FINAL DRAINAGE REPORT FOR HOMESTEAD AT STERLING RANCH FILING NO. 1

EL PASO COUNTY, COLORADO

April 2018

Prepared for:

SR Land, LLC
20 Boulder Crescent, Suite 210
Colorado Springs, CO 80903

Prepared by:

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

Project #09-005
DSD Project # SF-17-025

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HOMESTEAD AT STERLING RANCH FILING NO. 1

DRAINAGE PLAN STATEMENTS

ENGINEERS STATEMENT

The attached drainage plan and report was prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin.

_____

Virgil A. Sanchez, P.E. #37160
For and on Behalf of M&S Civil Consultants, Inc

DEVELOPER'S STATEMENT

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

BY:_____
James F Morley

TITLE:_____
DATE:_____

ADDRESS: SR Land, LLC
20 Boulder Crescent, Suite 210
Colorado Springs, CO 80903

EL PASO COUNTY'S STATEMENT

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

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

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TABLE OF CONTENTS

APPENDIX

FINAL DRAINAGE REPORT FOR
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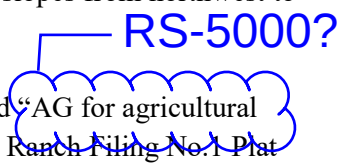
PURPOSE

The purpose of this document is to identify and analyze the on and offsite drainage patterns and to ensure that post development runoff is routed through the site and to downstream facilities in a safe manner that satisfies the requirements set forth by the El Paso County Drainage Criteria Manual and any conditions set forth by the approved master drainage development plans.

GENERAL LOCATION AND DESCRIPTION

Homestead at Sterling Ranch Filing No. 1 is located in the NE ¼ of the NW ¼ of Section 33, Township 12 South, Range 65 West of the 6th Principal Meridian, and the SE ¼ of the NW ¼ of Section 33, Township 12 South, Range 65 West of the 6th Principal Meridian within unincorporated El Paso County, Colorado. The site is bound on the north by Dines Boulevard and platted Tract C, within the Sterling Ranch development. The property is bound to the east by Dines Boulevard and to the west by existing Vollmer Road. The property is bound to the south by the existing Barbarick Subdivision and Tract BB within the Sterling Ranch. Tract BB is planned for residential development and shall be henceforth referred to as Branding Iron Filing No. 1 at Sterling Ranch. Sterling Ranch lies within the Sand Creek Drainage Basin. Flows from this site are tributary to Sand Creek.

Homestead at Sterling Ranch Filing No. 1 consists of 19.574 acres and is presently undeveloped. Vegetation is sparse, consisting of native grasses. Existing site terrain generally slopes from northwest to south and southeast at grades that vary between 2% and 4%.



Prior to development Homestead at Sterling Ranch Filing No. 1 is presently zoned "AG for agricultural grazing land, but has been identified to contain residential lots within the Sterling Ranch Filing No.1 Plat (Tract G) thereby conforming to the type of development approved Sterling Ranch Preliminary Plan. Improvements proposed for the site include paved, streets, trails, utilities, and storm drainage improvements, as normally required in constructed of a residential development. Onsite water quality is provided by the existing FSD Ponds 4, 8 and W-9 which were constructed with Sterling Ranch Filing No.1 (see MDDPSR).

SOILS

The soils associated with the drainage area analyzed by this study consist of Pring Coarse Sandy Loam (71) as determined by the mapping provided by the Natural Resources Conservations Service Web Soil Survey. According the information available on the website, this soil has a Hydrologic Soil Group rating of "B". A map showing the proposed site, studied watershed and hydrologic soil group classification is included in the appendix of this report.

PREVIOUS STUDIES

This area was previously studied in the "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Corporation, revised March 1996. More recently the area has been studied in the "Master

Development Drainage Report for Sterling Ranch Filing Nos. 1 & 2, and Final Drainage Report for Sterling Ranch Filing No.1" prepared by MS Civil Consultants, dated April 2017 (henceforth referred to as MDDPSR) and the Sterling Ranch MDDP revised April 2018.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County and City of Colorado Springs Storm Drainage Design Criteria manual and where applicable the Urban Storm Drainage Criteria Manual. The Rational Method was used to estimate stormwater runoff anticipated from design storms with 5-year and 100-year recurrence intervals.

HYDRAULIC CALCULATIONS

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

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain as determined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 08041C0535 F, effective date March 17, 1997 and revised to reflect LOMR, 08-08-O541P, dated July 23, 2009. An annotated FIRM Panel is included in the Appendix.

DRAINAGE CRITERIA

This drainage analysis has been prepared in accordance with the current City of Colorado Springs/El Paso County Drainage Criteria Manual, Volumes I & II, dated November 1991, including subsequent updates. El Paso County has also adopted Chapter 6 and Section 3.2.1 of Chapter 13 in the City of Colorado Springs & El Paso County Drainage Criteria Manual Volumes I and II, dated May 2014. (Appendix I of the El Paso County's Engineering Criteria Manual (ECM), 2008). In addition to the aforementioned ECMs, the Urban Storm Drainage Criteria Manuals, Volumes 1-3, published by the Urban Drainage and Flood Control District (Volumes 1 & 2 dated January 2016, Volume 3 dated November 2010 and updates) have been utilized to aid in design of the Full Spectrum Detention Facilities when required.

EXISTING DRAINAGE CONDITIONS

Homestead at Sterling Ranch Filing No. 1 site consists of 19.574 acres and is situated west of the Sand Creek Watershed. This area was previously studied in the "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Corporation, revised March 1996. More recently the area was studied in the "Master Development Drainage Report for Sterling Ranch Filing Nos. 1&2, and Final Drainage Report for Sterling Ranch Filing No.1" prepared by MS Civil Consultants, dated April 2017. Homestead at Sterling Ranch Filing No. 1 and the surrounding areas, with the exception of the existing Barbarick Subdivision, have recently overlot graded. Please refer to the MDDPSR and Sterling Ranch Early Onsite Grading Plan for information on historic conditions and overlot drainage patterns.

PROPOSED DRAINAGE CHARACTERISTICS

General Concept Drainage Discussion

The proposed drainage plan for Homestead at Sterling Ranch Filing No. 1 will mimic and formalize the grading patterns established with both the Sterling Ranch MDDP and the Master Development Drainage Report for Sterling Ranch Filing Nos. 1 & 2, and Final Drainage Report for Sterling Ranch Filing No.1 and with its approval allow for the constructing the internal subdivision roadways, utilities, sidewalks and ultimately the placement of homes. With the prior approval of the Sterling Ranch Filing Nos. 1 & 2, and Final Drainage Report for Sterling Ranch Filing No.1, construction plans have been recently approved by El Paso County which have allowed for the construction of the adjacent Dines Boulevard, Filing 1 Storm sewer infrastructure and the formalization of the adjacent Full Spectrum Detention Facilities (Pond Nos. 4, 8 and W-9) and the outlet structures which are needed to collect and convey the developed drainage to the existing channel. It should be noted that the construction of these facilities are occurring during the writing of this report. The following detailed drainage discussion provides an overview of the proposed development drainage analysis and ensures that no alternation of the planned improvements is necessary.

