STERLING RANCH MDDP AMENDMENT NO. 2 & PRELIMINARY DRAINAGE REPORT
FOR
STERLING RANCH EAST
PRELIMINARY PLAN NO. 1

Prepared for:
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Job No. 1183.22

PCD Project No.
SKP-22-004 / SP-22-004

Refer to comments also made on SKP-22-004

CLASSIC CONSULTING

STERLING RANCH MDDP AMENDMENT NO. 2 & PRELIM. DRAINAGE REPORT FOR STERLING RANCH EAST PRELIMINARY PLAN NO. 1

ENGINEER'S STATEMENT:

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

MARC ALAN WHORTON
37155

Marc A. Whorton Colorado P.E. #37155

11/11/2022
Date

OWNER'S/DEVELOPER'S STATEMENT:

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

Business Name: CLASSIC SRJ LAND, LLC

By: LOREN J. MORELAND

Title: VICE PRESIDENT

Address: 2138 Flying Horse Club Drive
Colorado Springs, CO 80921

EL PASO COUNTY:

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

For County Engineer, / ECM Administrator

Date

Conditions:

TABLE OF CONTENTS:

APPENDICES

PURPOSE

The purpose of this Sterling Ranch MDDP Amendment No. 2 & Preliminary Drainage Report is to address on-site and off-site drainage quantities and patterns for the proposed development, compare to approved MDDP and identify general drainage improvements and facilities required to minimize impacts to the adjacent properties. The MDDP Amendment No. 2 portion of the report only addresses adjustments proposed to help reduce the East Fork Basin transfer and the combining of ponds FSD-16A and FSD-16B into one single facility. All other overall basin hydrology and pond locations remain the same at this time.

GENERAL DESCRIPTION

Classic SRJ Land, LLC (Classic Homes) has recently purchased the remaining portion of the Sterling Ranch property east of Sand Creek from the Jim Morley. This initial development proposal east of Sand Creek in to be known as **Sterling Ranch East Preliminary Plan No. 1**. This initial Preliminary Plan consists of 3 distinct development areas east of Sand Creek separated by the proposed roadway plats, for Briargate Pkwy. and Sterling Ranch Road, platted with Homestead North at Sterling Ranch Filing No. 1, prepared by JR Engineering. The area north of Briargate Pkwy. is 84.74 acres (280 lots). The area south of Briargate Pkwy. but north of Sterling Ranch Road is 161.90 acres (294 lots); and the area south of Sterling Ranch Road is 74.73 acres (187 lots). The total Preliminary Plan area is then **321.37 acres** located in portions sections 27, 28, 33 and 34, township 12 south, range 65 west of the sixth principal meridian. The site is bounded on the north by the Retreat at TimberRidge development, to the east by future Sterling Ranch East property (zoned for future urban development), to the west by Sand Creek and existing Sterling Ranch residential development and to the south by existing rural residential development zoned RR-5. The site is in the upper portion of both the Sand Creek and Sand Creek East Fork Drainage Basins. Urban single family residential development **totaling 761 lots**, along with two future District 20 school sites and several park areas are proposed within this Sterling Ranch East Preliminary Plan No. 1.

The average soil condition reflects Hydrologic Group “A” (Blakeland loamy sand and Columbine gravelly sandy loam) with also some presence of Hydrologic Group “B” (Pring coarse sandy loam) as determined by the “Web Soil Survey of El Paso County Area,” prepared by the Natural Resources Conservation Service (see map in Appendix).

EXISTING DRAINAGE CONDITIONS

The Sterling Ranch East Preliminary Plan No. 1 property is located in the upper portion of the Sand Creek drainage basin on the south edge of Black Forest. However, some easterly portions of the site lie within the East Fork tributary of Sand Creek. (See MDDP Amendment portion of this report for further discussion) Nearly the entire site, other than the Sand Creek corridor, is mainly covered with native grasses with few or no trees. Some minor disturbance due to utility installation has also taken place within the utility esmt. corridors traversing the site for the future Briargate Pkwy. Other land disturbance including some grading operations by the previous land owner has also taken place just north of the future Briargate Pkwy. alignment and within the parcel south of Briargate Pkwy. and northwest of Sterling Ranch Road. The Sand Creek channel exists along the extreme westerly edge of the property. All required improvements to the Sand Creek channel adjacent to this property are described in a separate report prepared by JR Engineering, “Final Design Report for Sand Creek Restoration”, dated September 2022. Please reference this report for all adjacent creek improvement requirements and associated wetland mitigation plans and permitting within jurisdictional waters.

The adjacent Sand Creek portions of this site have been previously studied in the “Sand Creek Drainage Basin Planning Study” (DBPS) prepared by Kiowa Engineering Corporation, March 1996 and more recently in the above-mentioned Sand Creek Restoration Report by JR Engineering, LLC, dated September 2022. CORE Consultants is the wetland consultant working with JR Engineering, LLC on this stretch of Sand Creek. They are coordinating the effort with the Corps. of Eng. for the required 404 permitting for all the proposed channel improvements. Two public roadway crossings of Sand Creek are also proposed to serve as direct access for the Sterling Ranch East Preliminary Plan No. 1 development areas. These crossings are currently covered under a 404 permit (Action No. SPA-2015-00428-SCO) with the previous land owner dated February 2016. JR Engineering, LLC is also coordinating a CLOMR/LOMR for this stretch of Sand Creek that is adjacent to the site and defined as Reach SC-8 (south of Briargate Pkwy.) and SC-9 north of Briargate Pkwy.). This entre site was also studied as a part of the "Master Development Drainage Plan for Sterling Ranch", prepared by M&S Civil Consultants, approved November 2018 which includes modeling of this property as well as the large acreage north up to the top of the Sand Creek Basin. The MDDP proposes developed flows within Sand Creek that are significantly lower than both the DBPS and FEMA currently show. These flows are as follows: At Arroya Lane crossing (DP-77) Q_{10} = 581 cfs Q_{100} = 1468 cfs and Sterling Ranch south property line (DP-63) Q_{10} = 713 cfs Q_{100} = 1912 cfs. However, the focus of this report is not on Sand Creek, but the adjacent residential development proposed. As mentioned earlier, eastern portions of this site lie within the East Fork of Sand Creek. The following descriptions represent the pre-development flow design points for the property consistent with the approved MDDP for Sterling Ranch, yet differentiate Sand Creek main tributary basins verses the East Fork basins. The nomenclature is similar to the MDDP for easy comparison:

Sand Creek Main

The Retreat at TimberRidge development exists at the northwest portion of the Sterling Ranch East property. Retreat at TimberRidge Filing No. 2 was recently approved by County Staff and proposes several temporary sediment basins and drainage swales adjacent to this property. These facilities will be removed upon construction from this proposed development in these areas. The following basins are off-site basins (outside the proposed Preliminary Plan area but within the overall Sterling Ranch East ownership) accounted for in the Retreat at TimberRidge development and are not tributary to the proposed development:

Basin TR-12 (Q_5 = 2 cfs, Q_{100} = 9 cfs) consists of 4.7 ac. of future large lot residential area that currently is undeveloped and sheet flows in a southwesterly direction off-site into the future Retreat at TimberRidge development. These flows were anticipated and accounted for within that development and future downstream storm facilities. **Basin TR-20 (Q_5 = 10 cfs, Q_{100} = 32**

cfs) consists of 23.2 ac. of future large lot residential area that currently is undeveloped and sheet flows in a southwesterly direction off-site directly into an existing stock pond within the future Retreat at TimberRidge development. These flows were anticipated and accounted for within that development and downstream storm facilities. **Basin TR-4 (Q_5 = 2 cfs, Q_{100} = 9 cfs)** consists of 4.4 ac. of future urban residential area that currently is undeveloped and sheet flows in a southwesterly direction off-site into the future Retreat at TimberRidge development. These flows were anticipated and accounted for within that development and downstream storm facilities. **Basin TR-5 (Q_5 = 5 cfs, Q_{100} = 17 cfs)** consists of 13.7 ac. of future urban residential area that currently is undeveloped and sheet flows in a southwesterly direction directly into a temporary sediment basin constructed with the Retreat at TimberRidge Filing No. 2 project. These flows were anticipated and accounted for within that development and downstream storm facilities. **Basin TR-6 (Q_5 = 1 cfs, Q_{100} = 4 cfs)** consists of a small future urban residential area of 1.5 ac. that currently is undeveloped and sheet flows in a southwesterly direction off-site into the Retreat at TimberRidge development. These flows were anticipated and accounted for within that development and downstream storm facilities. **Basin TR-7 (Q_5 = 1 cfs, Q_{100} = 5 cfs)** consists of a 2.6 ac. basin that sheet flows towards the Retreat property but then captured by a temporary swale and routed to the west into another temporary sediment basin constructed by the Retreat development.

The following basins are within the proposed Preliminary Plan area and also within the Sand Creek main basin boundary:

Basin EX-4A (Q_5 = 19 cfs, Q_{100} = 50 cfs) consists of the smaller portion of the property (44.2 acres) south of the Briargate Pkwy. crossing that currently sheet flows in a southwesterly direction directly into the Sand Creek main channel. These sheet flows are then conveyed downstream as channel flow towards the south property boundary. This basin differs from the MDDP as it only represents the on-site existing flows from the east side of the channel as defined by the current ownership boundary and does not include the off-site flows from the development along the west side of the channel or the significant existing off-site channel flow itself.

Basin EX-5 (Q_5 = 12 cfs, Q_{100} = 32 cfs) also consists of the smaller portion of the property (26.2 acres) north of the Briargate Pkwy. crossing that currently sheet flows in a southwesterly direction directly into the Sand Creek main channel. These sheet flows are then conveyed downstream as channel flow towards the proposed Briargate Pkwy. roadway crossing. This basin differs from the MDDP as it only represents the on-site existing flows from the east side of the channel as defined by the proposed platted boundary from the Homestead North at Sterling Ranch development and does not include the off-site flows from the west side of the channel or the significant existing off-site channel flow itself.

Basin EX-7 (Q_5 = 46 cfs, Q_{100} = 105 cfs) consists of approximately 152.8 acres of property that sheet flows in a southerly direction. This basin is similar to the MDDP and the east basin line defines the westerly edge of the East Fork basin. The sheet flows become more concentrated towards the south end of the basin as the topography becomes steeper and more defined south of the proposed Sterling Ranch Road crossing. The existing flows exit the property along the south Sterling Ranch boundary within the well-defined natural channel at **Design Point 4**. Given the difference in hydrologic modeling (SWMM 5.1 vs. HEC-HMS) these flows are fairly consistent with the flows determined by the MDDP at DP-4 (Q_5 = 21.5 cfs, Q_{100} = 107.4 cfs). Upon development and the construction of Pond FSD-11B, nearly all of the tributary area for this existing basin will be captured and treated. Thus, the downstream natural channel corridor through the existing rural lots within the Pawnee Rancheros Filing 2 Subd. and south of Mustang Place, just east of Mustang Road will continue to handle these off-site flows adequately.

Basin EX-7A (Q_5 = 1 cfs, Q_{100} = 5 cfs) consists of a small basin of only 2.4 ac. that sheet flows in a southerly direction. The MDDP included this small basin as a part of Basin EX-7. However, a more detailed look at this area finds that the larger basin EX-7 seems to all be tributary to the defined natural channel while Basin EX-7A appears to sheet flow off-site towards the Mustang Place cul-de-sac. These minor sheet flows ultimately combine with the pre-developed flows from Basin EX-7 south of Mustang Place within the natural channel. Again, with the construction of the Pond FSD-11B, the majority of the tributary area for this existing basin will be captured and treated. Thus, the downstream natural channel corridor will continue to handle these off-site flows adequately.

Sand Creek East Fork

Basin EX-8 (Q_5 = 5 cfs, Q_{100} = 23 cfs) consists of approximately 32.2 acres of property that sheet flows in a southerly direction. This basin is similar to the MDDP and the north portion of the west basin line defines the westerly edge of the East Fork basin. This basin incorporates the majority of MDDP basins EX-8. The flows seem to remain as sheet flows as they exit the property along the south boundary at **Design Point 5**. Again, these flows seem consistent with the flows determined by the MDDP at DP-5 (Q_5 = 1.7 cfs, Q_{100} = 20.5 cfs). Upon development of Filing 2 of the proposed development, the majority of the tributary area to this basin will be routed towards Pond FSD-11B. The remaining large lot rear yard sheet flows from Basin EF-A will be treated by runoff reduction techniques through long buffer areas and then continue to sheet flow off-site where the downstream properties will continue to adequately handle these less than historic sheet flows.

Basin EX-8A (Q_5 = 2 cfs, Q_{100} = 9 cfs) consists of a small basin of 6.6 ac. that sheet flows in a southerly direction. The MDDP included this small basin as a part of Bain EX-8. However, a more detailed look at this area finds that the larger basin EX-8 seems to sheet flow through properties east of Cochise Road while Basin EX-8A sheet flows off-site along the south boundary at **Design Point 5A** directly down the Cochise Road corridor. These off-site flows seem to ultimately combine further south within the Cochise Road corridor. Upon development of Filing 2 of the proposed development, the majority of the tributary area to this basin will be routed towards Pond FSD-11B. The remaining large lot rear yard sheet flows from

Basin EF-A will be treated by runoff reduction techniques through long buffer areas and then continue to sheet flow off-site where the downstream properties will continue to adequately handle these less than historic sheet flows.

Basin EX-9 (Q_5 = 59 cfs, Q_{100} = 122 cfs) consists of approximately 139.3 acres of property that sheet flows in a southerly direction. This basin is similar to the MDDP with the northern portion of the west basin line defining the westerly edge of the East Fork basin. The flows seem to remain as sheet flows as they exit the property along the south boundary at **Design Point 6**. Again, these flows seem consistent with the flows determined by the MDDP at DP-6 (Q_5 = 23.9 cfs, Q_{100} = 125.2 cfs). Upon development of Filing 2 of the proposed development, the majority of the tributary area to this basin will be routed towards Pond FSD-11B. The remaining large lot rear yard sheet flows from Basin EF-A will be treated by runoff reduction techniques through long buffer areas and then continue to sheet flow off-site where the downstream properties will continue to adequately handle these less than historic sheet flows.

Basin EX-9A (Q_5 = 7 cfs, Q_{100} = 19 cfs) consists of a smaller basin of 21.8 ac. that sheet flows in a southerly direction. The MDDP included this basin as a part of Basin EX-10A. However, a more detailed look at this area finds that the larger basin EX-10A seems to be tributary to Oto Circle east of the high point in the road while Basin EX-9A appears to sheet flow off-site along the south boundary at **Design Point 6A** west of the high point, towards the intersection of Brule Road and Oto Circle. These sheet flows seem to ultimately combine with the pre-developed flows from Basin Ex-10A further south and east of Brule Road. Upon development, much of the upstream tributary area to this basin will be routed towards Ponds FSD-11B and FSD-14B. The remaining undeveloped property will continue to sheet flow off-site where the downstream properties will continue to adequately handle these less than historic sheet flows.

Basin EX-10 (Q_5 = 105 cfs, Q_{100} = 222 cfs) consists of approximately 265.9 acres of property at the extreme top of the Sand Creek East Fork Basin. The off-site northern portion of this basin is within the Black Forest, heavily treed area. The off-site eastern portion of the basin contains existing 5 ac. lot development (Indian Wells Subd. Filing 1). The flows from this large basin sheet flow in a southerly direction across the northe[illegible] Ranch property and enter Basin EX-10A.

Basin EX-10A (Q_5 = 46 cfs, Q_{100} = 103 cfs) consists of a[illegible] of property that sheet flows in a southerly direction through the Sterling Ranch property. The combined flows from both basins EX-10 and EX-10A seem to remain as sheet flow traveling in a southerly direction towards **Design Point 7 (Q_5 = 110 cfs, Q_{100} = 249 cfs)** At this location the flows exit the property along the south boundary. Again, these flows are fairly consistent with the flows determined by the MDDP at DP-7 (Q_5 = 57.1 cfs, Q_{100} = 277.9 cfs). Upon development, much of the upstream tributary area to this basin will be routed internally elsewhere. The remaining undeveloped property will continue to sheet flow off-site where the downstream properties will continue to adequately handle these less than historic sheet flows.

Include discussion why flows have almost doubled for 5-year scenario. What is the impact to downstream facilities during this interim condition

Basin EX-13 (Q_5 = 36 cfs, Q_{100} = 85 cfs) consists of approximately 94.8 acres of property at the extreme eastern edge of the Sterling Ranch property. The off-site northern portion of this basin contains existing 5 ac. lot development (Indian Wells Subd. Filing 1). The flows from this basin sheet flow in a southeasterly direction towards the eastern boundary of the Sterling Ranch property. To be consistent with the MDDP, the flows then seem to run along the eastern property boundary and enter Basin EX-11 near the Southeast corner of the property.

Basin EX-11 (Q_5 = 54 cfs, Q_{100} = 129 cfs) consists of approximately 214.3 acres of property that sheet flows across the southeastern corner of the Sterling Ranch property. The combined flows from both basins seem to remain as sheet flow traveling in a southerly direction towards **Design Point 56**. **(Q_5 = 60 cfs, Q_{100} = 160 cfs)** At this location the flows exit the property along the south boundary. Again, these flows are fairly consistent with the flows determined by the MDDP at DP-56 (Q_5 = 42.5 cfs, Q_{100} = 202.9 cfs). No development is proposed within this basin at this time. Thus, the downstream corridor will not be affected.

Include discussion why flows have increased for 5-year scenario. What is the impact to downstream facilities during this interim condition

STERLING RANCH MDDP AMENDMENT NO. 2

PURPOSE

This portion of the report represents the second amendment to the Sterling Ranch MDDP, originally prepared by M&S Civil Consultants, Inc., approved June 2018 *(County Project No. SKP-18-003 and SF-17-024)*. Amendment No. 1 was prepared by JR Engineering, LLC, dated September 2022. *(County Project No. SF-22-013)*. All existing basin hydrology, concept routing and pond locations remain the same except for the following proposed changes:

1. As described in the Sterling Ranch MDDP Amendment No. 1, Ponds FSD-16A and FSD-16B are proposed to be combined into one full-spectrum facility (FSD-16) located at the northeast corner of Briargate Pkwy. and Sterling Ranch Road.

2. All developed flows within Briargate Parkway will continue to be collected by public storm system within the roadway, as planned by JR Engineering, but be routed south down Sterling Ranch Road in a public storm system towards pond FSD-14A rather than into FSD-16.

3. Rather than divert significant surface routed flows from the East Fork Sand Creek basin to the Sand Creek main basin, this report proposes to continue to release surface flows into the East Fork Sand Creek basin matching as close to pre-development conditions as possible.

4. Small portions of original MDDP basins SCE-7 and SCE-10 are now proposed to be tributary to Pond FSD-14B with the outfall in a southerly direction instead of towards Pond W3.

DETAILED DESCRIPTION

The original MDDP basins SC3-16A and SC3-16B had total acreages of 168.1 Ac. and 50.7 Ac., respectively for a total of 218.8 Ac. The following proposed basins represent the revised total area tributary to the single **Pond FSD-16:**

P1-A	12.7 Ac.	P1-B	35.5 Ac.	P1-C	8.9 Ac.
P1-D	31.4 Ac.	P1-E1	30.4 Ac.	P1-E2	21.8 Ac.
P1-F	76.7 Ac.	TR-W	1.4 Ac.	TR-V	2.1 Ac.
Total	**220.9 Ac.**				

This single proposed full spectrum facility is planned to be designed as a pond and useable park (play fields in the base). Based on construction phasing of the Preliminary Plan, the facility may also be built in phases with associated orifice plates to be switched out based on development. The anticipated first phase of development tributary to this facility is the Foursquare at Sterling Ranch East PUDSP development (PCD No. PUDSP227 – currently under review) along with a small portion of the Sterling Ranch East Preliminary Plan No. 1 (PCD No. SP-22-004 – currently under review) north of Briargate, adjacent to channel (42 lots). The outfall for this facility will continue to be the planned 48" RCP storm system as shown on the "Sterling Ranch Road & Briargate Parkway Storm Plans", by JR Engineering, LLC, dated September 2022 (PCD File No. SF2213 - currently under review). This public storm system runs south down Sterling Ranch Road and then outfalls into Pond W3 within the Sand Creek Channel. Also described in these plans is the public storm system within Briargate Parkway. Originally, these developed flows from the roadway were designed to be tributary to the Pond FSD-16. However, they are now planned to be routed south down Sterling Ranch Road within a public storm system towards Pond FSD-14A. The main reasons for this design change were the challenges with the dual water main crossings at the intersection of Briargate Pkwy. and Sterling Ranch Road along with the HGL's in the intersection were not meeting criteria. The following proposed basins represent the revised total area tributary to the **Pond FSD-14A:**

Have the areas and flows from Retreat at TimberRidge Filing No. 2 at design point 15 been accounted for?

P1-A1	5.0 Ac.	P1-A2	6.4 Ac.	P1-A3	1.8 Ac.
P1-A4	2.0 Ac.	P1-A5	5.7 Ac.	P1-A6	2.8 Ac.
P2-S1	35.6 Ac.	P2-A	24.4 Ac.	P2-B	57.8 Ac.
P2-B1	2.5 Ac.	P2-B2	1.9 Ac.	P2-B3	2.8 Ac.
P2-B4	1.6 Ac.	P2-B5	1.9 Ac.	P2-B6	1.1 Ac.
P2-B7	2.5 Ac.	P2-B8	1.2 Ac.		
Total	**157.0 Ac.**				

Pond FSD-14A has been upsized accordingly and will still be located adjacent to the Regional Park and continue to outfall directly into Pond W3 within Sand Creek.

The original MDDP as approved in 2018 proposed for a fairly significant inter-basin transfer of approximately 267 acres from East Fork Sand Creek into Sand Creek main basin. (See Excerpt below) While this transfer was still kept within the overall Sand Creek basin, there was concern of surface water rights for the immediate downstream properties just south of Sterling Ranch with this approved concept. In an effort to address this concern, this MDDP Amendment proposes to continue to release surface flows as close to pre-development condition as possible within the same historic basin location. (See Basin Exhibit below) These flows will either be treated in a formal full spectrum facility or provide WQCV runoff reduction prior to being released. Also, given the size of the historic basins and natural sheet flow characteristics at these outfall locations, this MDDP Amendment proposes a level spreader design at these locations. These facilities will help better disburse the developed flows in a historic sheet flow manner. Pre-development Design Point 6 that is currently within the East Fork basin would be the location for this planned facility based on the concurrently submitted Preliminary Plan. Upon future Sterling Ranch East residential development further to the east within Basins EX10A and EX-11, additional level spreader facilities may also be planned. The exact location of these proposed level spreaders will be presented with the Final Plat and CD's for these adjacent developments. However, the general location will be within the 75' buffer tract along the south boundary line for Sterling Ranch. (Reference Developed Drainage Map – sheet 6)

Location of future potential level spreader (Basin EX10A) was not shown on sheet 6. Please add to map.

The original MDDP as approved in 2018 proposed Basin SC3-14B to be 34.7 Ac. The proposed Villages at Sterling Ranch East PUDSP development (PCD No. PUDSP226 – currently under review) encompasses additional property further to the east than originally depicted as Basin SC3-14B. The proposed basins that better represent the total tributary area for **Pond FSD-14B** are the proposed basins found in this report as P4-A (25.8 Ac.) and P4-B (37.3 Ac.). **Thus, the total area is 63.1 Ac.** Future basins SCE-7 and SCE-10 will be reduced by this same amount. The proposed Pond FSD-14B has been upsized accordingly to handle this additional developed flow. The outfall for this facility was originally planned to connect directly to the 48" RCP storm system within Sterling Ranch Road with an ultimate outfall location into Pond W3 and direct release into Sand Creek main channel. As mentioned in the previous paragraph, the outfall for this facility is now planned to head towards the south property line within a future pipe system. Ultimately, upon full build-out of this Preliminary Plan, a level spreader facility will be installed along the south property line as shown on the drainage map at Design Point 6. In the interim, until full build-out, a temporary plunge pool may be installed just south of the pond to help dissipate these released treated flows. The release quantity from Pond FSD-14B will approximate the pre-developed flows for the original Basin EX-9.

Pond FSD-11B remains fairly consistent with the original 2018 Sterling Ranch MDDP other than the two sump inlets at the low point in Sterling Ranch Road (Sand Creek Crossing) are now planned to be routed south along the school site towards Pond FSD-11B rather than towards Pond FSD-14A. HGL design concerns was the main reason for this adjustment. Pond FSD-11B has been upsized accordingly and is still planned to be located south of the Elementary school site along the south boundary. The following proposed basins represent the revised total area tributary to the **Pond FSD-11B:**

P2-B9	2.0 Ac.	P2-B10	1.7 Ac.	P3-S2	11.9 Ac.
P3-A	52.6 Ac.				
Total	**68.2 Ac.**				

(Excerpt from 2018 Sterling Ranch MDDP, M&S Civil Consultants, Inc.)

Step 2 **Implement BMPs that provide a water quality capture volume with slow release.** – Using Full Spectrum Detention Facilities which will incorporate water quality capture volumes that are intended to slowly drain in 40 hours and excess urban runoff volumes that are intended to drain within 72 hours. All storage facilities will be designed to meet State Statue SB15-212/ §37-92-602(8).

Step 3 **Stabilize streams.** – With the full spectrum detention facility in place, the runoff from the developments will be reduced to predevelopment conditions. The developed discharge from the sites will be less than existing and therefore is not anticipated to have negative effects on downstream drainage ways.

Step 4 **Consider need for Industrial and Commercial BMPs.** – No industrial land uses are proposed with this development. The proposed commercial development area will implement a Stormwater Management Plan (SWMP) incorporation proper housekeeping procedures. Onsite drainage will be routed through private Full Spectrum Detention (FSD) basins to minimize introduction of contaminates to the county's public drainage systems.

INTERBASIN TRANSFER EAST FORK SAND CREEK TO MAIN STEM SAND CREEK

It should be noted that the proposed development plan for the ~1444 acre of Sterling Ranch redistributes a small percentage of the historic watershed between the Sand Creek and East Fork of Sand Creek watershed.

Based upon the survey and contour mapping, prior to development approximately 682 acres of Sterling Ranch runoff was collected by the Sand Creek watershed with the remaining 762 acres was directed to the East Fork of Sand Creek.

After development approximately 267 acres will be redirected from the East Fork Sand Creek into the Sand Creek Basin, resulting in 949 acres of Sterling Ranch directed to the Sand Creek Basin with the remaining 495 acres directed to East Fork Sand Creek.

This modification is driven primarily by maximizing the area of land that can be delivered to the sanitary sewer lift station. It should be noted that the East Fork of Sand Creek is still tributary to the Main Branch of Sand Creek, and thus this transfer is between minor watersheds, not major watershed, and that the development as planned will still function to limit discharged runoff into Sand Creek and East Tributary to the historic flow rates. An exhibit was added to the appendix, which also accompanies the deviation request that shows this basin diversion.

It should be noted that the Developed Conditions Map (provided in the appendix) illustrated the diverted acreage based upon the DPBS mapped boundary(as mapped within the SCDBPS) and diversion based upon the actual field contour data.

Drainage Basin Descriptions

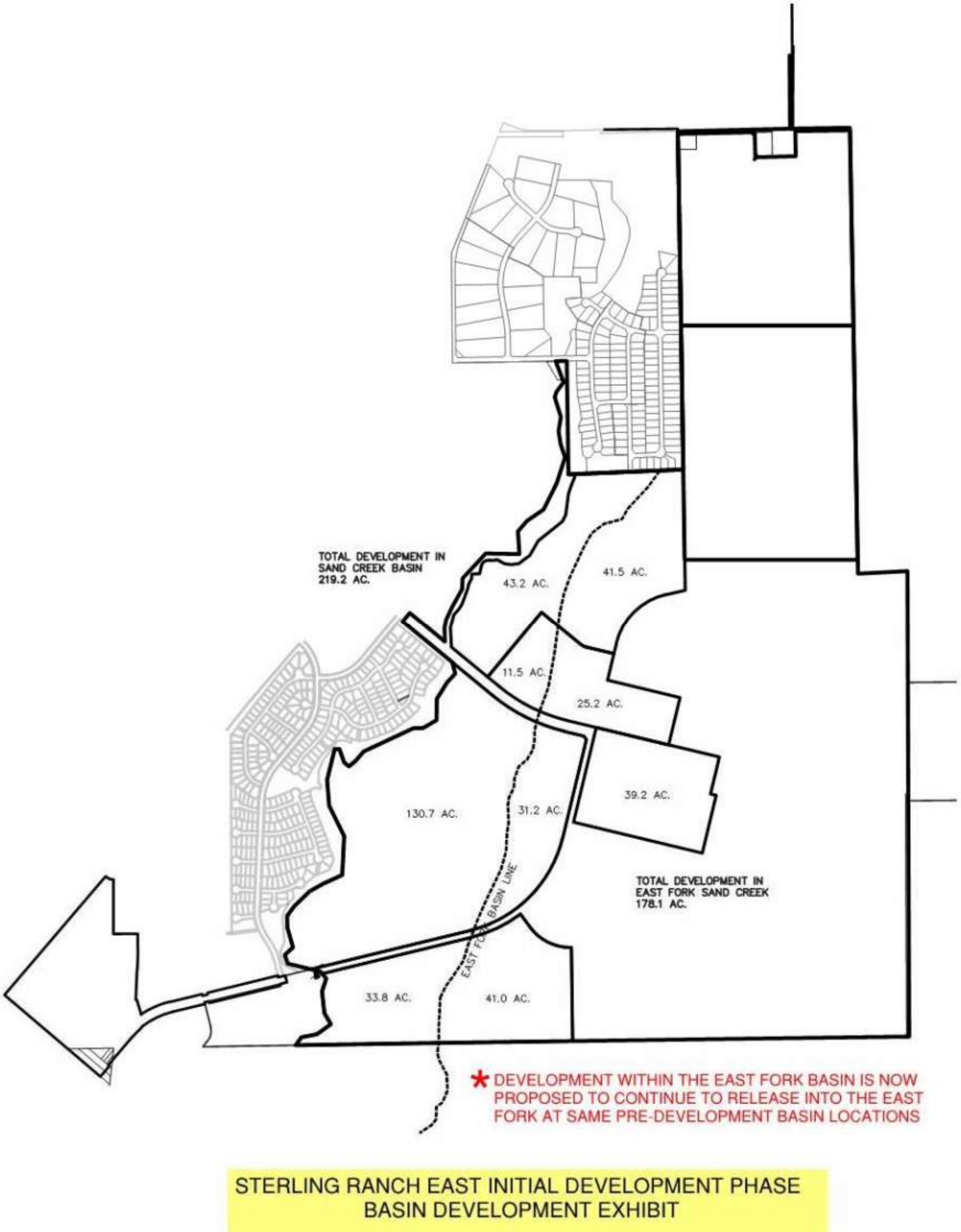
Developed Sand Creek (Main Stem) Basin Flows

Basin SC3-82 (Q5 = 33.2 cfs, Q100 = 132.3 cfs) which is located north of Sterling Ranch and Burgess Road to the east Basin SC3-81, assumes that the 117.8 is primarily undeveloped, pine forested land. In this undeveloped condition runoff from the basin continues south overland into Basin SC3-74.

Basin SC3-74 (Q5 = 36.5 cfs, Q100 = 140.7cfs) is a 119.7 acre area of 5 and 10-acre lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch and south of Burgess Road to the west and north of Basins SC3-73 and SC3-75. Runoff from Basins SC3-74 and SC3-82, combine at DP-74 (Q5 = 65.3 cfs, Q100 = 262.8 cfs), which is equivalent to the anticipated existing modeled flow rates of Q5 = 65.3 cfs, Q100 = 262.8 cfs.

Basin SC3-73 (Q5 = 26.4 cfs, Q100 = 102.0 cfs) is a 90.0 acre area of 5 to 40 acres lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch to the northeast of Vollmer Road. Runoff from the Basin SC3-73 will combine with runoff from DP-74 and will continue overland towards DP-75.

Basin SC3-81 (Q5 = 70.2 cfs, Q100 = 275.7 cfs) which is located north of Sterling Ranch (approx 1 mile) between Shoup and Burgess Roads, assumes that the 262.9 acre area of primarily undeveloped, pine forested, land. In this undeveloped condition runoff from the basin continues south overland into Basin SC3-75.



* DEVELOPMENT WITHIN THE EAST FORK BASIN IS NOW PROPOSED TO CONTINUE TO RELEASE INTO THE EAST FORK AT SAME PRE-DEVELOPMENT BASIN LOCATIONS

STERLING RANCH EAST INITIAL DEVELOPMENT PHASE
BASIN DEVELOPMENT EXHIBIT

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS

PROPOSED DRAINAGE CONDITIONS

As described in the General Description of the report, this proposed Preliminary Plan development contains 321+ acres that is geographically separated by two major roadways that are being final platted and constructed separately (Briargate Pkwy. and Sterling Ranch Rd.). Multiple full spectrum detention (FSD) facilities are planned with this overall Sterling Ranch East Preliminary Plan No. 1 development. They will be designed to handle these proposed lots, future adjacent development and the two other Sterling Ranch East PUD Developments (*Villages at Sterling Ranch East PUDSP - PCD No. PUDSP226 and Foursquare at Sterling Ranch East PUDSP - PCD No. PUDSP227 both currently under review but submitted concurrently*).

Development of these urban lots proposed will consist of overlot grading and utility installation for the planned roadways and lots. Per the El Paso County ECM, Section I.7.1.B, all urban lots are required to provide Water Quality Capture Volume (WQCV). Thus, the proposed FSD facilities within this development will provide WQCV along with an Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume with an outlet control device. Frequent and infrequent inflows are released at rates approximating undeveloped conditions. This concept provides some mitigation of increased runoff volume by releasing a portion of the increased runoff at a low rate over an extended period of time, up to 72 hours. This means that frequent storms, smaller than the 2-year event, will be reduced to very low flows near or below the sediment carrying threshold value for downstream drainage ways. Also, by incorporating an outlet structure that limits the 100-year runoff to the undeveloped condition rate, the discharge hydrograph for storms between the 2 year and the 100-year event will approximate the hydrograph for the undeveloped conditions and will help effectively mitigate the effects of development. As reasonably possible, WQCV will be provided for all new roads and urban lots.

This report will generally describe overall anticipated developed basins tributary to each of the proposed FSD facilities. Each of these developed basins will then be detailed further in final drainage reports prepared and submitted along with Final Plats and CD’s. This final design will include sizing of all inlets, storm systems and finalized FSD facilities including all required appurtenances. It is anticipated that Type-R at-grade and sump inlets ranging from 5' to 15' will be utilized in all street drainage and HGL's will be provided for all RCP storm system design.

The following developed basin descriptions will start at the north end of the project and move south and describe how this development proposes to handle both the off-site and on-site drainage conditions both from an interim standpoint based on construction phasing and the ultimate buildout scenario of the entire Sterling Ranch East ownership:

The following represent the basins and design points north of Briargate Pkwy.:
As described earlier, these first several basins (TR-12, TR-20, TR-4, TR-5 and TR-6) are all at the north end of the Sterling Ranch East overall property and are tributary to the adjacent Retreat at TimberRidge development and are consistent with what that approved report anticipated. (Reference "Final Drainage Report for Retreat at TimberRidge Filing No. 1", prepared by CCES, approved November 2020 and "Final Drainage Report for Retreat at TimberRidge Filing No. 2", prepared by CCES, dated March 2022) Basin TR-12 (4.7 Ac.) is currently routed through the Retreat at TimberRidge development and then directly into Sand Creek. Upon development of Retreat at TimberRidge Filing 3, this basin is planned to be captured by the public storm system and then formally treated downstream in the Retreat at TimberRidge Pond 2. Basin TR-20 (23.2 Ac.) is currently tributary to the existing stock pond within the Retreat at TimberRidge development, which outfalls into a storm system directly into Sand Creek. Upon future development within this basin, formal stormwater quality treatment must take place on-site with the release into the existing storm system directly to Sand Creek. Basins TR-4 (4.4 Ac.), TR-5 (13.7 Ac.) and TR-6 (1.5 Ac.) are all currently accounted for and routed through the Retreat at TimberRidge development for formal treatment. Upon future development within these basins, formal treatment is still planned to be handled in the downstream Retreat at TimberRidge Pond 2.

Address how flows will be conveyed along the east side and to the TSB

The following basins are all contained within basin SC3-16A as presented in the MDDP for Sterling Ranch, prepared by M&S Civil Consultants, approved in 2018:

Basin TR-V (Q_5 = 2 cfs, Q_{100} = 6 cfs) consists of 2.1 Ac. of rear yards of the adjacent Retreat at TimberRidge Filing No. 2 development. These flows are currently captured in a natural swale along the common property line and routed south and then west towards a temporary sediment basin at the end of Bison Valley Trail that was constructed with the TimberRidge development. With the development of this portion of the proposed Sterling Ranch East Preliminary Plan No. 1, these flows will likely remain being captured by the natural swale along the westerly property line but then be directed into **Basin P1-F (Q_5 = 111 cfs, Q_{100} = 215 cfs).** This basin represents 76.6 Ac. of the anticipated future urban residential basin tributary to a future downstream storm system within the northerly extension of Sterling Ranch Road.

Design Point 1 (Q_5 = 112 cfs, Q_{100} = 219 cfs) represents the anticipated total developed flow at this location upon full build-out. In the interim, before development within this basin, the historic flow patterns may be captured in a temporary sediment basin located just east of Design Point 1. This facility will help mitigate the historic flows from the large upstream basin (EX-10) prior to and during the construction of the extension of Sterling Ranch Road, Pond FSD-16 and the northerly portion of this proposed Preliminary Plan area. The final drainage report(s) for this portion of the development will describe any temporary sediment basins and collection points for these pre-development flows for safe routing further downstream.

Verify - address areas to the east if being diverted

Basin TR-W (Q_5 = 3 cfs, Q_{100} = 5 cfs) consists of 1.4 Ac. of rear yards and a small portion of the Bison Valley Trail roadway within the adjacent Retreat at TimberRidge Filing No. 2 development. These flows are currently captured in a natural swale along the common property line and routed westerly towards a temporary sediment basin at the end of Bison Valley Trail that was constructed with the TimberRidge development. With the development of the proposed Sterling Ranch East – Phase 1, these temporary facilities will be removed and allowed to flow directly into Basin P1-E1. **Basin P1-E1 (Q_5 = 50 cfs, Q_{100} = 97 cfs)** consists of 30.4 Ac. of the proposed urban residential at the north end of this Preliminary Plan, just east of Sand Creek and tributary to a proposed downstream storm system within the northerly

How will they be captured? Provide total flows.

extension of Sterling Ranch Road at **Design Point 2 (Q_5 = 53 cfs, Q_{100} = 103 cfs)**. These developed flows will then combine with the upstream developed flows from Design Point 1 and be routed in a large diameter storm system further south within Sterling Ranch Road.

Basin P1-E2 (Q_5 = 41 cfs, Q_{100} = 80 cfs) consists of 21.8 Ac. of the proposed urban residential at the north end of this Preliminary Plan, again just east of Sand Creek and tributary to a proposed downstream storm system within the northerly extension of Sterling Ranch Road at **Design Point 3 (Q_5 = 41 cfs, Q_{100} = 80 cfs)**. These developed flows will then combine with the upstream developed flows from Design Points 1 & 2 and be routed in a large diameter storm system further south within Sterling Ranch Road.

Basin P1-C (Q_5 = 23 cfs, Q_{100} = 46 cfs) consists of 8.9 Ac. of the anticipated tributary area for the Sterling Ranch Road ROW extension north of Briargate Pkwy. and adjacent development. These proposed developed flows will be collected in various at-grade inlets within the roadway, combine with the upstream pipe flows described above and then routed towards the proposed Pond FSD-16. The total developed flow at this northerly pipe outlet location into Pond FSD-16 is represented by **Design Point 4 (Q_5 = 218 cfs, Q_{100} = 379 cfs)**. The design of the required concrete forebay, impact structure and trickle channel at this outfall will be provided with the Final Drainage Report.

Basin P1-D (Q_5 = 53 cfs, Q_{100} = 102 cfs) represents 31.4 Ac. of the urban residential basin that is made up of the entire *Villages at Sterling Ranch East PUDSP - PCD No. PUDSP226 (currently under review)* area and a small portion of this proposed Preliminary Plan area just east of Sand Creek, north of Briargate Pkwy. This basin is tributary to **Design Point 5 (Q_5 = 53 cfs, Q_{100} = 102 cfs)** and the easterly pipe outlet location into Pond FSD-16. The design of the required concrete forebay, impact structure and trickle channel at this outfall will be provided with the Final Drainage Report.

The following basins are all contained within basin SC3-16B as presented in the MDDP for Sterling Ranch, prepared by M&S Civil Consultants, approved in 2018:

Basin P1-B (Q_5 = 55 cfs, Q_{100} = 108 cfs) consists of the anticipated tributary area for the future Sterling Ranch East urban residential area outside of this proposed Preliminary Plan. These anticipated future developed flows will be routed towards a downstream storm system. The total developed flow at this pipe system outlet location into Pond FSD-16 is represented by **Design Point 6 (Q_5 = 55 cfs, Q_{100} = 108 cfs)**. The design of the required concrete forebay, impact structure and trickle channel at this outfall will be provided with the Final Drainage Report. In the interim, before development within this basin, the historic flow patterns and quantities will continue to sheet flow in a southerly direction towards the proposed pond and Briargate Pkwy. The final drainage report(s) will describe any temporary sediment basins and collection points for these pre-development flows for safe routing around the development area and further downstream.

Basin P1-A (Q_5 = 6 cfs, Q_{100} = 19 cfs) consists of the anticipated tributary area from the adjacent future residential lots (rear yards only) along with the actual pond area itself. The developed sheet flows from this basin will sheet flow directly into the adjacent FSD-16 Pond where they will be formally treated.

As described in the MDDP Amendment portion of this report, the two FSD ponds planned in the 2018 MDDP (FSD16A and FSD16B) are now proposed to be combined into one facility (FSD-16) northeast of the intersection of Briargate Pkwy. and Sterling Ranch Road. The total anticipated developed flows entering this facility under the full build-out scenario are as follows. (See Appendix for MHFD-Detention pond design sheets):

<u>Detention Pond FSD-16</u> (Full Spectrum EDB) **Full Build-out Scenario**

Total Tributary Acreage: **220.9 ac.**

3.60 Ac.-ft. WQCV

7.68 Ac.-ft. EURV

"stage" or "zone" should be added to clarify that these are not totals

7.54 Ac.-ft. 100-yr. Storage

18.82 Ac.-ft. Total 21.56 Ac. ft proposed

Total Peak In-flow (SWMM Model): **Q_5 = 323 cfs, Q_{100} = 499 cfs**

Pond Peak Design Release (MHFD Sheet): **Q_5 = 3.6 cfs, Q_{100} = 117.4 cfs**

Pre-development Release (MHFD Sheet): **Q_5 = 4.5 cfs, Q_{100} = 204.0 cfs**

(Ownership and maintenance by the Sterling Ranch East Metro District)

Provide SWMM modeled release rates also

With the anticipated phasing of construction within the Sterling Ranch East overall development, this facility will be designed with two separate orifice plate designs to be swapped out upon full build-out. However, the overall pond size and outlet box size will remain consistent. The interim development phase includes development within all tributary basins except **P1-B and P1-F** (future residential development NOT within this initial Preliminary Plan). These basins are assumed to remain native under this scenario.

The total anticipated developed flows entering the facility under the interim development scenario are as follows. (See Appendix for MHFD-Detention pond design sheets):

<u>Detention Pond FSD-16</u> (Full Spectrum EDB) **Interim Development Scenario**

Total Tributary Acreage: **220.9 ac.**

2.55 Ac.-ft. WQCV

3.04 Ac.-ft. EURV

5.92 Ac.-ft. 100-yr. Storage

"stage" or "zone" should be added to clarify that these are not totals

11.51 Ac.-ft. Total 17.78 Ac. ft proposed

Total Peak In-flow (SWMM Model): **Q_5 = 197 cfs, Q_{100} = 410 cfs**

Pond Peak Design Release (MHFD Sheet): **Q_5 = 2.5 cfs, Q_{100} = 66.0 cfs**

Pre-development Release (MHFD Sheet): **Q_5 = 4.5 cfs, Q_{100} = 204.0 cfs**

(Ownership and maintenance by the Sterling Ranch East Metro District)

Provide SWMM modeled release rates also

In both scenarios, Pond FSD-16 will release into a large diameter downstream storm system within Briargate Pkwy. just east of the Sterling Ranch Road intersection. Please reference the "Drainage Letter for Sterling Ranch Road and Briargate Pkwy. Interim Plan", prepared by JR Engineering, LLC, dated December 2021 and the "Sterling Ranch Road and Briargate Pkwy. Storm Plans", prepared by JR Engineering, LLC, dated September 2022. These referenced design plans provide a 48" RCP outfall pipe at this location with an allowable release rate of (Q_{100} = 156.6 cfs). The 2018 MDDP presents a combined total release rate for the originally planned two ponds (FSD16A and FSD16B) of (Q_{100} = 174.9 cfs). As designed on the JR Engineering storm plans, this storm system will run in a southeasterly direction within the Sterling Ranch Roadway towards the crossing of Sand Creek. At this location, the pipe system will outfall into the planned Detention Pond W3. Reference the "Final Design Report for Sand Creek Restoration", prepared by JR Engineering, LLC, dated September 2022 for these design documents.

southwesterly?

