212 N.Wahsatch Avenue, Ste. 305
Colorado Springs, CO 80901
(719) 955-5485

October 22, 2021

El Paso County
Planning and Community Development
2880 International Circle, Suite 110
Colorado Springs, Colorado 80910

RE: Falcon Reserve Filing No.1 - Concept Drainage Analysis

Dear Staff,

This conceptual drainage analysis for Falcon Reserve Filing No.1 has been provided for your review as a foundation to discuss the following:

- Concepts for major drainage improvement from the site, which may differ from those recommended by the 2015 Falcon Drainage Basin Planning Study (DPBS) but function to achieve the same goals and more cost effective for the drainage basin

- Determine if improvements recommended by the DBPS, specially the recommendation to improve the existing box culvert at Meridian and Stapleton are necessary and if so discuss the cost and impacts associate with these improvements.

- Discuss the Stapleton – Briargate Corridor Study planned drainage assumptions and improvements and how they impact the subject site.

- Discuss deficiencies noted by the DBPS that are adjacent to the subject site and confirm that they are/ or are not the responsibility of the developer.

- Determine what drainage improvements associated with development is reimbursable to the developer.

Once your staff has had time to evaluate the analysis and recommendation for concept drainage improvements we would appreciate a chance to meet with your team to discuss the aforementioned discussion items.

Please let us know when you are available.

Respectfully,

Darin L. Moffett, P.E.
For and on behalf of M&S Civil Consultants, Inc.

CONCEPT DRAINAGE ANALYSIS

FOR

FALCON RESERVE FILING NO. 1

EL PASO COUNTY, COLORADO

OCTOBER 2021

Prepared for:

The Landhuis Company
212 N. Wahsatch Ave, Suite 301
Colorado Springs, CO 80903
(719) 635-3200

Prepared by:

CIVIL CONSULTANTS, INC.

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Project #43-144

PCD Project # SPXXX & SFXXX

CONCEPT DRAINAGE ANALYSIS
FOR
FALCON RESERVE FILING NO. 1

DRAINAGE PLAN STATEMENTS

ENGINEERS STATEMENT

The attached drainage plan and report was 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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omission on my part in preparing this report.

_____
Darin L. Moffett, P.E. #38923
For and on Behalf of M&S Civil Consultants, Inc

DEVELOPER'S STATEMENT

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

BY:_____

TITLE:_____
DATE:_____

ADDRESS: The Landhuis Company
212 N. Wahstach Ave, Suite 301
Colorado Springs, CO 80903

EL PASO COUNTY'S STATEMENT

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

BY:_____ DATE:_____
Jennifer Irvine, P.E.
County Engineer/ECM Administrator

CONDITIONS

CONCEPT DRAINAGE ANALYSIS
FOR
FALCON RESERVE FILING NO. 1

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CONCEPT DRAINAGE ANALYSIS
FOR
FALCON RESERVE FILING NO. 1

PURPOSE

The intent of this document it is to serve as Concept Design Analysis for Falcon Reserve Filing No. 1 and to identify large scale improvements necessary to allow for planning of a residential subdivision. The document will also serve to present an alternative solution to the drainage recommendations provided by the current Drainage Basin Planning Study, which will allow post development runoff is routed through the site safely and in a manner that satisfies the requirements set forth by the El Paso County Drainage Criteria Manual.

GENERAL LOCATION

The Falcon Reserve Filing No. 1 site is located in unincorporated El Paso County Colorado is located in the southeast quarter of the southeast quarter of Section 25, Township 12 South, Range 65 West of the 6th P.M. in El Paso County, Colorado. The parcel is bound to the north by existing single family residential Paint Brush Hills Filing No.4 and to the west by Liberty Grove Drive, to the south by existing Stapleton Road and to the east by existing Meridian Road. A Vicinity Map has been included in the appendix of this report.

PROPERTY DESCRIPTION

The Falcon Reserve Filing No.1 site consists of approximately 40 acres. The site is currently undeveloped. Existing ground cover consists of native or introduced grasses in fair condition. A dozen or so trees are located around the perimeter of the site. The existing site terrain generally slopes from northwest to southeast at approximately 3%. Existing roadside ditches are located along the south and east sides of the site.

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey data base indicates that the soils for this projects watershed area have been delineated, as Columbine Gravelly Sandy Loam (14), Pring Coarse Sandy Loam, (71), and Stapleton Sandy Loam is characterized as Hydrologic Soil Types “A” and "B". A Soils Map is provided in the appendix of this report.

The upper reach of the East Tributary of Falcon Basin flows southeast thru the site. In the existing condition two detention ponds are located on the site; at the northeast and southwest corners of the site. A detention pond (Paint Brush Hills Pond No. 4) is located offsite just to the northwest corner of the site. Flows conveyed through and along the site are collected by an existing box culvert which travels underneath the intersection of Meridian and Stapleton roadways.

Telephone and gas lines and are located along the north boundary, while cable and electric are located along the west property lines. Overhead utility lines are located along the south and east edges of the site. A sanitary sewer line runs along the eastern boundary of the site. No known irrigation facilities are located on the site.

The site is currently platted CR and the can be found under schedule number 5225400001. A rezone will be requested to develop this property into single family residential.

zoned (not platted yet)

DRAINAGE BASINS

Falcon Reserve Filing No.1 is located in the East Tributary of the Falcon Basin. The Faclon DBPS recommends that a channel with small drops structures with toe protection be installed across the site. A sub regional Pond SR6 is recommended to be constructed on the southeast corner of the site.

No portion of this site is within a designated F.E.M.A. floodplain as determined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 08041C0575 F, effective date March 17, 1997, taken from a past drainage study by MVE. According to the F.E.M.A. website the designated area map 08041C0551G 12/7/2018 was not printed. Copies of both documents have been included in the appendix of this report.

PREVIOUS STUDIES

The drainage basin area which encompasses Falcon Reserve Filing No.1 has been studied numerous times. Below is short outline of the assumptions regarding the lands of the subject site and those based upon the previously assembled and approved drainage reports and those that may include or be adjacent to the subject site.

"Falcon Drainage Basin Planning Study, Selected Plan Report Final – September 2015" prepared by Matrix Design Group.

- Identifies area within East Tributary of Falcon Drainage Basin
    - Determines Historic, Existing, and Future Peak Flow Rates and Flow Volumes at NW corner of Stapleton (DP Jet 020) for 2, 5, 10, 100 year events.
        - 100-year historic flow 200 cfs
        - 100-year developed flow 390 cfs
- Identifies deficiencies of Paint Brush Hills Pond #4, but doesn't recommend reconstruction
- Identifies deficiencies (HW/D) of existing dual 6'x2.5 RCBC at Stapleton Rd/Meridan Rd
- Notes erosion along the southern boundary of parcel
- Recommends construction of small drop structures with toe protection across parcel.
- Recommends sub-regional detention pond to be constructed on subject site (SR6)
    - EURV + 100 outlet configuration
    - 100-year peak discharge of 200 cfs

- Recommends replacement of (2) 6'x2.5 RCBC w/ (2) 12'x4' RCBC throught the intersection of Stapleton and Meridian Road.
- Establishes costs for drainage improvements (to be discussed in detail).
    - Assumes 15% engineering and 20% contingencies

"Conceptual Drainage Analysis for Falcon Reserve, El Paso County, Colorado" prepared by Core Engineering Group, March 2014.

- Concept study that made recommendations of large scale drainage improvements based upon modifying Falcon Reserve Study. Doesn't provide a detailed on site analysis.
- Provides a Peak flow rate comparison of KKBNA, Matrix and Core Engineering flow rates for proposed condition.
- Recommends removal of Pond in NE corner of site, due to planned roadway entrance near location, with installation of 5'x5' RCBC or channel along east boundary
- Recommends no improvements Paint Brush Hills Pond #4 at NW corner of site.
- Recommended construction of channel along north property line to convey flows from aforementioned pond. Swale should be sized for pre-detained flows which can also coincide as an emergency spillway.
- Recommends removal of Pond in SW corner of site, and construction of 48" RCP along south boundary.
- Recommends construction of the DBPS regional pond at the southeast corner of the site
    - Estimates a volume of 23.87 acre-ft of storage and 5 and 100 year release rates of 43 and 195 cfs.
- Does not make recommendation to replace existing of culvert crossing under Stapleton Drive.

"Falcon Reserve Drainage Study" prepared by LDC Inc., February 2006.

- Concept study that made recommendations of large scale drainage improvements to accompany the proposed construction of 126 residential lots. Does not provide a detailed onsite analysis.
- Recommends no improvements Paint Brush Hills Pond #4
- Recommends removal of ponds in SW and NE corner of site.
- Recommended construction of channel along north property line to convey flows from existing pond.
- Recommends construction of 5'x5' RCBC or Channel along east boundary.
- Recommends construction of 48" RCP along south boundary.
- Recommends construction of the DBPS regional pond.

"Master Development Drainage Plan, Falcon Reserve Filing No.1, prepared by MVE, Inc., September 12, 2000.

- MDDP study that made recommendations of large scale drainage improvements for the site based upon modifying the concepts within the previous KKBNA study.
- Updates "Drainage Analysis for Paint Brush Hills Filing No. 4" by utilizing the currently required Type IIA Rainfall Distribution vs. the Type II.

- Verifies volume deficiencies in Pond 1 (NE corner of site), Pond 2 (PBH No.4) and Pond 3 (SW corner of site)
- Estimates "historic" peak flows of 69 cfs, 255 cfs, existing peak flows of 197 cfs and 452 cfs at the southeast corner of the site in the 5 and 100 year storm events respectively.
- Estimates the culvert under Stapleton to have a capacity of 275 cfs before culvert headwater begins to encroach on the roadway shoulders. Calculates 100 year peak flow of 334 thru culvert with 118 cfs conveyed over the roadway thru the intersection.
- Anticipates site to be comprised of 122 - 1/4 acre single family residential lots, with a 6.3 acre multi-family site.
- Revises Pond 2 (PBH Pond 4) by realigning outlet pipe to proposed grasslined swale which with drop structure that skirts the northern boundary of the parcel.
- Removes existing Ponds at NE and SW corners of site (Pond 1 and 3).
- Recommends construction of grasslined swale with drop structures along eastern boundary of site
- Recommends 48" storm sewer along southern boundary to convey flows from offsite and onsites areas east.
- Recommends construction of 19 acre-foot Regional Detention Facility to be constructed in southeast corner of site, reducing developed flows of 248 and 564 cfs to 12 cfs and 167 cfs in the 5 and 100 year storm events respectively.
- Per the report flows along the boundary of the site (rights of way, etc) bypass pond and are allowed to freely discharge to the culvert under Stapleton Road.

"Paintbrush Hills Filing No.4 Final Drainage Report, prepared by KKBNA, December 1986.

- Report evaluative drainage reaching the 109.40 acres located north and west of the subject site.
- Identified subject site for commercial use.
- Established Ponds 1-3 which were to be constructed to detain runoff at the NE and SW corners of the future commercial area and one (Pond 2) to be constructed just to the NW of the subject site.
- Estimated Historic and Developed 100 year flow rates at Stapleton of 316 cfs and 460 cfs.
- Recommended construction of (3) 30" CMPs at 4.75% to convey the 5-year discharge under Stapleton Road.

DRAINAGE CRITERIA

This drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manual and where applicable the City of Colorado Springs DCM Volume 1 dated May 2014 effective January 2015. The NRCS curve number loss and dimensionless unit hydrograph method was applied with HEC-HMS in accordance with the drainage criteria manual for basins larger than 100 acres and for its benefit of modeling storage and conveyance with multiple detention facilities. Hydrologic calculations were performed to determine runoff quantities for the 5-year and 100-year frequency storms for developed conditions. Full spectrum detention facilities have been designed in accordance with Section 3.2.1. of Chapter 13 of the City of Colorado Springs DCM Volume 1, dated May 2014, effective January 31, 2015 and Urban Drainage and Flood Control District Manuals dated January 2016.

HYDROLOGIC CALCULATIONS

Hydrologic Modeling

A hydrologic model was utilized to simulate storm water runoff within the existing and developed watersheds to determine peak discharges and runoff volume for various conditions. The models were developed using the U.S. Army Corps of Engineers HEC-HMS hydrologic modeling program version 4.2.1. The hydrologic analysis for the watershed was completed for the proposed future land use conditions by applying a 24-hours storm event with the 5 and 100 year recurrence intervals. A detailed compilation of the model data, calculations and results are provided within the appendix of this report.

Precipitation

Precipitation was estimated from the Isopluvial maps published in NOAA atlas II, Volume 3. These values were crossed checked to the Falcon DBPS values. Given the size of the watershed analysis a reduction factor was not considered.

Times of Concentration Calculations

Topographic contour data collected from both USGS mapping and produced by aerial surveys were used in determining overland flow paths, reach slopes and reach geometry. In accordance with guidance provided in TR-55 this information was evaluated to calculate times of concentration for the hydrologic analysis.

For the existing conditions models, the time of concentration calculations for sheet flow was limited to a maximum of 300 feet and a shallow concentrated flow was limited to a maximum of 2000 feet. Open channel flow velocities were determined using Bentley's FlowMaster computer program. The depth was initially calculated using a trapezoidal channel section approximated from the contour data and an assumed flow based upon a logically selected flow per acre. A roughness factor of 0.020 was assumed for storm pipes and 0.050 for channels assuming a narrow grass lined channel with mild to steep earthen side slopes.

Similar rules were assigned for the future conditions model times of concentrations. Typically overland sheet flow was limited to a maximum of 100 feet for urban development, while sheet flow for rural development was limited to 300 feet. Shallow concentrated flows were limited to 1000 feet for urban sub-basins and less than 2000 feet for rural low density developments. The open channel flow velocities where estimated using the same process as the existing condition flows, however the channel geometry typically was reduced in width and bank slope to reflect conditions associated with man-made channels. When runoff was considered to be conveyed by storm sewer times of concentration were based upon assigning an average velocity based upon slope ranging from 6 feet per second to 15 feet per second which coincided with slopes ranging from 0.5 to 5.0%.

Lag Times

Equation 6-13 from the DCM, $T_{(lag)} = 0.6 * Tc$ was utilized to convert times of concentration to lag time. The existing conditions and developed conditions times of concentration and resultant lag times are provided in spreadsheets in the appendix.

Reach Routing

Reach Routing for stream and pipe conveyance was performed within HEC HMS using the Kinematic Wave method. The Kinematic Wave method requires input parameters of channel or pipe length, channel or pipe slope, Manning's N value, channel shape, bottom width and side slope, and/or pipe diameter. Spreadsheets in Sections C and D of the attachments list the reach data that has been entered into the existing and future HEC-HMS hydrologic models. Most typically a roughness factor of 0.050 was assumed for channels assuming a narrow grass lined channel with mild to steep earthen side slopes, while a roughness value of 0.020 was utilized in modeling concrete lined conveyance structures and pipes. Labeling of the channel reaches within this HMS model have been designated by Reach-X and are shown on the model schematics and on the existing and developed conditions maps included in Section A the attachments.

Model Comparison

Reach Routing for stream and pipe conveyance was performed within HEC HMS using the Kinematic Wave method.

HYDRAULIC CALCULATIONS

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria manual. The relevant data sheets are included in the appendix of this report.

EXISTING DRAINAGE CHARACTERISTICS

The purposes of this document are to evaluate a concept drainage design which aligns and yet varies from the previous concept studies and drainage basin planning studies for the area. Given the numerous times in which the existing facilities have been analyzed deemed to be considered insufficient M&S Civil will forgo evaluating or providing an existing conditions analysis but rather refer to the latest 2015 Falcon Drainage Basin Planning Study for the evaluation of historic and existing condition flow rates. This is especially feasible given no additional development has occurred within the watershed since its preparation.

PROPOSED DRAINAGE CHARACTERISTICS

Detailed Drainage Discussion

Offsite Basin A

This offsite drainage **Basin A** is approximately 29.5 acres in size and consists of existing Paint Brush Hills Filing No. 9 (single family residential lots) and portions of Londonberry Drive. The calculated runoff produced within this area totals approximately 32.6 cfs and 74.3 cfs in the 5 and 100-year events respectively. Storm water produced by the basin continues south and east through PBH Filings 4 and 5 via storm sewer systems and an existing grass-lined channel located within **Basin B**.

Offsite Basin B

This offsite drainage **Basin B** is approximately is 60.8 acres in size and is located to the north and west of the subject site. **Basin B** consists of portions of existing Paint Brush Hills Filing No. 4, 5, 13A (single family residential lots) and a portion of Falcon Middle School. The calculated runoff produced within this area totals approximately 45.7 cfs and 111.5 cfs in the 5 and 100-year events respectively. Runoff from **Basin A** and **B** combine at existing Paint Brush Hills Pond 4 at the northwest corner of the site.

Offsite Basin C

This offsite drainage **Basin C** is approximately is 58.7 acres in size and is located to the north of the subject site. **Basin C** consists of portions of existing Paint Brush Hills Filing No. 4, 5, 6, 7 (single family residential lots) and a portions of Londonberry Drive. The calculated runoff produced within this area totals approximately 68.7 cfs and 155.3 cfs in the 5 and 100-year events respectively. Runoff from **Basin C** discharges to a small existing detention pond located at the northeast corner of the site via a 21" RCP and an overflow swale located between to residential lots. Flows to the existing pond are conveyed within a small drainage channel located along the western side of existing Meridian Road.

Offsite Basin D

This offsite drainage **Basin D** is approximately is 47.1 acres in size and is located to the west of the subject site. **Basin D** consists of portions of existing Paint Brush Hills Filing No. 4 (single family residential lots) and a small portion of the Falcon Middle School, Scenic View at Paint Brush Hills Subdivision as well as portions of the Stapleton Drive. The calculated runoff produced within this area totals approximately 57.8 cfs and 131.0 cfs in the 5 and 100-year events respectively. Runoff from **Basin D** is collected by existing storm sewer infrastructure located in or adjacent to existing Liberty Grove Drive before being discharged into a small detention pond located at the northwest corner of the site. Flows exiting the pond continue down the rights of way to the southeast corner of the site.

Onsite Basin E

This drainage basin **Basin E** includes runoff from the proposed 38.7 acre Falcon Reserve Filing No.1 residential subdivision. The calculated runoff produced within this area totals approximately 81.9 cfs and 171.7 cfs in the 5 and 100-year events respectively. Runoff from **Basin E** will be conveyed to a proposed Full Spectrum detention pond that is to be located at the SE corner of the site.

Onsite/Offsite Basin F

This drainage basin **Basin F** includes runoff from the periphery of Reserve Filing No.1 residential subdivision and the adjacent roadway corridors. The calculated runoff produced within this area totals approximately 7.3 cfs and 14.5 cfs in the 5 and 100-year events respectively. Runoff from **Basin F** will be conveyed via existing roadside ditches to the existing dual box culvert at NW corner of Stapleton Road and Meridian Road.

HYDRAULIC ANALYSIS, RECOMMENDATIONS and COSTS

Design Point 1 (northwest corner of site)

DP1 includes runoff from **Basin A** and **B** combine at existing Paint Brush Hills Pond 4 at the northwest corner of the site. The calculated runoff entering the pond from this area totals approximately 68.7 cfs and 168.7 cfs in the 5 and 100-year events respectively. Per the MDDP for Falcon Reserve by MVE the pond at this location study Flows currently leave the pond via an existing 42" CMP where they flow southeasterly across the site.

Previous modeling of the existing pond and outlet structure within the Matrix DBPS indicates that the 100 year flows overtop the existing embankment of Paint Brush Hills Pond #4 (MS Pond 1). Recommendations within that report indicate that it is "recommend that on-site detention be incorporate upstream of these pond to reduce flooding at these locations." verify (same quote below?)

The LDC and Core Engineering Reports for Falcon Reserve indicated that the runoff from the facility (Pond A could be routed to the west via a channel relocated to the DBPS recommended sub-regional pond which could be located at the southeast corner of the site. Per the LDC report a 5' 4:1 5' deep channel with drops would be need to convey runoff east.