Detailed Drainage Discussion

The following is a description of the onsite basins, offsite bypass flows and the overall drainage characteristics for the development of Homestead at Sterling Ranch Filing No. 1 and the Amendment to Master Development Drainage Report for Sterling Ranch Filing No. 1 & 2. The development of Homestead at Sterling Ranch Filing No. 1 consists only of the two cul-de-sacs, an eyebrow, roadways, and lots located within the filing boundary. The proposed development drainage patterns and flow values are generally the same as those recommended within the MDDPSR. The following design points and basin results were determined using the Rational Method. Developed surface flow is designated as Design Points (DP) and flow within the storm sewer as (Pipe Run (PR)). To allow for comparison, an **asterisk (*)** symbol in the detailed drainage discussions below represents each Basin or Design Point as labeled in the Sterling Ranch Filing Nos. 1 & 2 MDDP.

Detailed Drainage Discussion (Design Points)

DP1, 2.79 acres, consists of proposed residential lots and streets (Basin A) which have been assigned runoff coefficients of 0.38 for the 5-year and 0.55 for the 100-year events. Developed runoff of 3.6 cfs and 8.7 cfs has been calculated to reach DP1 as shallow overland and street flows in the 5 and 100 year events respectively. A proposed 15’ CDOT type R at-grade inlet will intercept flows of Q5=3.6 cfs and Q100=8.6 cfs (PR1)and route them under Wheatland road via a proposed 30” RCP to DP2. Although not accounted for the in the MDDP, the flow-by of approximately 0.1 cfs in the 100 year event (negligible) is not anticipated to adversely affect the downstream infrastructure.

DP2, 2.70 acres, consists of proposed residential lots and streets (Basin B) that have been assigned runoff coefficients of 0.38 for the 5-year and 0.55 for the 100-year storm events. Developed runoff of 3.6 cfs and 8.6 cfs has been calculated to reach DP2 as shallow overland and street flows in the two events respectively. A proposed 15’ CDOT type R at-grade inlet will intercept flows of Q5=3.6 cfs and Q100=8.5 cfs will combine with flows from PR1 be routed via a 36” RCP (PR2) to an existing 36” RCP stub in the western

right of way of existing Dines Boulevard. The cumulative flows in PR2 (Q5=7.1 cfs and Q100=17.2 cfs) are just slightly less than the flows documented in the MDDPSR report (Q5=8.0 cfs and Q100=19.3 cfs) (Aka DP2*). Similar to the inlet at DP1 flow-by of approximately 0.1 cfs in the 100 year event is anticipated to continue to existing Dines Boulevard. The negligible runoff is not anticipated to adversely affect the downstream infrastructure.

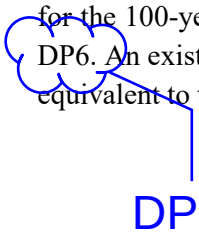
DP3, (**Aka DP3***), 2.92 acres, consists of proposed residential lots and streets (Basin C) that have been assigned runoff coefficients of 0.38 for the 5-year and 0.55 for the 100-year events. Developed runoff of 4.2 cfs and 10.1 cfs has been calculated to reach DP3. A proposed 10' CDOT type R sump inlet and 18" RCP storm pipe will intercept and convey flood flows of Q5=4.2 cfs and Q100=10.1 cfs to an 18" RCP existing stub. The flows in PR3 are equivalent to the flows documented in the MDDPSR report of Q5=4.2 cfs and Q100=10.1 cfs.

DP4, (**Aka DP4***), 9.36 acres, consists of proposed residential lots Basin D (2.9 ac) and Basin E (5.34 ac) with runoff coefficients of 0.38 for the 5-year and 0.55 for the 100-year and 1.12 acres of streets (Basin F, Dines Boulevard) with runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year. Developed runoff of Q5=16.1 cfs and Q100=36.7 cfs has been calculated to reach DP4. A proposed 15' CDOT type R at-grade inlet will intercepted flows of Q5=13.3 cfs and Q100=20.0 cfs prior to combining with flows from PR3 and routed east via an existing 30" RCP to existing FSD Pond 4. The flows at DP4 are equivalent to the flows documented in the MDDPSR report (Q5=16.1 cfs and Q100=36.7 cfs). Flow-by from DP4 will be routed to DP5.

DP5, (**Aka DP5***) 0.80 acres, consists of 0.61 acres proposed backyards of residential lots (Basin G) that have assigned runoff coefficients of 0.22 for the 5-year and 0.46 for the 100-year, as well 0.19 acres of Dines Boulevard (Basin H) with runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year as well as flow by from DP4. Developed runoff of 4.2 and 19.7 cfs has been calculated to reach DP5 in the two events respectively. An existing 15' CDOT type R at-grade inlet at. DP5 will intercept flows of Q5=4.2 cfs and Q100=14.7 cfs. These flows are equivalent to the flows documented in the MDDPSR report (Q5=4.2 cfs and Q100=19.7 cfs). An existing 36" RCP will carry the collected runoff under existing Dines Boulevard towards DP6, while flow-by from DP5 will continue south within Dines Boulevard.

DP6, (**Aka DP5***) 4.68 acres, consists backyards of residential lots of 0.43 and 0.61 acres in size (Basins OS3 and OS4) that have been assigned runoff coefficients of 0.22 for the 5-year and 0.46 for the 100-year events and 2.1 acre portion of Wheatland Drive and 1.54 acre portion of Dines Boulevard, both with assigned runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year events. Developed runoff of Q5=14.1 cfs and Q100=26.7 cfs has been calculated to reach DP6. An existing 15' CDOT type R at-grade inlet. These flows are equivalent to the flows documented in the MDDPSR report (Q5=14.1 cfs and Q100=26.7 cfs). Flow-by from DP6 will continue south within Dines Boulevard.

DP7, (**Aka DP9***) 9.73 acres, consists of proposed residential lots of the planned development located east of the subject site (Basin 0S-6) that have been assigned runoff coefficients of 0.38 for the 5-year and 0.55 for the 100-year events. Developed runoff of Q5=12.6 cfs and Q100=30.5 cfs has been calculated to reach DP6. An existing 30" RCP will convey runoff to existing FSD Pond 4. The flows in PR7 are approximately equivalent to the flows documented in the MDDPSR report of Q5=12.5 cfs and Q100=30.4 cfs.



DP8,(**Aka DP10***) 1.97 acres, consists of Basin S (Existing FSD Pond 4) with runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year and runoff from PR4, PR6 and PR7. Based upon this drainage analysis the total combined developed runoff to reach DP10 at the existing pond will be Q5=49.2 cfs and Q100=105.39 cfs for the 5 and 100 year events respectively, which varies just slightly from the MDDPSR flows of Q5=50.0 cfs and Q100=102.9 cfs that the facility was designed for.

The existing privately maintained facility, as constructed, continues to provide full spectrum detention and water quality for the calculated runoff as planned. The pond will continue to treat approx 27.63 acres, and provide 0.46 ac-ft of water quality storage and 2.915 ac-ft of 100-year storage (refer to UD-Detention worksheet in appendix of this report). According to the updated UD detention worksheet, the slight inflow increase in results in only an increase in the ponding elevation of 0.03'and an increase of 0.6 cfs being released from the pond when compared to the initial design worksheets. Despite the minor increase the pond continues to meet the required drain times and pre-developed flow release rates as necessary with no negative impacts to downstream facilities.

In the event of clogging or total inlet failure, flows at DP8 will over top the existing emergency spillway and outfall into Sand Creek. The existing detention pond will be private and shall be maintained by the Sterling Ranch Metropolitan District (SRMD). Access has been granted to the SRMD and El Paso County for access and maintenance of the private detention pond.

