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FINAL DRAINAGE REPORT
FOR
RETREAT AT TIMBERRIDGE
FILING NO. 2

Prepared for:
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See comment letter also

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Job No. 1185.20

PCD Project No. SF-21-021

FINAL DRAINAGE REPORT FOR
RETREAT AT TIMBERRIDGE FILING NO. 2

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 A. Whorton Colorado P.E. #37155 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: TIMBERRIDGE DEVELOPMENT GROUP, LLC

By: ____________________________________

Title: ____________________________________

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:

CLASSIC CONSULTING ENGINEERS & SURVEYORS

FINAL DRAINAGE REPORT FOR
RETREAT AT TIMBERRIDGE FILING NO. 2

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CLASSIC CONSULTING ENGINEERS & SURVEYORS

FINAL DRAINAGE REPORT FOR RETREAT AT TIMBERRIDGE FILING NO. 2

PURPOSE

The purpose of this Final Drainage Report is to address on-site and off-site drainage patterns and identify specific drainage improvements and facilities required to minimize impacts to the adjacent properties.

GENERAL DESCRIPTION

The Retreat at TimberRidge Filing No. 2 is 75.829-acre site located in portions sections 27 and 28, township 12 south, range 65 west of the sixth principal meridian. The site is bounded on the north by future development phases within the TimberRidge property, to the south, east and west by Sterling Ranch property (zoned for future urban development), TimberRidge Filing No. 1 and Vollmer Road. The site is in the upper portion of the Sand Creek Drainage Basin. Both large lot rural single family residential and urban single family residential are proposed in this Filing.

The average soil condition reflects Hydrologic Group "B" (Pring coarse sandy loam and Kettle gravelly loamy sand) 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 Retreat at TimberRidge Filing No. 2 property is located in the upper portion of the Sand Creek drainage basin on the south edge of Black Forest. Nearly the entire site, other than the Sand Creek corridor, is mainly covered with native grasses with few or no pine trees. The Sand Creek channel bisects the site in a north-south direction. A wetlands delineation was prepared by CORE Consultants, Inc., which included the entire TimberRidge property and submitted along with Filing No. 1. (See Appendix) This document reflects some wetlands throughout the Sand Creek channel. Any effect on these wetlands within jurisdictional waters will be described later in this report along with the appropriate permitting.

Portions of this site have been previously studied in the "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Engineering Corporation, March 1996. The portion of Sand

Creek that traverses the site is defined as Reach SC-9 in the DBPS. 1000+ acres north of this property is tributary to this reach of the channel. (See Off-site Drainage Map in Appendix) According to the DBPS, this reach of Sand Creek all contained within the channel has the following flow characteristics: Q_{10} = 630 cfs Q_{100} = 2170 cfs. However, the 100 yr. flow recognized by FEMA in the LOMR 08-08-0541P with effective date of July 23, 2009, equals nearly Q_{100} = 2600 cfs. Also, Sterling Ranch has finalized their MDDP 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 Q_{10} = 430 cfs Q_{100} = 1487 cfs and TimberRidge south property line Q_{10} = 452 cfs Q_{100} = 1523 cfs. Even with the County approval of the MDDP and these adjusted flows, a CLOMR/LOMR will be required to be prepared, submitted and approved by FEMA prior to utilizing these flows in any Final Drainage Reports within this development. Based on the anticipated 12–18-month timing of the CLOMR/LOMR process, this development will continue to utilize the much larger FEMA recognized flows for all proposed channel improvements through this property, including the culvert crossing at Poco Road. This is how Filing No. 1 was developed as well.

The majority of these off-site flows enter the property at the north end of the site conveying flows from the northwest (Black Forest area) and the off-site stock ponds to the north (both tributary to hundreds of acres of property in Black Forest). There are multiple existing culvert crossings of Vollmer Rd. just north of Arroya Lane to facilitate these historic flow patterns. The following are the few key culverts that directly feed the Sand Creek channel north of Arroya Lane: Approximately 1,000 feet north of Arroya Lane, an existing 36" CMP crosses Vollmer Road (Basin SC-1 on Off-site Drainage Map). A small basin and natural ravine just west of Vollmer feeds this facility. From a recent field visit, this small facility seems to be in good working condition, however, not labeled in the DBPS. Another 700 feet+ north along Vollmer a much larger basin exists west of the roadway. This off-site basin is approximately 350+ acres northwest of Vollmer Road (Basin SC-2 on Off-site Drainage Map). As shown within the DBPS, this existing crossing is a 60" CMP with some very dense and tall vegetation at both the entrance and exit of this facility.

But, based on a recent field visit this facility seems to be in good working condition. The DBPS depicts this facility and recommends an additional 60" CMP at this location. However, there are no signs of erosion or over topping the road at this location at this time based on the current development within the tributary area to this facility. Based on the existing surrounding topography and roadway configuration, the 100 yr. historic flows at this location would appear to spill over the roadway and continue in their historic drainage pattern downstream within the upper reach of Sand Creek.

The following descriptions represent the pre-development flow design points for the property excluding the major off-site flows within Sand Creek just described:

EX DP-1 (Q_2 = 1 cfs, Q_5 = 3 cfs, Q_{100} = 18 cfs) consists of small portion of the property at the SE corner that currently sheet flows in a southwesterly direction. These pre-development flows travel off-site directly onto Sterling Ranch property prior to eventually entering the Sand Creek channel.

Basin EX-2 (Q_2 = 2 cfs, Q_5 = 7 cfs, Q_{100} = 44 cfs) consists of approximately 50% off-site and 50% on-site property. The off-site property is part of the future Sterling Ranch development and is conveyed in a southwesterly direction directly on-site via a natural ravine. Portions of the on-site property were graded along with Filing No. 1 to allow for this area to be captured in two temporary sediment basins and away from the Filing No. 1 lot development. These two facilities will be removed along with Filing No. 2 construction.

Basin EX-3 (Q_2 = 1 cfs, Q_5 = 2 cfs, Q_{100} = 16 cfs) consists of again both off-site and on-site property. These flows are conveyed in a southwesterly direction and captured in a graded ditch and routed towards another temporary sediment basin constructed with Filing No. 1. This facility will remain during Filing No. 2 construction as it captures undeveloped flows further north.

Basin EX-4 (Q_2 = 4 cfs, Q_5 = 13 cfs, Q_{100} = 90 cfs) consists of the remaining portion of the yet undeveloped TimberRidge property along with off-site future Sterling Ranch property. This entire area sheet flows in a southwesterly direction towards Sand Creek. Along with the development of Filing No. 1 and the secondary emergency access road up to Arroya Lane, several storm system were installed to convey portions of these flows under the access road. The existing on-site stock pond will continue to remain as it captures much of the off-site tributary area.

Include flows for Basin EX-5

Existing DP routing needs to be shown in appendix. Flows do not match those shown on drainage map.

Revised

EX DP-5 (Q_2 = 3 cfs, Q_5 = 11 cfs, Q_{100} = 69 cfs) consists of combined flows from basins EX-5 and EX-7. Basin EX-5 is the northwest portion of the TimberRidge property with some spruce trees and a very defined natural ravine that conveys flows in a southeast direction towards Sand Creek. Vollmer Road is the westerly boundary of this basin. Basin EX-7 (Q_2 = 3 cfs Q_5 = 8 cfs, Q_{100} = 42 cfs) consists of an off-site basin west of Vollmer Road (not a part of this development) that drains under Vollmer into the TimberRidge property via an existing 48" CMP culvert. These off-site flows enter Basin EX-5 and then travel within the on-site ravine towards Sand Creek. Dual 30" culverts were installed along with Filing No. 1 where the future road crosses this ravine. This condition will remain with the development of Filing 2 and these off-site flows will be accounted for in downstream design.

culvert material?

RCP

PROPOSED DRAINAGE CONDITIONS

Proposed development within the Retreat at TimberRidge Filing No. 2 will consist of a variety of different residential lot sizes ranging from 1.0 – 2.5-acre large rural lots to 12,000 SF min. urban lots. The rural lots will have paved streets and roadside ditches while the urban lots paved streets with County standard curb, gutter and sidewalk. Development of the urban lots proposed will consist of overlot grading for the planned roadways and lots. Development of rural lots proposed within the site will be limited to roadways and building pads, conserving the natural feature areas. Individual home sites on these lots are to be left generally in their natural condition with minimal disturbance to existing conditions per individual lot construction. Per the El Paso County ECM, Section I.7.1.B.5, rural lots of 2.5 ac. and larger are not required to provide Water Quality

Capture Volume (WQCV). However, based on the current County/Urban Drainage stormwater quality standards, a WQCV component is automatically built into the UD Detention spreadsheet utilized in the detention basin design. Thus, the proposed facilities within both the rural and urban portions of 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. The following describes how this development proposes to handle both the off-site and on-site drainage conditions:

As mentioned previously, the majority of the off-site flows are already within the Sand Creek channel prior to entering the property. However, the few off-site basins that must travel through the proposed site development areas prior to entering Sand Creek have been accounted for.

Reference the water quality plan and state how much area from roads and urban lots is proposed not to be treated.

see Revised

The following represent the basins and design points west of Sand Creek:

Basins OS-1 (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 9 cfs) and OS-2 (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 7 cfs) represent off-site flows from future TimberRidge development adjacent to Vollmer Rd. and Arroya Lane. These flows calculated as future development flows will continue to travel in a southerly direction within the existing natural ravine and enter Basin B. As mentioned previously, Basin Ex-7 (Q_2 = 3 cfs Q_5 = 8 cfs, Q_{100} = 42 cfs) consists of the off-site basin west of Vollmer Road (not a part of this development) that drains under Vollmer into the TimberRidge property via an existing 48" CMP culvert. These flows are then combined with the flows from basins OS-1 and OS-2.

state the entity the drainage easement will be granted to and will maintain these.

Include flows and discussion of Basin B

Design Point 1 (Q_5 = 12 cfs, Q_{100} = 57 cfs) represents this combined total where the existing dual 30" RCP culverts crossing Aspen Valley Rd. will convey the flows under the road and towards Design Point 3. (See Appendix for culvert and rip-rap calculations) The natural ravine within lots 4 and 5 is contained within a drainage esmt. as shown on the drainage map and final plat. Permanent rock check dams are planned through this corridor to mitigate erosion and sediment transfer potential.

RR calculations for this culvert are missing from appendix.

Design Point 2 (Q_5 = 5 cfs, Q_{100} = 20 cfs) represents developed flows from Basin A. At this location a proposed 24" RCP culvert crossing Aspen Valley Rd. will convey the flows under the road into the natural drainage area within the drainage easement on lot 7. (See Appendix for culvert and rip-rap calculations)

Basin D (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 6 cfs) represents a portion of the proposed 2.5 ac. rural lots adjacent to Aspen Valley Road. Developed flows from this basin will continue to sheet flow in a southeasterly direction towards Design Point 3 and combine with the upstream flows. **Design Point 3 (Q_5 = 17 cfs, Q_{100} = 74 cfs)** represents this combined flow total where a proposed 42" RCP will collect and convey the developed flows under Falcon Nest Court towards Pond 3. The proposed channel within lot 7 is contained within a drainage esmt. as shown on the drainage map and final plat. It will convey the developed flows from Design Points 1 and 2 towards Design Point 3 and be lined with Turf Reinforcement Matting. (See Appendix for channel calculations)

with culvert ponding area easement

Basin C (Q_2 = 2 cfs Q_5 = 3 cfs, Q_{100} = 8 cfs) represents a portion of the proposed 2.5 ac. rural lots with developed flows that sheet flow in a southeasterly direction towards Design Point 4. At this location a proposed 24" RCP will collect and convey these flows to where they combine with the previously mentioned developed flows from Design Point 3.

Basin E1 (Q_2 = 2 cfs Q_5 = 4 cfs, Q_{100} = 15 cfs) represents a portion of the proposed 2.5 ac. rural lots (Lots 10-12) that will continue to sheet flow in a southeasterly direction towards the natural ravine. The majority of the upstream pre-development flows will be collected by the previously described proposed 42" RCP at Design Point 3. Only the developed flows from lots 10-12 will now contribute to this area and thus, the natural ravine will remain native with no further improvements required. This natural drainage corridor will be protected and placed in a drainage esmt. across these lots as shown on the Final Plat. Given the size of these lots, minimal unconnected impervious area introduced and sizeable receiving pervious areas per lot, the WQCV reduction = 100% with 0 untreated WQCV within this basin. (See UD-BMP Runoff Reduction Sheet – Ver. 3.07 in Appendix)

Basin E2 (Q_2 = 0.5 cfs Q_5 = 1.2 cfs, Q_{100} = 6 cfs) represents a portion of lots 9 & 10 that will continue to sheet flow in a southerly direction towards Pond 3. These flows are accounted for in the Design Point 5 and Pond 3 calculations.