M&S Civil recommends expanding the pond by lowering its invert and replacing the outlet structure to function as a Full Spectrum Detention Facility. Based upon 90.3 acres of contributing watershed and an approximate imperviousness of 23.3% a total of 5.16 acres of detention is required for detention storage and water quality. By providing 4.1 acre feet of storage in the minor event and 8.0 acre-feet of storage in the major event runoff rates can be reduced to approximately 25.0 cfs and 63.0 cfs in the 5 and 100-year events respectively. Runoff can be directed east underground via a proposed 36" RCP after exiting a concrete outlet box with an orifice plate and a restrictor plate. An earthen trapezoidal channel will be recommended to provide an emergency overflow path to route water east around the residential area in the case of clogged outlet structure.

Pond Construction	~4 acre feet (additional)	$ 98,000.00
36" RCP storm sewer	1200 LF	$240,000.00
Storm sewer manholes	2	$ 10,000.00
Overflow swale	650 LF	$ 48,750.00
		$396,750.00

Design Point 2 (northeast corner of site)

DP2 includes runoff from **Basin C** that reaches an existing pond located at the northeast corner of the site. The calculated runoff entering the pond from this area totals approximately 68.7 cfs and 155.3 cfs in the 5 and 100-year events respectively. Flows currently leave the facility via an existing 36" CMP where they discharge to the Meridian Road Right of Way.

Previous modeling of the existing facility (by MVE) indicates that the 100-year flows overtop the existing embankment of Pond 2 (aka Pond A-1). Recommendations within that report indicate that it is

"recommend that on-site detention be incorporate upstream of these pond to reduce flooding at these locations." verify (same quote above?)

The LDC and Core Engineering Reports for Falcon Reserve indicated that runoff reaching existing Pond 2 (A-1*) be relocated to the DBPS recommended sub-regional pond which could be located at the southeast corner of the site. LDC concurrence to remove the pond is caveated by the anticipation of an access to be located from Meridian Roadway. Per the LDC report a 5'x5' RCBC is to be provided to convey the runoff from **DP1** and **DP2** south to the regional pond.

In early meetings with El Paso County it was determined that access will not be permitted to the site from Meridian Road. Given this, M&S Civil recommends retaining and expanding the pond by lowering its invert and adding an outlet structure to function as a Full Spectrum Detention Facility. Based upon 58.7 acres of contributing watershed and an approximate imperviousness of 29.0% a total of 3.82 acres of detention is required for detention storage and water quality. By providing 3.0 acre feet of storage in the minor event and 5.4 acre-feet of storage in the major event runoff rates can be reduced to approximately 22.4 cfs and 55.8 cfs in the 5 and 100-year events respectively. Runoff can be directed east underground via a proposed 36" RCP after exiting a concrete outlet box with an orifice plate and a restrictor plate. A proposed 42" RCP storm sewer can be constructed n earthen trapezoidal channel will be recommended to provide an emergency overflow path to route water east around the residential area in the case of clogged outlet structure.

Pond Construction	5.4 acre feet	$132,300.00
36" RCP storm sewer	140 LF	$ 28,000.00
42" RCP storm sewer	875 LF	$218,750.00
Storm sewer manholes	2	$ 10,000.00
		$389,050.00

Design Point 3 (southwest corner of site)

DP3 includes runoff from **Basin D** that reaches an existing pond located at the southwest corner of the site. The calculated runoff entering the pond from this area totals approximately 57.8 cfs and 131.0 cfs in the 5 and 100-year events respectively. Flows leaving the pond currently outfall to the roadside ditch located within the north half of the Stapleton Right of Way.

Previous modeling of the existing facility (by MVE) indicates that the 100-year flows overtop the existing embankment of Pond 3 (aka Pond A-3). Recommendations within that report indicate that it is "recommended that on-site detention be incorporate upstream of these pond to reduce flooding at these locations."

In lieu of routing the flows to sub regional facility M&S Civil recommends retaining and expanding the pond by lowering its invert and adding an outlet structure to function as a Full Spectrum Detention Facility. Based upon 47.1 acres of contributing watershed and an approximate imperviousness of 27.0% a total of 2.93 acres of detention is required for detention storage and water quality. By providing approximately 2.7 acre feet of storage in the minor event and 6.0 acre-feet of storage in the major event runoff rates can be reduced to approximately 22.4 cfs and 55.8 cfs in the 5 and 100-year events

respectively. Runoff can be directed east underground via a proposed 36" RCP after exiting a concrete outlet box with an orifice plate and a restrictor plate.

Pond Construction	6.0 acre feet	$147,000.00
36" RCP storm sewer	1030 LF	$206,000.00
Storm sewer manholes	2	$ 10,000.00
		$363,000.00

Design Point 4 (southeast corner of site)

DP4 includes runoff from the developed subject site **Basin E** that reaches a proposed pond located at the southeast corner of the site. The calculated runoff entering the pond from this area totals approximately 57.8 cfs and 131.0 cfs in the 5 and 100-year events respectively. Unlike past recommendations (LDC, DBPS) M&S Civil recommends that the pond proposed at this corner of the site is not intended to compensate for the removal of the existing onsite ponds but is exclusive to the proposed onsite development.

Pond Construction	7.7 acre feet	$188,650.00
36" RCP storm sewer	110 LF	$ 22,000.00
		$210,650.00

Design Point 5 (NW corner of Stapleton and Meridian Road)

DP5 includes runoff conveyed by the outlet pipes of the 4 ponds and the flows from **Basin F** that culminates at the existing dual 2.5'x6' reinforced concrete box culvert. It is anticipated that a riprap still basin and concrete headwalls will be need just upstream of the existing box culvert to reduce flow velocities and prevent erosion. The calculated runoff reaching the pond from this area totals approximately 57.8 cfs and 131.0 cfs in the 5 and 100-year events respectively. M&S Civil does not see the need to improve the culvert under Meridian Road as increasing its size will likely lead for the need to raise the roadway section which would substantially increase costs over those defined within the DBPS. Secondly replacing the culvert to decrease the headwater depth from 1.5 to 1.2 or 1.0 does not seem practical given the costs.

Is this the updated value?

Outfall Headwalls & Stilling Basin	1 LS	$ 35,000.00
		35,000.00

Total Construction Costs

Infrastructure and Ponds 1-4 (without land costs)		$1,394,450.00
Engineering / Const Admin	(15%)	$209,167.50
Contingencies	(20%)	$278,890.00
		$1,882,507.50

2015 DPBS Estimated Costs

Paint Brush Hills Pond #4	(no improvements)	$0.00
Small Drop Structure Reach (RET020)	1915 LF	$1,169,444.00
Sub Regional Pond SR6	1 LS	$586,078.00
(2) 4'x12 Stapleton Drive (ET 31)	302 LF	$525,026.00
		$2,280,548.00
Factor (2016-2021) (1.047% avg increase)		1.317286
2021 dollars		$3,004,134.00

DRAINAGE & BRIDGE FEES

Drainage and Bridge Fees for the **Falcon Reserve Filing No. 1** site are as follows:

	Acres		Imperviousness		Falcon Drainage Basin Fee		
2021 Drainage Fees:	40.0	x	40.8%	x	$31,885.00	=	$520,363.20
2021 Bridge Fees:	40.0	x	40.8%	x	$4,380.00	=	$71,481.60
						Total	**$591,844.80**

M &S Civil Consultants, Inc. (M &S) cannot and does not guarantee the construction cost will not vary from these opinions of probable costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular. The above is only an estimate of the facility cost and drainage basin fee amounts in 2021.

OTHER DESIGN CONSIDERATIONS

Address the benefits and drawbacks of eliminating the DBPS channel improvements.

Development of the Falcon Reserve Filing No. 1 site will likely be impacted by the Briargate-Stapleton Roadway Corridor Improvement project. M&S Civil has reviewed the available data on the public project website and had reached out to the engineering company responsible for planning and preparation of the Briargate Stapleton Drainage Report, but had not received information prior to this initial submittal of the concept drainage plan for Falcon Reserve Filing No.1. M&S plans to continue their effort to further our understanding of the proposed improvement project and how the assumptions for drainage will impact the development. Once findings are accessed an amendment to this report will be provided. At this time several assumptions regarding the roadway corridor were made in order to complete this report. A list of these assumptions are as follows;

- Offsite flows will remain separate from onsite runoff for the roadway project.
- The discharge to Stapleton shall be governed by the DBPS historic flow rate and not the future flow rates and volumes.
- Sub-regional pond SR6/Pond 4 will not be utilized to detain or treat runoff

It should noted that several factors are at play given that the regional pond is to be located onsite and will need to be located above in elevation and outside of the rights of way, therefore treating drainage from the roadway will be a difficult measure especially given the limitation of the downstream outfall for the subject site. It is recommended that consideration for offsite treatment of the roadway flows be considered with the development of Stapleton Road. It is al

The DBPS recommendation to increase the box culvert across Meridian Road/Stapleton Road will likely require the intersection to be raised. If historic roadway flows are to be the limitation upon which the culvert is to be remove and replaced

State what the overtopping flow would be and where it will go.

SUMMARY

The Development of the Falcon Reserve Filing No. 1 site shall require addressing the large offsite flows that reach the site. The recommendations made within this drainage analysis can be used as the basis for

development of a preliminary plan. The recommendation for concept drainage infrastructure provided by this report:

- Can be provided at less cost that those plan for and prescribed by the Falcon Drainage Basin Planning Study.
- Results in no disruption to the intersection of Meridian Road and Stapleton Road by forgoing the installation of a new RCBC.
- With the exception of HW/D for the existing RCBC (MR/SR intersection), the development of the parcel would meet El Paso County (ECP) Drainage Criteria.
- Amends but does not negatively alter downstream drainage recommendations or flow rates.
- Will reduce EPC maintenance of sub-regional pond by placing maintenance of 4 Ponds to Paint Brush Hills Metro District
- Will reduce the release rate below the future rates anticipated by the DPBS and more closely mimic historic release rates.
- No offsite drainage improvements will be required other than the PBH Pond #4 and Right of Way and ditch improvements.

The development of the Falcon Reserve Filing No. 1 project shall not adversely affect adjacent or downstream property. The proposed discharge from the subject site will not adversely affect the downstream infrastructure or affect water quality.

Address the calculated value in the narrative above.

REFERENCES

City of Colorado Springs/El Paso County and City of Colorado Springs Drainage Criteria Manual" City of Colorado Springs, May 2014 https://coloradosprings.gov/stormwater-enterprise/page/stormwater-criteria

Drainage Criteria Manual County of El Paso, Colorado Volume 1, Volume 1 Update https://library.municode.com/co/el_paso_county/codes/drainage_criteria_manual

HEC-HMS Version 4.2.1, https://www.hec.usace.army.mil/software/hec-hms/downloads.aspx

Mile High Flood District Software Excel Detention Design https://mhfd.org/resources/software/

Flood Insurance Rate Map (FIRM), Federal Emergency Management Agency, Effective date March 17, 1997; revised March 4, 2004.

FEMA Map Service Center https://msc.fema.gov/portal/advanceSearch

El Paso County Assessor https://property.spatialest.com/co/elpaso/#/property/4230319053

Web Soil Survey. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

"Conceptual Drainage Analysis for Falcon Reserve, El Paso County, Colorado, prepared by Core Engineering Group, March 2014.

"Drainage Analysis for Paint Brush Hills Filing No. 4" prepared by KKBNA, December 1986

"Falcon Drainage Basin Planning Study, Selected Plan Report Final – September 2015" prepared by Matrix Design Group.

"Falcon Reserve Drainage Study" prepared by LDC Inc., February 2006.

"Master Development Drainage Plan, Falcon Reserve Filing No.1" prepared by MVE, Inc., September 12, 2000.

.

APPENDIX

VICINITY MAP

VICINITY MAP

N.T.S.

FEMA MAP

NO MAPPED FLOODPLAIN ZONE 'A', ZONE 'A/E' OR ZONE 'X' PRESENT WITHIN THE WATERSHED OR ADJACENT TO THE SITE

NOT TO SCALE

FALCON RESERVE
FILING NO. 1

FLOODPLAIN MAP

M&S CIVIL CONSULTANTS, INC.

25
30
29
36
31
32
5
6
7
8
SITE
ZONE A
ZONE A
AREA REVISED BY LOMR DATED MARCH 19, 2004
RIO SECCO ROAD
REVISED AREA
ZONE A
BONIFY LOOP
LAZY E ROAD
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT
WOODMEN HILLS DRIVE
JUDGE
ORR ROAD
AND LAKE CITY
ROAD
ZONE A
DEL RIO ROAD
SOUTHERN
CADILLAC
ZONE A
AND
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CHANNEL
TOMPKINS ROAD
ZONE X
ZONE A
COLORADO
ZONE A
ZONE A
OLD
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT
PINTO PONY ROAD
ZONE A
CADILLAC
AREA REVISED BY LOMR DATED AUGUST 5, 2002
1% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CHANNEL
GELBVIEH ROAD
SWINGLINE ROAD
6805
D
ZONE A
ZONE AE
AREA REVISED BY LOMR DATED MAY 14, 2002
6792
C
ZONE A
APPROXIMATE SCALE IN FEET
2,000 1,000 0 2,000
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 575 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS 080059 0575 F
COLORADO SPRINGS, CITY OF 080061 0575 F
MAR 0 4 200
MAP NUMBER 08041C0575 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

SOILS MAP

NOT TO SCALE

FALCON RESERVE
FILING NO. 1

Summary by Map Unit — El Paso County Area, Colorado (CO625)		
Summary by Map Unit — El Paso County Area, Colorado (CO625)		
Map unit symbol	**Map unit name**	**Rating**
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A
71	Pring coarse sandy loam, 3 to 8 percent slopes	B
83	Stapleton sandy loam, 3 to 8 percent slopes	B

TYPE A SOILS

TYPE B SOILS

SOILS MAP

CIVIL CONSULTANTS, INC.

HYDROLOGIC CALCULATIONS

Falcon Preserve
~~Sterling Ranch~~ MDDP

Hydrologic Study - Land Use / Imperivous % / CN Table

Land Use	Percent Impervious	Curve Number (CN) Hydrologic Soil Type	
		A	B
Woods/Grass	0	41	62
Grassland (Rangeland)	0	41	62
Exclusion (Floodplain Rangeland)	0.5	41	62
> 5 Acre Rural Residential	7	42	63
5 Acre Rural Residential	10	44	63
2-2.5 Acre Rural Residential	12	46	65
1 Acre Single Family Urban	20	51	68
1/2 Acre Single Family Urban	25	54	70
1/3 Acre Single Family Urban	30	57	72
1/4 Acre Single Family Urban	38	61	75
1/5 Acre Single Family Urban	45	65	83
1/8 Acre Single Family Urban	65	77	85
8-12 DU/AC Multifamiily	70	79	87
12-20 DU/AC Multifamily	80	86	90
Schools	55	71	81
Roads - Paved	100	98	98
Commercial and Business	95	89	92
Industrial	72	81	88
Open Space (Parks)	10	43	64
Utilities	60	74	83
Gravel Pit	27	--	71

Taken from DCM Table 6-10 (NRCS CN ARC II)

Figure 6-25. Estimate of Average Concentrated Shallow Flow

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Date:

CN VALUES	IMP.	Hyd. Soil Type "A"	"B"
1/8 AC	45%	77*	85
1/4 AC	38%	61*	75
1/3 AC	30%	57*	72
1/2 AC	25%	54*	70
1 AC	20%	51*	68
OPEN SPACES (UNDEV.)			
GOOD COND	0%	39	61
FAIR COND	0%	49	69
PASTURE / RANGE			
GOOD COND	0%	59	78
FAIR COND	0%	69	84
SCHOOLS	55%	71	81
ROADS (PVD)	98%	98	98
ROADS/ROW (GRAVEL)	88%	83	89
OPEN SPACE (PARKS)	10%	43	64
COMMERCIAL / BUSINESS	85%	89	92

* NOT TO BE USED WHERE DUMPLOTTING IS TO OCCUR.

1/5 AC = CN 77.5 - 78
I
44.75 - 45%

1/6 AC = CN 80
I
51.5 - 52%

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"B SOILS"

BASIN A

AREA = 1,284,951.09 sq ft = 29.498 AC ~ 29.50 = 0.046091 sq mi

ZDU/AC = 1,221,947.55 sq ft = 28.05 AC 25% imp

PAVEMENT = 63003.54 sq ft = 1.45 AC 85% imp
INCL ROW

CN WEIGHTED

$$\frac{28.05 \cdot 70 + 1.45 \cdot 89}{28.05 + 1.45} = 70.9 \sim 71$$

% imp. =

$$\frac{28.05\,(25) + 1.45\,(85)}{28.05 + 1.45} = 27.9 \sim 28\%$$

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Date: _____

BASIN B "B soils"

AREA = 2,649,045.18 sq ft = 60.81 AC = 0.095021 sq mi

2 DU/AC = 1942118.44 sq ft = 44.58 AC - 25% imp

OPEN SPACE/PARK SCHOOL = 415,546.77 sq ft = 9.54 AC - 10% imp

OPEN SPACE/PARK/DET = 291379.97 sq ft = 6.69 AC 10% imp.

CN WEIGHTED

$$\frac{44.58 \cdot 70 + 9.54(64) + 6.69(64)}{44.58 + 9.54 \cdot 6.69} = 68.39 \sim 68.4$$

% imp

$$\frac{44.58(25) + 9.54(10) + 6.69(10)}{44.58 + 9.54 + 6.69} = 20.99 \sim 21.0\%$$

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Date: _____

BASIN C

AREA = 2558714.80 sq ft = 58.74 AC = 0.091781 sq mi

2DU/AC 2,273,749.81 = 52.20 AC – 25%

ROADWAY INCL. ROW = 208,376.46 sq ft = 4.78 AC – 80%

OPEN SPACE/PARK = 76588.53 = 1.76 AC – 10%

CN WEIGHTED

$$\frac{52.20 \cdot (70) + 4.78(89) + 1.76(64)}{52.20 + 4.78 + 1.76} = 71.4$$

$$\% \text{ IMP} = \frac{52.20(25) + 4.78(80) + 1.76(10)}{52.20 + 4.78 + 1.76} = 29.0$$

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Colorado Springs, CO
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Project: _____

Date: _____

BASIN D

AREA = 2049770.20 sq ft. = 47.056 AC. = 0.073523 sq mi

20 DU/AC = 1876771.26 sq ft = 43.08 AC — 25%

5 DU/AC = 85224.22 sq ft = 1.956 AC. — 45%

SCHOOL/OPEN = 38823.61 sq ft = 0.89 AC — 10%

ROADWAY INCL ROW = 45728.49 sq ft = 1.05 AC — 80%

CN WEIGHTED

$$\frac{43.08 \cdot (70) + 1.96(78) + 0.89(64) + 1.05(89)}{43.08 + 1.96 + 0.89 + 1.05} = 70.6$$

% IMP

$$\frac{43.08(25) + 1.96(45) + 0.89(10) + 1.05(80)}{43.08 + 1.96 + 0.89 + 1.05} = 26.8\%$$

MS CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: _____

DATE: _____

BASIN: E

AREA = 1684611.99 sq ft = 38.67 AC = 0.060427 sq mi

6 DU/AC = 1,234,028.53 = 28.33 AC 52% imp

PARK/OPENSPACE/DET = 450,583.46 = 10.34 AC 10% imp

CN WEIGHTED.

$$\frac{28.33\,(80) + 10.34\,(64)}{28.33 + 10.34} = 75.7$$

% imp

$$\frac{28.33\,(52) + 10.34\,(10)}{28.33 + 10.34} = 40.8$$

CIVIL CONSULTANTS, INC.

20 BOULDER CRESCENT, STE 110
COLORADO SPRINGS, CO 80903
(719) 955-5485

PROJECT: _____

DATE: _____

BASIN F

AREA = 174,374.25 = 4.003 AC. = 0.006255 sq mi

PAVEMENT INCL. ROW = 108,889.34 sq ft = 2.50 AC 85% imp

OPEN SPACE PARK/DET = 65484.91 sq ft = 1.503 AC 10% imp

CN WEIGHTED

$$\frac{2.50\,AC\,(89) + 1.503\,AC\,(61)}{2.50 + 1.503} = 79.61 =$$

% imp $$\frac{2.50\,(85) + 1.503\,(10)}{2.50 + 1.503} = 54.84 \sim 57$$

CIVIL CONSULTANTS, INC.