Basins P1-A1 (Q_5 = 11 cfs, Q_{100} = 21 cfs), **Basin P1-A2 (Q_5 = 12 cfs, Q_{100} = 23 cfs), Basin P1-A3 (Q_5 = 5 cfs, Q_{100} = 9 cfs)** and **Basin P1-A4 (Q_5 = 5 cfs, Q_{100} = 10 cfs)** all represent tributary area within the Briargate Pkwy. roadway extension between Vollmer and Sterling Ranch Road. These basins have been studied in the "Drainage Letter for Sterling Ranch Road and Briargate Pkwy. Interim Plan", prepared by JR Engineering, LLC, dated September 2022. Reference this report as well as the "Sterling Ranch Road and Briargate Pkwy. Street Plans", prepared by JR Engineering, LLC, dated September 2022 for inlet and pipe sizes through this corridor. These final designed facilities are shown and labeled on the drainage map. However, as described in the MDDP Amendment portion of this report, these final storm plans will be adjusted prior to formal storm sewer approval to show these developed flows now being routed south down Sterling Ranch Road.

Design Point 7 (Q_5 = 20 cfs, Q_{100} = 39 cfs) is the location of the proposed low-point in Briargate Pkwy. just east of Sterling Ranch Road, with the following two basins being tributary to this sump condition. The emergency overflow release is planned to be around the corner and south down Sterling Ranch Road. **Basin P1-A5 (Q_5 = 13 cfs, Q_{100} = 25 cfs)** and **Basin P1-A6 (Q_5 = 7 cfs, Q_{100} = 14 cfs)** consist of 5.7 Ac. and 2.8 Ac. respectively, of the anticipated area within the ROW tributary to this low-point. The collected flows will then be routed via a storm system and combine with the previously described basins further west in Briargate Pkwy. and then south down Sterling Ranch Road. The anticipated storm system at this point is a 42" RCP.

Basin SC-4 (Q_5 = 8 cfs, Q_{100} = 27 cfs) consists of the anticipated rear yards of the lots adjacent to the creek that will continue to sheet flows directly towards the Sand Creek corridor. At this time, these rear yards are not able to be captured and routed to a formal stormwater quality facility. However, given the minimal unconnected impervious area and sizeable receiving pervious are within this basin, the WQCV reduction = 100% with 0 untreated WQCV. (See Appendix)

The following represent the basins and design points south of Briargate Pkwy. and west of Sterling Ranch Road *all contained within basin SC3-14A as presented in the MDDP for Sterling Ranch, prepared by M&S Civil Consultants, approved in 2018:*

Basin P2-S1 (Q_5 = 68 cfs, Q_{100} = 133 cfs) consists of the anticipated basin for the proposed middle school site. These developed flows will be routed internally within the school site property towards **Design Point 8 (Q_5 = 68 cfs, Q_{100} = 133 cfs)** where a storm stub will be provided. This storm stub will then outfall into the proposed downstream storm system within Sterling Ranch Road and combine with the upstream flows from Briargate Pkwy. as described above. The anticipated storm system at this point is a 60" RCP tributary to Pond FSD-14A.

Basin P2-B (Q_5 = 88 cfs, Q_{100} = 173 cfs) consists of the anticipated basin for this large urban residential area. These developed flows will be captured in multiple public storm systems on-site and routed towards the storm stub provided at Design Point 9. **Design Point 9 (Q_5 = 88 cfs, Q_{100} = 173 cfs)** represents these developed flows. They then combine with the upstream developed flows described above and are routed in an anticipated 72" RCP storm system towards Pond FSD-14A. **Design Point 10 (Q_5 = 223 cfs, Q_{100} = 441 cfs)** represents the total piped developed flows entering Pond FSD-14A. This does not include **Basin P2-A (Q_5 = 15 cfs,**

Q_{100} = 43 cfs) that represents the regional park area and some adjacent rear yards of lots that is directly tributary to Pond FSD-14A.

Basin P2-A (Q_5 = 13 cfs, Q_{100} = 41 cfs) consists of the better portion of the proposed park area. The developed sheet flows from this area are anticipated to sheet flow directly into the adjacent Pond FSD-14A where they will be formally treated.

Basin SC-2 (Q_5 = 6 cfs, Q_{100} = 20 cfs) consists of a portion of the existing Sand Creek Channel that will ultimately be improved based on the JR Eng. channel improvement plans previously referenced. This area will eventually become Pond W3 upon these channel improvements being made. Both in the interim, prior to the channel improvements and ultimately, upon construction of Pond W3, this area will remain directly tributary to Sand Creek and contain only channel improvements. No proposed lot construction will take place in this basin.

Basin SC-3 (Q_5 = 12 cfs, Q_{100} = 26 cfs) consists of portions of the proposed linear park/open space along with the anticipated rear yards of the lots adjacent to the creek. This area will continue to sheet flow directly towards the Sand Creek corridor. At this time, these rear yards are anticipated to not be captured and routed to a formal stormwater quality facility. However, given the minimal unconnected impervious area and sizeable receiving pervious are within this basin, the WQCV reduction = 100% with 0 untreated WQCV. (See Appendix)

Basins P2-B1 (Q_5 = 7 cfs, Q_{100} = 13 cfs), **Basin P2-B2 (Q_5 = 5 cfs, Q_{100} = 10 cfs), Basin P2-B3 (Q_5 = 7 cfs, Q_{100} = 13 cfs)**, **P2-B4 (Q_5 = 4 cfs, Q_{100} = 8 cfs)**, **Basin P2-B5 (Q_5 = 5 cfs, Q_{100} = 9 cfs), Basin P2-B6 (Q_5 = 3 cfs, Q_{100} = 6 cfs), P2-B7 (Q_5 = 6 cfs, Q_{100} = 12 cfs)** and **Basin P2-B8 (Q_5 = 3 cfs, Q_{100} = 7 cfs)** all represent tributary area within the Sterling Ranch Road roadway extension between Dines Blvd. and Briargate Pkwy. These final designed facilities (Type R curb inlets) are shown and labeled on the drainage map. These basins have been studied in the "Drainage Letter for Sterling Ranch Road and Briargate Pkwy. Interim Plan", prepared by JR Engineering, LLC, dated September 2022. Please reference this report along with the "Sterling Ranch Road and

Briargate Pkwy. Storm Plans", prepared by JR Engineering, LLC, dated September 2022 and the "Sterling Ranch Road and Briargate Pkwy. Street Plans", prepared by JR Engineering, LLC, dated September 2022. These referenced design plans provide for separate storm outfalls from each of the at-grade inlet locations within Sterling Ranch Road to daylight into a temporary graded channel on the north side of the roadway. This channel then routes the developed roadway flows towards Pond FSD-14A. The ultimate design proposed to handle these roadway flows along with the adjacent development of Basins P2-S1, P2-A and P2-B (as described above) will be a 60"-72" RCP storm system located within the open space tract along the north side of Sterling Ranch Road. (See Drainage Map) All the designed curb inlets within this stretch of Sterling Ranch Road will then connect into this proposed storm system.

The original MDDP basin SC3-14A included the entire Sand Creek channel including both the in-line stock pond and the proposed Detention Pond W3. However, there is only about a 10+ acre difference in area from this original basin vs. the actual development area tributary to the proposed FSD-14A Pond. The total anticipated developed flows entering this facility are as follows. (See Appendix for MHFD-Detention pond design sheets):

<u>Detention Pond FSD-14A</u> (Full Spectrum EDB)

Total Tributary Acreage: 157.0 ac.

2.66 Ac.-ft. WQCV

(Same comments as above)

6.10 Ac.-ft. EURV

5.37 Ac.-ft. 100-yr. Storage

14.13 Ac.-ft. Total ← 14.33 Ac. ft proposed

Total Peak In-flow (SWMM Model): Q_5 = 234 cfs, Q_{100} = 486 cfs

Pond Peak Design Release (MHFD Sheet): Q_5 = 3.3 cfs, Q_{100} = 118.8 cfs

Pre-development Release (MHFD Sheet): Q_5 = 4.1 cfs, Q_{100} = 174.2 cfs

(Ownership and maintenance by the Sterling Ranch East Metro District)

The allowable release rate from this facility per the 2018 MDDP equals (Q_{100} = 142.4 cfs). This facility is planned to release directly into the adjacent in-line Pond W3. Please reference “Final Design Report for Sand Creek Restoration”, prepared by JR Engineering, LLC, dated September 2022 for this pond design along with the adjacent Sand Creek improvements proposed in this area.

The following represent the basins and design points south of Briargate Pkwy. and east of Sterling Ranch Road *contained within basins SC3-14B, SCE-7 and SCE-10 as presented in the MDDP for Sterling Ranch, prepared by M&S Civil Consultants, approved in 2018:*

Basin P4-B (Q_5 = 63 cfs, Q_{100} = 123 cfs) consists of the anticipated basin for the proposed Villages at Sterling Ranch East PUD site. These developed flows will be collected via a public storm system on-site and then routed towards **Design Point 12 (Q_5 = 63 cfs, Q_{100} = 123 cfs)** at the south edge of the site where a 48” RCP storm stub will be provided. This storm stub will then outfall in a southerly direction through future Sterling Ranch residential development towards Pond FSD-14B.

Basin P4-A (Q_5 = 41 cfs, Q_{100} = 80 cfs) consists of the anticipated tributary area for the future Sterling Ranch East urban residential area outside of this proposed Preliminary Plan. These anticipated future developed flows will be routed towards a downstream storm system represented by **Design Point 13 (Q_5 = 41 cfs, Q_{100} = 80 cfs).** These future developed flows then combine with the previously described developed flows from Design Point 14 and are routed into Pond FSD-14B. **Design Point 14 (Q_5 = 97 cfs, Q_{100} = 189 cfs)** represents the total anticipated developed flows into Pond FSD-14B. The design of the required concrete forebay, impact structure and trickle channel at this outfall will be provided with the Final Drainage Report. In the interim, before development within this future basin P4-A, the developed flows from the Villages site may be routed via a temporary channel towards Pond FSD-14B. The final drainage report(s) will further describe any temporary conveyance facilities for these developed flows.

The original MDDP basin SC3-14B only included 34.7 acres tributary to Pond FSD-14B. The entire proposed Villages at Sterling Ranch East PUD site along with the planned future residential area due south is now proposed to be tributary to Pond FSD-14B. This total acreage equals 63.1 acres. The planned outfall for this facility as presented in the 2018 MDDP was to the west and into the previously mentioned 48" RCP outfall within Sterling Ranch Road from Pond FSD-16. However, based on this proposed MDDP Amendment, the ultimate outfall for this facility is now planned to be a 42"-48" RCP storm system routed in a southerly direction towards the south property line of the overall Sterling Ranch East ownership. At this location, a level spreader is proposed to evenly allow the developed, treated flows to exit the property within the Pre-development Basin EX-9 at DP6. The allowed release from Pond FSD-14B and the spreader facility will be equal to or less than the pre-developed flows at this location of (Q_5 = 59 cfs, Q_{100} = 122 cfs).

The total anticipated developed flows entering this facility are as follows. (See Appendix for MHFD-Detention pond design sheets):

Detention Pond FSD-14B (Full Spectrum EDB)

Total Tributary Acreage: 63.1 ac.

1.24 Ac.-ft. WQCV

3.35 Ac.-ft. EURV

(Same comments as above)

2.38 Ac.-ft. 100-yr. Storage

6.97 Ac.-ft. Total

6.44 Ac. ft proposed

Total Peak In-flow (SWMM Model): Q_5 = 97 cfs, Q_{100} = 189 cfs

Pond Peak Design Release (MHFD Sheet): Q_5 = 2.0 cfs, Q_{100} = 48.9 cfs

Pre-development Release (MHFD Sheet): Q_5 = 1.2 cfs, Q_{100} = 48.9 cfs

(Ownership and maintenance by the Sterling Ranch East Metro District)

The following represent the basins and design points south of Sterling Ranch Road *contained within basin SC3-11B as presented in the MDDP for Sterling Ranch, prepared by M&S Civil Consultants, approved in 2018:*

Basin P3-A (Q_5 = 85 cfs, Q_{100} = 166 cfs) consists of the anticipated basin for the proposed urban residential at the south end of the overall Sterling Ranch East project. These developed flows will be collected via a public storm system on-site and then routed towards **Design Point 15 (Q_5 = 85 cfs, Q_{100} = 166 cfs)** at the southwest edge of the site where a 48”-54” RCP storm stub will be provided. This storm stub will then outfall directly into the proposed Pond FSD-11B. The Sterling Ranch East Phase 1 Preliminary Plan in this area proposes RR-5 zoning adjacent to the south overall boundary. The lots presented in this area are all at least 1/2 ac. in size and typically 100’ wide and 225’ deep. **Basin EF-A (Q_5 = 7 cfs, Q_{100} = 20 cfs)** consists of rear portion of these proposed large lots along with a 75’+ wide buffer/utility corridor immediately adjacent to the south property line. This basin will be allowed to continue to sheet flow in a southerly direction off-site. At this time, these rear yards and buffer corridor are anticipated to not be captured and routed to a formal stormwater quality facility. However, given the minimal unconnected impervious area and sizeable receiving pervious are within this basin, the WQCV reduction = 100% with 0 untreated WQCV. (See Appendix) **Basin P3-C (Q_5 = 1 cfs, Q_{100} = 5 cfs)** consists of a small portion of the 75’+ wide buffer/utility corridor immediately adjacent to the south property line. This basin will be allowed to continue to sheet flow in a southerly direction off-site. No impervious development is anticipated within this basin and thus no formal stormwater quality feature is required for this small basin.

Basin P2-B9 (Q_5 = 5 cfs, Q_{100} = 11 cfs) and **Basin P2-B10 (Q_5 = 5 cfs, Q_{100} = 10 cfs)** represent tributary area for the Sterling Ranch Road low point just east of Dines Blvd. These final designed facilities (Type R curb inlets) are shown and labeled on the drainage map. These two basins have also been studied in the “Drainage Letter for Sterling Ranch Road and Briargate Pkwy. Interim Plan”, prepared by JR Engineering, LLC, dated September 2022. Please reference this report along with the “Sterling Ranch Road and Briargate Pkwy. Storm Plans”, prepared by JR Engineering, LLC, dated September 2022 and the “Sterling Ranch Road and Briargate Pkwy.

See comment memo.

Street Plans", prepared by JR Engineering, LLC, dated September 2022. Originally, these flows were to be routed northeast into Pond FSD-14A. However, as described in the MDDP Amendment portion of this report above, these flows are now planned to be routed towards Pond FSD-11B south of the Elementary School site. Prior to the school development, these flows will be handled by a temporary sediment basin. The total flow entering this temporary facility is represented by **Design Point 11 (Q_5 = 10 cfs, Q_{100} = 21 cfs).** Ultimately, upon the school development and the removal of this temporary facility, these flows will be routed via a 24" RCP storm system adjacent to the school site towards Design Point 16. **Basin P3-S2 (Q_5 = 25 cfs, Q_{100} = 50 cfs)** consists of the anticipated basin for the proposed elementary school site. These developed flows will be routed internally within the school site property towards **Design Point 16 (Q_5 = 34 cfs, Q_{100} = 69 cfs)** where a 36" RCP storm stub will be provided. This storm stub will then also outfall directly into the proposed Pond FSD-11B.

The 2018 MDDP presented a total inflow to this facility of (Q_5 = 81.3 cfs, Q_{100} = 213.7 cfs) and an allowable release rate of (Q_5 = 4.5 cfs, Q_{100} = 69.6 cfs). The outlet pipe for this pond will outfall directly into Sand Creek just south of the Sterling Ranch Road crossing. Reference the "Final Design Report for Sand Creek Restoration", prepared by JR Engineering, LLC, dated September 2022 for the Sand Creek channel design documents. The total anticipated developed flows entering this facility are as follows. (See Appendix for MHFD-Detention pond design sheets):

<u>Detention Pond FSD-11B</u> (Full Spectrum EDB)
Total Tributary Acreage: 68.2 ac.
1.32 Ac.-ft. WQCV
3.36 Ac.-ft. EURV
2.66 Ac.-ft. 100-yr. Storage
7.34 Ac.-ft. Total ← 8.03 Ac. ft proposed
Total Peak In-flow (SWMM Model): Q_5 = 115 cfs, Q_{100} = 227 cfs
Pond Peak Design Release (MHFD Sheet): Q_5 = 1.9 cfs, Q_{100} = 44.2 cfs
Pre-development Release (MHFD Sheet): Q_5 = 1.9 cfs, Q_{100} = 84.4 cfs
(Ownership and maintenance by the Sterling Ranch East Metro District)

(Same comments as above)

Basin SC-1 (Q_5 = 2 cfs, Q_{100} = 6 cfs) is a small basin due west of the elementary school site that consists of mainly the eastern slope of the Sand Creek channel. No impervious development is proposed other than the required maintenance access road/trail as presented on the Sand Creek channel plans. At this time, this area is not anticipated to be captured and routed to a formal stormwater quality facility. However, given the minimal unconnected impervious area and sizeable receiving pervious are within this basin, the WQCV reduction = 100% with 0 untreated WQCV. (See Appendix)

After development of the Sterling Ranch East Preliminary Plan No. 1, the majority of the upstream tributary area of Basins EX-9, EX-9A and EX-10A is routed to proposed treatment facilities (Pond FSD-14A, Pond FSD-14B and FSD- 11B). The remaining portion of **Basin EX-9 (Q_5 = 2 cfs, Q_{100} =** 8 **fs)** is a small basin of 6.0 ac. that will remain undeveloped and continue to sheet flow in a southerly direction and exit along the south boundary at Design Point 6. These minor flows will combine with the previously described release from Pond FSD-14B through a proposed level spreader structure. The final design and construction timing of this facility will be detailed in a future Final Drainage Report for this area.

The remaining portion of **Basin EX-9A (Q_5 = 4 cfs, Q_{100} =** 16 **fs)** is a basin of 12.7 ac. that will remain undeveloped and continue to sheet flow in a southerly direction and exit along the south boundary at Design Point 6A. The pre-development flow at this location **Design Point 6A (Q_5 = 7 cfs, Q_{100} = 19 cfs).** Thus, the downstream corridor will continue to adequately handle these off-site flows.

The remaining portion of **Basin EX-10A (Q_5 = 18 cfs, Q_{100} = 50 cfs)** is a basin of 60.4 ac. that will remain undeveloped and continue to sheet flow in a southerly direction and exit along the south boundary at Design Point 7. The pre-development flow at this location **Design Point 7 (Q_5 = 110 cfs, Q_{100} = 249 cfs).** Thus, the downstream corridor will continue to adequately handle these off-site flows.

DETENTION / STORMWATER QUALITY FACILITES

As required, storm water quality measures will be utilized in order to reduce the amount of sediment, debris and pollutants that are allowed to enter Sand Creek. These features include but are not limited to Full Spectrum Detention Basins and temporary sediment basins. Site Planning and design techniques for urban areas that require detention will provide a Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume that will release the more frequent storms at a slower rate to help minimize the effects of development of the property. The proposed detention/SWQ facilities are to be private facilities with ownership and maintenance by the Sterling Ranch Metropolitan District.

SAND CREEK CHANNEL IMPROVEMENTS

As mentioned previously, the Sand Creek channel exists along the extreme westerly edge of this property. All required improvements to the Sand Creek channel adjacent to this property are described in a separate report prepared by JR Engineering, “Final Design Report for Sand Creek Restoration”, dated September 2022. Please reference this report for all adjacent creek improvement requirements and associated wetland mitigation plans and permitting within jurisdictional waters. CORE Consultants is the wetland consultant working with JR Engineering, LLC on this stretch of Sand Creek. They are coordinating the effort with the Corps. of Eng. for the required 404 permitting for all the proposed channel improvements. The two public roadway crossings of Sand Creek (Briargate Pkwy. and Sterling Ranch Road) are currently covered under a 404 permit (Action No. SPA-2015-00428-SCO) with the previous land owner dated February 2016. JR Engineering, LLC is also coordinating a CLOMR/LOMR for this stretch of Sand Creek that is adjacent to the site and defined as Reach SC-8 (south of Briargate Pkwy.) and SC-9 north of Briargate Pkwy.).

DRAINAGE CRITERIA

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014. General on-site and off-site basin design used for detention/SWQ basin sizing was calculated using the EPA Storm Water Management Model method (SWMM) Ver. 5.1. Rain Gage inputs based on City of Colorado Springs 2-hr. design storm distributions. Basin imperviousness of the particular land uses in accordance with Table 6-6. The Horton infiltration method used in basin modeling. Mile High Flood District (MHFD)-Detention spreadsheet Ver. 4.05 used for Preliminary Detention/SWQ design. (See Appendix)

The City of Colorado Springs/El Paso County DCM requires the Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls. The Four Step Process pertains to management of smaller, frequently occurring storm events, as opposed to larger storms for which drainage and flood control infrastructure are sized. Implementation of these four steps helps to achieve storm water permit requirements.

At this point (MDDP level design), this site generally adheres to this **Four Step Process** as follows:

1. **Employ Runoff Reduction Practices:** Proposed urban lot impervious area (roof tops, patios, etc.) will sheet flow across landscape areas (yards) and open space areas to slow runoff and increase time of concentration prior to being conveyed to the proposed public streets or detention facilities. This will minimize directly connected impervious areas within the project site. Water quality reduction will be employed for specific areas that are anticipated not able to be captured and routed to SWQ facilities.

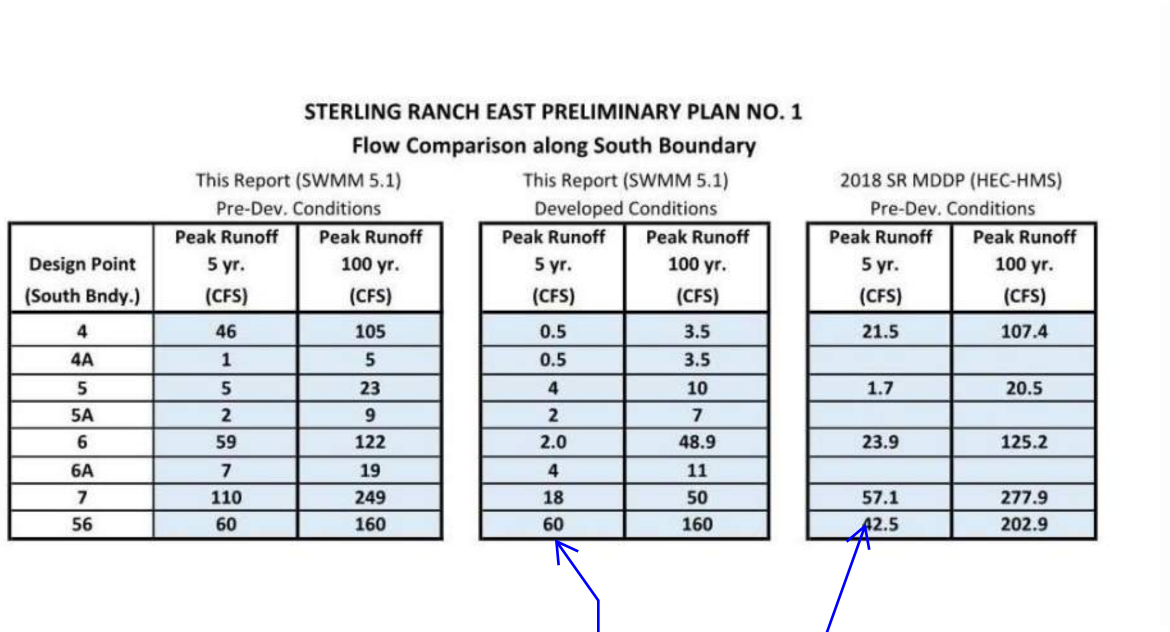
2. **Stabilize Drainageways:** After developed flows utilize the runoff reduction practices through the front and rear yards, developed flows will travel via curb and gutter within the public streets of the development and eventually public storm systems. These collected flows are then routed directly to multiple extended detention basins (full-spectrum facilities). Sand Creek improvements and restoration plans are being proposed for this entire reach as described in "Final Design Report for Sand Creek Restoration", prepared by JR Engineering, LLC, dated September 2022.

3. **Provide Water Quality Capture Volume (WQCV):** Runoff from this development will be treated through capture and slow release of the WQCV and excess urban runoff volume (EURV) in the proposed Full-Spectrum permanent Extended Detention Basins designed per current El Paso County drainage criteria.

4. **Consider need for Industrial and Commercial BMPs**: No industrial uses are proposed within this development. A site-specific storm water quality and erosion control plan and narrative will be submitted along with the grading and erosion control plan. Details such as site-specific sediment and erosion control construction BMP's as well as temporary and permanent BMP's were detailed in this plan and narrative to protect receiving waters. BMP's will be constructed and maintained as the development has been graded and erosion control methods employed.

The following is a comparison of flows along the south boundary at each individual Design Point. Visual inspection of these off-site drainage corridors downstream found no significant evidence of flooding, erosion or sediment transport. The various corridors seem more than adequate in handling the current pre-development flows. As seen from the comparison below, with the proposed development, re-routing of flows and the multiple on-site full spectrum ponds planned, these downstream corridors will experience less than historic rates and thus, continue to adequately handle the off-site flows proposed.

State that the manner of discharge will match existing conditions or easements will be obtained for any changes.



STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Flow Comparison along South Boundary

	This Report (SWMM 5.1) Pre-Dev. Conditions		This Report (SWMM 5.1) Developed Conditions		2018 SR MDDP (HEC-HMS) Pre-Dev. Conditions	
Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	46	105	0.5	3.5	21.5	107.4
4A	1	5	0.5	3.5		
5	5	23	4	10	1.7	20.5
5A	2	9	2	7		
6	59	122	2.0	48.9	23.9	125.2
6A	7	19	4	11		
7	110	249	18	50	57.1	277.9
56	60	160	60	160	42.5	202.9

Include discussion on DP's where developed 5-year flow is larger than 2018 MDDP 5-year flows

FLOODPLAIN STATEMENT

Portions of this site are located within a floodplain as determined by the Flood Insurance Rate Maps (F.I.R.M.) Map Numbers 08041C 0533G and 08041C 0535G with effective dates of December 7, 2018 and the previously mentioned LOMR 08-08-0541P with an effective date of July 23, 2009. (See Appendix). JR Engineering, LLC is coordinating a CLOMR/LOMR for this stretch of Sand Creek that is adjacent to the site and defined as Reach SC-8 (south of Briargate Pkwy.) and SC-9 north of Briargate Pkwy.)

DRAINAGE AND BRIDGE FEES

This site lies entirely within the Sand Creek Drainage Basin boundaries.

Fees are calculated using the following impervious acreage method approved by El Paso County. The final fee estimate will be included in the Final Drainage Report(s), however, the following represent fee estimates based on the Sterling Ranch East Preliminary Plan No. 1 submittal with a total area of 321.37 acres with the following different land uses proposed:

Development Parcel North of Briargate Pkwy.

11.98 Ac.	Sand Creek Corridor
8.83 Ac.	Open Space
63.93 Ac.	0.20 Ac. avg. lot size
84.74 Ac.	**Total**

Development Parcel South of Briargate Pkwy. / North of Sterling Ranch Rd.

28.99 Ac.	Sand Creek Corridor
34.40 Ac.	Open Space / Park / Pond
59.96 Ac.	0.18 Ac. avg. lot size
38.55 Ac.	School Site
161.90 Ac.	**Total**

Development Parcel South of Sterling Ranch Rd.

3.48 Ac.	Sand Creek Corridor
9.63	Open Space / Pond
39.83 Ac.	0.24 Ac. avg. lot size
9.93 AC.	1/2 AC. Lot size
11.86 Ac.	School Site
74.73 Ac.	**Total**

The percent imperviousness for this subdivision is calculated as follows:

Fees for Sand Creek Drainage Corridor

(Per El Paso County Percent Impervious Chart: 2**%**)

44.45 Ac. x 2% = **0.89 Impervious Ac.**

Fees for Detention Facilities & Park

(Per El Paso County Percent Impervious Chart: 7%)

52.86 Ac. x 7% = **3.70 Impervious Ac.**

Fees for 0.18 Ac. Avg. lots

(Per El Paso County Percent Impervious Chart: 46%)

59.96 Ac. x 46% = **27.58 Impervious Ac.**

Fees for 0.20 Ac. Avg. lots

(Per El Paso County Percent Impervious Chart: 43%)

63.93 Ac. x 43% = **27.49 Impervious Ac.**

Fees for 0.24 Ac. Avg. lots

(Per El Paso County Percent Impervious Chart: 41%)

39.83 Ac. x 41% = **16.33 Impervious Ac.**

Fees for 1/2 Ac. Avg. lots

(Per El Paso County Percent Impervious Chart: 25%)

9.93 Ac. x 25% = **2.48 Impervious Ac.**

Fees for School Site

(Per El Paso County Percent Impervious Chart: 70%)

50.41 Ac. x 70% = **35.29 Impervious Ac.**

Total Impervious Acreage: 111.28 Imp. Ac.

The following calculations are based on the 2022 Sand Creek drainage/bridge fees:

ESTIMATED FEE TOTALS:

Bridge Fees

$ 8,923.00 x 111.28 Impervious Ac. = **$ 992,951.44**

Drainage Fees

$ 21,814.00 x 111.28 Impervious Ac. = **$ 2,427,461.92**

SUMMARY

The proposed Sterling Ranch East Preliminary Plan No. 1 is within the Sand Creek Drainage Basin. Recommendations are made within this report concerning necessary improvements that will be required as a result of development of this property. The points of storm water release from the proposed site are required to be at or below the calculated historic flow quantities. The development of the proposed site does not significantly impact any downstream facility or property to an extent greater than that which currently exists in the pre-development conditions. All drainage facilities within this report were sized according to the Drainage Criteria Manuals and the full-spectrum storm water quality requirements.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

maw/118322/PDR.doc

REFERENCES

1. City of Colorado Springs/County of El Paso Drainage Criteria Manual as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014.

2. “Urban Storm Drainage Criteria Manual Volume 1, 2 & 3” Urban Drainage and Flood Control District, dated January 2016.

3. “Sand Creek Drainage Basin Planning Study,” Kiowa Engineering Corporation, dated March 1996.

4. “2018 Sterling Ranch MDDP”, M&S Civil Consultants, Inc., June 2018

5. “Final Drainage Report for Retreat at TimberRidge Filing No. 1”, Classic Consulting, approved November, 2020.

6. “Final Drainage Report for Retreat at TimberRidge Filing No. 2”, Classic Consulting, dated March, 2022

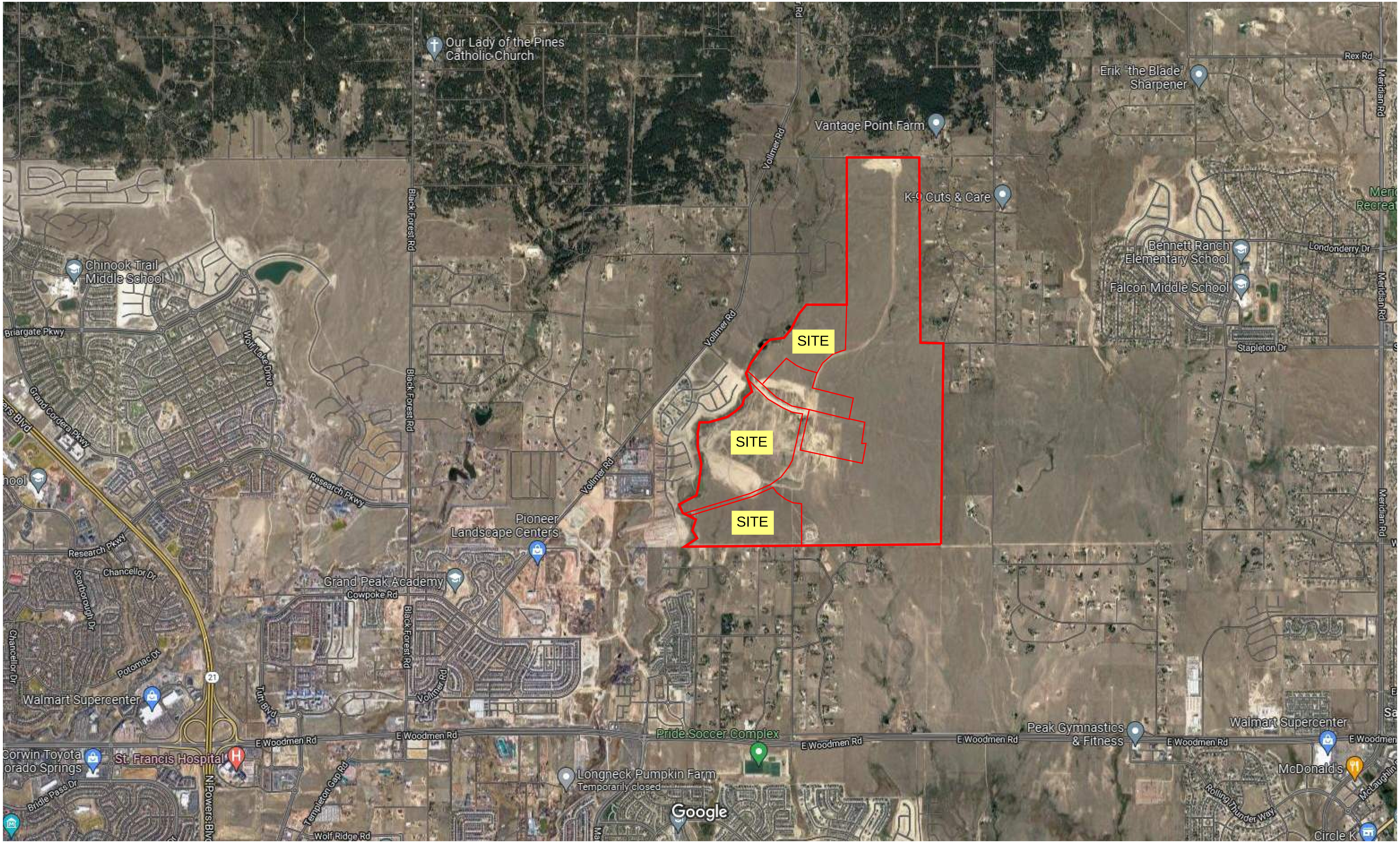
7. “Final Design Report for Sand Creek Restoration”, JR Engineering, LLC, dated September 2022

8. “Drainage Letter for Sterling Ranch Road and Briargate Pkwy. Interim Plan”, prepared by JR Engineering, LLC, dated September 2022

9. “Master Development Drainage Plan Amendment for Sterling Ranch”, prepared by JR Engineering, LLC, dated September 2022

APPENDIX

VICINITY MAP

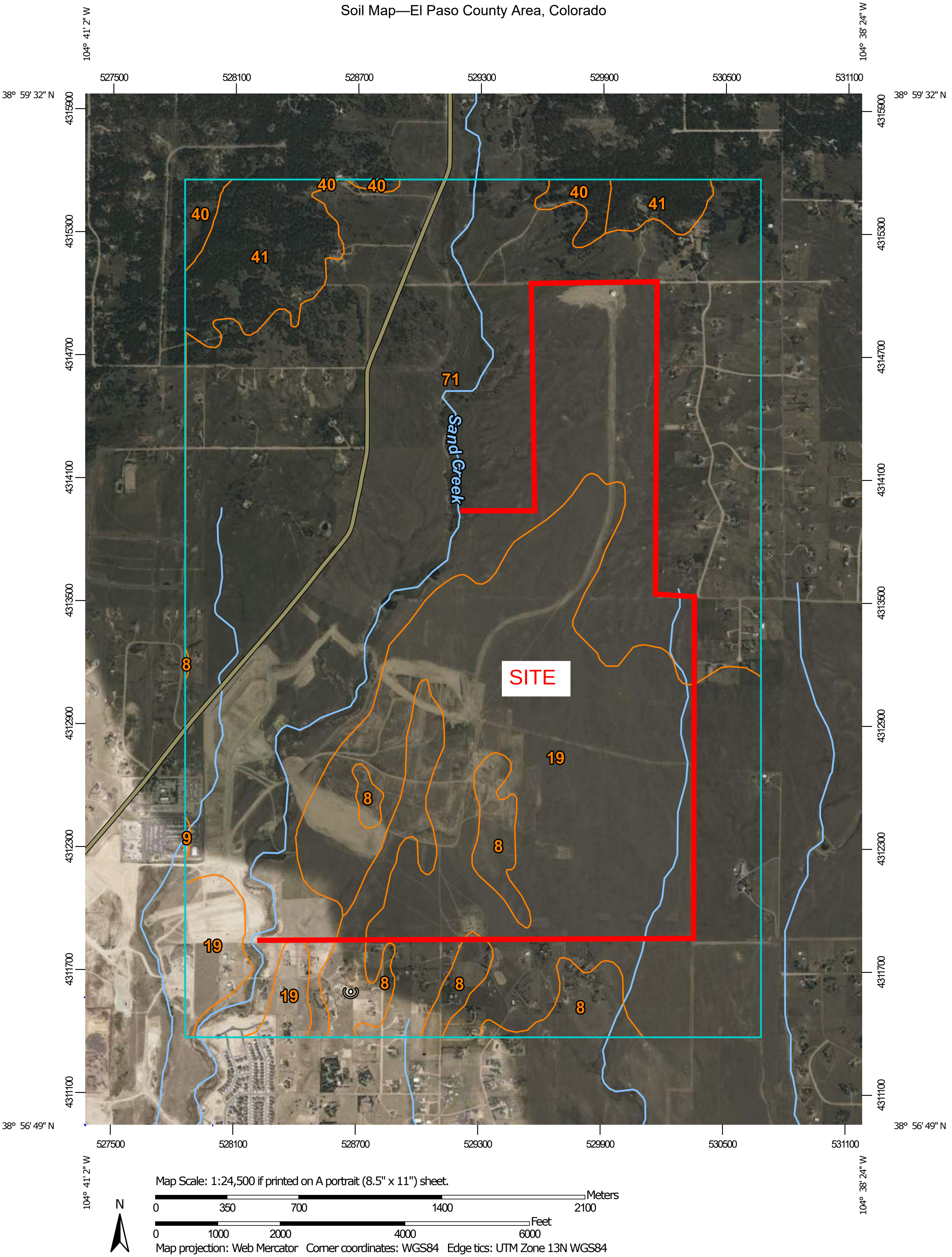


Imagery ©2022 Landsat / Copernicus, Maxar Technologies, USDA/FPAC/GEO, Map data ©2022 2000 ft

VICINITY MAP

SOILS MAP (S.C.S SURVEY)

Soil Map—El Paso County Area, Colorado



Map Scale: 1:24,500 if printed on A portrait (8.5" x 11") sheet.

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- ☐ Soil Map Unit Polygons
- Soil Map Unit Lines
- ■ Soil Map Unit Points

Special Point Features

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Aug 19, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	171.3	5.8%
9	Blakeland-Fluvaquentic Haplaquolls	1.0	0.0%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	982.6	33.5%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	33.7	1.2%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	135.2	4.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	1,605.2	54.8%
Totals for Area of Interest		**2,929.0**	**100.0%**

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

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

Map Unit Composition

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

Description of Blakeland

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

Minor Components

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Flood plains, fan terraces, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent

Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
Hydric soil rating: No

Minor Components

Pleasant

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

Other soils

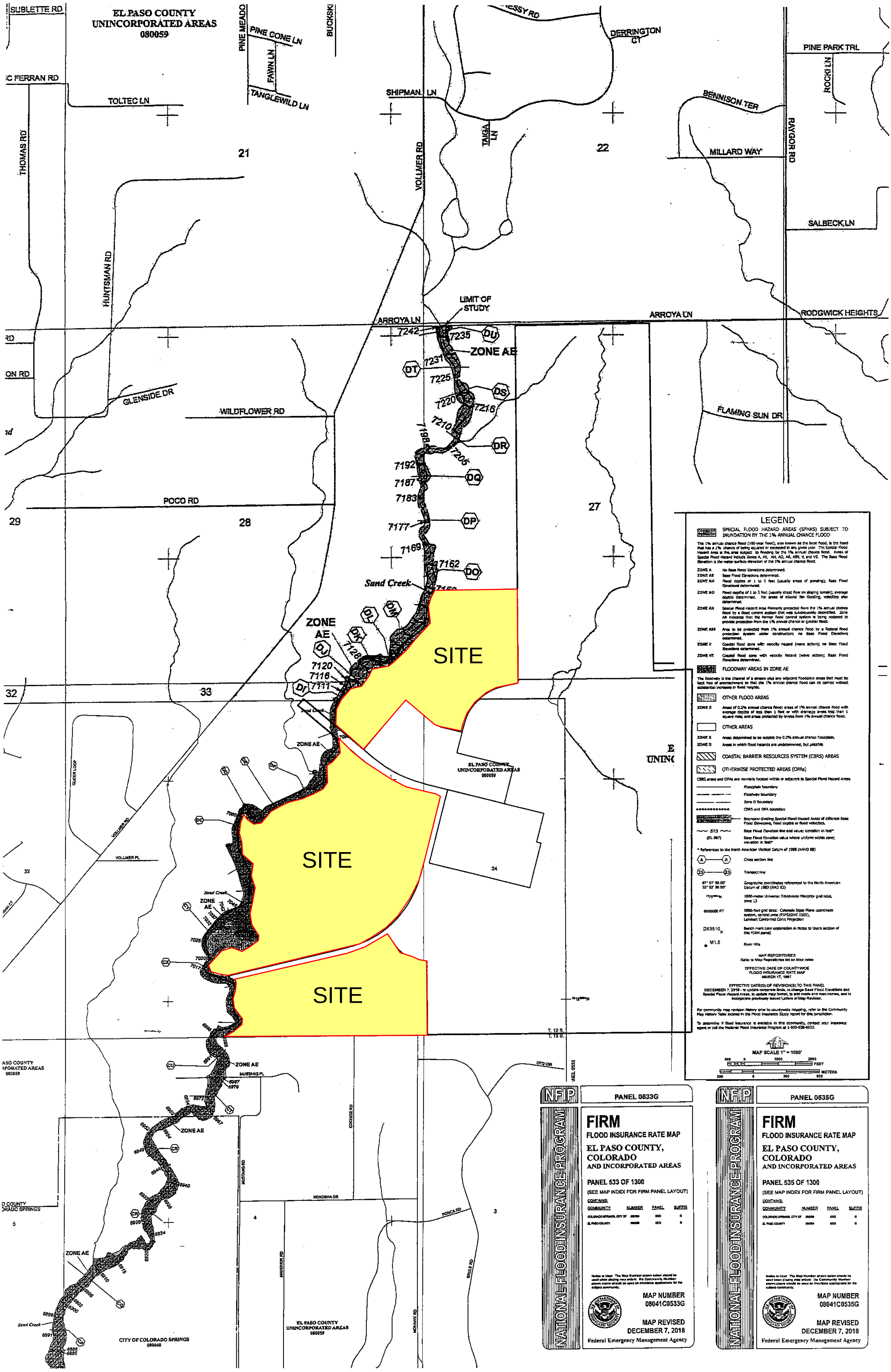
Percent of map unit:
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

F.E.M.A. MAP / LOMR (08-08-0541P)

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS



LEGEND

▨ SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▨ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

▨ COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

▨ OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

———	Floodplain boundary
— — —	Floodway boundary
— —	Zone D Boundary
••••••••••	CBRS and OPA boundary
▨	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~ 513 ~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

Ⓐ——Ⓐ	Cross section line
㉓——㉓	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000 N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0533G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 533 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0533	G
EL PASO COUNTY	080059	0533	G

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0533G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0535G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 535 OF 1300
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0535	G
EL PASO COUNTY	080059	0535	G

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0535G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Page 1 of 4	**Issue Date: March 6, 2009**	**Effective Date: July 23, 2009**	**Case No.: 08-08-0541P**	LOMR-APP

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		**PROJECT DESCRIPTION**	**BASIS OF REQUEST**
COMMUNITY	**El Paso County** **Colorado** **(Unincorporated Areas)**	**NO PROJECT**	**HYDRAULIC ANALYSIS** **NEW TOPOGRAPHIC DATA**
	COMMUNITY NO.: 080059		
IDENTIFIER	Sand Creek Letter of Map Revision, Mustang Place to Arroya Lane	**APPROXIMATE LATITUDE & LONGITUDE: 38.971, -104.668** **SOURCE:** USGS QUADRANGLE **DATUM:** NAD 27	

ANNOTATED MAPPING ENCLOSURES	**ANNOTATED STUDY ENCLOSURES**
TYPE: FIRM* NO.: 08041C0535 F DATE: March 17, 1997	DATE OF EFFECTIVE FLOOD INSURANCE STUDY: August 23, 1999 PROFILE(S): 204P(a), 204P(b), 204P(c) AND 204P(d) FLOODWAY DATA TABLE: 5

Enclosures reflect changes to flooding sources affected by this revision.
* FIRM - Flood Insurance Rate Map; ** FBFM - Flood Boundary and Floodway Map; *** FHBM - Flood Hazard Boundary Map

FLOODING SOURCE(S) & REVISED REACH(ES)

Sand Creek - from approximately 360 feet downstream of Mustang Place to just downstream of Arroya Lane

SUMMARY OF REVISIONS

Flooding Source	**Effective Flooding**	**Revised Flooding**	**Increases**	**Decreases**
Sand Creek	Zone A	Zone AE	YES	YES
	No BFEs*	BFEs	YES	NONE
	No Floodway	Floodway	YES	NONE

* BFEs - Base Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

We provide the floodway designation to your community as a tool to regulate floodplain development. Therefore, the floodway revision we have described in this letter, while acceptable to us, must also be acceptable to your community and adopted by appropriate community action, as specified in Paragraph 60.3(d) of the NFIP regulations.