Basin OS-3 (Q_2 = 0.1 cfs Q_5 = 0.4 cfs, Q_{100} = 2 cfs) represents a small portion of the extreme rear yard of the proposed lots 11 & 12 that continues to sheet flow towards Sand Creek as originally anticipated.

Design Point 5 (Q_5 = 18 cfs, Q_{100} = 79 cfs) represents the total developed flows entering the proposed **Pond 3.** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. The following describes the design of this facility. (See Appendix for MHFD-Detention pond design sheets):

Detention Pond 3 (Full Spectrum EDB – see multiple storm release data below)

0.395 Ac.-ft. WQCV required

0.309 Ac.-ft. EURV required with 4:1 max. slopes

1.700 Ac.-ft. 100-yr. Storage

2.404 Ac.-ft. Total

Total Peak In-flow:	**Q_2 = 10.3 cfs, Q_5 = 20.8 cfs, Q_{100} = 74.7 cfs**
Pond Peak Design Release:	**Q_2 = 1.0 cfs, Q_5 = 10.1 cfs, Q_{100} = 59.6 cfs**
Pre-development Release:	**Q_2 = 5.6 cfs, Q_5 = 15.8 cfs, Q_{100} = 69.2 cfs**

(Ownership and maintenance by the Retreat at TimberRidge Metro District)

At this proposed outfall location, the overall channel flows will not significantly change based on Detention Pond 3 peak release of Q_{100} = 59.6 cfs which is less than the predevelopment flows at this location of Q_{100} = 69.2 cfs. (See Appendix for culvert outlet and rip-rap calculations)

The following represent the basins east of Sand Creek:

Design Point 6 (Q_5 = 3 cfs, Q_{100} = 8 cfs) represents developed flows from on-site Basin G (Q_2 = 1.7 cfs Q_5 = 2.4 cfs, Q_{100} = 5 cfs) and off-site Basin OS-9 (Q_2 = 0.5 cfs Q_5 = 0.9 cfs, Q_{100} = 3 cfs). These flows remain consistent with the previous Filing No. 1 report where an existing 10' Type R at-grade inlet was installed with Filing No. 1. This facility continues to intercept 100% of the 5 yr. and 79% of the 100 yr. developed flows. The flow-by that will continue down the west side of the street into Filing No. 1 remains consistent with the previous report and equals Q_5 = 0 cfs, Q_{100} = 1.7 cfs. (See Appendix for calculations) Basins H1 (Q_2 = 0.6 cfs Q_5 = 0.9 cfs, Q_{100} = 2 cfs), H2 (Q_2 = 0.6 cfs Q_5 = 0.8 cfs, Q_{100} = 2 cfs) and I (Q_2 = 0.2 cfs Q_5 = 0.3 cfs, Q_{100} = 0.8 cfs) represents the rear lots of proposed lots 13-16. As previously accounted for in the Filing No. 1 report, these rear yard developed flows will sheet flow directly off-site and into the open space tract in Filing No. 1. Given the minimal unconnected impervious area introduced and sizeable receiving pervious areas per lot, the WQCV reduction = 100% with 0 untreated WQCV within these basins. (See UD-BMP Runoff Reduction Sheet – Ver. 3.07 in Appendix)

Design Point 7 (Q_5 = 9 cfs, Q_{100} = 39 cfs) represents developed flows from on-site Basin J (Q_2 = 4 cfs Q_5 = 7 cfs, Q_{100} = 18 cfs), off-site Basin OS-4 (Q_2 = 0.2 cfs Q_5 = 0.7 cfs, Q_{100} = 5 cfs) and a 70% portion of the anticipated future Sterling Ranch development within off-site Basin OS-5 (Q_2 = 1 cfs Q_5 = 4 cfs, Q_{100} = 26 cfs). In the interim, the pre-development off-site flows from Basin OS-5 will be captured in an off-site temporary sediment basin at the east termination point of Elk Antler Lane. This facility sizing is based on the 13.7 ac. off-site basin OS-5 and is shown on the grading and erosion control plan. Both the overflow spillway and outlet pipe will be routed into the proposed curb line of Elk Antler Lane. Appropriate temporary grading and drainage easements will be acquired from the adjacent property owner prior to construction. However, the proposed downstream storm system has been sized and accounts for these anticipated off-site basins. Upon future development within the off-site basins OS-4 and OS-5, developed release must adhere to these anticipated flows described above. Ultimately, the total developed flows will combine and travel in a southerly direction to Design Point 7 where a proposed 15' Type R sump inlet will completely intercept both the 5 yr. and 100 yr. developed flows. The emergency overflow will be 12" and then down the street to the west within Elk Antler Lane.

How will this flow get to the curb and inlet? it appears that a pipe is needed due to the basin elevation.

Adjusted basin

Design Point 8 (Q_5 = 2 cfs, Q_{100} = 10 cfs) represents developed flows from on-site Basin N (Q_2 = 0.7 cfs Q_5 = 1 cfs, Q_{100} = 2 cfs) and a 30% portion of the anticipated future Sterling Ranch development within off-site Basin OS-5 (Q_2 = 1 cfs Q_5 = 4 cfs, Q_{100} = 26 cfs). Again, in the interim, the pre-development off-site flows from Basin OS-5 will be captured in the off-site temporary sediment basin at the east termination point of Elk Antler Lane. (See GEC Plan) The proposed downstream storm system has been sized and accounts for this anticipated off-site basin. Ultimately, the total developed flows will combine at Design Point 8 where a proposed 10' Type R sump inlet will completely intercept both the 5 yr. and 100 yr. developed flows. The emergency overflow will be 12" and then down the street to the west within Elk Antler Lane.

Basin K (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 5 cfs) represents a portion of the rear yards of proposed lots 21-26. These developed flows will continue to sheet flow in a westerly direction towards a temporary sediment basin constructed with Filing No. 1. Given the minimal unconnected impervious area introduced and sizeable receiving pervious areas per lot, the WQCV reduction = 100% with 0 untreated WQCV within this basin. (See UD-BMP Runoff Reduction Sheet – Ver. 3.07 in Appendix) Basin L (Q_2 = 0.3 cfs Q_5 = 0.6 cfs, Q_{100} = 2 cfs) represents the rear yard of the proposed lot 27. These minor developed flows will continue to sheet flow in a westerly direction towards another temporary sediment basin constructed with Filing No. 1. Again, given the minimal unconnected impervious area introduced and sizeable receiving pervious area for this lot, the WQCV reduction = 100% with 0 untreated WQCV within this basin. (See UD-BMP Runoff Reduction Sheet – Ver. 3.07 in Appendix) Basin M (Q_2 = 0.9 cfs Q_5 = 1.2 cfs, Q_{100} = 3 cfs) represents the developed flows from proposed lots 19-20. These developed flows were accounted for in the Filing No. 1 report and will continue to sheet flow in a southwesterly direction directly into the north side of Elk Antler Lane. The existing downstream 15' Type R At-grade Inlet, just south of the intersection of Elk Antler Lane and Antelope Ravine Dr., will continue to adequately collect these flows.

The now permanent sediment basins will need maintenance agreements, O&M, and MS4/SDI sheets

Not permanent Added more text

Design Point 9 (Q_5 = 4 cfs, Q_{100} = 14 cfs) represents the developed flows from Basins OS-8 (Q_2 = 2 cfs Q_5 = 3 cfs, Q_{100} = 10 cfs) and Q (Q_2 = 0.4 cfs Q_5 = 1.2 cfs, Q_{100} = 6 cfs). At this location, an existing 10' Type R Sump Inlet was installed with Filing No. 1 to completely intercept both the 5 yr. and 100 yr. developed flows. These flows remain consistent with the Filing No. 1 report as anticipated as Q_5 = 5 cfs, Q_{100} = 15 cfs.

Design Point 10 (Q_5 = 3 cfs, Q_{100} = 11 cfs) represents developed flows from Basins O (Q_2 = 2 cfs Q_5 = 3 cfs, Q_{100} = 9 cfs) and OS-6 (Q_2 = 0.1 cfs Q_5 = 0.4 cfs, Q_{100} = 3 cfs). These developed flows sheet flow in a southwesterly direction towards Design Point 10 where a proposed 10' Type R Sump Inlet will be installed to completely intercept both the 5 yr. and 100 yr. developed flows. The emergency overflow will be 12" and then south over the highpoint. It is planned with this report that with the future development of this portion of Sterling Ranch (Basin OS-6) developed flows equal to pre-development quantities are accounted for downstream in the existing on-site Pond 2. These future flows quantities will be treated and detained within Pond 2. Any developed flows above these quantities will need to be routed further downstream within the Sterling Ranch development.

Design Point 11 (Q_5 = 2 cfs, Q_{100} = 4 cfs) represents developed flows from Basin P. At this location, a proposed 5' Type R Sump Inlet will be installed to completely intercept both the 5 yr. and 100 yr. developed flows. The emergency overflow will be 12" and then southerly over the highpoint of Owl Perch Loop.

Design Point 12 (Q_5 = 4 cfs, Q_{100} = 9 cfs) represents the developed flows from Basin R. At this location, a proposed 10' Type R At-grade Inlet will be installed to intercept 99% of the 5 yr. and 75% of the 100 yr. developed flows. The flow-by (Q_5 = 0 cfs, Q_{100} = 2.3 cfs) will then continue down the street to the west towards Design Point 13. (See A [illegible]

List Basin S flows

Design Point 13 (Q_5 = 8 cfs, Q_{100} = 23 cfs) represents flows from Basin S and the flow-by from Basin R mentioned above. At this location, a proposed 15' Type R Sump Inlet will be installed to completely intercept both the 5 yr. and 100 yr. developed flows. The emergency overflow will be 12" and then southerly over the highpoint in Bison Valley Trail.

Design Point 14 (Q_5 = 1 cfs, Q_{100} = 3 cfs) represents flows from Basin T. At this location, a proposed 5' Type R Sump Inlet will be installed to completely intercept both the 5 yr. and 100 yr. developed flows. Again, the emergency overflow will be 12" and then southerly over the highpoint in Bison Valley Trail.

Pipe Run 15 (Q_5 = 25 cfs, Q_{100} = 85 cfs) represents the total developed flows entering the existing Pond 2 at the NE corner via the existing 42" RCP storm stub provided with Filing No. 1 construction. These flows are compared to the anticipated flows at this location in the Filing No. 1 report of Q_5 = 19 cfs, Q_{100} = 74 cfs. The existing Pond 2 continues to adequately provide detention and stormwater quality per County criteria with these additional flows.

The following represents the existing Pond 2 with the minor adjusted developed flows:
(See revised MHFD-Detention Pond Design Sheets in Appendix)

Existing Detention Pond 2 (Full Spectrum EDB – see multiple storm release data below)

1.03 Ac.-ft. WQCV required

1.16 Ac.-ft. EURV required with 4:1 max. slopes

3.36 Ac.-ft. 100-yr. Storage

5.55 Ac.-ft. Total

Total In-flow:	**Q_2 = 24.5 cfs,**	**Q_5 = 43.1 cfs,**	**Q_{100} = 135.8 cfs**
Pond Design Release:	**Q_2 = 0.9 cfs,**	**Q_5 = 13.5 cfs,**	**Q_{100} = 96.2 cfs**
Pre-development Release:	**Q_2 = 9.1 cfs,**	**Q_5 = 25.4 cfs,**	**Q_{100} = 115.0 cfs**

(Existing ownership and maintenance by the Retreat at TimberRidge Metro District)

Basin U (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 5 cfs) represents a portion of the rear yards of proposed lots 61-67. These developed flows were accounted for in the previous report for Filing No. 1 and remain consistent with the anticipated flows at this location of (Q_5 = 2 cfs, Q_{100} = 5 cfs). Basin V (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 6 cfs) represents the rear yards of the proposed lots 44-54. These developed flows will sheet flow in a southeasterly direction and directly into the proposed off-site swale and ultimately into the temporary sediment basin proposed at the southerly termination point of Bison Valley Trail. Based on the extremely large lot depths (215'+), given the minimal unconnected impervious area anticipated at the rear of these lots and the sizeable receiving pervious area per lot, the WQCV reduction = 100% with 0 untreated WQCV within this basin. (See UD-BMP Runoff Reduction Sheet – Ver. 3.07 in Appendix) Basin OS-7 (Q_2 = 0.2 cfs Q_5 = 0.8 cfs, Q_{100} = 5 cfs) represents an off-site basin within the future Sterling Ranch development that will continue to sheet flow in its historic drainage pattern. The TimberRidge development will coordinate with the Sterling Ranch property owner for the acquisition of appropriate temporary grading and permanent drainage easements along the eastern property line to facility this drainage condition. Basin W (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 5 cfs) represents the rear yards of the proposed lots 54-60. Given the minimal unconnected impervious area introduced and sizeable receiving pervious area per lot, the WQCV reduction = 100% with 0 untreated WQCV within this basin. (See UD-BMP Runoff Reduction Sheet – Ver.

