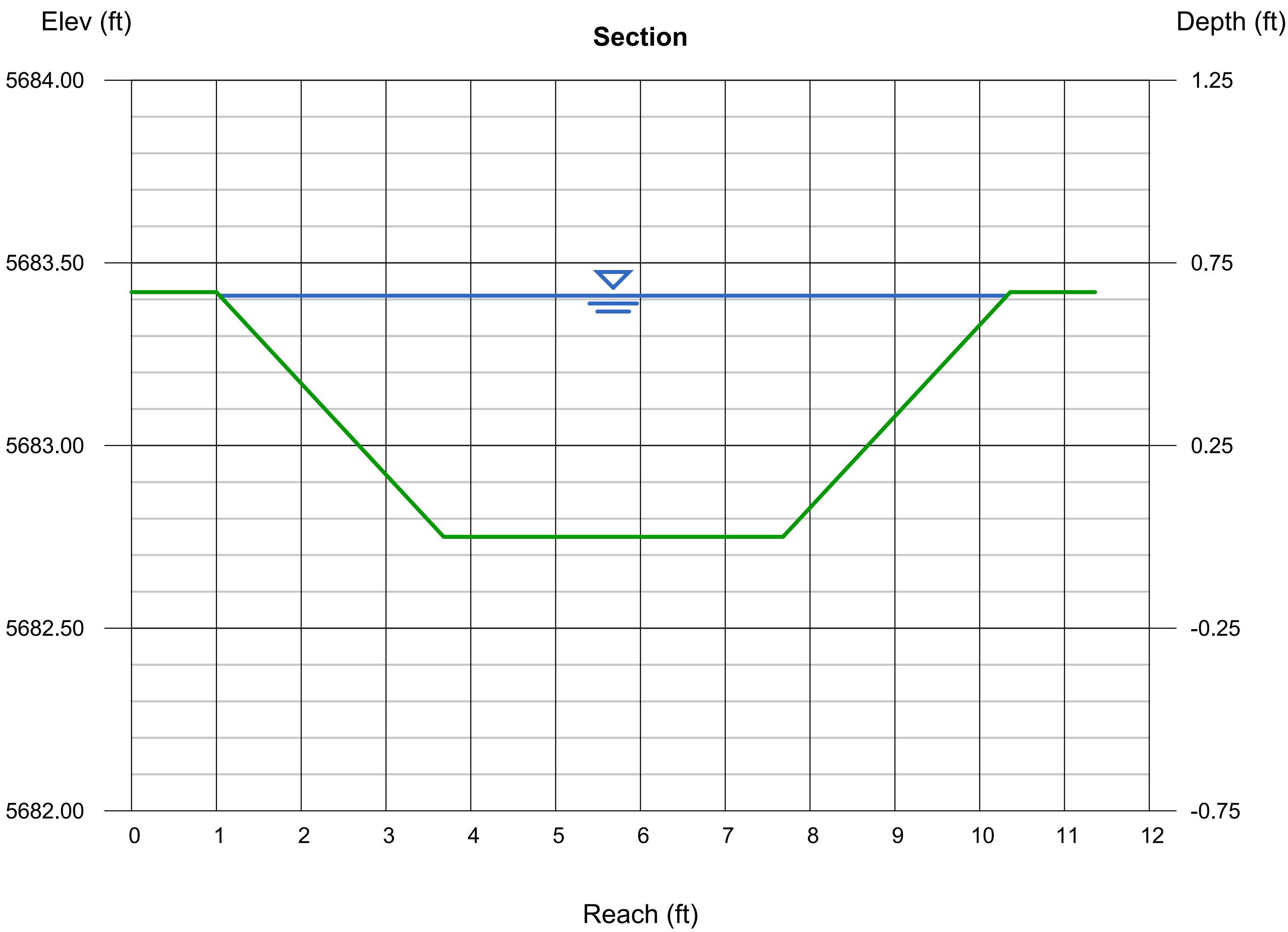
Time Interval	Hydrograph Constant
4.16 min	1.202

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
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]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:08:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:12:29	0.73	1.63	1.47	2.27	3.14	4.60	5.53	6.63	8.64
0:16:38	1.97	4.46	3.99	6.24	8.69	13.01	15.89	19.41	26.27
0:20:48	5.06	11.45	10.26	16.03	22.31	33.40	40.80	49.86	67.54
0:24:58	13.91	31.44	28.17	43.98	61.18	91.49	111.65	136.31	184.25
0:29:07	16.56	37.96	33.94	53.45	75.11	115.05	142.81	178.01	250.07
0:33:17	15.82	36.35	32.48	51.25	72.20	111.43	139.10	174.58	248.50
0:37:26	14.40	33.08	29.57	46.64	65.72	101.79	127.33	160.21	229.06
0:41:36	12.88	29.70	26.53	41.94	59.20	91.76	114.84	144.56	206.83
0:45:46	11.14	25.81	23.04	36.56	51.76	80.48	100.89	127.23	182.54
0:49:55	9.70	22.42	20.01	31.84	45.17	70.37	88.28	111.40	159.96
0:54:05	8.79	20.33	18.15	28.82	40.79	63.34	79.32	99.87	142.89
0:58:14	7.27	16.95	15.12	24.07	34.17	53.32	66.99	84.67	121.91
1:02:24	5.95	13.98	12.45	19.89	28.30	44.27	55.67	70.42	101.55
1:06:34	4.60	10.95	9.74	15.67	22.40	35.27	44.51	56.51	81.95
1:10:43	3.44	8.34	7.40	12.01	17.28	27.38	34.64	44.10	64.19
1:14:53	2.49	6.13	5.43	8.90	12.89	20.58	26.13	33.37	48.85
1:19:02	1.92	4.66	4.13	6.72	9.68	15.34	19.41	24.69	36.08
1:23:12	1.58	3.79	3.37	5.44	7.79	12.27	15.46	19.60	28.43
1:27:22	1.34	3.20	2.84	4.59	6.56	10.30	12.97	16.43	23.74
1:31:31	1.17	2.80	2.49	4.00	5.71	8.94	11.24	14.21	20.48
1:35:41	1.06	2.51	2.23	3.58	5.11	7.99	10.03	12.66	18.20
1:39:50	0.97	2.30	2.05	3.29	4.68	7.30	9.16	11.56	16.58
1:44:00	0.71	1.70	1.51	2.43	3.48	5.50	6.96	8.86	12.92
1:48:10	0.52	1.24	1.10	1.77	2.52	3.97	5.02	6.38	9.31
1:52:19	0.38	0.91	0.81	1.30	1.86	2.94	3.72	4.74	6.91
1:56:29	0.28	0.68	0.60	0.97	1.39	2.19	2.77	3.52	5.12
2:00:38	0.20	0.49	0.43	0.70	1.01	1.61	2.04	2.60	3.80
2:04:48	0.14	0.35	0.31	0.50	0.73	1.16	1.47	1.88	2.75
2:08:58	0.10	0.25	0.22	0.37	0.53	0.84	1.07	1.36	1.99
2:13:07	0.07	0.17	0.15	0.25	0.37	0.59	0.75	0.97	1.42
2:17:17	0.04	0.11	0.10	0.16	0.24	0.39	0.50	0.64	0.95
2:21:26	0.02	0.06	0.05	0.09	0.13	0.22	0.29	0.38	0.58
2:25:36	0.01	0.02	0.02	0.04	0.06	0.11	0.14	0.19	0.29
2:29:46	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.10
2:33:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:38:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:42:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:46:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:50:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:54:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:58:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:03:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:07:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:11:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:15:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:19:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:23:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:28:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:32:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:36:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:44:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:48:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:52:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:57:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:01:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:09:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:13:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:17:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:22:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:26:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:34:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:38:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:42:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:47:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:51:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:55:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:59:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Channel Report

Interim Outflow Ditch for North Curb Line Pennycress Dr

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 4.00	Depth (ft)	= 0.66
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 16.30
Total Depth (ft)	= 0.67	Area (sqft)	= 4.38
Invert Elev (ft)	= 5682.75	Velocity (ft/s)	= 3.72
Slope (%)	= 0.72	Wetted Perim (ft)	= 9.44
N-Value	= 0.020	Crit Depth, Yc (ft)	= 0.65
		Top Width (ft)	= 9.28
Calculations		EGL (ft)	= 0.88
Compute by:	Known Q		
Known Q (cfs)	= 16.30		