DP9,(**Aka DP10***) 3.01 acres, consists of 2.71 acres of existing low density residential (Basin OS1A) that have assigned runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year and 0.31 acres of existing west half of Vollmer Road (Basin V1A) with assigned runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year. Developed runoff of Q5=1.6 cfs and Q100=7.0 cfs has been calculated to reach an existing 12" CMP culvert (PR8) at DP9. The runoff shall continue south in its historic drainage pattern via an existing road side swale to DP10.

DP10 (Aka DP63*), 9.35 acres, consists of 9.09 acres of existing low density residential (Basin OS1B) that have assigned runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year and 0.31 acres of the existing west half of Vollmer Road (Basin V1B) with runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year. Runoff reaching DP10, including flows from DP9, are calculated to be Q5=4.8 cfs and Q100=26.3 cfs in the 5 and 100 year events respectively. Runoff reaching DP 10, is captured by an existing CDOT type D inlet and routed, under Vollmer Road via an existing 24" RCP (PR9). As discussed in the SRMDDP, in the event of clogging, runoff will overtop the local sump condition and the surface runoff shall be routed via historic drainage patterns and an existing road side swale to DP11.

DP11 (Aka DP 64*), 5.85 acres, consists of 5.64 ac existing low density residential (Basin OS1C) with assigned runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year and approximately 0.21 ac of the existing west half of Vollmer Road (Basin V1C) with assigned runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year. Runoff reaching DP11 has been calculated to be Q5=2.2 cfs and Q100=12.3 cfs for the 5 and 100 year events respectively. An existing CDOT type C inlet and existing 18" RCP (PR10) route the collected runoff under Vollmer Road. These flows combine with flows within the existing 24" 24" RCP (PR9) before continuing to the south via an existing 30" RCP, (PR11) at flow rates of Q5=7.0 cfs and Q100=38.6 cfs. In the event of clogging, runoff will overtop the sump condition and the surface runoff shall be routed via historic drainage patterns and an existing road side swale to DP12.

DP12, **(Aka DP 64*)**, 104.75 acres, consists of 94.3 and 10.0 acre basins of existing low density residential (Basin OS1D and Basin W-2), that have been assigned runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year storm events and 0.13 and 0.32 acre basins of the existing west half of Vollmer Road (Basin V1D and Basin V2) that have been assigned runoff coefficients of 0.90 for the 5-year and 0.96 for the 100-year. Runoff reaching DP12 has been calculated to be 18.9 cfs and 133.7 cfs in the 5 and 100 year events. An existing 4.0'x14.0' modified CDOT type D inlet will collect the runoff and route it under Vollmer Road, via an existing 54" RCP (PR12) to an existing manhole located within a tract east of the Vollmer Road right of way. Complete the description of where this flow goes (undetained through the site to Sand Creek).

DP13, 2.04 acres, consists of a portion of Vollmer Road and (Basin RP-2B) with runoff coefficients of 0.63 for the 5-year and 0.76 for the 100-year storm events. Developed runoff of Q5=2.8 cfs and Q100=5.6 cfs has been calculated to reach DP13. The collected surface runoff will be routed existing via curb and gutter to an existing 6.0' wide CDOT Type 5 embankment protector. An existing riprap apron placed at the bottom of the rundown provides to dissipate energy and prevent local scour. Runoff is conveyed southerly in an existing earthen swale that leads to existing Detention Pond W-9.

DP14 (Aka DP61*), 4.03 acres, consists 1.15 acres of rear residential lots with runoff coefficients of 0.22 for the 5-year and 0.46 for the 100-year and 1.60 acres of landscape area and an existing FSD pond (Basin M2) that has been assigned runoff coefficients of 0.08 for the 5-year and 0.35 for the 100-year and 2.04 acres of the eastern half of existing Vollmer Road and adjacent landscaped areas, which have been assigned runoff coefficients of 0.63 and 0.76 for the 5 and 100 year events respectively as well as flows from DP13. Runoff reaching the existing pond at DP 14 is calculated to be Q5=8.9 cfs and Q100=21.2 cfs, which matches the MDDPSR flows of Q5=8.9 cfs and Q100=21.2 cfs that the facility was designed for.

The existing facility functions to provide full spectrum detention and water quality for runoff calculated to reach DP14. The existing pond will treat approx 5.87 acres, and provide 0.092 ac-ft of water quality storage and 0.638 ac-ft of 100-year storage. As described within the MDDPSR the detention facility is private and shall be maintained by the Sterling Ranch Metropolitan District. Access shall be granted to the owner and El Paso County for access and maintenance of the private detention pond. In the event of clogging or total inlet failure, flows at DP14 will over top the emergency spillway and outfall into a proposed swale which will route flows to an existing Vollmer Road side swale. The peak release rates from Pond W-9 (PR13, Q5=0.6 cfs and Q100=8.7 cfs) are conveyed within an existing 18" RCP to and existing 30" RCP ((PR14) (Q5=7.6 cfs and Q100=47.2 cfs)). These flows will be combine with flows from PR12 and be routed east, within the Homestead Sterling Ranch Filing No. 1 subdivision, via a 54" RCP, PR15 (Q5=23.8 cfs and Q100=164.1 cfs). These flows will combine with flows from PR16 (Q5=2.8 cfs and Q100=36.8 cfs, release rate Pond 4) and be routed south via a 60" RCP, PR12 (Q5=26.6 cfs and Q100=200.9 cfs). These flows are nearly equivalent to the SRMDDP runoff rates of (Q5=26.5 cfs and Q100=200.3 cfs) which the pipe was designed. The collected runoff will outfall into an existing low tailwater riprap basin at Sand Creek.

Basin N 2.08 acres, consists of proposed residential backyard lots and part of Tract L located along the south boundary of Homestead at Sterling Ranch Filing No. 1 with runoff coefficients of 0.22 for the 5-year and 0.46 for the 100-year. Developed runoff of Q5=1.6 cfs and Q100=5.7 cfs have been calculated for the basin. Runoff from the proposed residential backyard lots will flow to an existing swale that falls along the east boundary of the Barbarick Subdivision. Basin N was part of a larger Basin YY* that was as discussed

shall. (Also add to plat note re swales.)

in the MDDPSR. The limited developed flows from Basin N that are discharged to the south are considerably less than the historic flows previously directed toward the Barbarick subdivision as can be seen by noting Basin EX-3A in the Sterling Ranch MDDP Existing Conditions Map. As the backyards are typically permeable, and roof drainage from the back of the house can be directed to the front of the lot water quality treatment is not required for this area. As such the proposed develop shall not adversely affect the downstream infrastructure.

is required unless there is an approved deviation request.

Basin O 0.57 acres, consists of planned residential backyard lots located along the south boundary of Homestead at Sterling Ranch Filing No. 1 that have been assigned runoff coefficients of 0.22 for the 5-year and 0.46 for the 100-year storm events. Developed runoff of, Q5=0.5 cfs and Q100=1.8 cfs is anticipated to be produced by the basin. Runoff from the proposed residential backyard lots will sheet flows towards the planned Branding Iron at Sterling Ranch Filing No. 1 as discussed in the MDDPSR. Basin O was part of a larger Basin GG* in the MDDPSR. Runoff from basin O and the flow-by from DP1, 2, 5 and 6 will be collected within existing system within existing Dines Boulevard and detained and released at pre-developed flow rates from FSD Pond 4. Refer to Branding Iron at Sterling Ranch filing No.1 FDR for additional information.