Design Point 15?

Added text

3.07 in Appendix) Regardless, these rear yard developed flows sheet flow in a southerly direction directly into the off-site swale and ultimately into the temporary sediment basin proposed at the southerly termination point of Bison Valley Trail. At this point, all on-site developed flows will be captured and temporarily treated until future Sterling Ranch development takes place. Coordination with the Sterling Ranch property owner is taking place for the acquisition of appropriate temporary grading and permanent drainage easements along the southern property line to facilitate these facilities. Upon future development of Sterling Ranch in this area, Basins V, W and OS-7 will be further analyzed to determine how to potentially eliminate the swale along the property line.

Missing discussion on Basin F

Added text above in basin descriptions for basins west of Sand Creek

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 the large lot, rural areas should help limit impervious area, minimize directly impervious area, lengthen time of travel and increase infiltration in order to decrease the rate and volume of stormwater runoff. 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 TimberRidge Metropolitan District. After completion of construction and upon the Board of County Commissioners acceptance, the Sand Creek channel will be owned and maintained by the El Paso County along with all drainage facilities within the public Right of Way.

Describe maintenance access for ponds.

Added

structural improvements

SAND CREEK CHANNEL IMPROVEMENTS

As stated in the Sand Creek DBPS, this Reach SC-9 is recommended as a floodplain preservation design concept. Given the fact of the current requirements for detention/SWQ facilities planned for the property with designed release at or below pre-development flows, the existing Sand velocities do or do not exceed recommended allowable? List the range of velocities.

✓ Added vel. range for exist. channel

Creek drainageway is expected to remain stable. Existing FEMA FIS channel velocities as found in the LOMR 08-080541P seem to exceed recommended allowable velocities. Although, based on the findings from the CORE Consultants, Inc. Impact Identification Report, no significant erosion or channel degradation through this property currently exists at this time. Specifically located grade control structures (See Appendix) were specified in the DBPS through this reach in order to slow the cannel velocity to the DBPS recommended 7 feet per second and to prevent localized and long-term stream degradation affecting channel linings and overbanks. The allowable velocity and shear stress will vary depending upon the existing riparian vegetation/wetlands found within the channel and overbank floodplain terrace areas. A HEC-RAS hydraulic analysis for this portion of Reach SC-9 has been provided in order to determine the necessary channel improvements for the proposed Filing No. 2 development and future Filings. A separate wetland impact report along with the Section 404 permitting, prepared by CORE Consultants, has been developed based on these proposed channel improvements and submitted directly to the U.S. Army Corps of Engineers with necessary consult with U.S. Fish and Wildlife for their review and approval. This report and documentation can be found in the Appendix for El Paso County staff review.

There is still not enough information in this section. Provide the proposed criteria being used in the channel design.

Added see revised

HEC-RAS MODELING

Autodesk River and Flood Analysis Module 2019 and HEC-RAS ver. 5.0.6 were used to perform an updated one-dimensional, steady flow hydraulic model of the upper portion of Reach SC-9 from Arroya Lane down to approximately 500 feet north of the Poco Road culvert crossing constructed with Retreat at TimberRidge Filing No. 1. This AutoCAD River Module was used to define the stream centerline, overbanks, cross-sections and manning's n values. The stream centerline follows the channel thalweg to define the reach network. Cross-section topography data was obtained by using the generated surface from the 2-ft. flown contours utilized for all site design. This data was then utilized within the AutoCAD River Module containing three-dimensional coordinates for the stream centerline, cross-sections, reach stations, overbank stations and reach lengths. Two separate models defining the existing condition and proposed condition were prepared using the same centerline stationing. Different Manning's n values were applied across the various channel cross-sections to reflect the changes in vegetative cover within the channel and overbanks. The selected Manning's n values for the channel and overbanks were determined using Tables 10-1 and 10-2 from the DCM and Table 3 from the USGS Guide for selecting Manning's Roughness Coefficients based on numerous site visits in an effort to photograph and document each cross-section. (See Appendix) The following table summarizes the selected Manning's n values:

Table 1 Manning's n Values

Feature	Manning's n Value
Main Channel	0.03 – 0.10
Overbank Floodplain Terraces	0.12 – 0.16

Steady flow data was entered starting just south of Arroya Lane, channel station 27+00.00 down to approximately 500 feet north of the Poco Road crossing, channel station 1+00.00 all within the Sand Creek DBPS segment 171. Steady flow data corresponding to recurrence intervals of 10 Yr. and 100 Yr. for the FEMA, DBPS and Sterling Ranch MDDP conditions was entered. The models were run in subcritical mode to evaluate hydraulic conditions. Boundary conditions for the entire reach were based on normal depth calculations for the upstream and downstream channel slopes. The following table summarizes the flows used in the models:

Table 2 Model Flow Values

Flood Event / Location	Flow Value (cfs)
DBPS Segment 171	
FEMA 100 Yr.	2600
DBPS 100 Yr.	2170
DBPS 10 Yr.	630
Sterling MDDP 100 Yr.	1487
Sterling MDDP 10 Yr.	430

Per the approved DBPS, the anticipated developed flows just upstream of this project are Q_{10} = 630 cfs and Q_{100} = 2170 cfs as depicted within DBPS segment no. 171. As discussed earlier, the FEMA FIS flows appear to be significantly higher than both those presented in the DBPS and the Sterling Ranch MDDP. However, we have continued to utilize the significantly larger flows as determined by the FEMA FIS (2600 cfs) in the channel improvement designs. The proposed public roadway crossing of Sand Creek at Poco Road was constructed with Filing No. 1 and consisted of a two cell multi-plate steel single radius arch (24' x 10.33') with concrete headwalls to facilitate the conveyance of the 100 yr. flow.

Based on site visits during May and July of 2019, the entire Sand Creek drainage corridor through the Retreat at TimberRidge development was walked and photographed for documentation purposes and aide in the HEC-RAS modeling. (See Appendix) As discovered in the field and documented in the photos taken at each HES-RAS station, this reach of the Sand Creek channel appears very stable with no signs of erosion within the main channel or channel overbanks. This is mainly due to the significant vegetal cover throughout the reach. The classification of the vegetal cover seems to have a range from Retardance Class A-C as defined by HEC-15 chart (See Appendix) This type of vegetation retardance significantly increases the allowable shear stress within the channel while reducing the velocity. The following table defines the retardance level based on the vegetation class:

Table 3

Vegetal Retardance Curve Index by SCS Retardance Class

SCS Retardance Class	Retardance Curve Index
A	10.0
B	7.64
C	5.60
D	4.44
E	2.88

Based on this information, the maximum allowable sheer stress is found by the flowing equation:

$$\tau = 0.75\text{Curve Index}$$

Thus, the range of shear stress for this reach of Sand Creek equals 4.2 – 7.5 (lb/ft^2).

Referencing the HES-RAS model existing conditions calculations in the Appendix shows that a few stations showed velocity exceeding 7.0 ft./sec. and shear stress exceeding the limit above. (Sta: 6+00 and 7+00) Improvements in this area is being proposed to help reduce both the velocity and shear. These channel improvements within Filing No. 2 consist of widening of the floodplain from stations 6+50 – 10+00, installation of rip-rap stabilization from stations 6+50 – 11+00 and installation of one additional check structure located at station 17+00.

What is the range of shear stress in the channel after improvements?

The DBPS recommended to provide selective rip-rap channel stabilization located at culvert crossings, pipe outlets and outside bends of the channel. Based on the mean channel slope and maximum allowable velocity of 7.0 fps, Type L Rip-Rap stabilization will be provided at select locations within Filing No. 2. (See Appendix for tables describing slope, velocity, shear, Froude No., etc.) Between stations 6+50 and 10+00, the north side of the natural channel floodplain is proposed to be widened to help mitigate the existing velocity and sheer in this area. Then both sides of the channel through this stretch will be provided with rip-rap stabilization. The existing channel slope throughout this reach ranges from 0.7% to 2.5%. Per the HEC-RAS model, the proposed channel velocities, after improvements range from 2.6 ft./sec. to 6.3 ft./sec. All stations are within the allowable velocity of 7.0 ft./sec.

Address whether this is valid based on current design practices.

The DBPS does not depict any structures along this stretch of channel. However, an additional one is being planned at station 17+00 to further limit degradation and help control the elevation of the channel invert as well as aide in the adjacent wetland mitigation self-irrigation plan. The check structure is designed to be sheet piling with a concrete cap per Urban Drainage Vol. 2 Figures 9-27 thru 9-28. The intent of this structure is to hold grade so if the stream wants to flatten its equilibrium slope, the incision is limited. Thus, the plan is for this structure to eventually become drop structures as dictated by future channel characteristics.

The HEC-RAS model calculations shows no stations with Froude No. over 1.0 for this stretch of the creek within Filing No. 2. Thus, the Froude No. at all stations remains less than 1.0, with subcritical flow characteristics.

A public trail along the west side of Sand Creek is planned and will allow

Per DCM section 10.7, FR No. < 0.90

see Revised

to associated channel improvements. (See channel plans for exact ramp locations and details)

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. Individual on-site developed basin design used for detention/SWQ basin sizing, inlet sizing and storm system routing was calculated using the Rational Method. Runoff Coefficients are based on the imperviousness of the particular land use and the hydrologic soil type in accordance with Table 6-6. The average rainfall intensity, by recurrence interval found in the Intensity-Duration-Frequency (IDF) curves in Figure 6-5. (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.

This site adheres to this **Four Step Process** as follows:

1. **Employ Runoff Reduction Practices:** Proposed rural lot impervious area (roof tops, patios, etc.) will sheet flow across lengthy landscape/natural areas within the large lots and proposed urban lot impervious areas (roof tops, patios, etc.) will sheet flow across

landscaped yards and through 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.

2. **Stabilize Drainageways:** After developed flows utilize the runoff reduction practices through the front and rear yards, developed flows will travel via roadside ditches in the large lot, rural portions of the development, curb and gutter within the public streets in the urban portions of the development and eventually public storm systems. These collected flows are then routed directly to multiple extended detention basins (full-spectrum facilities). Where developed flows are not able to be routed to public street, sheet flows will travel across landscaped rear yards and then through undeveloped property prior to entering Sand Creek. The Sand Creek channel corridor will be protected with various channel improvements as recommended in the Sand Creek DBPS and proposed with this Filing in order to reduce velocities to erosive levels.

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 or commercial uses are proposed within this development. However, a site-specific storm water quality and erosion control plan and narrative has been 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. Multiple temporary BMP's are proposed based on specific phasing of the overall development. BMP's will be constructed and maintained as the development has been graded and erosion control methods employed.

FLOODPLAIN STATEMENT

Portions of this site are located within a floodplain as determined by the Flood Insurance Rate Maps (F.I.R.M.) Map Number 08041C 0535G with effective date of December 7, 2018 and the previously mentioned LOMR 08-08-0541P with an effective date of July 23, 2009. (See Appendix).

DRAINAGE AND BRIDGE FEES

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

The fees are calculated using the following impervious acreage method approved by El Paso County. The Retreat at TimberRidge Filing No. 2 has a total area of 75.83 acres with the following different land uses proposed:

7.74 Ac.	Sand Creek Drainage corridor (Tract B)
0.96 Ac.	Detention Facility (Tract A)
34.30 Ac.	2.5 Ac. lots (Rural Lots 1-12 incl. ROW dedication)
32.83 Ac.	1/3 Ac. lots (Urban Lots 13-90 with avg. size 15,575 SF)
75.83	Total

The percent imperviousness for this subdivision is calculated as follows:

<u>Fees for Sand Creek Drainage Corridor</u>

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

7.74 Ac. x 2% = **0.15 Impervious Ac.**

<u>Fees for Detention Facilities & Park</u>

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

0.96 Ac. x 7% = **0.07 Impervious Ac.**

Fees for 2.5 Ac. lots

(Per El Paso County Percent Impervious Chart: 11% with

25% fee reduction for 2.5 ac. lots planned) – *Reduction for Drainage Fees only*

34.30 Ac. x 11% x 75% = **2.83 Impervious Ac.** (Drainage Fees)

34.30 Ac. x 11% = **3.77 Impervious Ac.** (Bridge Fees)

Fees for 1/3 Ac. lots (Avg. lot size of 15,575 SF)

(Per El Paso County Percent Impervious Chart: 30%)

32.83 Ac. x 30% = **9.85 Impervious Ac.**

Total Impervious Acreage: **12.90 Imp. Ac.** (Drainage Fees)

Total Impervious Acreage: **13.84 Imp. Ac.** (Bridge Fees)

The following calculations are based on the 2021 Sand Creek drainage/bridge fees:

ESTIMATED FEE TOTALS:

Bridge Fees

$ 8,339.00 x 13.84 Impervious Ac. = **$ 115,411.76**

Drainage Fees

$ 20,387.00 x 12.90 Impervious Ac. = **$ 262,992.30**

Per the ECM 3.10.5.a, this development requests a reduction of drainage fees based on the on-site regional channel improvements for this stretch of Sand Creek Reach SC-9, Segment 171 as shown in the DBPS. However, Retreat at TimberRidge Filing No. 1 requested fee reduction based on the channel improvements presented in the DBPS for this portion of Segment 171. These Filing 1 fee offsets need to be vetted and finalized following the process in the DCM (Sections 1.7 and 3.3). Any additional request for fee reduction with Filing 2 must be brought to Drainage Board for approval of fee increase. The following facilities within the Sand Creek Drainage Basin seem to meet the criteria for this reduction:

Verify based on other comments

Proposed Sand Creek Channel Improvements (Filing 2):

Sheet Pile Check Structure w/ Conc. Cap	$45,000 EA x 1 =	$ 45,000
Selective Bank Stabilization (Buried Rip-Rap)	$100/LF x 800 LF =	$ 80,000
Selective Bank Stabilization (Grading & Reveg.)	=	$120,000
Total	=	**$245,000**

(Exact facility costs provided upon construction and acceptance by County. Any approved credits may be used for future Filings)

Classic Consulting Engineers & Surveyors cannot and does not guarantee that the construction cost will not vary from these opinions of probable construction costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular.