Channel Report

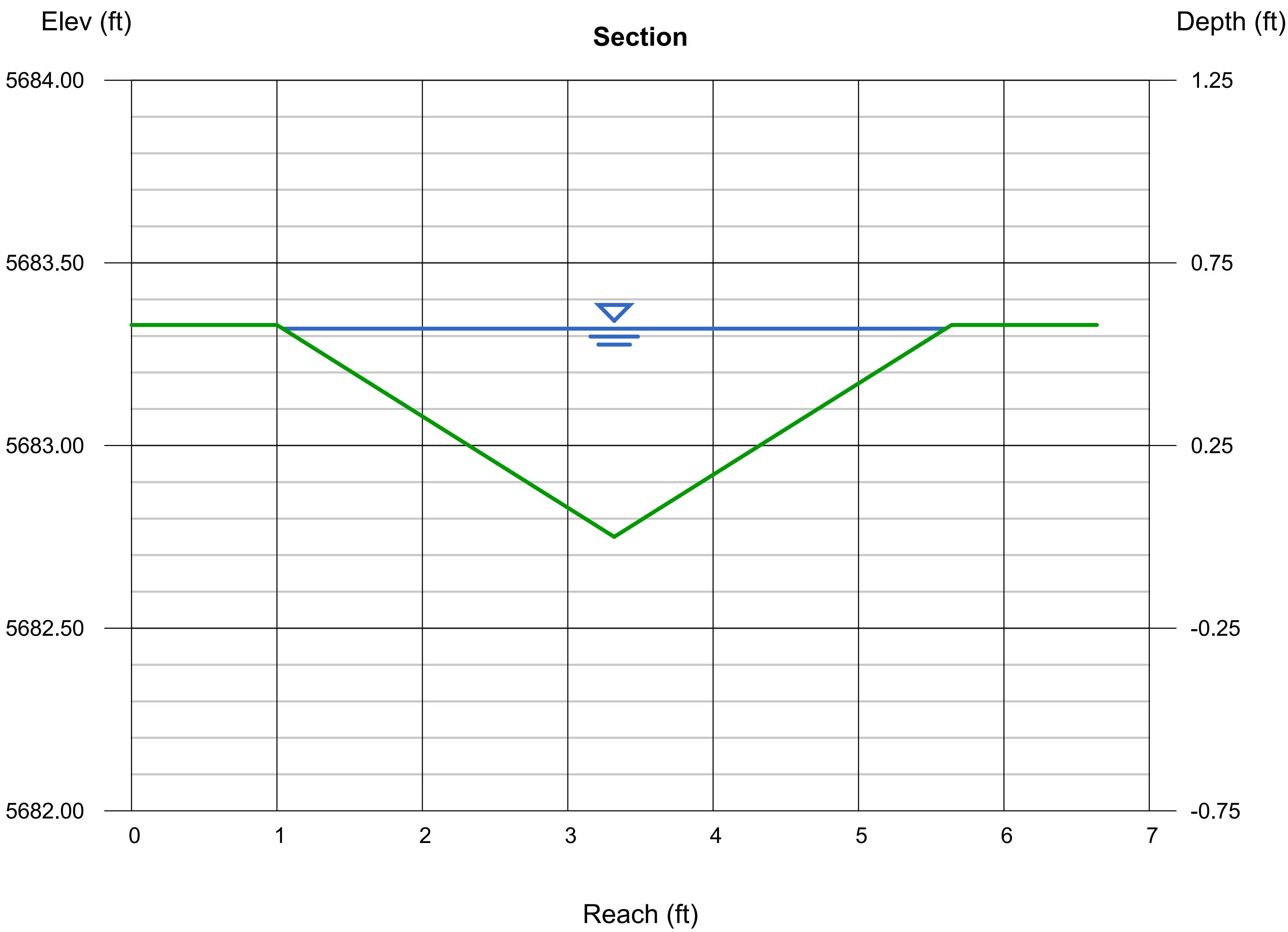
Interim Outflow Ditch for South Curb Line Pennycress Dr

Triangular
Side Slopes (z:1) = 4.00, 4.00
Total Depth (ft) = 0.58

Invert Elev (ft) = 5682.75
Slope (%) = 0.70
N-Value = 0.022

Calculations
Compute by: Known Q
Known Q (cfs) = 3.10

Highlighted
Depth (ft) = 0.57
Q (cfs) = 3.100
Area (sqft) = 1.30
Velocity (ft/s) = 2.39
Wetted Perim (ft) = 4.70
Crit Depth, Yc (ft) = 0.52
Top Width (ft) = 4.56
EGL (ft) = 0.66



Channel Report

TEMPORARY OUTFLOW DITCH

Trapezoidal

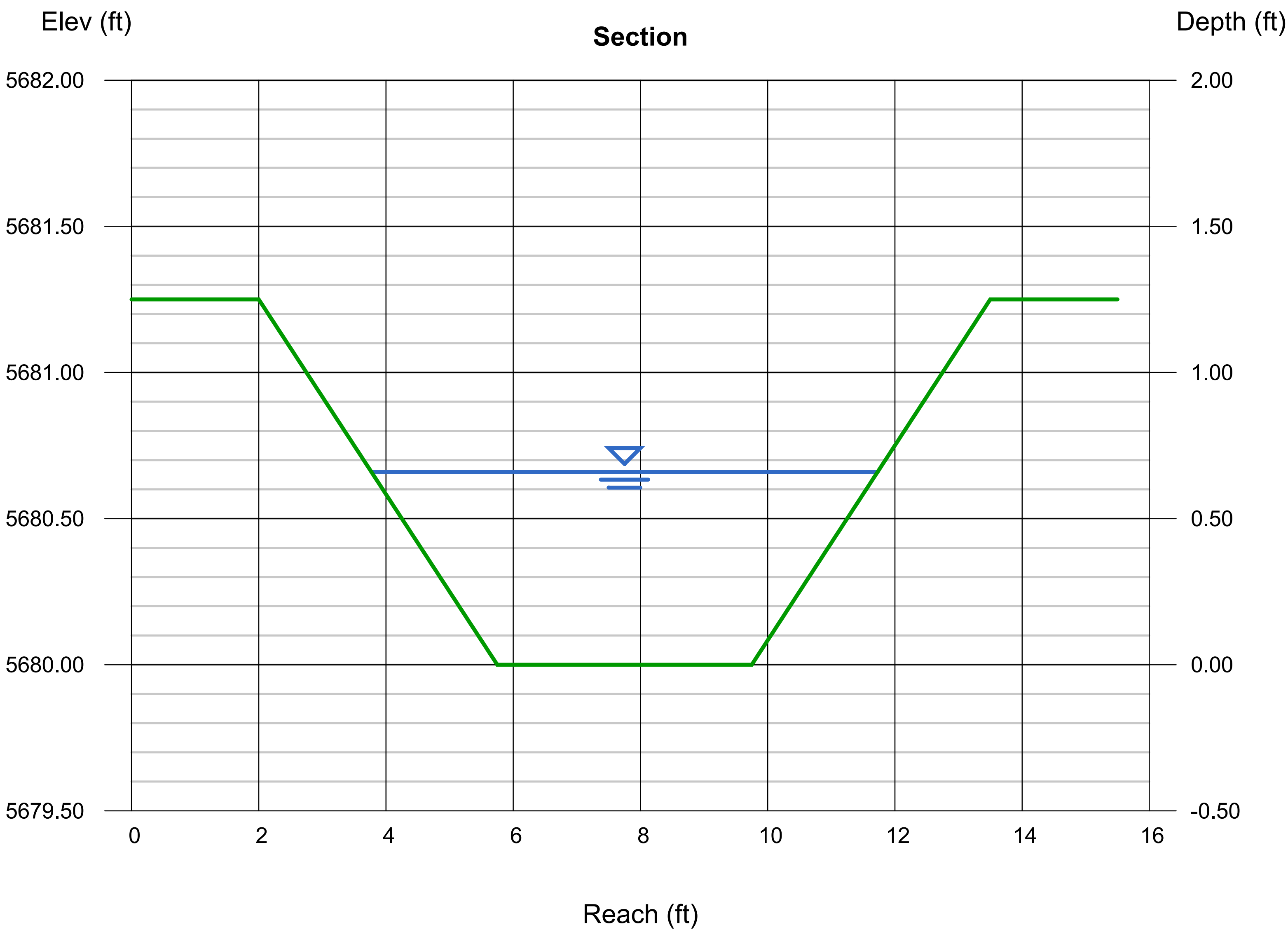
Bottom Width (ft)	= 4.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.25
Invert Elev (ft)	= 5680.00
Slope (%)	= 1.00
N-Value	= 0.020

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.90

Highlighted

Depth (ft)	= 0.66
Q (cfs)	= 17.90
Area (sqft)	= 3.95
Velocity (ft/s)	= 4.54
Wetted Perim (ft)	= 8.17
Crit Depth, Yc (ft)	= 0.71
Top Width (ft)	= 7.96
EGL (ft)	= 0.98



APPENDIX B.3

Supporting Detention Basin Tables and Figures

beneficial if a project is being phased or when adequate land is not available to combine all of the elements in one facility.

4.1.1 Flood Control Volume

UDFCD has developed empirical equations for estimating the total required storage volume that can be applied to on-site, multi-level ponds or to on-site or sub-regional FSD ponds. The empirical equations include:

$$V_i = K_i A \quad \text{Equation 13-1}$$

For NRCS soil types B, C and D.

$$K_{100} = (1.78 \cdot I - 0.002\, I^2 - 3.56) / 900 \quad \text{Equation 13-2}$$

$$K_5 = (0.77 \cdot I - 2.65) / 1{,}000 \quad \text{Equation 13-3}$$

For NRCS soil Type A:

$$K_{100A} = (-0.00005501 \cdot I^2 + 0.030148 \cdot I - 0.12) / 12 \quad \text{Equation 13-4}$$

Where:

V_i = required volume, with i= year storm, acre-feet

K_i = empirical volume coefficient, with i= year storm

i = return period for storm event, years

I = fully developed tributary basin imperviousness, %

A = tributary drainage basin area, acres

These equations can be applied to calculate the total detention storage for drainage basins up to about 130 acres. When more than one soil type or land use is present in the drainage basin, the storage volume must be weighted by the proportionate areas of each soil type and/or land use. For FSDs, the EURV need not be added to this volume. See UDFCD Manual Volume 2, Storage Chapter for a full description of this method.