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Colorado Springs, CO
719.955.5485

Project:

Date:

BASIN F

AREA = 174374.25 sqft = 4.00 AC = 0.00625431

PAVEMENT INCL ROW = 108889.34 SQFT = 2.499 = 2.50 85% imp

OPEN SPACE 10% = 65484.91 = 1.50 AC

CN WEIGHTED

$$\frac{2.50(89) + 1.50(64)}{4.00} = 79.625 = 79.6$$

% imp $\frac{2.5(80\%) + 1.5(10\%)}{4.00} = 53.8$

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Project: _____

Date: _____

BASIN A POND REQ'MTS

WATERSHED AREA = 29.50 AC.

WATERSHED LENGTH = 1750'

WATERSHED SLOPE = $\frac{7246-7206}{1750}$

= 0.0229

= 0.023

WATERSHED LENGTH TO CENTROID = 1380

WATERSHED IMPERVIOUSNESS = 28%

HYDROGRAPH SOIL GROUP A = 0%

B = 100%

C/D = 0%

TARGET WQCV DRAIN TIME = 40 HRS.

ZONE 1 WQCV = 0.357 AC-FT
ZONE 2 EURV = 0.486 AC-FT
ZONE 3 100YR. = 1.035 AC-FT

TOTAL DET. 1.878 AC-FT

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Project: _____

Date: _____

BASIN B POND PERMITS

WATERSHED AREA = 60.81 ACRES

WATERSHED LENGTH = 3010'

WATERSHED SLOPE = $\frac{7208 - 7131}{3010}$ = 0.0256 = 0.026

WATERSHED LENGTH TO CENTROID = 1650

WATERSHED IMPERVIOUSNESS = 21%

HYDROLOGIC SOIL GROUP A = 0%

B = 100%

C/D = 0

TARGET WQCV DRAIN TIME = 40 HRS

ZONE 1 (WQCV) = 0.627 AC-FT

ZONE 2 (EURV) = 0.712 AC-FT

ZONE 3 (100YR) = 2.023 AC-FT

DET TOTAL 3.362 AC-FT

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Project: FALCON RESERVE

Date:

POND 1 (BASIN A/B)

AREA = 29.498 + 60.81 = 90.31

$$\text{W.S. \% imp} = \frac{28.05(25) + 1.45(85) + 44.58(25) + 9.54(10) + 6.69(10)}{28.05 + 1.45 + 44.58 + 9.54 + 6.69}$$

$$\frac{2101.3}{90.31} = 23.27\%$$

$$= 23.3\%$$

WATERSHED LENGTH = 100 + 1275 + 1800 + 1750 = 4925'

WATERSHED LENGTH TO CENTROID = 2665

WATERSHED SLOPE

7244 - 7231 = 113

$\frac{113}{4925}$

= 0.023

Hyp Soil Group = B = 100%

TARGET WQCV DRAIN TIME = 40 HRS

ZONE 1 WQCV = 0.968

ZONE 2 EURV = 1.148

ZONE 3 100-YR = 3.043

TOTAL DET. 5.160 AC-FT

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BASIN C POND REQ'MTS

WATERSHED AREA = 58.74 AC.

WATERSHED LENGTH = 2330' WATERSHED SLOPE = $\frac{7151 - 7110}{2330}$

WATERSHED LENGTH TO CENTROID = 1340

= 0.0175

WATERSHED IMPERVIOUSNESS = 29.0% = 0.018

HYDROGRAPH SOIL GROUP A = area of A assumed to be b since disturbed

B = 100%

C/D = 0%

TARGET WQCV DRAIN TIME = 40 hrs.

ZONE 1 WQCV = 0.726 AC-FT

ZONE 2 EURV = 1.017 AC-FT

ZONE 3 100-YR = 2.078 AC-FT

TOTAL DET = 3.821 AC-FT

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BASIN D POND REQ'MTS

WATERSHED AREA = 47.06

WATERSHED LENGTH = 2430

WATERSHED SLOPE = $\frac{7182 - 7110}{2430}$ = 0.0296 → 0.03

WATERSHED LENGTH TO CENTROID = 1420

WATERSHED IMPERVIOUSNESS = 27%

HYDROGRAPH SOIL GROUP. A = 0

B = 100%

C/D = 0%

TARGET WQCV DRAIN TIME = 40 HRS

ZONE 1 (WQCV) = 0.556 AC-FT

ZONE 2 (EURV) 0.737 AC-FT

ZONE 3 (100 YR) 1.639 AC-FT

TOTAL DET. 2.932 AC-FT

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Project: _____

Date: _____

BASIN E POND REQMTS

WATERSHED AREA = 38.67 AC.

WATERSHED LENGTH = 1468 WATERSHED SLOPE = $\frac{7136-7088}{1468}$

WATERSHED LENGTH TO CENTROID = 778 = 0.0326

WATERSHED IMPERVIOUSNESS = 40.8 % = 0.033

HYDROGRAPH SOIL GROUP A = 0%

B = 100%

C/D = 0%

TARGET WQCV DRAIN TIME = 40 HRS.

ZONE 1 WQCV = 0.586 AC-FT

ZONE 2 EURV = 1.073 AC-FT

ZONE 3 100YR = 1.476 AC-FT

3.135 AC-FT

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Project: _____

Date: _____

BASIN A

Overland = 100' Slope = 0.02

Shallow Gutter Flow

L = 1275 E_2 = 7246 S = 0.0188
E_1 = 7222 0.019

Storm Pipe = E_2 = 7222 S = 0.032
E_1 = 7202
L = 620'

REACH 1

L = 1180 E_2 = 7202 S = 0.0186
E_1 = 7180 0.019

D = 3.5

Reach 2

L = 1750 E_2 = 7180 S = 0.0297
E_1 = 7128 0.03

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Date: _____

Basin B

Overland 100' Slope = 0.02

Shallow Gutter Flow

L = 300' E_2 = 7206 S = 0.09
E_1 = 7203

Storm Pipe E_2 = 7203 S = 0.027
L = 850' E_1 7180

Channel

L = 1750 E_2 = 7180 S = 0.03
E_1 = 7128

Channel Area = 40.9 Ac

Channel Area = 90.3

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Project:

Date:

BASIN C

Overland 100' Slope = 0.02

Shallow Gutter Flow

L = 1950' E_2 = 46' S = 1.6%
E_1 14'

Storm Pipe L = 230 E_2 = 14 S = 0.014
E_1 = 12 0.017

Area to pipe = 1280001/43560 = 29.4 Ac

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Project:

Date:

BASIN D

Overland 100 Slope = 0.02

Shallow Concentrated Flow

L = 2310 E_2 = 7180' S = 2.9%
E_1 = 7114'

Storm Sewer

L = 130' Drop Elev. 7114 S = 1.7%
7110

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Colorado Springs, CO
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Project:

Date:

BASIN E

Overland = 100 Slope 2%

Shallow Gutter Flow

L = 680' E_2 7131 S = 0.021
E_1 = 7117
14

Storm Sewer Pipe Flow

L = 815 E_2 = 7117 S = 0.035
E_1 = 7088
29

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Project:

Date:

BASIN F

Overland Flow 50' @ 2%

Shallow Channel Flow. = 1250'

E_2 = 7104 S = 0.019
E_1 = 7080

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Project: _____

Date: _____

				CFS/AC.
BASIN A	-	74.3 CFS	29.5 AC.	2.5
BASIN B	-	111.5 CFS	60.8 AC	1.8
BASIN C	-	155.3 CFS	58.7 AC	2.6
BASIN D	-	131.0 CFS	47.1 AC	2.8
BASIN E	-	171.7 CFS	38.7 AC	4.4
BASIN F	-	14.5 CFS	4.0 AC.	3.6

DISCHARGE = 450 CFS ANT. 390 CFS PROPOSED 200 CFS

TOTAL ACREAGE = 238.8 AC.

AVERAGE CN VALUE = 70.8

Falcon Reserve Master Development Drainage Plan

Developed Condition - Lag Time Calculations

9/28/2021

Basin	OVERLAND FLOW					SHALLOW GUTTER FLOW				SHALLOW CHANNEL FLOW				STORM SEWER FLOW				CHANNELIZED FLOW				Tc	TLag
ID	P2	n	Length	Slope	Tt	Length	Slope	Vel	Tt	Length	Slope	Vel	Tt	Length	Slope	Vel	Tt	Length	Slope	Vel	Tt	Total	0.6*Tc
	(in)		(ft)	(%)	(min)	(ft)	(%)	(fps)	(min)	(ft)	(%)	(fps)	(min)	(ft)	(%)	(fps)	(min)	(ft)	(%)	(fps)	(min)	(min)	(min)
A	2.1	0.15	100	2.0	12.1	1275	1.9	1.9	2.8	0	0	0.0	0.0	618	0.0	10	1.0	0	0.0	0.0	0.0	15.9	9.6
B	2.1	0.15	100	2.0	12.1	300	1.0	1	2.0	0	0	0.0	0.0	850	2.7	10	1.4	1750	3.0	5.0	5.8	21.3	12.8
C	2.1	0.15	100	2.0	12.1	1950	1.5	1.5	2.5	0	0	0.0	0.0	230	1.7	8	0.5	0	0.0	0.0	0.0	15.1	9.0
D	2.1	0.15	100	2.0	12.1	2310	2.9	2.9	3.4	0	0	0.0	0.0	130	3.1	10	0.2	0	0.0	0.0	0.0	15.7	9.4
E	2.1	0.15	100	2.0	12.1	680	2.1	2.1	2.9	0	0	0.0	0.0	815	3.6	10	1.4	0	0.0	0.0	0.0	16.4	9.8
F	2.1	0.15	50	2.0	6.9	0	0.0	0.0	0	1250	24	1.0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0	6.9	4.2

DCM TABLE 6-25 WAS USED FOR SHALLOW CONCENTRATED SWALE & GUTTER FLOW
N VALUE FOR OVERLAND FLOW WAS ASSUMED TO BE 0.15 FOR ALL BASINS
A ROUGHNESS COEFFICENT OF 0.050 WAS USED FOR EARTHEN CHANNEL BOTTOMS
A ROUGHNESS COEFFICENT OF 0.020 WAS USED FOR CONCRETE LINED CONVEYANCES

Falcon Reserve Master Development Drainage Plan

Developed Condition Composite CN & Impervious % Table

9/28/2021

Basin	Basin	Basin	Basin	Sub-Area 1		HSG	UA CN	CN	Sub-Area 2		HSG	UA CN	CN	Sub-Area 3		HSG	UA CN	CN	Sub-Area 4		HSG	UA CN	CN	Sub-Areas	% HSG	% HSG	Weighted	Weighted
ID	Area	Area	Area	Area	Imp	Type	Value	Value	Area	Imp	Type	Value	Value	Area	Imp	Type	Value	Value	Area	Imp	Type	Value	Value	Total	A	B	Sub Areas Imp	Sub Area CN
	(SF)	(AC)	(SQ MI)	(AC)	(%)			(HSG B)	(AC)	(%)			(HSG B)	(AC)	(%)			(HSG B)	(AC)	(%)			(HSG B)	(Check)	%	%	%	No.
A	1284951	29.5	0.046	28.1	25	B	70	70	1.45	85	B	89	89											29.5	0	100	27.9	70.9
B	2649045	60.8	0.095	44.6	25	B	70	70	9.54	10	B	64	64	6.7	10	B	64	64						60.8	0	100	21.0	68.4
C	2558715	58.7	0.092	52.2	25	B	70	70	4.8	80	B	89	89	1.8	10	B	64	64						58.7	0	0	29.0	71.4
D	2049770	47.1	0.074	43.1	25	B	70	70	2.0	45	B	78	78	0.9	10	B	64	64	1.1	80	B	89		47.1	0	100	26.9	68.5
E	1684612	38.7	0.060	28.3	52	B	80	80	10.3	10	B	64	64											38.7	0	100	40.8	75.7
F	174374	4.0	0.006	2.5	80	B	89	89	1.5	10	B	64	64											4.0	0	100	53.7	79.6

Falcon Reserve Master Development Drainage Plan
Hydrologic Study - Proposed Conditions - Reach Data
9/29/2021

Reach ID	Reach Length L1 (ft)	Reach Vert. Drop H1 (ft)	Reach Slope S1 %	Mannings N Value n	Reach Side Slope SS (H/V)	Bottom Width BW (ft)	Diameter D (ft)
RT-1	1180	22	1.9%	0.02	N/A	N/A	3.0
RT-1A	1750	52	3.0%	0.05	4	10	N/A
RT-2	1210	29	2.4%	0.02	N/A	N/A	3.0
RT-3	875	16	1.8%	0.02	N/A	N/A	3.5
RT-4	1045	25	2.4%	0.02	N/A	N/A	3.0

HEC-HMS MODEL SCHEMATIC

Project: Falcon Reserve 4 Ponds Simulation Run: 5yr

Start of Run: 01Jun2022, 00:00 Basin Model: Falcon Reserve
End of Run: 06Jun2022, 00:00 Meteorologic Model: 5yr 24hr SCS II
Compute Time: 17Oct2021, 13:01:24 Control Specifications:Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin A	0.0460910	32.6	01Jun2022, 12:00	3.1
Basin B	0.0950210	45.7	01Jun2022, 12:00	5.5
Basin C	0.0917810	68.7	01Jun2022, 12:00	6.4
Basin D	0.0917810	57.8	01Jun2022, 12:00	6.4
Basin E	0.0917810	81.9	01Jun2022, 12:00	7.9
Basin F	0.0062548	7.3	01Jun2022, 12:00	0.6
Junction-1	0.2328930	44.6	01Jun2022, 12:30	15.0
Junction-2	0.4227098	94.0	01Jun2022, 12:30	30.0
Pond 1	0.1411120	25.0	01Jun2022, 12:45	8.6
Pond 2	0.0917810	22.4	01Jun2022, 12:30	6.4
Pond 3	0.0917810	22.4	01Jun2022, 12:30	6.4
Pond 4	0.0917810	27.3	01Jun2022, 12:30	7.9
Reach-1	0.0460910	30.7	01Jun2022, 12:00	3.1
Reach-1A	0.0460910	23.5	01Jun2022, 12:15	3.2
Reach-2	0.1411120	24.9	01Jun2022, 12:45	8.6
Reach-3	0.2328930	42.8	01Jun2022, 12:30	15.0
Reach-4	0.0917810	22.3	01Jun2022, 12:30	6.4

verify sizes

Project: Falcon Reserve 4 Ponds Simulation Run: 100yr

Start of Run: 01Jun2022, 00:00 Basin Model: Falcon Reserve
End of Run: 06Jun2022, 00:00 Meteorologic Model: 100yr 24hr SCS II
Compute Time: 17Oct2021, 13:02:04 Control Specifications:Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Basin A	0.0460910	74.3	01Jun2022, 12:00	6.9
Basin B	0.0950210	111.5	01Jun2022, 12:00	12.7
Basin C	0.0917810	155.3	01Jun2022, 12:00	14.0
Basin D	0.0917810	131.0	01Jun2022, 12:00	14.0
Basin E	0.0917810	171.7	01Jun2022, 12:00	16.3
Basin F	0.0062548	14.5	01Jun2022, 12:00	1.2
Junction-1	0.2328930	118.0	01Jun2022, 12:30	33.7
Junction-2	0.4227098	196.3	01Jun2022, 12:30	65.2
Pond 1	0.1411120	63.0	01Jun2022, 12:30	19.7
Pond 2	0.0917810	55.8	01Jun2022, 12:30	14.0
Pond 3	0.0917810	45.0	01Jun2022, 12:30	14.0
Pond 4	0.0917810	32.9	01Jun2022, 12:45	16.3
Reach-1	0.0460910	70.7	01Jun2022, 12:00	6.9
Reach-1A	0.0460910	57.2	01Jun2022, 12:00	6.9
Reach-2	0.1411120	62.2	01Jun2022, 12:30	19.7
Reach-3	0.2328930	117.3	01Jun2022, 12:30	33.7
Reach-4	0.0917810	43.3	01Jun2022, 12:30	14.0

Modeling Results and Comparitive Analysis

	POND A-2		POND A-1		POND A-3		POND A-4	
	SUB BASIN A-2		SUB BASIN A-1		SUB BASIN A-3		SUB BASIN 4 OR B-1	
	5-yr	100-yr	5-yr	100-yr	5-yr	100-yr	5-yr	100-yr
MVE	102 cfs	262 cfs	87 cfs	198 cfs	86 cfs	180 cfs	248 cfs	564 cfs
CORE	86 cfs	211 cfs	79 cfs	172 cfs	67 cfs	141 cfs	53 cfs	116 cfs
KKBNA	83 cfs	200 cfs	68 cfs	150 cfs	72 cfs	157 cfs	cfs	cfs
MATRIX	67 cfs	200 cfs	63 cfs	174 cfs	67 cfs	186 cfs	cfs	cfs

	POND 1		POND 2		POND 3		POND 4	
	SUB BASINS A/B		SUB BASIN C		SUB BASIN D		SUB BASIN E	
	5-yr	100-yr	5-yr	100-yr	5-yr	100-yr	5-yr	100-yr
MS CIVIL	68.7 cfs	168.7 cfs	68.7 cfs	155.3 cfs	57.8 cfs	131.0 cfs	81.9 cfs	171.7 cfs
	4.1 af	8.0 af	3.0 af	5.4 af	2.7 af	6.0 af	3.6 af	7.7 af
	25.0 cfs	63.0 cfs	22.4 cfs	55.8 cfs	22.4 cfs	45.0 cfs	27.3 cfs	32.9 cfs

POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 1

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	90.31	acres
Watershed Length =	4,925	ft
Watershed Length to Centroid =	2,665	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	23.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.968	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.116	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.252	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.927	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.503	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	8.002	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	9.825	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	12.321	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	17.047	acre-feet		inches
Approximate 2-yr Detention Volume =	1.475	acre-feet		
Approximate 5-yr Detention Volume =	2.155	acre-feet		
Approximate 10-yr Detention Volume =	3.342	acre-feet		
Approximate 25-yr Detention Volume =	4.031	acre-feet		
Approximate 50-yr Detention Volume =	4.256	acre-feet		
Approximate 100-yr Detention Volume =	5.160	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.968	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.148	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.043	acre-feet
Total Detention Basin Volume =	5.160	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)
7125.5	**Top of Micropool**	--	0.00	--	--	--	0	0.000		
7126		--	0.50	--	--	--	40	0.001	10	0.000
		--	2.50	--	--	--	28,035	0.644	28,085	0.645
		--	4.50	--	--	--	40,925	0.940	97,045	2.228
		--	6.50	--	--	--	49,014	1.125	186,984	4.293
		--	8.50	--	--	--	57,533	1.321	293,531	6.739
		--	10.50	--	--	--	70,000	1.607	421,064	9.666

20
15
10
5
0
Length, Width (ft.)
70000
52500
35000
17500
0
Area (sq.ft.)
0.00
3.00
6.00
9.00
12.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

1.620
1.215
0.810
0.405
0.000
Area (acres)
9.680
7.260
4.840
2.420
0.000
Volume (ac-ft)
0.00
3.00
6.00
9.00
12.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Falcon Reserve**

Basin ID: **Pond 1**

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.98	0.968	Orifice Plate
Zone 2 (EURV)	4.39	1.148	Orifice Plate
Zone 3 (100-year)	7.25	3.043	Weir&Pipe (Restrict)
Total (all zones)		5.160	

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

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	3.035E-02	ft^2
Depth at top of Zone using Orifice Plate =	4.39	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	17.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	4.37	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.46	2.93					
Orifice Area (sq. inches)	4.37	4.37	4.37					

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

Calculated Parameters for Vertical Orif

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	4.39	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.39	N/A
Overflow Weir Front Edge Length =	7.00	N/A	feet	Overflow Weir Slope Length =	7.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.15	N/A
Horiz. Length of Weir Sides =	7.00	N/A	feet	Overflow Grate Open Area w/o Debris =	34.10	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	17.05	N/A
Debris Clogging % =	50%	N/A	%			