JOB NAME: *RETREAT AT TIMBERRIDGE FILING NO. 2*
JOB NUMBER: *1185.20*
DATE: *09/17/21*
CALC'D BY: *MAW*

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$

$$V = C_v S_w^{0.5}$$

Tc=L/V

Table 6-7. Conveyance Coefficient, C_v

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

$$t_c = \frac{L}{180} + 10$$

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

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FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED CA(2)	WEIGHTED CA(5)	WEIGHTED CA(100)	OVERLAND C(5)	OVERLAND Length (ft)	OVERLAND Height (ft)	OVERLAND Tc (min)	STREET / CHANNEL FLOW Length (ft)	STREET / CHANNEL FLOW Slope (%)	STREET / CHANNEL FLOW Velocity (fps)	STREET / CHANNEL FLOW Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	INTENSITY I(5) (in/hr)	INTENSITY I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	TOTAL FLOWS Q(5) (cfs)	TOTAL FLOWS Q(100) (cfs)
OS-9	0.16	0.23	0.42	0.25	50	1	8.6	600	3.0%	3.5	2.9	11.5	3.13	3.92	6.58	0.5	0.9	3
A	0.99	1.71	4.08	0.14	300	10.5	19.9	375	4.0%	2.0	3.1	23.0	2.30	2.88	4.84	2	5	20
B	0.86	1.30	2.74	0.14	230	15	14.2	450	2.0%	1.4	5.3	19.5	2.50	3.13	5.25	2	4	14
C	0.61	0.84	1.60	0.14	300	10	20.2					20.2	2.46	3.08	5.16	2	3	8
D	0.30	0.47	1.03	0.14	250	10	17.3					17.3	2.64	3.30	5.54	1	2	6
E1	0.80	1.34	3.09	0.14	300	12	19.0	300	2.0%	1.4	3.5	22.5	2.33	2.91	4.88	2	4	15
E2	0.21	0.43	1.15	0.14	300	7	22.7					22.7	2.32	2.90	4.87	0.5	1.2	6
F	0.49	1.22	4.64	0.10	300	9	21.8	600	1.5%	1.2	8.2	29.9	1.99	2.48	4.17	1	3	19
G	0.58	0.65	0.90	0.14	100	2	13.8					13.8	2.91	3.65	6.12	1.7	2.4	5
H1	0.19	0.22	0.31	0.22	100	4	10.1					10.1	3.29	4.12	6.92	0.6	0.9	2
H2	0.18	0.21	0.29	0.22	100	4	10.1					10.1	3.29	4.12	6.92	0.6	0.8	2
I	0.07	0.08	0.10	0.25	100	6	8.5					8.5	3.49	4.37	7.34	0.2	0.3	0.8
J	1.56	1.93	3.12	0.25	100	2	12.2	600	2.0%	2.8	3.5	15.7	2.75	3.45	5.79	4	7	18
K	0.27	0.38	0.71	0.25	100	3	10.7					10.7	3.22	4.03	6.77	1	2	5

JOB NAME: *RETREAT AT TIMBERRIDGE FILING NO. 2*
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$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$

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Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
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Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

$t_c = \frac{L}{180} + 10$

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

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED CA(2)	CA(5)	CA(100)	OVERLAND C(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
L	0.10	0.13	0.25	0.25	100	8	7.7					7.7	3.60	4.52	7.58	0.3	0.6	2
M	0.29	0.33	0.48	0.25	100	2	12.2	100	2.0%	2.8	0.6	12.8	3.00	3.76	6.31	0.9	1.2	3
N	0.22	0.26	0.37	0.25	100	2	12.2	80	2.0%	2.8	0.5	12.7	3.01	3.77	6.33	0.7	1.0	2
O	0.68	0.86	1.44	0.25	100	2	12.2	400	3.0%	3.5	1.9	14.1	2.88	3.61	6.06	2	3	9
P	0.36	0.41	0.59	0.25	50	1	8.6	400	3.0%	3.5	1.9	10.6	3.23	4.05	6.80	1	2	4
Q	0.11	0.27	0.76	0.14	80	5	8.5					8.5	3.49	4.38	7.35	0.4	1.2	6
R	0.91	1.07	1.56	0.25	100	2	12.2	700	3.0%	3.5	3.4	15.6	2.77	3.46	5.82	3	4	9
S	1.83	2.24	3.54	0.25	50	1	8.6	1100	3.0%	3.5	5.3	13.9	2.90	3.63	6.10	5	8	22
T	0.28	0.33	0.53	0.08	50	1	10.4	500	3.0%	3.5	2.4	12.8	3.00	3.76	6.32	0.8	1.2	3
U	0.27	0.38	0.71	0.25	80	5	7.5					7.5	3.64	4.56	7.66	1	2	5
V	0.38	0.53	0.99	0.25	90	1.8	11.6					11.6	3.12	3.91	6.56	1	2	6
W	0.36	0.45	0.73	0.25	100	3	10.7					10.7	3.22	4.03	6.77	1	2	5

JOB NAME: *RETREAT AT TIMBERRIDGE FILING NO. 2*
JOB NUMBER: *1185.20*
DATE: *09/17/21*
CALCULATED BY: *MAW*

Include design point surface routing for existing conditions/basins

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Inlet Size
1	EX-7, OS-1, OS-2, B (40.4 AC.)	6.09	16.61	40.4	2.04	3.41	12	57	EX. DUAL 30" RCP CULVERTS
2	Basin A (9.5 AC.)	1.71	4.08	23.0	2.88	4.84	5	20	24" RCP CULVERT
3	DP-1, DP-2, Basin D (52.2 ac.)	8.28	21.72	40.9	2.02	3.38	17	74	42" RCP CULVERT
4	Basin C (3.3 AC.)	0.84	1.60	20.2	3.08	5.16	3	8	24" RCP CULVERT
5	**POND 3 TOTAL INFLOW DP-3, DP-4, BASIN E2 (58.3 AC.)**	**9.55**	**24.47**	**43.4**	**1.93**	**3.23**	**18**	**79**	**POND 3**
6	Basin G, Basin OS-9 (2.3 ac.)	0.88	1.32	13.8	3.65	6.12	3	8	Exist. 10' TYPE R AT GRADE INLET
7	Basin OS-4, J and 70% of Basin OS-5 (18.0 ac.)	3.02	7.47	20.2	3.08	5.16	9	39	15' TYPE R SUMP INLET
8	Basin N and 30% of Basin OS-5 (4.7 ac.)	0.62	1.85	20.2	3.08	5.16	2	10	10' TYPE R SUMP INLET
9	Basin OS-8, Q (5.5 ac.)	1.17	2.45	15.7	3.45	5.79	4	14	Exist. 10' TYPE R SUMP INLET
10	Basin OS-6, O (4.3 ac.)	1.00	1.98	18.1	3.24	5.44	3	11	10' TYPE R SUMP INLET
11	Basin P (1.0 ac.)	0.41	0.59	10.6	4.05	6.80	2	4	5' TYPE R SUMP INLET

JOB NAME: ***RETREAT AT TIMBERRIDGE FILING NO. 2***
JOB NUMBER: ***1185.20***
DATE: ***09/17/21***
CALCULATED BY: ***MAW***

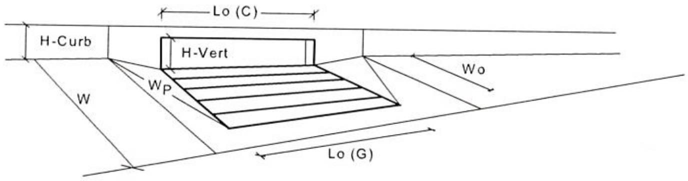
FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		
					I(5)	I(100)	Q(5)	Q(100)	Inlet Size
12	Basin R (2.7 ac.)	1.07	1.56	15.6	3.46	5.82	4	9	10' TYPE R AT GRADE INLET
13	Basin S and Flow-by from Basin R (9.3 ac.)	2.25	3.93	16.1	3.42	5.74	8	23	15' TYPE R SUMP INLET
14	Basin T (1.0 ac.)	0.33	0.53	12.8	3.76	6.32	1	3	5' TYPE R SUMP INLET
15	Basin V, W and OS-7 (6.1 ac.)	1.21	2.65	15.6	3.46	5.81	4	15	TEMP. SEDIMENT BASIN

Include DP discussion in report

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.0	3.0	cfs

Include analysis of existing inlet at DP 6 to show it still functions appropriately.

Now added

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 30 2021

Existing

Q100=57 cfs per summary spreadsheet

Revised

DUAL 30 IN. RCP CULVERTS AT DP 1

Invert Elev Dn (ft)	= 7228.28
Pipe Length (ft)	= 60.68
Slope (%)	= 1.01
Invert Elev Up (ft)	= 7228.89
Rise (in)	= 30.0
Shape	= Circular
Span (in)	= 30.0
No. Barrels	= 2
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

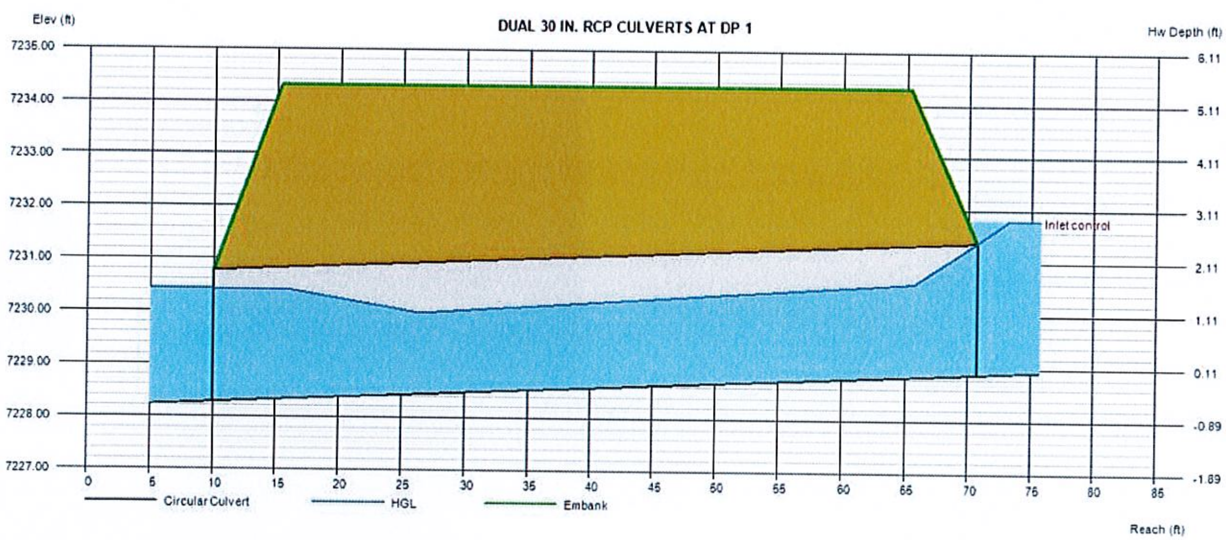
Top Elevation (ft)	= 7234.30
Top Width (ft)	= 50.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 55.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 55.00
Qpipe (cfs)	= 55.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.14
Veloc Up (ft/s)	= 7.33
HGL Dn (ft)	= 7230.42
HGL Up (ft)	= 7230.68
Hw Elev (ft)	= 7231.81
Hw/D (ft)	= 1.17
Flow Regime	= Inlet Control



Include calculations for RR outlet protection, unless installed with Filing 1. If so, please note that in report and remove reference to rr calculations in report.