4.1.2 EURV

UDFCD has developed empirical equations for estimating the EURV portion of the storage volume that can be applied to on-site, sub-regional or regional FSD ponds.

The empirical equations are as follows:

For NRCS Soil Group A:

$$EURV_A = 1.1\,(2.0491(I/100) - 0.1113) \quad \text{Equation 13-5}$$

For NRCS Soil Group B:

$$EURV_B = 1.1\,(1.2846(I/100) - 0.0461) \quad \text{Equation 13-6}$$

For NRCS Soil Group C/D:

$$EURV_{CD} = 1.1\ (1.1381(I/100) - 0.0339) \quad \text{Equation 13-7}$$

Where:

$EURV_K$ = Excess Urban Runoff Volume in watershed inches, K=A, B or C/D soil group

I = drainage basin imperviousness, %

These equations apply to all FSDs and the EURV need not be added to the flood control volume or to the WQCV. When more than one soil type or land use is present in the drainage basin, the EURV must be weighted by the proportionate areas of each soil type and/or land use. If hydrologic routing is used to size the flood control volume, the EURV remains the same as calculated by these equations and is included in the pond's stage/storage configuration for modeling.

4.1.3 Initial Surcharge Volume

The initial surcharge volume is at least 0.3 percent of the WQCV and should be 4- to 12-inches deep. The initial surcharge volume is included in the WQCV and does not increase the required total storage volume.

4.1.4 Design Worksheets

The Full Spectrum Worksheet in the UD-Detention Spreadsheet performs all of these calculations for the standard designs. For multi-level ponds, the flood control volumes are calculated for the two design storm frequencies: the major storm and the minor storm.

4.2 Allowable Release Rates

Allowable release rates from detention facilities vary with the type of facility and with the storage volume type, as follows:

- **Flood Storage Volume**: The flood storage release rates are determined by the allowable release rates that are intended to approximate storm event runoff rates from the undeveloped upstream drainage basin.

- **EURV**: The EURV release rate is determined based on a72-hour drain time. The purpose of this slow release rate is to mitigate the impacts of increased runoff volumes due to development by reducing the potential for downstream erosion.

- **WQCV**: The WQCV release rate is determined based on a 40-hour drain time for extended detention basins. The purpose of this slow release rate is to provide time for pollutants to settle, The WQCV is incorporated into the EURV and works with it to release less erosive flows. The method for determining this design rate is described in Chapter 3 of Volume 2 of this Manual.

4.2.1 Flood Storage Release Rates

Allowable releases rates from the flood storage element of detention may be based on generalized average unit runoff rates or estimates of pre-development runoff rates. Allowable unit release rates (cfs/ac) may be used for any type of detention, however, when a hydrograph routing method is applied (for regional or

Safety Grates

Safety grates are intended to keep people and animals from inadvertently entering a storm drain. They are sometimes required even when debris entering a storm drain is not a concern. The grate on top of the outlet drop box is considered a safety grate and should be designed accordingly. The danger associated with outlet structures is the potential associated with pinning a person or animal to unexposed outlet pipe or grate. See the *Culverts and Bridges* chapter of Volume 2 of this manual for design criteria related to safety grates.

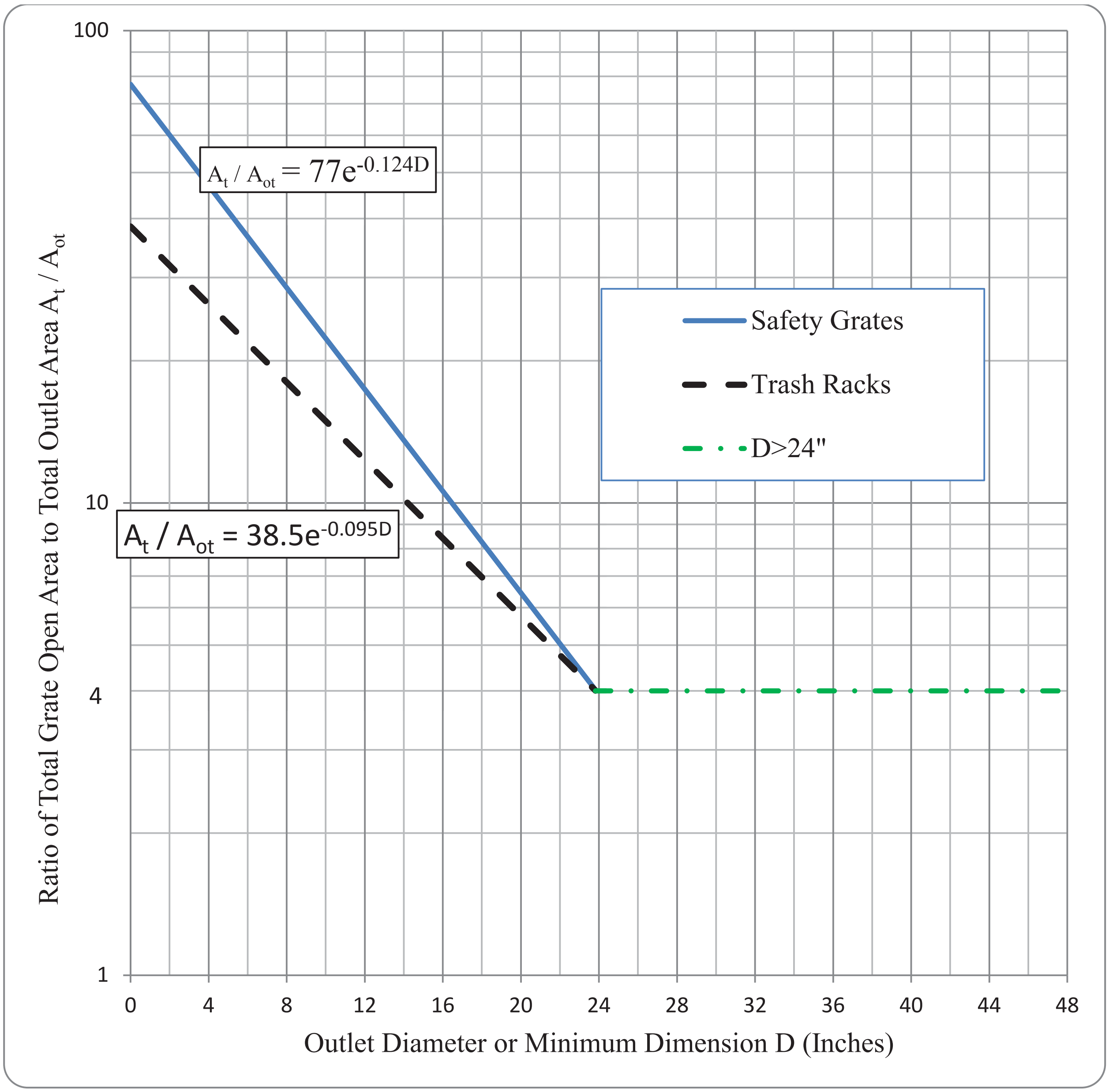
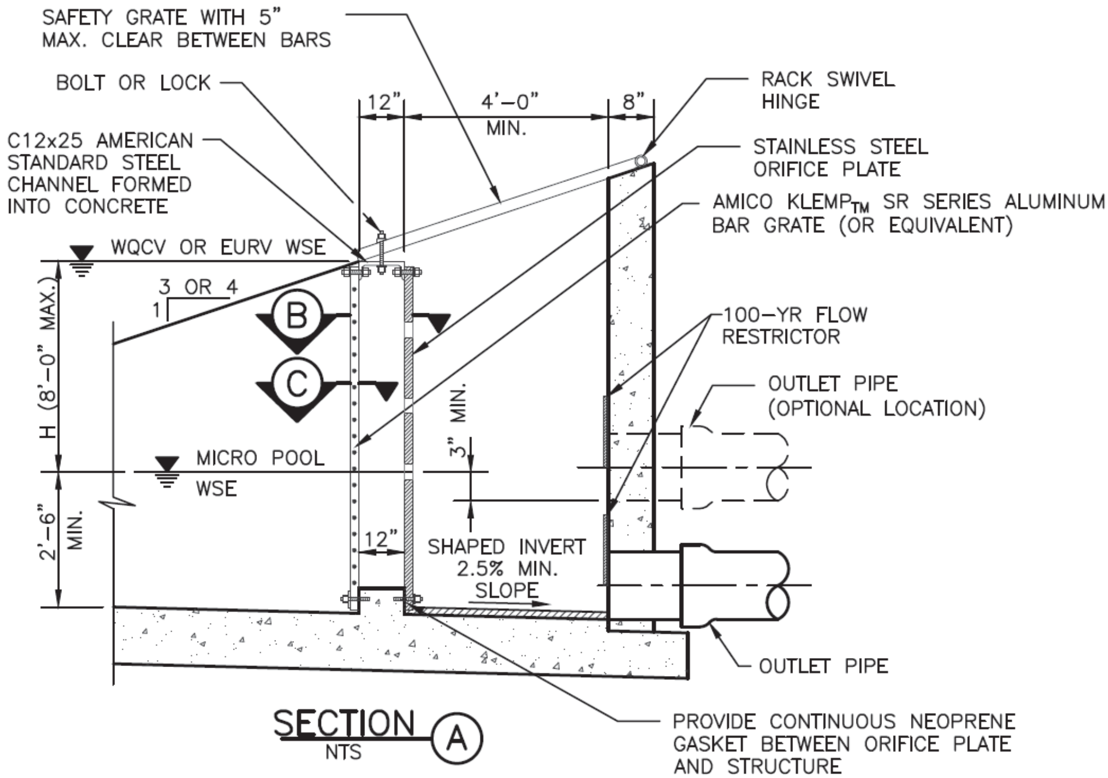
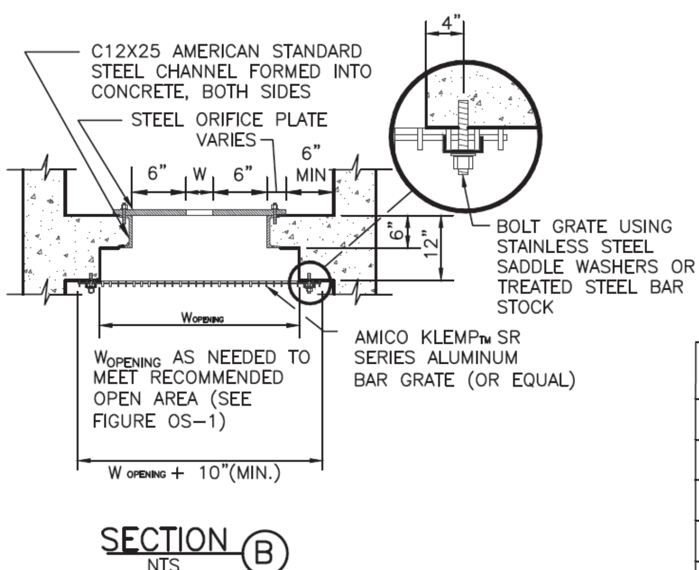