COMMUNITY REMINDERS

We based this determination on the 1-percent-annual-chance flood discharges computed in the FIS for your community without considering subsequent changes in watershed characteristics that could increase flood discharges. Future development of projects upstream could cause increased flood discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on flood discharges subsequent to the publication of the FIS report for your community and could, therefore, establish greater flood hazards in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine D. Petterson
Director, Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

STATUS OF THE COMMUNITY NFIP MAPS

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

PUBLIC NOTIFICATION OF REVISION

PUBLIC NOTIFICATION

FLOODING SOURCE	LOCATION OF REFERENCED ELEVATION	BFE (FEET NGVD 29)		MAP PANEL NUMBER(S)
		EFFECTIVE	REVISED	
Sand Creek	Just upstream of Mustang Place	None	6,984	08041C0535 F
	Just downstream of Arroya Lane	None	7,238	08041C0535 F

Within 90 days of the second publication in the local newspaper, a citizen may request that we reconsider this determination. Any request for reconsideration must be based on scientific or technical data. Therefore, this letter will be effective only after the 90-day appeal period has elapsed and we have resolved any appeals that we receive during this appeal period. Until this LOMR is effective, the revised BFEs presented in this LOMR may be changed.

A notice of changes will be published in the *Federal Register*. A short notice also will be published in your local newspaper on or about the dates listed below. Please refer to FEMA's website at https://www.floodmaps.fema.gov/fhm/Scripts/bfe_main.asp for a more detailed description of proposed BFE changes, which will be posted within a week of the date of this letter.

LOCAL NEWSPAPER
Name: *El Paso County News*
Dates: 03/18/09 03/25/09

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

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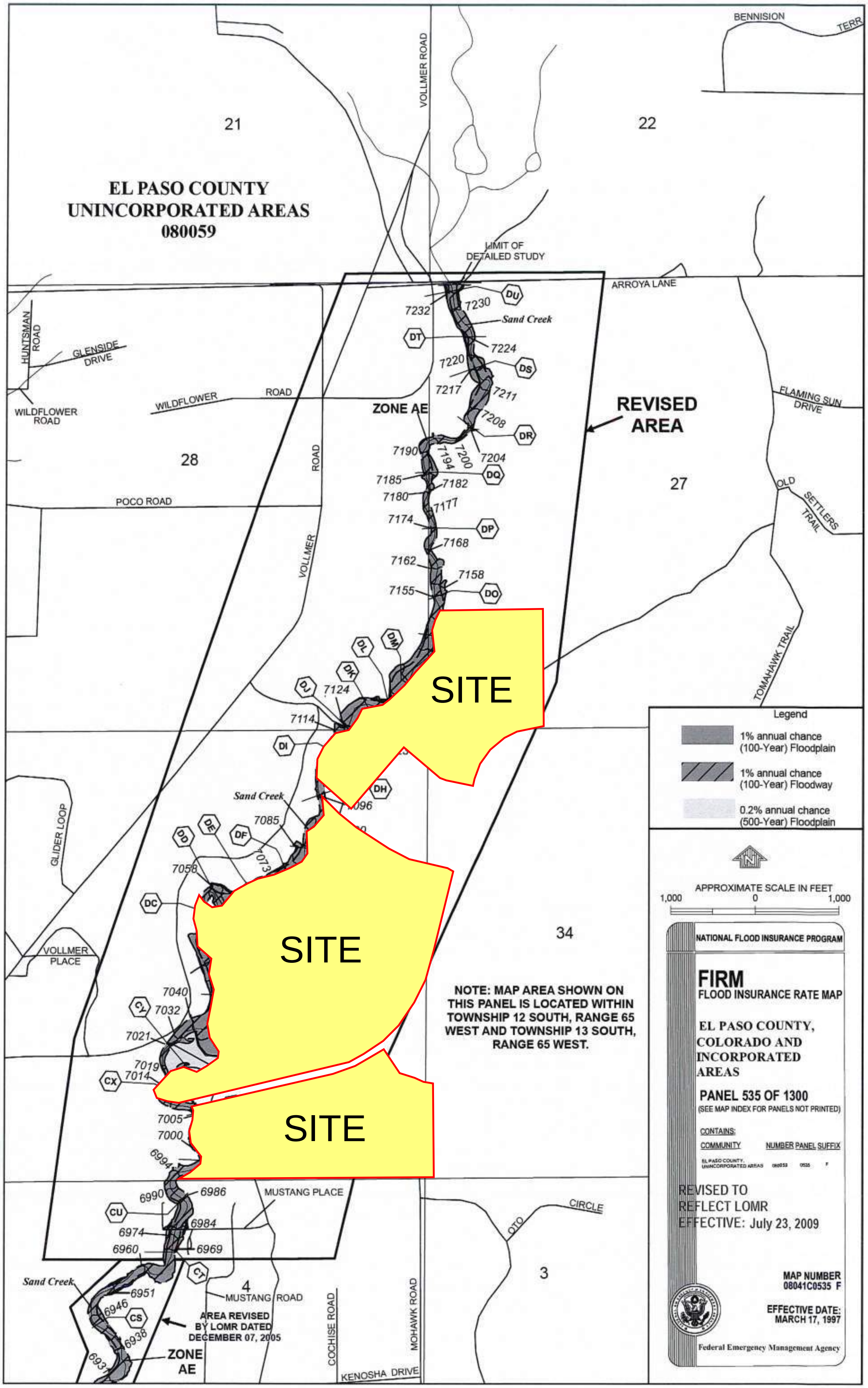
Mitigation Directorate


EL PASO COUNTY
UNINCORPORATED AREAS
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21
22
28
27
34
3
4
BENNISION
TERR
VOLLMER ROAD
LIMIT OF DETAILED STUDY
ARROYA LANE
HUNTSMAN ROAD
GLENSIDE DRIVE
WILDFLOWER ROAD
WILDFLOWER ROAD
POCO ROAD
VOLLMER ROAD
FLAMING SUN DRIVE
OLD SETTLERS TRAIL
TOMAHAWK TRAIL
GLIDER LOOP
VOLLMER PLACE
MUSTANG PLACE
MUSTANG ROAD
CIRCLE
OTO
COCHISE ROAD
MOHAWK ROAD
KENOSHA DRIVE
REVISED AREA
ZONE AE
ZONE AE
Sand Creek
Sand Creek
Sand Creek
SITE
SITE
SITE
7232
7230
DU
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7224
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7005
7000
6994
6990
6986
CU
6984
6974
6969
6960
CT
6951
6946
CS
6938
6931
AREA REVISED BY LOMR DATED DECEMBER 07, 2005
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.
Legend
1% annual chance (100-Year) Floodplain
1% annual chance (100-Year) Floodway
0.2% annual chance (500-Year) Floodplain
APPROXIMATE SCALE IN FEET
1,000
0
1,000
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS
PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY
NUMBER
PANEL
SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS
0535
F
REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009
MAP NUMBER 08041C0535 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

REFERENCE MATERIAL

MASTER DEVELOPMENT DRAINAGE PLAN FOR STERLING RANCH

OCTOBER 2018

Prepared for:

Morley-Bentley Investments, LLC
20 Boulder Crescent, 2^{nd} Floor
Colorado Springs, CO 80903
(719) 471-1742

Prepared by:

M&S
CIVIL CONSULTANTS, INC.

20 Boulder Crescent, Suite 110
Colorado Springs, CO 80903
(719) 955-5485

Project #09-002
SKP-18-003
SF-17-024

at DP87 culminating in peak runoff rates within Sand Creek of Q5 = 374.6 cfs, Q100 = 1905.9 cfs.

Basin SC3-16A (Q5 = 120.4 cfs, Q100 = 351.8 cfs) consists of a 168.1 acre area located within Sterling Ranch, that is located north of Briargate Parkway and east of Sand Creek Channel. This portion of Sterling Ranch is planned to house residential development that ranges from low density rural lots 1 acres in size to medium density urban residential with lots ranging in size from 0.1 to 0.2 acres. Runoff from the basin shall be collected and conveyed within street and storm sewer systems to a full spectrum detention pond (FSD16A), at the northwest corner of Briargate Parkway and Sterling Ranch Road. The treated detained flows from the pond will discharge to DP22 at peak flow rates of 8.8 cfs and 128.3 cfs in the 5 and 100 year events respectively.

Basin SC3-16B (Q5 = 53.7 cfs, Q100 = 143.8 cfs) consists of a 50.7 acre area located within Sterling Ranch, that is located north of Briargate Parkway and east of Sand Creek Channel. This portion of Sterling Ranch is planned for a low to medium density residential lots ranging in size from 0.1 to 0.2 acres lots and portions of roadways. Runoff from the basin shall be collected and conveyed within street and storm sewer systems to a full spectrum detention pond (FSD16B), at the northeast corner of Briargate Parkway and Sterling Ranch Road. The treated detained flows from the pond will discharge to DP22 at peak flow rates of 0.4 cfs and 28.1 cfs in the 5 and 100 year events respectively. The combined peak flow rates from SC3-16B and FSD14A (DP22, Q5=8.8 cfs and Q100=174.9 cfs) will be conveyed south via storm sewer system to DP21.

Basin SC3-14B (Q5 = 34.3 cfs, Q100 = 94.1 cfs) consists of a 34.7 acre area located within of Sterling. Ranch, that is located between south of Briargate Parkway and east of Sterling Ranch Road, east of Sand Creek. This portion of Sterling Ranch is planned for a low to medium density residential lots ranging in size from 0.1 to 0.33 acres lots and portions of roadways. Runoff from the basin shall be collected and conveyed within street and storm sewer systems to a full spectrum detention pond (FSD14B), at the south end of the basin. The treated detained flows from the pond will discharge to DP21 at peak flow rates of 0.3 cfs and 19.3 cfs in the 5 and 100 year events respectively. The combined peak flow rates from DP22 and FSD14B (DP21, Q5=8.8 cfs and Q100=174.9 cfs) will be conveyed to Pond W3 above the intersection of Sand Creek channel and Sterling Ranch Road.

Basin SC3-14A (Q5 = 175.4 cfs, Q100 = 466.3 cfs) consists of a 164.9 acre area located within of Sterling. Ranch, that is located between south of Briargate Parkway and east of Sterling Ranch Road, east of Sand Creek. This portion of Sterling Ranch is planned for a k-8 school site, several single family residential lots ranging in size from 0.2 to 0.33 acres lots as well as portions of park and open space. Runoff from the basin shall be collected and conveyed within street and storm sewer systems and directed to a full spectrum detention pond (FSD14A), at the southwest corner of the basin. The treated detained flows from the pond will discharge to Pond W3 at peak flow rates of 7.5 cfs and 142.2 cfs in the 5 and 100 year events respectively.

Basin SC3-13 (Q5 = 57.8 cfs, Q100 = 136.9 cfs) consists of a 41.0 acre area located within of Sterling. Ranch, that is located just the east of the Barbarick Subdivision and north of Sterling Ranch Road. This portion of Sterling Ranch is planned for residential lots ranging in size from 0.1 to 0.2 acres in size. Runoff from the basin shall be collected by storm sewer systems and conveyed to a full spectrum detention pond (FSD13) located in the south end of the basin, adjacent to sand creek. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 4.2 cfs and 47.2 cfs in the 5 and 100 year events respectively.

Runoff from DP87, DP21 and from FSD Ponds 13, and 14A will combine within the Sand Creek Channel at proposed Regional Pond Detention Facility W3. The purpose of the regional pond is to reduce the post development flow rates within the Sand Creek Channel at the Southern Sterling Ranch boundary to at or below the existing flow rates calculated by this report. The pond is also necessary due to the drainage basin diversion, as discussed in other parts of this report. The total combined discharge reaching the regional facility (Pond W-3) has been calculated at 374.5 cfs and 2204.1 cfs in the 5 and 100 year events respectively.

As conceptually designed the proposed facility will utilize a check/diversion wall located upstream of the existing stock pond and proposed detention facility that will function to divert base flows within the channel to aid in retaining a fixed water surface within the existing stock pond and in larger storm events diverted flows safely around the amenity to the west side to detention Pond W3. A small controlled outlet structure along with an improved downstream embankment will be added to the existing stock pond to stabilize it and retain a fixed maximum water surface elevation. In the larger detention pond eight (8) small 24” storm sewer pipe located within a separate embankment will allow for free flow discharge of 2 year runoff and begin to detain flows of 5 years and larger events. Flows exiting the small storm pipes or overtopping the separated embankment will enter a concrete forebay that conveys drainage to two (2) cell 8’h x10’w concrete box culvert (CBC) under Proposed Sterling Ranch Road to DP68. As the anticipated flow rate leaving the pond is planned to be less than 1,500 cfs, and the proposed culvert crossing is conceptually planned to have an open area of less than 200 ft sq of open area and thus will need to meet the headwater requirements of Table 6-5 of the DCM, which in this concept design is a ratio of about ~1.3. The total combined discharge calculated to leave the regional facility (Pond W-3) has been calculated at 200.3 cfs and 1,350.6 cfs in the 5 and 100 year events respectively, with a maximum 100 year water surface of 7017.3, a

HW/D ratio of ~1.3. The peak detained volume has been estimated at 78.2 ac-ft. A low point in Sterling Ranch Road will be designed adjacent to the facility to provide a safe overflow route. An exhibit showing the concept design and its various elements is included in the appendix of this report.

As previously discussed a Condition Letter of Map Revision and Letter of Map Revision (CLOMR/LOMR) will need to be processed through the Federal Emergency Management Agency (FEMA) to revise the hydrology to the Sand Creek Channel and allow for the remapping of the revised floodplains. It should be noted that the DBPS flow rates for Reach SC-8 (Reach 163) adjacent to this location were estimate to be 2,630 cfs and that the effective FEMA 100 year flow rate is 2,600cfs. A comparison table of the various flow rates is provided later in this text and on the accompanying drainage maps.

The final design of the culvert crossing and final determination of approved rates as well as the final pond design will be discussed within the future Sterling Ranch Channel Design Report and Sand Creek CLOMR/LOMR documents. No deviations for this pond and accompanying outlet structure are anticipated at this time.

It is important to note that the planned discharge outlet pipe for the FSD pond located to the west of the pond W3 will need to be extended to the downstream outlet side of the culvert to ensure that the 100 year water surface elevation with W3 does not affect the functionality of the adjacent FSD and its storm sewer systems.

In regards to timing, the need to construction this facility can be tied to the Sand Creek Channel improvements which is discussed within this report and also within the Subdivision Improvements Agreement. In no case should runoff from the East Fork of Sand Creek be diverted to the Main Branch of the Sand Creek Channel prior to the construction and of this facility.

Basin SC3-11A (Q5 = 7.8 cfs, Q100 = 24.3 cfs) consists of a 10.7 acre area located within of Sterling. Ranch, that is south of Sterling Ranch Road, west of Sand Creek. This portion of Sterling Ranch consists of single family residential for lots ranging in size from 0.2 to 0.3 acres in size and open space associated with the Sand Creek Channel. Runoff from the developed portion of the basin shall be collected and conveyed within street and storm sewer systems to a full spectrum detention pond FSD11A. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 0.9 cfs and 12.3 cfs in the 5 and 100 year events respectively just upstream of DP-63. It should be noted that this detention facility may not be necessary if grading can be oriented to force surface runoff to the west.

Basin SC3-11B (Q5 = 81.3 cfs, Q100 = 213.7 cfs) consists of a 76.6 acre area located within of Sterling. Ranch, that is south of Sterling Ranch Road, east of Sand Creek. This portion of Sterling Ranch consists of single family residential planned for lots ranging in size from 0.2 to 0.3 acres in size and a portion of a park site and collector roadways. Runoff from the developed portion of the basin shall be collected and conveyed within street and storm sewer systems westward to a full spectrum detention pond FSD11B. The treated detained flows from the pond will discharge into Sand Creek at peak flow rates of 4.5 cfs and 69.5 cfs in the 5 and 100 year events respectively. The runoff from DP68 and from FSD ponds 11A and 11B combine at DP63 at peak flow rates of Q5 = 201.0 cfs, Q100 = 1385.1, which is less than the anticipated existing modeled flow rates of Q5 = 430.7 cfs, Q100 = 1911.5 at DP63. Runoff from DP63 continues south within the Sand Creek Channel toward DP61.

Basin SC3-7 (Q5 = 69.9 cfs, Q100 = 157.2 cfs) consists of a 45.7 acre industrial zoned area, referred to as the Barbarick Subdivision, located outside of Sterling Ranch. Per the Final Drainage Report for Barbarick Subdivision, Portions of Lots 1, 2 and Lots 3and 4 the filing consists of four lots which upon which development will be constructed which will include adding a proposed Extended Detention Basin within Lot 4. This detention basin will provide water quality treatment for portions of Lots 1 & 2, and Lots 3 & 4. The EBD will structure will outfall at the south end of Lot 4 at the Barbarick Subdivision/Sterling Ranch property line. Per the report the proposed total outflow from the EDB pond will be Q5 = 0.3 cfs, Q100 = 45.9** cfs(**which includes pass through flows of 29.4 cfs). A second Sand Filter Basin water quality detention catchment will be provided at the southeast/downstream end of Lot 2. The SFB will outfall at the southeast corner of the Lot 2 at the Barbarick Subdivision/Sterling Ranch property line. Per the report the proposed total outflow the SFB pond will be Q5 = 0.1 cfs, Q100 = 3.6 cfs. At the initial writing of this report, neither EDB nor SFB structure has been fully constructed, and thus the assumption was made to utilize the full un-detained untreated runoff from the offsite development for onsite drainage planning purposes. Thus the downstream facilities planned within Sterling Ranch will account for the total un-detained runoff from the parcel of Q5 = 69.9 cfs, Q100 = 157.2 cfs and will plan to treat the total runoff onsite facilities. This provides a conservative approach for master planning. Runoff discharged from the property will be collected by proposed storm sewer within Sterling Ranch and routed to DP64. These facilities and their effects on drainage will be re-reviewed with subsequent drainage report and shall be implemented into final design and construction.

Basin SC3-6B (Q5=43.4 cfs, Q100=102.7 cfs) consists of a 30.9 acre area located within of Sterling Ranch, that is north of Sterling

(Excerpt from 2018 Sterling Ranch MDDP, M&S Civil Consultants, Inc.)

Step 2 **Implement BMPs that provide a water quality capture volume with slow release.** – Using Full Spectrum Detention Facilities which will incorporate water quality capture volumes that are intended to slowly drain in 40 hours and excess urban runoff volumes that are intended to drain within 72 hours. All storage facilities will be designed to meet State Statue SB15-212/ §37-92-602(8).

Step 3 **Stabilize streams.** – With the full spectrum detention facility in place, the runoff from the developments will be reduced to predevelopment conditions. The developed discharge from the sites will be less than existing and therefore is not anticipated to have negative effects on downstream drainage ways.

Step 4 **Consider need for Industrial and Commercial BMPs.** – No industrial land uses are proposed with this development. The proposed commercial development area will implement a Stormwater Management Plan (SWMP) incorporation proper housekeeping procedures. Onsite drainage will be routed through private Full Spectrum Detention (FSD) basins to minimize introduction of contaminates to the county's public drainage systems.

INTERBASIN TRANSFER EAST FORK SAND CREEK TO MAIN STEM SAND CREEK

It should be noted that the proposed development plan for the ~1444 acre of Sterling Ranch redistributes a small percentage of the historic watershed between the Sand Creek and East Fork of Sand Creek watershed.

Based upon the survey and contour mapping, prior to development approximately 682 acres of Sterling Ranch runoff was collected by the Sand Creek watershed with the remaining 762 acres was directed to the East Fork of Sand Creek.

After development approximately 267 acres will be redirected from the East Fork Sand Creek into the Sand Creek Basin, resulting in 949 acres of Sterling Ranch directed to the Sand Creek Basin with the remaining 495 acres directed to East Fork Sand Creek.

This modification is driven primarily by maximizing the area of land that can be delivered to the sanitary sewer lift station. It should be noted that the East Fork of Sand Creek is still tributary to the Main Branch of Sand Creek, and thus this transfer is between minor watersheds, not major watershed, and that the development as planned will still function to limit discharged runoff into Sand Creek and East Tributary to the historic flow rates. An exhibit was added to the appendix, which also accompanies the deviation request that shows this basin diversion.

It should be noted that the Developed Conditions Map (provided in the appendix) illustrated the diverted acreage based upon the DPBS mapped boundary(as mapped within the SCDBPS) and diversion based upon the actual field contour data.

Drainage Basin Descriptions

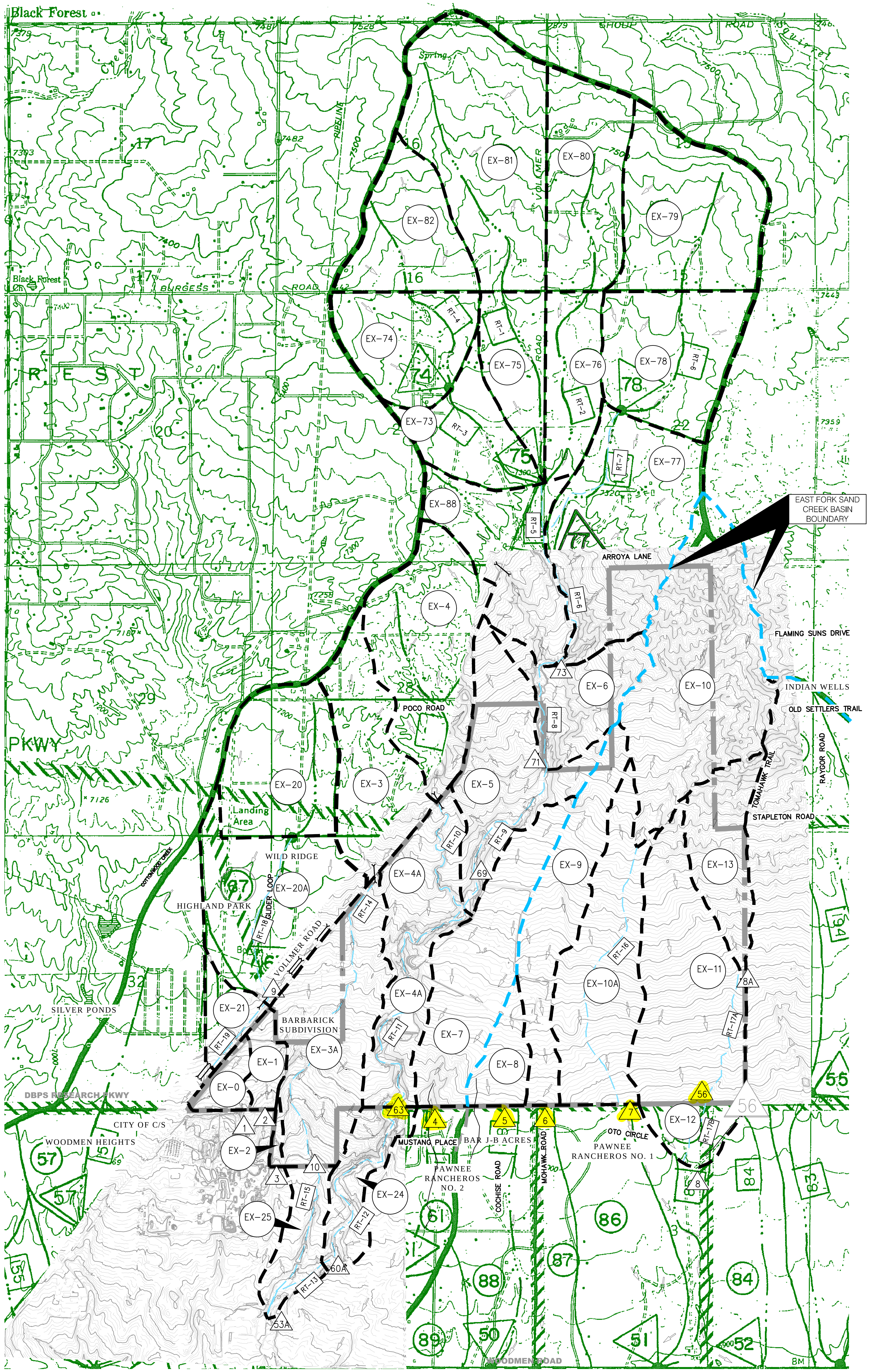
Developed Sand Creek (Main Stem) Basin Flows

Basin SC3-82 (Q5 = 33.2 cfs, Q100 = 132.3 cfs) which is located north of Sterling Ranch and Burgess Road to the east Basin SC3-81, assumes that the 117.8 is primarily undeveloped, pine forested land. In this undeveloped condition runoff from the basin continues south overland into Basin SC3-74.

Basin SC3-74 (Q5 = 36.5 cfs, Q100 = 140.7cfs) is a 119.7 acre area of 5 and 10-acre lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch and south of Burgess Road to the west and north of Basins SC3-73 and SC3-75. Runoff from Basins SC3-74 and SC3-82, combine at DP-74 (Q5 = 65.3 cfs, Q100 = 262.8 cfs), which is equivalent to the anticipated existing modeled flow rates of Q5 = 65.3 cfs, Q100 = 262.8 cfs.

Basin SC3-73 (Q5 = 26.4 cfs, Q100 = 102.0 cfs) is a 90.0 acre area of 5 to 40 acres lots covered with a mixture of native prairie grasses and pine trees land located north of Sterling Ranch to the northeast of Vollmer Road. Runoff from the Basin SC3-73 will combine with runoff from DP-74 and will continue overland towards DP-75.

Basin SC3-81 (Q5 = 70.2 cfs, Q100 = 275.7 cfs) which is located north of Sterling Ranch (approx 1 mile) between Shoup and Burgess Roads, assumes that the 262.9 acre area of primarily undeveloped, pine forested, land. In this undeveloped condition runoff from the basin continues south overland into Basin SC3-75.



0 600 1200 2400
Scale in Feet

LEGEND

BASIN ID – SC3-77

DESIGN POINT – 87

REACH IDENTIFIER – RT-17A

BASIN BOUNDARY – ▬ ▬ ▬

EAST FORK SAND CREEK BASIN BOUNDARY – ▬ ▬ ▬

FLOW DIRECTION – ⇨

BASIN SUMMARY

BASIN	CN	AREA (ACRES)	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)
EX-0	62	23.8	0.037	5.0	8.2	13.0	19.6	25.7	32.2
EX-1	62	25.7	0.040	4.8	7.9	12.4	18.7	24.5	30.9
EX-2	62	5.5	0.009	1.1	1.8	2.8	4.3	5.6	7.1
EX-3	62	136.8	0.214	22.0	36.4	57.6	86.9	114.0	143.1
EX-3A	61	188.1	0.294	28.3	47.4	75.7	115.1	152.2	192.6
EX-4	62	192.0	0.300	30.1	49.9	79.1	119.5	157.0	197.3
EX-4A	62	151.5	0.237	24.7	40.8	64.4	97.0	127.2	160.1
EX-5	62	153.9	0.240	24.2	40.0	63.4	95.9	125.9	158.2
EX-6	62	90.2	0.141	15.3	25.5	40.1	60.7	79.9	100.5
EX-7	56	165.0	0.258	11.6	21.5	37.5	60.9	83.1	107.4
EX-8	45	42.0	0.066	0.5	1.7	4.5	9.4	14.5	20.5
EX-9	54	131.9	0.206	12.2	23.9	43.1	70.9	97.0	125.2
EX-10	60	270.7	0.423	32.7	56.0	91.1	140.1	185.9	236.1
EX-10A	41	179.3	0.280	0.6	2.2	7.3	17.4	29.1	43.1
EX-11	43	209.3	0.327	18.0	29.8	47.7	73.4	98.3	126.1
EX-12	51	39.5	0.062	2.2	5.1	10.1	17.7	25.1	33.3
EX-13	55	89.3	0.139	7.7	15.2	27.1	44.2	60.5	78.4
EX-20	62	143.4	0.224	25.4	42.1	66.7	100.7	132.3	166.2
EX-20A	64	179.7	0.281	32.2	51.9	80.5	119.8	155.9	194.6
EX-21	65	33.3	0.052	8.6	13.5	20.7	30.5	39.4	49.0
EX-24	59	63.1	0.099	9.5	16.6	27.5	42.9	57.4	73.0
EX-25	43	54.4	0.085	0.3	1.5	4.8	10.7	17.2	25.1
EX-73	63	90.0	0.141	16.4	26.4	41.3	62.1	81.3	102.0
EX-74	63	119.7	0.187	22.3	36.5	57.3	85.9	112.3	140.7
EX-75	63	79.3	0.124	13.1	21.5	33.7	50.5	66.1	82.8
EX-76	63	86.4	0.135	14.2	23.1	36.4	54.6	71.4	89.6
EX-77	62	230.6	0.360	34.7	56.9	90.6	137.5	180.9	227.7
EX-78	63	155.6	0.243	28.1	45.3	70.6	106.2	139.1	174.5
EX-79	63	189.0	0.295	34.9	57.0	89.5	134.3	175.6	220.1
EX-80	63	147.7	0.231	27.3	44.3	69.6	104.5	136.8	171.4
EX-81	62	262.9	0.411	42.6	70.2	111.0	167.4	219.6	275.7
EX-82	62	117.8	0.184	20.0	33.2	52.8	80.0	105.1	132.3
EX-88	62	139.2	0.217	22.2	36.7	58.0	87.6	115.0	144.4

DESIGN POINT SUMMARY (PEAK FLOW)

DESIGN POINT	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)	LOCATION
DP-74	0.371	39.3	65.3	104.8	158.9	209.1	262.8	
DP-75	1.413	141.2	235.1	376.6	566.6	750.9	950.5	
DP-78	0.538	59.7	98.4	154.0	232.6	306.2	385.3	
DP-73	2.528	225.9	380.7	618.0	957.0	1260.4	1582.3	
DP-71	2.669	229.3	388.9	629.7	978.8	1277.3	1637.9	STERLING RANCH NORTHERN BNDRY
DP-69	3.209	253.0	434.8	707.7	1100.0	1453.3	1870.4	
DP-63	3.446	251.4	430.7	713.1	1113.2	1496.2	1911.5	STERLING RANCH SOUTHERN BNDRY
DP-10	0.508	36.5	56.0	106.4	162.9	220.6	287.2	COLORADO SPRINGS/EL PASO BNDRY
DP-9A	0.557	55.3	94.3	150.3	227.7	299.5	380.5	VOLLMER/TAHITI DRIVE
DP-9	0.505	52.8	88.8	142.1	214.2	281.0	351.4	VOLLMER/LOCHWINNOCH LN
DP-8A	0.139	7.7	15.2	27.1	44.2	60.5	78.4	D/S STERLING RANCH EASTERN BNDRY
DP-8	0.528	24.2	45.1	77.8	124.4	169.5	220.9	D/S STERLING RANCH SOUTHERN BNDRY
DP-7	0.703	32.4	57.1	97.3	156.1	213.8	277.9	STERLING RANCH SOUTHERN BNDRY
DP-6	0.206	12.2	23.9	43.1	70.9	97.0	125.2	STERLING RANCH SOUTHERN BNDRY
DP-5	0.066	0.5	1.7	4.5	9.4	14.5	20.5	STERLING RANCH SOUTHERN BNDRY
DP-4	0.258	11.6	21.5	37.5	60.9	83.1	107.4	STERLING RANCH SOUTHERN BNDRY
DP-3	0.009	1.1	1.8	2.8	4.3	5.6	7.1	STERLING RANCH SOUTHERN BNDRY
DP-2	0.040	4.8	7.9	12.4	18.7	24.5	30.9	STERLING RANCH SOUTHERN BNDRY
DP-1	0.037	5.0	8.2	13.0	19.6	25.7	32.2	STERLING RANCH SOUTHERN BNDRY
DP-60A	3.545	247.7	430.2	707.1	1113.0	1496.6	1913.5	FUTURE MARKSHEFFEL X-ING
DP-56	0.466	23.2	42.5	71.9	115.6	157.4	202.9	STERLING RANCH SOUTHERN BNDRY
DP-53A	4.138	262.1	454.0	763.2	1196.5	1609.8	2061.5	SAND CREEK AND POND 3

DESIGN POINT SUMMARY (VOLUME)

DESIGN POINT	AREA (SQ MI)	V_2 (AC-FT)	V_5 (AC-FT)	V_{10} (AC-FT)	V_{25} (AC-FT)	V_{50} (AC-FT)	V_{100} (AC-FT)	LOCATION
DP-74	0.371	5.9	9.0	13.6	19.8	25.5	31.6	
DP-75	1.413	22.7	34.5	51.7	75.4	97.1	120.5	
DP-78	0.538	8.9	13.5	20.1	29.3	37.7	46.7	
DP-73	2.528	40.4	61.5	92.1	134.3	173.1	214.9	
DP-71	2.669	42.5	64.9	97.1	141.6	182.5	226.6	STERLING RANCH NORTHERN BNDRY
DP-69	3.209	50.7	77.4	116.1	169.4	218.6	271.4	
DP-63	3.446	54.1	82.5	123.8	180.8	233.3	289.9	STERLING RANCH SOUTHERN BNDRY
DP-10	0.508	7.6	11.7	17.6	25.8	33.4	41.6	COLORADO SPRINGS/EL PASO BNDRY
DP-9A	0.557	9.3	14.1	21.1	30.7	39.4	48.8	VOLLMER/TAHITI DRIVE
DP-9	0.505	8.4	12.7	19.0	27.6	35.5	44.0	VOLLMER/LOCHWINNOCH LN
DP-8A	0.139	1.3	2.1	3.4	5.2	7.0	8.9	D/S STERLING RANCH EASTERN BNDRY
DP-8	0.528	4.4	7.0	11.1	16.8	22.3	28.4	D/S STERLING RANCH SOUTHERN BNDRY
DP-7	0.703	6.1	10.0	15.9	24.3	32.4	41.3	STERLING RANCH SOUTHERN BNDRY
DP-6	0.206	2.4	4.0	6.3	9.6	12.7	16.0	STERLING RANCH SOUTHERN BNDRY
DP-5	0.066	0.2	0.4	0.8	1.4	1.9	2.6	STERLING RANCH SOUTHERN BNDRY
DP-4	0.258	2.6	4.2	6.7	10.2	13.5	17.2	STERLING RANCH SOUTHERN BNDRY
DP-3	0.009	0.1	0.2	0.3	0.5	0.6	0.8	STERLING RANCH SOUTHERN BNDRY
DP-2	0.040	0.6	0.9	1.4	2.1	2.7	3.4	STERLING RANCH SOUTHERN BNDRY
DP-1	0.037	0.6	0.9	1.3	1.9	2.5	3.1	STERLING RANCH SOUTHERN BNDRY
DP-60A	3.545	55.3	84.4	126.4	184.8	238.5	296.6	FUTURE MARKSHEFFEL X-ING
DP-56	0.466	4.0	6.3	9.9	14.9	19.8	25.1	SAND CREEK AND POND 3
DP-53A	4.138	63.0	96.4	144.7	211.8	273.9	340.9	SAND CREEK AND POND 3

EFSC DBPS DESIGN POINT SUMMARY (PEAK FLOW)

DBPS DESIGN POINT	AREA (SQ MI)	Q_{10} (CFS)	Q_{100} (CFS)
DP-50	0.32	47.0	195.7
DP-51 (BASIN 86)	0.33	17.7	74.1
DP-52	1.67	80.5	456.5
DP-56	0.79	63.6	265.0

Values reported from SCDBPS
(DP 50, 51, 52 Not analyzed as a part of this study)
DBPS Reach 85(Basin91)=Q10=28.8cfs Q100=115.2cfs

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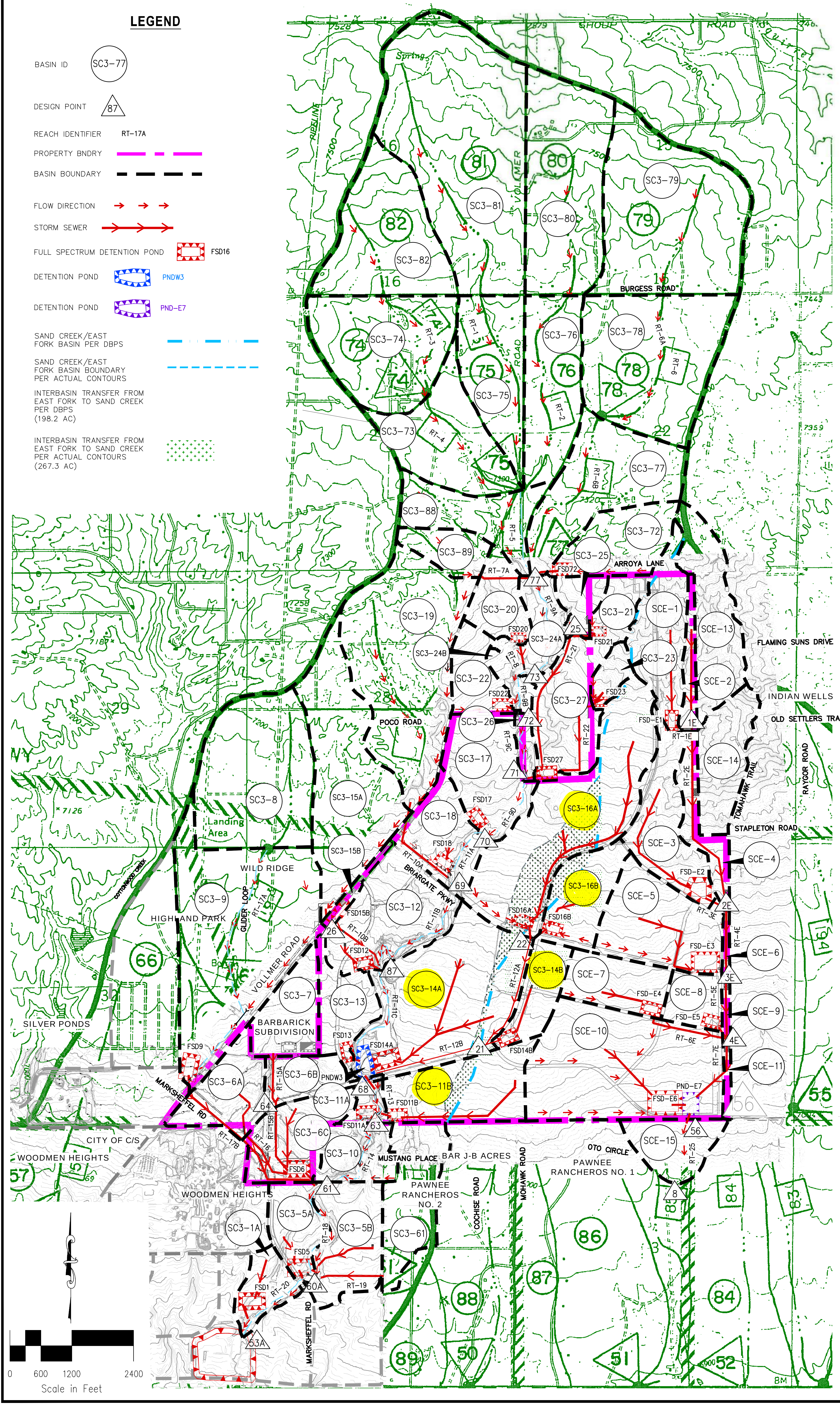
2018 STERLING RANCH MDDP
EXISTING HYDROLOGIC CONDITIONS MAP

PROJECT NO. 09-002
FILE: \dwg\Eng Exhibits\2018-MDDP-ExistCondWSWrkMap.dwg
DESIGNED BY: DLM
DRAWN BY: DLM
CHECKED BY: VAS
SCALE
HORIZ: NTS
VERT: NTS
DATE: 08-22-18
DM1



BASIN SUMMARY

BASIN	CN	AREA (ACRES)	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)
SC3-1A	73	27.8	0.044	16.3	23.3	33.0	45.8	57.1	68.9
SC3-5A	84	39.1	0.061	40.6	53.7	71.0	92.4	110.6	129.1
SC3-5B	81	63.0	0.098	53.8	73.0	98.5	130.8	158.6	187.0
SC3-6A	88	49.3	0.077	61.4	79.3	102.2	130.1	153.6	177.1
SC3-6B	85	30.9	0.048	32.9	43.4	57.0	73.9	88.2	102.7
SC3-6C	82	58.0	0.091	53.9	72.5	97.1	128.0	154.5	181.5
SC3-7	88	45.7	0.071	54.0	69.9	90.3	115.2	136.2	157.2
SC3-8	62	143.4	0.224	25.4	42.1	66.7	100.7	132.3	166.2
SC3-9	66	217.4	0.340	45.8	71.5	108.6	158.9	204.9	254.0
SC3-10	63	36.0	0.056	7.6	12.3	19.4	29.1	38.0	47.7
SC3-11A	70	10.7	0.017	5.3	7.8	11.3	15.9	20.0	24.3
SC3-11B	80	76.6	0.120	59.4	81.3	110.8	148.1	180.5	213.7
SC3-12	81	88.2	0.138	77.8	105.6	142.5	189.1	229.1	270.0
SC3-13	85	41.0	0.064	43.9	57.8	76.0	98.5	117.6	136.9
SC3-14A	79	164.9	0.258	127.6	175.4	239.8	321.9	393.2	466.3
SC3-14B	77	34.7	0.054	24.6	34.3	47.4	64.2	79.0	94.1
SC3-15A	62	139.7	0.218	21.3	35.5	56.3	85.3	112.1	141.0
SC3-15B	87	7.9	0.012	10.8	14.0	18.2	23.3	27.6	31.9
SC3-16A	74	168.1	0.263	84.4	120.4	170.0	234.8	292.2	351.8
SC3-16B	78	50.7	0.079	39.0	53.7	73.6	99.0	121.1	143.8
SC3-17	73	70.6	0.110	41.8	59.6	85.2	119.0	149.1	180.6
SC3-18	81	53.8	0.084	49.3	67.1	91.0	121.2	147.3	174.0
SC3-19	62	184.0	0.287	28.8	47.7	75.7	114.4	150.2	188.8
SC3-20	65	34.2	0.053	9.9	15.5	23.8	35.1	45.5	56.6
SC3-21	66	23.3	0.036	7.0	10.8	16.3	23.7	30.4	37.5
SC3-22	65	33.9	0.053	9.4	14.8	22.5	32.9	42.5	52.6
SC3-23	67	14.5	0.023	5.5	8.3	12.4	18.0	23.0	28.4
SC3-24A	65	35.7	0.056	13.0	20.4	31.1	45.7	59.0	73.2
SC3-24B	65	12.2	0.019	3.4	5.3	8.1	11.8	15.2	18.9
SC3-25	66	19.0	0.030	5.8	8.9	13.4	19.5	25.1	31.0
SC3-26	63	10.0	0.016	2.5	4.0	6.2	9.2	12.1	15.1
SC3-27	71	70.0	0.109	35.1	51.2	73.8	103.7	130.3	158.3
SC3-61	63	65.5	0.102	13.7	22.0	34.4	51.6	67.6	84.8
SC3-72	64	56.2	0.088	12.8	20.2	31.4	46.7	60.9	76.0
SC3-73	63	90.0	0.141	16.4	26.4	41.3	62.1	81.3	102.0
SC3-74	63	119.7	0.187	22.3	36.5	57.3	85.9	112.3	140.7
SC3-75	63	79.3	0.124	13.1	21.5	33.7	50.5	66.1	82.8
SC3-76	63	86.4	0.135	14.2	23.1	36.4	54.6	71.4	89.6
SC3-77	62	106.9	0.167	16.6	27.6	43.8	66.2	87.0	109.4
SC3-78	63	155.6	0.243	28.1	45.3	70.6	106.2	139.1	174.5
SC3-79	63	189.0	0.295	34.9	57.0	89.5	134.3	175.6	220.1
SC3-80	63	147.7	0.231	27.3	44.3	69.6	104.5	136.8	171.4
SC3-81	62	262.9	0.411	42.6	70.2	111.0	167.4	219.6	275.7
SC3-82	62	117.8	0.184	20.0	33.2	52.8	80.0	105.1	132.3
SC3-88	62	60.2	0.094	10.5	17.4	27.6	41.8	54.9	69.0
SC3-89	62	27.5	0.043	6.1	10	15.7	23.6	30.8	38.6
SCE-1	65	64.4	0.101	23.3	35.9	53.8	79.1	102.4	127.4
SCE-2	64	15.0	0.023	4.4	7.0	10.8	15.9	20.7	25.7
SCE-3	70	67.5	0.105	30.6	45.2	65.9	93.3	118.0	143.9
SCE-4	70	29.5	0.046	13.3	19.6	28.6	40.6	257.8	62.6
SCE-5	87	85.5	0.134	100.4	130.6	169.6	217.4	257.8	298.4
SCE-6	64	3.8	0.006	1.6	2.5	3.7	5.4	7.0	8.6
SCE-7	89	44.9	0.070	58.9	75.5	96.6	122.2	143.7	165.2
SCE-8	92	25.5	0.040	38.6	48.4	60.7	75.4	87.7	99.9
SCE-9	64	4.0	0.006	1.5	2.4	3.6	5.3	6.8	8.5
SCE-10	83	174.3	0.272	7.6	189.4	19.4	29.1	398.9	467.5
SCE-11	64	5.8	0.009	2.3	3.6	5.5	8.0	10.3	12.8
SCE-13	63	78.6	0.123	19.6	31.3	48.7	73.1	95.7	120.0
SCE-14	63	52.5	0.082	13.2	21.2	33.3	49.9	65.2	81.7
SCE-15	51	39.7	0.062	2.2	5.1	10.1	17.7	25.1	33.4