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Sep 17 2021

24 in. RCP Culvert at DP 2

Invert Elev Dn (ft)	= 7229.81
Pipe Length (ft)	= 100.12
Slope (%)	= 1.00
Invert Elev Up (ft)	= 7230.81
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

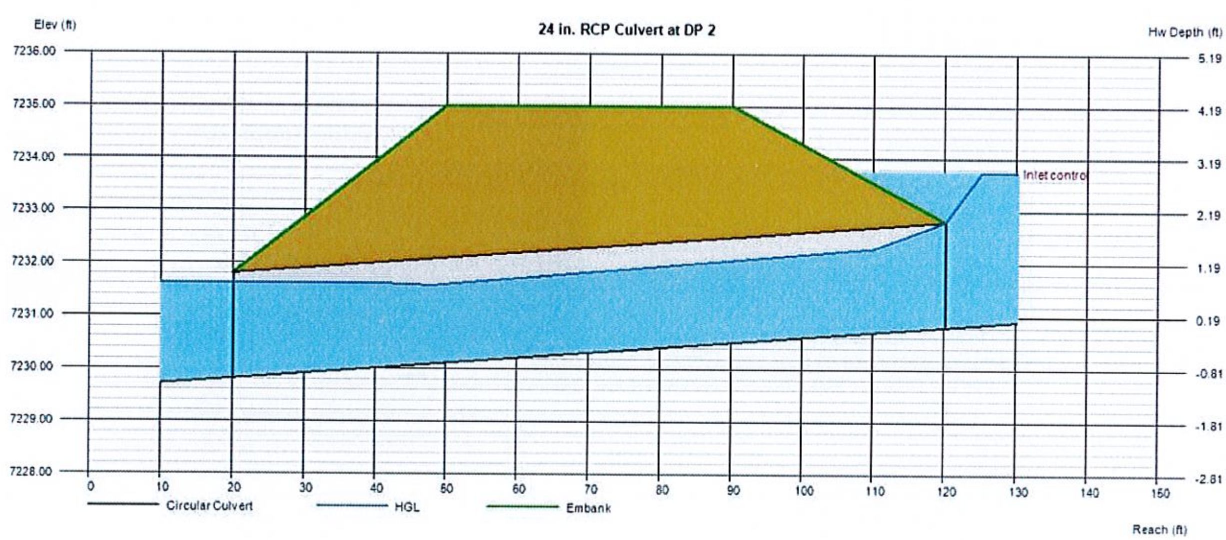
Top Elevation (ft)	= 7235.00
Top Width (ft)	= 40.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 20.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 20.00
Qpipe (cfs)	= 20.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.71
Veloc Up (ft/s)	= 7.40
HGL Dn (ft)	= 7231.61
HGL Up (ft)	= 7232.42
Hw Elev (ft)	= 7233.75
Hw/D (ft)	= 1.47
Flow Regime	= Inlet Control

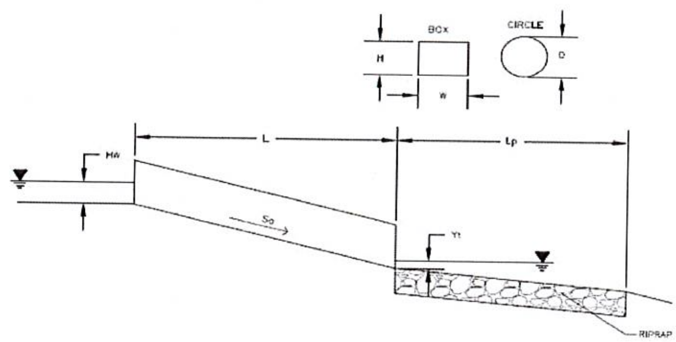


DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Retreat at TimberRidge Filing No. 2**

ID: **DP-2 (24" Culvert)**



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	20	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:		**OR**	
Box Culvert:			
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	7230.81	ft
Outlet Elevation **OR** Slope	Elev OUT =	7230	ft
Culvert Length	L =	81	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t, Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Update invert & pipe length to match culvert calculations on previous sheet

Calculated Results:

Culvert Cross Sectional Area Available	A =	3.14	ft^2
Culvert Normal Depth	Y_n =	1.46	ft
Culvert Critical Depth	Y_c =	1.61	ft
Froude Number	Fr =	1.22	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.00	
Sum of All Loss Coefficients	k_s =	2.20	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.65	ft
Outlet Control Headwater	HW_O =	2.38	ft
Design Headwater Elevation	**HW =**	**7233.46**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.33**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.54	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.80	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	3.91	
Flow Area at Max Channel Velocity	A_t =	4.00	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**12**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**6**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	1.73	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	9	in
MHFD Riprap Type	**Type =**	**L**	

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Friday, Sep 17 2021

42 IN. RCP STORM SYSTEM AT DP 3

Invert Elev Dn (ft)	= 7218.85
Pipe Length (ft)	= 39.91
Slope (%)	= 2.88
Invert Elev Up (ft)	= 7220.00
Rise (in)	= 42.0
Shape	= Circular
Span (in)	= 42.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

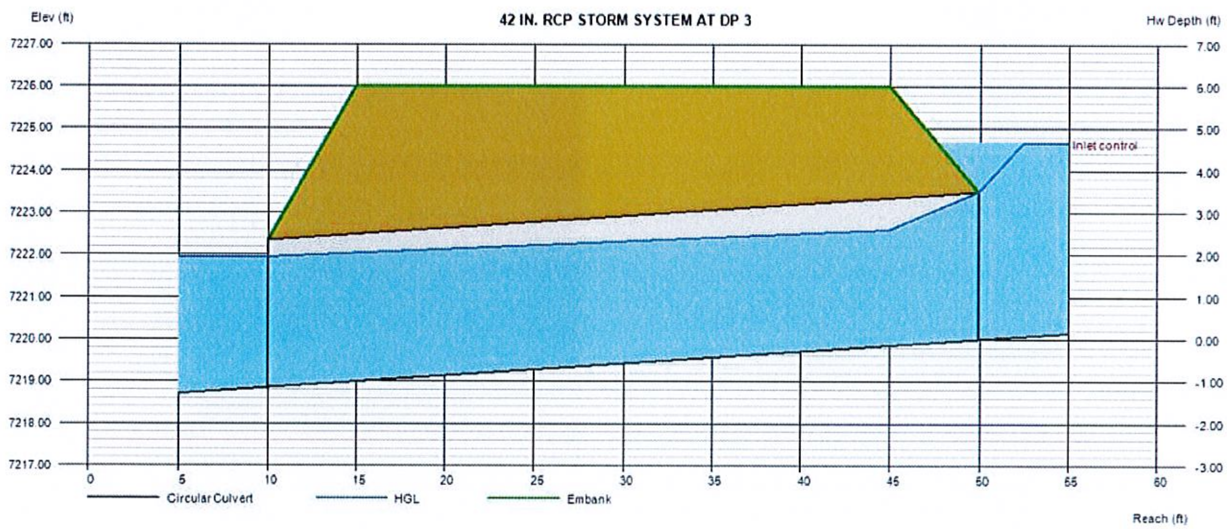
Top Elevation (ft)	= 7226.00
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 74.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 74.00
Qpipe (cfs)	= 74.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 8.22
Veloc Up (ft/s)	= 9.32
HGL Dn (ft)	= 7221.95
HGL Up (ft)	= 7222.69
Hw Elev (ft)	= 7224.65
Hw/D (ft)	= 1.33
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Friday, Sep 17 2021

24 in. RCP Culvert at DP 4

Invert Elev Dn (ft)	= 7218.67
Pipe Length (ft)	= 8.87
Slope (%)	= 12.18
Invert Elev Up (ft)	= 7219.75
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

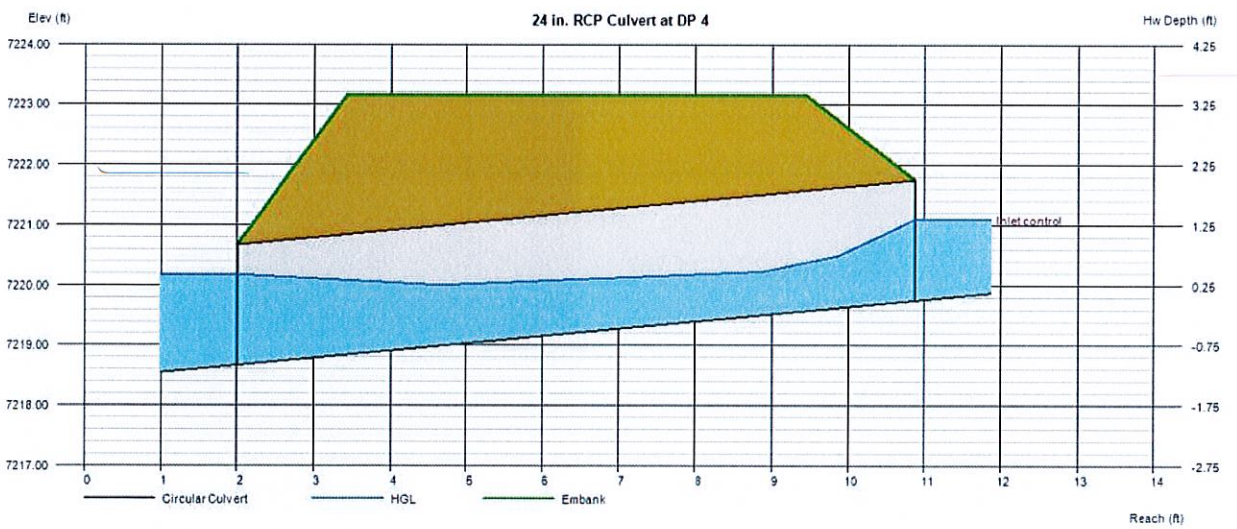
Top Elevation (ft)	= 7223.16
Top Width (ft)	= 6.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 8.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 8.00
Qpipe (cfs)	= 8.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 3.16
Veloc Up (ft/s)	= 5.06
HGL Dn (ft)	= 7220.17
HGL Up (ft)	= 7220.76
Hw Elev (ft)	= 7221.10
Hw/D (ft)	= 0.67
Flow Regime	= Inlet Control



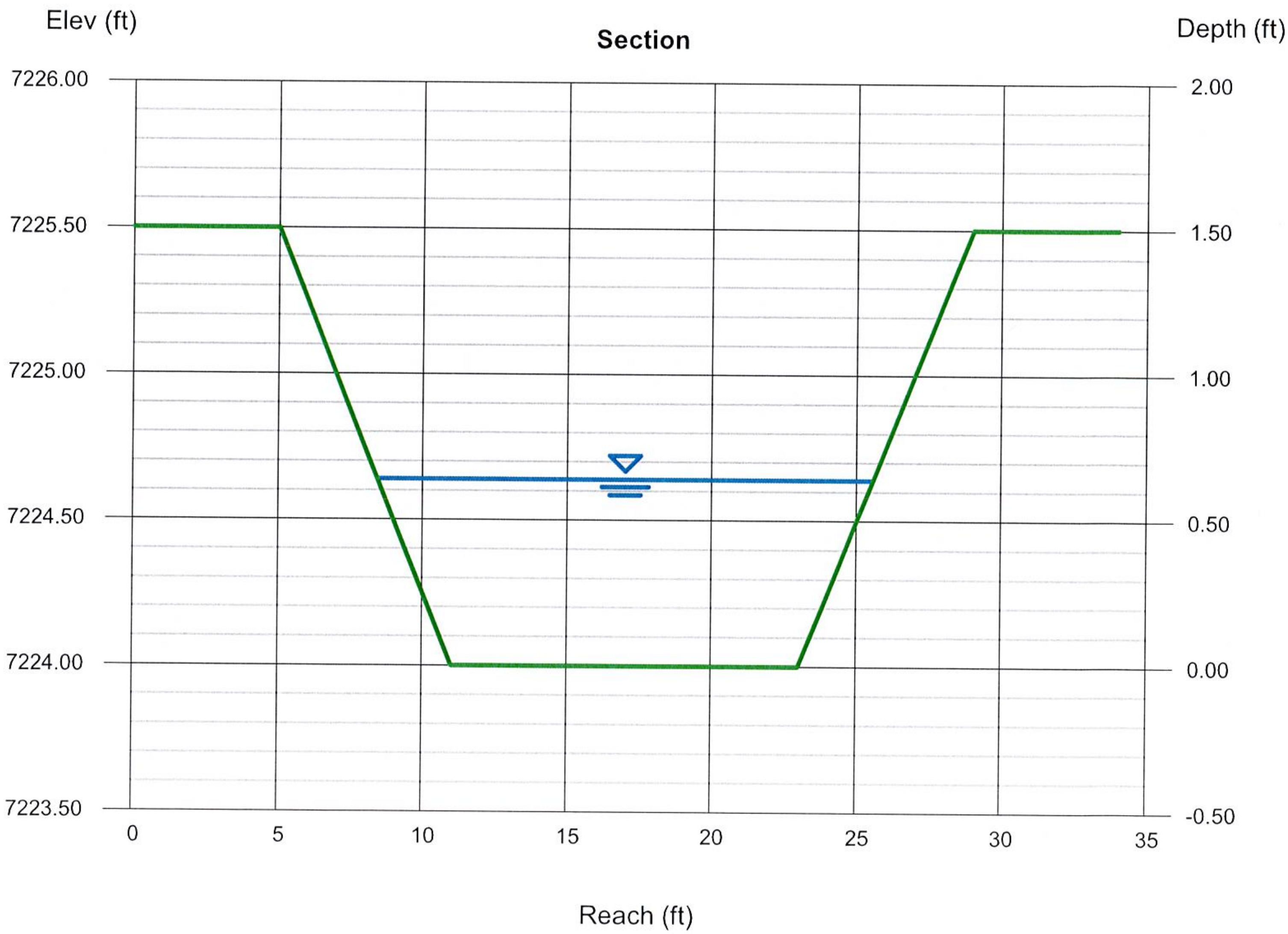
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 16 2021

Total channel depth needs to be 1.64' min (0.64' +1.0' freeboard). Please increase channel depth by 0.15'

Proposed Channel within Lot 7 - North side of Falcon Nest Ct.