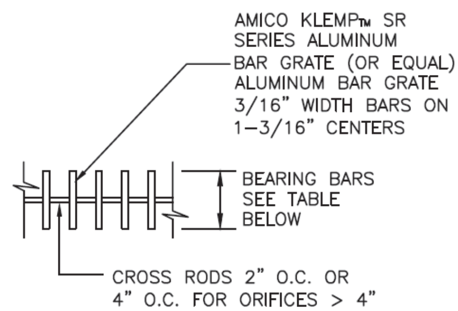
Figure OS-1. Trash Rack Sizing

Table OS-2. Thickness of steel water quality plate

Steel plate thickness (in inches) based on design depth and span of plate											
		Head (feet)									
		3	4	5	6	7	8	9	10	11	12
Span (feet)	1	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875
	2	0.1875	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500
	3	0.2500	0.2500	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.3750	0.5000
	4	0.2500	0.3750	0.3750	0.3750	0.3750	0.5000	0.5000	0.5000	0.5000	0.5000







WATER DEPTH ABOVE LOWEST OPENING, H	MINIMUM BEARING BAR SIZE, BARS ALIGNED VERTICALLY
2.0 FT.	1" x 3/16"
3.0 FT.	1-1/4" x 3/16"
4.0 FT.	1-3/4" x 3/16"
5.0 FT.	2" x 3/16"
6.0 FT.	2-1/4" x 3/16"

R VALUE=(NET OPEN AREA)/GROSS RACK AREA)
=0.71 FOR CROSS RODS ON 2" CENTERS
=0.77 FOR CROSS RODS ON 4" CENTERS

SECTION C
NTS

Figure OS-6. Typical outlet structure with bar grate trash rack

Figure 13-9. Concept for Integral Forebay at Pipe Outfall

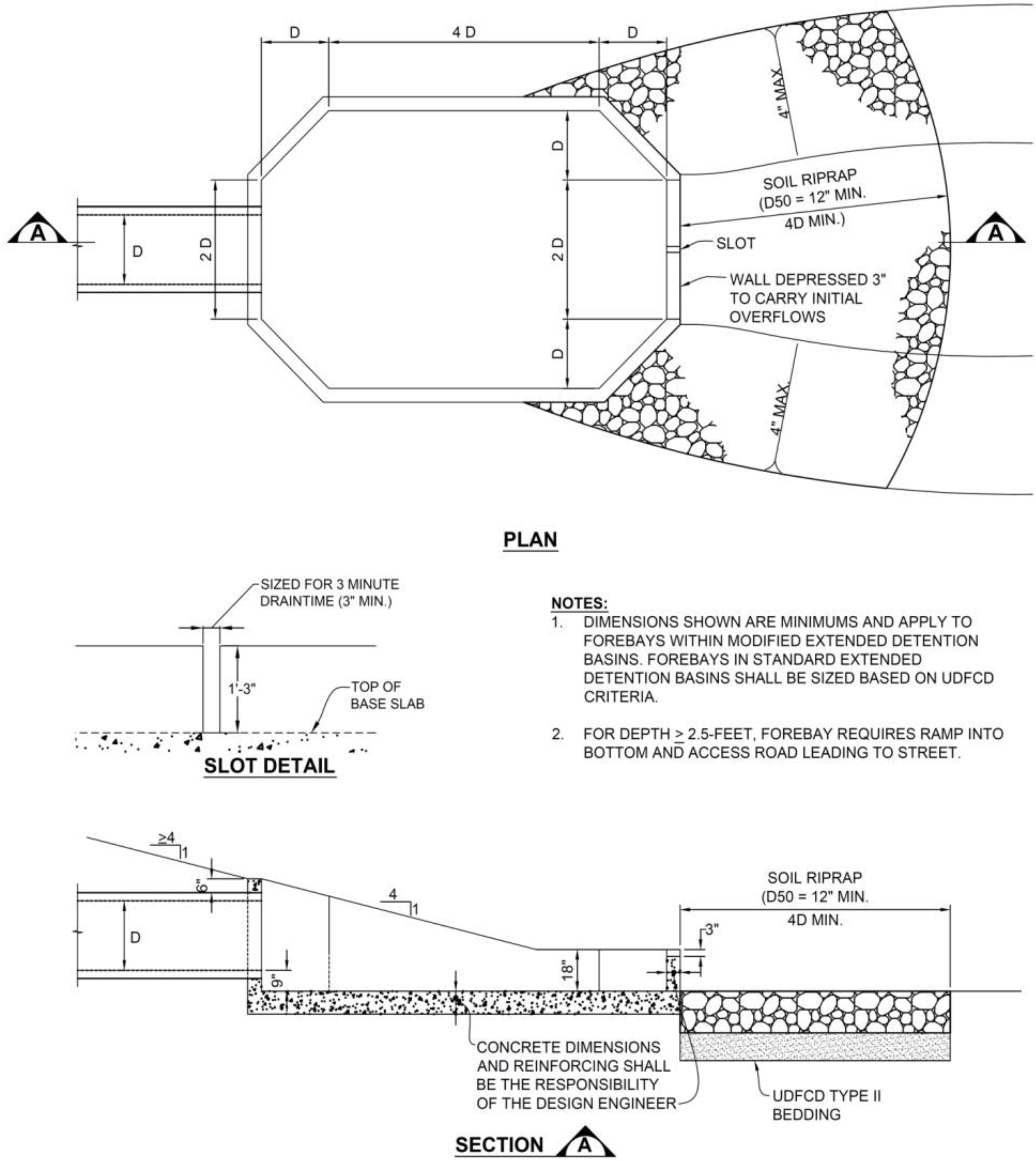


Figure 13-11. Concept for Outlet Structure with Flared Wingwalls and Handrail
(Integral Micropool Shown)