DESIGN POINT SUMMARY

DESIGN POINT	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)	LOCATION
DP-74	0.371	39.3	65.3	104.8	158.9	209.1	262.8	
DP-75	1.413	141.2	235.1	376.6	566.6	750.9	950.5	
DP-77	2.343	209.9	351.9	580.6	886.6	1168.4	1467.7	ARROYA LANE X-ING
DP-78	0.538	59.7	98.4	154.0	232.6	306.2	385.3	
DP-73	2.471	207.5	354.3	588.5	897.1	1187.2	1506.7	
DP-72	2.543	206.2	352.5	586.7	897.2	1195.3	1518.6	POCO ROAD X-ING
DP-71	2.757	205.9	349.3	610.5	932.4	1226.9	1612.2	STERLING RANCH NORTHERN BNDRY
DP-70	2.867	205.3	349.8	614.0	940.1	1260.6	1636.7	
DP-69	3.238	212.7	366.6	653.7	1010.6	1364.1	1775.7	BRIARGATE PARKWAY X-ING
DP-87	3.594	216.9	374.6	681.9	1072.1	1471.5	1905.9	
DP-68	4.312	214.6	374.5	714.9	1187.6	1674.9	2204.1	UPSTREAM OF POND W3
DP-64	0.119	85.9	112.1	145.9	187.5	222.6	258.0	
DP-63	4.449	154.4	201.0	375.7	815.9	1112.1	1385.1	STERLING RANCH SOUTHERN BNDRY
DP-61	5.356	156.6	223.9	428.0	928.2	1287.3	1620.1	COLORADO SPRINGS/EL PASO BNDRY
DP-60A	5.617	161.6	224.8	439.1	950.4	1320.5	1661.8	MARKSHEFFEL X-ING
DP-53A	5.661	161.6	225.7	441.8	951.1	1326.0	1668.9	SAND CREEK AND POND 3
DP-1E	0.247	23.9	38.3	70.1	132.8	173.0	220.9	
DP-2E	0.486	48.9	76.8	123.0	228.7	319.7	419.4	
DP-3E	0.626	48.5	75.7	122.2	271.1	387.1	500.1	
DP-4E	0.745	48.1	76.2	122.4	286.9	407.3	534.8	
DP-56	1.017	23.1	35.3	71.5	108.3	152.1	196.4	NEAR SE PROP CORNER
DP-8	1.079	24.1	37.2	73.5	111.3	155.4	200.7	BELOW SE PROP CORNER
DP-21	0.396	0.6	8.8	17.8	57.1	116.8	174.9	
DP-22	0.342	0.6	8.8	17.6	56.8	105.1	156.4	
DP-25	0.066	5.9	9.1	16.3	35.1	46.4	58.2	
DP-26	0.012	0.1	1.1	3.2	7.3	9.5	12.0	

DESIGN POINT SUMMARY (VOLUME)

DESIGN POINT	AREA (SQ MI)	V_2 (AC-FT)	V_5 (AC-FT)	V_{10} (AC-FT)	V_{25} (AC-FT)	V_{50} (AC-FT)	V_{100} (AC-FT)	LOCATION
DP-74	0.371	5.9	9.0	13.6	19.8	25.5	31.6	
DP-75	1.413	22.7	34.5	51.7	75.4	97.1	120.5	
DP-77	2.343	37.7	57.4	85.9	125.1	161.1	199.9	ARROYA LANE X-ING
DP-78	0.538	8.9	13.5	20.1	29.3	37.7	46.7	
DP-73	2.471	40.0	60.8	91.0	132.5	170.7	211.7	
DP-72	2.543	41.3	62.9	94.0	136.8	176.2	218.5	POCO ROAD X-ING
DP-71	2.757	46.3	70.0	104.3	151.3	194.5	240.8	STERLING RANCH NORTHERN BNDRY
DP-70	2.867	49.5	74.5	110.6	160.1	205.4	254.0	
DP-69	3.238	57.5	86.1	127.4	183.8	235.3	290.6	BRIARGATE PARKWAY X-ING
DP-87	3.594	66.5	98.9	145.6	209.1	267.1	329.1	
DP-68	4.312	81.8	123.7	183.9	264.9	338.0	415.8	UPSTREAM OF POND W3
DP-64	0.119	7.0	9.1	11.8	15.2	18.1	21.1	
DP-63	4.449	85.6	129.5	192.3	276.7	352.8	433.5	STERLING RANCH SOUTHERN BNDRY
DP-61	5.356	103.7	157.8	235.1	338.4	431.3	529.8	COLORADO SPRINGS/EL PASO BNDRY
DP-60A	5.617	111.0	168.6	250.4	359.5	457.7	561.5	MARKSHEFFEL X-ING
DP-53A	5.661	112.0	170.0	252.6	362.6	461.7	566.5	SAND CREEK AND POND 3
DP-1E	0.247	3.1	5.2	8.4	12.7	16.6	20.9	
DP-2E	0.480	6.1	10.4	16.9	25.7	33.7	42.2	
DP-3E	0.620	7.0	13.7	23.4	36.1	47.4	59.3	
DP-4E	0.736	7.6	15.6	27.2	43.0	57.2	72.0	
DP-56	1.017	7.7	16.1	28.6	51.3	71.7	92.9	NEAR SE PROP CORNER
DP-8	1.079	8.0	16.7	26.6	53.0	74.0	95.9	BELOW SE PROP CORNER
DP-21	0.396	6.3	11.3	18.3	27.5	35.6	44.0	
DP-22	0.736	6.3	10.7	16.7	24.6	31.5	38.7	
DP-25	1.017	1.3	1.9	2.8	4.1	5.2	6.4	
DP-26	1.079	0.7	0.9	1.2	1.5	1.8	2.1	

WATER QUALITY & DETENTION POND SUMMARY

FSD1

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	16.3	23.3	33.0	45.8	57.1	68.9
ALLOWABLE RELEASE (CFS)	0.1	1.7	3.3	10.9	17.5	25.5
MODELED RELEASE (CFS)	0.1	1.6	3.2	10.9	17.4	25.4
STORED VOLUME (AC-FT)	2.4	2.6	3.0	3.6	1.9	2.2

FSD5

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	40.6	53.7	71.0	92.4	110.6	129.1
ALLOWABLE RELEASE (CFS)	0.1	1.4	2.6	11.3	19.8	30.2
MODELED RELEASE (CFS)	0.1	1.4	2.6	11.2	19.7	30.1
STORED VOLUME (AC-FT)	3.0	3.2	3.8	4.1	4.7	5.2

FSD6

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	196.5	258.5	339.1	438.7	523.3	608.6
ALLOWABLE RELEASE (CFS)	0.5	7.6	14.6	58.4	99.6	149.7
MODELED RELEASE (CFS)	0.5	7.5	14.5	58.2	99.6	149.6
STORED VOLUME (AC-FT)	15.5	16.4	18.7	20.8	23.3	26.0

FSD9

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	64.6	105.6	169.5	252.3	327.1	410.1
ALLOWABLE RELEASE (CFS)	1.7	24.9	49.8	141.1	207.2	290.0
MODELED RELEASE (CFS)	1.7	24.9	49.8	141.1	207.0	289.9
STORED VOLUME (AC-FT)	8.7	8.7	9.6	10.8	12.3	13.8

FSD11A

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	5.3	7.8	11.3	15.9	20.0	24.3
ALLOWABLE RELEASE (CFS)	0.1	1.6	3.2	7.5	9.7	12.4
MODELED RELEASE (CFS)	0.2	0.9	3.0	7.5	9.7	12.3
STORED VOLUME (AC-FT)	0.3	0.3	0.4	0.4	0.5	0.6

FSD11B

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	59.4	81.3	110.8	148.1	180.5	213.7
ALLOWABLE RELEASE (CFS)	0.3	4.5	8.7	29.6	47.7	69.6
MODELED RELEASE (CFS)	0.3	4.5	8.6	29.5	47.7	69.5
STORED VOLUME (AC-FT)	4.8	4.9	5.5	6.4	7.3	8.2

FSD12

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	77.8	105.6	142.5	189.1	229.1	270.0
ALLOWABLE RELEASE (CFS)	0.9	13.2	26.7	62.0	80.2	103.2
MODELED RELEASE (CFS)	0.9	9.0	26.7	61.9	80.1	103.1
STORED VOLUME (AC-FT)	5.2	5.5	5.8	6.7	7.8	8.9

FSD13

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	43.9	57.8	76.0	98.5	117.6	136.9
ALLOWABLE RELEASE (CFS)	0.4	6.1	12.3	28.6	37.0	47.6
MODELED RELEASE (CFS)	0.4	4.2	12.3	28.6	36.9	47.2
STORED VOLUME (AC-FT)	3.1	3.1	3.3	3.8	4.4	5.0

FSD14A

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	127.6	175.4	239.8	321.9	393.2	466.3
ALLOWABLE RELEASE (CFS)	0.5	7.5	14.4	56.2	95.2	142.4
MODELED RELEASE (CFS)	0.5	7.5	14.4	56.2	95.1	142.2
STORED VOLUME (AC-FT)	9.9	10.6	11.9	13.5	15.3	17.3

FSD14B

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	24.6	34.3	47.4	64.2	79.0	94.1
ALLOWABLE RELEASE (CFS)	0.0	0.3	0.5	5.7	11.8	19.3
MODELED RELEASE (CFS)	0.0	0.3	0.5	4.5	11.8	19.3
STORED VOLUME (AC-FT)	1.9	2.5	3.3	3.5	3.5	3.8

FSD15B

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	10.8	14.0	18.2	23.3	27.6	31.9
ALLOWABLE RELEASE (CFS)	0.1	1.6	3.2	7.3	9.5	12.0
MODELED RELEASE (CFS)	0.1	1.1	3.2	7.3	9.5	12.0
STORED VOLUME (AC-FT)	0.6	0.6	0.7	0.8	0.9	1.0

FSD16A

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	84.4	120.4	170.0	234.8	292.2	351.8
ALLOWABLE RELEASE (CFS)	0.6	8.8	17.3	56.2	88.4	128.3
MODELED RELEASE (CFS)	0.6	8.8	17.3	56.2	88.3	128.3
STORED VOLUME (AC-FT)	7.6	7.7	8.9	10.4	12.1	13.8

SAND CREEK FLOW COMPARISON CHART

DESIGN POINT	AREA (SQ MI)	Q_{100} (CFS)	DESCRIPTION
DP-77	2.343	1468	PROPOSED CONDITION
	2.91	2262	SAND CREEK DBPS
		2600	FEMA
DP-71	2.757	1612	PROPOSED CONDITION
		2260	SAND CREEK DBPS
DP-63	4.449	1385	PROPOSED CONDITION
	4.33	2630	SAND CREEK DBPS
		2600	FEMA
DP-60A	5.661	1662	PROPOSED CONDITION
	5.38	3295	SAND CREEK DBPS

EFSC DBPS DESIGN POINT SUMMARY (PEAK FLOW)

DBPS DESIGN POINT	AREA (SQ MI)	Q_{10} (CFS) (EXIST)	Q_{100} (CFS) (EXIST)	AREA (SQ MI)	Q_{10} (CFS) (PROP)	Q_{100} (CFS) (PROP)
DP-50	0.32	47.0	195.7	0.32	146.7	370.3
DP-51 (BASIN 86)	0.33	17.7	74.1	0.33	110.0	233.5
DP-52	1.67	80.5	456.5	1.67	1207.9	2123.0
DP-56	0.79	63.6	265.0	0.79	513.0	908.2

Values reported from SCDBPS, (DP 50, 51, 52 Not analyzed as a part of this study)
DBPS Reach 85(Basin91)=Q10=28.8cfs Q100=115.2cfs / Q10=345.7cfs Q100=588.9cfs
(EXISTING) (PROPOSED)

WATER QUALITY & DETENTION POND SUMMARY

FSD16B

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	39.0	53.7	73.6	99.0	121.1	143.8
ALLOWABLE RELEASE (CFS)	0.0	0.4	0.7	8.3	17.2	28.2
MODELED RELEASE (CFS)	0.0	0.4	0.7	7.9	17.2	28.1
STORED VOLUME (AC-FT)	3.0	3.9	5.1	5.1	5.3	5.8

FSD17

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	41.8	59.6	85.2	119.0	149.1	180.6
ALLOWABLE RELEASE (CFS)	0.7	11.1	22.5	52.0	67.2	86.3
MODELED RELEASE (CFS)	0.7	8.4	22.4	52.0	67.2	86.1
STORED VOLUME (AC-FT)	2.6	2.6	2.8	3.4	4.0	4.7

FSD18

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	49.3	67.1	91.0	121.2	147.3	174.0
ALLOWABLE RELEASE (CFS)	0.6	9.2	18.4	42.2	54.6	69.9
MODELED RELEASE (CFS)	0.6	6.3	18.4	42.2	54.6	69.6
STORED VOLUME (AC-FT)	3.2	3.2	3.4	4.0	4.7	5.3

FSD20

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	9.9	15.5	23.8	35.1	45.5	56.6
ALLOWABLE RELEASE (CFS)	0.4	5.5	11.1	25.7	33.2	42.5
MODELED RELEASE (CFS)	0.4	2.8	10.9	25.7	33.0	42.4
STORED VOLUME (AC-FT)	0.7	0.8	0.8	0.9	1.0	1.2

FSD21

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	7.0	10.8	16.3	23.7	30.4	37.5
ALLOWABLE RELEASE (CFS)	0.3	4.0	8.0	18.3	23.7	30.3
MODELED RELEASE (CFS)	0.3	3.3	8.0	18.3	23.7	30.1
STORED VOLUME (AC-FT)	0.5	0.5	0.5	0.6	0.7	0.8

FSD22

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	9.4	14.8	22.5	32.9	42.5	52.6
ALLOWABLE RELEASE (CFS)	0.4	5.8	11.5	26.5	34.3	43.9
MODELED RELEASE (CFS)	0.4	5.8	11.4	26.5	34.3	43.8
STORED VOLUME (AC-FT)	0.6	0.6	0.7	0.8	0.9	1.0

FSD23

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	5.5	8.3	12.4	18.0	23.0	28.4
ALLOWABLE RELEASE (CFS)	0.2	2.4	4.9	11.2	14.5	18.6
MODELED RELEASE (CFS)	0.2	2.0	4.9	11.2	14.5	18.6
STORED VOLUME (AC-FT)	0.3	0.3	0.4	0.4	0.5	0.6

FSD27

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	38.8	57.6	84.1	119.7	159.2	206.3
ALLOWABLE RELEASE (CFS)	1.4	21.1	42.4	97.8	126.4	161.9
MODELED RELEASE (CFS)	1.4	18.4	42.3	97.7	126.2	161.9
STORED VOLUME (AC-FT)	2.7	2.8	2.9	3.2	3.7	4.2

FSD72

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	12.8	20.2	31.4	46.7	60.9	76.0
ALLOWABLE RELEASE (CFS)	0.6	9.6	19.3	44.4	57.4	73.4
MODELED RELEASE (CFS)	0.6	9.3	19.2	44.4	57.4	73.4
STORED VOLUME (AC-FT)	1.0	1.0	1.1	1.1	1.2	1.3

PNDW3

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	214.6	374.5	714.9	1187.6	1674.9	2204.1
MODELED RELEASE (CFS)	154.3	200.3	366.8	799.9	1085.6	1350.6
STORED VOLUME (AC-FT)	2.8	9.5	26.3	41.2	57.2	78.2

FSD-E1

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	23.3	35.9	53.8	79.1	102.4	127.4
ALLOWABLE RELEASE (CFS)	0.7	11.0	22.1	50.9	65.7	84.1
MODELED RELEASE (CFS)	0.7	5.4	19.9	48.9	62.8	84.0
STORED VOLUME (AC-FT)	1.3	1.3	1.5	1.8	2.1	2.5

FSD-E2

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	30.6	45.2	65.9	93.3	118.0	143.9
ALLOWABLE RELEASE (CFS)	0.6	9.5	19.2	45.5	59.8	77.6
MODELED RELEASE (CFS)	0.6	3.2	18.5	41.3	58.5	74.7
STORED VOLUME (AC-FT)	2.1	2.3	2.4	2.8	3.3	3.8

FSD-E3

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	100.4	130.6	169.6	217.4	257.8	298.4
ALLOWABLE RELEASE (CFS)	0.9	13.2	26.5	61.6	79.8	102.6
MODELED RELEASE (CFS)	1.0	6.8	25.7	56.0	79.8	101.3
STORED VOLUME (AC-FT)	7.0	7.2	7.7	8.9	10.1	11.4

FSD-E4

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	58.9	75.5	96.6	122.2	143.7	165.2
ALLOWABLE RELEASE (CFS)	0.3	4.4	8.8	23.0	32.2	43.7
MODELED RELEASE (CFS)	0.9	2.8	8.7	21.9	32.2	43.6
STORED VOLUME (AC-FT)	4.2	4.3	4.7	5.4	6.2	6.9

FSD-E5

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	38.6	48.4	60.7	75.4	87.7	99.9
ALLOWABLE RELEASE (CFS)	0.0	0.2	0.4	4.2	8.7	14.3
MODELED RELEASE (CFS)	0.0	0.2	0.5	2.2	5.1	10.0
STORED VOLUME (AC-FT)	3.0	3.7	4.4	4.8	5.0	5.3

FSD-E6

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	141.6	189.4	252.5	331.4	398.9	467.5
ALLOWABLE RELEASE (CFS)	0.2	1.9	3.2	37.4	77.3	125.6
MODELED RELEASE (CFS)	0.2	0.9	3.2	18.3	64.1	123.3
STORED VOLUME (AC-FT)	13.0	17.0	21.9	22.2	22.6	23.7

PND-E7

STORM EVENT (YR)	2	5	10	25	50	100
PEAK INFLOW (CFS)	46.5	75.4	121.2	285.2	402.4	548.0
MODELED RELEASE (CFS)	23.1	35.3	71.5	108.3	152.1	196.4
STORED VOLUME (AC-FT)	1.0	1.8	4.6	10.5	17.9	28.0

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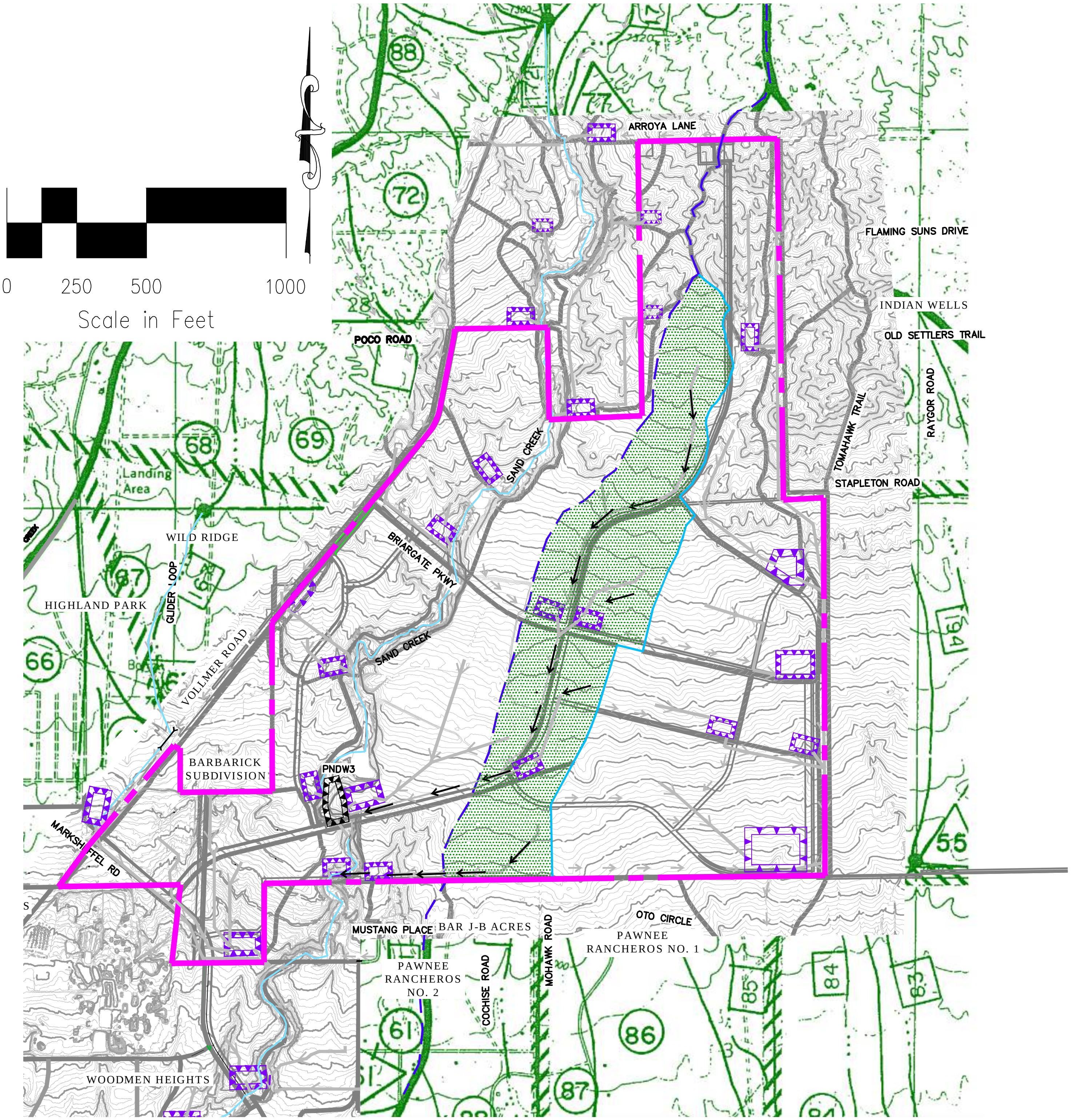
2018 STERLING RANCH MDDP

DEVELOPED HYDROLOGIC CONDITIONS MAP

PROJECT NO. 09-002
FILE: \dwg\Eng Exhibits\2018-MDDP-PROPCOND.dwg
DESIGNED BY: JD
DRAWN BY: JD
CHECKED BY: VAS
SCALE
HORIZ: 1"=2400'
VERT: 1"=2400'
DATE: 10-21-2018
DM2

File: O:\09002A\Sterling Ranch District\dwg\Eng Exhibits\2018 MDDP\2018-MDDP-eInterimCondWSWrkMap.dwg Plotstamp: 10/24/2018 3:21 PM

STERLING RANCH DRAINAGE DIVERSION EXHIBIT



PROPERTY BNDRY ▬ ▬ ▬

HISTORIC SC/EFSC BNDRY LINE – – – –

PROPOSED SC/EFSC BNDRY LINE ───

BASIN DIVERSION AREA
(EAST FORK SAND CREEK TO
SAND CREEK) * ~267.3 AC ▨

PNDW3 POND W3 WILL BE UTILIZED TO AID IN REDUCING CHANNELIZED RUNOFF TO HISTORIC LEVELS.

▭ POTENTIAL LOCATION FOR FULL SPECTRUM DETENTION POND

*ALL DIVERTED RUNOFF SHALL BE DIRECTED TO FULL SPECTRUM DETENTION PONDS PRIOR TO DISCHARGE INTO SAND CREEK CHANNEL. WHENEVER POSSIBLE ADDITIONAL LID BMP'S WILL BE UTILIZED TO REDUCE INCREASES IN RUNOFF VOLUMES.

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SHEET 1 OF 1

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HYDROLOGIC CALCULATIONS

EPA- 600/R-14/413b
Revisied September 2015

Storm Water Management Model User's Manual Version 5.1

by

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September 2015

SWMM MODEL RAIN GAGE INPUT PARAMETERS
(PER DCM CPT. 6)

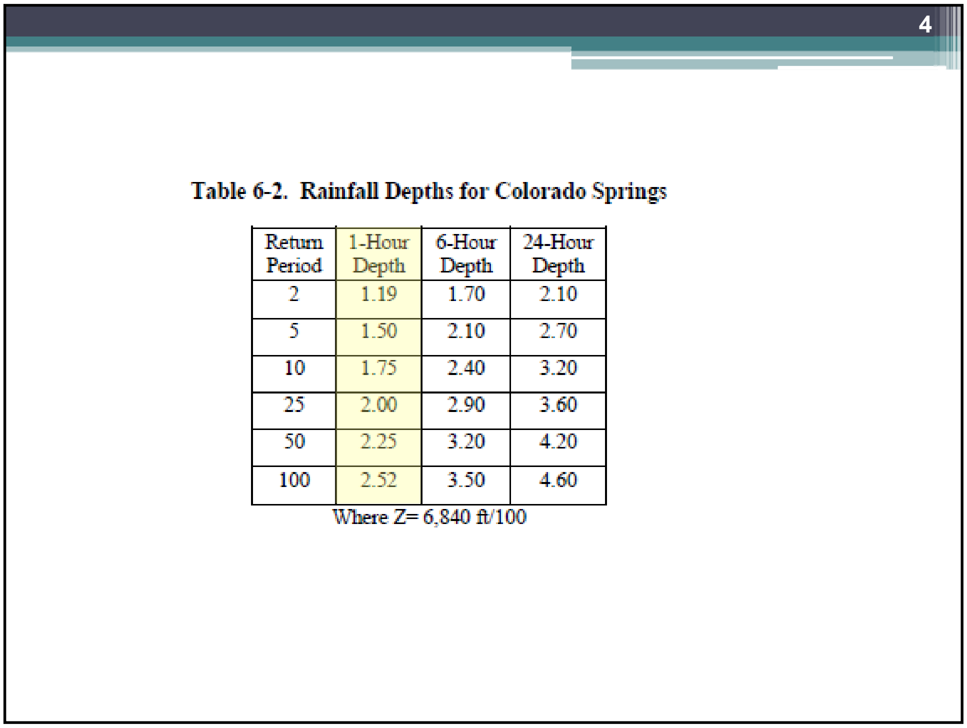
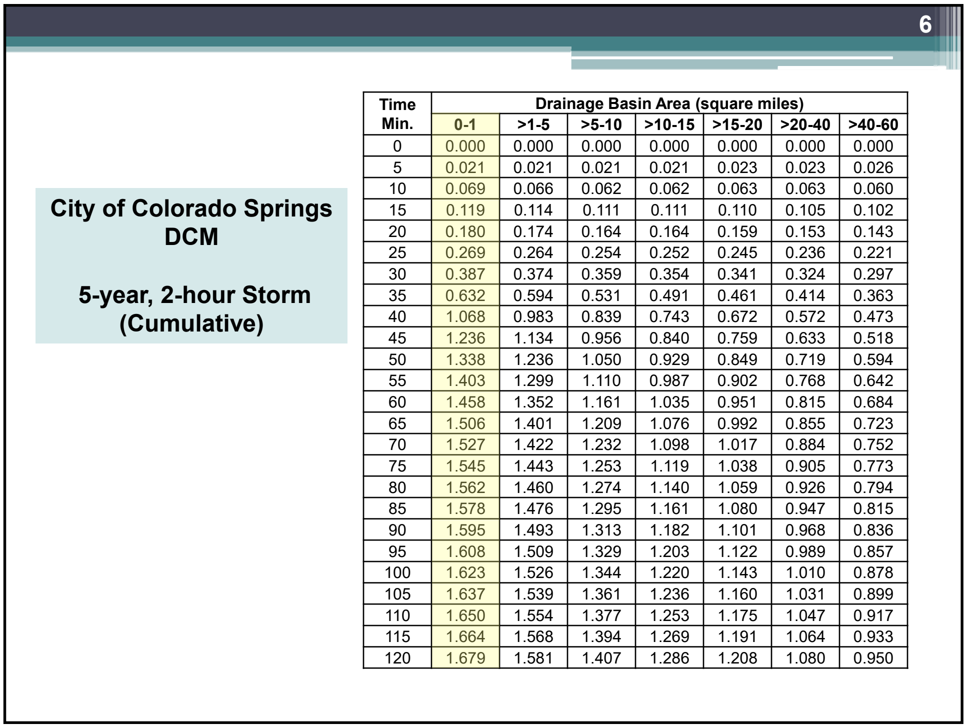


Table 6-2. Rainfall Depths for Colorado Springs

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

Where Z= 6,840 ft/100



City of Colorado Springs DCM

5-year, 2-hour Storm (Cumulative)

Time Min.	Drainage Basin Area (square miles)						
	0-1	>1-5	>5-10	>10-15	>15-20	>20-40	>40-60
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.021	0.021	0.021	0.021	0.023	0.023	0.026
10	0.069	0.066	0.062	0.062	0.063	0.063	0.060
15	0.119	0.114	0.111	0.111	0.110	0.105	0.102
20	0.180	0.174	0.164	0.164	0.159	0.153	0.143
25	0.269	0.264	0.254	0.252	0.245	0.236	0.221
30	0.387	0.374	0.359	0.354	0.341	0.324	0.297
35	0.632	0.594	0.531	0.491	0.461	0.414	0.363
40	1.068	0.983	0.839	0.743	0.672	0.572	0.473
45	1.236	1.134	0.956	0.840	0.759	0.633	0.518
50	1.338	1.236	1.050	0.929	0.849	0.719	0.594
55	1.403	1.299	1.110	0.987	0.902	0.768	0.642
60	1.458	1.352	1.161	1.035	0.951	0.815	0.684
65	1.506	1.401	1.209	1.076	0.992	0.855	0.723
70	1.527	1.422	1.232	1.098	1.017	0.884	0.752
75	1.545	1.443	1.253	1.119	1.038	0.905	0.773
80	1.562	1.460	1.274	1.140	1.059	0.926	0.794
85	1.578	1.476	1.295	1.161	1.080	0.947	0.815
90	1.595	1.493	1.313	1.182	1.101	0.968	0.836
95	1.608	1.509	1.329	1.203	1.122	0.989	0.857
100	1.623	1.526	1.344	1.220	1.143	1.010	0.878
105	1.637	1.539	1.361	1.236	1.160	1.031	0.899
110	1.650	1.554	1.377	1.253	1.175	1.047	0.917
115	1.664	1.568	1.394	1.269	1.191	1.064	0.933
120	1.679	1.581	1.407	1.286	1.208	1.080	0.950

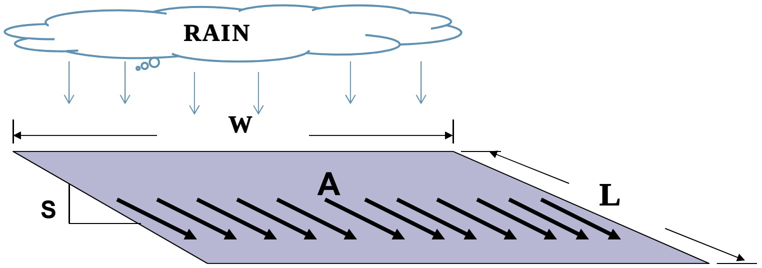
City of Colorado Springs DCM

100-year, 2-hour Storm (Cumulative)

Time Min.	Drainage Basin Area (square miles)						
	0-1	>1-5	>5-10	>10-15	>15-20	>20-40	>40-60
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.035	0.035	0.035	0.035	0.038	0.038	0.043
10	0.116	0.111	0.103	0.103	0.106	0.106	0.101
15	0.199	0.192	0.186	0.186	0.184	0.176	0.171
20	0.302	0.292	0.275	0.275	0.267	0.257	0.239
25	0.451	0.444	0.426	0.423	0.411	0.396	0.370
30	0.650	0.627	0.602	0.595	0.572	0.544	0.499
35	1.061	0.998	0.892	0.824	0.774	0.696	0.610
40	1.794	1.651	1.409	1.247	1.129	0.960	0.794
45	2.076	1.905	1.605	1.411	1.275	1.063	0.869
50	2.248	2.076	1.764	1.560	1.426	1.207	0.998
55	2.356	2.182	1.865	1.658	1.515	1.290	1.079
60	2.449	2.271	1.950	1.739	1.598	1.368	1.149
65	2.530	2.354	2.031	1.807	1.666	1.436	1.215
70	2.565	2.389	2.069	1.845	1.709	1.484	1.263
75	2.596	2.424	2.104	1.880	1.744	1.520	1.298
80	2.623	2.452	2.139	1.915	1.779	1.555	1.333
85	2.651	2.480	2.175	1.950	1.814	1.590	1.368
90	2.679	2.507	2.205	1.986	1.850	1.625	1.404
95	2.701	2.535	2.233	2.021	1.885	1.661	1.439
100	2.727	2.563	2.258	2.049	1.920	1.696	1.474
105	2.749	2.586	2.286	2.076	1.948	1.731	1.509
110	2.772	2.611	2.313	2.104	1.973	1.759	1.540
115	2.795	2.633	2.341	2.132	2.001	1.787	1.567
120	2.820	2.656	2.364	2.160	2.029	1.814	1.595

SWMM MODEL SUBCATCHMENT INPUT PARAMETERS

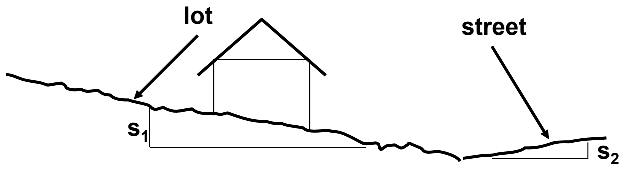
Subcatchment Conceptual Model



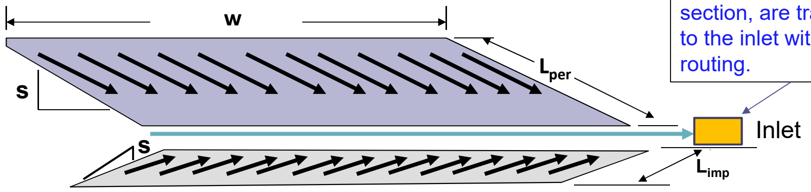
Subcatchment represented as a sloped, rectangular plane

W = width
L = length
S = slope
A = area

Subcatchment Conceptual Model



Pervious and Impervious areas are processed independently
and are then combined.
<u>Both have the same tributary width (W).</u>



Flows calculated at edge for rectangular section, are transferred to the inlet without flow routing.

You can set them up as separate subcatchments.

Width Parameter

NEVER use default value

Approx. Width = (Area) ÷ (Length)

Length = average overland sheet flow length of runoff

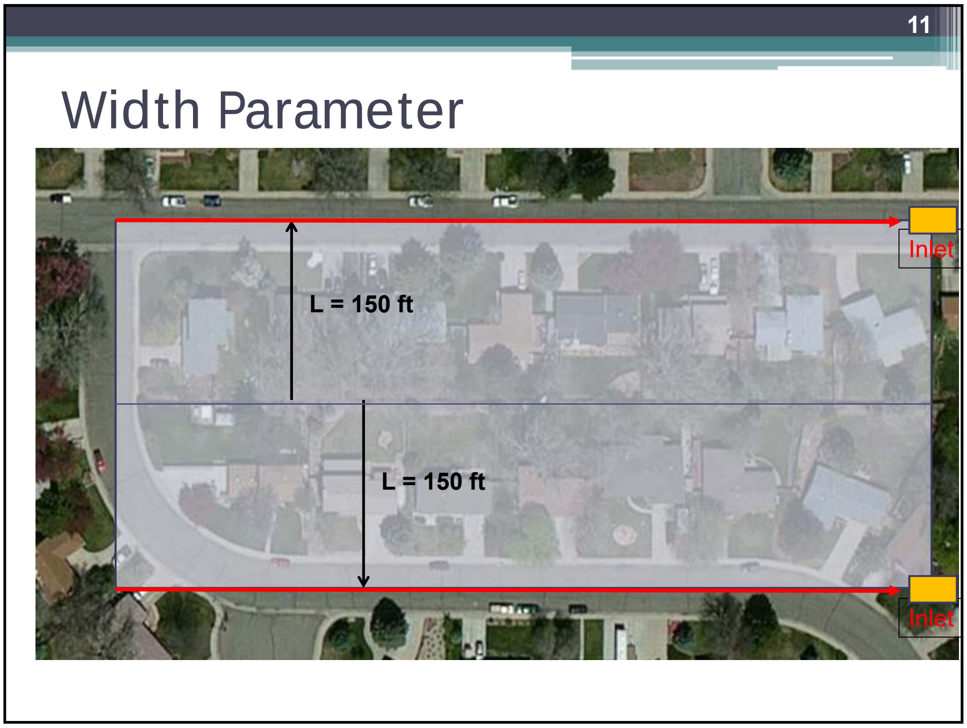
<u>Suggested Rules of Thumb</u>:

<u>Undeveloped</u>:

- **Maximum length = 100- to 500-feet**

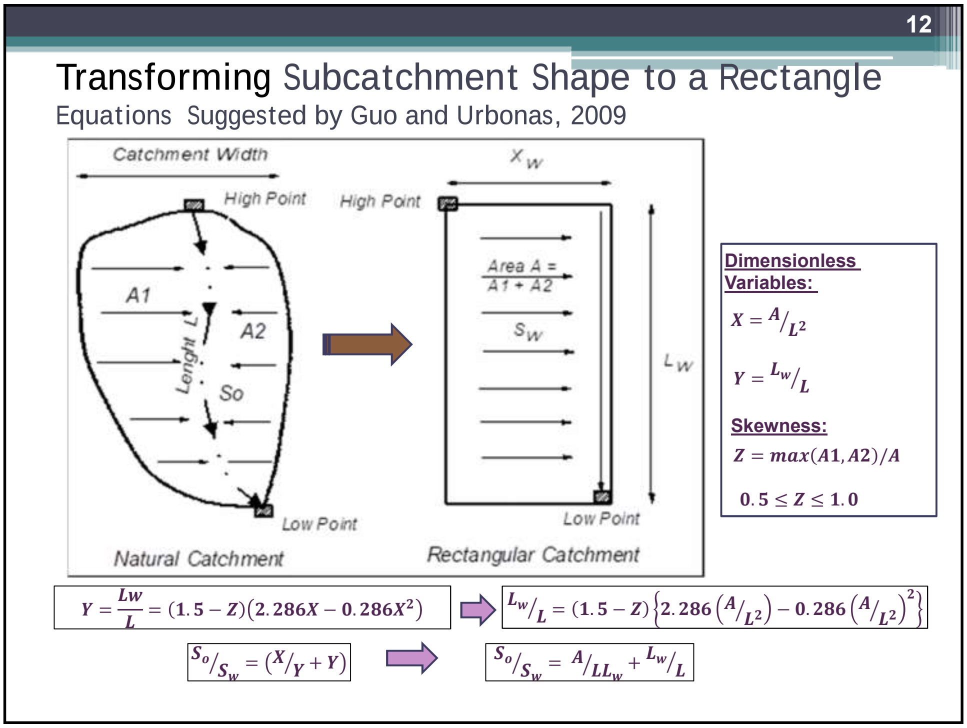
<u>Residential Catchments</u>:

- **Maximum length = 100 to 300 feet**
- **back of lot to street gutter (100-175 ft)**



Width Parameter

11



Transforming Subcatchment Shape to a Rectangle

Equations Suggested by Guo and Urbonas, 2009

Dimensionless Variables:

$X = A/L^2$

$Y = L_w/L$

Skewness:

$Z = max(A1, A2)/A$

$0.5 \le Z \le 1.0$

$$Y = \frac{Lw}{L} = (1.5 - Z)(2.286X - 0.286X^2) \Rightarrow L_w/L = (1.5 - Z)\left\{2.286\left(A/L^2\right) - 0.286\left(A/L^2\right)^2\right\}$$

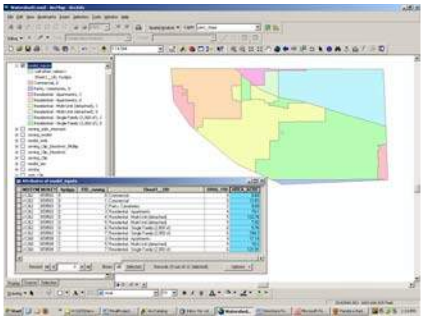
$$S_o/S_w = \left(X/Y + Y\right) \Rightarrow S_o/S_w = A/LL_w + L_w/L$$

12

Percent Impervious

Estimating/Measuring Percent Impervious:

- **If site-specific information is not available, <u>use land use classification</u>**
- **Sometimes, site-specific impervious GIS layers are available**



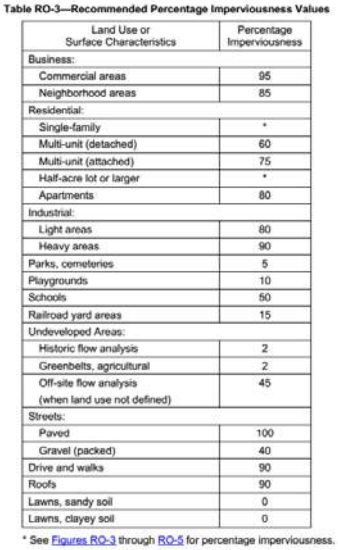


Table RO-3—Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

Source: UDFCD Storm Drainage Criteria Manual

City of Colorado Springs DCM - Manning's n

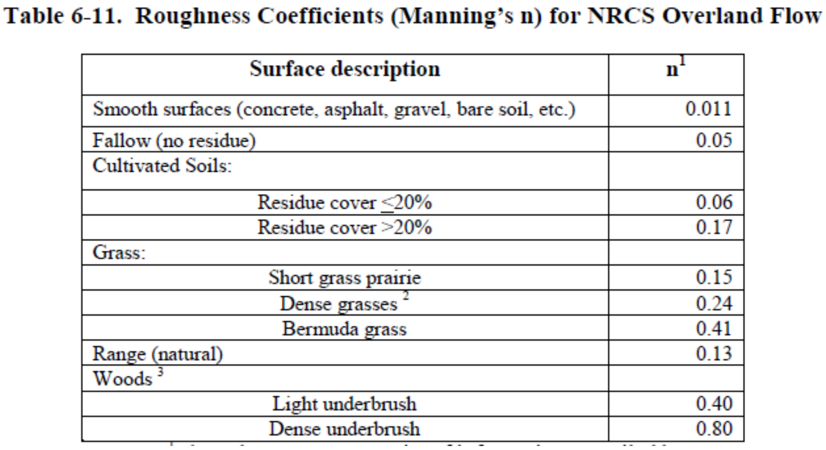


Table 6-11. Roughness Coefficients (Manning's n) for NRCS Overland Flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, bare soil, etc.)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods [3]	
Light underbrush	0.40
Dense underbrush	0.80

Table 3-1 Impervious area as a percentage of land use.