Calculated Parameters for Overflow W

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

	Zone 3 Restrictor	Not Selected			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 Orifice Area =	4.77	N/A
Outlet Pipe Diameter =	36.00	N/A	inches	Outlet Orifice Centroid =	1.08	N/A
Restrictor Plate Height Above Pipe Invert =	23.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.85	N/A

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.66	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.00	feet
Spillway Crest Length =	23.00	feet	Stage at Top of Freeboard =	8.66	feet
Spillway End Slopes =	10.00	H:V	Basin Area at Top of Freeboard =	1.34	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	6.95	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.968	2.116	2.252	3.927	5.503	8.002	9.825	12.321
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.252	3.927	5.503	8.002	9.825	12.321
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	5.7	16.2	25.4	47.0	59.1	77.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.06	0.18	0.28	0.52	0.65	0.85
Peak Inflow Q (cfs) =	N/A	N/A	16.9	29.2	39.3	62.2	75.5	94.2
Peak Outflow Q (cfs) =	0.5	0.7	0.7	12.9	24.0	43.9	51.0	55.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.9	0.9	0.9	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.4	0.7	1.3	1.5	1.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	58	61	59	56	53	50	48
Time to Drain 99% of Inflow Volume (hours) =	**40**	62	65	65	64	62	61	59
Maximum Ponding Depth (ft) =	2.98	4.38	4.32	4.81	5.03	5.36	5.69	6.61
Area at Maximum Ponding Depth (acres) =	0.71	0.92	0.91	0.97	0.99	1.02	1.05	1.13
Maximum Volume Stored (acre-ft) =	0.971	2.116	2.052	2.514	2.739	3.070	3.401	4.406

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.09
	0:15:00	0.00	0.00	0.23	0.38	0.47	0.32	0.43	0.39	0.66
	0:20:00	0.00	0.00	1.08	2.01	2.70	1.17	1.48	1.71	2.84
	0:25:00	0.00	0.00	4.51	8.57	12.61	4.50	5.55	6.73	12.67
	0:30:00	0.00	0.00	10.20	18.72	26.29	20.05	25.00	29.42	44.74
	0:35:00	0.00	0.00	14.51	25.82	34.87	39.91	49.29	59.05	83.22
	0:40:00	0.00	0.00	16.42	28.59	38.24	52.71	64.39	78.08	107.59
	0:45:00	0.00	0.00	16.92	29.22	39.31	59.01	71.76	87.97	120.31
	0:50:00	0.00	0.00	16.69	28.86	38.96	61.89	75.18	92.97	126.70
	0:55:00	0.00	0.00	16.08	27.81	37.57	62.15	75.52	94.24	128.19
	1:00:00	0.00	0.00	15.30	26.36	35.85	60.17	73.23	92.85	126.36
	1:05:00	0.00	0.00	14.62	25.11	34.52	57.49	70.16	90.63	123.66
	1:10:00	0.00	0.00	13.96	24.08	33.41	54.84	67.15	87.44	119.70
	1:15:00	0.00	0.00	13.20	23.00	32.33	51.90	63.74	82.79	113.86
	1:20:00	0.00	0.00	12.43	21.81	31.00	48.80	60.04	77.53	106.99
	1:25:00	0.00	0.00	11.68	20.61	29.41	45.62	56.15	72.08	99.64
	1:30:00	0.00	0.00	11.04	19.62	27.92	42.58	52.44	66.92	92.70
	1:35:00	0.00	0.00	10.51	18.78	26.54	39.95	49.22	62.49	86.66
	1:40:00	0.00	0.00	10.01	17.87	25.20	37.55	46.28	58.54	81.20
	1:45:00	0.00	0.00	9.54	16.88	23.89	35.31	43.53	54.89	76.13
	1:50:00	0.00	0.00	9.07	15.88	22.61	33.15	40.88	51.40	71.29
	1:55:00	0.00	0.00	8.56	14.88	21.31	31.07	38.31	48.02	66.61
	2:00:00	0.00	0.00	8.01	13.87	19.93	29.01	35.79	44.71	62.03
	2:05:00	0.00	0.00	7.41	12.80	18.41	26.86	33.14	41.33	57.34
	2:10:00	0.00	0.00	6.78	11.68	16.81	24.61	30.36	37.87	52.50
	2:15:00	0.00	0.00	6.16	10.60	15.26	22.36	27.58	34.41	47.68
	2:20:00	0.00	0.00	5.61	9.68	13.99	20.20	24.93	31.11	43.21
	2:25:00	0.00	0.00	5.18	8.97	12.99	18.50	22.86	28.51	39.69
	2:30:00	0.00	0.00	4.83	8.38	12.12	17.13	21.19	26.40	36.78
	2:35:00	0.00	0.00	4.52	7.84	11.32	15.97	19.75	24.55	34.20
	2:40:00	0.00	0.00	4.24	7.34	10.57	14.92	18.44	22.89	31.87
	2:45:00	0.00	0.00	3.96	6.86	9.86	13.96	17.24	21.36	29.71
	2:50:00	0.00	0.00	3.70	6.39	9.17	13.05	16.10	19.93	27.69
	2:55:00	0.00	0.00	3.44	5.94	8.52	12.18	15.01	18.59	25.79
	3:00:00	0.00	0.00	3.20	5.51	7.89	11.35	13.98	17.34	24.03
	3:05:00	0.00	0.00	2.97	5.10	7.29	10.54	12.98	16.12	22.31
	3:10:00	0.00	0.00	2.74	4.69	6.71	9.74	11.99	14.92	20.63
	3:15:00	0.00	0.00	2.51	4.29	6.15	8.96	11.03	13.73	18.96
	3:20:00	0.00	0.00	2.29	3.90	5.59	8.18	10.07	12.54	17.30
	3:25:00	0.00	0.00	2.07	3.52	5.05	7.42	9.12	11.36	15.65
	3:30:00	0.00	0.00	1.85	3.14	4.51	6.65	8.17	10.18	14.01
	3:35:00	0.00	0.00	1.63	2.77	3.98	5.89	7.24	9.01	12.38
	3:40:00	0.00	0.00	1.42	2.40	3.45	5.14	6.31	7.85	10.76
	3:45:00	0.00	0.00	1.21	2.04	2.94	4.39	5.38	6.69	9.15
	3:50:00	0.00	0.00	1.01	1.68	2.43	3.65	4.47	5.54	7.55
	3:55:00	0.00	0.00	0.81	1.33	1.93	2.92	3.57	4.41	5.97
	4:00:00	0.00	0.00	0.61	0.99	1.46	2.20	2.68	3.29	4.44
	4:05:00	0.00	0.00	0.45	0.73	1.12	1.52	1.86	2.26	3.11
	4:10:00	0.00	0.00	0.34	0.57	0.91	1.07	1.34	1.61	2.27
	4:15:00	0.00	0.00	0.27	0.47	0.76	0.79	1.00	1.17	1.70
	4:20:00	0.00	0.00	0.23	0.39	0.63	0.60	0.77	0.86	1.26
	4:25:00	0.00	0.00	0.19	0.32	0.52	0.46	0.59	0.62	0.93
	4:30:00	0.00	0.00	0.16	0.26	0.43	0.35	0.46	0.45	0.68
	4:35:00	0.00	0.00	0.13	0.21	0.35	0.28	0.35	0.32	0.49
	4:40:00	0.00	0.00	0.11	0.17	0.27	0.21	0.27	0.23	0.35
	4:45:00	0.00	0.00	0.09	0.13	0.21	0.17	0.21	0.18	0.28
	4:50:00	0.00	0.00	0.07	0.10	0.16	0.13	0.17	0.14	0.22
	4:55:00	0.00	0.00	0.06	0.08	0.13	0.10	0.13	0.12	0.17
	5:00:00	0.00	0.00	0.04	0.06	0.10	0.08	0.10	0.09	0.13
	5:05:00	0.00	0.00	0.03	0.04	0.07	0.06	0.08	0.07	0.10
	5:10:00	0.00	0.00	0.02	0.03	0.05	0.04	0.05	0.05	0.07
	5:15:00	0.00	0.00	0.02	0.02	0.03	0.03	0.04	0.03	0.05
	5:20:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03
	5:25:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

provide sheets in order please

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Falcon Reserve**

Basin ID: **Pond 2**

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.78	0.726	Orifice Plate
Zone 2 (EURV)	4.33	1.017	Orifice Plate
Zone 3 (100-year)	6.86	2.078	Weir&Pipe (Restrict)
Total (all zones)		3.821	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	4.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	17.30	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.44	2.89					
Orifice Area (sq. inches)	3.45	3.45	0.50					

	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 Orif

	Not Selected	Not Selected
Vertical Orifice Area =	N/A	N/A
Vertical Orifice Centroid =	N/A	N/A

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.33	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	7.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	7.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow W

	Zone 3 Weir	Not Selected
Height of Grate Upper Edge, H_t =	4.33	N/A
Overflow Weir Slope Length =	7.00	N/A
Grate Open Area / 100-yr Orifice Area =	7.15	N/A
Overflow Grate Open Area w/o Debris =	34.10	N/A
Overflow Grate Open Area w/ Debris =	17.05	N/A

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 =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	23.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	4.77	N/A
Outlet Orifice Centroid =	1.08	N/A
Half-Central Angle of Restrictor Plate on Pipe =	1.85	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	31.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.94	feet
Stage at Top of Freeboard =	8.44	feet
Basin Area at Top of Freeboard =	1.04	acres
Basin Volume at Top of Freeboard =	5.38	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.726	1.743	1.777	2.913	3.962	5.557	6.756	8.362
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.777	2.913	3.962	5.557	6.756	8.362
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	5.6	15.8	24.0	43.2	54.2	69.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.27	0.41	0.74	0.92	1.18
Peak Inflow Q (cfs) =	N/A	N/A	19.5	32.4	42.4	63.3	76.6	94.0
Peak Outflow Q (cfs) =	0.3	0.5	0.4	11.5	22.2	42.4	50.3	54.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.9	1.0	0.9	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.3	0.6	1.2	1.5	1.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	66	68	67	65	61	59	56
Time to Drain 99% of Inflow Volume (hours) =	**40**	70	72	73	72	70	69	68
Maximum Ponding Depth (ft) =	2.78	4.33	4.23	4.72	4.94	5.28	5.56	6.40
Area at Maximum Ponding Depth (acres) =	0.59	0.73	0.72	0.76	0.77	0.80	0.82	0.88
Maximum Volume Stored (acre-ft) =	0.730	1.750	1.678	2.039	2.207	2.474	2.692	3.406

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.27
	0:15:00	0.00	0.00	0.71	1.17	1.47	0.99	1.28	1.23	1.88
	0:20:00	0.00	0.00	2.78	4.63	6.17	2.90	3.45	3.97	6.44
	0:25:00	0.00	0.00	9.60	16.90	24.29	9.71	11.82	13.93	24.81
	0:30:00	0.00	0.00	16.71	28.65	38.39	37.21	46.09	53.62	76.86
	0:35:00	0.00	0.00	19.36	32.36	42.45	55.57	67.88	81.92	112.65
	0:40:00	0.00	0.00	19.46	31.83	41.55	63.29	76.64	92.77	125.85
	0:45:00	0.00	0.00	18.10	29.51	38.95	63.15	76.20	94.03	126.84
	0:50:00	0.00	0.00	16.59	27.26	35.98	60.86	73.36	90.89	122.55
	0:55:00	0.00	0.00	15.27	25.04	33.18	56.64	68.39	85.99	115.99
	1:00:00	0.00	0.00	14.12	23.04	30.84	52.01	62.95	80.88	109.30
	1:05:00	0.00	0.00	13.22	21.44	29.03	48.11	58.44	76.78	104.02
	1:10:00	0.00	0.00	12.19	20.03	27.41	43.99	53.59	70.27	95.61
	1:15:00	0.00	0.00	11.11	18.47	25.78	39.96	48.80	63.17	86.39
	1:20:00	0.00	0.00	10.04	16.74	23.60	35.77	43.66	55.73	76.24
	1:25:00	0.00	0.00	9.00	15.03	21.06	31.68	38.60	48.58	66.35
	1:30:00	0.00	0.00	8.05	13.55	18.82	27.65	33.65	42.02	57.45
	1:35:00	0.00	0.00	7.35	12.50	17.17	24.31	29.67	36.85	50.62
	1:40:00	0.00	0.00	6.87	11.53	15.87	21.80	26.65	32.91	45.29
	1:45:00	0.00	0.00	6.47	10.58	14.70	19.73	24.13	29.58	40.70
	1:50:00	0.00	0.00	6.09	9.68	13.63	17.91	21.89	26.60	36.59
	1:55:00	0.00	0.00	5.60	8.83	12.52	16.24	19.85	23.87	32.79
	2:00:00	0.00	0.00	5.09	8.00	11.28	14.68	17.92	21.31	29.22
	2:05:00	0.00	0.00	4.48	6.98	9.80	12.84	15.63	18.50	25.27
	2:10:00	0.00	0.00	3.85	5.95	8.30	10.97	13.32	15.75	21.38
	2:15:00	0.00	0.00	3.26	4.95	6.87	9.15	11.07	13.07	17.60
	2:20:00	0.00	0.00	2.68	4.00	5.54	7.41	8.92	10.49	13.99
	2:25:00	0.00	0.00	2.14	3.11	4.32	5.75	6.87	8.01	10.54
	2:30:00	0.00	0.00	1.65	2.31	3.29	4.20	4.99	5.73	7.52
	2:35:00	0.00	0.00	1.24	1.76	2.61	2.98	3.61	4.11	5.55
	2:40:00	0.00	0.00	0.96	1.43	2.14	2.22	2.72	3.03	4.17
	2:45:00	0.00	0.00	0.78	1.18	1.76	1.68	2.08	2.24	3.12
	2:50:00	0.00	0.00	0.64	0.97	1.44	1.29	1.60	1.65	2.31
	2:55:00	0.00	0.00	0.53	0.79	1.17	0.99	1.23	1.20	1.70
	3:00:00	0.00	0.00	0.44	0.64	0.94	0.77	0.95	0.86	1.23
	3:05:00	0.00	0.00	0.36	0.52	0.75	0.60	0.74	0.63	0.91
	3:10:00	0.00	0.00	0.30	0.41	0.60	0.47	0.58	0.50	0.72
	3:15:00	0.00	0.00	0.24	0.33	0.47	0.37	0.46	0.40	0.57
	3:20:00	0.00	0.00	0.20	0.26	0.36	0.29	0.36	0.32	0.46
	3:25:00	0.00	0.00	0.16	0.19	0.28	0.23	0.28	0.25	0.35
	3:30:00	0.00	0.00	0.12	0.14	0.21	0.17	0.21	0.19	0.27
	3:35:00	0.00	0.00	0.09	0.10	0.15	0.13	0.16	0.14	0.19
	3:40:00	0.00	0.00	0.06	0.07	0.10	0.09	0.11	0.09	0.13
	3:45:00	0.00	0.00	0.04	0.05	0.06	0.06	0.07	0.06	0.08
	3:50:00	0.00	0.00	0.03	0.03	0.04	0.03	0.04	0.03	0.04
	3:55:00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.01	0.01
	4:00:00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 2

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	58.74	acres
Watershed Length =	2,330	ft
Watershed Length to Centroid =	1,340	ft
Watershed Slope =	0.018	ft/ft
Watershed Imperviousness =	29.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.726	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.743	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.777	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.913	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.962	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.557	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	6.756	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	8.362	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	11.452	acre-feet		inches
Approximate 2-yr Detention Volume =	1.243	acre-feet		
Approximate 5-yr Detention Volume =	1.784	acre-feet		
Approximate 10-yr Detention Volume =	2.621	acre-feet		
Approximate 25-yr Detention Volume =	3.055	acre-feet		
Approximate 50-yr Detention Volume =	3.220	acre-feet		
Approximate 100-yr Detention Volume =	3.821	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.726	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.017	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.078	acre-feet
Total Detention Basin Volume =	3.821	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)
7099.5	**Top of Micropool**	--	0.00	--	--	--	0	0.000		
		--	0.50	--	--	--	40	0.001	10	0.000
		--	2.50	--	--	--	24,675	0.566	24,725	0.568
		--	4.50	--	--	--	32,242	0.740	81,642	1.874
		--	6.50	--	--	--	38,724	0.889	152,608	3.503
		--	8.50	--	--	--	45,609	1.047	236,941	5.439
		--		--	--	--				
		--		--	--	--				
		--		--	--	--			

20
15
10
5
0
Length, Width (ft.)
46000
34500
23000
11500
0
Area (sq.ft.)
0.00
2.50
5.00
7.50
10.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

1.060
0.795
0.530
0.265
0.000
Area (acres)
5.440
4.080
2.720
1.360
0.000
Volume (ac-ft)
0.00
2.50
5.00
7.50
10.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 3

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	47.06	acres
Watershed Length =	2,430	ft
Watershed Length to Centroid =	1,420	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	27.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.556	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.293	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.333	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.230	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.063	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.347	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.304	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	6.596	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	9.069	acre-feet		inches
Approximate 2-yr Detention Volume =	0.915	acre-feet		
Approximate 5-yr Detention Volume =	1.321	acre-feet		
Approximate 10-yr Detention Volume =	1.974	acre-feet		
Approximate 25-yr Detention Volume =	2.326	acre-feet		
Approximate 50-yr Detention Volume =	2.453	acre-feet		
Approximate 100-yr Detention Volume =	2.932	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.556	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.737	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.639	acre-feet
Total Detention Basin Volume =	2.932	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)
7005.5	**Top of Micropool**	--	0.00	--	--	--	0	0.000		
		--	0.50	--	--	--	40	0.001	10	0.000
		--	2.50	--	--	--	29,770	0.683	29,820	0.685
		--	4.50	--	--	--	36,125	0.829	95,715	2.197
		--	6.50	--	--	--	42,420	0.974	174,260	4.000
		--	8.50	--	--	--	56,235	1.291	272,915	6.265
		--		--	--	--				
		--		--	--	--				
		--		--	--	--			

20
15
10
5
0
Length, Width (ft.)
56400
42300
28200
14100
0
Area (sq.ft.)
0.00
2.50
5.00
7.50
10.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

1.300
0.975
0.650
0.325
0.000
Area (acres)
6.280
4.710
3.140
1.570
0.000
Volume (ac-ft)
0.00
2.50
5.00
7.50
10.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 3

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.31	0.556	Orifice Plate
Zone 2 (EURV)	3.36	0.737	Orifice Plate
Zone 3 (100-year)	5.36	1.639	Weir&Pipe (Restrict)
Total (all zones)		2.932	

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

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

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	3.36	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.12	2.24					
Orifice Area (sq. inches)	2.71	2.71	0.50					

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

Calculated Parameters for Vertical Orific

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	3.36	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.36	N/A
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	6.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	10.89	N/A
Horiz. Length of Weir Sides =	6.00	N/A	feet	Overflow Grate Open Area w/o Debris =	25.06	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	12.53	N/A
Debris Clogging % =	50%	N/A	%			

Calculated Parameters for Overflow Wei

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

	Zone 3 Restrictor	Not Selected			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 Orifice Area =	2.30	N/A
Outlet Pipe Diameter =	36.00	N/A	inches	Outlet Orifice Centroid =	0.63	N/A
Restrictor Plate Height Above Pipe Invert =	13.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.29	N/A

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.92	feet
Spillway Crest Length =	23.00	feet	Stage at Top of Freeboard =	7.92	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.20	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	5.54	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.556	1.293	1.333	2.230	3.063	4.347	5.304	6.596
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.333	2.230	3.063	4.347	5.304	6.596
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	4.4	12.3	18.8	33.8	42.5	54.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.26	0.40	0.72	0.90	1.16
Peak Inflow Q (cfs) =	N/A	N/A	14.0	23.3	30.6	46.5	56.5	69.9
Peak Outflow Q (cfs) =	0.2	0.3	0.3	8.1	15.8	22.5	24.1	26.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.8	0.7	0.6	0.5
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.3	0.6	0.9	0.9	1.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	67	69	68	66	63	61	58
Time to Drain 99% of Inflow Volume (hours) =	**40**	71	73	74	73	71	70	69
Maximum Ponding Depth (ft) =	2.31	3.36	3.31	3.70	3.90	4.43	5.02	5.95
Area at Maximum Ponding Depth (acres) =	0.62	0.75	0.74	0.77	0.79	0.82	0.87	0.93
Maximum Volume Stored (acre-ft) =	0.561	1.299	1.255	1.557	1.713	2.139	2.638	3.476