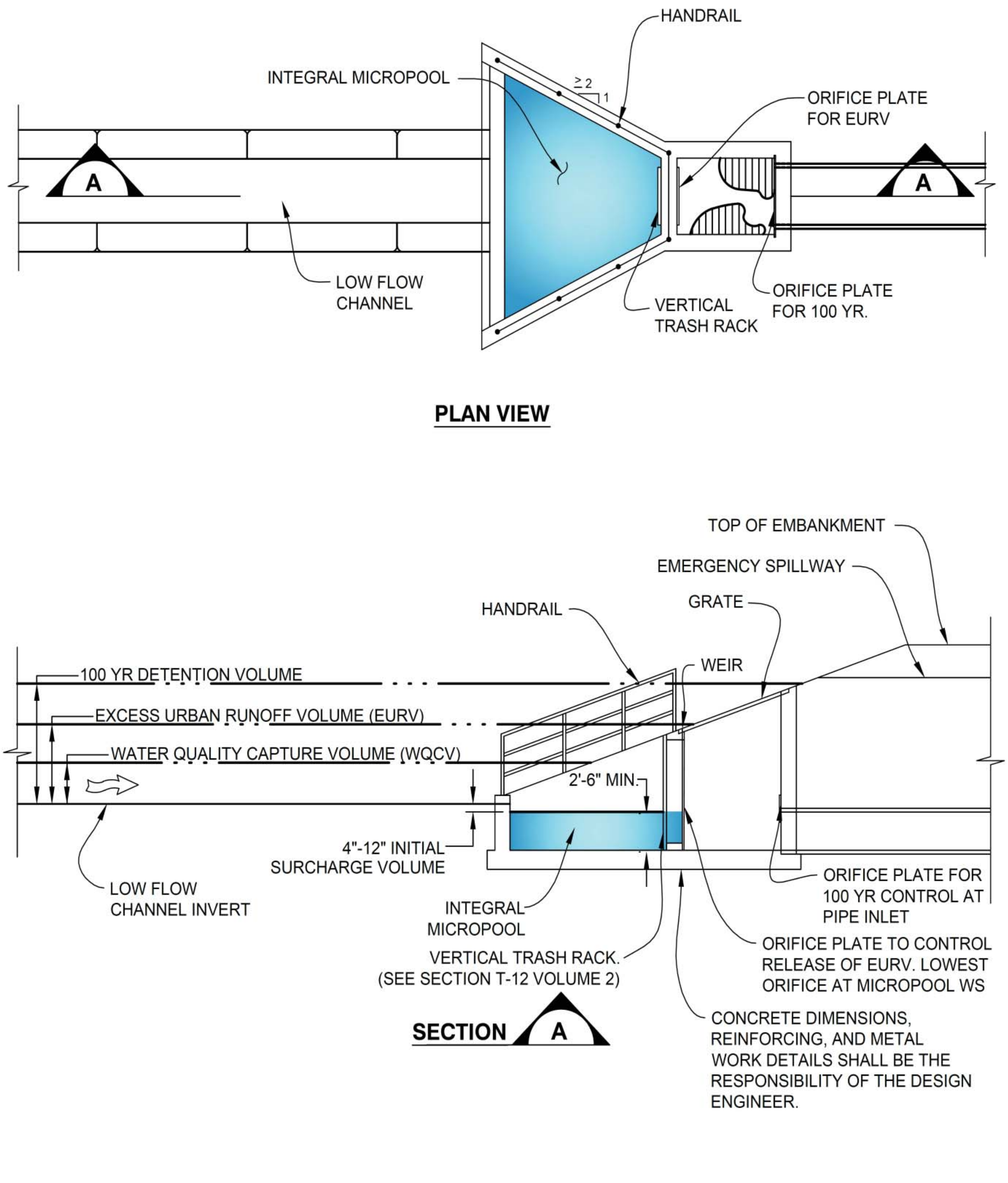


Figure 13-12c. Emergency Spillway Protection

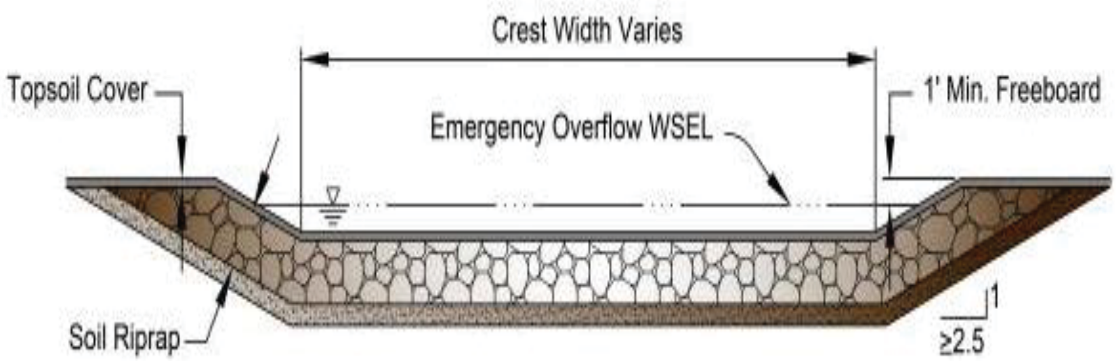
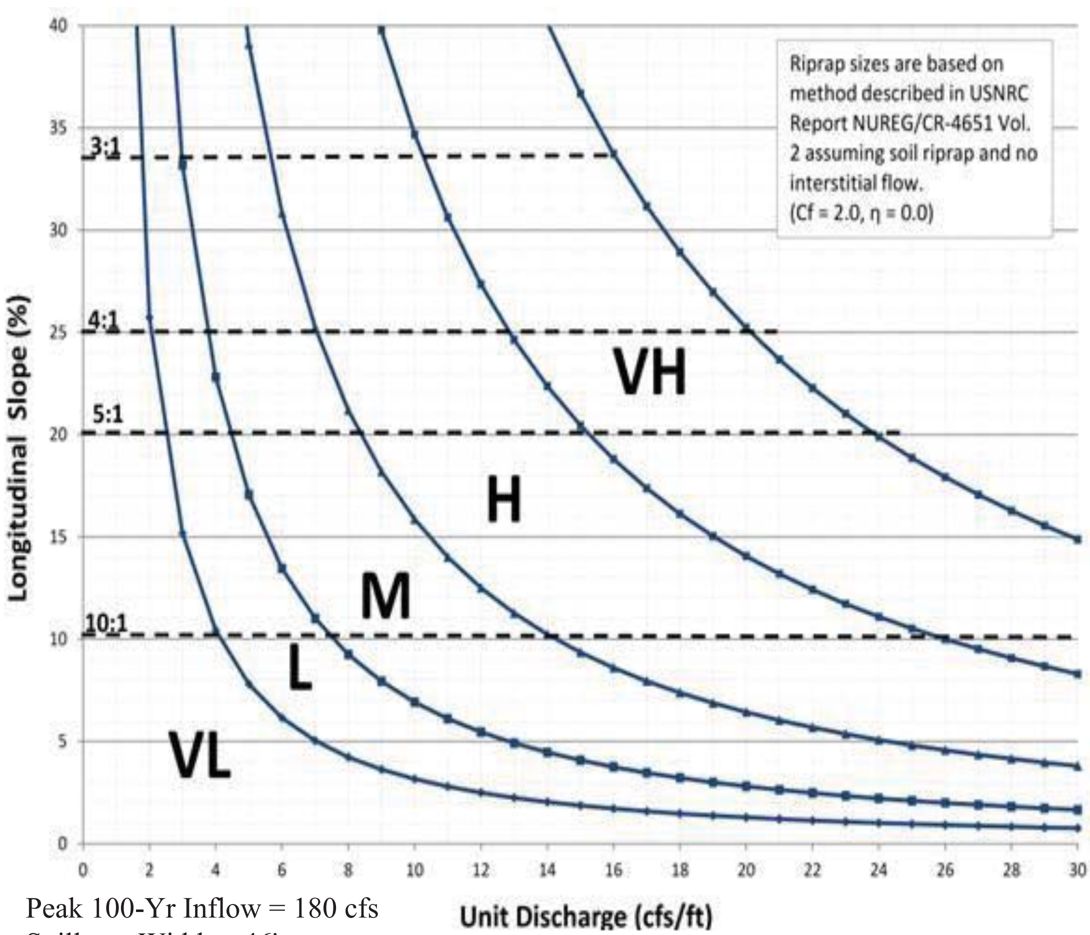


Figure 13-12d. Riprap Types for Emergency Spillway Protection

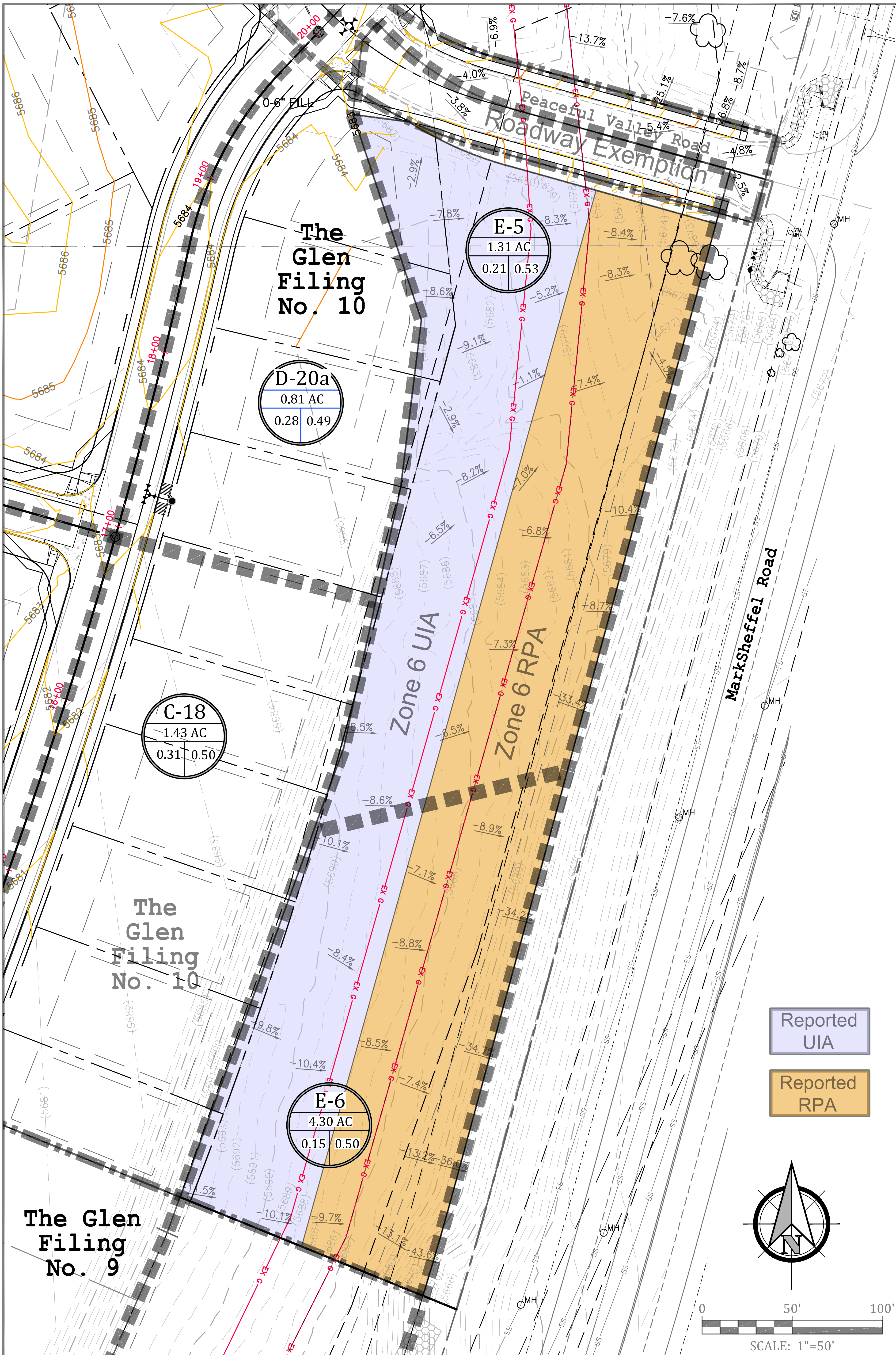


Peak 100-Yr Inflow = 180 cfs
Spillway Width = 46'
Analysis Unit = 3.9
Use Type 'M'