DETENTION PONDS

Water Quality/Full Spectrum Detention Facilities

As discussed in the detained drainage summary, developed runoff from Branding Iron at Sterling Ranch Filing No. 1 is conveyed to existing Full Spectrum Detention Ponds No 4, 8 and W-9 in accordance with the Sterling Ranch Filing Nos. 1&2 MDDP. Based upon the provided analysis the ponds are adequate to server there intended purpose and require no modification. This is because this final drainage report and the SR Filing 1 and 2 MDDP were nearly concurrent. Thus the larger scale concept planning was very finite and thus allowed for the developed flow rates to align between the two documents and thereby not requiring modifications to facility which is often common between conceptual and final design. The information provided in this report regarding Ponds 8 and W-9 shall supersede the information presented in the MDDP and should be re-referenced with future design.

EROSION CONTROL

It is the policy of the El Paso County that a grading and erosion control plan be submitted with the drainage report. EPC approved "Early Grading Plan for Sterling Ranch Phase I Onsite Grading & Erosion Control", November 18, 2015. And "Early Grading Plan for Sterling Ranch Phase I Offsite Grading & Erosion Control", December 3, 2015. Grading and Erosion control operations are currently underway (August 2016). Grading and Erosion Control will cease with the final development of the site in the next 12-36 months.

Address WQCV deviation (maintenance of vegetated buffer/swale to be addressed in deviation request)

Copy paragraph from Branding Iron

CONSTRUCTION COST OPINION – HOMESTEAD AT STERLING RANCH FILING NO. 1

Drainage Facilities:

See Construction Cost Opinion for Alternative Sterling Ranch Filing No. 1 MDDP on the next page following the Summary paragraph.

M & S Civil Consultants, Inc. (M & S) cannot and does not guarantee the construction cost will not vary from these opinions of probable costs. These opinions represent our best judgment as design professionals familiar with the construction industry and this development in particular. The above is only an estimate of the facility cost and drainage basin fee amounts in 2017.

DRAINAGE & BRIDGE FEES – HOMESTEAD AT STERLING RANCH FILING NO. 1

This site is within the Sand Creek Drainage Basin. The 2017 Drainage and Bridge Fees per El Paso County for the Homestead at Sterling Ranch Filing No. 1site are as follows:

Item	Description	Quantity	Unit Cost		Cost
1	18" RCP	10	$40	/LF	$400.00
2	30" RCP	34	$65	/LF	$2,210.00
3	36" RCP	36	$75	/LF	$2,700.00
4	15' CDOT Type R At-Grade	2	$6000	/EA	$12,000.00
5	8' CDOT Type R Sump Inlet	1	$4700	/EA	$4,700.00
			Total		**$22,010.00**
Per Homestead at Sterling Ranch Filing No.1 Plat –			**Total Area**		**19.574 Acres**

FILING NO. 1 FEES:

Drainage Fees:	19.574	x	42%	$	16,270.00	=	$	133756.97
Bridge Fees:	19.574	x	42%	$	4,929.00	=	$	40,521.70
						Total	**$**	**174,275.67**

SUMMARY

Developed runoff from Homestead at Sterling Ranch Filing No.1 will be conveyed into the existing and proposed drainage systems as shown on the enclosed Drainage Map. The majority of the stormwater will be convey to the south within the proposed rights of way and public storm sewer systems to the Existing Pond No. 4 which will provide full spectrum detention. A small portion of the site adjacent to Vollmer Road will drain to existing Full Spectrum Detention Facility W-9, while a small segment of the development adjacent to Branding Iron at Sterling Ranch Filing No.1 will be collected within existing Dines Boulevard and treated by Full Spectrum Detention Facility No.8. All facilities will discharge runoff to Sand Creek at rates that are equivalent or less than the pre-developed condition in patterns that concur with the both the Sterling Ranch MDDP and the Sterling Ranch filing No.1 and 2 MDDP. As such, the development of this site will not adversely affect the surrounding development and is anticipated to have no negative impact to downstream facilities. The detention facilities treating the runoff from Homestead at Sterling Ranch Filing No.1 and the surface and subsurface improvements to convey runoff located outside the public right of way shall be owned and maintained by the Sterling Ranch Metropolitan District..

REFERENCES

1.) "El Paso County and City of Colorado Springs Drainage Criteria Manual, Vol I & II".

2.) "Urban Storm Drainage Criteria Manuals, Volumes 1-3"

3.) NRSC Web Soil Survey Map for El Paso County. http://websoilsurvey.nrcs.usda.gov

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

5.) "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Corporation, revised March 1996

6.) "Preliminary Drainage Report for Sterling Ranch-Phase 1", dated May 2015, by M&S Civil Consultants, Inc.

7.) "Sterling Ranch-Phase 1 Offsite Grading, Early Grading & Erosion Control Plans", prepared by M&S Civil Consultants, Inc., dated November 2015

8.) "Sterling Ranch-Phase 1 Onsite Grading, Early Grading & Erosion Control Plans", prepared by M&S Civil Consultants, Inc., dated November 2015

9.) "Final Drainage Report for Barbarick Subdivision, Portions of Lots 1, 2 and Lots 3 & 4, by Matrix Design Group, dated June 2016.

10.) "Preliminary and Final Drainage Report, Barbarick Subdivision, A Replat of Lot "D", McClintock Subdivision", El Paso County, Revised August 15, 2007, prepared by Oliver E. Watts, Consulting Engineer, Inc.

11.) "Master Development Drainage Plan For Sterling Ranch", prepared by M&S Civil Consultants, Inc., dated July 2010 (Draft not approved)