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 12.00	Depth (ft)	= 0.64
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 74.00
Total Depth (ft)	= 1.50	Area (sqft)	= 9.32
Invert Elev (ft)	= 7224.00	Velocity (ft/s)	= 7.94
Slope (%)	= 6.00	Wetted Perim (ft)	= 17.28
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.95
		Top Width (ft)	= 17.12
Calculations		EGL (ft)	= 1.62
Compute by:	Known Q		
Known Q (cfs)	= 74.00		



DITCH CALCUALTIONS

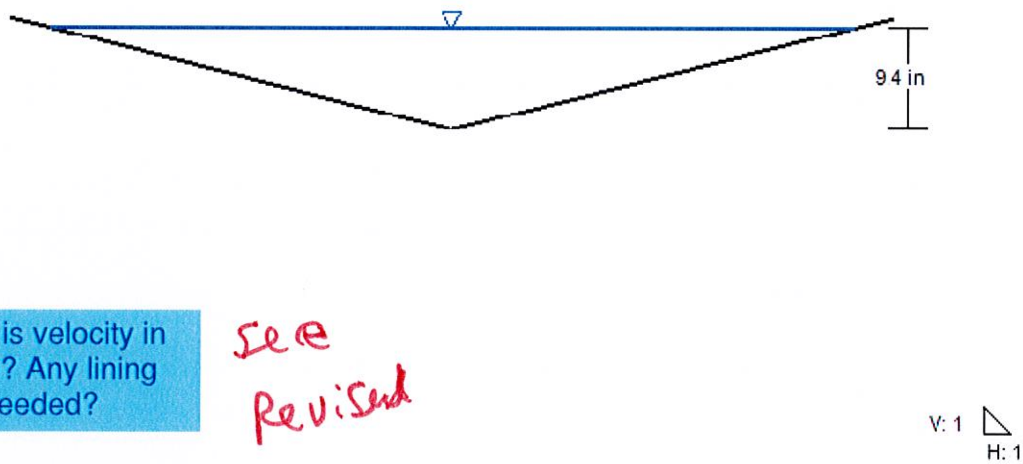
Proposed Channel within Lot 7 - North side of Falcon Nest Ct.

	Erosion Control Blanket (ECB) **(North American Green - SC150)**	**Turf Reinforcement Mat (TRM)** **(North American Green - P300)**	**Revegetation - Grass lined** **(Native Seed Mix)**
Given:	**(Temporary - 24 months)**	**(Permanent)**	
Design Flow (cfs)	74.0	74.0	74.0
Permissible Shear (lbs/ft.^{2})	2.0	8.0	0.1
Permissible Velocity (ft./sec.)	8.0	16.0	3.0
Safety Factor	1	1	1
Ditch Slope (Max.)	6.0%	6.0%	6.0%
Channel Section (18 in. depth 12' wide bottom w/ 4:1 sides)	Trapezoidal -Ditch	Trapezoidal -Ditch	Trapezoidal -Ditch
Flow Area (ft.^{2})	9.32	9.32	9.32
Wetted Perimeter (ft.)	17.28	17.28	17.28
Hydraulic Radius	0.95	0.95	0.95
Mannings n	0.035	0.030	0.030
Depth of Flow (max.)	1.0	1.0	0.5
Calculations:			
Shear Stress (lbs/ft.^{2})	3.7	3.7	1.9
Velocity (ft./sec.)	7.9	7.9	7.9
Allowed Flow (cfs)	93.9	109.6	109.6

Natural Swale adjacent to Lots 43-54 (24" depth)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.035
Channel Slope	0.040 ft/ft
Normal Depth	9.4 in
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Discharge	11.00 cfs



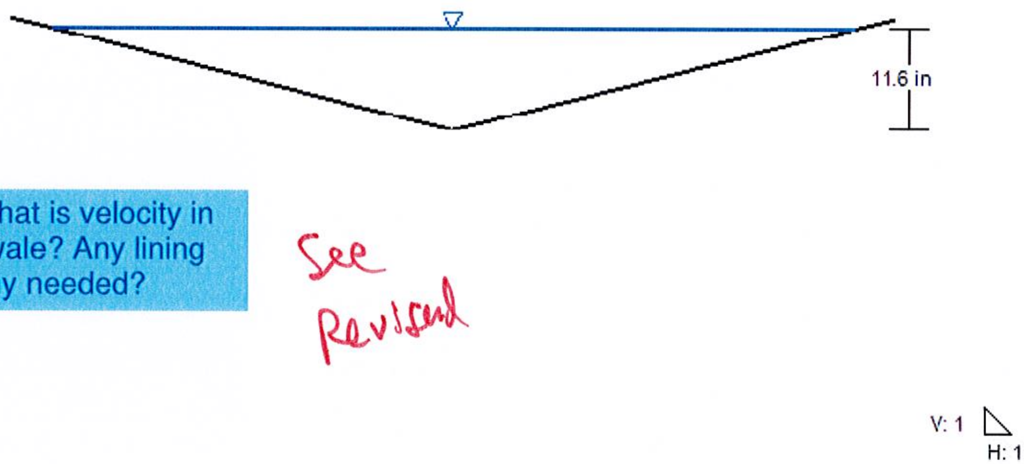
What is velocity in swale? Any lining any needed?

See Revised

Natural Swale adjacent to Lots 54-60 (24" Depth)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.035
Channel Slope	0.025 ft/ft
Normal Depth	11.6 in
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Discharge	15.00 cfs



What is velocity in swale? Any lining any needed?

See Revised

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
MH 1 SWR 1 - 1	142.67	14.83	34.46	10.06	23.35	15.47	2.17	Supercritical Jump	85.00	3.88	
MH 2 SWR 2 - 1	352.36	36.62	34.46	10.06	14.05	30.14	5.75	Supercritical	85.00	0.00	Velocity is Too High
MH 6 SWR 6 - 1	135.24	19.13	30.83	9.93	17.43	18.87	3.13	Supercritical	64.00	0.00	Velocity is Too High
MH 7 SWR 7 - 1	104.18	14.74	29.80	9.43	19.39	15.20	2.35	Supercritical	59.00	0.00	
MH 8 SWR 8 - 1	66.83	9.45	29.80	9.43	26.28	10.67	1.31	Supercritical	59.00	0.00	
MH 11 SWR 11 - 1	94.29	13.34	26.79	8.33	17.97	13.33	2.17	Supercritical	47.00	0.00	
MH 12 SWR 12 - 1	66.88	9.46	26.79	8.33	22.25	10.25	1.44	Supercritical	47.00	0.00	
MH 13 SWR 13 - 1	66.88	9.46	26.79	8.33	22.25	10.25	1.44	Supercritical Jump	47.00	5.06	
MH 14 SWR 14 - 1	41.13	8.38	25.28	8.84	23.30	9.53	1.20	Pressurized	39.00	26.28	
MH 15 SWR 15 - 1	60.44	19.24	13.58	5.46	6.60	14.23	4.00	Supercritical	10.00	0.00	

-Velocities are higher than the allowed 18 fps.

-Pressure pipe-look at upsizing pipe size

Cannot fix unless pipe is 10' deep. Street slope is 5%. Will use class IV pipe.

pipe already built w/ Filing 1 and used class IV pipe w/ joint restraints outfall into pond 2.

fixed

Response to MH 3 on next page

Tried upsizing to 36" and still under pressure. DCM 1 8.3 allows HGL is 1.0' under surface grade. This meets criteria.

-Pressure pipe-look at upsizing pipe size

fixed

See response on previous sheet

MH 9 SWR 9 - 1	31.27	9.95	15.56	6.03	10.79	9.49	2.02	Pressurized	13.00	26.17	
MH 10 SWR 10 - 1	38.41	21.74	9.18	4.41	3.92	14.06	5.17	Supercritical	4.00	0.00	
MH 16 SWR 16 - 1	22.39	7.13	12.08	5.05	9.91	6.53	1.46	Supercritical	8.00	0.00	
MH 3 SWR 3 - 1	41.13	8.38	20.44	7.02	16.89	8.78	1.45	Pressurized	25.00	41.27	
MH 5 SWR 5 - 1	63.71	12.98	19.58	6.78	12.46	11.93	2.38	Supercritical Jump	23.00	22.28	
MH 4 SWR 4 - 1	34.61	19.59	7.90	4.02	3.58	12.01	4.63	Supercritical Jump	3.00	5.18	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
MH 1 SWR 1 - 1	85.00	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
MH 2 SWR 2 - 1	85.00	CIRCULAR	42.00 in	42.00 in	27.00 in	27.00 in	42.00 in	42.00 in	9.62	
MH 6 SWR 6 - 1	64.00	CIRCULAR	36.00 in	36.00 in	30.00 in	30.00 in	36.00 in	36.00 in	7.07	

provide a figure showing all proposed UIA and RPA areas to be utilized for runoff reduction. All RPA areas will need to be within a no build/drainage easement and discussed in the maintenance agreement and O&M Manual.

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: Marc A. Whorton, P.E.
Company: Classic Consulting
Date: September 16, 2021
Project: Retreat at TimberRidge Filing No. 2
Location: BASIN E1

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	SPA
Area ID	ROADWAY	HOUSES	YARDS
Downstream Design Point ID	SC	SC	SC
Downstream BMP Type	None	None	None
DCIA (ft^2)	--	--	--
UIA (ft^2)	17,135	11,800	--
RPA (ft^2)	34,000	38,000	--
SPA (ft^2)	--	--	208,341
HSG A (%)	0%	0%	0%
HSG B (%)	100%	100%	100%
HSG C/D (%)	0%	0%	0%
Average Slope of RPA (ft/ft)	0.030	0.060	--
UIA:RPA Interface Width (ft)	60.00	70.00	--

CALCULATED RUNOFF RESULTS

Area ID	ROADWAY	HOUSES	YARDS
UIA:RPA Area (ft^2)	51,135	49,800	--
L / W Ratio	14.20	10.16	--
UIA / Area	0.3351	0.2369	--
Runoff (in)	0.00	0.00	0.00
Runoff (ft^3)	0	0	0
Runoff Reduction (ft^3)	614	423	9202

CALCULATED WQCV RESULTS

Area ID	ROADWAY	HOUSES	YARDS
WQCV (ft^3)	697	480	0
WQCV Reduction (ft^3)	697	480	0
WQCV Reduction (%)	100%	100%	0%
Untreated WQCV (ft^3)	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)	28,935
RPA (ft^2)	72,000
SPA (ft^2)	208,341
Total Area (ft^2)	309,276
Total Impervious Area (ft^2)	28,935
WQCV (ft^3)	1,178
WQCV Reduction (ft^3)	1,178
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

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

Total Area (ft^2)	309,276
Total Impervious Area (ft^2)	28,935
WQCV (ft^3)	1,178
WQCV Reduction (ft^3)	1,178
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

DETENTION POND CALCULATIONS

Include calculation for sizing of riprap on emergency spillway ✓

Include calculation for sizing of plunge pool at end of pond outlet culvert ✓ Added

Include culvert analysis for 30" pond outlet culvert ✓

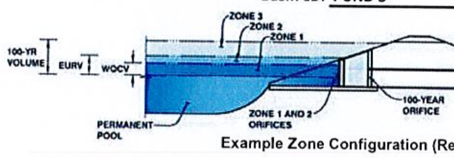
CLASSIC CONSULTING ENGINEERS & SURVEYORS

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: RETREAT AT TIMBERRIDGE FILING NO. 2

Basin ID: POND 3



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.04	0.395	Orifice Plate
Zone 2 (EURV)	4.84	0.309	Orifice Plate
Zone 3 (100-year)	8.16	1.700	Weir&Pipe (Restrict)
Total (all zones)		2.404	

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	20.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

1.23 sq. in. based on orifice diameter shown on plans

Revised

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					
Orifice Area (sq. inches)	1.20	1.29	1.29					

	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 =	5.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	10.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.00	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.30	N/A	
Overflow Grate Open Area w/o Debris =	30.92	N/A	ft^2
Overflow Grate Open Area w/ Debris =	15.46	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 =	0.50	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=	7.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	35.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.76	feet
Stage at Top of Freeboard =	9.26	feet
Basin Area at Top of Freeboard =	0.68	acres
Basin Volume at Top of Freeboard =	3.12	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).