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.18
	0:15:00	0.00	0.00	0.47	0.77	0.96	0.65	0.83	0.80	1.22
	0:20:00	0.00	0.00	1.83	3.17	4.23	1.86	2.24	2.66	4.39
	0:25:00	0.00	0.00	6.76	12.07	17.49	6.66	8.17	9.74	17.83
	0:30:00	0.00	0.00	11.93	20.62	27.61	26.99	33.70	39.34	56.61
	0:35:00	0.00	0.00	13.85	23.32	30.65	40.10	49.30	59.75	82.55
	0:40:00	0.00	0.00	14.04	23.19	30.40	45.98	56.04	68.00	92.75
	0:45:00	0.00	0.00	13.15	21.69	28.74	46.49	56.45	69.85	94.66
	0:50:00	0.00	0.00	12.13	20.18	26.77	45.15	54.73	67.98	92.12
	0:55:00	0.00	0.00	11.26	18.71	24.96	42.44	51.53	64.94	88.04
	1:00:00	0.00	0.00	10.45	17.28	23.25	39.43	47.96	61.73	83.76
	1:05:00	0.00	0.00	9.80	16.11	21.95	36.57	44.60	58.68	79.88
	1:10:00	0.00	0.00	9.08	15.17	20.92	33.66	41.19	54.06	73.94
	1:15:00	0.00	0.00	8.35	14.15	19.91	30.95	37.97	49.26	67.74
	1:20:00	0.00	0.00	7.64	13.03	18.50	28.18	34.53	44.23	60.84
	1:25:00	0.00	0.00	6.94	11.87	16.78	25.44	31.11	39.35	54.04
	1:30:00	0.00	0.00	6.26	10.76	15.04	22.69	27.69	34.77	47.64
	1:35:00	0.00	0.00	5.63	9.75	13.48	20.00	24.37	30.45	41.73
	1:40:00	0.00	0.00	5.17	8.87	12.38	17.64	21.57	26.87	37.04
	1:45:00	0.00	0.00	4.86	8.18	11.54	15.93	19.53	24.20	33.43
	1:50:00	0.00	0.00	4.59	7.56	10.79	14.55	17.84	21.95	30.34
	1:55:00	0.00	0.00	4.26	6.98	10.04	13.35	16.36	19.96	27.58
	2:00:00	0.00	0.00	3.92	6.42	9.20	12.25	15.00	18.14	25.04
	2:05:00	0.00	0.00	3.51	5.74	8.21	11.01	13.45	16.16	22.25
	2:10:00	0.00	0.00	3.10	5.05	7.21	9.75	11.87	14.23	19.51
	2:15:00	0.00	0.00	2.71	4.39	6.26	8.55	10.36	12.42	16.93
	2:20:00	0.00	0.00	2.33	3.76	5.35	7.39	8.92	10.69	14.47
	2:25:00	0.00	0.00	1.97	3.16	4.51	6.28	7.53	9.01	12.10
	2:30:00	0.00	0.00	1.63	2.58	3.70	5.20	6.18	7.37	9.79
	2:35:00	0.00	0.00	1.29	2.03	2.94	4.15	4.88	5.76	7.55
	2:40:00	0.00	0.00	0.98	1.52	2.24	3.14	3.63	4.24	5.50
	2:45:00	0.00	0.00	0.73	1.14	1.73	2.21	2.53	2.95	3.96
	2:50:00	0.00	0.00	0.56	0.90	1.39	1.58	1.87	2.14	2.93
	2:55:00	0.00	0.00	0.46	0.74	1.15	1.18	1.41	1.57	2.19
	3:00:00	0.00	0.00	0.38	0.61	0.94	0.89	1.09	1.15	1.62
	3:05:00	0.00	0.00	0.31	0.50	0.77	0.68	0.83	0.84	1.19
	3:10:00	0.00	0.00	0.26	0.41	0.63	0.53	0.65	0.61	0.87
	3:15:00	0.00	0.00	0.22	0.33	0.51	0.42	0.51	0.44	0.64
	3:20:00	0.00	0.00	0.18	0.27	0.41	0.33	0.40	0.33	0.49
	3:25:00	0.00	0.00	0.15	0.21	0.32	0.26	0.31	0.27	0.39
	3:30:00	0.00	0.00	0.12	0.17	0.25	0.20	0.25	0.21	0.31
	3:35:00	0.00	0.00	0.09	0.13	0.19	0.16	0.19	0.17	0.24
	3:40:00	0.00	0.00	0.07	0.09	0.15	0.12	0.15	0.13	0.18
	3:45:00	0.00	0.00	0.05	0.07	0.11	0.09	0.11	0.10	0.14
	3:50:00	0.00	0.00	0.04	0.05	0.08	0.07	0.08	0.07	0.09
	3:55:00	0.00	0.00	0.02	0.03	0.05	0.05	0.05	0.04	0.06
	4:00:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.03
	4:05:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.01
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 4

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	38.67	acres
Watershed Length =	1,468	ft
Watershed Length to Centroid =	778	ft
Watershed Slope =	0.033	ft/ft
Watershed Imperviousness =	40.80%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.586	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.659	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.615	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.402	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.109	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.120	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.908	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.936	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.979	acre-feet		inches
Approximate 2-yr Detention Volume =	1.226	acre-feet		
Approximate 5-yr Detention Volume =	1.709	acre-feet		
Approximate 10-yr Detention Volume =	2.344	acre-feet		
Approximate 25-yr Detention Volume =	2.615	acre-feet		
Approximate 50-yr Detention Volume =	2.743	acre-feet		
Approximate 100-yr Detention Volume =	3.135	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.586	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.073	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.476	acre-feet
Total Detention Basin Volume =	3.135	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)
83.5	**Top of Micropool**	--	0.00	--	--	--	0	0.000		
		--	0.50	--	--	--	40	0.001	10	0.000
		--	2.50	--	--	--	24,060	0.552	24,110	0.553
		--	4.50	--	--	--	37,322	0.857	85,492	1.963
		--	6.50	--	--	--	44,662	1.025	167,476	3.845
		--	8.50	--	--	--	52,487	1.205	264,625	6.075
		--	10.50	--	--	--	61,970	1.423	379,082	8.703

20
15
10
5
0
Length, Width (ft.)
62000
46500
31000
15500
0
Area (sq.ft.)
0.00
3.00
6.00
9.00
12.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

1.440
1.080
0.720
0.360
0.000
Area (acres)
8.720
6.540
4.360
2.180
0.000
Volume (ac-ft)
0.00
3.00
6.00
9.00
12.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Falcon Reserve

Basin ID: Pond 4

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.56	0.586	Orifice Plate
Zone 2 (EURV)	4.14	1.073	Orifice Plate
Zone 3 (100-year)	5.79	1.476	Weir&Pipe (Restrict)
Total (all zones)		3.135	

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

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	4.14	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	16.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.38	2.76					
Orifice Area (sq. inches)	2.93	2.94	2.94					

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

Calculated Parameters for Vertical Orific

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	4.14	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.14	N/A
Overflow Weir Front Edge Length =	7.00	N/A	feet	Overflow Weir Slope Length =	7.00	N/A
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	13.29	N/A
Horiz. Length of Weir Sides =	7.00	N/A	feet	Overflow Grate Open Area w/o Debris =	34.10	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	17.05	N/A
Debris Clogging % =	50%	N/A	%			

Calculated Parameters for Overflow Wei

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

	Zone 3 Restrictor	Not Selected			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 Orifice Area =	2.57	N/A
Outlet Pipe Diameter =	36.00	N/A	inches	Outlet Orifice Centroid =	0.68	N/A
Restrictor Plate Height Above Pipe Invert =	14.10		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.35	N/A

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.94	feet
Spillway Crest Length =	36.00	feet	Stage at Top of Freeboard =	9.44	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.31	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	7.26	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.586	1.659	1.615	2.402	3.109	4.120	4.908	5.936
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.615	2.402	3.109	4.120	4.908	5.936
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	5.4	15.1	22.7	39.8	50.0	62.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.14	0.39	0.59	1.03	1.29	1.62
Peak Inflow Q (cfs) =	N/A	N/A	28.9	44.6	56.0	75.4	89.8	108.3
Peak Outflow Q (cfs) =	0.3	0.5	0.5	7.3	16.2	27.0	28.4	30.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.7	0.7	0.6	0.5
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.2	0.5	0.8	0.8	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	68	68	70	67	64	63	61
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	72	75	74	73	72	71
Maximum Ponding Depth (ft) =	2.56	4.14	3.98	4.42	4.63	5.12	5.62	6.42
Area at Maximum Ponding Depth (acres) =	0.56	0.80	0.78	0.84	0.87	0.91	0.95	1.02
Maximum Volume Stored (acre-ft) =	0.587	1.664	1.538	1.895	2.075	2.501	2.966	3.763

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.03	0.92
	0:15:00	0.00	0.00	2.49	4.09	5.08	3.42	4.26	4.17	5.97
	0:20:00	0.00	0.00	8.78	11.57	14.63	8.58	9.99	10.73	14.76
	0:25:00	0.00	0.00	21.32	33.68	45.47	20.93	25.01	28.42	45.59
	0:30:00	0.00	0.00	28.89	44.62	56.01	64.48	78.06	89.29	121.15
	0:35:00	0.00	0.00	26.85	40.29	49.99	75.40	89.83	108.29	143.26
	0:40:00	0.00	0.00	23.19	33.94	42.30	71.71	84.83	101.76	133.98
	0:45:00	0.00	0.00	18.92	28.12	35.84	62.08	73.43	91.01	119.74
	0:50:00	0.00	0.00	15.48	23.47	29.39	54.66	64.62	79.66	104.65
	0:55:00	0.00	0.00	12.90	19.39	24.68	44.44	52.67	67.04	88.35
	1:00:00	0.00	0.00	11.17	16.63	21.64	36.83	43.88	57.98	76.81
	1:05:00	0.00	0.00	9.84	14.50	19.21	31.64	37.89	51.94	68.95
	1:10:00	0.00	0.00	8.10	12.52	16.87	25.83	31.05	41.29	55.31
	1:15:00	0.00	0.00	6.51	10.24	14.70	20.72	25.01	31.97	43.33
	1:20:00	0.00	0.00	5.19	8.02	11.79	15.65	18.84	23.09	31.26
	1:25:00	0.00	0.00	4.35	6.69	9.48	11.42	13.76	15.88	21.78
	1:30:00	0.00	0.00	3.93	6.05	8.09	8.69	10.46	11.58	16.04
	1:35:00	0.00	0.00	3.73	5.67	7.16	6.99	8.38	9.01	12.57
	1:40:00	0.00	0.00	3.63	5.01	6.50	5.93	7.05	7.31	10.22
	1:45:00	0.00	0.00	3.55	4.48	6.04	5.21	6.14	6.14	8.61
	1:50:00	0.00	0.00	3.49	4.11	5.72	4.77	5.57	5.34	7.50
	1:55:00	0.00	0.00	3.04	3.83	5.28	4.45	5.17	4.78	6.72
	2:00:00	0.00	0.00	2.66	3.52	4.68	4.25	4.90	4.47	6.27
	2:05:00	0.00	0.00	1.98	2.60	3.41	3.14	3.61	3.31	4.61
	2:10:00	0.00	0.00	1.43	1.86	2.41	2.23	2.55	2.35	3.27
	2:15:00	0.00	0.00	1.03	1.33	1.72	1.59	1.82	1.70	2.35
	2:20:00	0.00	0.00	0.73	0.93	1.21	1.12	1.28	1.20	1.66
	2:25:00	0.00	0.00	0.50	0.63	0.84	0.77	0.88	0.83	1.14
	2:30:00	0.00	0.00	0.34	0.42	0.57	0.53	0.61	0.57	0.79
	2:35:00	0.00	0.00	0.21	0.28	0.37	0.36	0.40	0.38	0.52
	2:40:00	0.00	0.00	0.12	0.17	0.21	0.21	0.24	0.22	0.31
	2:45:00	0.00	0.00	0.06	0.08	0.10	0.11	0.12	0.11	0.15
	2:50:00	0.00	0.00	0.02	0.03	0.03	0.04	0.04	0.04	0.05
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DRAINAGE MAPS

LEGEND

BASIN DESIGNATION — G1 — 2.35 (ACRES) — .53 (C5) — .66 (C100)

- 4 — PIPE RUN REFERENCE LABEL
- 6 — SURFACE DESIGN POINT
- BASIN BOUNDARY
- (6920) — EXISTING CONTOUR
- 6920 — PROP CONTOUR
- SUBDIVISION BOUNDARY
- PROPOSED STORM SEWER PIPE
- EXISTING STORM SEWER PIPE
- EXISTING FLOW DIRECTION ARROW
- PROPOSED FLOW DIRECTION ARROW
- FLARED END SECTION
- H.P. — HIGH POINT
- L.P. — LOW POINT
- EMERGENCY OVERFLOW DIRECTION

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q_5	Q_{100}
A	29.5	32.5	74.3
B	60.8	45.7	111.5
C	58.7	68.7	155.3
D	47.1	57.8	131.0
E	38.7	81.9	171.7
F	4.0	7.3	14.5

STORM SEWER SUMMARY				
PIPE RUN	Q_5	Q_{100}	PIPE SIZE	CONTRIBUTING PIPES/DESIGN POINTS
1	24.9	63.0	36" RCP	POND 1
2	22.4	55.8	36" RCP	POND 2
3	44.6	118.0	42" RCP	PR1, PR2
4	22.3	45.0	36" RCP	POND 3
5	27.3	32.9	36" RCP	POND 4
6	94.0	196.3	2.5'x6' RCBC	PR3, PR4, PR5

DESIGN POINT SUMMARY				
DESIGN POINT	Q_5	Q_{100}	BASIN	STRUCTURE
1	68.7	168.7	A, B	POND 1
2	68.7	155.3	C	POND 2
3	57.8	131.0	D	POND 3
4	81.9	171.7	E	POND 4
5	94.0	196.3	PR3, PR4, PR5	EXIST (2) 2.5'X6'

is this scale correct?

1" = 100'

0 25 50 100 200

Scale in Feet

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FALCON RESERVE FILING NO.1

CONCEPT DRAINAGE MAP

PROJECT NO. 43-144
DESIGNED BY: DLM
DRAWN BY: DLM
CHECKED BY: VAS
SCALE: HORIZONTAL: N/A VERTICAL: N/A
DATE: 10-19-21
SHEET 1 OF 1
CDM01

212 N. WAHSATCH AVE, STE 305
COLORADO SPRINGS, CO 80903
PHONE:719.955.5485
CIVIL CONSULTANTS, INC.

VIRGIL A. SANCHEZ, COLORADO P.E. NO. 37160

FOR AND ON BEHALF OF MACE CIVIL CONSULTANTS, INC.

REVISIONS:

NO.	DATE:	BY:	DESCRIPTION:	APPV'D. BY:	DATE:

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

CAUTION

File: C:\Users\dmoffett\Desktop\concept map.dwg Plotstamp: 10/19/2021 9:48 AM

BACKGROUND

Conceptual Drainage Analysis

for

Falcon Reserve
El Paso County, CO

Prepared For:

The Landhuis Company
212 N. Wahsatch Avenue, Suite 301
Colorado Springs, CO 80903

By:

Core Engineering Group
15004 1st Avenue S.
Burnsville, MN 55306
(719) 570-1100

Job No. xxx

March, 2014

DESIGN POINT	TRIBUTARY AREA	Q_5 cfs	Q_{100} cfs	COMMENTS
O.S. A.3	–	72.0	157.0	FLOW INTO PIPE
1	5.4	9.5	19.8	FLOW TO INLETS
2	5.2	9.1	18.7	FLOW TO INLET
3	8.0	9.6	17.1	FLOW TO INLET
4	2.6	4.8	9.7	FLOW TO INLET
5	–	105.0	222.3	FLOW INTO POND
6	11.3	25.1	49.0	FLOW INTO POND FROM PHASE II
7	2.3	6.8	13.8	FLOW TO INLET
8	–	93.1	199.0	FLOW FROM OLD POND #1 & DP6
9	TOTAL FLOW	208.0	442.7	
10	–	103.7	311.9	TOTAL FLOW INTO BOX CULVERT Q POND OUT + Q BY PASS

NOTE:
PROPOSED CHANGES TO DRAINAGE MAP
(IN COLOR) MADE BY CORE ENGINEERING GROUP

LDC, Inc.
PLANNING, SURVEYING, LANDSCAPE ARCHITECTURE
3520 Austin Bluffs Parkway
Colorado Springs, CO 80918
(719) 528-6133 FAX (719) 528-6848

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PRELIMINARY PLAN - DRAINAGE MAP

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FALCON RESERVE
MASTER DEVELOPMENT DRAINAGE PLAN

PROJECT NO.	04086.1	Drawn By: KEM	Date: 02-21-06
		Checked By:	Sheet: 1 of 1

DRAINAGE ANALYSIS

FOR

PAINT BRUSH HILLS

FILING NO. 4

DECEMBER 1986

Owner: Paint Brush Hills Partnership
3720 Sinton Road, Suite 200
Colorado Springs, CO 80907

Engineer: KKBNA, Inc., Consulting Engineers
4251 Kipling Street
Wheat Ridge, CO 80033
431-6100

NOTE:
1. EXISTING CONTOURS ARE REDRAWN USING INFORMATION FROM A 1972 AERIAL SURVEY.
2. ROADS IN AREAS OTHER THAN FILING NO. 4 ARE DRAWN AS ASSUMED CONFIGURATION BASED ON THE BEST INFORMATION AVAILABLE.

project _____
project manager _____ job no. _____
designed by _____ sheet no. _____
drawn by _____

KKBNA
INCORPORATED
CONSULTING ENGINEERS

PAINT BRUSH HILLS
FILING NO. 4

DRAINAGE MAP

no	description of revisions	date	name

date NOVEMBER 1986
job number 9205.01.0007
design by M. SCHOLZ
drawn by C. BURK
checked by R. DOMINICAK

sheet number

D-1

FALCON DRAINAGE BASIN PLANNING STUDY

SELECTED PLAN REPORT

FINAL - SEPTEMBER 2015

Prepared for:

El Paso County Public Services Department
3275 Akers Drive
Colorado Springs, CO 80922

Prepared By:

Matrix Design Group
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920

Matrix Project No. 10.122.003

Table 3-9. Time of Concentration Summary for the Falcon Watershed

	Historical T_c	Existing T_c	Future T_c
Minimum	8 min	6 min	5 min
Maximum	153 min	115 min	86 min
Average	51 min	41 min	34 min

Notes:
min = minutes

3.10. Channel Routing

The Muskingum-Cunge method was used for channel routing in 70 reaches in the Falcon Watershed, which is dominated by a wide, grass bottom channel. Reach delineations were performed for existing conditions and were likely much different historically because of the absence of development. Reach delineations will also likely change in the future condition but are not able to be identified at this point due to data limitations and ambiguity of future development patterns. Manning's channel roughness coefficient (Manning's n) values for earthen channels were assigned based on published values. Storm sewer reaches were represented as either circular or rectangular cross sections and were assigned a Manning's n value of 0.013. Table 3-10 outlines the channel characteristics in the Falcon Watershed.

Table 3-10. Channel Characteristics within Falcon Watershed

	West Tributary		Middle Tributary		East Tributary	
	Slope	Manning's n	Slope	Manning's n	Slope	Manning's n
Minimum	0.50%	0.013	0.40%	0.013	0.40%	0.030
Maximum	2.9%	0.070	2.1%	0.070	2.1%	0.070
Average	1.7%	0.047	1.5%	0.044	1.3%	0.049

3.11. Detention Ponds

Fifteen existing detention ponds were included in the Falcon Watershed HEC-HMS model. According to discussion with the County, no as-built drawings exist for any of these detention ponds and the stage-storage-discharge relationships published in available drainage plans and reports are not reliable. As a result, Matrix developed stage-storage-discharge relationships using 2-ft contour information and field measurements of the outlet structures for each of the 15 detention ponds. The stage-storage-discharge relationships developed for this DBPS should only be used for planning purposes and not for further design of any the existing detention ponds in the Falcon Watershed. Detailed survey information should be obtained for any of the existing ponds where additional design is desired.