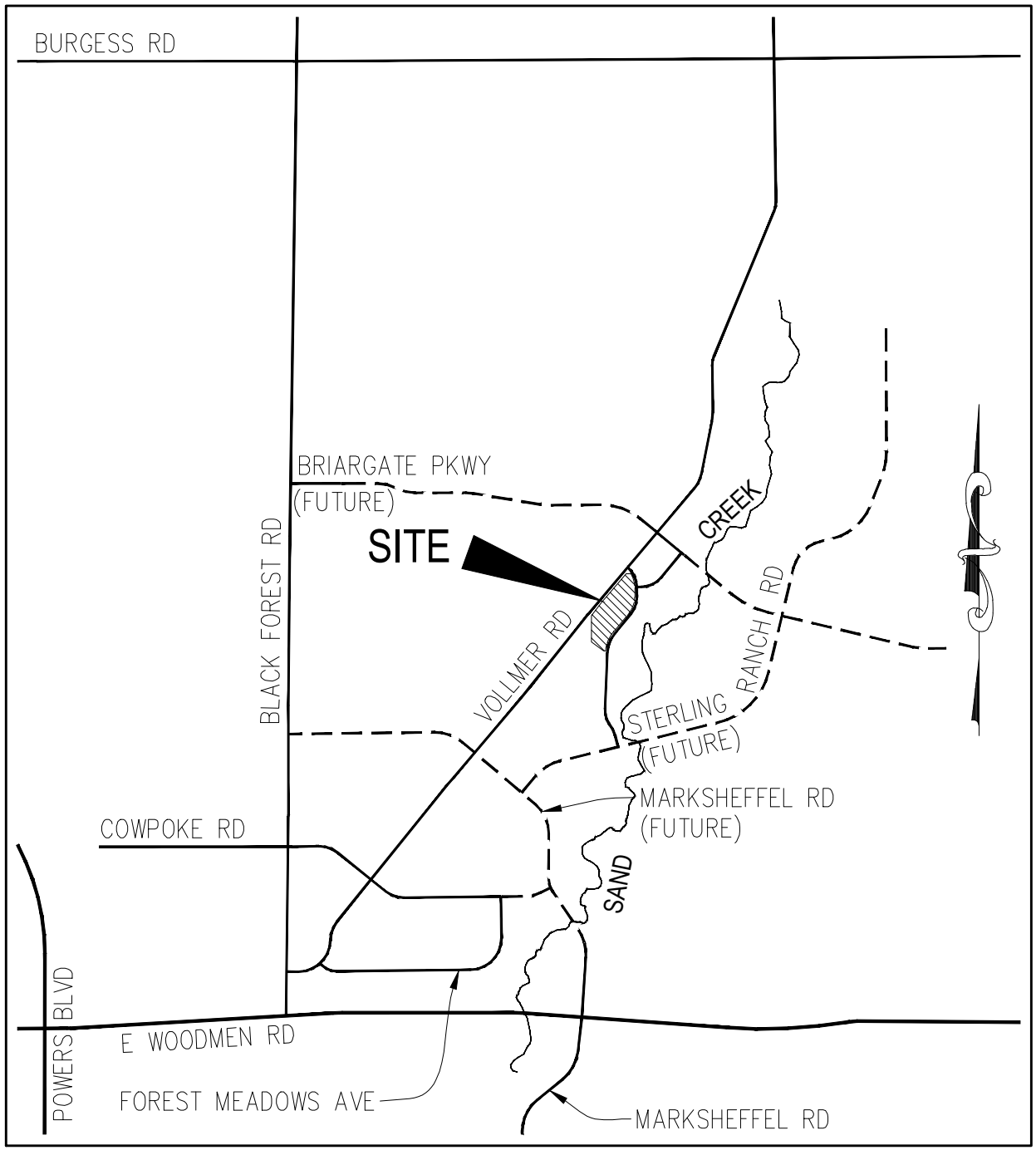
12.) "Technical Memorandum Sand Creek Channel Study (North of Woodmen Road) Hydrologic Analysis" (TM-SCCS) prepared by M&S Civil Consultants, Inc., dated July 2016

13.) "Master Development Drainage Report for Sterling Ranch Filing Nos. 1&2 and Final Drainage Report for Sterling Ranch Filing No. 1", prepared by M&S Civil Consultants, Inc., dated April 2017

14.) "Master Development Drainage Report for Sterling Ranch, prepared by M&S Civil Consultants, Inc., dated April 2018

APPENDIX

VICINITY MAP



VICINITY MAP

N.T.S.

SOILS MAP

Map Scale: 1:2,460 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 2011

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	11.3	100.0%
Totals for Area of Interest			**11.3**	**100.0%**

Description

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

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

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

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

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

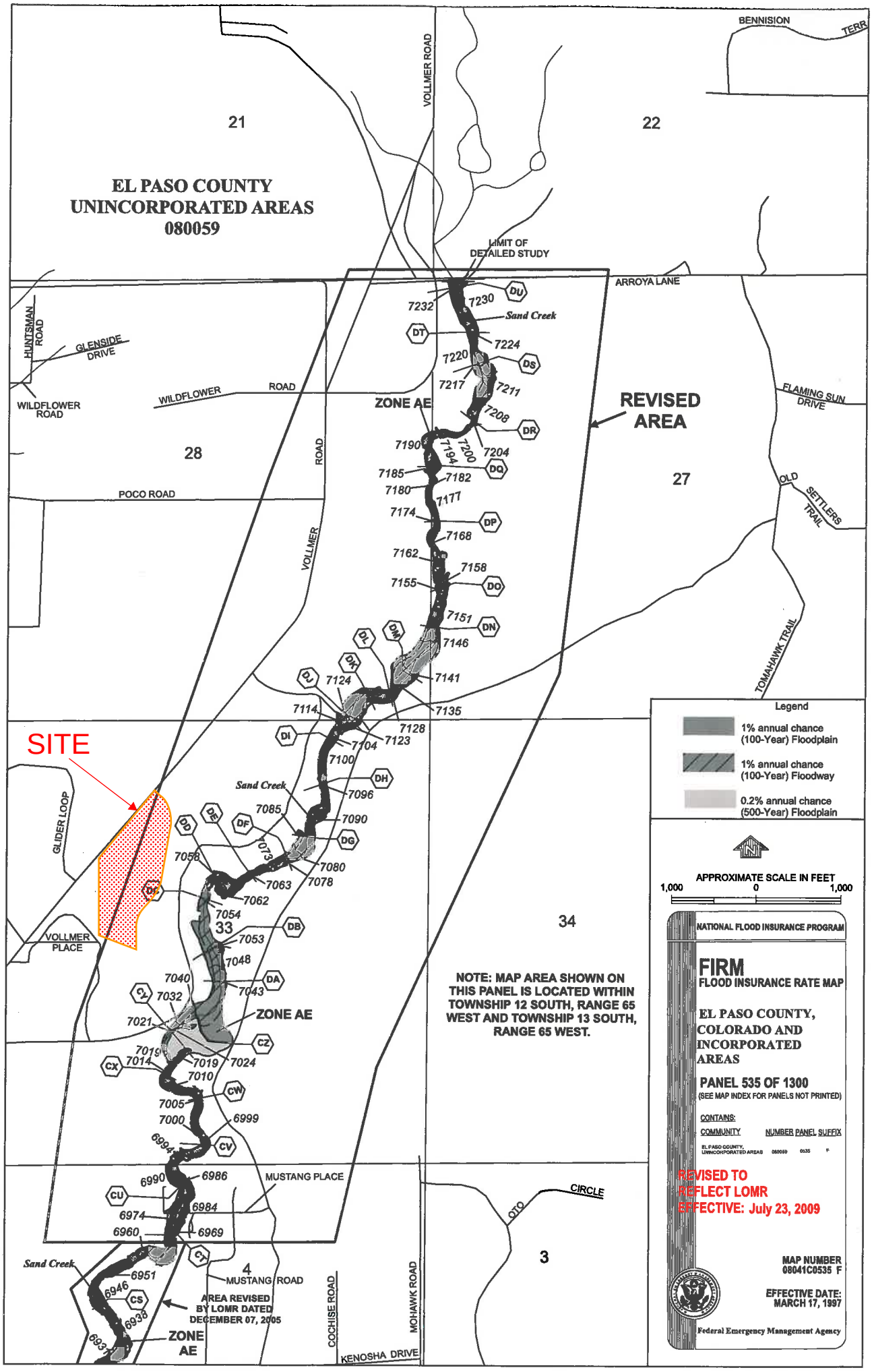
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over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

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

Rating Options

Aggregation Method: Dominant Condition

FIRM PANEL W/ REVISED LOMR


EL PASO COUNTY
UNINCORPORATED AREAS
080059
21
22
28
27
34
3
4
33
BENNISION TERR
VOLLMER ROAD
LIMIT OF DETAILED STUDY
ARROYA LANE
HUNTSMAN ROAD
GLENSIDE DRIVE
WILDFLOWER ROAD
WILDFLOWER ROAD
ROAD
ZONE AE
REVISED AREA
FLAMING SUN DRIVE
POCO ROAD
VOLLMER ROAD
OLD SETTLERS TRAIL
TOMAHAWK TRAIL
Sand Creek
SITE
GLIDER LOOP
VOLLMER PLACE
ZONE AE
MUSTANG PLACE
MUSTANG ROAD
AREA REVISED BY LOMR DATED DECEMBER 07, 2005
ZONE AE
COCHISE ROAD
MOHAWK ROAD
KENOSHA DRIVE
CIRCLE
OTO
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 080059 0535 F
REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009
MAP NUMBER 08041C0535 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