APPENDIX C

IRF Runoff Reduction Methodology

- **Runoff Reduction Exhibit**
- **Runoff Reduction Calculation**



Kiowa Engineering

The Glen at Widefield - Filing No. 10
IRF Runoff Exhibit

May 28, 2020

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: AWMc
Company: Kiowa Engineering Corporation
Date: May 27, 2020
Project: The Glen Filing No 10
Location: Widefield, CO

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches

Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	DCIA	UIA:RPA	DCIA	DCIA
Area ID	E-5 Road	E-5,E-6		
Downstream Design Point ID	E-6	DP100		
Downstream BMP Type	None	None		
DCIA (ft^2)	7,050	--		
UIA (ft^2)	--	38,792	--	--
RPA (ft^2)	--	39,907	--	--
SPA (ft^2)	--	--	--	--
HSG A (%)	--	0%	--	--
HSG B (%)	--	0%	--	--
HSG C/D (%)	--	100%	--	--
Average Slope of RPA (ft/ft)	--	0.250	--	--
UIA:RPA Interface Width (ft)	--	125.00	--	--

CALCULATED RUNOFF RESULTS

Area ID	E-5 Road	E-5,E-6		
UIA:RPA Area (ft^2)	--	78,699	--	--
L / W Ratio	--	5.04	--	--
UIA / Area	--	0.4929	--	--
Runoff (in)	0.50	0.00	0.50	0.50
Runoff (ft^3)	294	0	0	0
Runoff Reduction (ft^3)	0	1616	0	0

CALCULATED WQCV RESULTS

Area ID	E-5 Road	E-5,E-6
WQCV (ft^3)	294	1616
WQCV Reduction (ft^3)	0	1616
WQCV Reduction (%)	0%	100%
Untreated WQCV (ft^3)	294	0

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	E-6	DP100
DCIA (ft^2)	7,050	0
UIA (ft^2)	0	38,792
RPA (ft^2)	0	39,907
SPA (ft^2)	0	0
Total Area (ft^2)	7,050	78,699
Total Impervious Area (ft^2)	7,050	38,792
WQCV (ft^3)	294	1,616
WQCV Reduction (ft^3)	0	1,616
WQCV Reduction (%)	0%	100%
Untreated WQCV (ft^3)	294	0

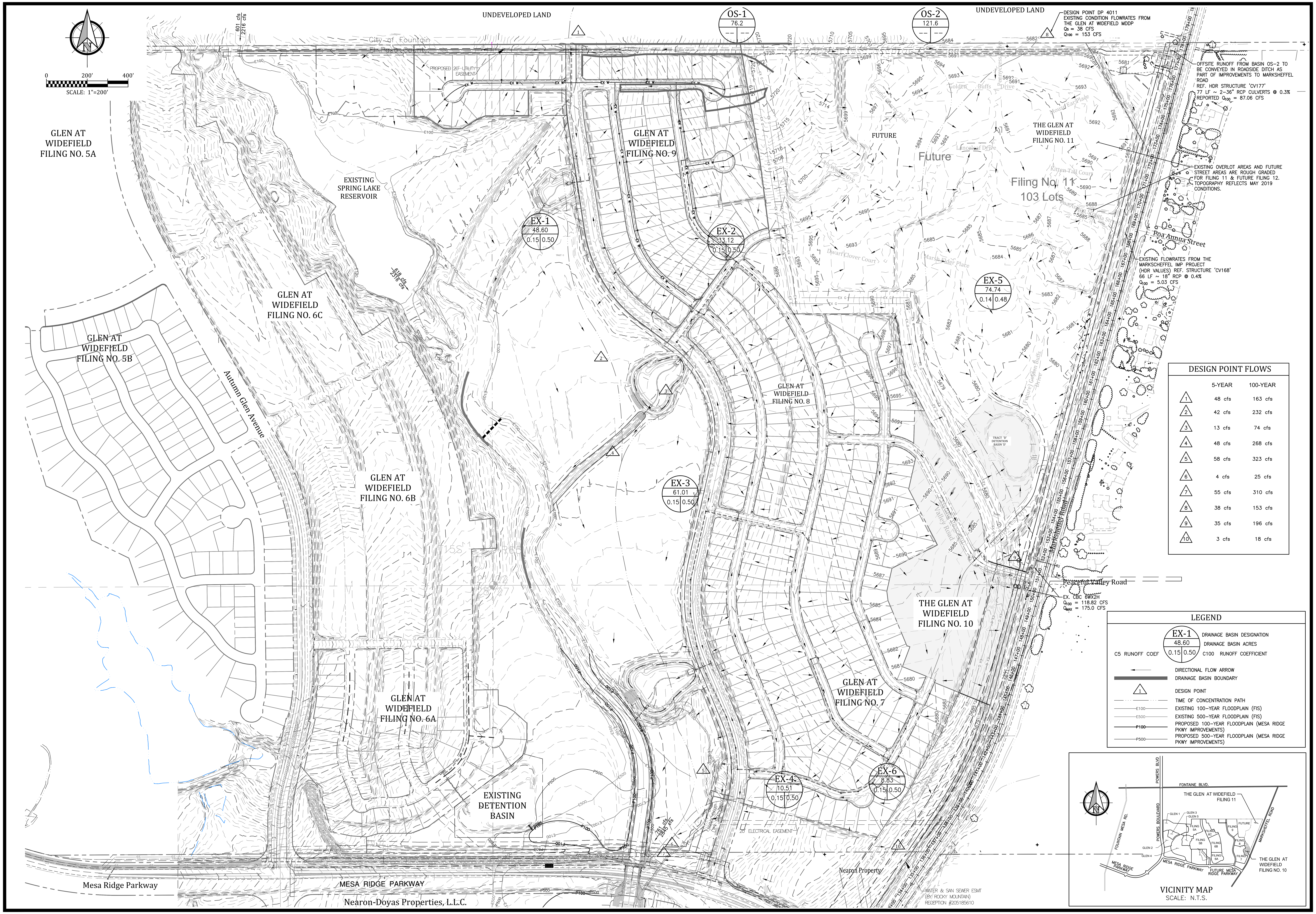
CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	85,749
Total Impervious Area (ft^2)	45,842
WQCV (ft^3)	1,910
WQCV Reduction (ft^3)	1,616
WQCV Reduction (%)	85%
Untreated WQCV (ft^3)	294

APPENDIX D

Existing and Proposed Drainage Plans

- **Drainage Plan Existing Condition H-1**
- **Final Drainage Plan Developed Conditions Onsite D-1**
- **Developed Conditions Offsite D-2**



DESIGN POINT FLOWS

Design Point	5-YEAR	100-YEAR
1	48 cfs	163 cfs
2	42 cfs	232 cfs
3	13 cfs	74 cfs
4	48 cfs	268 cfs
5	58 cfs	323 cfs
6	4 cfs	25 cfs
7	55 cfs	310 cfs
8	38 cfs	153 cfs
9	35 cfs	196 cfs
10	3 cfs	18 cfs

LEGEND

EX-1	DRAINAGE BASIN DESIGNATION
48.60	DRAINAGE BASIN ACRES
0.15 / 0.50	C5 RUNOFF COEF / C100 RUNOFF COEFFICIENT
←	DIRECTIONAL FLOW ARROW
▬	DRAINAGE BASIN BOUNDARY
△1	DESIGN POINT
—·—	TIME OF CONCENTRATION PATH
E100	EXISTING 100-YEAR FLOODPLAIN (FIS)
E500	EXISTING 500-YEAR FLOODPLAIN (FIS)
P100	PROPOSED 100-YEAR FLOODPLAIN (MESA RIDGE PKWY IMPROVEMENTS)
P500	PROPOSED 500-YEAR FLOODPLAIN (MESA RIDGE PKWY IMPROVEMENTS)