According to Falcon Highlands Final Drainage Report Filing No. 1 (URS Corporation 2005), Regional Pond WU was intended to be an off-line detention pond with a constructed weir to control flow into the pond from the main channel. However, based on field observation and measurements Regional Pond WU is an on-line detention pond that captures all flow from the upstream channel up to the elevation of the secondary outlet structure which discharges flow to the adjacent channel.

There are several stock ponds throughout the Falcon Watershed that appear to always remain full and do not have any apparent outlet structures. These ponds provide minimal flood attenuation and were not modeled using a detention reservoir model. All detention pond locations are shown on Figure 3-1. Detention pond characteristics are summarized in Table 3-11.

Note that all detention ponds must be approved by the Federal Emergency Management Agency (FEMA) before a hydrology model can be approved by FEMA. FEMA-approved ponds likely consist only of County- and District-owned and maintained ponds and likely do not include privately-owned and maintained ponds. Some of the ponds included in this analysis are within developments and are possibly privately owned and maintained.

Table 3-11. Detention Pond Summary for the Falcon Watershed

Detention Pond	I.D.	Location	Surface Area (ac)	Vol. (ac-ft)	Initial Condition[2]
Meadows Pond #1	M 1	600 ft east of Towner Ave. on Woodmen Hills Dr.	1.0	2.2	Initial Storage = 0
Meadows Pond #2	M 2	2,100 ft east of Towner Ave. on Woodmen Hills Dr.	1.6	6.3	Initial Storage = 0
Paint Brush Hills Pond #4	PBH 4	Northeast corner of Brockton Ln. & Liberty Grove Dr.	0.90	1.3	Initial Storage = 0
Paint Brush Hills Pond A	PB A	300 ft west of Keating Dr. on Rockingham Dr.	1.1	2.6	Initial Storage = 0
Paint Brush Hills Pond B1	PB B1	North of Duxbury Dr.	1.6	9.2	Initial Storage = 0
Paint Brush Hills Pond B2	PB B2	East of Duxbury Dr.	2.5	12	Initial Storage = 0
Paint Brush Hills Pond C	PB C	East of London Derry Dr. & Rockingham Dr.	1.9	6.8	Initial Storage = 0
Regional Pond MN	R MN	Between Meridian Rd. & McLaughlin Rd.	2.1	7.5	Initial Storage = 0
Regional Pond WU[1]	R WU	Southwest corner of Meridian Rd. & Tamlin Rd.	6.5	41	Initial Storage = 0
Woodmen Hills Pond #1[1]	WH 1	500 ft east of Tompkins Rd. on Woodmen Hills Dr.	3.6	16	Initial Storage = 0
Woodmen Hills Pond #2	WH 2	West of Ledoux Rd.	2.8	9.2	Initial Storage = 0
Woodmen Hills Pond #3	WH 3	North of Tompkins Rd. & Eastonville Rd.	5.5	8.4	Initial Storage = 0
Woodmen Hills Pond #4	WH 4	Northeast corner of Woodmen Rd. & Hwy. 24	8.1	22	Initial Storage = 0
Woodmen Hills Pond #5	WH 5	South of Corbu Heights & Maybeck view	1.5	4.1	Initial Storage = 0
Woodmen Hills Pond H	WH H	Northwest corner of Meridian Rd. & Woodmen Hills Dr.	1.0	2.7	Initial Storage = 0

Notes:
[1] Pond is divided by road. Values represent cumulative value of both areas.
[2] All detention ponds were assumed to be empty at the beginning of the model simulation.

3.12. Hypothetical Rainfall

A hypothetical rainfall event was used to simulate precipitation for hydrologic analyses. The SCS Type IIa 24-hour storm distribution is recommended for temporal distribution in the DCM. Storm

events with 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals were selected for hydrologic modeling. These storm events have an equivalent of a 50-, 20-, 10-, 4-, 2-, and 1-percent chance of exceedance annually, respectively.

Isopluvial maps published in *NOAA Atlas 2 Vol. III* (Miller et al. 1973) were used to estimate rainfall in the Falcon Watershed for each recurrence interval. Since the Falcon Watershed is slightly larger than 10 sq mi, an areal reduction of 2% was applied as prescribed by *NOAA Atlas 2 Vol. III*. Table 3-12 provides the 24-hour rainfall depths for each recurrence interval.

Table 3-12. Rainfall Depths within the Falcon Watershed

Recurrence Interval	Unadjusted Rainfall Depths	Areal Adjusted Rainfall Depths[1]
2-year	2.0 in.	1.96 in.
5-year	2.6 in.	2.55 in.
10-year	3.0 in.	2.94 in.
25-year	3.8 in.	3.72 in.
50-year	4.2 in.	4.12 in.
100-year	4.6 in.	4.51 in.

Notes:
[1] Areal reduction of 2% applied to rainfall depths from the *NOAA Atlas 2 Vol. III*

The areal adjusted rainfall depths for all modeled storm events were multiplied by each ordinate of the SCS Type IIa 24-hour temporal unit distribution to develop hyetographs for each storm event.

3.13. Results

The HEC-HMS model for the Falcon Watershed was run to simulate the rainfall-runoff process and generate flood hydrographs for historical, existing, and future land use conditions by applying a 24-hour storm event with 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals. As expected, future peak flows increased over existing conditions in conjunction with planned development. Table 3-15 provides a brief summary of peak flows at points of interest within the Falcon Watershed and Table 3-16 provides a brief summary of flow volumes at the same points of interest. The future conditions model results reported in this section do not reflect any proposed detention, channel improvements, or other alternatives described in later sections of this report. Historical, existing, and future results are summarized graphically on Figure 3-11, Figure 3-12, and Figure 3-13, respectively.

3.14. Model Comparison

Previously published studies and flood flow analyses applicable to the Falcon Watershed include:

- URS Corporation *Falcon DBPS*, 2000
- FEMA Flood Insurance Study (FIS)
- FEMA Letters of Map Revision (LOMR)
- USGS *Analysis of the Magnitude and Frequency of Floods in Colorado*, 2000
- Colorado Water Conservation Board (CWCB) *Guidelines for Determining 100-year Flood Flows for Approximate Floodplains in Colorado*, 2004.

The peak flow results of this modeling effort were compared to the studies and analyses listed above to check for reasonableness. Table 3-14 provides a comparison of peak flow results at the Falcon Watershed outlet from the various flood studies. Flood flows are not published in the FEMA FIS for the tributaries in the Falcon Watershed. However, flood flows at sporadic locations throughout the Falcon Watershed were published in some of the LOMRs completed for developments. A comparison of these flows is provided in Table 3-17.

As shown in Table 3-14 the existing conditions peak flows for this DBPS are higher than the 2000 DBPS for the 5-yr event and lower than the 2000 DBPS for the 100-yr event. The reason for this is because of the lower initial abstraction value that was used for this DBPS. Lowering the initial abstraction ratio has a more noticeable impact on increasing smaller flood flows compared to larger flood flows. A summary of the major differences between this DBPS and the 2000 DBPS are:

- The 2000 DBPS model included 3 detention ponds with a total storage volume of approximately 31 ac-ft while this DBPS includes 15 detention ponds with a total volume of approximately 151 ac-ft.
- The 2000 DBPS did not account for the existing basin diversion in the northwest portion of the watershed
- It is assumed that the 2000 DBPS used an initial abstraction ratio of 0.20. The HEC-1 data that was received from the County shows that the first value in the LS card was left blank which indicates that the default initial abstraction value was used. There is no formal documentation that this value was used, however, this is typically the default initial abstraction ratio for most models. This DBPS used an initial abstraction ratio of 0.10.

A comparison of model parameters between this DBPS and the 2000 DBPS is provided in Table 3-13.

Table 3-13. Comparison of Model Parameters

	CN		T_c (min)		Manning's n	
	2000 DBPS	2011 DBPS	2000 DBPS	2011 DBPS	2000 DBPS	2011 DBPS
Min.	60	41	3.9	6.2	.020	.013
Max.	81	86	33	115	.035	.070
Avg.	61	62	14	41	.034	.047

Figure 3-1
Routing Schematic
Falcon DBPS
El Paso County, CO

Matrix Design Group Inc.
Integrated Design Solutions

DRAWING NOT TO SCALE

LEGEND
«-- Subbasin ID
«-- Subbasin Area (square miles)
Existing Watershed Boundary
Historical and Future Watershed Boundary
Tributary Basin Boundary
East Tributary
Middle Tributary
West Tributary
Subbasin Boundary
Major Tributary
Elevation Contour (feet)
Falcon Drainage Basin
Total Basin Area 10.7 mi²
Average Subbasin Area 0.16 mi²
Minimum Subbasin Area 0.03 mi²
Maximum Subbasin Area 0.33 mi²
BURGESS RD
GOODSON RD
MERIDIAN RD
RAYGOR RD
STAPLETON DR
EASTONVILLE RD
JUDGE ORR RD
WOODMEN RD
TAMLIN RD
FALCON HWY
GARRETT RD
East Tributary
West Tributary
Middle Tributary
FALCON WATERSHED
Black Forest
Colorado Springs
Fort Carson
Fountain
I-25
US-24
Kettle Creek
Monument Creek
Black Squirrel Creek
Jimmy Camp Creek
Williams Creek
Chico Creek
Sand Creek
Fountain Creek
Figure 3-2
Drainage Basin Map
Falcon DBPS
El Paso County, CO
0
0.5
1
Miles
Matrix DESIGN GROUP
NOTE: FIGURE MUST BE VIEWED IN COLOR
FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\basin_map.mxd, 8/29/2011, wilson_wheeler

Hydrologic Soil Group	% of Watershed
A	9.9
B	41.8
A Regraded to B	48.1
Water	0.1
Total	**100.0**

Figure 3-3
Hydrologic Soil Groups
Falcon DBPS
El Paso County, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\soil_groups.mxd, 8/29/2011, wilson_wheeler

Historical Land Use	
Land Use	**% of Watershed**
Rangeland Good Condition	94.1
Woods Good Condition	5.9
Total	**100.0**

Figure 3-4
Historical Land Use
Falcon DBPS
El Paso County, CO

Existing Land Use	
Land Use	**% of Watershed**
Commercial	1.9
County	1.1
Dry Farm Land	0.1
Grazing Land	8.2
Industrial	1.0
Other	3.0
Political Subdivision	4.4
ROW	8.2
Rural	26.4
Rural Residential	16.0
Urban	14.7
Vacant <2.5 Acres	1.0
Vacant 2.5-5 Acres	1.6
Vacant >5 Acres	12.4
Total	**100.0**

Figure 3-5
Existing Land Use
Falcon DBPS
El Paso County, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20130617\Fig_3-5_landuse_existing.mxd, 6/18/2013, ron_ramold

Future Land Use	
Land Use	**% of Watershed**
Multi-Family	0.8
Single Family Urban	10.3
0.5 Acre Residential	16.2
2.5 Acre Rural Residential	5.4
5 Acre Rural Residential	43.4
Community Commercial	0.9
Neighborhood Commercial	0.02
Service Commercial	3.3
Churches/Quasi-Public	0.05
Schools And Colleges	1.7
Light Industrial	0.6
Office	0.1
Open Space	0.2
Parks	0.8
Utilities	0.04
Exclusion	16.3
Total	**100.0**

Figure 3-6
Future Land Use
Buildout Condition
Falcon DBPS
El Paso County, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20130617\Fig_3-6_landuse_future.mxd, 6/18/2013, ron_ramold

Existing Land Use	Measured % Impervious
Commercial	45.3
County	1.7
Dry Farm Land	1.9
Grazing Land	0.6
Industrial	0.4
Other	6.3
Political Subdivision	16.4
ROW	46.7
Rural	1.9
Rural Residential	3.0
State	0.5
Urban	18.1
Vacant <2.5 Acres	2.3
Vacant >5 Acres	0.1
Vacant 2.5-5 Acres	0.2

Figure 3-7
Impervious Area
Falcon DBPS
El Paso County, CO

0 0.5 1
Miles

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\impervious.mxd, 8/29/2011, wilson_wheeler

Subbasin Historical Curve Numbers	
Minimum	39
Maximum	61
Area-Weighted Average	48

Figure 3-8
Historical Runoff Curve Numbers
Falcon DBPS
El Paso County, CO

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\CN_historical.mxd, 8/29/2011, wilson_wheeler

Subbasin Existing Curve Numbers	
Minimum	41
Maximum	86
Area-Weighted Average	62

Figure 3-9
Existing Runoff Curve Numbers
Falcon DBPS
El Paso County, CO

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\CN_existing.mxd, 8/29/2011, wilson_wheeler

Hydrologic Element	Area (sq mi)	Existing Peak Flows (cfs)		Hydrologic Element	Area (sq mi)	Existing Peak Flows (cfs)	
		2-year	100-year			2-year	100-year
ET010	0.15	25	150	RET050	0.71	23	480
ET020	0.21	44	260	RET060	0.83	7	400
ET030	0.20	34	190	RET070	1.11	13	340
ET040	0.15	28	170	RET080	1.36	65	420
ET050	0.12	37	200	RET090	1.66	14	320
ET060	0.29	110	530	RET100	1.78	15	370
ET070	0.25	94	460	RET110	1.83	15	380
ET080	0.29	91	440	RET120	2.05	16	410
ET090	0.12	7	63	RET140	0.13	7	62
ET100	0.05	1	34	RET152	2.16	17	430
ET110	0.23	8	120	RET154	0.40	18	150
ET120	0.11	8	70	RET156	2.57	28	570
ET130	0.13	7	62	RET162	2.74	30	590
ET140	0.27	11	89	RET164	2.93	32	620
ET150	0.18	17	140	RMT030	0.09	14	100
ET160	0.19	19	140	RMT040	0.25	33	240
FS010	0.12	2	41	RMT050	0.56	40	470
JET010	0.15	23	120	RMT062	0.29	1	160
JET020	0.36	44	280	RMT064	0.67	50	580
JET030	0.56	65	460	RMT070	1.16	54	670
JET040	0.71	23	480	RMT080	1.36	61	760
JET050	0.83	7	410	RMT090	0.04	8	30
JET060	1.11	13	340	RMT102	1.42	40	770
JET070	1.36	94	490	RMT104	0.04	8	30
JET080	1.66	14	320	RMT106	1.46	44	780
JET090	1.78	15	370	RMT112	1.52	44	790
JET100	1.83	15	380	RMT114	1.64	46	820
JET110	2.05	16	410	RWT030	0.07	4	42
JET120	2.16	17	430	RWT042	0.14	9	85
JET130	0.13	7	62	RWT044	0.14	9	89
JET140	0.40	18	150	RWT046	0.28	15	170
JET152	2.57	28	570	RWT054	0.46	24	260
JET154	2.74	31	590	RWT080	0.17	14	130
JET160	2.93	32	620	RWT092	0.85	43	480
JFS010				RWT094	1.09	54	610
OUTLET	0.12	2	41	RWT122	1.43	66	740
JMT010	0.29	1	160	RWT124	1.63	76	850
JMT020	0.09	14	100	RWT150	0.12	14	110
JMT030	0.25	34	240	RWT160	0.36	11	91
JMT040	0.56	40	470	RWT172	1.77	84	900
JMT050	0.67	50	580	RWT174	0.47	35	180
JMT060	1.16	54	670	RWT176	2.24	90	930
JMT070	1.36	61	760	RWT180	2.36	0	760
JMT080	1.42	40	770	RWT202	2.46	0	770
JMT090	0.04	8	30	RWT204	0.06	4	43
JMT102	1.46	44	790	RWT210	2.82	14	880
JMT104	0.04	8	30	RWT232	3.09	20	950
JMT106	1.52	45	800	RWT234	0.19	16	130
JMT110	1.64	46	820	RWT236	3.28	27	990
JWT010	0.14	9	89	RWT240	3.47	50	1,000
JWT020	0.07	4	42	RWT240			
JWT030	0.14	9	85	_Diversion			
JWT042	0.28	15	170	Reach	0.00	16	39
JWT044	0.46	24	260	RWT250	3.55	26	880
JWT050	0.85	43	480	RWT260	3.70	38	890
JWT070	0.17	14	130	RWT291	3.84	46	910
JWT080	1.09	54	610	RWT292	0.03	8	45
JWT090	1.43	67	740	RWT294	0.27	33	250
JWT110	1.63	76	850	RWT295	3.87	49	910
JWT120	1.77	84	910	RWT296	4.13	70	920
JWT140	0.13	14	110	RWT312	0.10	12	91
JWT150	0.36	11	91	RWT314	5.88	93	1,300
JWT160	0.47	35	180	RWT320	6.25	120	1,300
JWT172	2.24	90	930	RWT344	0.33	16	160
JWT174	2.36	92	960	RWT352	6.46	120	1,300
JWT174				RWT354	9.69	160	1,900
Diversion	2.36	0	760	RWT372	10.30	190	1,900
JWT174				RWT374	0.07	7	55
Diversion				RWT376	10.36	190	1,900
OUTLET	0.00	92	200	M1	0.06	4	43
JWT180	2.46	0	770	M2	0.29	1	160
JWT190	0.06	4	43	WH1 North	0.71	59	480
JWT200	2.82	14	880	WH1 South	0.71	23	480
JWT210	3.09	21	950	WH2	0.83	7	410
JWT220	0.19	16	130	WH3	1.11	13	340
JWT232	3.28	27	990	WH4	1.66	14	320
JWT234	3.47	50	1,000	WH5	0.04	8	30
JWT240	3.55	26	890	WHH	0.56	40	470
JWT250	3.70	39	890	WT010	0.14	9	89
JWT260	3.84	47	910	WT020	0.07	4	42
JWT270	0.03	8	45	WT030	0.08	9	75
JWT280	0.27	33	250	WT040	0.19	9	93
JWT292	3.87	49	910	WT050	0.19	17	140
JWT294	4.13	71	930	WT060	0.20	14	120
JWT296	5.88	94	1,300	WT070	0.17	14	130
JWT300	0.10	12	92	WT080	0.07	9	67
JWT310	6.25	120	1,300	WT090	0.15	17	130
JWT320	6.46	120	1,300	WT100	0.19	28	210
JWT330	0.33	16	160	WT110	0.19	15	130
JWT352	9.69	160	1,900	WT120	0.05	2	31
JWT354	10.30	190	1,900	WT130	0.10	35	170
JWT360	0.07	7	55	WT140	0.13	14	110
JWT372	10.36	190	1,900	WT150	0.23	20	140
JWT374				WT160	0.11	35	180
OUTLET	10.58	190	1,900	WT170	0.12	10	96
MT010	0.29	28	210	WT180	0.10	0	15
MT020	0.09	14	100	WT190	0.06	11	75
MT030	0.16	30	190	WT200	0.30	10	110
MT040	0.31	34	250	WT210	0.27	7	80
MT050	0.12	17	110	WT220	0.19	16	130
MT060	0.19	8	99	WT230	0.20	50	280
MT070	0.20	10	93	WT240	0.08	28	140
MT080	0.06	58	190	WT250	0.15	39	220
MT090	0.04	36	120	WT260	0.14	10	78
MT100	0.06	11	70	WT270	0.03	8	45
MT110	0.12	19	120	WT280	0.27	33	250
PBH4	0.15	23	120	WT290	0.10	15	110
PBHA	0.10	10	130	WT300	0.10	12	92
PBHB1	0.36	23	170	WT310	0.28	20	180
PBHB2	0.36	11	91	WT320	0.21	18	150
PBHC	0.19	7	60	WT330	0.33	16	160
RMN	1.42	40	770	WT340	0.28	19	150
RWU				WT350	0.30	26	210
Diversion	3.55	14	970	WT360	0.07	7	55
RWU North	3.55	30	1,000	WT370	0.21	1	64
RWU South	3.55	10	850				
RET020	0.15	23	120				
RET030	0.36	43	280				
RET040	0.56	62	460				