HYDROLOGIC CALCULATIONS

HOMESTEAD AT STERLING RANCH FILING NO.1
FINAL DRAINAGE REPORT

(Area Drainage Summary)

From Area Runoff Coefficient Summary				*OVERLAND*				*STREET / CHANNEL FLOW*				*Time of Travel (T_t)*		*INTENSITY **		*TOTAL FLOWS*		*#REF!*		*#REF!*
BASIN	**AREA TOTAL**	**C_5**	**C_{100}**	**C_5**	**Length**	**Height**	**T_C**	**Length**	**Slope**	**Velocity**	**T_t**	**TOTAL**	**CHECK**	**I_5**	**I_{100}**	**Q_5**	**Q_{100}**	**CA_5**	**Basin**	**CA_{100}**
	(Acres)	*From DCM Table 5-1*			*(ft)*	*(ft)*	*(min)*	*(ft)*	*(%)*	*(fps)*	*(min)*	*(min)*	*(min)*	*(in/hr)*	*(in/hr)*	*(c.f.s.)*	*(c.f.s.)*			
Proposed Area Drainage Summary																				
OS2	2.1	0.90	0.96	0.90	10	0.2	0.9	1082	2.5%	3.0	5.9	6.9	16.1	4.7	7.9	***8.9***	***15.9***	1.89	OS2	2.02
OS3	0.43	0.22	0.46	0.22	90	1.8	12.0	0	0.0%	0.0	0.0	12.0	10.5	4.1	6.8	***0.4***	***1.3***	0.09	OS3	0.20
OS4	0.61	0.22	0.46	0.22	75	1.5	10.9	0	0.0%	0.0	0.0	10.9	10.4	4.1	6.8	***0.5***	***1.9***	0.13	OS4	0.28
OS5	1.54	0.90	0.96	0.90	10	0.2	0.9	1805	2.1%	3.0	9.9	10.8	20.1	4.0	6.7	***5.6***	***10.0***	1.39	OS5	1.48
OS6	9.73	0.38	0.55	0.38	100	2	10.3	1100	2.5%	3.0	6.0	16.4	16.7	3.4	5.7	***12.5***	***30.4***	3.70	OS6	5.35
OS7	1.97	0.08	0.35	0.08	60	10	5.6	270	0.5%	2.3	2.0	7.6	11.8	4.5	7.6	***0.7***	***5.3***	0.16	OS7	0.69
A	2.79	0.38	0.55	0.38	65	1.3	8.3	1449	2.8%	3.0	8.0	16.3	18.4	3.4	5.7	***3.6***	***8.7***	1.06	A	1.53
B	2.70	0.38	0.55	0.38	60	1.2	8.0	1381	2.8%	3.0	7.6	15.6	18.0	3.5	5.8	***3.6***	***8.6***	1.03	B	1.49
C	2.92	0.38	0.55	0.38	100	1.2	12.2	411	3.0%	3.0	2.3	14.5	12.8	3.8	6.3	***4.2***	***10.1***	1.11	C	1.61
D	2.9	0.38	0.55	0.38	100	2	10.3	245	2.1%	3.0	1.3	11.7	11.9	3.9	6.5	***4.3***	***10.4***	1.10	D	1.60
E	5.34	0.38	0.55	0.38	100	2	10.3	61	3.3%	3.0	0.3	10.7	10.9	4.0	6.8	***8.2***	***19.9***	2.03	E	2.94
F	1.12	0.90	0.96	0.90	10	0.2	0.9	1525	2.8%	3.0	8.4	9.3	18.5	4.2	7.1	***4.3***	***7.7***	1.01	F	1.08
G	0.61	0.22	0.46	0.22	100	2	12.6	0	2.2%	3.0	0.0	12.6	10.6	4.0	6.8	***0.5***	***1.9***	0.13	G	0.28
EX-H	0.19	0.90	0.96	0.90	10	0.2	0.9	280	2.1%	3.0	1.5	5.0	11.6	5.2	8.7	***0.9***	***1.6***	0.17	EX-H	0.18
M	1.15	0.22	0.46	0.22	100	2	12.6					12.6	10.6	4.0	6.8	***1.0***	***3.6***	0.25	M	0.53
M2	1.6	0.08	0.35	0.08	100	2	14.7	1015	2.4%	2.3	7.4	22.1	16.2	3.4	5.7	***0.4***	***3.2***	0.13	M2	0.56
N	2.08	0.22	0.46	0.22	75	1.5	10.9	818	2.9%	3.0	4.5	15.4	15.0	3.5	5.9	***1.6***	***5.7***	0.46	N	0.96
O	0.57	0.22	0.46	0.22	100	4	10.1	0	2.7%	3.0	0.0	10.1	10.6	4.1	6.9	***0.5***	***1.8***	0.13	O	0.26
W-2	10	0.08	0.35	0.08	100	2	14.7	1113	4.0%	2.3	8.2	22.8	16.7	3.4	5.6	***2.7***	***19.7***	0.80	W-2	3.50
OS1 Historic	111.7	0.08	0.35	FROM HISTORIC MDDP CALC AREA WEST OF VOLLMER ROAD												***18.9***	***136.8***	8.94	OS1 Historic	39.10
SUB-BASIN OS1A	2.7	0.08	0.35	0.08	100	0.57	22.2	1174	2.5%	1.5	12.9	35.1	17.1	3.3	5.6	***0.7***	***5.3***	0.22	SUB-BASIN OS1A	0.95
SUB-BASIN OS1B	9.09	0.08	0.35	0.08	100	0.57	22.2	1174	2.5%	2.3	8.6	30.8	17.1	3.3	5.6	***2.4***	***17.8***	0.73	SUB-BASIN OS1B	3.18
SUB-BASIN OS1C	5.64	0.08	0.35	0.08	300	9	22.2	907	3.3%	2.3	6.6	28.8	16.7	3.4	5.6	***1.5***	***11.1***	0.45	SUB-BASIN OS1C	1.97
SUB-BASIN OS1D	94.3	0.08	0.35	0.08	100	0.57	22.2	4800	3.0%	2.3	35.2	57.3	37.2	2.2	3.6	***16.3***	***119.5***	7.54	SUB-BASIN OS1D	33.01
V1A	0.31	0.90	0.96	0.90	20	0.4	1.3					5.0	10.1	5.2	8.7	***1.4***	***2.6***	0.28	V1A	0.30
V1B	0.26	0.90	0.96	0.90	20	0.4	1.3					5.0	10.1	5.2	8.7	***1.2***	***2.2***	0.23	V1B	0.25
V1C	0.21	0.90	0.96	0.90	20	0.4	1.3					5.0	10.1	5.2	8.7	***1.0***	***1.7***	0.19	V1C	0.20
V1D	0.13	0.90	0.96	0.90	20	0.4	1.3					5.0	10.1	5.2	8.7	***0.6***	***1.1***	0.12	V1D	0.12
V2	0.32	0.90	0.96	0.90	20	0.4	1.3					5.0	10.1	5.2	8.7	***1.5***	***2.7***	0.29	V2	0.31
RP-2B	2.04	0.63	0.76	0.63	50	1	4.8	1380	2.2%	3.0	7.6	12.4	17.9	3.8	6.4	***4.9***	***9.9***	1.29	RP-2B	1.55
RP-2C	1.28	0.74	0.84	0.74	50	1	3.7	692	2.2%	3.0	3.8	7.5	14.1	4.6	7.7	***4.3***	***8.2***	0.95	RP-2C	1.08