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

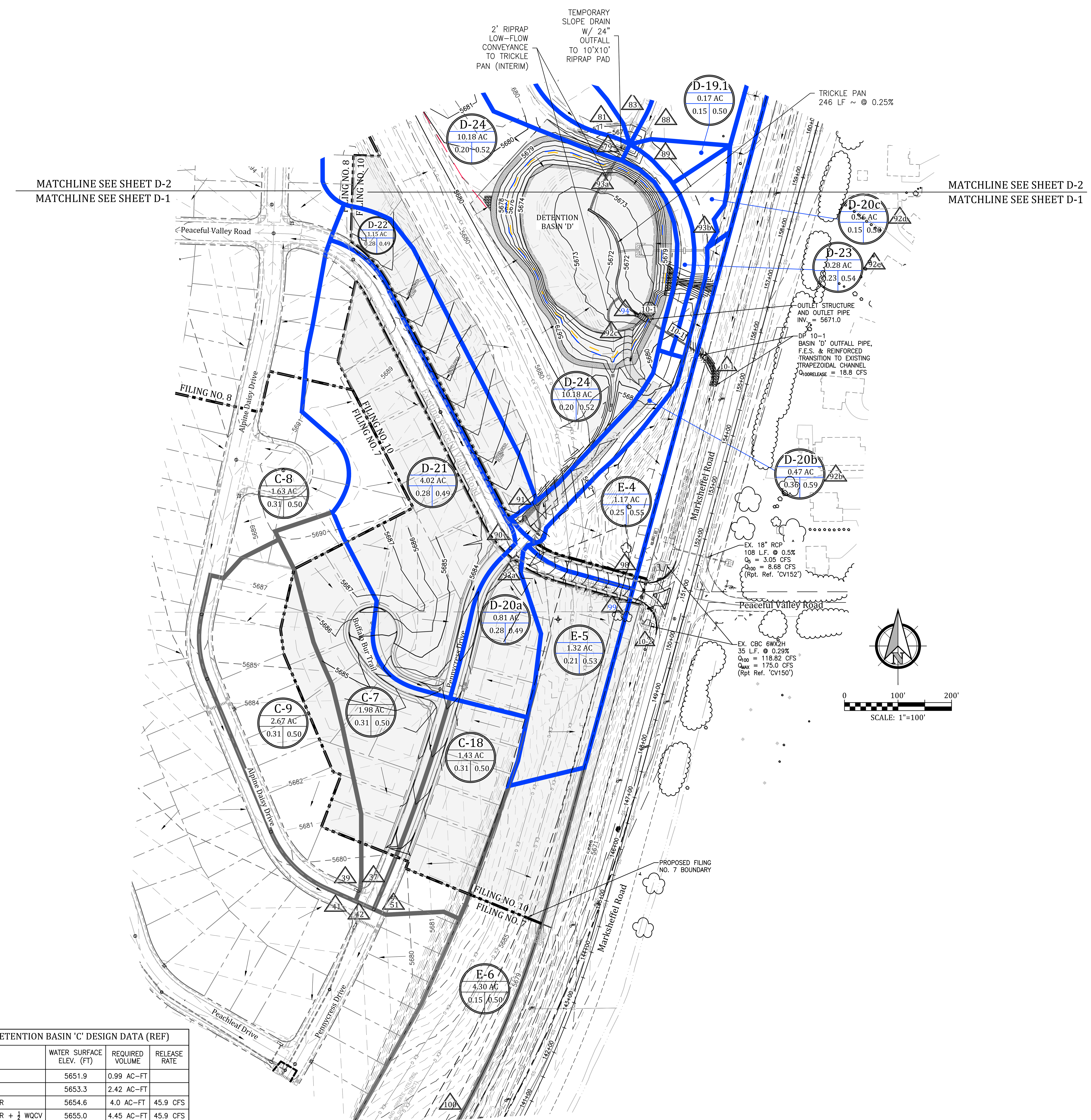
WIDEFIELD Investment Group

THE GLEN AT WIDEFIELD
FILING NO. 10
HISTORIC DRAINAGE BASINS (WITH CURRENT CONDITIONS)
El Paso, County, Colorado

Project No.:	19016
Date:	May 27, 2020
Design:	CJC
Drawn:	MJK
Check:	AMcC
Revisions:	

SHEET
H-1
1 of 3 Sheets

19016 Filing 10 - Drainage Plan.dwg/Jun 04, 2020



LEGEND

C-4 / 2.67 AC / 0.31, 0.50	DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF COEF; C100 RUNOFF COEFFICIENT
2.2 cfs / 4.3 cfs	5-YEAR RUNOFF / 100-YEAR RUNOFF
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN C BOUNDARY
	DRAINAGE BASIN D BOUNDARY
	INTERIM (FILING 10) 100-YR W.S.EL.
	ULTIMATE (FILINGS 10-12) 100-YR W.S.EL.
1	DESIGN POINT
	TIME OF CONCENTRATION PATH
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM DRAINAGE CURB INLET
(6020)	EXISTING CONTOURS
6020	PROPOSED CONTOURS

INTERIM CONDITION (FILING NO. 10)

DETENTION BASIN 'D' DATA

	REQUIRED VOLUME	RELEASE RATE
WQCV	0.192 AC-FT	0.2 CFS
EURV	0.066 AC-FT	0.2 CFS
100-YR	1.396 AC-FT	18.8 CFS
100-YR + ½ WQCV	1.525 AC-FT	18.8 CFS
TOP OF EMBANKMENT ELEVATION: 5679.14		

ULTIMATE CONDITION (FILINGS 10-12) DESIGN POINT FLOWS (INTERIM CONDITION)

	REQUIRED VOLUME	RELEASE RATE
WQCV	0.833 AC-FT	0.4 CFS
EURV	1.093 AC-FT	0.9 CFS
100-YR	0.885 AC-FT	41.8 CFS
100-YR + ½ WQCV	2.811 AC-FT	41.8 CFS
TOP OF EMBANKMENT ELEVATION: 5679.14		

SUBJECT TO FUTURE REVIEW. PROVIDED FOR PROOF OF CONCEPT

DESIGN POINT FLOWS (INTERIM CONDITION)

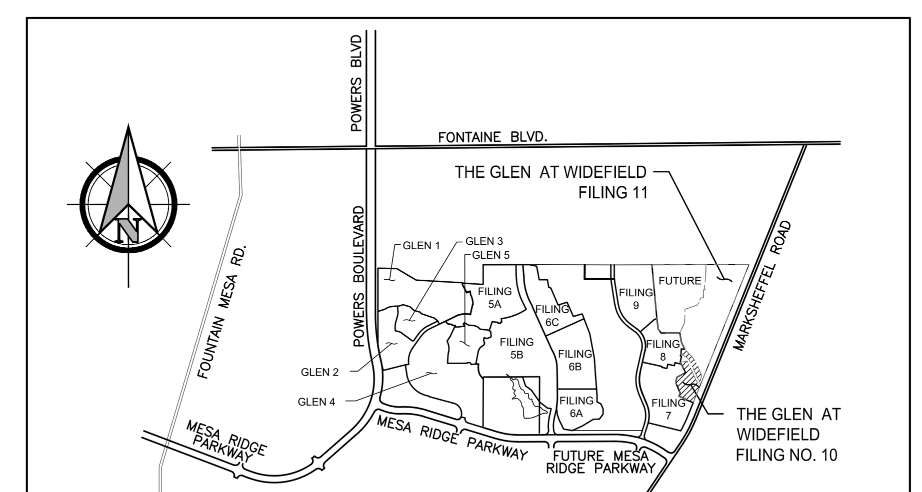
Design Point	5-YEAR	100-YEAR	Design Point	5-YEAR	100-YEAR
37	2.2 cfs	6.0 cfs	93a	2.7 cfs	7.7 cfs
39	4.4 cfs	12.0 cfs	93b	0.2 cfs	1.1 cfs
40	1.3 cfs	3.5 cfs	94	18.1 cfs	86.0 cfs
41	2.6 cfs	7.1 cfs	98	0.9 cfs	3.8 cfs
42	9.0 cfs	24.6 cfs	99	1.1 cfs	4.6 cfs
51	1.6 cfs	4.5 cfs	100	3.3 cfs	18.7 cfs
			10-1	0.5 cfs	18.8 cfs
92a	0.9 cfs	2.5 cfs	10-2	16.45 cfs*	118.82 cfs*
92b	0.7 cfs	1.9 cfs			
92c	2.7 cfs	7.7 cfs			
92d	0.2 cfs	1.2 cfs			
92e	0.3 cfs	1.0 cfs			

STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION
10-1	BASIN 'D' OUTLET STRUCTURE	10-1	30-INCH RCP @ 0.47%

*HDR FINAL DRAINAGE REPORT VALUE FOR MARKSCHEFFEL IMPS PROJECT

DETENTION BASIN 'C' DESIGN DATA (REF)

	WATER SURFACE ELEV. (FT)	REQUIRED VOLUME	RELEASE RATE
WQCV	5651.9	0.99 AC-FT	
EURV	5653.3	2.42 AC-FT	
100-YR	5654.6	4.0 AC-FT	45.9 CFS
100-YR + ½ WQCV	5655.0	4.45 AC-FT	45.9 CFS
SPILLWAY CREST ELEVATION: 5655.0			
TOP OF EMBANKMENT MINIMUM ELEVATION: 5657.0			



VICINITY MAP
SCALE: N.T.S.