Figure 3-12
Existing Hydrology
Falcon DBPS
El Paso County, CO

0 0.5 1
Miles

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\hydrology_existing.mxd, 12/22/2011, wilson_wheeler

Hydrologic Element	Area (sq mi)	Future Peak Flows (cfs)		Hydrologic Element	Area (sq mi)	Future Peak Flows (cfs)	
		2-year	100-year			2-year	100-year
ET010	0.15	38	200	RET050	0.71	27	570
ET020	0.21	73	360	RET060	0.83	11	530
ET030	0.20	45	240	RET070	1.11	13	430
ET040	0.15	28	170	RET080	1.36	65	420
ET050	0.12	37	200	RET090	1.66	15	350
ET060	0.29	110	530	RET100	1.78	26	390
ET070	0.25	94	460	RET110	1.83	27	390
ET080	0.29	110	520	RET120	2.05	39	430
ET090	0.12	26	130	RET140	0.13	11	85
ET100	0.05	11	72	RET152	2.16	49	450
ET110	0.23	24	200	RET154	0.40	26	200
ET120	0.11	11	89	RET156	2.57	50	650
ET130	0.13	11	85	RET162	2.74	59	680
ET140	0.27	16	120	RET164	2.93	66	710
ET150	0.18	17	140	RMT030	0.09	25	140
ET160	0.19	19	140	RMT040	0.25	49	290
FS010	0.12	6	75	RMT050	0.56	110	750
JET010	0.15	29	150	RMT062	0.29	1	160
JET020	0.36	74	390	RMT064	0.67	120	850
JET030	0.56	97	580	RMT070	1.16	130	1,000
JET040	0.71	97	510	RMT080	1.36	150	1,200
JET050	0.83	11	530	RMT090	0.04	9	32
JET060	1.11	13	430	RMT102	1.42	86	1,200
JET070	1.36	94	480	RMT104	0.04	9	32
JET080	1.66	15	350	RMT106	1.46	91	1,200
JET090	1.78	26	390	RMT112	1.52	92	1,200
JET100	1.83	27	390	RMT114	1.64	94	1,200
JET110	2.05	40	440	RWT030	0.07	4	42
JET120	2.16	49	450	RWT042	0.14	9	85
JET130	0.13	11	85	RWT044	0.14	9	89
JET140	0.40	26	200	RWT046	0.28	15	170
JET152	2.57	51	650	RWT054	0.46	24	260
JET154	2.74	62	680	RWT080	0.17	14	130
JET160	2.93	66	710	RWT092	0.85	43	480
JFS010 _OUTLET	0.12	6	75	RWT094	1.09	54	610
JMT010	0.29	1	160	RWT122	1.43	68	730
JMT020	0.09	26	140	RWT124	1.63	77	840
JMT030	0.25	50	290	RWT150	0.13	32	180
JMT040	0.56	110	750	RWT160	0.36	15	170
JMT050	0.67	120	850	RWT172	1.77	85	920
JMT060	1.16	130	1,000	RWT174	0.47	35	180
JMT070	1.36	150	1,200	RWT176	2.24	98	960
JMT080	1.42	86	1,200	RWT180	2.36	100	990
JMT090	0.04	9	32	RWT202	2.46	100	1,000
JMT102	1.46	91	1,200	RWT204	0.06	4	43
JMT104	0.04	9	32	RWT210	2.82	110	1,200
JMT106	1.52	92	1,200	RWT232	3.09	120	1,300
JMT110	1.64	94	1,200	RWT234	0.19	47	250
JWT010	0.14	9	89	RWT236	3.28	120	1,400
JWT020	0.07	4	42	RWT240	3.47	130	1,400
JWT030	0.14	9	85	RWT240 _Diversion Reach	0.00	30	39
JWT042	0.28	15	170	RWT250	3.55	83	1,100
JWT044	0.46	24	260	RWT260	3.70	85	1,100
JWT050	0.85	43	480	RWT291	3.84	86	1,100
JWT070	0.17	14	130	RWT292	0.03	11	57
JWT080	1.09	54	610	RWT294	0.27	33	250
JWT090	1.43	68	730	RWT295	3.87	86	1,100
JWT110	1.63	77	840	RWT296	4.13	94	1,100
JWT120	1.77	85	920	RWT312	0.10	12	91
JWT140	0.13	32	180	RWT314	5.88	160	1,700
JWT150	0.36	15	170	RWT320	6.25	160	1,700
JWT160	0.47	35	190	RWT344	0.33	32	250
JWT172	2.24	99	960	RWT352	6.46	160	1,700
JWT174	2.36	100	990	RWT354	9.69	210	2,400
JWT180	2.46	100	1,000	RWT372	10.30	230	2,500
JWT190	0.06	4	43	RWT374	0.07	7	55
JWT200	2.82	110	1,200	RWT376	10.36	230	2,500
JWT210	3.09	120	1,300	M1	0.06	4	43
JWT220	0.19	47	250	M2	0.29	1	160
JWT232	3.28	120	1,400	WH1 North	0.71	88	570
JWT234	3.47	130	1,400	WH1 South	0.71	27	570
JWT240	3.55	83	1,100	WH2	0.83	11	530
JWT250	3.70	85	1,100	WH3	1.11	13	430
JWT260	3.84	86	1,100	WH4	1.66	15	350
JWT270	0.03	11	57	WH5	0.04	9	32
JWT280	0.27	33	250	WHH	0.56	110	750
JWT292	3.87	86	1,100	WT010	0.14	9	89
JWT294	4.13	96	1,100	WT020	0.07	4	42
JWT296	5.88	160	1,700	WT030	0.08	9	75
JWT300	0.10	12	92	WT040	0.19	9	93
JWT310	6.25	160	1,700	WT050	0.19	17	140
JWT320	6.46	160	1,700	WT060	0.20	14	120
JWT330	0.33	32	250	WT070	0.17	14	130
JWT352	9.69	210	2,400	WT080	0.07	9	67
JWT354	10.30	230	2,500	WT090	0.15	22	160
JWT360	0.07	7	55	WT100	0.19	56	300
JWT372	10.36	230	2,500	WT110	0.19	22	170
JWT374 _OUTLET	10.58	230	2,500	WT120	0.05	8	55
MT010	0.29	28	210	WT130	0.10	35	170
MT020	0.09	26	140	WT140	0.13	32	180
MT030	0.16	39	230	WT150	0.23	49	250
MT040	0.31	95	460	WT160	0.11	35	180
MT050	0.12	17	110	WT170	0.12	21	140
MT060	0.19	30	200	WT180	0.10	8	66
MT070	0.20	25	170	WT190	0.06	11	75
MT080	0.06	62	190	WT200	0.30	25	190
MT090	0.04	40	130	WT210	0.27	32	190
MT100	0.06	17	88	WT220	0.19	47	250
MT110	0.12	19	120	WT230	0.20	71	350
PBH4	0.15	29	150	WT240	0.08	36	160
PBHA	0.10	10	130	WT250	0.15	63	290
PBHB1	0.36	51	270	WT260	0.14	10	78
PBHB2	0.36	15	170	WT270	0.03	11	57
PBHC	0.19	11	160	WT280	0.27	33	250
RMN	1.42	86	1,200	WT290	0.10	15	110
RWU _Diversion	3.55	83	1,300	WT300	0.10	12	92
RWU North	3.55	110	1,400	WT310	0.28	31	250
RWU South	3.55	55	1,000	WT320	0.21	27	200
RET020	0.15	29	150	WT330	0.33	32	250
RET030	0.36	71	380	WT340	0.28	19	150
RET040	0.56	95	580	WT350	0.30	38	280
				WT360	0.07	7	55
				WT370	0.21	7	120

Figure 3-13
Future Hydrology
Falcon DBPS
El Paso County, CO

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Table 4-11. Drainageway Crossing Deficiencies

Crossing Name	Priority[1]	Tributary	100-yr Flow (cfs)		Location	Size[2]	Existing Deficiency[3]	Future Deficiency[3]
			Existing	Future				
WT 14	1	West	89	89	Burgess Rd.	18” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
WT 13	1	West	170	170	Pine Park Trl.	30” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
WT 11	1	West	480	480	Arroya Ln.	12” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
Pond WU Inlet Structure	1	West	1,017	1,398	Tamlin Rd.	(3) 18” RCP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
WT 6	1	West	910	1,100	Falcon Hwy.	(2) 5.58’ x 8.25’ Arch CMP	Overtops	Overtops
WT 5	1	West	910	1,100	Meridian Rd.	24” CMP	Overtops	Overtops
WT 5-2	1	West	910	1,100	Meridian Rd.	18” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
WT 4	1	West	1,300	1,700	W. Condor Rd.	48” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Freeboard Criteria
WT 1	1	West	1,900	2,406	Blaney Rd.	(2) 36” RCP	Overtops, Does Not Meet Freeboard Criteria	Overtops, Does Not Meet Freeboard Criteria
MT 7	1	Middle	259	360	Owl Ln.	1.75’ x 1.25’ Elliptical CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
MT 6	1	Middle	760	1,200	Woodmen Rd.	(3) 48” RCP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
MT 6-2	1	Middle	760	1,200	Woodmen Rd.	(3) 48” RCP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
MT 1	1	Middle	820	1,200	Falcon Hwy.	24” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 31	1	East	280	390	Stapleton Dr.	(2) 6’ x 2.5’ RCBC	Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 26	1	East	460	580	Rio Secco Ln.	(3) 48” RCP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 13	1	East	380	390	Pinto Pony Rd.	(2) 48” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 11	1	East	430	450	Falcon Hwy.	(2) 60” RCP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 10	1	East	590	680	N. Condor Rd.	4.67’ x 3.17’ Arch CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 9	1	East	590	680	Sunset Trl.	48” CMP	Overtops, Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
ET 4	1	East	309	325	Garrett Rd.	4.67’ x 3.17’ Arch CMP	Does Not Meet Hw/D Criteria	Overtops, Does Not Meet Hw/D Criteria
WT 10	2	West	950	1,100	Woodmen Road	8.75’ x 18.92’ RCBC	None	Does Not Meet Hw/D Criteria
WT 9	2	West	1,000	1,400	Meridian Rd.	(4) 10’ x 6’ RCBC	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
WT 7-2	2	West	890	1,100	Rail Road	54’ Wood Bridge	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
WT 7-1	2	West	890	1,100	Hwy. 24	(3) 12’ x 6’ RCBC	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
WT 3	2	West	1,300	1,700	Garrett Rd.	(2) 12’ x 7.33’ Arch CMP	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
MT 5-1	2	Middle	770	1,200	McLaughlin Rd.	27’ Steel Bridge	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
MT 4	2	Middle	800	1,200	Rail Road	77’ Wood Bridge	None	Does Not Meet Freeboard Criteria
MT 3	2	Middle	800	1,200	Hwy. 24	(2) 12’ x 6’ RCBC	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
MT 2	2	Middle	820	1,200	Swingline Rd.	20’ x 6.83’ RCBC	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria
ET 32	2	East	150	200	Liberty Grove Dr.	(2) 42” CMP	Does Not Meet Hw/D Criteria	Does Not Meet Hw/D Criteria
ET 30	2	East	460	580	Royal County Down Rd.	72” RCP	Does Not Meet Hw/D Criteria	Does Not Meet Hw/D Criteria
ET 19	2	East	733	733	Eastonville Rd.	72” CMP	Does Not Meet Hw/D Criteria	Does Not Meet Hw/D Criteria
ET 14	2	East	370	390	Hwy. 24	(2) 12’ x 4.83’ RCBC	Does Not Meet Freeboard Criteria	Does Not Meet Freeboard Criteria

Notes:
1) Priority 1 = Overtopping, Priority 2 = Does Not Meet Hw/D Criteria or Freeboard Criteria
2) Based on field measurements
3) Per DCM page 6-10

Table 4-12. Storm Sewer Deficiencies

Storm Sewer ID[1]	Priority[2]	Location	Size (in)	Capacity (cfs)			Existing 100-yr Flow (cfs)[3]	Existing Deficiency	Future 100-yr Flow (cfs)[3]	Future Deficiency
				Storm Sewer	Street	Total				
DP149763	1	Maybeck View	18	4.8	0.0	5	60	92%	65	93%
DP150714	1	Maybeck View	18	6.0	0.0	6	60	90%	65	91%
DP292284	1	Woodmen Hills Dr.	30	29	16	45	320	86%	320	86%
DP292283	1	Woodmen Hills Dr.	30	41	22	63	320	80%	320	80%
DP292940	1	Mc Laughlin Rd.	24	20	0.0	20	88	77%	90	78%
DP150712	2	Cranston Dr.	30	41	0.0	41	130	68%	160	74%
DP292942	2	Tomkins Rd.	42	45	0.0	45	130	65%	130	65%
DP292201	2	Fort Smith Rd.	18	15	34	49	140	65%	140	65%
DP292290	2	Tompkins Rd.	18	17	38	54	140	60%	140	60%
DP292333	2	McLaughlin Rd.	24	23	22	44	110	60%	110	61%
DP292164	2	Greenough Rd.	18	14	31	45	110	59%	110	60%
DP292345	2	Tompkins Rd.	24	23	0.0	23	53	57%	53	57%
DP149784	2	Londonderry Dr.	18	11	22	33	75	57%	85	62%
DP292151	2	Greenough Rd.	30	32	18	50	110	54%	110	55%
DP292147	2	McClure Rd.	30	29	17	46	100	54%	100	54%
DP292133	2	Midnight Rd.	30	32	19	51	110	54%	110	55%
DP292213	2	Buschborn Rd.	18	14	31	44	92	52%	92	52%
DP292132	2	Midnight Rd.	24	26	27	53	110	52%	110	53%
DP292293	2	Tompkins Rd.	30	32	18	50	100	50%	100	50%
DP292353	2	Woodmen Hills Dr.	36	52	17	68	140	50%	140	50%
DP149767	2	Liberty Grove Dr.	24	34	33	66	130	49%	160	58%

Notes:
1) From County GIS database
2) Priority 1 = 75% to 100% deficient, Priority 2 = 50% to 75% deficient
3) Peak flow calculated by multiplying the peak flow for the encompassing subbasin by the estimated percentage of drainage area contributing to each storm system

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20111222\Deficiencies_Existing.mxd, 12/22/2011, wilson_wheeler

Figure 4-39
Future Conditions Deficiency Map
Falcon DBPS
El Paso County, CO

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20111222\Deficiencies_Future.mxd, 12/22/2011, wilson_wheeler

some cases other controls were used due to pond volume limitations. A list of all detention ponds, and the type of outlet control used in each, is provided in Table 5-2.

Table 5-2. Sub Regional Detention Alternative

Detention Pond	Tributary	Outlet Stages	Type of Outlet Control
Proposed Sub Regional Pond SR1	West Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr
Paint Brush Hills Pond C	West Tributary	EURV + 100-yr	Full Spectrum
Paint Brush Hills Pond A	West Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr
Paint Brush Hills Pond B1	West Tributary	No Modification	N/A
Paint Brush Hills Pond B2	West Tributary	EURV + 100-yr	Full Spectrum
Proposed Sub Regional Pond SR2	West Tributary	EURV Only	~2-yr
The Meadows Pond #1	West Tributary	EURV + 100-yr	Full Spectrum
Proposed Sub Regional Pond SR3	West Tributary	EURV Only	~2-yr
Regional Pond WU	West Tributary	EURV + 100-yr	Full Spectrum
Proposed Regional Pond R1	West Tributary	EURV + 100-yr	Full Spectrum
Proposed Regional Pond R2	West Tributary	EURV Only	~2-yr
Woodmen Hills Pond H	Middle Tributary	No Modification	N/A
The Meadows Pond #2	Middle Tributary	EURV + 100-yr	Full Spectrum
Proposed Sub Regional Pond SR4	Middle Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr
Regional pond MN	Middle Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr
Woodmen Hills Pond #5	Middle Tributary	EURV + 100-yr	Full Spectrum
Paint Brush Hills Pond #4	East Tributary	No Modification	N/A
Proposed Sub Regional Pond SR6 (previously planned location)	East Tributary	EURV + 100-yr	Full Spectrum
Woodmen Hills Pond #1 North	East Tributary	EURV + 100-yr	Full Spectrum
Woodmen Hills Pond #1 South	East Tributary	EURV Only	~2-yr
Woodmen Hills Pond #2	East Tributary	EURV + 100-yr	Full Spectrum
Woodmen Hills Pond #3	East Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr
Woodmen Hills Pond #4	East Tributary	WQCV + 100-yr	Low Flow (<2-yr) + 100-yr

Both Woodmen Hills Pond H and Paint Brush Hills Pond #4 are grossly undersized and both of the spillways currently overtop during the 100-yr storm. As a result, no retrofit solution was provided for these ponds. It is recommended that on-site detention be incorporated upstream of these ponds to reduce flooding at these locations. The drainage area that needs to be mitigated by an EURV or WQCV at these pond locations was accounted for in downstream detention ponds. A detailed analysis and summary for all of the detention ponds in this alternative is provided in Appendix C.

5.3.4. Hydrologic Results

The hydrologic results for each of the detention alternatives at key locations throughout the Falcon Watershed are shown in Table 5-3. These results reflect all 16 existing, 1 planned, and all potential detention ponds as shown on Figure 5-1 through Figure 5-3. Note that in some cases the reported peak flows for the Regional Detention and Sub Regional Detention alternatives is higher than the Do Nothing alternative. This is because the configuration of the outlet structures for existing detention ponds had to be modified for these alternatives in order to meet the EURV/WQCV discharge rates. This resulted in having to increase the discharge rates for larger floods to meet the storage constraints within the existing detention ponds. In general, the Sub Regional Detention Alternative reduces peak flows the most throughout the Falcon Watershed. A summary of peak flows at the location of each detention pond is provided on Figure 5-2 and Figure 5-3.