Land Use	Percent Impervious Area
Commercial	56
Industrial	76
High density residential	51
Medium density residential	38
Low density residential	19
Institutional	34
Agricultural	2
Forest	1.9
Open Urban Land	11

As mentioned earlier, impervious areas in SWMM are hydraulically (directly) connected to the drainage system – called directly connected impervious areas (DCIA). For instance, if rooftops drain onto adjacent pervious lawn areas, they should not be treated as a hydraulically effective impervious area. Such areas are non-effective impervious areas (Doyle and Miller, 1980). On the other hand, if a driveway drains to a street and then to a stormwater inlet, the driveway would be considered hydraulically connected. Rooftops with downspouts connected directly to a sewer are clearly hydraulically connected. An example of careful measurements and statistics on imperviousness may be found in Field et al. (2000), Lee (2003), and Roy and Shuster (2007). Lee and Heaney (2003) provide detailed comparisons of imperviousness computations and their implications for modeling.

Should rooftops be treated as "pervious," the real surrounding pervious area is subject to more incoming water than rainfall alone and thus might produce runoff sooner than if rainfall alone were considered. In the possible event that this effect is important (a judgment based on infiltration parameters) it can be modeled using the overland flow re-routing option discussed earlier in Section 3.7. For example, if disconnected rooftops comprised 25 percent of the total impervious area of a subcatchment (as opposed to the total DCIA) then one could tell SWMM that this percentage of impervious area should be internally routed onto the pervious sub-area of the subcatchment.

Another method of estimating the effective impervious area given measured data is to plot the runoff (in. or mm) vs. rainfall (in. or mm) for small storms. The slope of the regression line is a good estimate of the effective impervious area (Doyle and Miller, 1980).

Table 3-5 Estimates of Manning's roughness coefficient for overland flow

Source	Ground Cover	n	Range
Crawford and Linsley (1966)[a]	Smooth asphalt	0.01	
	Asphalt of concrete paving	0.014	
	Packed clay	0.03	
	Light turf	0.20	
	Dense turf	0.35	
	Dense shrubbery and forest litter	0.4	
Engman (1986)[b]	Concrete or asphalt	0.011	0.010-0.013
	Bare sand	0.010	0.01-0.016
	Graveled surface	0.02	0.012-0.03
	Bare clay-loam (eroded)	0.02	0.012-0.033
	Range (natural)	0.13	0.01-0.32
	Bluegrass sod	0.45	0.39-0.63
	Short grass prairie	0.15	0.10-0.20
	Bermuda grass	0.41	0.30-0.48
Yen (2001)[c]	Smooth asphalt pavement	0.012	0.010-0.015
	Smooth impervious surface	0.013	0.011-0.015
	Tar and sand pavement	0.014	0.012-0.016
	Concrete pavement	0.017	0.014-0.020
	Rough impervious surface	0.019	0.015-0.023
	Smooth bare packed soil	0.021	0.017-0.025
	Moderate bare packed soil	0.030	0.025-0.035
	Rough bare packed soil	0.038	0.032-0.045
	Gravel soil	0.032	0.025-0.045
	Mowed poor grass	0.038	0.030-0.045
	Average grass, closely clipped sod	0.050	0.040-0.060
	Pasture	0.055	0.040-0.070
	Timberland	0.090	0.060-0.120
	Dense grass	0.090	0.060-0.120
	Shrubs and bushes	0.120	0.080-0.180
	Business land use	0.022	0.014-0.035
	Semi-business land use	0.035	0.022-0.050
	Industrial land use	0.035	0.020-0.050
	Dense residential land use	0.040	0.025-0.060
	Suburban residential land use	0.055	0.030-0.080
	Parks and lawns	0.075	0.040-0.120

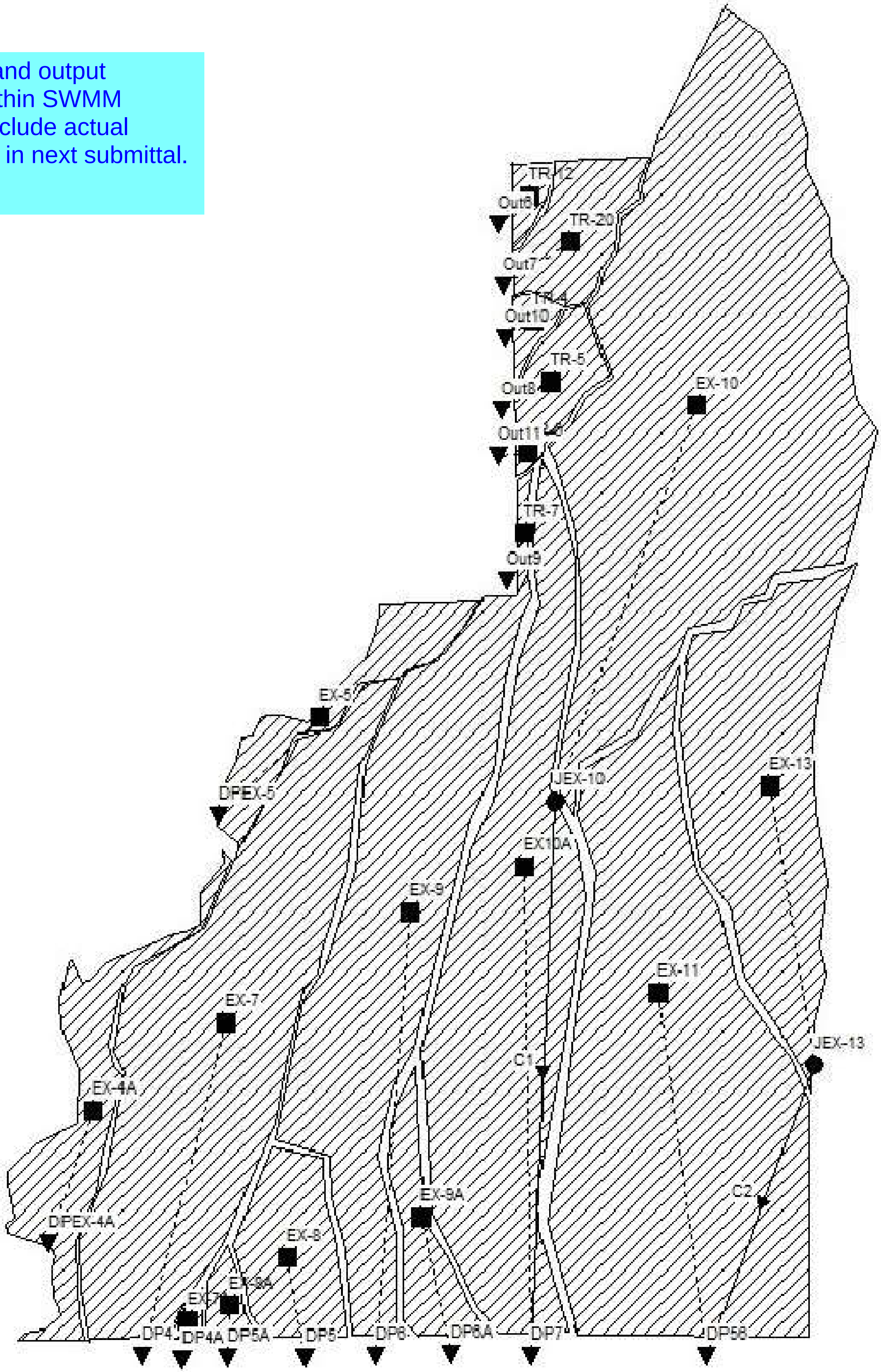
[a] Obtained by calibration of Stanford Watershed Model.

[b] Computed by Engman (1986) by kinematic wave and storage analysis of measured rainfall-runoff data.

[c] Computed on basis of kinematic wave analysis.

EXISTING CONDITIONS SWMM MODEL MAP

Include input and output information within SWMM model. Also include actual SWMM model in next submittal.



STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Surface Routing

Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	**46**	**105**
4A	**1**	**5**
5	**5**	**23**
5A	**2**	**9**
6	**59**	**122**
6A	**7**	**19**
7	**110**	**249**
56	**60**	**160**

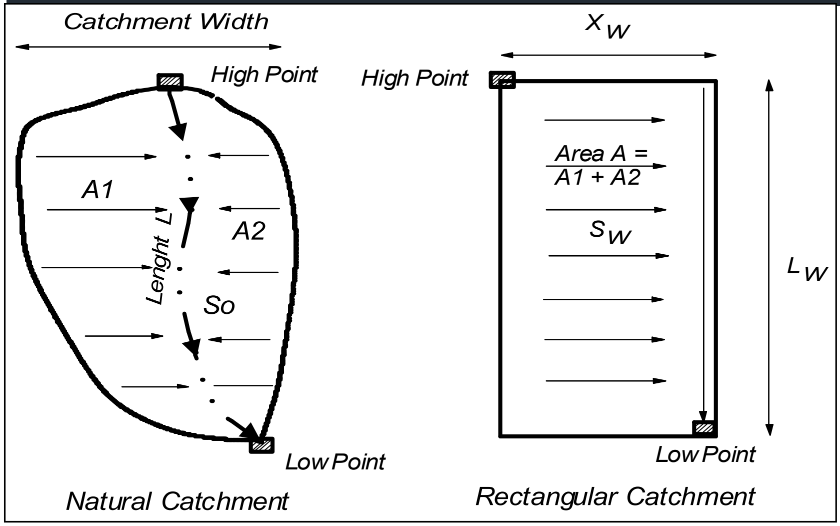
STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	*SWMM Width (Lw) (ft.)	*SWMM Slope (Sw) (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	3365	3.41%	**105**	**222**
EX10A	153.5	5%	1857	4.05%	**46**	**103**
EX-11 +	214.3	4%	3255	3.01%	**54**	**129**
EX-13 +	94.8	6%	1877	3.97%	**36**	**85**
EX-4A	44.2	8%	3355	1.09%	**19**	**50**
EX-5	26.2	8%	1959	1.65%	**12**	**32**
EX-7	152.8	5%	2234	3.13%	**46**	**105**
EX-7A	2.4	2%	416	2.70%	**1**	**5**
EX-8	32.2	2%	1679	1.47%	**5**	**23**
EX-8A	6.6	2%	698	1.80%	**2**	**9**
EX-9	139.3	8%	1837	3.19%	**59**	**122**
EX-9A	21.8	5%	786	3.01%	**7**	**19**
TR-12 +	4.7	5%	544	4.13%	**2**	**9**
TR-20 +	23.2	7%	1388	3.21%	**10**	**32**
TR-4 +	4.4	5%	645	2.76%	**2**	**9**
TR-5 +	13.7	5%	990	2.70%	**5**	**17**
TR-6 +	1.5	5%	519	1.55%	**1**	**4**
TR-7 +	2.6	5%	233	5.84%	**1**	**5**

* Reference SWMM Catchment Shape Parameter Finder for calculations

CATCHMENT SHAPE PARAMETER FINDER

Convert Natural Catchment to a Rectangular Shape



Subcatchment Center	Z=0.5
Side Collector	Z=1
Skewed Location	0.5<Z<1

Dimensionless Variables

$$Y = \frac{L}{L_w}; \qquad X = \frac{A}{L^2}$$

$$Y = (1.5 - Z)(2.286X - 0.286X^2)$$

$$\frac{Lw}{L} = (1.5 - Z)[2.286(\frac{A}{L^2}) - 0.286(\frac{A}{L^2})^2]$$

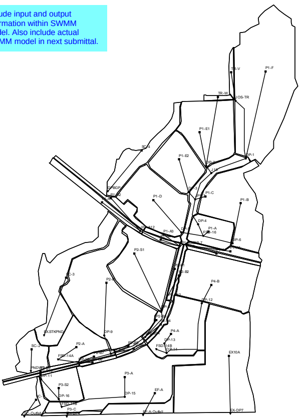
$$S_o/S_w = A/(LL_w) + L_w/L$$

$$X_w = A/L_w$$

Subarea ID	Area acre	A1 acre	A2 acre	L ft	High Pt Elev. ft	Low Pt Elev. ft	Z=Am/A	$X=A/L^2$	Y=Lw/L	Lw ft	Xw ft	So %	So/Sw	Sw %
EX-7	152.80	82.00	70.80	6,430	7160.0	6997.0	0.54	0.16	0.35	2,234	2,980	2.53	0.81	3.13
EX-9	139.30	65.00	74.30	7,190	7190.0	7026.0	0.53	0.12	0.26	1,837	3,302	2.28	0.71	3.19
EX10A	153.50	75.00	78.50	8,030	7,236	7,015	0.51	0.10	0.23	1,857	3,600	2.75	0.68	4.05
EX10	265.90	120.00	145.90	7,280	7,380	7,148	0.55	0.22	0.46	3,365	3,442	3.19	0.94	3.41
EX-11	214.30	100.00	114.30	6,140	7,192	7,008	0.53	0.25	0.53	3,255	2,867	3.00	1.00	3.01
EX-13	94.80	47.00	47.80	4,900	7,232	7,070	0.50	0.17	0.38	1,877	2,200	3.31	0.83	3.97
TR-4	4.40	2.20	2.20	640	7,270	7,244	0.50	0.47	1.01	645	297	4.06	1.47	2.76
TR-5	13.70	7.50	6.20	1,250	7,273	7,230	0.55	0.38	0.79	990	603	3.44	1.27	2.70
TR-6	1.50	0.75	0.75	250	7,238	7,228	0.50	1.05	2.08	519	126	4.00	2.58	1.55
TR-7	2.60	1.30	1.30	1,100	7,234	7,192	0.50	0.09	0.21	233	487	3.82	0.65	5.84
TR-12	4.70	2.50	2.20	800	7,300	7,262	0.53	0.32	0.68	544	377	4.75	1.15	4.13
TR-20	23.20	12.00	11.20	1,550	7,314	7,246	0.52	0.42	0.90	1,388	728	4.39	1.37	3.21
EX-4A	44.20	22.10	22.10	750	7,044	7,001	0.50	3.42	4.47	3,355	574	5.73	5.24	1.09
EX-5	26.20	13.10	13.10	1,200	7,186	7,144	0.50	0.79	1.63	1,959	583	3.50	2.12	1.65
EX-7A	2.40	1.20	1.20	550	7,039	7,021	0.50	0.35	0.76	416	251	3.27	1.21	2.70
EX-8A	6.60	3.30	3.30	900	7,045	7,025	0.50	0.35	0.78	698	412	2.22	1.23	1.80
EX-8A	32.20	17.00	15.20	1,750	7,062	7,025	0.53	0.46	0.96	1,679	835	2.11	1.44	1.47
EX-9A	21.80	11.80	10.00	2,600	7,082	7,022	0.54	0.14	0.30	786	1,208	2.31	0.77	3.01

DEVELOPED CONDITIONS SWMM MODEL MAP

Include input and output information within SWMM model. Also include actual SWMM model in next submittal.



SWMM 5.1

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWWM Imperv. (%)	*SWMM Width (Lw) (ft.)	*SWMM Slope (Sw) (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EF-A	8.2	15%	1064	1.57%	**7**	**20**
EX10A +	60.4	5%	2452	1.79%	**18**	**50**
EX-9 +	6.0	5%	578	1.70%	**2**	**8**
EX-9A +	12.7	5%	1080	1.94%	**4**	**16**
P1-A	12.7	8%	1276	1.29%	**6**	**19**
P1-A1	5.0	45%	258	1.66%	**11**	**21**
P1-A2	6.4	45%	258	0.77%	**12**	**23**
P1-A3	1.8	50%	196	1.17%	**5**	**9**
P1-A4	2.0	50%	208	1.12%	**5**	**10**
P1-A5	5.7	45%	417	1.38%	**13**	**25**
P1-A6	2.8	50%	205	1.75%	**7**	**14**
P1-B (Dev.)	35.5	38%	873	1.36%	**55**	**108**
P1-B (Un-dev.)	35.5	5%	873	1.36%	**10**	**23**
P1-C	8.9	50%	581	3.69%	**23**	**46**
P1-D	31.4	38%	1033	1.27%	**53**	**102**
P1-E1	30.4	35%	1148	1.56%	**50**	**97**
P1-E2	21.8	40%	1048	1.23%	**41**	**80**
P1-F (Dev.)	76.7	30%	2322	2.18%	**111**	**215**
P1-F (Un-dev.)	76.7	5%	2322	2.18%	**22**	**59**
P2-A	24.4	10%	2164	2.11%	**15**	**43**
P2-B	57.8	38%	1215	1.64%	**88**	**173**
P2-B1	2.5	50%	201	3.37%	**7**	**13**
P2-B10	1.7	50%	187	3.43%	**5**	**10**
P2-B2	1.9	50%	148	3.54%	**5**	**10**
P2-B3	2.8	45%	245	2.15%	**7**	**13**
P2-B4	1.6	50%	138	2.49%	**4**	**8**
P2-B5	1.9	45%	230	1.86%	**5**	**9**
P2-B6	1.1	50%	141	2.28%	**3**	**6**
P2-B7	2.5	45%	272	1.78%	**6**	**12**
P2-B8	1.2	50%	141	2.34%	**3**	**7**
P2-B9	2.0	50%	226	3.27%	**5**	**11**
P2-S1	35.6	40%	1756	1.44%	**68**	**133**
P3-A	52.6	40%	1290	1.37%	**85**	**166**
P3-C	1.7	11%	446	1.31%	**1**	**5**
P3-S2	11.9	40%	1103	1.27%	**25**	**50**
P4-A	25.8	35%	920	1.21%	**41**	**80**
P4-B	37.3	35%	1773	1.34%	**63**	**123**
SC-1 +	3.6	8%	306	2.20%	**2**	**6**
SC-2 +	10.8	8%	1211	2.44%	**6**	**20**
SC-3 +	27.2	8%	616	2.68%	**12**	**26**
SC-4 +	16.4	8%	1918	1.48%	**8**	**27**
TR-V	2.1	19%	162	4.13%	**2**	**6**
TR-W	1.4	38%	90	1.30%	**3**	**5**

*** Reference SWMM Catchment Shape Parameter Finder for calculations**

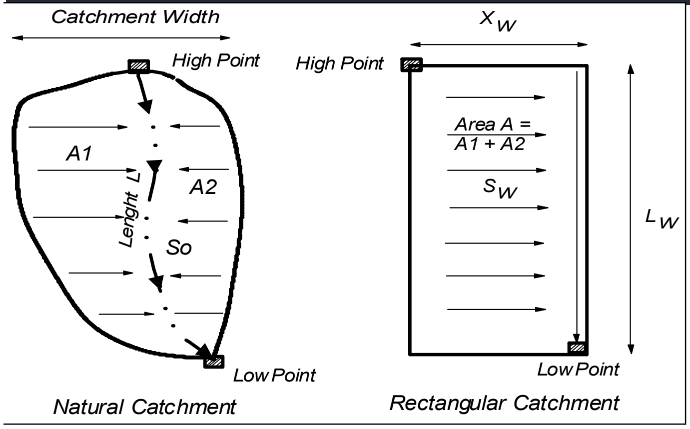
+ Basin not changed from pre-development conditions

See drainage map for comments on summary table.

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Developed Surface Routing

Design Point (On-Site)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
DP-1	112	219
DP-2	53	103
DP-3	41	80
DP-4	218	379
DP-5	53	102
DP-6	55	108
DP-7	20	39
DP-8	68	133
DP-9	88	173
DP-10	223	441
DP-11	10	21
DP-12	63	123
DP-13	41	80
DP-14	97	189
DP-15	85	166
DP-16	34	69
Pond FSD-11B	115	227
Pond FSD-14A	234	486
Pond FSD-14B	97	189
Pond FSD-16 (Ultimate)	323	499
Pond FSD-16 (Interim)	197	410
Design Point (South Bndy.)	**Peak Runoff 5 yr. (CFS)**	**Peak Runoff 100 yr. (CFS)**
4	0.5	3.5
4A	0.5	3.5
5	4	10
5A	2	7
6	2.0	48.9
6A	4	16
7	18	50

Convert Natural Catchment to a Rectangular Shape



Subcatchment Center	Z=0.5
Side Collector	Z=1
Skewed Location	0.5<Z<1

Dimensionless Variables

$$Y = \frac{L}{L_w}; \qquad X = \frac{A}{L^2}$$

$$Y = (1.5 - Z)(2.286X - 0.286X^2)$$

$$\frac{Lw}{L} = (1.5 - Z)[2.286(\frac{A}{L^2}) - 0.286(\frac{A}{L^2})^2]$$

$$S_o/S_w = A/(LL_w) + L_w/L$$

$$X_w = A/L_w$$

Subarea ID	Area acre	A1 acre	A2 acre	L ft	High Pt Elev. ft	Low Pt Elev. ft	Z=Am/A	$X=A/L^2$	Y=Lw/L	Lw ft	Xw ft	So %	So/Sw	Sw %
EF-A	8.20	4.10	4.10	260	7050.0	7028.0	0.50	5.28	4.09	1,064	336	8.46	5.38	1.57
P3-C	1.70	0.50	1.20	260	7027.0	7019.0	0.71	1.10	1.72	446	166	3.08	2.35	1.31
P1-A	12.70	7.00	5.70	850	7,124	7,102	0.55	0.77	1.50	1,276	433	2.59	2.01	1.29
P1-B	35.50	10.00	25.50	3,100	7,160	7,124	0.72	0.16	0.28	873	1,770	1.16	0.85	1.36
P1-C	8.90	4.50	4.40	1,700	7,158	7,122	0.51	0.13	0.30	510	761	2.12	0.75	2.83
P1-D	31.40	14.00	17.40	2,800	7,136	7,106	0.55	0.17	0.37	1,033	1,324	1.07	0.84	1.27
P1-E1	30.40	16.00	14.40	2,500	7,188	7,152	0.53	0.21	0.46	1,148	1,154	1.44	0.92	1.56
P1-E2	21.80	11.00	10.80	2,000	7,158	7,134	0.50	0.24	0.52	1,048	906	1.20	0.98	1.23
P1-F	76.70	35.00	41.70	3,000	7,240	7,158	0.54	0.37	0.77	2,322	1,439	2.73	1.25	2.18
TR-W	1.40	0.70	0.70	90	7,192	7,182	0.50	7.53	1.00	90	678	11.11	8.53	1.30
TR-V	2.10	1.50	0.60	1,000	7,220	7,190	0.71	0.09	0.16	162	563	3.00	0.73	4.13
P1-A1	5.00	3.10	1.90	2,400	7,134	7,112	0.62	0.04	0.08	182	1,199	0.92	0.58	1.59
P1-A2	6.40	3.20	3.20	2,400	7,134	7,110	0.50	0.05	0.11	264	1,056	1.00	0.55	1.82
P1-A3	1.80	0.70	1.10	800	7,110	7,103	0.61	0.12	0.25	196	400	0.88	0.74	1.17
P1-A4	2.00	1.30	0.70	800	7,112	7,105	0.65	0.14	0.26	208	419	0.88	0.78	1.12
P1-A5	5.70	3.00	2.70	1,300	7,114	7,100	0.53	0.15	0.32	417	595	1.08	0.78	1.38
P1-A6	2.80	1.30	1.50	1,300	7,114	7,100	0.54	0.07	0.16	205	595	1.08	0.62	1.75
P2-A	24.40	13.20	11.20	900	7,056	7,000	0.54	1.31	2.40	2,164	491	6.22	2.95	2.11
P2-B	57.80	18.50	39.30	3,800	7,106	7,052	0.68	0.17	0.32	1,215	2,072	1.42	0.87	1.64
P2-S1	35.60	18.00	17.60	1,900	7,110	7,072	0.51	0.43	0.92	1,756	883	2.00	1.39	1.44
P2-B1	2.50	1.50	1.00	1,100	7,102	7,077	0.60	0.09	0.18	201	541	2.27	0.67	3.37
P2-B2	1.90	1.20	0.70	1,100	7,102	7,077	0.63	0.07	0.13	148	559	2.27	0.64	3.54
P2-B3	2.80	1.70	1.10	1,000	7,077	7,061	0.61	0.12	0.25	245	498	1.60	0.74	2.15
P2-B4	1.60	1.00	0.60	1,000	7,077	7,061	0.63	0.07	0.14	138	504	1.60	0.64	2.49
P2-B5	1.90	1.20	0.70	700	7,061	7,050	0.63	0.17	0.33	230	360	1.57	0.84	1.86
P2-B6	1.10	0.65	0.45	700	7,061	7,050	0.59	0.10	0.20	141	341	1.57	0.69	2.28
P2-B7	2.50	1.60	0.90	770	7,050	7,038	0.64	0.18	0.35	272	401	1.56	0.87	1.78
P2-B8	1.20	0.70	0.50	770	7,050	7,038	0.58	0.09	0.18	141	372	1.56	0.67	2.34
P2-B9	2.00	1.00	1.00	870	7,038	7,018	0.50	0.12	0.26	226	386	2.30	0.70	3.27
P2-B10	1.70	0.90	0.80	870	7,038	7,018	0.53	0.10	0.21	187	397	2.30	0.67	3.43
P3-A	1.70	0.90	0.80	870	7,038	7,018	0.53	0.10	0.21	187	397	2.30	0.67	3.43
P3-S2	11.90	6.00	5.90	1,000	7,036	7,016	0.50	0.52	1.10	1,103	470	2.00	1.57	1.27
P4-A	25.80	20.00	5.80	1,950	7,078	7,052	0.78	0.30	0.47	920	1,222	1.33	1.10	1.21
P4-B	37.30	25.00	12.30	1,600	7,116	7,080	0.67	0.63	1.11	1,773	916	2.25	1.68	1.34
SC-1	3.60	1.80	1.80	150	7,014	6,996	0.50	6.97	2.04	306	512	12.00	5.46	2.20
SC-2	10.80	5.00	5.80	770	7040.0	7001.0	0.54	0.79	1.57	1,211	388	5.06	2.08	2.44
SC-3	27.20	14.00	13.20	4,300	7100.0	7032.0	0.51	0.06	0.14	616	1,925	1.58	0.59	2.68
SC-4	16.40	8.20	8.20	420	7,136	7,102	0.50	4.05	4.57	1,918	372	8.10	5.45	1.48
EX-9	6.00	3.00	3.00	1,000	7,050	7,030	0.50	0.26	0.58	578	452	2.00	1.03	1.94
EX-9A	12.70	6.30	6.40	1,100	7,049	7,022	0.50	0.46	0.98	1,080	512	2.45	1.45	1.70

PROPOSED PONDS
EFFECTIVE IMPERVIOUS AREA CALCULATIONS

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-16 Tributary Area

(Full Build Out)

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A	12.7	N/A	15%
P1-B	35.5	7,500	55%
P1-C	8.9	N/A	70%
P1-D	31.4	6,500	60%
P1-E1	30.4	8,500	50%
P1-E2	21.8	7,500	55%
P1-F	76.7	12,500	35%
TR-V	2.1	17,500	27%
TR-W	1.4	13,500	32%
TOTAL	**220.9**		**46%**

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-16 Tributary Area

(Prelim. Plan 1 & Foursquare PUD Only)

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A	12.7	N/A	15%
P1-B	35.5	Un dev.	2%
P1-C	8.9	N/A	70%
P1-D	31.4	6,500	60%
P1-E1	30.4	8,500	50%
P1-E2	21.8	7,500	55%
P1-F	76.7	Un dev.	2%
TR-V	2.1	17,500	27%
TR-W	1.4	13,500	32%
TOTAL	**220.9**		**26%**

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-14A Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A1	5.0	N/A	70%
P1-A2	6.4	N/A	70%
P1-A3	1.8	N/A	70%
P1-A4	2.0	N/A	70%
P1-A5	5.7	N/A	70%
P1-A6	2.8	N/A	70%
P2-S1	35.6	School	50%
P2-A	24.4	Park	7%
P2-B	57.8	7,000	57%
P2-B1	2.5	N/A	50%
P2-B2	1.9	N/A	70%
P2-B3	2.8	N/A	50%
P2-B4	1.6	N/A	70%
P2-B5	1.9	N/A	50%
P2-B6	1.1	N/A	70%
P2-B7	2.5	N/A	25%
P2-B8	1.2	N/A	70%
TOTAL	**157.0**		**49%**

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-14B Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P4-A	25.8	6,500	60%
P4-B	37.3	6,500	60%
TOTAL	**63.1**		**60%**

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-11B Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P2-B9	2.0	N/A	70%
P2-B10	1.7	N/A	70%
P3-S2	11.9	School	65%
P3-A	52.6	7,000	57%
TOTAL	**68.2**		**59%**

% impervious per basins on these spreadsheets are different than % impervious shown on basin spreadsheets (appendix and maps). Please provide spreadsheet/input showing how % impervious is calculated and update %'s to match throughout calculations.

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Flow Comparison along South Boundary

	This Report (SWMM 5.1) Pre-Dev. Conditions		This Report (SWMM 5.1) Developed Conditions		2018 SR MDDP (HEC-HMS) Pre-Dev. Conditions	
Design Point (South Bndy.)	**Peak Runoff 5 yr. (CFS)**	**Peak Runoff 100 yr. (CFS)**	**Peak Runoff 5 yr. (CFS)**	**Peak Runoff 100 yr. (CFS)**	**Peak Runoff 5 yr. (CFS)**	**Peak Runoff 100 yr. (CFS)**
4	46	105	0.5	3.5	21.5	107.4
4A	1	5	0.5	3.5		
5	5	23	4	10	1.7	20.5
5A	2	9	2	7		
6	59	122	2.0	48.9	23.9	125.2
6A	7	19	4	11		
7	110	249	18	50	57.1	277.9
56	60	160	60	160	42.5	202.9

Include explanation of why these flows are larger than MDDP flows.

STORMWATER QUALITY CALCULATIONS

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-11B**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 59.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.590
C) Contributing Watershed Area	Area = 68.200 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)	V_{DESIGN}= ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= 1.293 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed	
i) Percentage of Watershed consisting of Type A Soils	HSG_A = 65 %
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = 35 %
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = 0 %
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ = 4.689 ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.039 ac-ft
B) Actual Forebay Volume	V_F = 0.039 ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 30.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 227.00 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 4.54 cfs
E) Forebay Discharge Design	Choose One ○ Berm With Pipe ● Wall with Rect. Notch ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 10.1 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-11B**

6. Trickle Channel	Choose One
A) Type of Trickle Channel	● Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0060 ft / ft

7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 132 sq ft
C) Outlet Type	Choose One ● Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 2.99 inches
E) Total Outlet Area	A_{ot} = 37.00 square inches

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 169 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 66.0 cu ft

9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 1,072 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 1510 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 5.25 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 91 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 16.6 inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-11B**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping: B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One ○ Irrigated ● Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Per Maintenance Plan

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-14A**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 49.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.490
C) Contributing Watershed Area	Area = 157.000 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)	V_{DESIGN}= ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$	$V_{DESIGN\ OTHER}$= 2.601 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed	
i) Percentage of Watershed consisting of Type A Soils	HSG_A = 90 %
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = 10 %
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = 0 %
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ = 8.762 ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.078 ac-ft
B) Actual Forebay Volume	V_F = 0.078 ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 30.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 486.00 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 9.72 cfs
E) Forebay Discharge Design	Choose One ○ Berm With Pipe ● Wall with Rect. Notch ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 14.9 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-14A**

6. Trickle Channel

A) Type of Trickle Channel

Choose One
● Concrete
○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0060 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 132 sq ft

C) Outlet Type

Choose One
● Orifice Plate
○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 2.99 inches

E) Total Outlet Area — A_{ot} = 62.00 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 6 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 340 cu ft

C) Initial Surcharge Provided Above Micropool — V_s= 66.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = 1,797 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) — *Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = 2531 sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= 6.8 feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= 109.6 inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = 23.1 inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-14A**

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = 4.00 ft / ft

11. Vegetation

Choose One
○ Irrigated
● Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Per manitenance plan

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-14B**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 60.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.600
C) Contributing Watershed Area	Area = 63.100 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= 1.213 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) NRCS Hydrologic Soil Groups of Tributary Watershed	
i) Percentage of Watershed consisting of Type A Soils	HSG_A = 100 %
ii) Percentage of Watershed consisting of Type B Soils	HSG_B = 0 %
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ = 0 %
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ = 4.594 ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$= ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	
5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)	V_{FMIN} = 0.036 ac-ft
B) Actual Forebay Volume	V_F = 0.036 ac-ft
C) Forebay Depth (D_F = 30 inch maximum)	D_F = 18.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 189.00 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 3.78 cfs
E) Forebay Discharge Design	Choose One ○ Berm With Pipe ● Wall with Rect. Notch ○ Wall with V-Notch Weir
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = in
G) Rectangular Notch Width	Calculated W_N = 11.0 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer:	**Marc A. Whorton, P.E.**
Company:	**Classic Consulting**
Date:	**November 11, 2022**
Project:	**Sterling Ranch East Preliminary Plan No. 1**
Location:	**FSD-14B**

6. Trickle Channel

A) Type of Trickle Channel

Choose One
● Concrete
○ Soft Bottom

F) Slope of Trickle Channel

S = 0.0060 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum)

A_M = 132 sq ft

C) Outlet Type

Choose One
● Orifice Plate
○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)

$D_{orifice}$ = 2.52 inches

E) Total Outlet Area

A_{ot} = 42.00 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)

D_{IS} = 6 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)

V_{IS} = 159 cu ft

C) Initial Surcharge Provided Above Micropool

V_s= 66.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$

A_t = 1,273 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other')

User Ratio =

D) Total Water Quality Screen Area (based on screen type)

A_{total} = 1793 sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)

H= 5.5 feet

F) Height of Water Quality Screen (H_{TR})

H_{TR}= 94 inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)

$W_{opening}$ = 19.1 inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-14B**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One ○ Irrigated ● Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Per maintenance plan

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-16 (Full Build-out)**

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 46.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.460

C) Contributing Watershed Area — Area = 220.900 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.42 in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
○ Water Quality Capture Volume (WQCV)
● Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN}= ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$= 3.516 ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$= ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
  i) Percentage of Watershed consisting of Type A Soils — HSG_A = 75 %
  ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 25 %
  iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
  For HSG A: $EURV_A = 1.68 * i^{1.28}$
  For HSG B: $EURV_B = 1.36 * i^{1.08}$
  For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
  $EURV_{DESIGN}$ = 11.290 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$= ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.105 ac-ft

B) Actual Forebay Volume — V_F = 0.105 ac-ft

C) Forebay Depth (D_F = 30 inch maximum) — D_F = 30.0 in

D) Forebay Discharge

  i) Undetained 100-year Peak Discharge — Q_{100} = 499.00 cfs

  ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 9.98 cfs

E) Forebay Discharge Design

Choose One
○ Berm With Pipe
● Wall with Rect. Notch
○ Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 15.1 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-16 (Full Build-out)**

6. Trickle Channel	Choose One
A) Type of Trickle Channel	● Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0060 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 132 sq ft
C) Outlet Type	Choose One ● Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 3.57 inches
E) Total Outlet Area	A_{ot} = 52.00 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 460 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 66.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 1,426 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 2009 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 10 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 148 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 13.6 inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **November 11, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **FSD-16 (Full Build-out)**

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Concrete overflow wall with associated buried rip-rap per DCM
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = 4.00 ft / ft
11. Vegetation	Choose One ○ Irrigated ● Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Per maintenance plan

Notes:

WATER QUALITY TREATMENT PLAN MAP

	▬	STERLING RANCH EAST PHASE 1 DEVELOPMENT AREA
61.1 AC.	🟩	AREA QUALIFIES FOR EXCLUSION H – STREAM STABILIZATION (PBMP FORM)
64.5 AC.	🟧	AREA TREATED IN PROPOSED PERMANENT POND FSD–11B
130.8 AC.	🟦	AREA TREATED IN PROPOSED PERMANENT POND FSD–14A
63.1 AC.	🟦	AREA TREATED IN PROPOSED PERMANENT POND FSD–14B
245.0 AC.	🟨	AREA TREATED IN PROPOSED PERMANENT POND FSD–16
10.3 AC.	🟥	AREAS OF RUNOFF REDUCTION WATER QUALITY TREATMENT

Where is this area treated?

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

Designer: **Marc A. Whorton, P.E.**
Company: **Classic Consulting**
Date: **May 31, 2022**
Project: **Sterling Ranch East Preliminary Plan No. 1**
Location: **BASINS NOT TRIBUTARY TO PERMANENT SWQ FACILITY**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.53 inches

Depth of Average Runoff Producing Storm, d_6 = 0.42 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA							
Area ID	EF-A	SC-3-1	SC-3-2	SC-4-1	SC-4-2							
Downstream Design Point ID	SC	SC	SC	SC	SC							
Downstream BMP Type	None	None	None	None	None							
DCIA (ft^2)	--	--	--	--	--							
UIA (ft^2)	40,000	26,790	19,924	30,053	48,697							
RPA (ft^2)	37,188	17,918	12,924	21,985	28,692							
SPA (ft^2)	--	--	--	--	--							
HSG A (%)	0%	0%	0%	0%	0%							
HSG B (%)	100%	100%	100%	100%	100%							
HSG C/D (%)	0%	0%	0%	0%	0%							
Average Slope of RPA (ft/ft)	0.020	0.040	0.030	0.040	0.040							
UIA:RPA Interface Width (ft)	800.00	700.00	400.00	800.00	1000.00							

CALCULATED RUNOFF RESULTS

Area ID	EF-A	SC-3-1	SC-3-2	SC-4-1	SC-4-2							
UIA:RPA Area (ft^2)	77,188	44,708	32,848	52,038	77,389							
L / W Ratio	0.12	0.09	0.21	0.08	0.08							
UIA / Area	0.5182	0.5992	0.6066	0.5775	0.6292							
Runoff (in)	0.00	0.00	0.00	0.00	0.00							
Runoff (ft^3)	0	0	0	0	0							
Runoff Reduction (ft^3)	1433	960	714	1077	1745							

CALCULATED WQCV RESULTS

Area ID	EF-A	SC-3-1	SC-3-2	SC-4-1	SC-4-2							
WQCV (ft^3)	1628	1090	811	1223	1982							
WQCV Reduction (ft^3)	1628	1090	811	1223	1982							
WQCV Reduction (%)	100%	100%	100%	100%	100%							
Untreated WQCV (ft^3)	0	0	0	0	0							

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

Downstream Design Point ID	SC											
DCIA (ft^2)	0											
UIA (ft^2)	165,464											
RPA (ft^2)	118,707											
SPA (ft^2)	0											
Total Area (ft^2)	284,171											
Total Impervious Area (ft^2)	165,464											
WQCV (ft^3)	6,734											
WQCV Reduction (ft^3)	6,734											
WQCV Reduction (%)	100%											
Untreated WQCV (ft^3)	0											

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

Total Area (ft^2)	284,171
Total Impervious Area (ft^2)	165,464
WQCV (ft^3)	6,734
WQCV Reduction (ft^3)	6,734
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

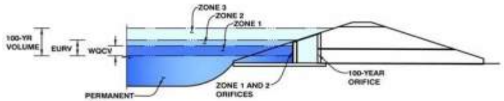
DETENTION POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**

Basin ID: **POND FSD-11B**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	68.20	acres
Watershed Length =	1,900	ft
Watershed Length to Centroid =	900	ft
Watershed Slope =	0.035	ft/ft
Watershed Imperviousness =	59.00%	percent
Percentage Hydrologic Soil Group A =	65.0%	percent
Percentage Hydrologic Soil Group B =	35.0%	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) =	1.323	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	4.684	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.693	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	4.844	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.982	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	7.589	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	8.907	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	10.654	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.48 in.) =	16.121	acre-feet	3.48	inches
Approximate 2-yr Detention Volume =	3.217	acre-feet		
Approximate 5-yr Detention Volume =	4.265	acre-feet		
Approximate 10-yr Detention Volume =	5.293	acre-feet		
Approximate 25-yr Detention Volume =	6.146	acre-feet		
Approximate 50-yr Detention Volume =	6.659	acre-feet		
Approximate 100-yr Detention Volume =	7.340	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.323	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.361	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.655	acre-feet
Total Detention Basin Volume =	7.340	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 = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^{2})	Optional Override Area (ft^{2})	Area (acre)	Volume (ft^{3})	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	525	0.012		
7004	--	2.00	--	--	--	25,865	0.594	26,390	0.606
7006	--	4.00	--	--	--	70,579	1.620	122,834	2.820
7008	--	6.00	--	--	--	119,914	2.753	313,327	7.193
7010	--	8.00	--	--	--	147,297	3.381	580,538	13.327
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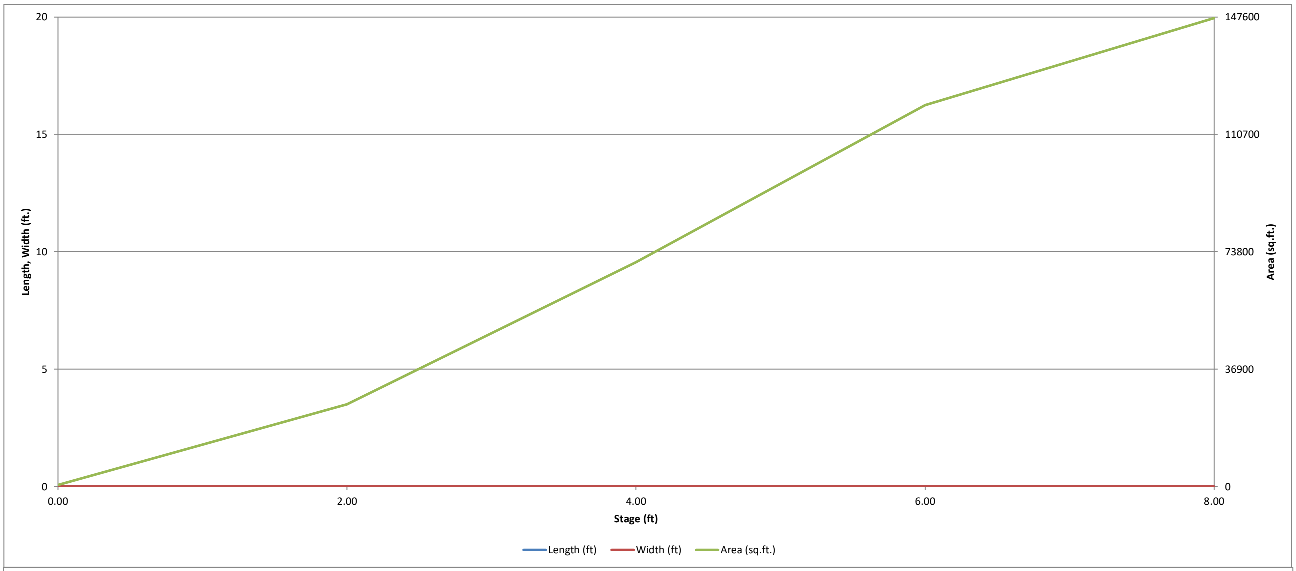
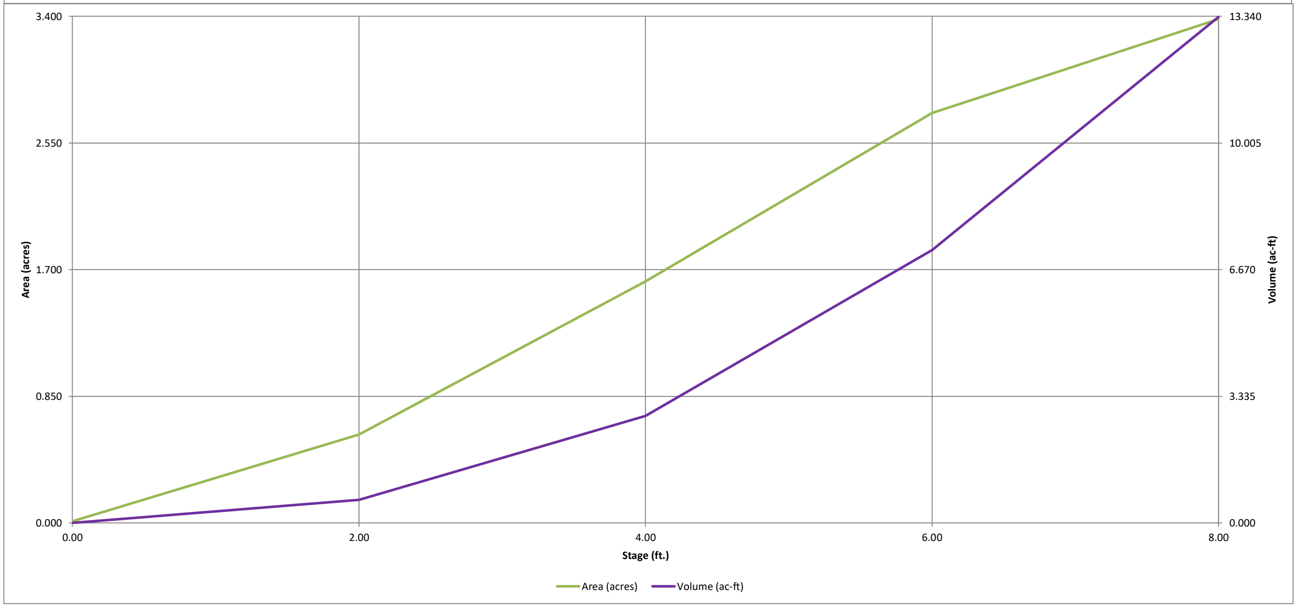
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