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

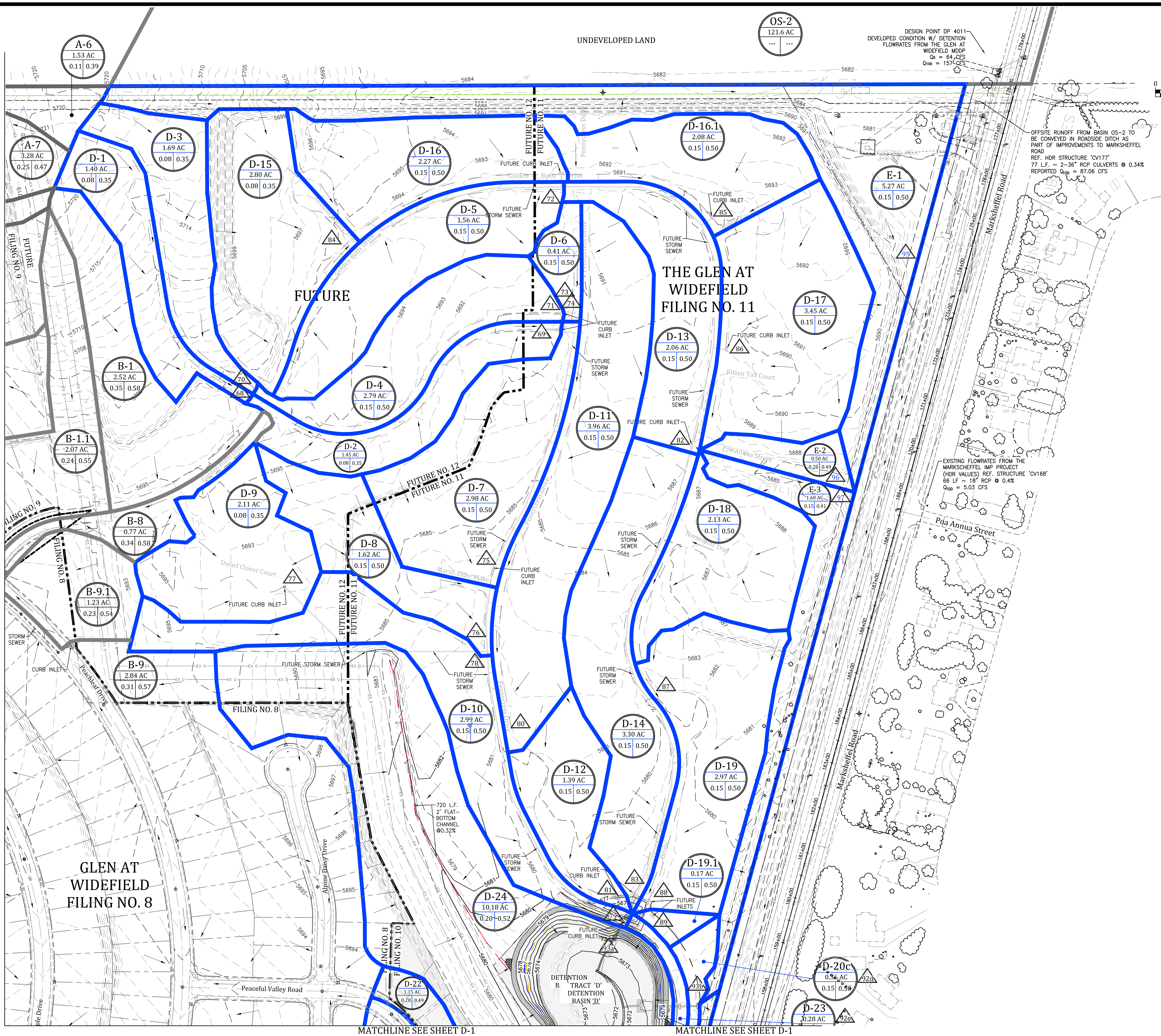
WIDEFIELD Investment Group

THE GLEN AT WIDEFIELD
FILING NO. 10
DEVELOPED DRAINAGE BASINS (ON-SITE)
El Paso, County, Colorado

Project No.:	19016
Date:	May 27, 2020
Design:	MJK
Drawn:	MJK
Check:	AMcC
Revisions:	

SHEET
D-1
2 of 3 Sheets

19016 Filing 10 – Drainage Plan.dwg/Nov 16, 2020



LEGEND

C-4	DRAINAGE BASIN DESIGNATION
2.67 AC	DRAINAGE BASIN ACRES
C5 RUNOFF COEF 0.31 / 0.50 C100 RUNOFF COEFFICIENT	
2.2 cfs	5-YEAR RUNOFF
4.3 cfs	100-YEAR RUNOFF
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN C BOUNDARY
	DRAINAGE BASIN D BOUNDARY
	INTERIM (FILING 10) 100-YR W.S.EL.
	ULTIMATE (FILINGS 10-12) 100-YR W.S.EL.
1	DESIGN POINT
	TIME OF CONCENTRATION PATH
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM DRAINAGE CURB INLET
(6020)	EXISTING CONTOURS
6020	PROPOSED CONTOURS

INTERIM CONDITION (FILING NO. 10)

DETENTION BASIN 'D' DATA

	REQUIRED VOLUME	RELEASE RATE
WQCV	0.192 AC–FT	0.2 CFS
EURV	0.066 AC–FT	0.2 CFS
100–YR	1.396 AC–FT	18.8 CFS
100–YR + ½ WQCV	1.525 AC–FT	18.8 CFS
TOP OF EMBANKMENT ELEVATION: 5679.14		

ULTIMATE CONDITION (FILINGS 10-12) DESIGN POINT FLOWS (INTERIM CONDITION)

	REQUIRED VOLUME	RELEASE RATE
WQCV	0.833 AC–FT	0.4 CFS
EURV	1.093 AC–FT	0.9 CFS
100–YR	0.885 AC–FT	41.8 CFS
100–YR + ½ WQCV	2.811 AC–FT	41.8 CFS
TOP OF EMBANKMENT ELEVATION: 5679.14		

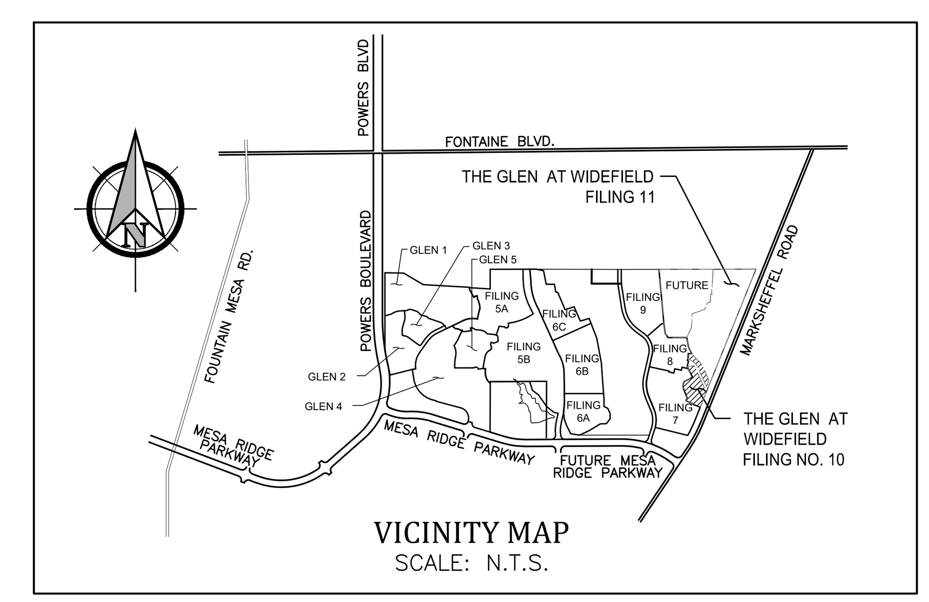
SUBJECT TO FUTURE REVIEW. PROVIDED FOR PROOF OF CONCEPT

DESIGN POINT FLOWS (INTERIM CONDITION)

Design Point	5-YEAR	100-YEAR	Design Point	5-YEAR	100-YEAR
68	0.3 cfs	2.6 cfs	83	0.8 cfs	6.1 cfs
69	0.5 cfs	4.1 cfs	84	0.7 cfs	5.5 cfs
70	0.4 cfs	3.1 cfs	85	2.5 cfs	14.0 cfs
71	0.7 cfs	5.5 cfs	86	3.3 cfs	18.2 cfs
72	0.6 cfs	3.3 cfs	87	3.4 cfs	18.8 cfs
73	0.2 cfs	1.1 cfs	88	3.6 cfs	20.1 cfs
74	1.6 cfs	8.8 cfs	89	0.1 cfs	0.5 cfs
75	3.2 cfs	18.0 cfs	90	1.3 cfs	3.6 cfs
76	3.6 cfs	20.3 cfs	91	4.2 cfs	12.0 cfs
77	0.5 cfs	3.9 cfs	92a	0.9 cfs	2.5 cfs
78	4.3 cfs	24.0 cfs	92b	0.7 cfs	1.9 cfs
79	4.3 cfs	24.3 cfs	92c	2.7 cfs	7.7 cfs
80	1.5 cfs	8.3 cfs	92d	0.2 cfs	1.2 cfs
81	1.8 cfs	9.9 cfs	92e	0.3 cfs	1.0 cfs
82	0.5 cfs	3.9 cfs	93a	2.7 cfs	7.7 cfs
			93b	0.2 cfs	1.1 cfs
			94	18.1 cfs	86.0 cfs

STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION
10-1	BASIN 'D' OUTLET STRUCTURE	10-1	30–INCH RCP @ 0.47%

*HDR FINAL DRAINAGE REPORT VALUE FOR MARKSCHEFFEL IMPS PROJECT



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SHEET
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