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: ET
Date: 4/11/2018
Checked by: VAS

HOMESTEAD AT STERLING RANCH FILING NO.1
FINAL DRAINAGE REPORT

(Basin Routing Summary)

From Area Runoff Coefficient Summary				*OVERLAND*				*PIPE / CHANNEL FLOW*				*Time of Travel (T_t)*	*INTENSITY **		*TOTAL FLOWS*		
DESIGN POINT	**CONTRIBUTING BASINS**	**CA_5**	**CA_{100}**	**C_5**	**Length** *(ft)*	**Height** *(ft)*	**T_C** *(min)*	**Length** *(ft)*	**Slope** *(%)*	**Velocity** *(fps)*	**T_t** *(min)*	**TOTAL** *(min)*	**I_5** *(in/hr)*	**I_{100}** *(in/hr)*	**Q_5** *(c.f.s.)*	**Q_{100}** *(c.f.s.)*	COMMENTS
PROPOSED DRAINAGE BASIN ROUTING SUMMARY																	
1	**A**	1.06	1.53									16.3	3.4	5.7	***3.6***	***8.7***	15' AT-GRADE INLET
2	**B**	1.03	1.49									15.6	3.5	5.8	***3.6***	***8.6***	15' AT-GRADE INLET
3	**C**	1.11	1.61									12.8	3.8	6.3	***4.2***	***10.1***	6' SUMP INLET
4	**D, E, F**	4.14	5.61									11.7	3.9	6.5	***16.1***	***36.7***	EX 15' AT-GRADE INLET
5	**G, EX-H, FLOWBY DP4**	1.07	3.02									11.7	3.9	6.5	***4.2***	***19.7***	EX 15' AT-GRADE INLET
6	**OS2, OS3, OS4, OS5**	3.50	3.97									10.8	4.0	6.7	***14.1***	***26.7***	EX 15' AT-GRADE INLET
7	**OS6**	3.70	5.35									16.4	3.4	5.7	***12.6***	***30.5***	EX 18" RCP
8	**OS7, PR4, PR6, PR7**	14.52	18.52									16.4	3.4	5.7	***49.2***	***105.3***	EX FSD POND 4
															50.0	***102.9***	(flows anticipated by MDDP 1&2)
9	**OS1A, V1A**	0.50	1.24									17.1	3.3	5.6	***1.6***	***7.0***	EX 12" CMP CULVERT
10	**OS1B,V1B, DP6**	1.46	4.67									17.1	3.3	5.6	***4.8***	***26.3***	EX 2.9'x5.7' CDOT TYPE D INLET
11	**OS1C, V1C**	0.64	2.18									16.7	3.4	5.6	***2.2***	***12.3***	EX 2.9'x2.9' CDOT TYPE C INLET
12	**OS1D, V1D, W-2, V2**	8.75	36.94									37.2	2.2	3.6	***18.9***	***133.7***	EX 4'x14' MOD CDOT TYPE D INLET
13	**RP-2B**	1.29	1.55									12.4	2.2	3.6	***2.8***	***5.6***	EX CDOT EMBANKMENT PROTECTOR TYPE 5
14	**M, M2, RP2C, DP13**	2.61	3.71									16.2	3.4	5.7	***8.9***	***21.2***	EX FSD SAND FILTER POND W-9
															8.9	***21.2***	(flows anticipated by MDDP 1&2)

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: ET
Date: 4/11/2018
Checked by: VAS

HOMESTEAD AT STERLING RANCH FILING NO.1
FINAL DRAINAGE REPORT
(Storm Sewer Routing Summary)

PIPE RUN	*Contributing Pipes/Design Points*	*Equivalent CA_5*	*Equivalent CA_{100}*	*Maximum T_C*	*Intensity**		*Flow*		PIPE SIZE
					I_5	*I_{100}*	*Q_5*	*Q_{100}*	
1	**DP1 (Int)**	1.06	1.53	16.3	3.4	5.7	***3.6***	***8.7***	30" RCP
2	**DP2 (Int), PR1**	2.09	3.02	16.3	3.4	5.7	***7.1***	***17.2***	36" RCP
3	**DP3**	1.11	1.61	12.8	3.8	6.3	***4.2***	***10.1***	18" RCP
4	**DP4 (Int), PR3**	4.48	4.66	12.8	3.8	6.3	***16.8***	***29.4***	30" RCP
5	**DP5 (Int), PR2**	3.17	5.27	16.3	3.4	5.7	***10.8***	***30.0***	36" RCP
6	**DP6 (Int), PR5**	6.18	7.82	16.3	3.4	5.7	***21.0***	***44.6***	36" RCP
7	**DP7**	3.70	5.35	16.4	3.4	5.7	***12.6***	***30.5***	30" RCP
8	**DP9**	0.50	1.24	17.1	3.3	5.6	***1.6***	***7.0***	12" CMP
9	**DP10**	1.46	4.67	17.1	3.3	5.6	***4.8***	***26.3***	24" RCP
10	**DP11**	0.64	2.18	16.7	3.4	5.6	***2.2***	***12.3***	18" RCP
11	**PR9, PR10**	2.10	6.85	17.1	3.3	5.6	***7.0***	***38.6***	30" RCP
12	**DP12**	8.75	36.94	37.2	2.2	3.6	***18.9***	***133.7***	54" RCP
13	**OUTFLOW EDB POND W-9**	0.18	1.53	16.2	3.4	5.7	***0.6***	***8.7***	18" RCP
14	**PR11, PR13**	2.28	8.38	17.1	3.3	5.6	***7.6***	***47.2***	30" RCP
15	**PR12, PR14**	11.03	45.32	37.2	2.2	3.6	***23.8***	***164.1***	54" RCP
16	**OUTFLOW EDB POND 4**	PEAK OUTFLOW FROM POND 4 UD DET v3.04					***2.8***	***36.8***	30" RCP
17	**PR15, PR16**	SUMMATION OF PR11 & PR18					***26.6***	***200.9***	60" RCP

* Intensity equations assume a minimum travel time of 5 minutes.