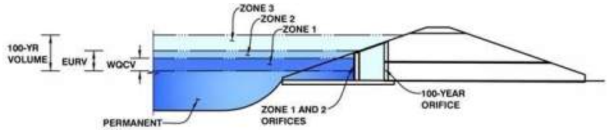




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**
Basin ID: **POND FSD-11B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.88	1.323	Orifice Plate
Zone 2 (EURV)	4.99	3.361	Orifice Plate
Zone 3 (100-year)	6.06	2.655	Weir&Pipe (Restrict)
Total (all zones)		7.340	

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

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

Calculated Parameters for Underdrain

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

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.25	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	21.00	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.80	3.60					
Orifice Area (sq. inches)	7.00	10.00	20.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.25	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	4.54	N/A	
Overflow Grate Open Area w/o Debris =	22.27	N/A	ft^2
Overflow Grate Open Area w/ Debris =	11.14	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	30.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	70.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	1.02	feet
Stage at Top of Freeboard =	8.52	feet
Basin Area at Top of Freeboard =	3.38	acres
Basin Volume at Top of Freeboard =	13.33	acre-ft

Routed Hydrograph Results

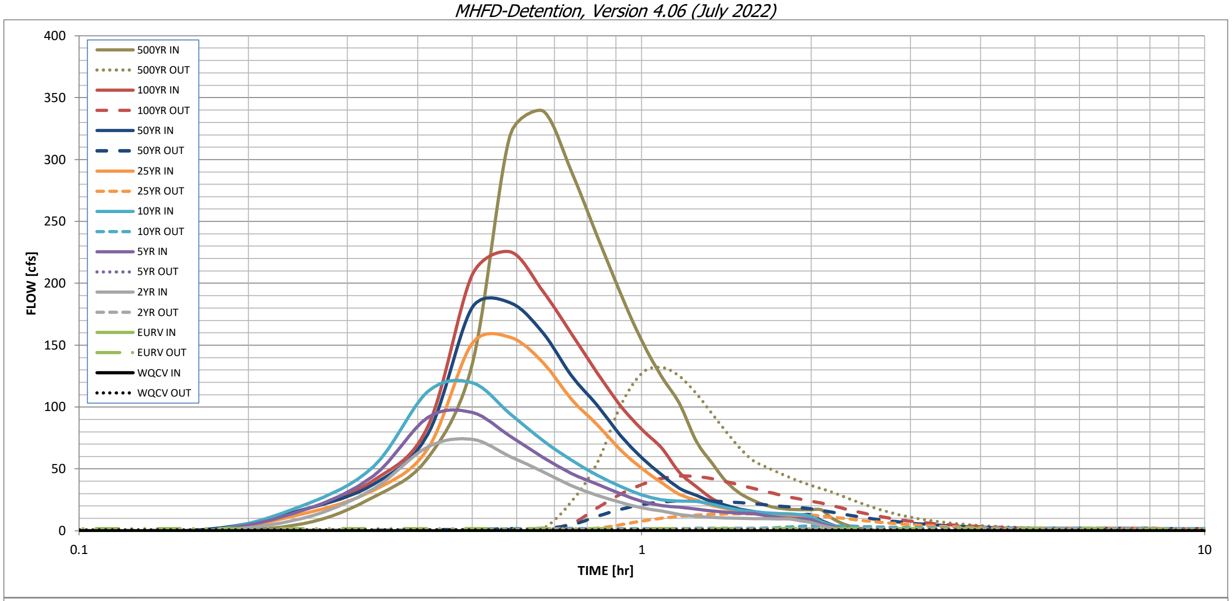
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

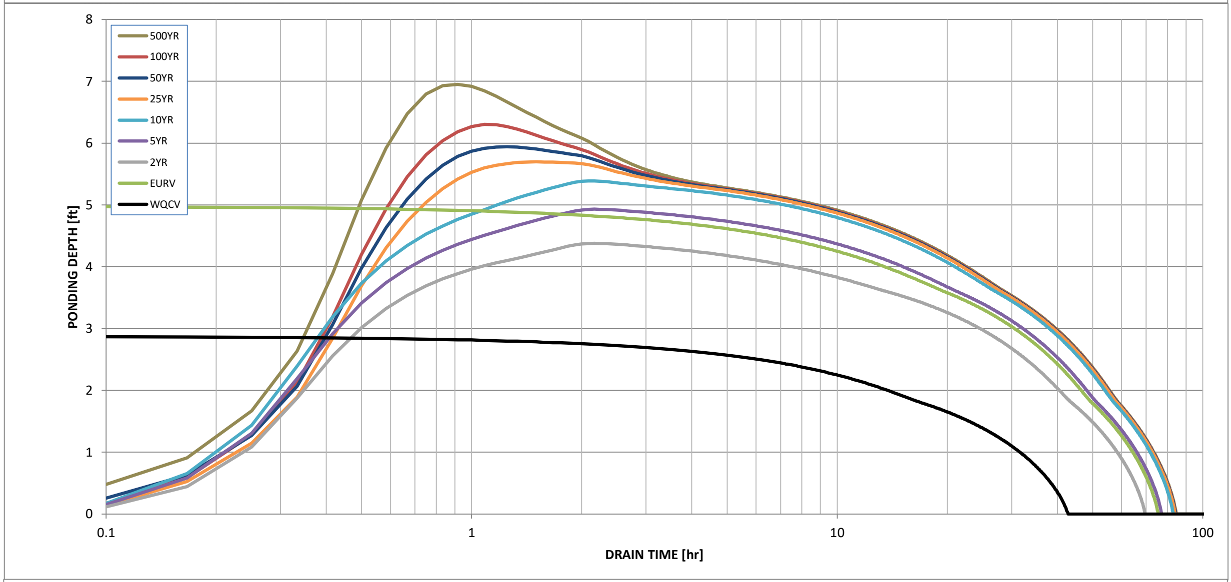
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.48
CUHP Runoff Volume (acre-ft) =	1.323	4.684	3.693	4.844	5.982	7.589	8.907	10.654	16.121
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.693	4.844	5.982	7.589	8.907	10.654	16.121
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.2	1.9	14.8	43.3	60.3	84.4	157.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.03	0.22	0.63	0.88	1.24	2.30
Peak Inflow Q (cfs) =	N/A	N/A	73.9	95.6	119.7	156.5	184.4	225.5	339.4
Peak Outflow Q (cfs) =	0.7	1.9	1.6	1.9	4.1	13.8	24.4	44.2	132.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.0	0.3	0.3	0.4	0.5	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.5	1.0	1.9	2.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	65	61	67	71	69	68	66	59
Time to Drain 99% of Inflow Volume (hours) =	**41**	71	66	73	78	78	77	76	73
Maximum Ponding Depth (ft) =	2.88	4.99	4.38	4.93	5.39	5.70	5.94	6.30	6.95
Area at Maximum Ponding Depth (acres) =	1.05	2.18	1.83	2.15	2.41	2.58	2.72	2.85	3.05
Maximum Volume Stored (acre-ft) =	1.327	4.701	3.458	4.572	5.619	6.367	7.029	8.033	9.920

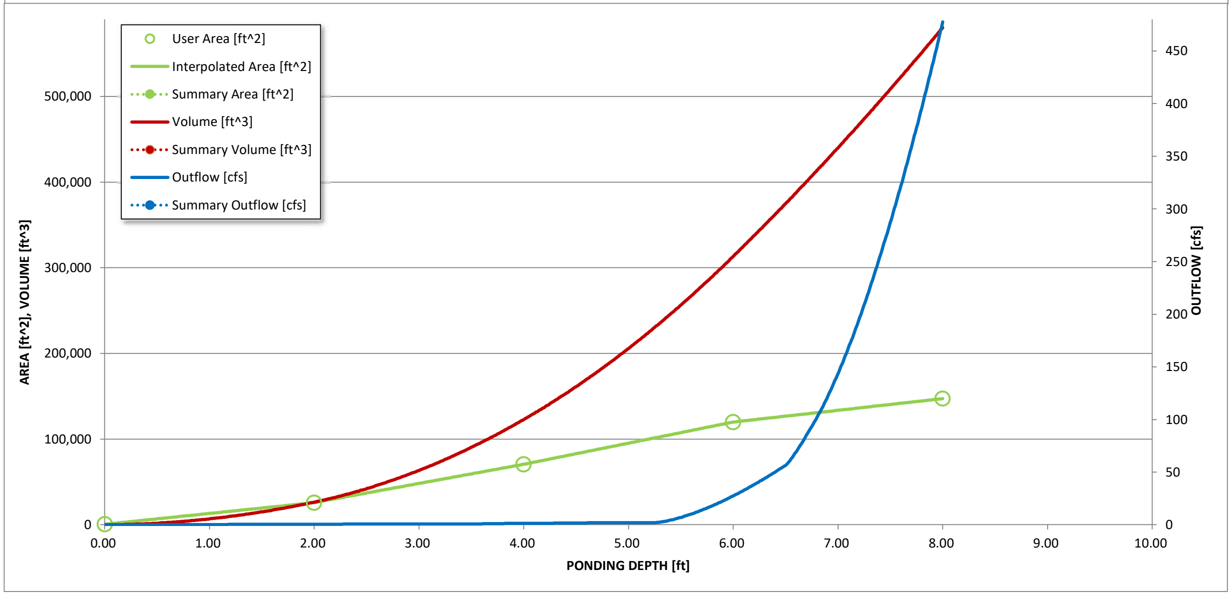
Hydrograph from SWMM model should be copied in to this spreadsheet to get the correct inflows.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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	1.15	0.12	5.67
	0:15:00	0.00	0.00	10.09	16.54	20.50	13.77	16.97	16.78	27.08
	0:20:00	0.00	0.00	34.00	44.25	51.83	32.53	37.62	40.66	58.81
	0:25:00	0.00	0.00	67.80	91.60	112.35	66.14	77.79	83.96	134.46
	0:30:00	0.00	0.00	73.89	95.57	119.70	151.59	180.39	206.74	319.40
	0:35:00	0.00	0.00	60.09	76.53	94.64	156.51	184.44	225.54	339.42
	0:40:00	0.00	0.00	47.91	59.57	73.08	136.31	160.27	193.88	290.30
	0:45:00	0.00	0.00	36.39	46.37	57.12	106.25	125.28	159.38	238.44
	0:50:00	0.00	0.00	28.70	37.73	44.94	85.93	101.63	127.76	192.17
	0:55:00	0.00	0.00	23.01	29.87	35.95	65.44	77.17	101.14	153.51
	1:00:00	0.00	0.00	18.54	23.78	28.98	50.33	59.03	81.96	124.95
	1:05:00	0.00	0.00	15.92	20.33	25.16	39.04	45.50	67.23	103.07
	1:10:00	0.00	0.00	13.20	19.03	23.98	29.53	34.36	47.20	72.47
	1:15:00	0.00	0.00	11.71	17.52	23.72	24.69	28.73	35.73	54.76
	1:20:00	0.00	0.00	10.86	15.93	21.54	20.44	23.56	26.11	39.35
	1:25:00	0.00	0.00	10.35	14.90	18.60	17.86	20.40	20.19	29.81
	1:30:00	0.00	0.00	10.05	14.27	16.63	15.27	17.35	16.73	24.18
	1:35:00	0.00	0.00	9.83	13.89	15.36	13.61	15.41	14.46	20.46
	1:40:00	0.00	0.00	9.70	12.14	14.55	12.58	14.20	13.11	18.29
	1:45:00	0.00	0.00	9.66	10.94	14.02	11.98	13.49	12.54	17.38
	1:50:00	0.00	0.00	9.66	10.19	13.68	11.65	13.10	12.33	17.03
	1:55:00	0.00	0.00	7.97	9.74	13.03	11.47	12.90	12.28	16.95
	2:00:00	0.00	0.00	6.79	9.04	11.65	11.39	12.81	12.28	16.95
	2:05:00	0.00	0.00	4.34	5.77	7.47	7.35	8.26	7.92	10.91
	2:10:00	0.00	0.00	2.66	3.53	4.60	4.56	5.12	4.90	6.74
	2:15:00	0.00	0.00	1.59	2.11	2.75	2.75	3.08	2.95	4.04
	2:20:00	0.00	0.00	0.87	1.22	1.56	1.58	1.77	1.70	2.32
	2:25:00	0.00	0.00	0.43	0.66	0.82	0.87	0.97	0.92	1.25
	2:30:00	0.00	0.00	0.17	0.28	0.32	0.37	0.40	0.38	0.51
	2:35:00	0.00	0.00	0.04	0.06	0.07	0.08	0.08	0.08	0.09
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

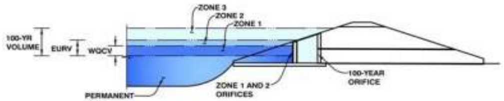
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**

Basin ID: **POND FSD-14A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type = **EDB**
Watershed Area = 157.00 acres
Watershed Length = 2,650 ft
Watershed Length to Centroid = 1,000 ft
Watershed Slope = 0.050 ft/ft
Watershed Imperviousness = 49.00% percent
Percentage Hydrologic Soil Group A = 90.0% percent
Percentage Hydrologic Soil Group B = 10.0% 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) =	2.663	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	8.759	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	6.642	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	8.802	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	10.541	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	13.839	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	16.586	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	20.226	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.48 in.) =	32.430	acre-feet	3.48	inches
Approximate 2-yr Detention Volume =	5.719	acre-feet		
Approximate 5-yr Detention Volume =	7.566	acre-feet		
Approximate 10-yr Detention Volume =	9.333	acre-feet		
Approximate 25-yr Detention Volume =	11.288	acre-feet		
Approximate 50-yr Detention Volume =	12.523	acre-feet		
Approximate 100-yr Detention Volume =	14.133	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) = 2.663 acre-feet
Zone 2 Volume (EURV - Zone 1) = 6.096 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) = 5.374 acre-feet
Total Detention Basin Volume = 14.133 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 = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	798	0.018		
7013.5	--	0.50	--	--	--	798	0.018	399	0.009
7014	--	1.00	--	--	--	1,548	0.036	985	0.023
7015	--	2.00	--	--	--	11,091	0.255	7,305	0.168
7016	--	3.00	--	--	--	49,238	1.130	37,469	0.860
7018	--	5.00	--	--	--	124,427	2.856	211,134	4.847
7020	--	7.00	--	--	--	136,372	3.131	471,933	10.834
7022	--	9.00	--	--	--	148,834	3.417	757,139	17.382
7024	--	11.00	--	--	--	161,766	3.714	1,067,739	24.512
7025	--	12.00	--	--	--	168,538	3.869	1,232,891	28.303
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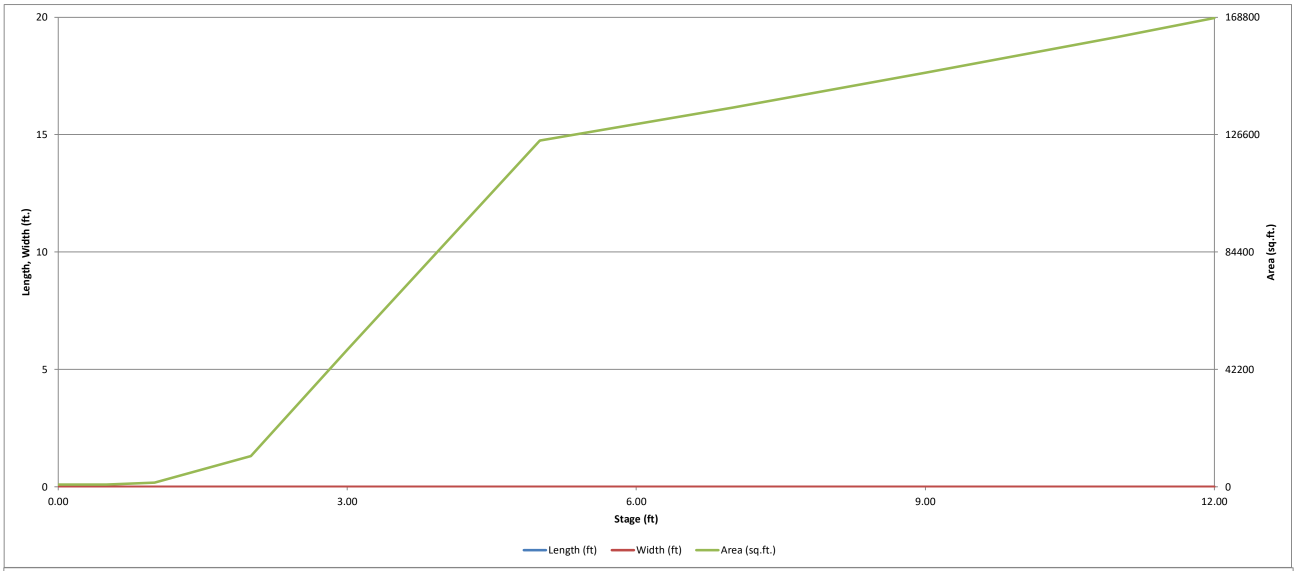
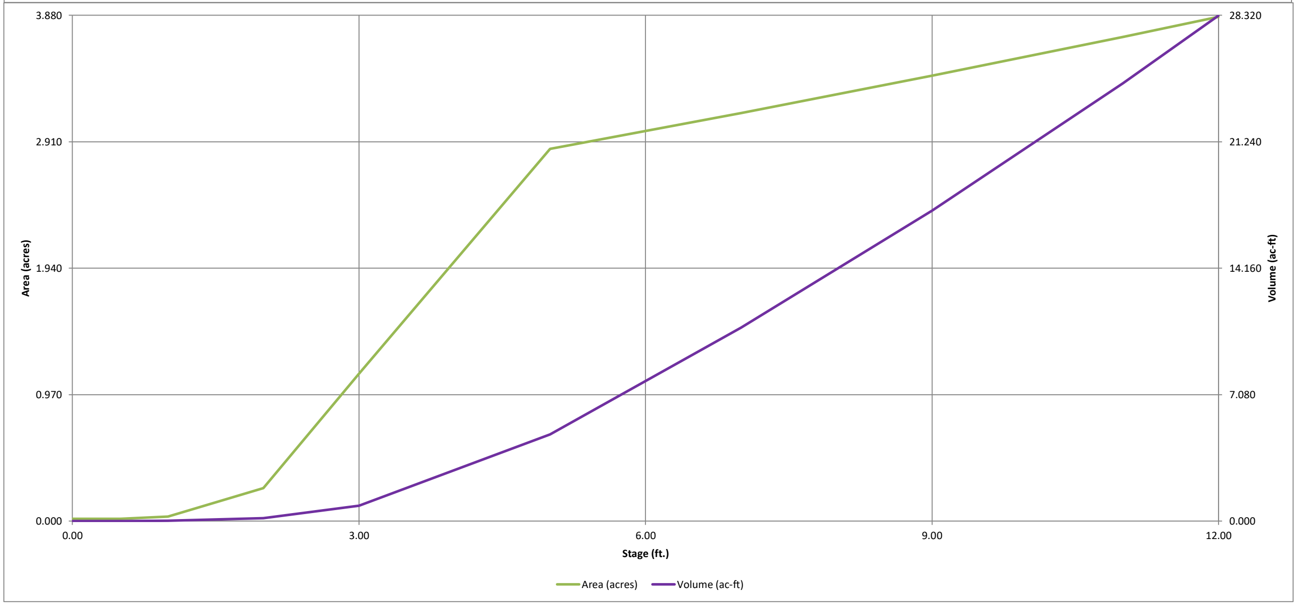
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

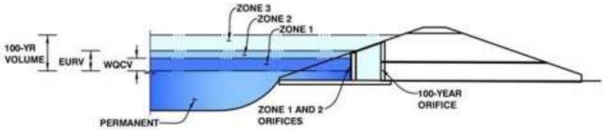




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**
Basin ID: **POND FSD-14A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.12	2.663	Orifice Plate
Zone 2 (EURV)	6.33	6.096	Orifice Plate
Zone 3 (100-year)	8.03	5.374	Weir&Pipe (Restrict)
Total (all zones)		14.133	

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

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

Calculated Parameters for Underdrain

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

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.80	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	20.40	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.70	3.40	5.10				
Orifice Area (sq. inches)	7.00	7.00	24.00	24.00				

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.80	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	20.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.80	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.79	N/A	
Overflow Grate Open Area w/o Debris =	55.68	N/A	ft^2
Overflow Grate Open Area w/ Debris =	27.84	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	42.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	9.62	N/A	ft^2
Outlet Orifice Centroid =	1.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	9.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	240.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.74	feet
Stage at Top of Freeboard =	10.99	feet
Basin Area at Top of Freeboard =	3.71	acres
Basin Volume at Top of Freeboard =	24.47	acre-ft

Routed Hydrograph Results

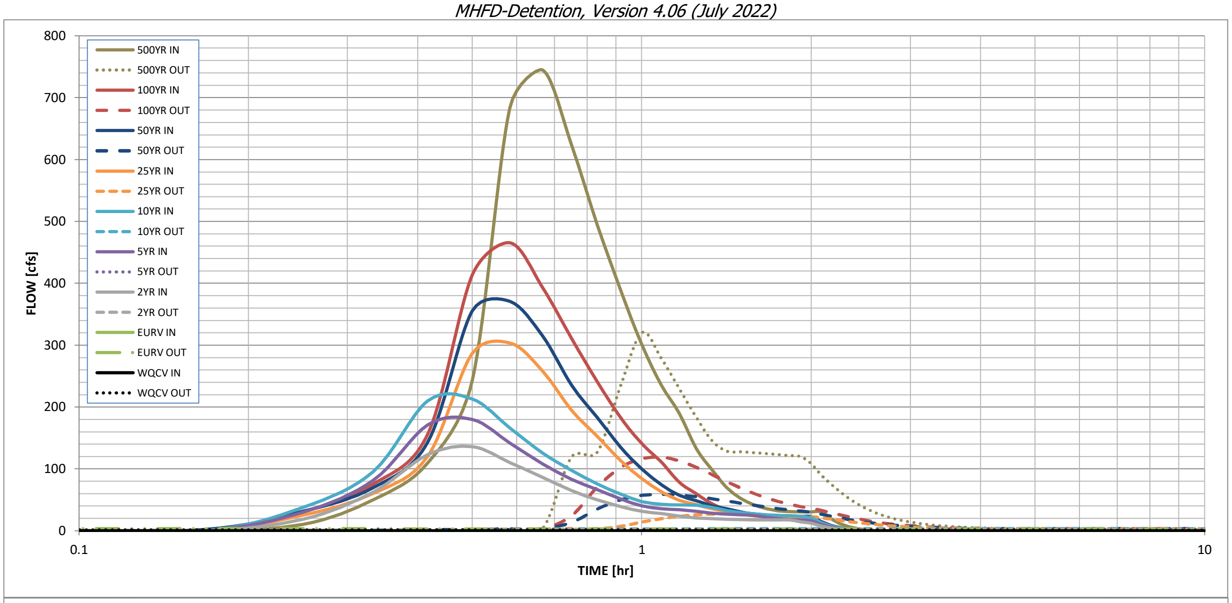
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

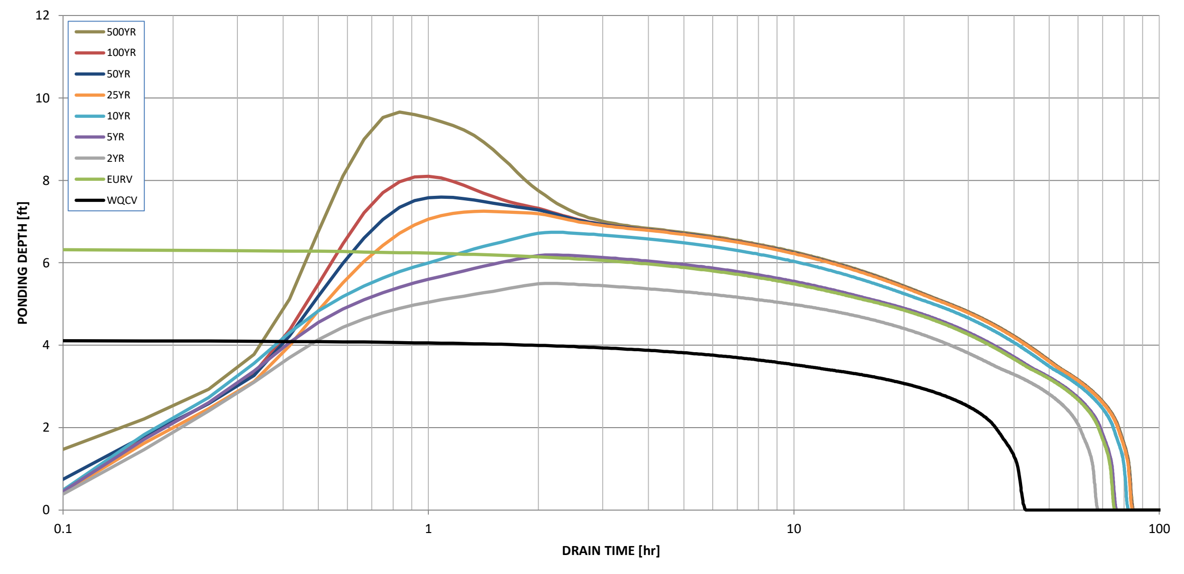
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.48
CUHP Runoff Volume (acre-ft) =	2.663	8.759	6.642	8.802	10.541	13.839	16.586	20.226	32.430
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.642	8.802	10.541	13.839	16.586	20.226	32.430
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.2	4.1	5.7	70.7	115.3	174.2	364.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.04	0.45	0.73	1.11	2.32
Peak Inflow Q (cfs) =	N/A	N/A	136.1	180.2	212.9	303.5	370.6	465.6	744.6
Peak Outflow Q (cfs) =	1.5	3.4	2.7	3.3	3.6	27.3	59.0	118.8	320.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.6	0.4	0.5	0.7	0.9
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	1.0	2.1	2.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	66	60	67	71	71	70	68	61
Time to Drain 99% of Inflow Volume (hours) =	**41**	71	64	72	77	78	77	76	74
Maximum Ponding Depth (ft) =	4.12	6.33	5.50	6.19	6.74	7.25	7.60	8.10	9.66
Area at Maximum Ponding Depth (acres) =	2.10	3.04	2.92	3.02	3.09	3.17	3.22	3.29	3.51
Maximum Volume Stored (acre-ft) =	2.667	8.767	6.263	8.343	9.994	11.621	12.706	14.331	19.634

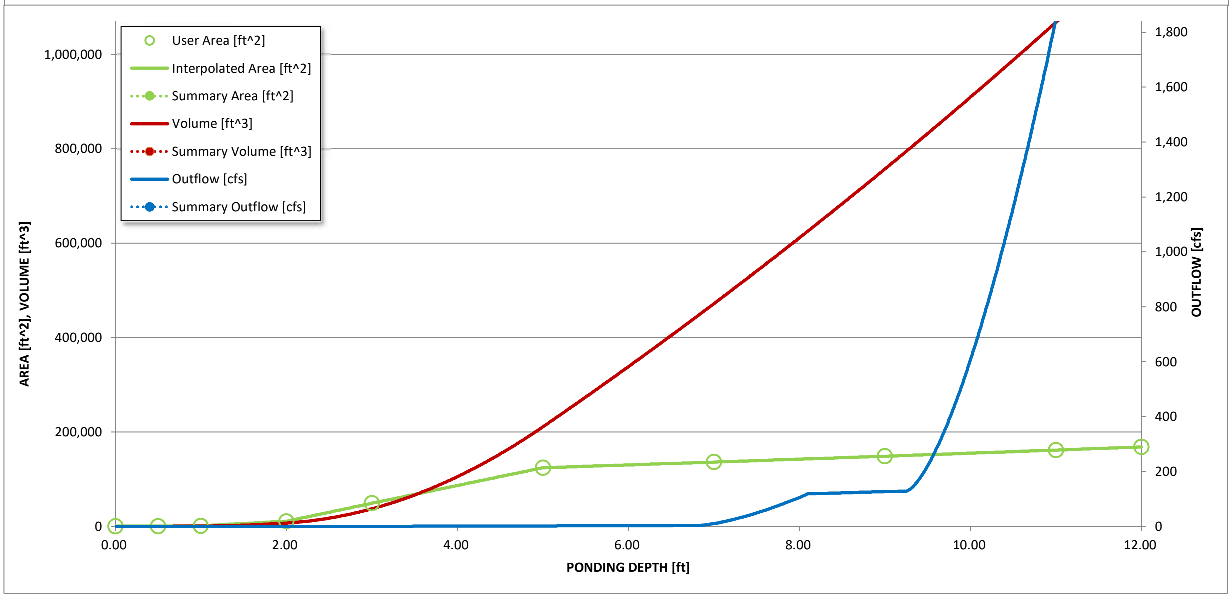
Hydrograph from SWMM model should be copied in to this spreadsheet to get the correct inflows.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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	2.12	0.21	10.47
	0:15:00	0.00	0.00	18.50	30.18	37.57	25.32	31.30	30.96	50.24
	0:20:00	0.00	0.00	62.73	81.48	95.81	60.30	69.86	75.58	109.61
	0:25:00	0.00	0.00	123.31	170.93	209.79	120.68	143.10	156.19	242.70
	0:30:00	0.00	0.00	136.12	180.20	212.91	286.61	355.09	413.27	684.18
	0:35:00	0.00	0.00	109.91	141.70	166.11	303.47	370.58	465.62	744.63
	0:40:00	0.00	0.00	86.36	108.21	125.85	258.24	314.87	393.07	624.22
	0:45:00	0.00	0.00	64.91	83.31	97.63	195.02	235.63	311.27	495.39
	0:50:00	0.00	0.00	50.19	66.56	75.91	153.25	183.65	241.30	390.10
	0:55:00	0.00	0.00	39.27	51.55	59.35	113.68	135.65	183.42	301.16
	1:00:00	0.00	0.00	31.41	40.36	47.14	84.33	99.99	140.99	235.54
	1:05:00	0.00	0.00	27.75	35.54	42.79	63.24	74.45	111.22	189.98
	1:10:00	0.00	0.00	23.53	34.05	41.66	49.30	57.34	78.50	133.05
	1:15:00	0.00	0.00	20.90	31.48	41.29	42.25	48.50	59.76	98.75
	1:20:00	0.00	0.00	19.46	28.62	37.89	35.58	40.55	43.71	69.76
	1:25:00	0.00	0.00	18.58	26.74	32.81	31.34	35.55	34.18	52.41
	1:30:00	0.00	0.00	18.03	25.65	29.37	27.03	30.54	28.59	42.11
	1:35:00	0.00	0.00	17.66	24.97	27.22	24.13	27.17	25.01	35.56
	1:40:00	0.00	0.00	17.47	21.81	25.89	22.37	25.15	23.06	32.13
	1:45:00	0.00	0.00	17.46	19.58	25.04	21.43	24.10	22.46	31.14
	1:50:00	0.00	0.00	17.46	18.25	24.53	20.89	23.50	22.18	30.68
	1:55:00	0.00	0.00	14.37	17.48	23.45	20.65	23.23	22.18	30.68
	2:00:00	0.00	0.00	12.14	16.22	20.96	20.53	23.10	22.18	30.68
	2:05:00	0.00	0.00	7.65	10.26	13.26	13.15	14.76	14.15	19.53
	2:10:00	0.00	0.00	4.53	6.08	7.89	7.87	8.81	8.43	11.54
	2:15:00	0.00	0.00	2.58	3.53	4.52	4.55	5.08	4.85	6.59
	2:20:00	0.00	0.00	1.33	1.96	2.44	2.52	2.81	2.68	3.63
	2:25:00	0.00	0.00	0.59	0.97	1.14	1.25	1.38	1.31	1.76
	2:30:00	0.00	0.00	0.21	0.33	0.34	0.41	0.45	0.42	0.55
	2:35:00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

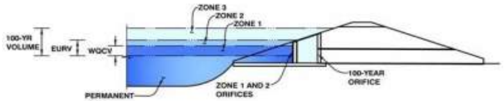
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**

Basin ID: **POND FSD-14B**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	63.10	acres
Watershed Length =	2,200	ft
Watershed Length to Centroid =	900	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	60.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.242	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	4.594	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.357	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	4.422	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.279	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	6.449	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.604	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	9.024	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.48 in.) =	13.911	acre-feet	3.48	inches
Approximate 2-yr Detention Volume =	2.978	acre-feet		
Approximate 5-yr Detention Volume =	3.902	acre-feet		
Approximate 10-yr Detention Volume =	4.721	acre-feet		
Approximate 25-yr Detention Volume =	5.709	acre-feet		
Approximate 50-yr Detention Volume =	6.313	acre-feet		
Approximate 100-yr Detention Volume =	6.974	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.242	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.352	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.380	acre-feet
Total Detention Basin Volume =	6.974	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 = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	100	0.002		
7052	--	2.00	--	--	--	25,000	0.574	25,100	0.576
7054	--	4.00	--	--	--	63,400	1.455	113,500	2.606
7056	--	6.00	--	--	--	72,250	1.659	249,150	5.720
7058	--	8.00	--	--	--	81,500	1.871	402,900	9.249
7060	--	10.00	--	--	--	91,150	2.093	575,550	13.213
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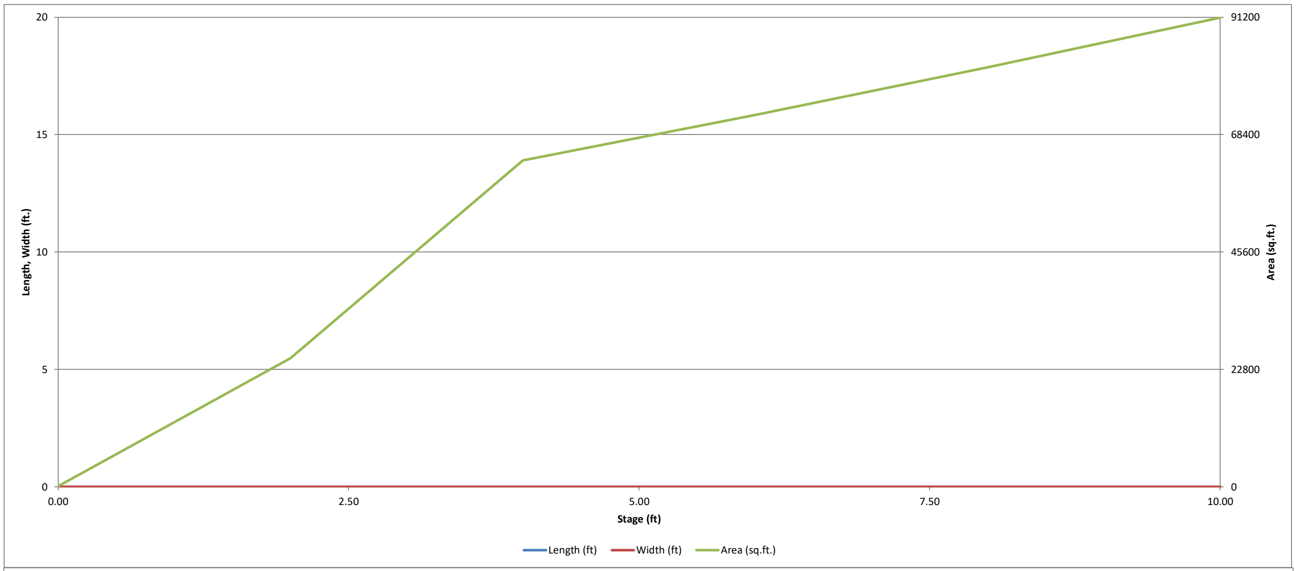
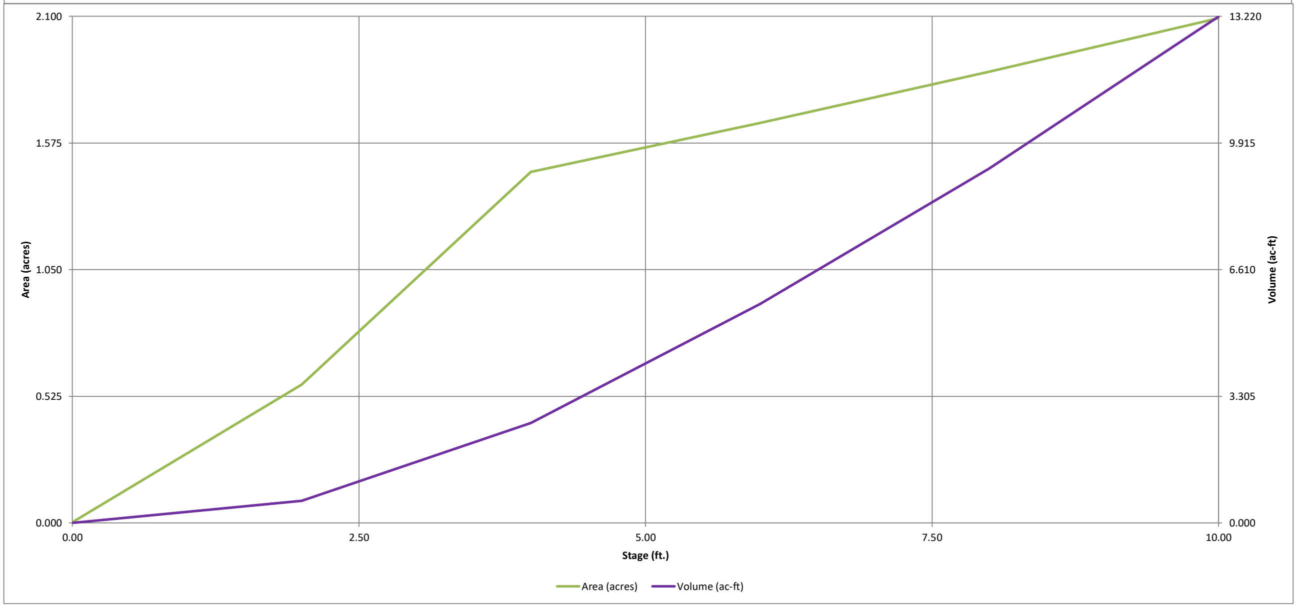
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

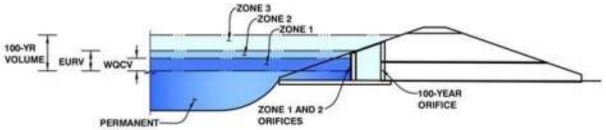




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**
Basin ID: **POND FSD-14B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.87	1.242	Orifice Plate
Zone 2 (EURV)	5.31	3.352	Orifice Plate
Zone 3 (100-year)	6.74	2.380	Weir&Pipe (Restrict)
	Total (all zones)	6.974	

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

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

Calculated Parameters for Underdrain

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

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.50	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	16.50	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.40	2.80	4.20				
Orifice Area (sq. inches)	5.00	5.00	16.00	16.00				

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	12.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.50	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.11	N/A	
Overflow Grate Open Area w/o Debris =	33.41	N/A	ft^2
Overflow Grate Open Area w/ Debris =	16.70	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	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 =	26.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	5.47	N/A	ft^2
Outlet Orifice Centroid =	1.20	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.03	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	70.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.90	feet
Stage at Top of Freeboard =	8.40	feet
Basin Area at Top of Freeboard =	1.92	acres
Basin Volume at Top of Freeboard =	10.01	acre-ft

Routed Hydrograph Results

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

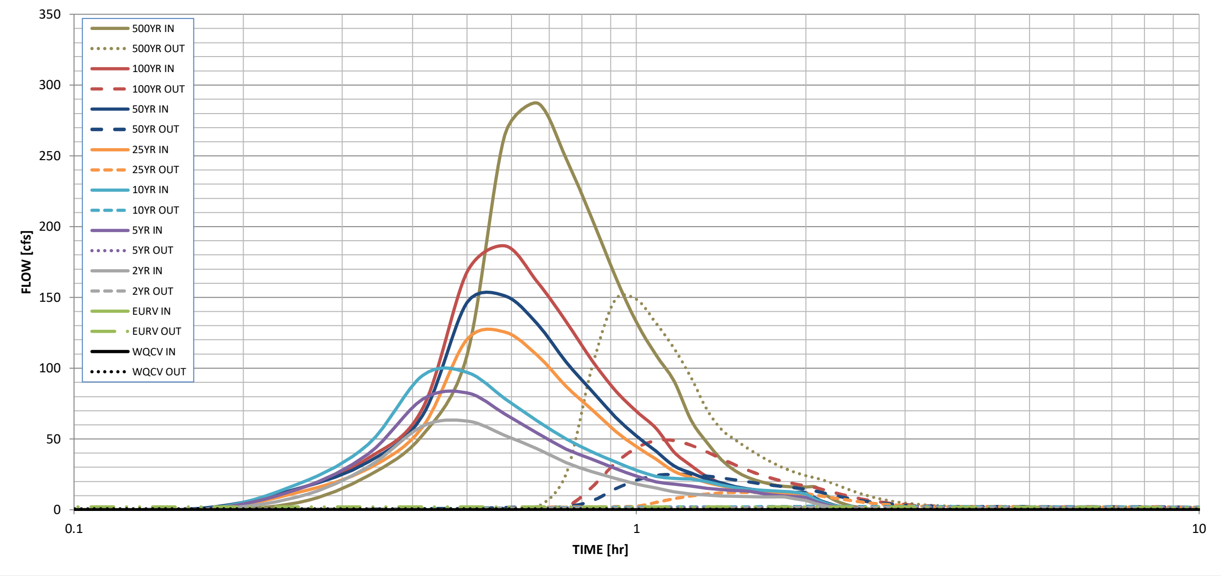
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.48
CUHP Runoff Volume (acre-ft) =	1.242	4.594	3.357	4.422	5.279	6.449	7.604	9.024	13.911
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.357	4.422	5.279	6.449	7.604	9.024	13.911
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.6	1.2	1.6	15.1	29.9	48.9	110.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.03	0.24	0.47	0.78	1.75
Peak Inflow Q (cfs) =	N/A	N/A	62.8	82.7	97.1	125.5	151.1	186.4	287.4
Peak Outflow Q (cfs) =	0.6	2.1	1.5	2.0	2.6	12.3	25.1	48.9	148.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.7	1.6	0.8	0.8	1.0	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.3	0.7	1.4	2.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	48	72	68	72	75	73	71	68	61
Time to Drain 99% of Inflow Volume (hours) =	**51**	79	73	79	83	83	82	81	77
Maximum Ponding Depth (ft) =	2.87	5.31	4.38	5.03	5.54	5.83	6.08	6.43	6.99
Area at Maximum Ponding Depth (acres) =	0.96	1.59	1.49	1.56	1.61	1.64	1.67	1.70	1.76
Maximum Volume Stored (acre-ft) =	1.242	4.599	3.151	4.143	4.951	5.439	5.836	6.443	7.396

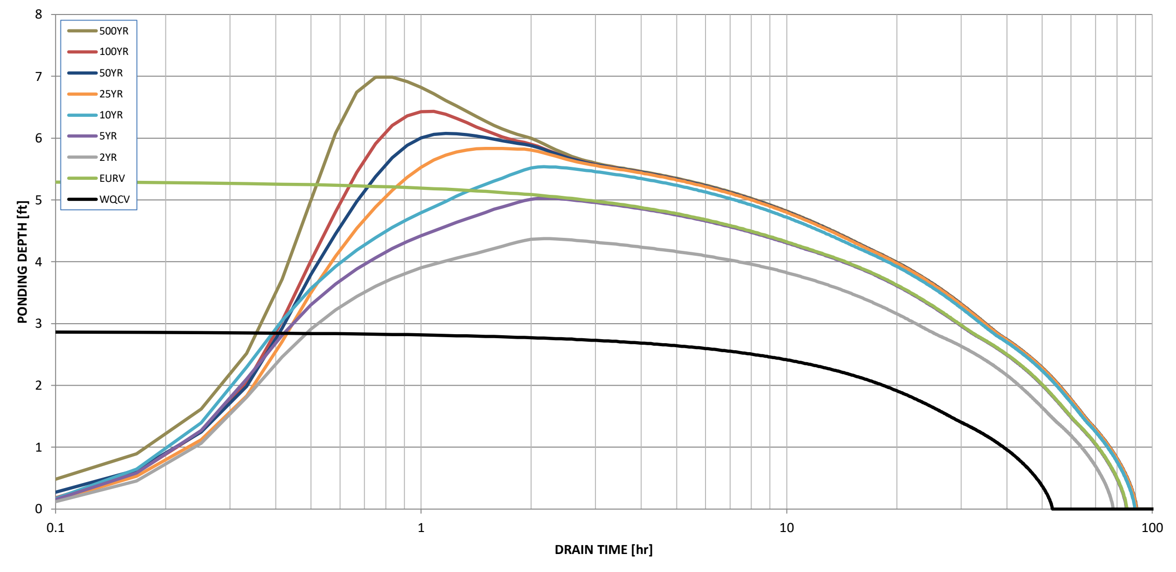
Hydrograph from SWMM model should be copied in to this spreadsheet to get the correct inflows.