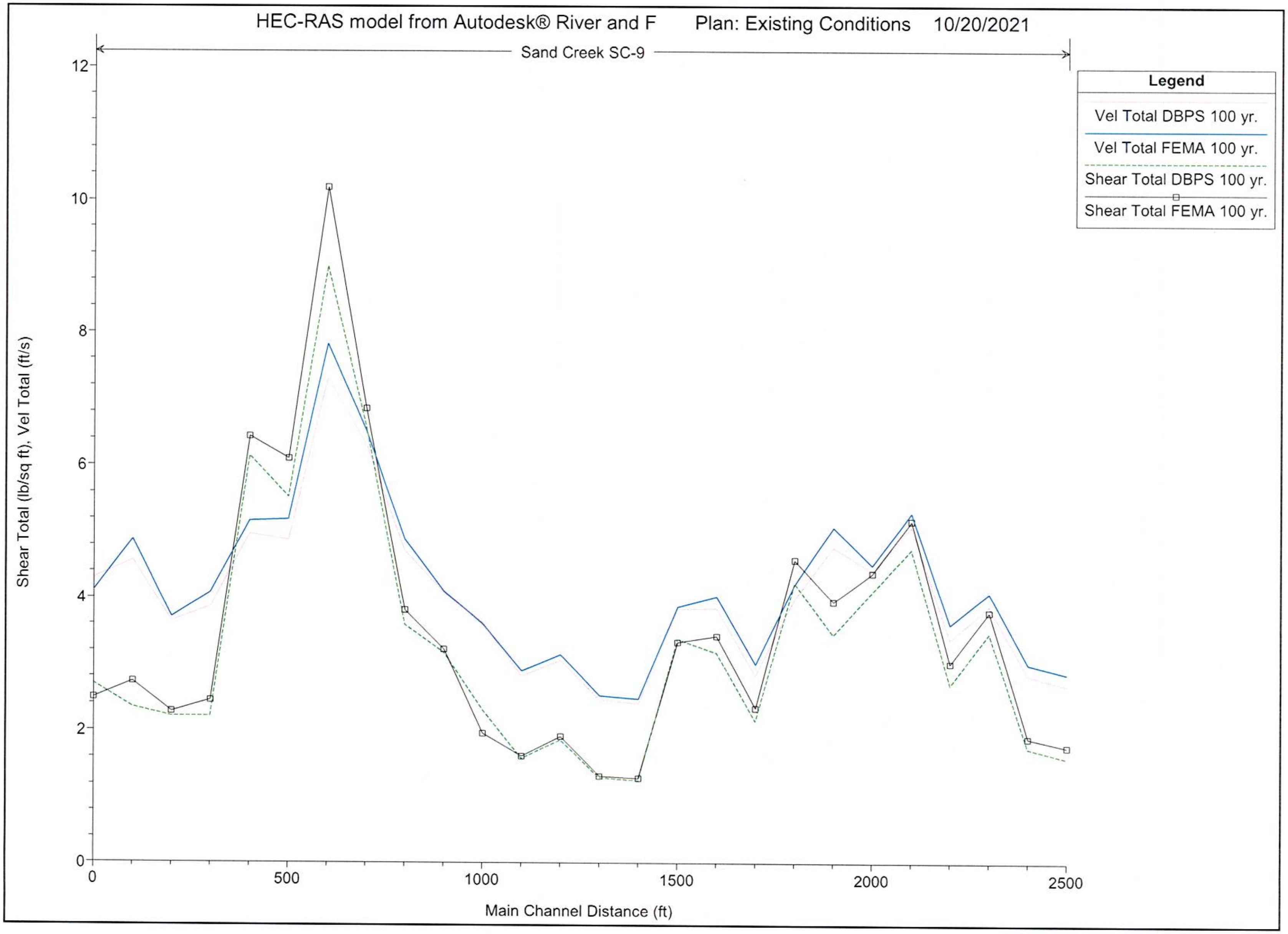
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.85
CUHP Runoff Volume (acre-ft) =	0.395	0.703	0.904	1.876	2.832	4.494	5.642	7.279	13.819
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.904	1.876	2.832	4.494	5.642	7.279	13.819
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	5.6	15.8	24.0	43.0	54.0	69.2	129.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.27	0.41	0.74	0.93	1.19	2.21
Peak Inflow Q (cfs) =	N/A	N/A	10.3	20.8	29.3	48.3	59.6	74.7	135.8
Peak Outflow Q (cfs) =	0.2	0.2	1.0	10.1	19.0	38.7	50.1	59.6	130.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.8	0.9	0.9	0.9	1.0
Structure Controlling Flow =	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.02	0.3	0.6	1.3	1.6	1.9	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) =	40	56	63	58	54	49	46	41	27
Time to Drain 99% of Inflow Volume (hours) =	42	60	67	65	63	60	58	56	49
Maximum Ponding Depth (ft) =	4.04	4.84	5.12	5.60	5.88	6.34	6.56	7.10	8.21
Area at Maximum Ponding Depth (acres) =	0.33	0.42	0.44	0.46	0.48	0.50	0.51	0.55	0.61
Maximum Volume Stored (acre-ft) =	0.397	0.705	0.820	1.040	1.167	1.392	1.503	1.790	2.432

HEC-RAS Plan: Ex. Cond. River: Sand Creek Reach: SC-9

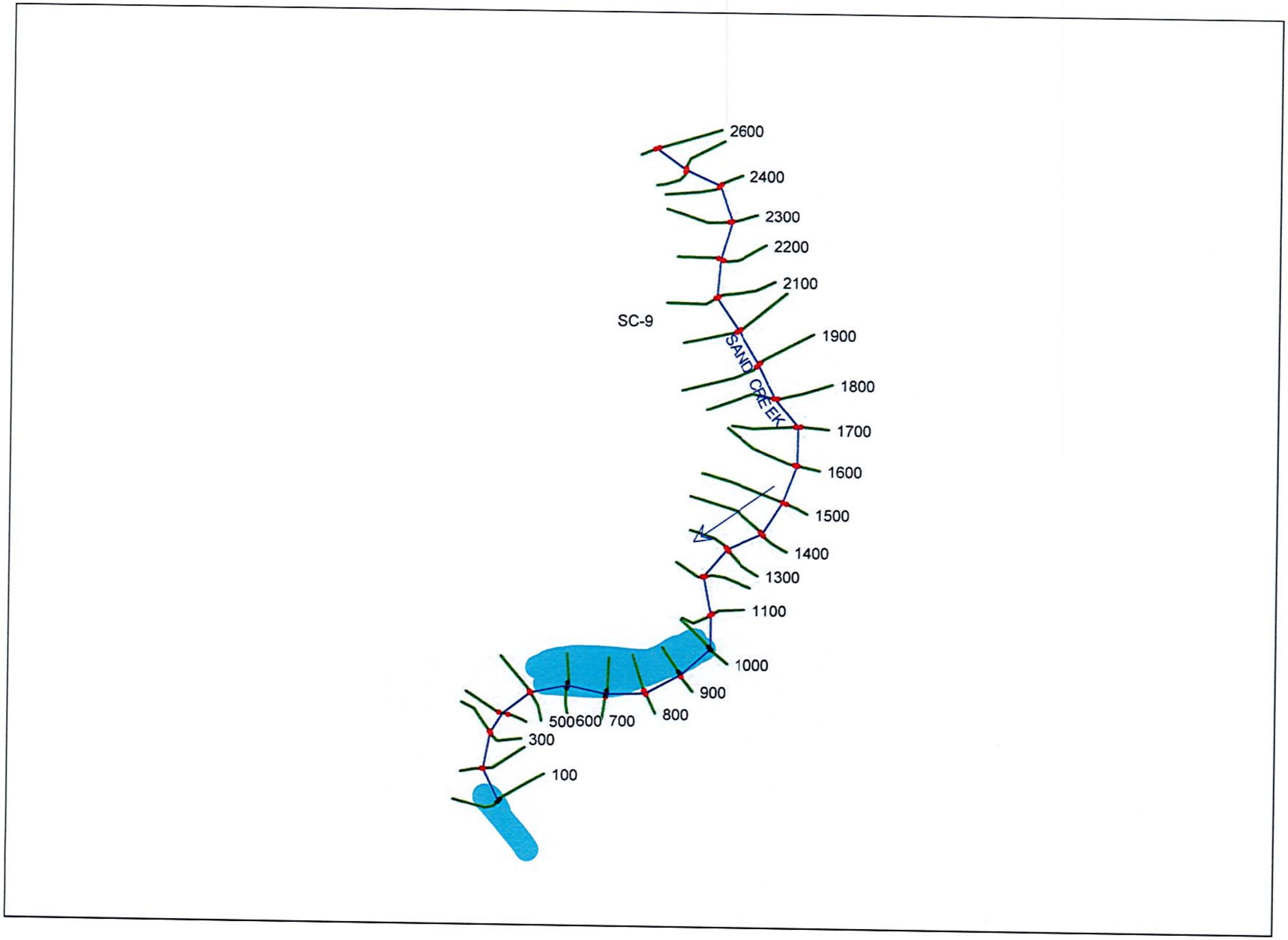
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Max Chl Dpth	Hydr Radius	E.G. Elev	E.G. Slope	Vel Total	Shear Total	Flow Area	Top Width	Froude # XS
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(lb/sq ft)	(sq ft)	(ft)	
SC-9	2600	FEMA 100 yr.	2600.00	7222.35	7230.04		7.69	5.42	7230.18	0.005197	2.85	1.76	913.30	165.94	0.22
SC-9	2600	DBPS 100 yr.	2170.00	7222.35	7229.43		7.08	4.98	7229.55	0.005114	2.67	1.59	813.19	161.08	0.22
SC-9	2500	FEMA 100 yr.	2600.00	7221.49	7229.47		7.98	4.81	7229.63	0.006294	3.00	1.89	867.87	178.83	0.26
SC-9	2500	DBPS 100 yr.	2170.00	7221.49	7228.88		7.39	4.68	7229.02	0.005957	2.83	1.74	767.52	162.56	0.24
SC-9	2400	FEMA 100 yr.	2600.00	7220.76	7228.38		7.62	4.07	7228.69	0.014896	4.07	3.79	638.08	154.82	0.39
SC-9	2400	DBPS 100 yr.	2170.00	7220.76	7227.85		7.09	3.91	7228.13	0.014193	**3.87**	**3.46**	**560.02**	**141.56**	0.38
SC-9	2300	FEMA 100 yr.	2600.00	7220.00	7227.17		7.17	4.26	7227.40	0.011310	**3.60**	**3.01**	**722.83**	**168.17**	0.33
SC-9	2300	DBPS 100 yr.	2170.00	7220.00	7226.70		6.70	4.00	7226.90	0.010742	**3.36**	**2.68**	**645.48**	**159.81**	0.31
SC-9	2200	FEMA 100 yr.	2600.00	7218.65	7224.71		6.06	2.91	7225.65	0.028534	**5.30**	5.18	**490.82**	**168.37**	0.80
SC-9	2200	DBPS 100 yr.	2170.00	7218.65	7224.32		5.67	2.67	7225.21	0.028458	**5.08**	**4.74**	**426.97**	**159.51**	0.81
SC-9	2100	FEMA 100 yr.	2600.00	7216.91	7222.47		5.60	3.08	7222.96	0.022789	**4.50**	**4.38**	**578.16**	**186.77**	0.56
SC-9	2100	DBPS 100 yr.	2170.00	7216.91	7222.00		5.13	2.76	7222.49	0.023773	4.41	4.10	492.54	177.30	**0.59**
SC-9	2000	FEMA 100 yr.	2600.00	7214.69	7219.27	7219.25	4.58	2.71	7220.59	0.023302	5.07	3.95	512.34	187.76	0.98
SC-9	2000	DBPS 100 yr.	2170.00	7214.69	7218.96	7218.91	4.27	2.49	7220.13	0.022155	4.77	3.44	455.40	181.96	0.97
SC-9	1900	FEMA 100 yr.	2600.00	7212.63	7217.55		4.92	2.97	7217.86	0.024680	4.21	4.58	618.13	207.11	**0.46**
SC-9	1900	DBPS 100 yr.	2170.00	7212.63	7217.20		4.57	2.68	7217.48	0.025323	3.98	4.23	544.59	202.67	**0.46**
SC-9	1800	FEMA 100 yr.	2600.00	7210.76	7216.16		5.40	3.55	7216.30	0.010533	3.00	2.34	867.60	242.34	0.28
SC-9	1800	DBPS 100 yr.	2170.00	7210.76	7215.75		4.99	3.18	7215.88	0.010824	2.82	2.15	769.37	240.62	0.28
SC-9	1700	FEMA 100 yr.	2600.00	7208.98	7214.66		5.68	3.51	7215.03	0.015604	4.02	3.42	646.19	182.35	0.46
SC-9	1700	DBPS 100 yr.	2170.00	7208.98	7214.21		5.23	3.10	7214.57	0.016339	3.84	3.17	565.04	180.53	0.48
SC-9	1600	FEMA 100 yr.	2600.00	7207.41	7213.24		5.83	3.85	7213.56	0.013840	3.86	3.33	673.00	173.53	0.41
SC-9	1600	DBPS 100 yr.	2170.00	7207.41	7212.62		5.21	3.35	7212.94	0.016136	3.82	3.37	567.56	168.40	0.44
SC-9	1500	FEMA 100 yr.	2600.00	7206.04	7212.69		6.69	4.93	7212.81	0.004188	2.47	1.29	1051.22	210.36	0.22
SC-9	1500	DBPS 100 yr.	2170.00	7206.04	7211.98		5.98	4.32	7212.10	0.004673	2.40	1.26	904.60	206.98	0.23
SC-9	1400	FEMA 100 yr.	2600.00	7204.96	7212.26		7.30	5.00	7212.39	0.004241	2.52	1.32	1031.11	204.28	0.23
SC-9	1400	DBPS 100 yr.	2170.00	7204.96	7211.51		6.55	4.45	7211.64	0.004685	2.46	1.30	882.00	196.51	0.24
SC-9	1300	FEMA 100 yr.	2600.00	7203.87	7211.69		7.82	5.49	7211.90	0.005574	3.14	1.91	829.19	148.59	0.27
SC-9	1300	DBPS 100 yr.	2170.00	7203.87	7210.89		7.02	4.85	7211.10	0.006154	3.05	1.86	712.30	144.96	0.29
SC-9	1200	FEMA 100 yr.	2600.00	7202.91	7211.21		8.30	5.49	7211.39	0.004722	2.89	1.62	900.68	160.49	0.25
SC-9	1200	DBPS 100 yr.	2170.00	7202.91	7210.39		7.48	5.19	7210.55	0.004885	2.80	1.58	774.19	145.69	0.24
SC-9	1100	FEMA 100 yr.	2600.00	7201.85	7210.32		8.47	3.44	7210.73	0.009117	3.60	1.96	722.95	208.12	0.48
SC-9	1100	DBPS 100 yr.	2170.00	7201.85	7209.57		7.72	4.40	7209.91	0.008409	3.62	2.31	600.24	134.55	0.39
SC-9	1000	FEMA 100 yr.	2600.00	7199.76	7209.27		9.51	4.28	7209.70	0.012015	4.09	3.21	635.18	144.59	0.44
SC-9	1000	DBPS 100 yr.	2170.00	7199.76	7208.51		8.75	4.21	7208.91	0.012048	4.07	3.17	532.92	122.92	0.43