Figure 5-1
Do Nothing Alternative
Falcon DBPS
El Paso County, CO

Existing Detention Ponds[1]

Pond	Map ID	Q_2 In (cfs)	Q_2 Out (cfs)	Q_{100} In (cfs)	Q_{100} Out (cfs)	Required Volume (AF)[2]
Paint Brush Hills Pond #4	PBH 4	38	29	200	150	1.34
Paint Brush Hills Pond A	PBH A	35	10	170	130	2.62
Paint Brush Hills Pond B1	PBH B1	80	51	420	270	9.17
Paint Brush Hills Pond B2	PBH B2	51	15	270	170	12.09
Paint Brush Hills Pond C	PBH C	56	11	300	160	6.77
Regional Pond MN	R MN	150	86	1,200	1,200	7.53
Regional Pond WU South	R WU	83	55	1,400	1,000	39.54
The Meadows Pond #1	M 1	11	4	75	43	3.25
The Meadows Pond #2	M 2	28	1	210	160	7.94
Woodmen Hills Pond #1 North	WH 1N	100	88	690	570	7.13
Woodmen Hills Pond #1 South	WH 1S	88	27	570	570	8.78
Woodmen Hills Pond #2	WH 2	37	11	580	530	9.18
Woodmen Hills Pond #3	WH 3	110	13	560	430	8.35
Woodmen Hills Pond #4	WH 4	110	15	700	350	22.02
Woodmen Hills Pond #5	WH 5	40	9	130	32	4.1
Woodmen Hills Pond H	WH H	140	110	750	750	2.66

Notes
1: Represents future hydrology with no modifications to existing detention ponds and no new detention
2: Required volume to highest WSE

Reach Alternative	Total (ft)
Protect In Place	13,226
Natural Channel Design	22,893
Small Drop Structures w/ Toe Protection	103,118
Large Drop Structures w/ Toe Protection	0

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Regional Detention Alternative[1]						
Pond		Q_2 In (cfs)	Q_2 Out (cfs)	Q_{100} In (cfs)	Q_{100} Out (cfs)	Required Volume (AF)[2]
Paint Brush Hills Pond #4	PBH 4	38	29	200	150	1.34
Paint Brush Hills Pond A	PBH A	35	7	170	140	2.62
Paint Brush Hills Pond B1	PBH B1	80	51	420	270	9.17
Paint Brush Hills Pond B2	PBH B2	51	10	270	180	12.09
Paint Brush Hills Pond C	PBH C	56	3	300	140	6.77
Regional Pond MN	R MN	150	140	1,200	1,100	7.53
Regional Pond R1	R R1	180	79	1,800	1,700	46.95
Regional Pond R2	R R2	140	140	2,400	2,400	7.90
Regional Pond WU South	R WU	68	27	1,300	1,200	39.54
The Meadows Pond #1	M 1	11	0	75	2	3.25
The Meadows Pond #2	M 2	28	5	210	99	7.94
Woodmen Hills Pond #1 North	WH 1N	100	65	690	670	7.13
Woodmen Hills Pond #1 South	WH 1S	65	14	670	620	8.78
Woodmen Hills Pond #2	WH 2	37	10	640	540	9.18
Woodmen Hills Pond #3	WH 3	110	14	570	510	8.35
Woodmen Hills Pond #4	WH 4	110	14	820	400	40.45
Woodmen Hills Pond #5	WH 5	40	1	130	19	4.10
Woodmen Hills Pond H	WH H	140	110	750	750	2.66

Notes
1: Represents future hydrology with retrofit existing detention ponds and 2 new regional detention ponds
2: Required volume to highest WSE

Reach Alternative	Total (ft)
Protect In Place	23,952
Natural Channel Design	22,581
Small Drop Structures w/ Toe Protection	92,704
Large Drop Structures w/ Toe Protection	0

Figure 5-2
Regional Detention Alternative
Falcon DBPS
El Paso County, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

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Figure 5-3
Sub-Regional Detention Alternative
Falcon DBPS
El Paso County, CO

Sub Regional Detention Alternative[1]

Pond		Q_2 In (cfs)	Q_2 Out (cfs)	Q_{100} In (cfs)	Q_{100} Out (cfs)	Required Volume (AF)[2]
Paint Brush Hills Pond #4	PBH 4	38	29	200	150	1.34
Paint Brush Hills Pond A	PBH A	35	7	170	140	2.62
Paint Brush Hills Pond B1	PBH B1	80	51	420	270	9.17
Paint Brush Hills Pond B2	PBH B2	51	10	270	180	12.09
Paint Brush Hills Pond C	PBH C	56	3	300	140	6.77
Regional Pond MN	R MN	65	32	850	820	7.53
Regional Pond R1	R R1	110	77	1,600	1,500	25.00
Regional Pond R2	R R2	140	140	2,100	2,100	7.90
Regional Pond WU South	R WU	47	22	1,070	930	39.54
Sub Regional Pond SR1	SR 1	54	42	610	510	11.03
Sub Regional Pond SR2	SR 2	65	65	840	840	2.05
Sub Regional Pond SR3	SR 3	72	72	910	910	1.03
Sub Regional Pond SR4	SR 4	130	27	1,000	730	19.37
Sub Regional Pond SR6	SR 6	74	9	390	200	11.82
The Meadows Pond #1	M 1	11	0	75	2	3.25
The Meadows Pond #2	M 2	28	5	210	99	7.94
Woodmen Hills Pond #1 North	WH 1N	65	61	390	260	7.13
Woodmen Hills Pond #1 South	WH 1S	61	10	260	260	8.78
Woodmen Hills Pond #2	WH 2	37	10	270	250	9.18
Woodmen Hills Pond #3	WH 3	105	13	530	360	8.35
Woodmen Hills Pond #4	WH 4	110	15	790	260	40.45
Woodmen Hills Pond #5	WH 5	40	1	130	19	4.10
Woodmen Hills Pond H	WH H	140	110	750	750	2.66

Notes
1: Represents future hydrology with retrofit existing detention ponds and 5 new subregional detention ponds
2: Required volume to highest WSE

Reach Alternative	Total (ft)
Protect In Place	30,066
Natural Channel Design	32,359
Small Drop Structures w/ Toe Protection	76,812
Large Drop Structures w/ Toe Protection	0

6.0 PLAN DEVELOPMENT DESIGN

6.1. Introduction

The purpose of the plan development design effort was to refine the selected detention and reach alternatives for the Falcon Watershed and finalize proposed infrastructure improvements and associated implementation costs. The recommended detention and reach alternatives, outlined in Section 5.0, were vetted through one public meeting and several project team meetings. The Sub Regional Detention Alternative along with the corresponding reach alternatives were selected to carry forward into plan development. The detention pond and reach components from the selected alternative were analyzed using a more detailed set of criteria to ensure that the recommendation would be feasible for future implementation. The outcome of the selected plan development design is a conceptual set of infrastructure improvements and costs for use in the fee development phase of this DBPS. All backup calculations and data are provided in Appendix D.

6.2. Selected Detention Alternative

The Sub Regional Detention Alternative that was recommended in Section 5.3 was refined by:

- Performing rough grading at each potential location.
- Maximizing storage for ponds based on existing site conditions.
- Modifying the SSD curves to target EURV or WQCV, and 100-yr volume with no spillway overtopping as outlined in Section 5-3. The EURV target outflow was based on releasing the EURV over 72 hours. The WQCV drain time was 40 hours. 100-yr target outflows were historical 100-yr flow where possible given storage constraints; selected as either the existing 100-yr flow or the lowest attainable 100-yr peak flow based on pond limitations. Release rates were greater than historic in some cases due to storage limitations. Storage and discharge requirements were calculated based on the guidelines outlined in the UDFCD DCM, Vol. 2.
- Assessing the hydrologic benefit of each pond.
- Spillway overtopping based on stage and storage calculations at 2 ft above the spillway elevation.

Full spectrum detention was incorporated into all existing and proposed detention ponds where applicable for this alternative. However, in some cases other controls were used due to pond volume limitations. A detailed analysis and summary for all of the detention ponds in the selected alternative are provided in Appendix D.

6.2.1. Detention Pond Classification

The selected detention alternative consists of 23 ponds that fall within 2 different classifications: existing constructed ponds and proposed ponds. All ponds are shown graphically in Figure 6-1.

Existing Constructed Ponds

Existing constructed ponds include PBH C, PBH A, PBH B1, PBH B2, M 1, R WUS, WH H, M 2, R MN, WH 5, PB 4, WH 1N, WH 1S, WH 2, WH 3, and WH 4. These ponds are currently constructed and functioning within the Falcon Watershed. Each of these ponds was evaluated to determine if it could be retrofit to provide a benefit to the selected detention alternative. Table 6-1 shows the proposed modification to the outlet stages of each of the existing constructed ponds.

Table 6-1. Existing Pond Outlet Modifications

Pond	Proposed Outlet Stages
Paintbrush Hills Pond C	EURV + 100-yr
Paintbrush Hills Pond A	WQCV + 100-yr
Paintbrush Hills Pond B1	Existing Configuration
Paintbrush Hills Pond B2	EURV + 100-yr
The Meadows Pond #1	EURV + 100-yr
Regional Pond WU South	EURV + 100-yr
Woodmen Hills Pond H	Existing Configuration
The Meadows Pond #2	EURV + 100-yr
Regional Pond MN	WQCV + 100-yr
Woodmen Hills Pond #5	EURV + 100-yr
Paint Brush Hills Pond #4	Existing Configuration
Woodmen Hills Pond #1 North	100-yr Only
Woodmen Hills Pond #1 South	EURV Only
Woodmen Hills Pond #2	EURV + 100-yr
Woodmen Hills Pond #3	WQCV + 100-yr
Woodmen Hills Pond #4	EURV + 100-yr

Both Woodmen Hills Pond H and Paint Brush Hills Pond #4 are grossly undersized and both of the spillways currently overtop during the 100-yr storm. As a result, no retrofit solution was provided for these ponds. It is recommended that on-site detention be incorporated upstream of these ponds to reduce flooding at these locations. The drainage area that needs to be mitigated by an EURV or WQCV at these pond locations was accounted for in downstream detention ponds.

Proposed Ponds

Proposed ponds include ponds SR 1, SR 2, SR 3, SR 4, R 1, SR 6, and R 2. These ponds are not constructed or planned for and are recommended as a part of the selected detention alternative. Table 6-2 shows the hydraulic configurations for the proposed ponds.

Table 6-2. Proposed Pond Outlet Configurations

Pond	Outlet Stages
Sub Regional Pond SR1	WQCV + 100-yr
Sub Regional Pond SR2	EURV Only
Sub Regional Pond SR3	EURV Only
Sub Regional Pond SR4	WQCV + 100-yr
Regional Pond R1	EURV + 100-yr
Sub Regional Pond SR6	EURV + 100-yr
Regional Pond R2	EURV Only

6.2.2. Hydrologic Results

The hydrologic results for the selected detention alternative are shown in Table 6-3. These results reflect all 23 ponds shown in Figure 6-1.

Table 6-3. Selected Detention Alternative Results

Location	HEC-HMS Element	Sub Regional Peak Flow (cfs)	
		2-year	100-year
West Tributary			
Raygor Rd.	JWT030	9	85
Stapleton Rd.	JWT120	55	710
Woodmen Rd.	JWT210	81	1,000
Hwy. 24	JWT250	64	980
Falcon Hwy.	JWT260	70	1,000
Garrett Rd.	JWT320	80	1,500
East Blaney Rd.	JWT354	140	2,200
Upstream of Bennett Ranch Tributary	JWT374_Outlet	140	2,200
Middle Tributary			
Woodmen Hills Dr.	JMT010	5	99
Woodmen Rd.	JMT070	31	840
Hwy. 24	JMT106	33	840
Falcon Hwy.	JMT110	34	860
Confluence with West Tributary	RMT114	34	860
East Tributary			
Stapleton Dr.	JET020	9	200
Woodmen Hills Dr.	JET040	10	260
Eastonville Rd.	JET060	13	360
Hwy. 24	JET090	31	300
Pinto Pony Rd.	JET100	32	300
Falcon Hwy.	JET120	50	400
Garrett Rd.	JET160	67	640
Confluence with West Tributary	RET164	66	630

6.2.3. Detention Pond Sizes & Cost Estimate

The detention ponds sizes and costs estimate as a result of selected detention alternative are provided in Table 6-4. Assumptions that were used in developing the detention pond cost estimate are as follows:

- Land requirement for proposed ponds is based on proposed rough grading and the corresponding footprint at the spillway stage.
- Construction cost based on $24,500/ac-ft as documented in the Jimmy Camp Creek DBPS - FSD Costs Memo. Engineering costs were removed from construction cost and added later to the subtotal.
- Land cost was estimated as $50,000/ac based on the current (2013) El Paso County Parks land value of $46,954/ac.
- Improvement cost was estimated at $20,000 per modified pond to retrofit existing outlet structures for EURV/WQCV and 100-yr flood control. Not all existing ponds were retrofit.

Table 6-4. Detention Pond Cost Estimate

Pond	Pond Volume (ac-ft)	Land Requirement (ac)	Construction Cost ($)	Land Cost ($)	Improvement Cost ($)	Total Cost ($)
Paint Brush Hills Pond #4	1.34	-	$ -	$ -	$ -	$ -
Paint Brush Hills Pond A	2.62	-	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond B1	9.17	-	$ -	$ -	$ -	$ -
Paint Brush Hills Pond B2	12.09	-	$ -	$ -	$ 20,000	$ 20,000
Paint Brush Hills Pond C	6.77	-	$ -	$ -	$ 20,000	$ 20,000
Regional Pond MN	7.53	-	$ -	$ -	$ 20,000	$ 20,000
Regional Pond R1	25.00	18.8	$ 532,609	$ 940,420	$ -	$ 1,473,028
Regional Pond R2	3.13	5.1	$ 66,634	$ 255,974	$ -	$ 322,608
Regional Pond WU South	39.54	-	$ -	$ -	$ 20,000	$ 20,000
Sub Regional Pond SR1	11.03	3.4	$ 234,987	$ 170,782	$ -	$ 405,769
Sub Regional Pond SR2	2.05	5.2	$ 43,674	$ 257,529	$ -	$ 301,203
Sub Regional Pond SR3	1.03	0.6	$ 21,943	$ 27,609	$ -	$ 49,552
Sub Regional Pond SR4	19.37	20.5	$ 412,665	$ 1,022,834	$ -	$ 1,435,500
Sub Regional Pond SR6	11.82	6.7	$ 251,817	$ 334,260	$ -	$ 586,078
The Meadows Pond #1	3.25	-	$ -	$ -	$ 20,000	$ 20,000
The Meadows Pond #2	7.94	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 North	7.13	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #1 South	8.78	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #2	9.18	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #3	8.35	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond #4	40.45	-	$ -	$ -	$ 240,000	$ 240,000
Woodmen Hills Pond #5	4.10	-	$ -	$ -	$ 20,000	$ 20,000
Woodmen Hills Pond H	2.66	-	$ -	$ -	$ -	$ -
				Subtotal		$ 5,053,738
				Engineering/ Construction Admin. (15%)		$ 758,061
				Contingency (20%)		$ 1,010,748
				Total		**$ 6,822,546**

Additional costs as a percentage of the subtotal construction cost include Engineering/Construction Administration (15%), and Contingency (20%). Detailed quantities and cost estimates are provided in Appendix D.

Sub Regional Detention Alternative[1]

Pond		Q_2 In (cfs)	Q_2 Out (cfs)	Q_{100} In (cfs)	Q_{100} Out (cfs)	Required Volume (AF)[2]
Paint Brush Hills Pond #4	PBH 4	38	29	200	150	1.34
Paint Brush Hills Pond A	PBH A	35	7	170	140	2.62
Paint Brush Hills Pond B1	PBH B1	80	51	420	270	9.11
Paint Brush Hills Pond B2	PBH B2	51	10	270	180	12.09
Paint Brush Hills Pond C	PBH C	56	3	300	140	6.77
Regional Pond MN	R MN	65	32	850	820	7.53
Regional Pond R1	R R1	110	77	1,600	1,500	25.00
Regional Pond R2	R R2	140	140	2,200	2,200	3.13
Regional Pond WU South	R WUs	47	22	1,100	930	39.54
Sub Regional Pond SR1	SR 1	54	42	610	510	11.03
Sub Regional Pond SR2	SR 2	65	65	840	840	2.05
Sub Regional Pond SR3	SR 3	72	72	910	910	1.03
Sub Regional Pond SR4	SR 4	130	27	1,000	730	19.37
Sub Regional Pond SR6	SR 6	74	9	390	200	11.82
The Meadows Pond #1	M 1	11	0	70	0	3.25
The Meadows Pond #2	M 2	28	5	210	100	7.94
Woodmen Hills Pond #1 North	WH 1N	65	61	390	260	7.13
Woodmen Hills Pond #1 South	WH 1S	61	10	260	260	8.78
Woodmen Hills Pond #2	WH 2	37	10	270	250	9.18
Woodmen Hills Pond #3	WH 3	110	13	530	360	8.35
Woodmen Hills Pond #4	WH 4	110	15	790	260	40.45
Woodmen Hills Pond #5	WH 5	40	1	130	20	4.10
Woodmen Hills Pond H	WH H	140	110	750	750	2.66

Notes

1: Represents future hydrology with retrofit existing detention ponds and 7 new sub regional detention ponds

2: Required volume to highest WSE not including embankment

Reach Alternative	Total (ft)
Natural Channel Design	13,216
Protect in Place	64,325
Roadside Ditch Improvement	7,519
Small Drop Structures w/ Toe Protection	50,750

Figure 7-1
County Cost Improvements
Falcon DBPS
El Paso County, CO

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Figure 7-2
Metro District Cost Improvements
Falcon DBPS
El Paso County, CO

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Falcon DBPS
Metro District Costs

Drainage Fees			
Reach/Pond	**Reach Length (ft)**	**Improvement**	**Cost**
RET030	5,042	Small Drop Structures w/Toe Protection	$ 1,405,908
RET040	1,820	Small Drop Structures w/Toe Protection	$ 1,073,275
~~ET 19~~	39	Crossing - Culvert	$ 63,340
Paint Brush Hills Pond #4		Detention Pond	$ -
Paint Brush Hills Pond B1		Detention Pond	$ -
Paint Brush Hills Pond B2		Detention Pond	$ 20,000
Regional Pond MN		Detention Pond	$ 20,000
Regional Pond WU South		Detention Pond	$ 20,000
Woodmen Hills Pond #1 North		Detention Pond	$ 20,000
Woodmen Hills Pond #1 South		Detention Pond	$ 20,000
Woodmen Hills Pond #2		Detention Pond	$ 20,000
Woodmen Hills Pond #3		Detention Pond	$ 20,000
Woodmen Hills Pond #4		Detention Pond	$ 240,000
Woodmen Hills Pond #5		Detention Pond	$ 20,000
		Subtotal	$ 2,942,524
		Engineering/Construction Admin (15%)	$ 441,379
		Contingency (20%)	$ 588,505
		Total	**$ 3,972,407**

Bridge Fees			
Reach/Pond	**Reach Length (ft)**	**Improvement**	**Cost**
Pond WU Inlet Structure	74	Crossing - Bridge	$ 658,410
MT 5-1	48	Crossing - Bridge	$ 191,098
ET 31	302	Crossing - Bridge	$ 525,026
		Subtotal	$ 1,374,534
		Engineering/Construction Admin (15%)	$ 206,180
		Contingency (20%)	$ 274,907
		Total	**$ 1,855,620**

Falcon DBPS
Developer Costs

Drainage Fees			
Reach/Pond	**Reach Length (ft)**	**Improvement**	**Cost**
RWT354	16	Roadside Ditch	$ 23,544
RMT106	226	Small Drop Structures w/Toe Protection	$ 212,322
RMT114	1,667	Small Drop Structures w/Toe Protection	$ 853,693
RWT150	3,741	Natural Channel Design	$ 765,482
RWT210_upstream	2,132	Natural Channel Design	$ 593,011
RWT124_upstream	1,246	Small Drop Structures w/Toe Protection	$ 640,054
RWT174	1,871	Small Drop Structures w/Toe Protection	$ 606,335
RWT234	2,129	Small Drop Structures w/Toe Protection	$ 976,863
RET020	1,915	Small Drop Structures w/Toe Protection	$ 1,169,444
RWT094	2,145	Natural Channel Design	$ 246,213
RWT296	1,134	Small Drop Structures w/Toe Protection	$ 223,458
RWT122	518	Natural Channel Design	$ 71,367
		Channel Subtotal	$ 6,381,788
		Engineering/Construction Admin (15%)	$ 957,268
		Contingency (20%)	$ 1,276,358
		Channel Total	**$ 8,615,414**
WT 14	66	Crossing - Culvert	$ 31,585
WT 13	53	Crossing - Culvert	$ 28,525
MT 6-2	220	Crossing - Culvert	$ 181,365
		Culvert Subtotal	$ 241,475
		Engineering/Construction Admin (15%)	$ 36,221
		Contingency (20%)	$ 48,295
		Culvert Total	**$ 325,991**
Paint Brush Hills Pond A		Detention Pond	$ 20,000
Paint Brush Hills Pond C		Detention Pond	$ 20,000
Regional Pond R1		Detention Pond	$ 1,473,028
Regional Pond R2		Detention Pond	$ 322,608
Sub Regional Pond SR2		Detention Pond	$ 301,203
Sub Regional Pond SR3		Detention Pond	$ 49,552
Sub Regional Pond SR4		Detention Pond	$ 1,435,500
Sub Regional Pond SR6		Detention Pond	$ 586,078
The Meadows Pond #1		Detention Pond	$ 20,000
Woodmen Hills Pond H		Detention Pond	$ -
		Detention Subtotal	$ 4,227,969
		Engineering/Construction Admin (15%)	$ 634,195
		Contingency (20%)	$ 845,594
		Detention Total	**$ 5,707,758**
		Grand Total	**$ 14,649,163**

Bridge Fees			
Reach/Pond	**Reach Length (ft)**	**Improvement**	**Cost**
WT 5-2	43	Crossing - Bridge	$ 718,121
MT 7	58	Crossing - Bridge	$ 207,465
MT 6	200	Crossing - Bridge	$ 166,177
MT 1	45	Crossing - Bridge	$ 433,032
		Subtotal	$ 1,524,796
		Engineering/Construction Admin (15%)	$ 228,719
		Contingency (20%)	$ 304,959
		Total	**$ 2,058,474**