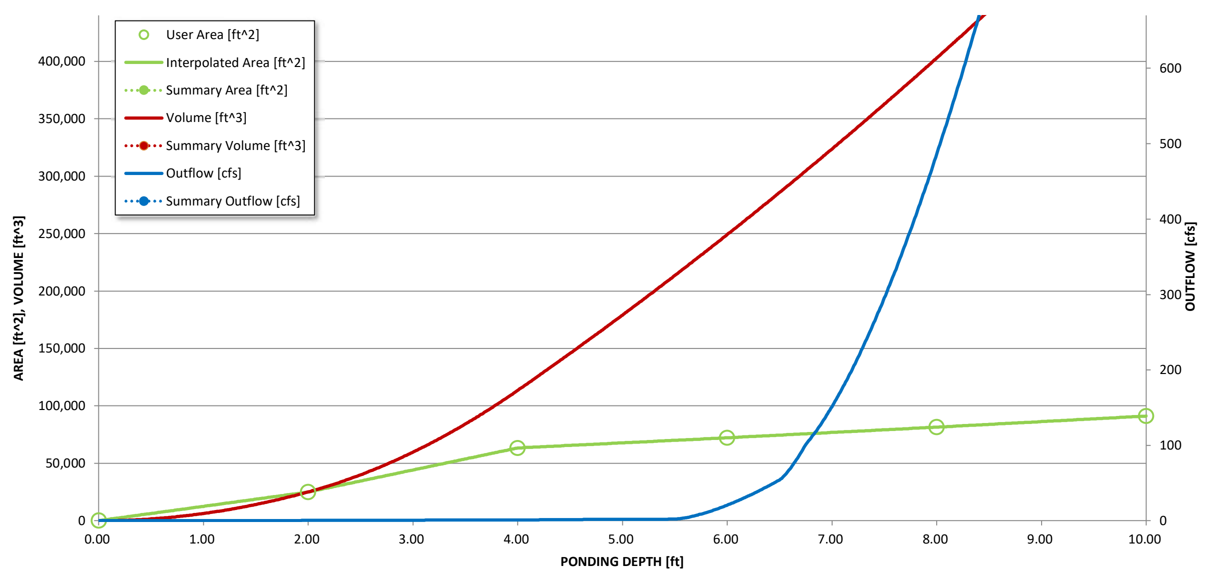
Outflow ratio needs to be closer to 1 or fill in "Override Predev Peak Q" based on 139 acre historic contributing area. Add a note to this sheet either way

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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	1.01	0.10	5.01
	0:15:00	0.00	0.00	8.95	14.54	18.04	12.14	15.00	14.80	24.07
	0:20:00	0.00	0.00	30.41	39.40	46.21	29.06	33.67	36.35	52.73
	0:25:00	0.00	0.00	59.07	78.13	94.83	58.47	66.52	71.53	109.03
	0:30:00	0.00	0.00	62.76	82.69	97.08	120.45	146.28	167.77	264.81
	0:35:00	0.00	0.00	52.51	67.57	78.56	125.54	151.12	186.37	287.39
	0:40:00	0.00	0.00	43.00	54.06	62.66	109.03	131.18	160.87	248.07
	0:45:00	0.00	0.00	33.29	42.84	50.00	87.08	104.22	132.83	205.99
	0:50:00	0.00	0.00	26.98	35.77	40.92	70.84	84.03	105.64	165.14
	0:55:00	0.00	0.00	22.25	29.23	33.83	55.75	65.69	84.46	132.41
	1:00:00	0.00	0.00	18.21	23.75	27.94	44.49	51.96	69.51	109.27
	1:05:00	0.00	0.00	15.38	19.77	23.61	35.76	41.36	57.55	91.00
	1:10:00	0.00	0.00	12.67	18.09	22.07	27.12	30.94	40.77	63.40
	1:15:00	0.00	0.00	11.19	16.64	21.63	22.88	25.95	31.26	47.83
	1:20:00	0.00	0.00	10.32	15.15	19.90	19.19	21.66	23.56	35.35
	1:25:00	0.00	0.00	9.82	14.17	17.39	16.94	19.08	18.61	27.29
	1:30:00	0.00	0.00	9.52	13.53	15.68	14.56	16.38	15.76	22.68
	1:35:00	0.00	0.00	9.30	13.15	14.54	13.03	14.66	13.84	19.57
	1:40:00	0.00	0.00	9.16	11.58	13.79	12.05	13.56	12.63	17.59
	1:45:00	0.00	0.00	9.08	10.44	13.31	11.40	12.83	11.92	16.48
	1:50:00	0.00	0.00	9.08	9.71	12.96	11.06	12.44	11.67	16.13
	1:55:00	0.00	0.00	7.59	9.24	12.32	10.84	12.20	11.56	15.97
	2:00:00	0.00	0.00	6.50	8.60	11.05	10.74	12.09	11.56	15.97
	2:05:00	0.00	0.00	4.29	5.69	7.33	7.16	8.04	7.72	10.64
	2:10:00	0.00	0.00	2.70	3.59	4.67	4.58	5.14	4.93	6.78
	2:15:00	0.00	0.00	1.68	2.21	2.91	2.88	3.23	3.10	4.25
	2:20:00	0.00	0.00	0.96	1.32	1.72	1.71	1.92	1.84	2.52
	2:25:00	0.00	0.00	0.52	0.78	0.99	1.02	1.14	1.09	1.48
	2:30:00	0.00	0.00	0.22	0.38	0.46	0.50	0.56	0.53	0.72
	2:35:00	0.00	0.00	0.07	0.12	0.14	0.16	0.18	0.17	0.23
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

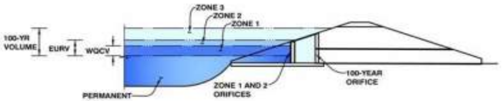
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**

Basin ID: **POND FSD-16 (FULL BUILD OUT)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type = **EDB**
Watershed Area = 220.90 acres
Watershed Length = 4,000 ft
Watershed Length to Centroid = 2,000 ft
Watershed Slope = 0.040 ft/ft
Watershed Imperviousness = 46.00% percent
Percentage Hydrologic Soil Group A = 75.0% percent
Percentage Hydrologic Soil Group B = 25.0% 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) = 3.600 acre-feet | acre-feet
Excess Urban Runoff Volume (EURV) = 11.282 acre-feet | acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) = 8.940 acre-feet | 1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) = 11.873 acre-feet | 1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) = 14.781 acre-feet | 1.75 inches
25-yr Runoff Volume (P1 = 2 in.) = 19.914 acre-feet | 2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) = 23.968 acre-feet | 2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) = 29.516 acre-feet | 2.52 inches
500-yr Runoff Volume (P1 = 3.48 in.) = 47.026 acre-feet | 3.48 inches
Approximate 2-yr Detention Volume = 7.518 acre-feet
Approximate 5-yr Detention Volume = 10.041 acre-feet
Approximate 10-yr Detention Volume = 12.630 acre-feet
Approximate 25-yr Detention Volume = 15.056 acre-feet
Approximate 50-yr Detention Volume = 16.576 acre-feet
Approximate 100-yr Detention Volume = 18.826 acre-feet

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) = 3.600 acre-feet
Zone 2 Volume (EURV - Zone 1) = 7.682 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) = 7.544 acre-feet
Total Detention Basin Volume = 18.826 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 = 2.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	650	0.015		
7092	--	0.50	--	--	--	650	0.015	325	0.007
7094	--	2.50	--	--	--	13,311	0.306	14,286	0.328
7096	--	4.50	--	--	--	51,595	1.184	79,192	1.818
7098	--	6.50	--	--	--	89,663	2.058	220,450	5.061
7100	--	8.50	--	--	--	107,054	2.458	417,167	9.577
7102	--	10.50	--	--	--	185,183	4.251	709,404	16.286
7104	--	12.50	--	--	--	263,928	6.059	1,158,515	26.596
7106	--	14.50	--	--	--	343,298	7.881	1,765,741	40.536
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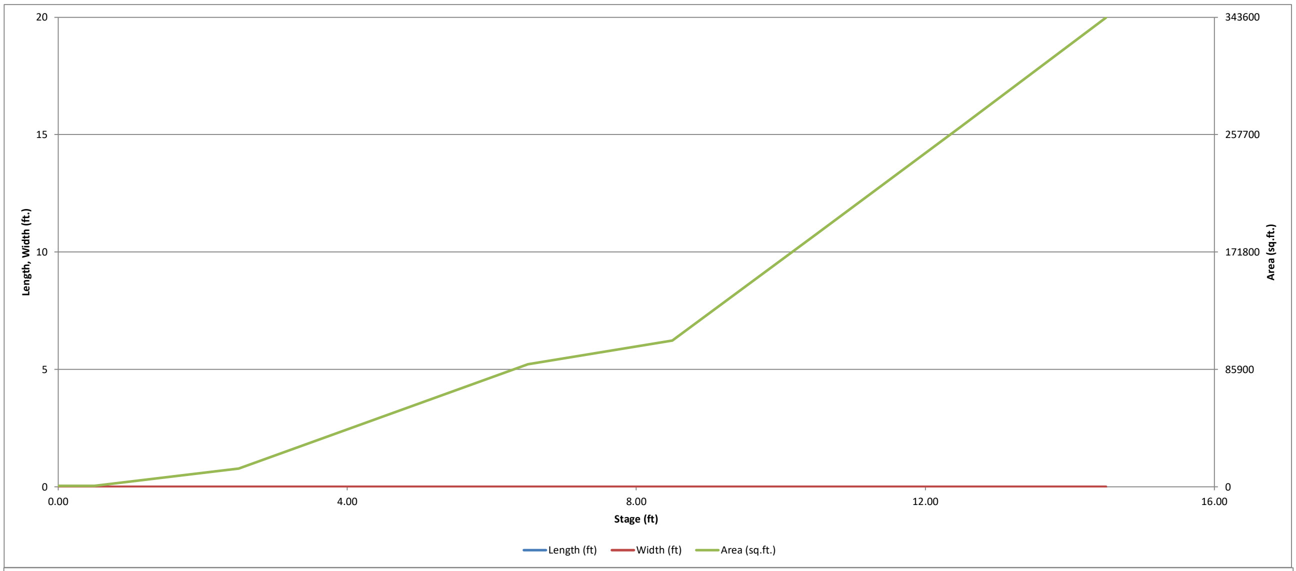
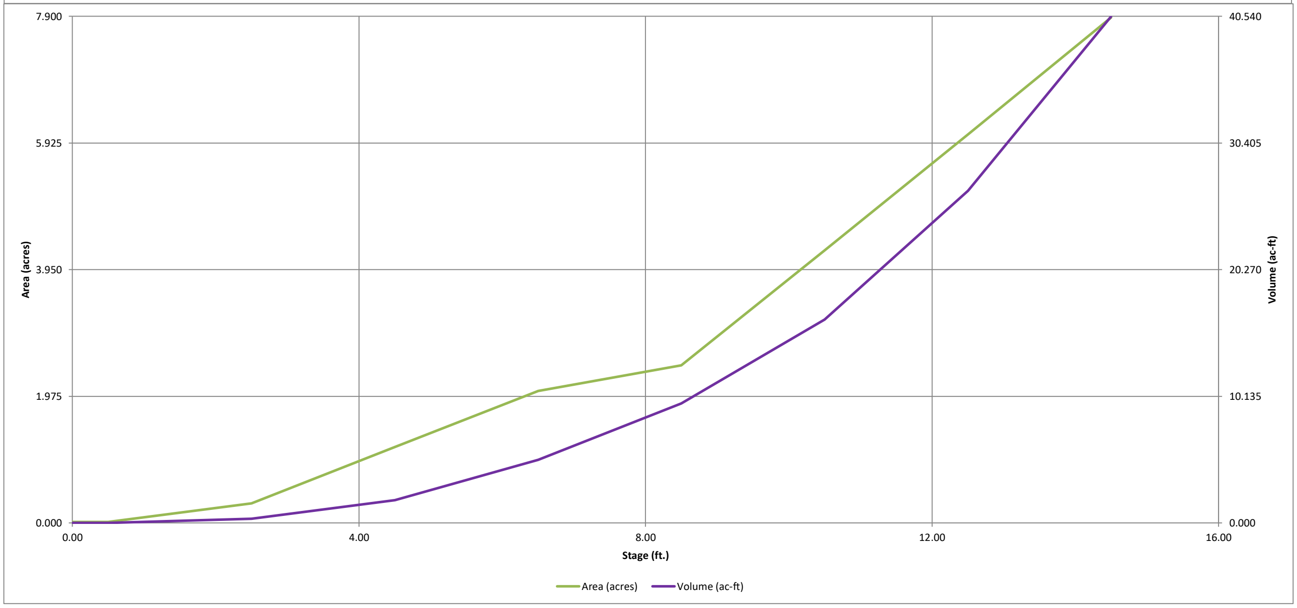
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

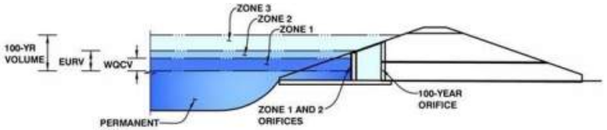




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**
Basin ID: **POND FSD-16 (FULL BUILD OUT)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.73	3.600	Orifice Plate
Zone 2 (EURV)	9.13	7.682	Orifice Plate
Zone 3 (100-year)	11.07	7.544	Weir&Pipe (Restrict)
	Total (all zones)	18.826	

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)

Calculated Parameters for Plate

Centroid 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 =	10.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	30.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.50	5.00	7.50				
Orifice Area (sq. inches)	10.00	10.00	16.00	16.00				

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

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orifice

	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	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	10.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	10.00	N/A	feet
Overflow Weir Front Edge Length =	20.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.17	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	55.68	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	27.84	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.81	N/A	ft^2
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.31	N/A	feet
Restrictor Plate Height Above Pipe Invert =	28.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=	12.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.91	feet
Spillway Crest Length =	165.00	feet	Stage at Top of Freeboard =	13.91	feet
Spillway End Slopes =	6.00	H:V	Basin Area at Top of Freeboard =	7.34	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	36.04	acre-ft

Routed Hydrograph Results

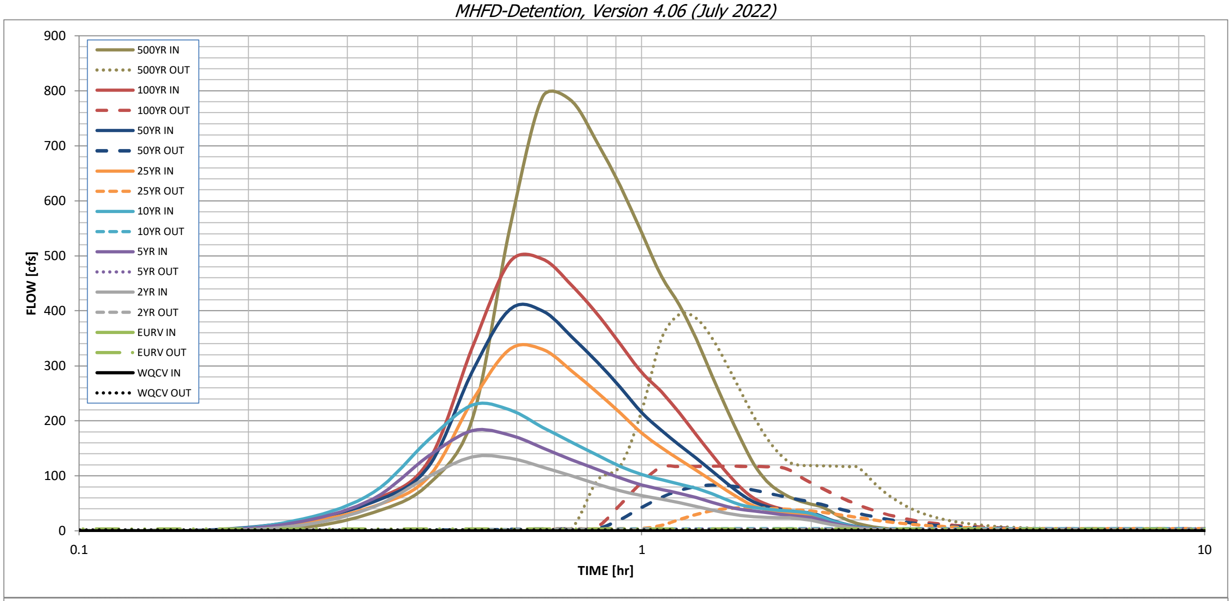
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

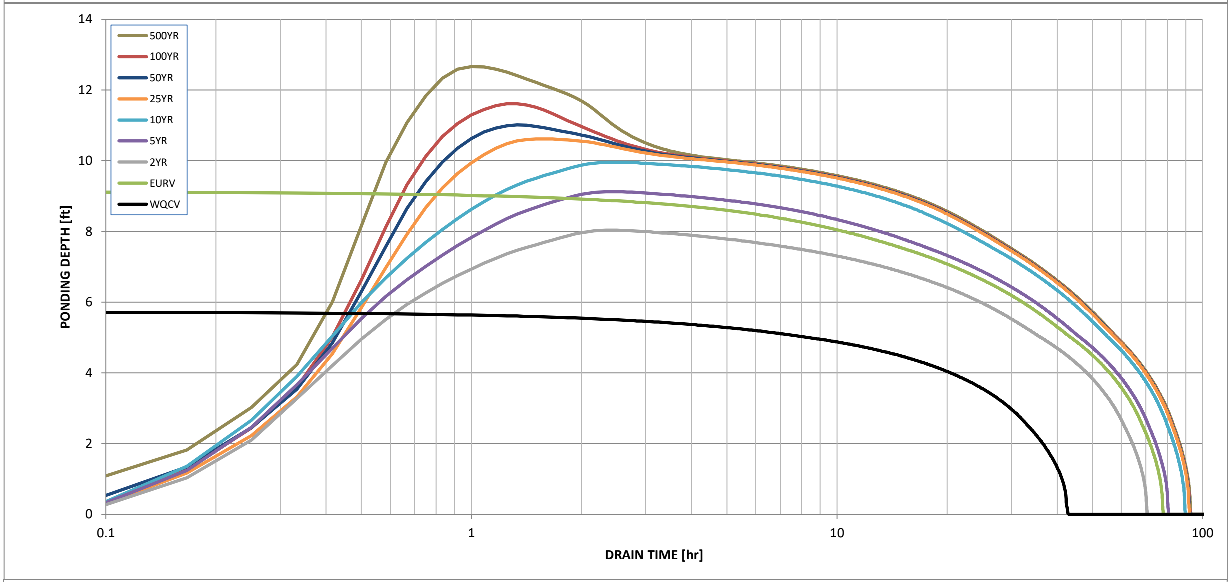
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.48
CUHP Runoff Volume (acre-ft) =	3.600	11.282	8.940	11.873	14.781	19.914	23.968	29.516	47.026
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	8.940	11.873	14.781	19.914	23.968	29.516	47.026
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.7	4.5	23.4	95.7	140.7	204.0	401.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.11	0.43	0.64	0.92	1.82
Peak Inflow Q (cfs) =	N/A	N/A	134.6	182.2	228.7	330.2	402.8	494.0	788.8
Peak Outflow Q (cfs) =	1.9	3.6	3.1	3.6	4.0	41.8	83.2	117.4	393.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.2	0.4	0.6	0.6	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.7	1.4	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	68	63	71	78	78	77	75	69
Time to Drain 99% of Inflow Volume (hours) =	**41**	74	67	77	85	86	85	84	81
Maximum Ponding Depth (ft) =	5.73	9.13	8.04	9.12	9.96	10.62	11.01	11.61	12.66
Area at Maximum Ponding Depth (acres) =	1.72	3.02	2.36	3.01	3.76	4.35	4.71	5.25	6.20
Maximum Volume Stored (acre-ft) =	3.605	11.303	8.444	11.273	14.083	16.759	18.571	21.561	27.577

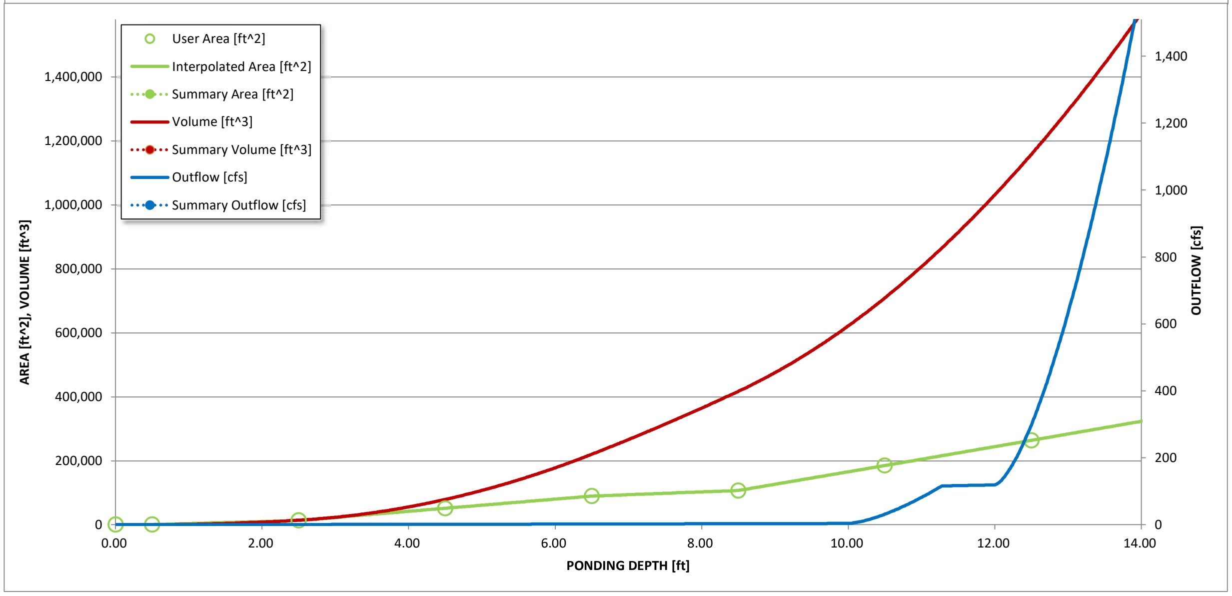
Hydrograph from SWMM model should be copied in to this spreadsheet.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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	1.23	0.12	6.09
	0:15:00	0.00	0.00	10.59	17.44	21.72	14.65	18.92	18.01	33.15
	0:20:00	0.00	0.00	42.82	58.40	69.52	44.42	52.36	55.47	83.15
	0:25:00	0.00	0.00	97.98	134.85	164.01	95.87	114.31	124.27	202.31
	0:30:00	0.00	0.00	134.60	182.19	228.67	236.07	289.41	332.60	551.71
	0:35:00	0.00	0.00	131.79	174.06	219.72	330.18	402.83	489.40	788.83
	0:40:00	0.00	0.00	116.03	150.52	188.12	329.89	399.70	494.03	781.97
	0:45:00	0.00	0.00	99.78	129.33	161.20	291.17	353.13	446.77	706.25
	0:50:00	0.00	0.00	84.86	111.72	137.59	251.98	307.08	394.53	626.56
	0:55:00	0.00	0.00	72.75	95.80	116.96	214.13	260.79	338.93	541.57
	1:00:00	0.00	0.00	63.74	83.42	102.26	177.34	214.84	287.76	463.09
	1:05:00	0.00	0.00	57.71	75.15	92.81	151.21	182.61	252.78	410.98
	1:10:00	0.00	0.00	51.11	68.33	85.12	129.57	155.96	214.40	348.78
	1:15:00	0.00	0.00	44.03	60.58	77.53	110.05	131.97	174.60	282.34
	1:20:00	0.00	0.00	37.59	51.87	67.69	91.14	108.56	138.48	221.64
	1:25:00	0.00	0.00	31.95	44.15	56.26	73.54	86.71	105.94	166.71
	1:30:00	0.00	0.00	27.78	38.75	47.33	57.34	66.81	78.39	120.90
	1:35:00	0.00	0.00	25.59	36.04	42.35	45.19	52.30	59.06	90.39
	1:40:00	0.00	0.00	24.62	33.05	39.39	38.38	44.14	48.07	72.80
	1:45:00	0.00	0.00	24.04	29.97	37.26	34.39	39.28	41.28	61.35
	1:50:00	0.00	0.00	23.66	27.76	35.77	31.84	36.14	36.74	53.51
	1:55:00	0.00	0.00	21.60	26.09	34.17	30.11	34.06	33.65	48.04
	2:00:00	0.00	0.00	18.95	24.37	31.53	28.96	32.69	31.47	44.16
	2:05:00	0.00	0.00	15.23	19.83	25.40	23.87	26.88	25.40	35.22
	2:10:00	0.00	0.00	11.36	14.66	18.68	17.50	19.66	18.43	25.40
	2:15:00	0.00	0.00	8.47	10.85	13.71	12.88	14.44	13.56	18.58
	2:20:00	0.00	0.00	6.24	7.96	10.01	9.45	10.57	9.99	13.65
	2:25:00	0.00	0.00	4.55	5.73	7.24	6.83	7.63	7.25	9.87
	2:30:00	0.00	0.00	3.25	4.01	5.16	4.84	5.40	5.15	6.97
	2:35:00	0.00	0.00	2.27	2.79	3.65	3.46	3.85	3.67	4.96
	2:40:00	0.00	0.00	1.52	1.91	2.49	2.40	2.67	2.53	3.40
	2:45:00	0.00	0.00	0.93	1.23	1.55	1.54	1.70	1.60	2.13
	2:50:00	0.00	0.00	0.49	0.70	0.84	0.87	0.95	0.89	1.15
	2:55:00	0.00	0.00	0.21	0.32	0.36	0.39	0.41	0.38	0.47
	3:00:00	0.00	0.00	0.06	0.09	0.09	0.10	0.10	0.09	0.09
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

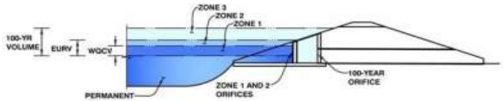
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **STERLING RANCH EAST PRELIMINARY PLAN NO. 1**

Basin ID: **POND FSD-16 (PRELIM. PLAN 1 & FOURSQUARE PUD ONLY)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type = **EDB**
Watershed Area = 220.90 acres
Watershed Length = 4,000 ft
Watershed Length to Centroid = 2,000 ft
Watershed Slope = 0.040 ft/ft
Watershed Imperviousness = 26.00% percent
Percentage Hydrologic Soil Group A = 75.0% percent
Percentage Hydrologic Soil Group B = 25.0% 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) =	2.547	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.592	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	4.110	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	5.787	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	8.129	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	13.122	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	16.794	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	22.358	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.48 in.) =	39.476	acre-feet	3.48	inches
Approximate 2-yr Detention Volume =	3.611	acre-feet		
Approximate 5-yr Detention Volume =	4.947	acre-feet		
Approximate 10-yr Detention Volume =	6.597	acre-feet		
Approximate 25-yr Detention Volume =	8.208	acre-feet		
Approximate 50-yr Detention Volume =	9.303	acre-feet		
Approximate 100-yr Detention Volume =	11.510	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) = 2.547 acre-feet
Zone 2 Volume (EURV - Zone 1) = 3.046 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) = 5.917 acre-feet
Total Detention Basin Volume = 11.510 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 = 2.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	650	0.015		
7092	--	0.50	--	--	--	650	0.015	325	0.007
7094	--	2.50	--	--	--	13,311	0.306	14,286	0.328
7096	--	4.50	--	--	--	51,595	1.184	79,192	1.818
7098	--	6.50	--	--	--	89,663	2.058	220,450	5.061
7100	--	8.50	--	--	--	107,054	2.458	417,167	9.577
7102	--	10.50	--	--	--	185,183	4.251	709,404	16.286
7104	--	12.50	--	--	--	263,928	6.059	1,158,515	26.596
7106	--	14.50	--	--	--	343,298	7.881	1,765,741	40.536
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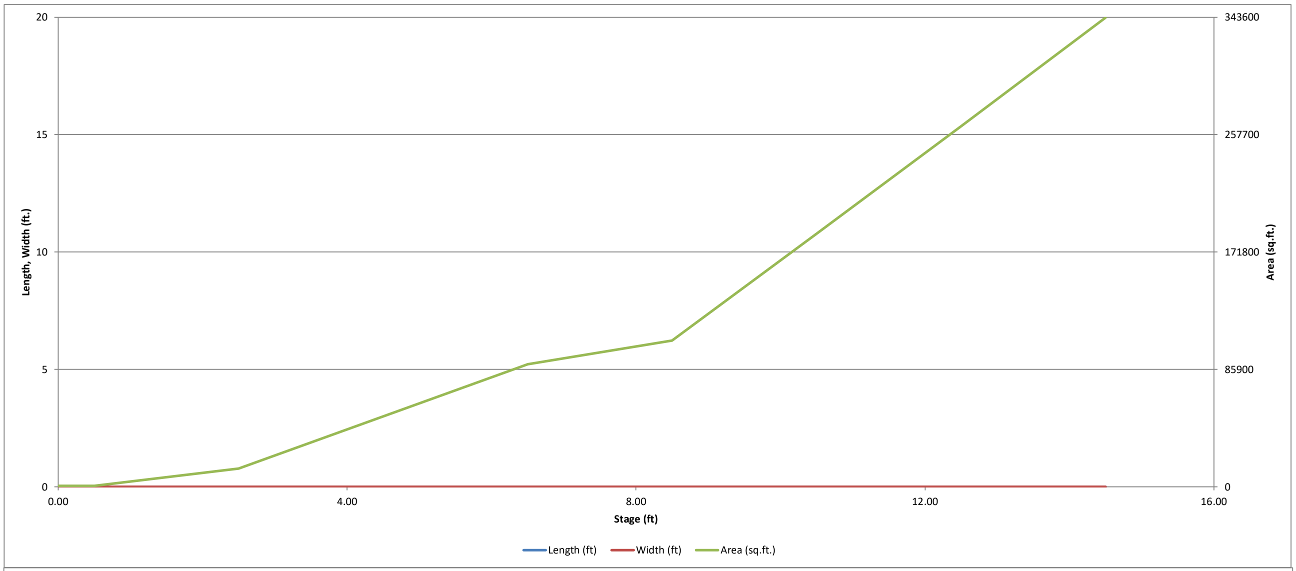
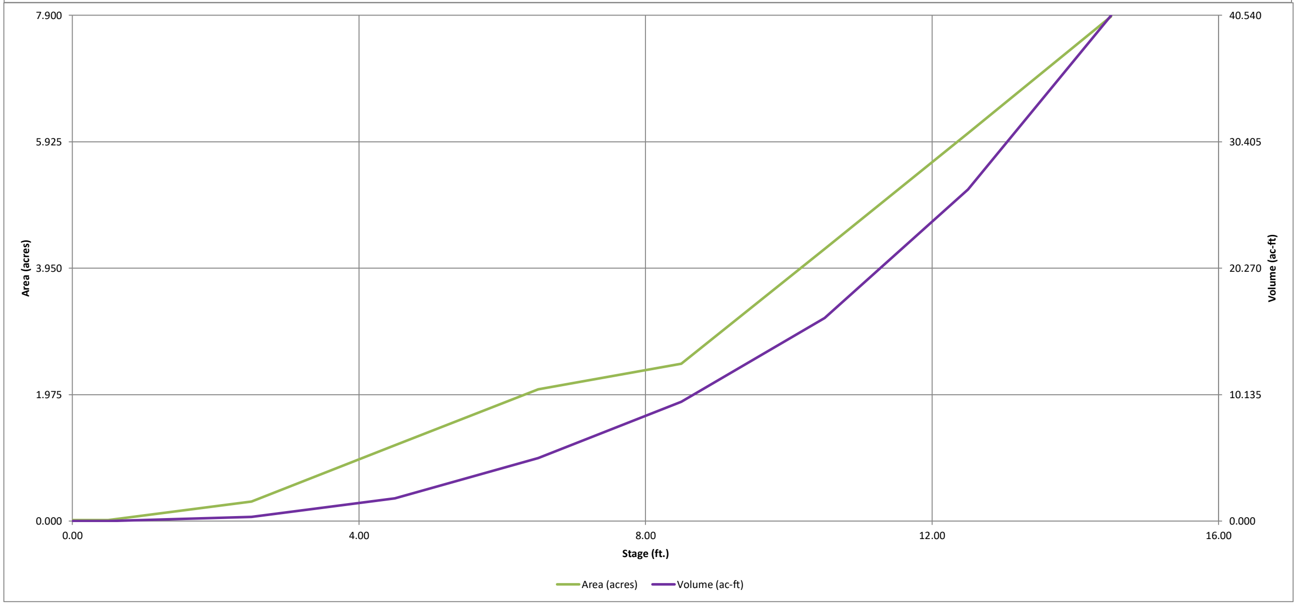
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



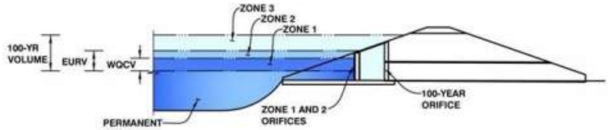


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Basin ID: POND FSD-16 (PRELIM. PLAN 1 & FOURSQUARE PUD ONLY)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.06	2.547	Orifice Plate
Zone 2 (EURV)	6.76	3.046	Orifice Plate
Zone 3 (100-year)	9.20	5.917	Weir&Pipe (Restrict)
Total (all zones)		11.510	

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)

Calculated Parameters for Plate

Centroid 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 =	10.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	30.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.50	5.00	7.50				
Orifice Area (sq. inches)	8.30	8.30	28.27	28.27				

	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)

Calculated Parameters for Vertical Orifice

	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	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	10.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	10.00	N/A	feet
Overflow Weir Front Edge Length =	20.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.17	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	55.68	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	27.84	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.81	N/A	ft^2
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.31	N/A	feet
Restrictor Plate Height Above Pipe Invert =	28.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=	12.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.91	feet
Spillway Crest Length =	165.00	feet	Stage at Top of Freeboard =	13.91	feet
Spillway End Slopes =	6.00	H:V	Basin Area at Top of Freeboard =	7.34	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	36.04	acre-ft

Routed Hydrograph Results

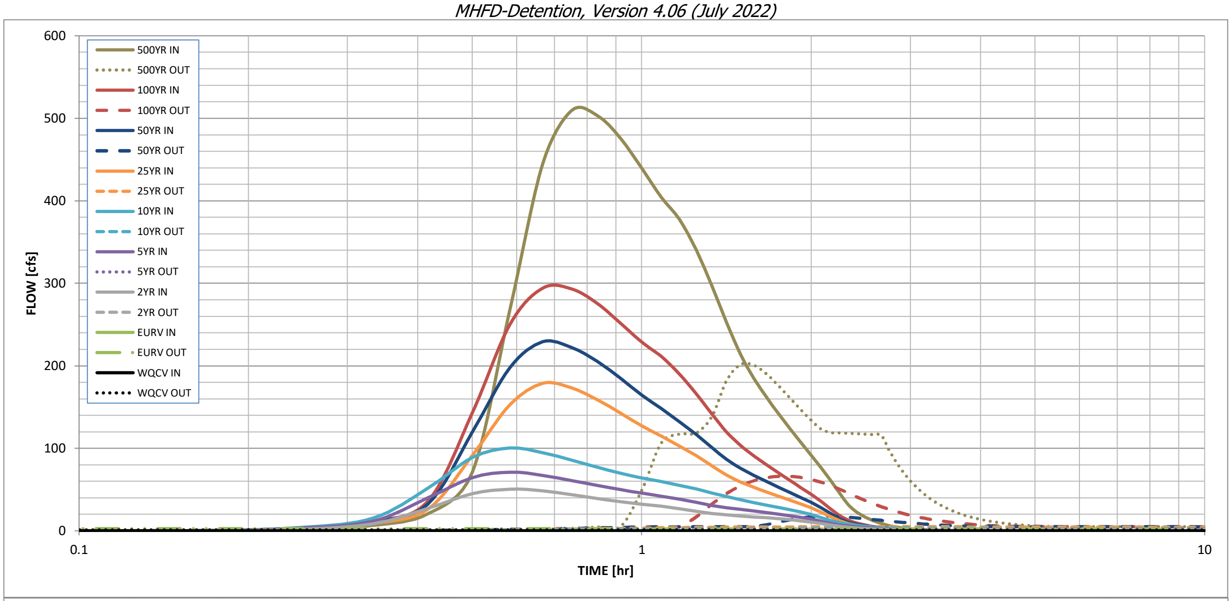
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

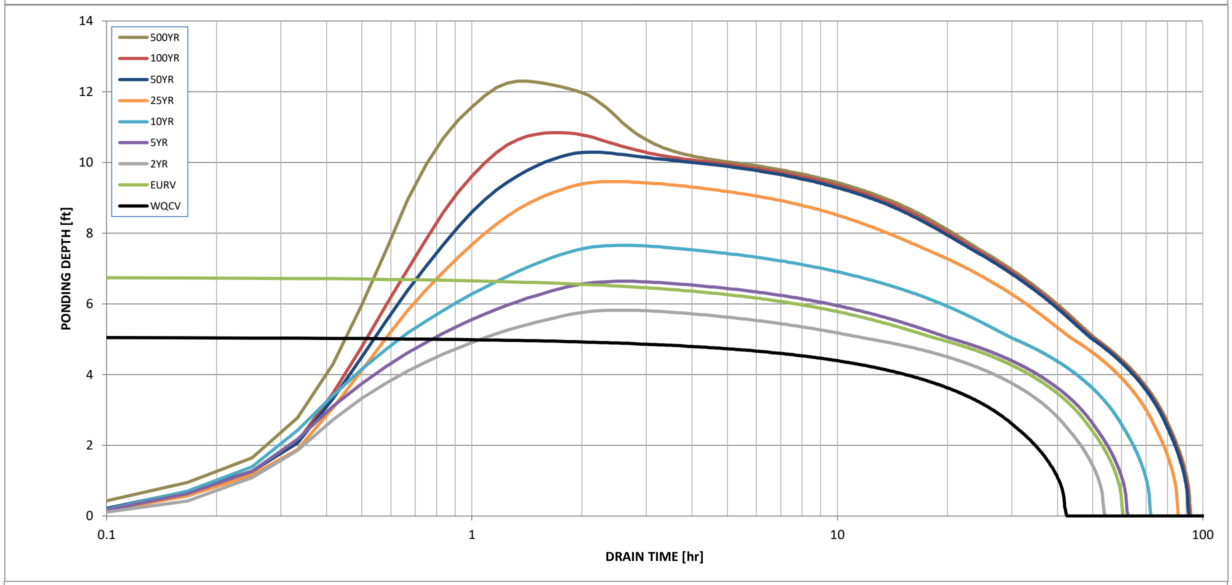
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.48
CUHP Runoff Volume (acre-ft) =	2.547	5.592	4.110	5.787	8.129	13.122	16.794	22.358	39.476
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.110	5.787	8.129	13.122	16.794	22.358	39.476
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.7	4.5	23.4	95.7	140.7	204.0	401.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.11	0.43	0.64	0.92	1.82
Peak Inflow Q (cfs) =	N/A	N/A	50.6	71.1	100.3	178.7	229.1	294.1	509.2
Peak Outflow Q (cfs) =	1.3	2.5	2.0	2.5	3.3	4.9	17.8	66.0	201.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.1	0.1	0.1	0.3	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.2	1.1	2.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	54	49	55	63	73	76	74	67
Time to Drain 99% of Inflow Volume (hours) =	**41**	58	52	59	68	80	85	84	80
Maximum Ponding Depth (ft) =	5.06	6.76	5.82	6.64	7.66	9.46	10.30	10.85	12.30
Area at Maximum Ponding Depth (acres) =	1.43	2.11	1.76	2.08	2.29	3.31	4.06	4.56	5.87
Maximum Volume Stored (acre-ft) =	2.550	5.603	3.762	5.330	7.560	12.316	15.413	17.783	25.343

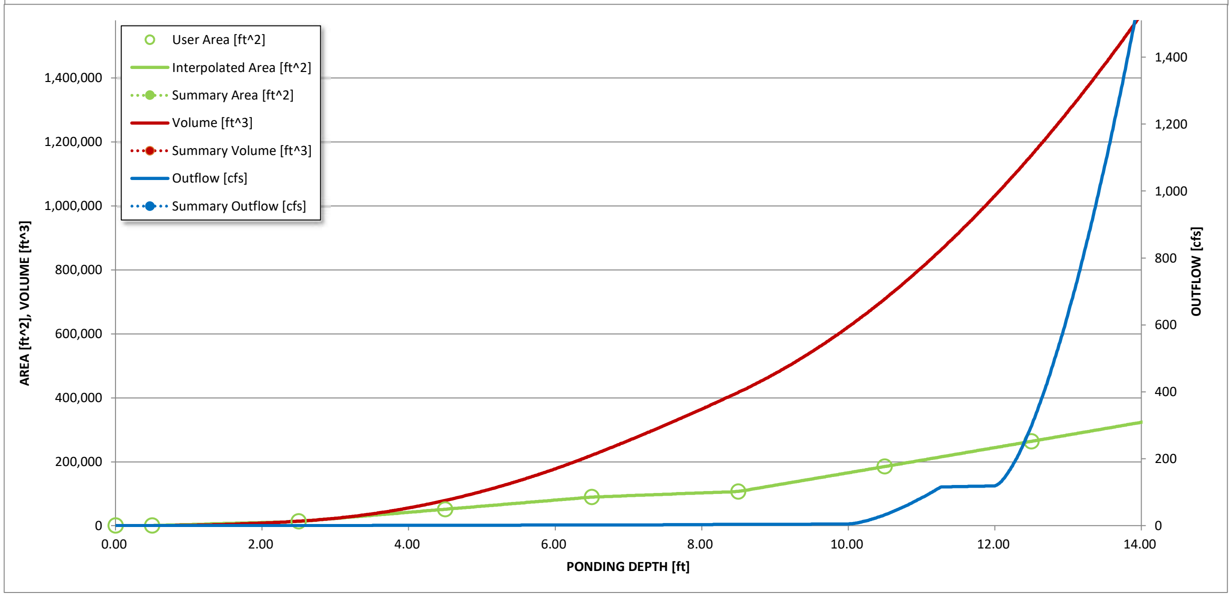
Hydrograph from SWMM model should be copied in to this spreadsheet to get the correct inflows.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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	0.24	0.02	1.18
	0:15:00	0.00	0.00	2.03	3.34	4.17	2.82	3.68	3.47	6.61
	0:20:00	0.00	0.00	8.59	11.82	15.31	9.04	10.77	11.30	20.43
	0:25:00	0.00	0.00	27.16	39.83	51.41	26.13	32.34	35.79	70.62
	0:30:00	0.00	0.00	44.93	64.44	88.85	91.14	119.27	142.88	268.21
	0:35:00	0.00	0.00	50.55	71.08	100.35	152.92	197.95	250.14	444.67
	0:40:00	0.00	0.00	48.41	67.27	94.81	178.70	229.13	294.14	509.21
	0:45:00	0.00	0.00	43.75	60.84	85.71	173.31	222.22	293.11	503.55
	0:50:00	0.00	0.00	39.15	55.15	77.15	159.03	205.45	275.77	476.05
	0:55:00	0.00	0.00	35.24	49.86	69.74	142.72	184.91	251.80	439.26
	1:00:00	0.00	0.00	32.24	45.61	64.15	127.18	164.52	228.67	404.19
	1:05:00	0.00	0.00	29.69	41.92	59.56	114.79	148.04	211.24	377.59
	1:10:00	0.00	0.00	26.81	38.40	55.04	102.87	132.34	190.08	340.58
	1:15:00	0.00	0.00	23.82	34.57	50.68	91.03	116.89	166.02	296.73
	1:20:00	0.00	0.00	21.07	30.64	45.81	78.75	100.91	141.51	252.08
	1:25:00	0.00	0.00	19.20	27.98	41.40	67.41	86.34	119.49	213.16
	1:30:00	0.00	0.00	17.91	26.00	37.70	59.10	75.65	103.29	184.49
	1:35:00	0.00	0.00	16.77	24.22	34.30	52.60	67.07	90.75	161.64
	1:40:00	0.00	0.00	15.71	22.25	31.20	47.10	59.73	80.01	141.90
	1:45:00	0.00	0.00	14.66	20.16	28.30	41.94	52.93	70.29	123.97
	1:50:00	0.00	0.00	13.60	18.12	25.52	37.13	46.62	61.21	107.29
	1:55:00	0.00	0.00	12.21	16.16	22.72	32.43	40.46	52.51	91.47
	2:00:00	0.00	0.00	10.62	14.16	19.71	27.86	34.48	44.22	76.59
	2:05:00	0.00	0.00	8.74	11.67	16.08	22.62	27.77	35.48	61.02
	2:10:00	0.00	0.00	6.83	9.07	12.40	17.10	20.76	26.48	45.13
	2:15:00	0.00	0.00	5.27	7.03	9.62	12.05	14.38	18.17	30.96
	2:20:00	0.00	0.00	4.22	5.67	7.80	8.61	10.26	12.72	22.24
	2:25:00	0.00	0.00	3.48	4.65	6.43	6.48	7.68	9.29	16.39
	2:30:00	0.00	0.00	2.87	3.83	5.28	5.07	5.95	6.86	12.05
	2:35:00	0.00	0.00	2.37	3.15	4.31	3.99	4.62	5.09	8.80
	2:40:00	0.00	0.00	1.93	2.56	3.47	3.14	3.62	3.76	6.34
	2:45:00	0.00	0.00	1.57	2.06	2.75	2.45	2.81	2.72	4.46
	2:50:00	0.00	0.00	1.28	1.64	2.15	1.90	2.17	1.98	3.18
	2:55:00	0.00	0.00	1.04	1.30	1.68	1.49	1.69	1.54	2.50
	3:00:00	0.00	0.00	0.84	1.04	1.32	1.19	1.34	1.23	2.00
	3:05:00	0.00	0.00	0.67	0.82	1.03	0.94	1.05	0.99	1.60
	3:10:00	0.00	0.00	0.52	0.63	0.80	0.73	0.81	0.77	1.24
	3:15:00	0.00	0.00	0.38	0.47	0.60	0.55	0.61	0.58	0.93
	3:20:00	0.00	0.00	0.27	0.33	0.43	0.40	0.44	0.42	0.67
	3:25:00	0.00	0.00	0.18	0.22	0.29	0.27	0.30	0.28	0.44
	3:30:00	0.00	0.00	0.11	0.14	0.17	0.17	0.18	0.17	0.26
	3:35:00	0.00	0.00	0.05	0.08	0.09	0.09	0.10	0.09	0.13
	3:40:00	0.00	0.00	0.02	0.03	0.03	0.04	0.04	0.03	0.04
	3:45:00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