HEC-RAS Plan: Ex. Cond. River: Sand Creek Reach: SC-9 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Max Chl Dpth	Hydr Radius	E.G. Elev	E.G. Slope	Vel Total	Shear Total	Flow Area	Top Width	Froude # XS
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(lb/sq ft)	(sq ft)	(ft)	
SC-9	900	FEMA 100 yr.	2600.00	7198.85	7207.76		8.91	4.77	7208.44	0.012804	4.88	3.81	533.05	109.31	0.53
SC-9	900	DBPS 100 yr.	2170.00	7198.85	7207.07		8.22	4.61	7207.67	0.012460	4.70	3.59	461.30	97.66	0.51
SC-9	800	FEMA 100 yr.	2600.00	7197.87	7205.34		7.47	4.02	7206.59	0.027271	6.52	6.85	398.94	97.06	0.78
SC-9	800	DBPS 100 yr.	2170.00	7197.87	7204.74		6.87	3.92	7205.86	0.026867	6.31	6.57	344.05	85.87	0.75
SC-9	700	FEMA 100 yr.	2600.00	7195.42	7201.76	7201.35	6.34	4.05	7203.28	0.040315	7.82	10.19	332.43	80.30	0.86
SC-9	700	DBPS 100 yr.	2170.00	7195.42	7201.31	7200.92	5.89	3.72	7202.65	0.038748	7.30	8.99	297.30	78.33	0.84
SC-9	600	FEMA 100 yr.	2600.00	7193.19	7199.53		6.34	4.29	7200.00	0.022766	5.18	6.09	501.48	115.45	0.46
SC-9	600	DBPS 100 yr.	2170.00	7193.19	7199.04		5.85	3.89	7199.46	0.022724	4.87	5.53	445.57	113.11	0.46
SC-9	500	FEMA 100 yr.	2600.00	7190.84	7197.18		6.34	4.16	7197.62	0.024773	5.16	6.43	503.76	119.34	0.46
SC-9	500	DBPS 100 yr.	2170.00	7190.84	7196.62		5.78	3.75	7197.03	0.026244	4.96	6.14	437.44	115.25	0.46
SC-9	400	FEMA 100 yr.	2600.00	7188.25	7195.91		7.66	4.78	7196.34	0.008189	4.07	2.45	638.96	130.44	0.42
SC-9	400	DBPS 100 yr.	2170.00	7188.25	7195.32		7.07	4.31	7195.72	0.008180	3.85	2.20	563.27	127.72	0.42
SC-9	300	FEMA 100 yr.	2600.00	7185.84	7194.84		9.00	4.52	7195.64	0.008073	3.70	2.28	703.58	152.77	0.59
SC-9	300	DBPS 100 yr.	2170.00	7185.84	7194.14		8.30	3.98	7194.97	0.008869	3.63	2.20	597.14	147.37	0.64
SC-9	200	FEMA 100 yr.	2600.00	7184.80	7192.65	7192.65	7.85	4.17	7194.62	0.010470	4.88	2.73	533.11	124.10	0.96
SC-9	200	DBPS 100 yr.	2170.00	7184.80	7192.19	7192.19	7.39	3.80	7193.95	0.009869	4.56	2.34	476.02	121.78	0.95
SC-9	100	FEMA 100 yr.	2600.00	7183.63	7189.18	7189.18	5.55	3.39	7190.74	0.011738	4.10	2.48	634.04	186.15	0.96
SC-9	100	DBPS 100 yr.	2170.00	7183.63	7188.47	7185.99	4.84	2.87	7190.25	0.015020	4.29	2.69	506.39	175.71	1.11



HEC-RAS model from Autodesk® River and F
Plan: Existing Conditions
10/20/2021
Sand Creek SC-9
Legend
Vel Total DBPS 100 yr.
Vel Total FEMA 100 yr.
Shear Total DBPS 100 yr.
Shear Total FEMA 100 yr.
Shear Total (lb/sq ft), Vel Total (ft/s)
0
2
4
6
8
10
12
0
500
1000
1500
2000
2500
Main Channel Distance (ft)



2600
2400
2300
2200
2100
SC-9
1900
SAND CREEK
1800
1700
1600
1500
1400
1300
1100
1000
900
800
500600 700
300
100

HEC-RAS Plan: Pr. Cond. River: SAND CREEK Reach: SC-9 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	Hydr Radius (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Total (ft/s)	Shear Total (lb/sq ft)	Flow Area (sq ft)	Top Width (ft)	Froude # XS
SC-9	900	FEMA 100 yr.	2600.00	7198.85	7205.76		6.91	4.92	7206.55	0.018791	5.83	5.78	446.23	88.45	0.56
SC-9	900	DBPS 100 yr.	2170.00	7198.85	7205.23		6.38	4.57	7205.92	0.017833	5.42	5.08	400.56	85.73	0.54
SC-9	800	FEMA 100 yr.	2600.00	7197.87	7204.40		6.53	4.62	7204.83	0.014136	4.54	4.08	573.01	121.52	0.43
SC-9	800	DBPS 100 yr.	2170.00	7197.87	7203.90		6.03	4.23	7204.27	0.013742	4.23	3.63	512.78	118.93	0.42
SC-9	700	FEMA 100 yr.	2600.00	7195.42	7201.74		6.32	3.69	7202.80	0.030615	6.30	7.05	412.73	110.63	0.76
SC-9	700	DBPS 100 yr.	2170.00	7195.42	7201.28		5.86	3.31	7202.27	0.030978	5.99	6.40	362.43	108.33	0.77
SC-9	600	FEMA 100 yr.	2600.00	7193.19	7199.52		6.33	4.27	7199.99	0.022882	5.21	6.10	499.50	115.40	0.47
SC-9	600	DBPS 100 yr.	2170.00	7193.19	7199.02		5.83	3.87	7199.44	0.022993	4.90	5.56	442.67	113.02	0.47
SC-9	500	FEMA 100 yr.	2600.00	7190.84	7197.32		6.48	4.27	7197.73	0.022127	4.98	5.90	521.78	120.35	0.44
SC-9	500	DBPS 100 yr.	2170.00	7190.84	7196.74		5.90	3.85	7197.13	0.023317	4.78	5.61	453.66	116.16	0.44
SC-9	400	FEMA 100 yr.	2600.00	7188.25	7196.04		7.79	4.71	7196.49	0.008322	4.12	2.45	631.75	131.06	0.43
SC-9	400	DBPS 100 yr.	2170.00	7188.25	7195.43		7.18	4.22	7195.85	0.008447	3.93	2.22	552.76	128.22	0.44
SC-9	300	FEMA 100 yr.	2600.00	7185.84	7195.23		9.39	4.78	7195.87	0.006622	3.43	1.98	757.36	155.51	0.51
SC-9	300	DBPS 100 yr.	2170.00	7185.84	7194.55		8.71	4.26	7195.19	0.006960	3.32	1.85	653.98	150.67	0.54
SC-9	200	FEMA 100 yr.	2600.00	7184.80	7193.06	7193.06	8.26	4.57	7194.94	0.010234	4.43	2.92	587.44	126.11	0.90
SC-9	200	DBPS 100 yr.	2170.00	7184.80	7192.56	7192.56	7.76	4.17	7194.28	0.009715	4.13	2.53	525.79	123.67	0.90
SC-9	100	FEMA 100 yr.	2600.00	7183.63	7189.19	7189.19	5.56	3.39	7190.75	0.011746	4.10	2.48	634.41	186.38	0.96
SC-9	100	DBPS 100 yr.	2170.00	7183.63	7188.80	7188.80	5.17	3.10	7190.21	0.011294	3.85	2.19	563.36	180.62	0.95

These (and 2 above) are still very high

See revised calcs. Added 2 more check structures

Grade control required?

Added check structure

Table 8-3. Design parameters for naturalized channels

Design Parameter	Design Value
Maximum 100-year depth outside of bankfull channel	5 ft
Roughness values	Per Table 8-5
Maximum 5-year velocity, main channel (within bankfull channel width) (ft/s)	5 ft/s
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	7 ft/s
Froude No., 5-year, main channel (within bankfull channel width)	0.7
Froude No., 100-year, main channel (within bankfull channel width)	0.8
Maximum shear stress, 100-year, main channel (within bankfull channel width)	1.2 lb/sf
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater[1]
Minimum bankfull channel geometry	Per Table 8-2
Minimum bankfull channel width/depth ratio (Equation 8-3)	9
Minimum entrenchment ratio (Equation 8-4)	3
Maximum longitudinal slope of low flow channel (assuming unlined, unvegetated low flow channel)	0.2 percent
Bankfull channel sinuosity (Equation 8-5)	1.1 to 1.3
Maximum overbank side slope	4(H):1(V)
Maximum bankfull side slope	2.5(H):1(V)
Minimum radius of curvature	2.5 times top width

[1]Roughly equivalent to a 1.5-year event based on extrapolation of regional data.

MHFD has acceptable criteria; address channel design and stability.

Added criteria to report. See revised.