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

DRAINAGE MAPS

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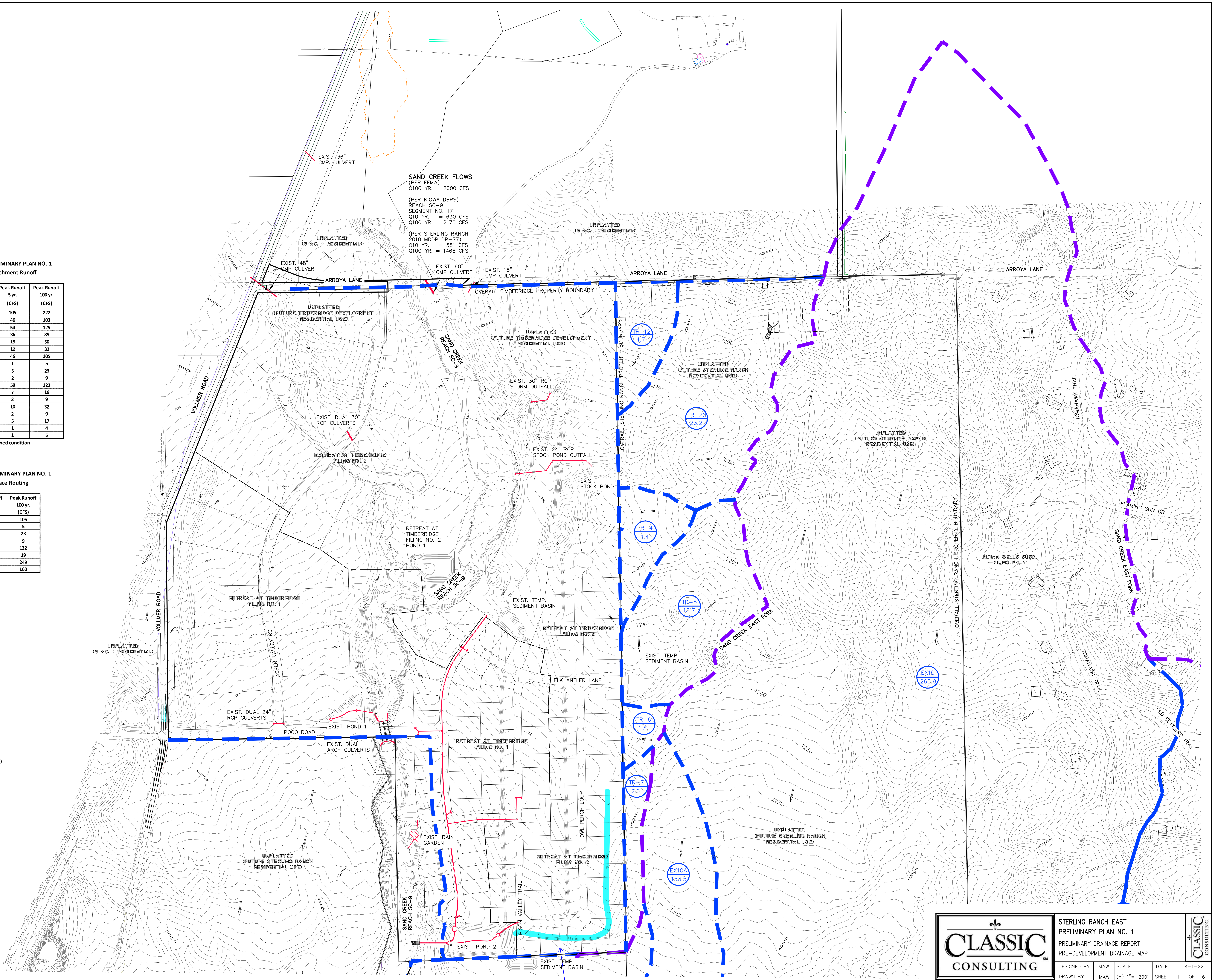
STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
EX10A	153.5	5%	46	103
EX-11 *	214.3	4%	54	129
EX-13 *	94.8	6%	36	85
EX-4A	44.2	8%	19	50
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Surface Routing

Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	46	105
4A	1	5
5	5	23
5A	2	9
6	59	122
6A	7	19
7	110	249
56	60	160



SCALE: 1" = 200'

Show basin contributing flows to SR

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	—— 6910 ——
SUB–BASIN BOUNDARY	▬ ▬ ▬
SAND CREEK EAST FORK BASIN LINE	▬ ▬
DESIGN POINT	△4
BASIN IDENTIFIER AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	⇨
EXISTING STORM SEWER	▬

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STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
PRE-DEVELOPMENT DRAINAGE MAP

DESIGNED BY MAW	SCALE	DATE 4-1-22	
DRAWN BY MAW	(H) 1"= 200'	SHEET 1 OF 6	
CHECKED BY	(V) 1"= N/A	JOB NO. 1183.22	

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	—— 6910 ——
SUB–BASIN BOUNDARY	▬ ▬ ▬
SAND CREEK EAST FORK BASIN LINE	▬ ▬
DESIGN POINT	△ 4
BASIN IDENTIFIER → AREA IN ACRES →	BB 10.0
EXISTING DIRECTION OF FLOW	⇨
EXISTING STORM SEWER	▬

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
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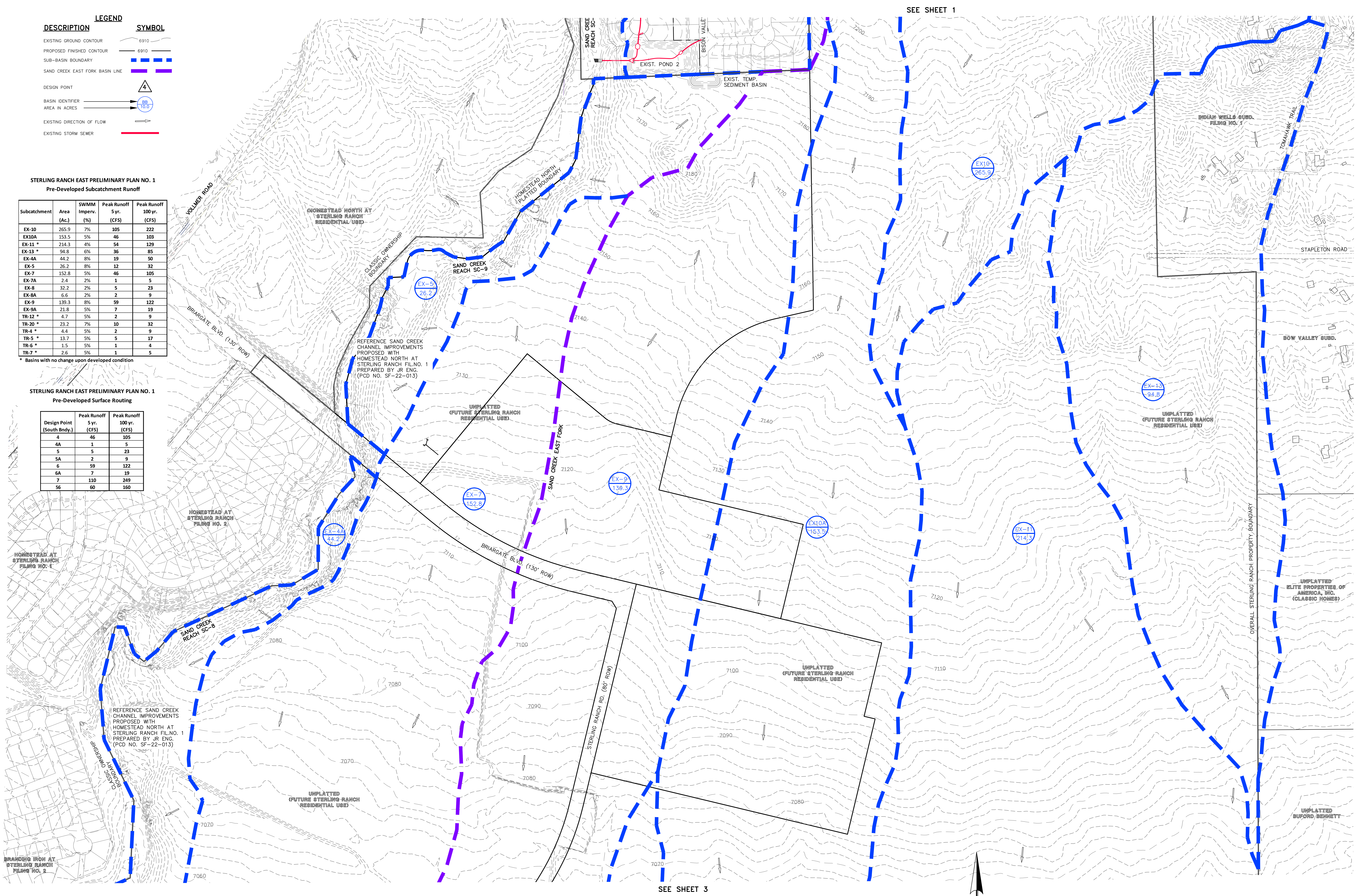
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Surface Routing

Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	46	105
4A	1	5
5	5	23
5A	2	9
6	59	122
6A	7	19
7	110	249
56	60	160



REFERENCE SAND CREEK CHANNEL IMPROVEMENTS PROPOSED WITH HOMESTEAD NORTH AT STERLING RANCH FIL.NO. 1 PREPARED BY JR ENG. (PCD NO. SF–22–013)

REFERENCE SAND CREEK CHANNEL IMPROVEMENTS PROPOSED WITH HOMESTEAD NORTH AT STERLING RANCH FIL.NO. 1 PREPARED BY JR ENG. (PCD NO. SF–22–013)

200 100 0 200 400

SCALE: 1" = 200'

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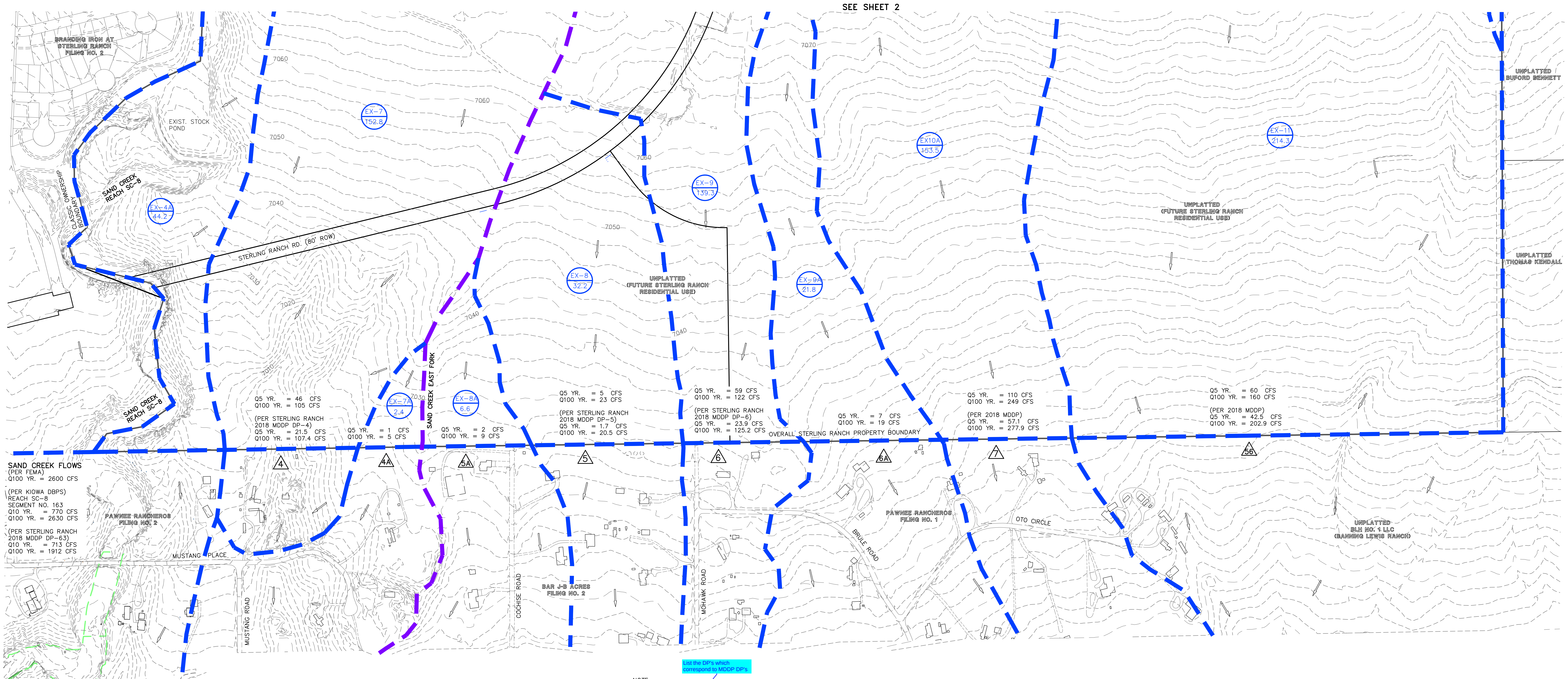
STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
PRE–DEVELOPMENT DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4–1–22
DRAWN BY	MAW	(H) 1"= 200'	SHEET 2 OF 6
CHECKED BY		(V) 1"= N/A	JOB NO. 1183.22



List the DP's which correspond to MDDP DP's

NOTE:

THE FOLLOWING LABELS AS SHOWN ALONG THE SOUTH BOUNDARY REPRESENT PRE-DEVELOPED FLOWS AS PRESENTED IN THE 2018 STERLING RANCH MDDP. SEE REFERENCE MATERIAL IN APPENDIX FOR ORIGINAL MAP.

(PER STERLING RANCH
2018 MDDP DP-5)
Q5 YR. = 1.7 CFS
Q100 YR. = 20.5 CFS

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
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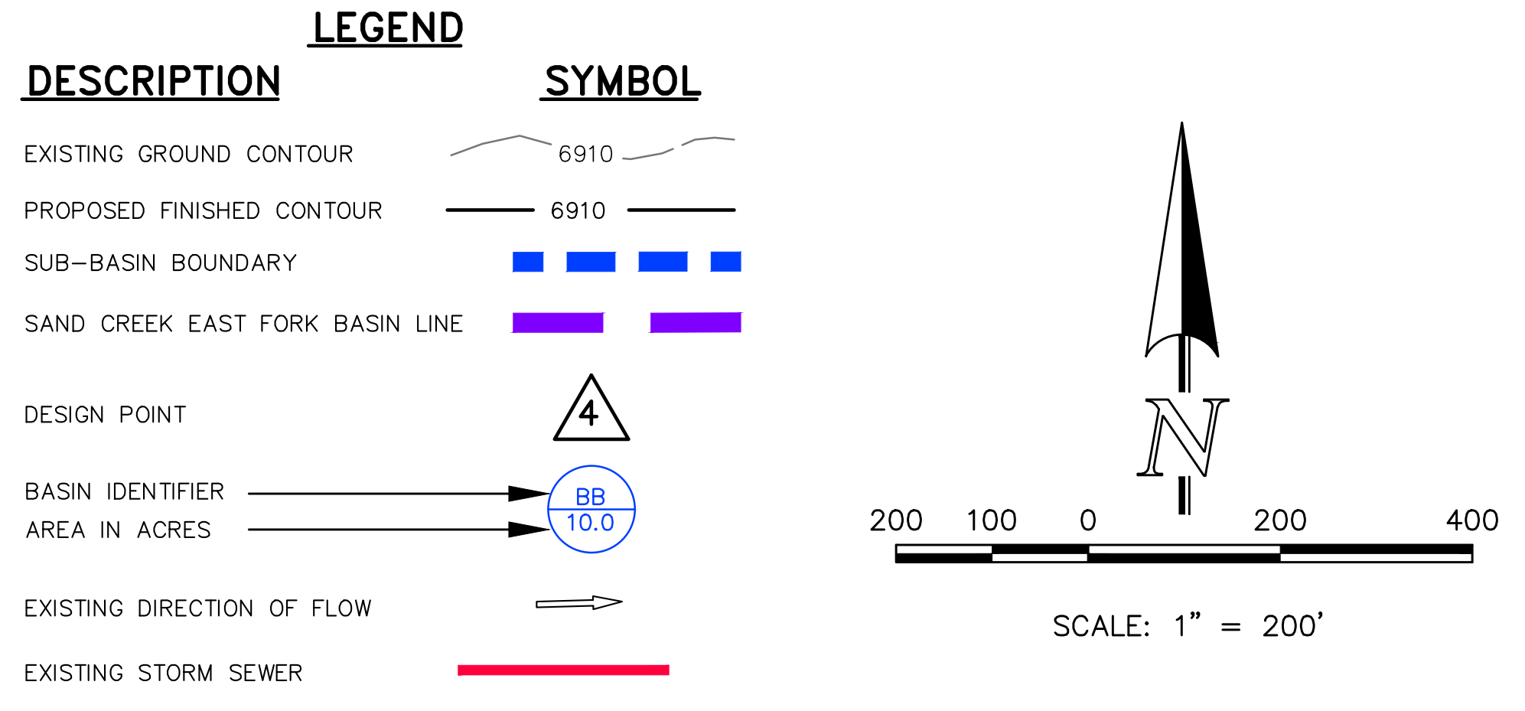
EX-4A	44.2	8%	19	50
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pre-Developed Surface Routing

Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	46	105
4A	1	5
5	5	23
5A	2	9
6	59	122
6A	7	19
7	110	249
56	60	160



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STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
PRE-DEVELOPMENT DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4-1-22
DRAWN BY	MAW	(H) 1"= 200'	SHEET 3 OF 6
CHECKED BY		(V) 1"= N/A	JOB NO. 1183.22

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
EX10A	153.5	5%	46	103
EX-11 *	214.3	4%	54	129
EX-13 *	94.8	6%	36	85
EX-4A	44.2	8%	19	50
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

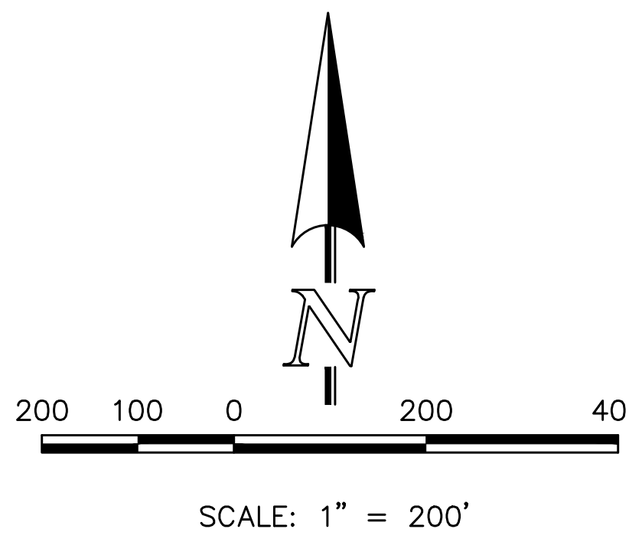
* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Developed Subcatchment Runoff

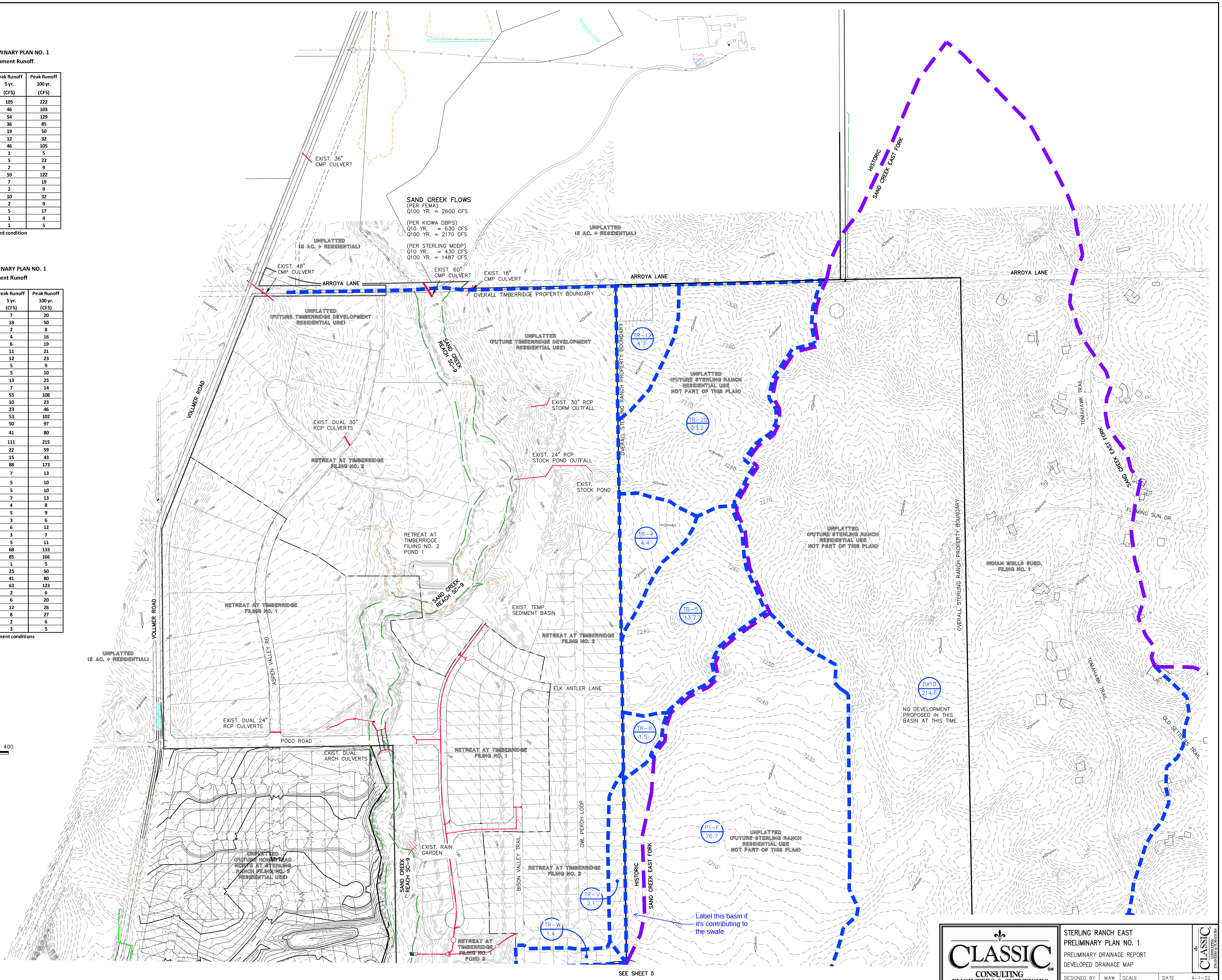
Basins do change (area). Acreage shown in table does not match labels on map

Subcatchment	Area (Ac.)	SWWM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EF-A	8.2	15%	7	20
EX10A +	60.4	5%	18	50
EX-9 +	6.0	5%	2	8
EX-9A +	12.7	5%	4	16
P1-A	12.7	8%	6	19
P1-A1	5.0	45%	11	21
P1-A2	6.4	45%	12	23
P1-A3	1.8	50%	5	9
P1-A4	2.0	50%	5	10
P1-A5	5.7	45%	13	25
P1-A6	2.8	50%	7	14
P1-B (Dev.)	35.5	38%	55	108
P1-B (Un-dev.)	35.5	5%	10	23
P1-C	8.9	50%	23	46
P1-D	31.4	38%	53	102
P1-E1	30.4	35%	50	97
P1-E2	21.8	40%	41	80
P1-F (Dev.)	76.7	30%	111	215
P1-F (Un-dev.)	76.7	5%	22	59
P2-A	24.4	10%	15	43
P2-B	57.8	38%	88	173
P2-B1	2.5	50%	7	13
P2-B10	1.7	50%	5	10
P2-B2	1.9	50%	5	10
P2-B3	2.8	45%	7	13
P2-B4	1.6	50%	4	8
P2-B5	1.9	45%	5	9
P2-B6	1.1	50%	3	6
P2-B7	2.5	45%	6	12
P2-B8	1.2	50%	3	7
P2-B9	2.0	50%	5	11
P2-S1	35.6	40%	68	133
P3-A	52.6	40%	85	166
P3-C	1.7	11%	1	5
P3-S2	11.9	40%	25	50
P4-A	25.8	35%	41	80
P4-B	37.3	35%	63	123
SC-1 +	3.6	8%	2	6
SC-2 +	10.8	8%	6	20
SC-3 +	27.2	8%	12	26
SC-4 +	16.4	8%	8	27
TR-V	2.1	19%	2	6
TR-W	1.4	38%	3	5

\+ Basin not changed from pre-development conditions



SCALE: 1" = 200'



Label this basin if it's contributing to the swale

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	——— 6910 ———
BASIN BOUNDARY	▬ ▬ ▬ ▬
EAST FORK BASIN BOUNDARY	▬▬ ▬▬
DESIGN POINT	⬡15
BASIN IDENTIFIER AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	⇨
PROPOSED DIRECTION OF FLOW	←
PROPOSED STORM SEWER	▬▬▬
PROPOSED STORM SEWER PER JR ENG. PLANS	▬▬▬
PROPOSED POND OUTFALL PER JR ENG. PLANS	▬▬▬

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STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4-1-22
DRAWN BY	MAW	(H) 1"= 200'	SHEET 4 OF 6
CHECKED BY		(V) 1"= N/A	JOB NO. 1183.22

Provide DP and flows

Call out swale in lots or tract

How will swale flows be captured?

Provide DPs for swale and road flows

Address conveyance, flows and outfall

Label this sub-basin. Is this in the model?

Provide flow arrow

Show all storm drains and inlets upstream of this

Show storm drains and inlets for this area

Could not determine how 5-year flow was determined. DP 4(218 cfs), DP 5 (53 cfs), DP 6 (55 cfs) & Basin P1-a (6 cfs) is 332 cfs.

Too many proposed contours

Show storm drains and inlets for this area

Label all stubs

Areas of concern for cross-lot drainage. Provide flow arrows for swales

Too many contours

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY	
EAST FORK BASIN BOUNDARY	
DESIGN POINT	15
BASIN IDENTIFIER AREA IN ACRES	89 10.0
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
PROPOSED STORM SEWER	
PROPOSED STORM SEWER PER JR ENG. PLANS	
PROPOSED POND OUTFALL PER JR ENG. PLANS	
STERLING RANCH EAST PRELIMINARY PLAN NO. 1 AREA	

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWWM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EF-A	8.2	15%	7	20
EX10A +	60.4	5%	18	50
EX-9 +	6.0	5%	2	8
EX-9A +	12.7	5%	4	16
P1-A	12.7	8%	6	19
P1-A1	5.0	45%	11	21
P1-A2	6.4	45%	12	23
P1-A3	1.8	50%	5	9
P1-A4	2.0	50%	5	10
P1-A5	5.7	45%	13	25
P1-A6	2.8	50%	7	14
P1-B (Dev.)	35.5	38%	55	108
P1-B (Un-dev.)	35.5	5%	10	23
P1-C	8.9	50%	23	46
P1-D	31.4	38%	53	102
P1-E1	30.4	35%	50	97
P1-E2	21.8	40%	41	80
P1-F (Dev.)	76.7	30%	111	215
P1-F (Un-dev.)	76.7	5%	22	59
P2-A	24.4	10%	15	43
P2-B	57.8	38%	88	173
P2-B1	2.5	50%	7	13
P2-B10	1.7	50%	5	10
P2-B2	1.9	50%	5	10
P2-B3	2.8	45%	7	13
P2-B4	1.6	50%	4	8
P2-B5	1.9	45%	5	9
P2-B6	1.1	50%	3	6
P2-B7	2.5	45%	6	12
P2-B8	1.2	50%	3	7
P2-B9	2.0	50%	5	11
P2-S1	35.6	40%	68	133
P3-A	52.6	40%	85	166
P3-C	1.7	11%	1	5
P3-S2	11.9	40%	25	50
P4-A	25.8	35%	41	80
P4-B	37.3	35%	63	123
SC-1 +	3.6	8%	2	6
SC-2 +	10.8	8%	6	20
SC-3 +	27.2	8%	12	26
SC-4 +	16.4	8%	8	27
TR-V	2.1	19%	2	6
TR-W	1.4	38%	3	5

+ Basin not changed from pre-development conditions

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-14A Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A1	5.0	N/A	70%
P1-A2	6.4	N/A	70%
P1-A3	1.8	N/A	70%
P1-A4	2.0	N/A	70%
P1-A5	5.7	N/A	70%
P1-A6	2.8	N/A	70%
P2-S1	35.6	School	40%
P2-A	24.4	Park	7%
P2-B	57.8	7,000	60%
P2-B1	2.5	N/A	70%
P2-B2	1.9	N/A	70%
P2-B3	2.8	N/A	70%
P2-B4	1.6	N/A	70%
P2-B5	1.9	N/A	50%
P2-B6	1.1	N/A	70%
P2-B7	2.5	N/A	30%
P2-B8	1.2	N/A	70%
TOTAL	157.0		49%

POND FSD–14A (EDB)

TRIB. AREA = 157.0 AC.
WQCV = 2.66 AC.–FT.
EURV = 6.10 AC.–FT.
100 YR. = 5.37 AC.–FT.
TOTAL = 14.13 AC.–FT.

INFLOW: (SWWM MODEL)
Q5 = 234 CFS
Q100 = 486 CFS

OUTFLOW: (MHFD–DETENTION)
Q5 = 3.3 CFS
Q100 = 118.8 CFS

POND FSD–16 (EDB)
(FULL BUILD–OUT)

TRIB. AREA = 220.9 AC.
WQCV = 3.60 AC.–FT.
EURV = 7.68 AC.–FT.
100 YR. = 7.54 AC.–FT.
TOTAL = 18.82 AC.–FT.

INFLOW: (SWWM MODEL)
Q5 = 323 CFS
Q100 = 499 CFS

OUTFLOW: (MHFD–DETENTION)
Q5 = 3.6 CFS
Q100 = 117.4 CFS

POND FSD–16 (EDB)
(PRELIM. PLAN 1 & FOURSQUARE PUD DEVELOPMENTS ONLY
BASINS P1–B & P1–F UNDEVELOPED)

TRIB. AREA = 220.9 AC.
WQCV = 2.55 AC.–FT.
EURV = 3.04 AC.–FT.
100 YR. = 5.92 AC.–FT.
TOTAL = 11.51 AC.–FT.

INFLOW: (SWWM MODEL)
Q5 = 197 CFS
Q100 = 410 CFS

OUTFLOW: (MHFD–DETENTION)
Q5 = 2.5 CFS
Q100 = 66.0 CFS

POND FSD–14B (EDB)

TRIB. AREA = 63.1 AC.
WQCV = 1.24 AC.–FT.
EURV = 3.35 AC.–FT.
100 YR. = 2.38 AC.–FT.
TOTAL = 6.97 AC.–FT.

INFLOW: (SWWM MODEL)
Q5 = 97 CFS
Q100 = 189 CFS

OUTFLOW: (MHFD–DETENTION)
Q5 = 2.0 CFS
Q100 = 48.9 CFS

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Developed Surface Routing

Design Point (On-Site)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
DP-1	112	219
DP-2	53	103
DP-3	41	80
DP-4	218	379
DP-5	53	102
DP-6	55	108
DP-7	20	39
DP-8	68	133
DP-9	88	173
DP-10	223	441
DP-11	10	21
DP-12	63	123
DP-13	41	80
DP-14	97	189
DP-15	85	166
DP-16	34	69
Pond FSD-11B	115	227
Pond FSD-14A	234	486
Pond FSD-14B	97	189
Pond FSD-16 (Ultimate)	323	499
Pond FSD-16 (Interim)	197	410

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-16 Tributary Area

(Full Build Out)

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A	12.7	N/A	15%
P1-B	35.5	7,500	55%
P1-C	8.9	N/A	70%
P1-D	31.4	6,500	60%
P1-E1	30.4	8,500	50%
P1-E2	21.8	7,500	55%
P1-F	76.7	12,500	35%
TR-V	2.1	17,500	27%
TR-W	1.4	13,500	32%
TOTAL	220.9		46%

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-16 Tributary Area

(Prelim. Plan 1 & Foursquare PUD Only)

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A	12.7	N/A	15%
P1-B	35.5	Un dev.	2%
P1-C	8.9	N/A	70%
P1-D	31.4	6,500	60%
P1-E1	30.4	8,500	50%
P1-E2	21.8	7,500	55%
P1-F	76.7	Un dev.	2%
TR-V	2.1	17,500	27%
TR-W	1.4	13,500	32%
TOTAL	220.9		26%

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
EX10A	153.5	5%	46	103
EX-11 *	214.3	4%	54	129
EX-13 *	94.8	6%	36	85
EX-4A	44.2	8%	19	50
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1
Pond FSD-14B Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P4-A	37.3	6,500	60%
P4-B	25.8	6,500	60%
TOTAL	63.1		60%

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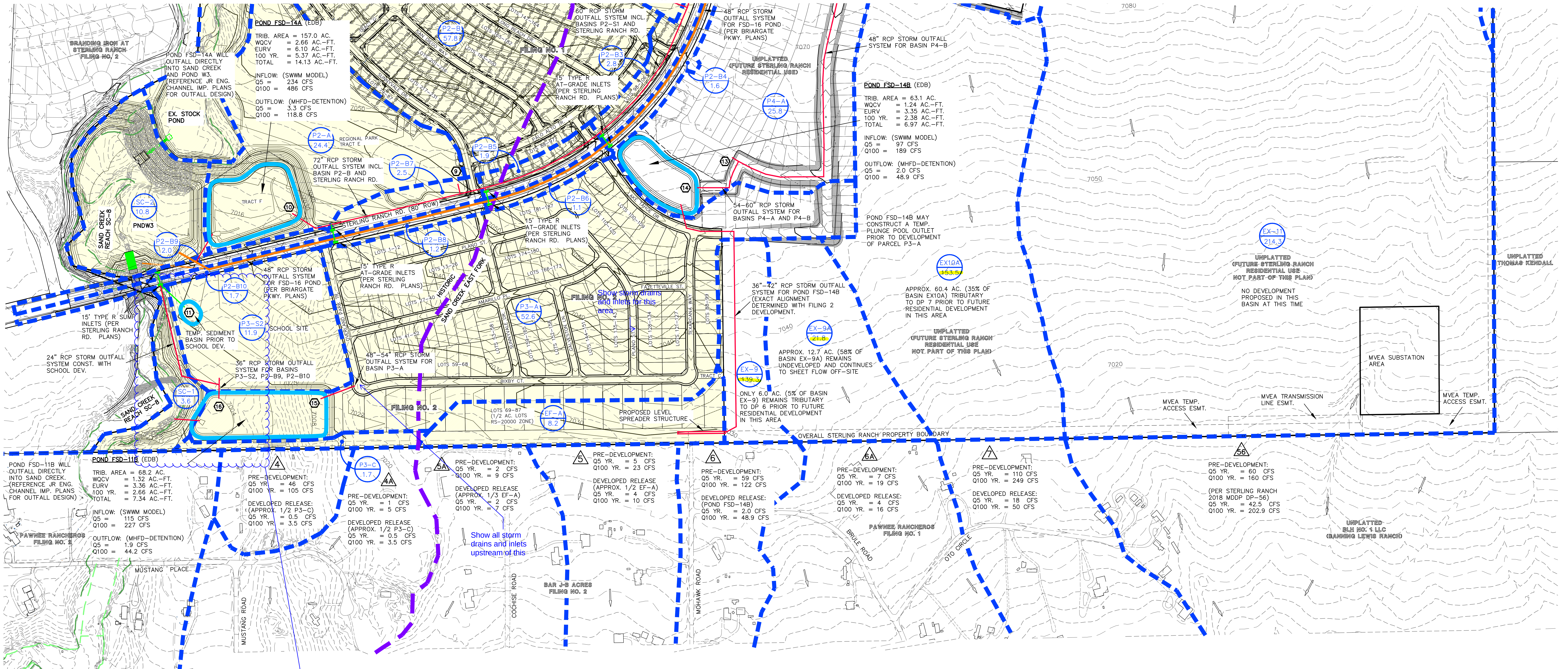
Colorado Springs, Colorado 80903
(719)785–0790
(719)785–0799 (Fax)

STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4–1–22
DRAWN BY	MAW	(H) 1"= 200'	SHEET 5 OF 6
CHECKED BY		(V) 1"= N/A	JOB NO. 1183.22



See comment memo

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pond FSD-14A Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P1-A1	5.0	N/A	70%
P1-A2	6.4	N/A	70%
P1-A3	1.8	N/A	70%
P1-A4	2.0	N/A	70%
P1-A5	5.7	N/A	70%
P1-A6	2.8	N/A	70%
P2-S1	35.6	School	40%
P2-A	24.4	Park	7%
P2-B	57.8	7,000	60%
P2-B1	2.5	N/A	70%
P2-B2	1.9	N/A	70%
P2-B3	2.8	N/A	70%
P2-B4	1.6	N/A	70%
P2-B5	1.9	N/A	50%
P2-B6	1.1	N/A	70%
P2-B7	2.5	N/A	30%
P2-B8	1.2	N/A	70%
TOTAL	**157.0**		**49%**

Areas shown for these basins do not match map labels.

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pond FSD-14B Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P4-A	37.3	6,500	60%
P4-B	25.8	6,500	60%
TOTAL	**63.1**		**60%**

Areas appear to be switched for these 2 basins

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pond FSD-11B Tributary Area

Subcatchment	Area (Ac.)	Avg. Lot size (AC)	Effective Imperv. (%)
P2-B9	2.0	N/A	70%
P2-B10	1.7	N/A	70%
P3-S2	11.9	School	65%
P3-A	52.6	7,000	57%
TOTAL	**68.2**		**59%**

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWWM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EF-A	8.2	15%	7	20
EX10A +	60.4	5%	18	50
EX-9 +	6.0	5%	2	8
EX-9A +	12.7	5%	4	16
P1-A	12.7	8%	6	19
P1-A1	5.0	45%	11	21
P1-A2	6.4	45%	12	23
P1-A3	1.8	50%	5	9
P1-A4	2.0	50%	5	10
P1-A5	5.7	45%	13	25
P1-A6	2.8	50%	7	14
P1-B (Dev.)	35.5	38%	55	108
P1-B (Un-dev.)	35.5	5%	10	23
P1-C	8.9	50%	23	46
P1-D	31.4	38%	53	102
P1-E1	30.4	35%	50	97
P1-E2	21.8	40%	41	80
P1-F (Dev.)	76.7	30%	111	215
P1-F (Un-dev.)	76.7	5%	22	59
P2-A	24.4	10%	15	43
P2-B	57.8	38%	88	173
P2-B1	2.5	50%	7	13
P2-B10	1.7	50%	5	10
P2-B2	1.9	50%	5	10
P2-B3	2.8	45%	7	13
P2-B4	1.6	50%	4	8
P2-B5	1.9	45%	5	9
P2-B6	1.1	50%	3	6
P2-B7	2.5	45%	6	12
P2-B8	1.2	50%	3	7
P2-B9	2.0	50%	5	11
P2-S1	35.6	40%	68	133
P3-A	52.6	40%	85	166
P3-C	1.7	11%	1	5
P3-S2	11.9	40%	25	50
P4-A	25.8	35%	41	80
P4-B	37.3	35%	63	123
SC-1 +	3.6	8%	2	6
SC-2 +	10.8	8%	6	20
SC-3 +	27.2	8%	12	26
SC-4 +	16.4	8%	8	27
TR-V	2.1	19%	2	6
TR-W	1.4	38%	3	5

+ Basin not changed from pre-development conditions

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Developed Surface Routing

Design Point (On-Site)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
DP-1	112	219
DP-2	53	103
DP-3	41	80
DP-4	218	379
DP-5	53	102
DP-6	55	108
DP-7	20	39
DP-8	68	133
DP-9	88	173
DP-10	223	441
DP-11	10	21
DP-12	63	123
DP-13	41	80
DP-14	97	189
DP-15	85	166
DP-16	34	69
Pond FSD-11B	115	227
Pond FSD-14A	234	486
Pond FSD-14B	97	189
Pond FSD-16 (Ultimate)	323	499
Pond FSD-16 (Interim)	197	410

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Pre-Developed Subcatchment Runoff

Subcatchment	Area (Ac.)	SWMM Imperv. (%)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
EX-10	265.9	7%	105	222
EX10A	153.5	5%	46	103
EX-11 *	214.3	4%	54	129
EX-13 *	94.8	6%	36	85
EX-4A	44.2	8%	19	50
EX-5	26.2	8%	12	32
EX-7	152.8	5%	46	105
EX-7A	2.4	2%	1	5
EX-8	32.2	2%	5	23
EX-8A	6.6	2%	2	9
EX-9	139.3	8%	59	122
EX-9A	21.8	5%	7	19
TR-12 *	4.7	5%	2	9
TR-20 *	23.2	7%	10	32
TR-4 *	4.4	5%	2	9
TR-5 *	13.7	5%	5	17
TR-6 *	1.5	5%	1	4
TR-7 *	2.6	5%	1	5

* Basins with no change upon developed condition

STERLING RANCH EAST PRELIMINARY PLAN NO. 1

Flow Comparison along South Boundary

	This Report (SWMM 5.1) Pre-Dev. Conditions		This Report (SWMM 5.1) Developed Conditions		2018 SR MDDP (HEC-HMS) Pre-Dev. Conditions	
Design Point (South Bndy.)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)	Peak Runoff 5 yr. (CFS)	Peak Runoff 100 yr. (CFS)
4	46	105	0.5	3.5	21.5	107.4
4A	1	5	0.5	3.5		
5	5	23	4	10	1.7	20.5
5A	2	9	2	7		
6	59	122	2.0	48.9	23.9	125.2
6A	7	19	4	11		
7	110	249	18	50	57.1	277.9
56	60	160	60	160	42.5	202.9

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	— 6910 —
BASIN BOUNDARY	▬ ▬ ▬
EAST FORK BASIN BOUNDARY	▬ ▬
DESIGN POINT (ON-SITE)	15
DESIGN POINT (MATCHING PRE-DEV) LOCATION ALONG SOUTH BOUNDARY)	△ 4
BASIN IDENTIFIER AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	⇨
PROPOSED DIRECTION OF FLOW	←
PROPOSED STORM SEWER	▬
PROPOSED STORM SEWER PER JR ENG. PLANS	▬
PROPOSED POND OUTFALL PER JR ENG. PLANS	▬
STERLING RANCH EAST PRELIMINARY PLAN NO. 1 AREA	▭

N

200 100 0 200 400

SCALE: 1" = 200'

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STERLING RANCH EAST
PRELIMINARY PLAN NO. 1
PRELIMINARY DRAINAGE REPORT
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4-1-22
DRAWN BY	MAW	(H) 1"= 200'	SHEET 6 OF 6
CHECKED BY		(V) 1"= N/A	JOB NO. 1183.22