DP - Design Point
EX - Existing Design Point
FB- Flow By from Design Point
INT- Intercepted Flow from Design Point

Calculated by: ET
Date: 4/11/2018
Checked by: VAS

HYDRAULIC CALCULATIONS

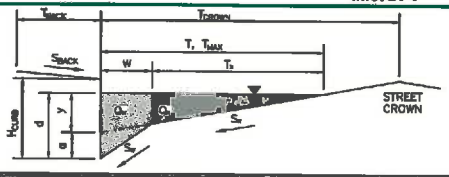
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Homestead at Sterling Ranch Filing No. 1

Inlet ID: Inlet DP1



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.022	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.1	7.8	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

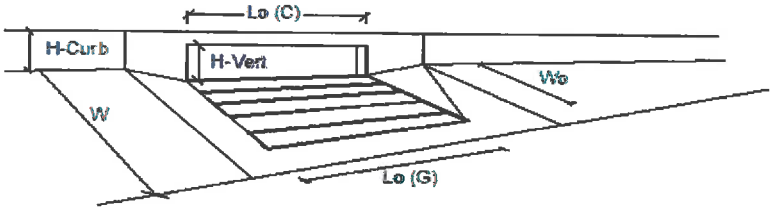
	Minor Storm	Major Storm	
Q_{allow} =	9.4	29.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	3.6	8.6	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	0.1	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	99	%

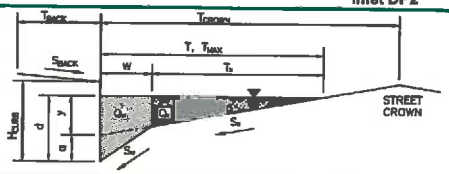
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Homestead at Sterling Ranch Filing No. 1

Inlet ID: Inlet DP2



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_x =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_w =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_o =	0.022	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	5.1	7.8	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

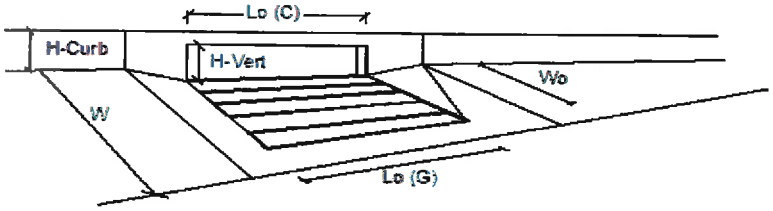
	Minor Storm	Major Storm	
Q_{allow} =	9.4	29.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	3.6	8.5	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	0.1	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	99	%

HOMESTEAD AT STERLING RANCH FILING NO.1
FINAL DRAINAGE REPORT
(CDOT Type R Inlet Calculations - Sump Condition)

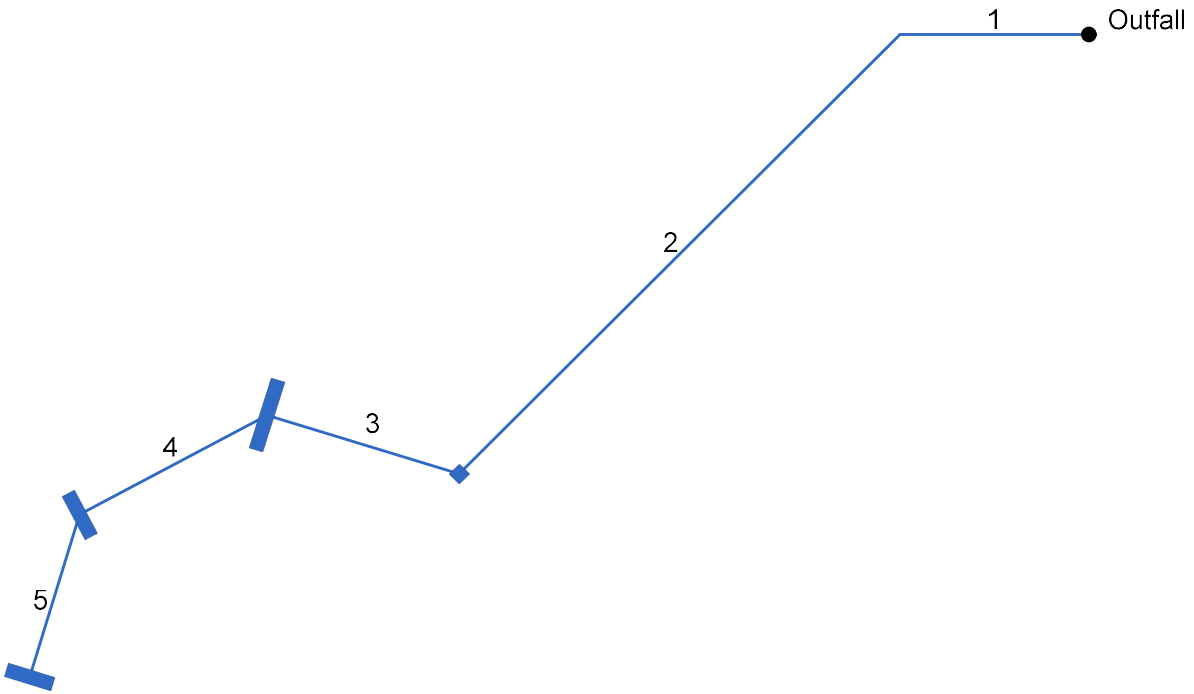
Urban Local Roadway-50' ROW-30' Pavement-6" Vertical Curb
Maximum allowable depth for **MINOR (0.43')** & **MAJOR (0.66')** storm

Inlet Length	Storm	Depth	Eqn. 7-31	Eqn. 7-32	Eqn. 7-29
			$Q_w=C_wN_wL_eD^{3/2}$	$Q_o=C_oN_o(L_eH_c)(2g(D-0.5H_c))^{1/2}$	$Q_m=C_m(Q_wQ_o)^{1/2}$
5	Q_5	0.43	5.1	5.7	5.0
5	Q_{100}	0.66	9.7	8.6	8.5
6	Q_5	0.43	6.1	6.8	6.0
6	Q_{100}	0.66	11.6	10.3	10.2
8	Q_5	0.43	8.1	9.1	8.0
8	Q_{100}	0.66	15.4	13.8	13.6
10	Q_5	0.43	10.2	11.4	10.0
10	Q_{100}	0.66	19.3	17.2	17.0
12	Q_5	0.43	12.2	13.7	12.0
12	Q_{100}	0.66	23.2	20.7	20.3
14	Q_5	0.43	14.2	16.0	14.0
14	Q_{100}	0.66	27.0	24.1	23.7
15	Q_5	0.43	15.2	17.1	15.0
15	Q_{100}	0.66	29.0	25.8	25.4
16	Q_5	0.43	16.2	18.2	16.0
16	Q_{100}	0.66	30.9	27.5	27.1

Table 7-7. Coefficients for various inlets in sumps

Inlet Type	Nw	Cw	No	Co	Cm
CDOT Type 13 Grate	0.7	3.3	0.43	0.6	0.93
Denver No. 16 Grate	0.73	3.6	0.31	0.6	0.9
Curb Opening for Type 13/No. 16 Combination	1	3.7	1	0.66	0.86
CDOT Type R Curb Opening	1	3.6	1	0.67	0.93

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Storm 1 2 5 and 6.stm	Number of lines: 5	Date: 4/24/2018

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	39.070	180.000	None	44.60	0.00	0.00	0.0	7054.50	1.51	7055.09	36	Cir	0.013	0.40	7062.00	
2	1	129.130	-45.000	Curb	44.60	0.00	0.00	0.0	7055.09	1.52	7057.05	36	Cir	0.013	1.50	7064.32	
3	2	41.540	62.000	Curb	30.00	0.00	0.00	0.0	7057.75	0.51	7057.96	36	Cir	0.013	1.50	7064.40	
4	3	43.910	-45.000	Curb	17.20	0.00	0.00	0.0	7058.29	0.50	7058.51	36	Cir	0.013	1.70	7063.55	
5	4	35.330	-45.000	Curb	8.70	0.00	0.00	0.0	7059.01	0.51	7059.19	30	Cir	0.013	1.50	7063.06	

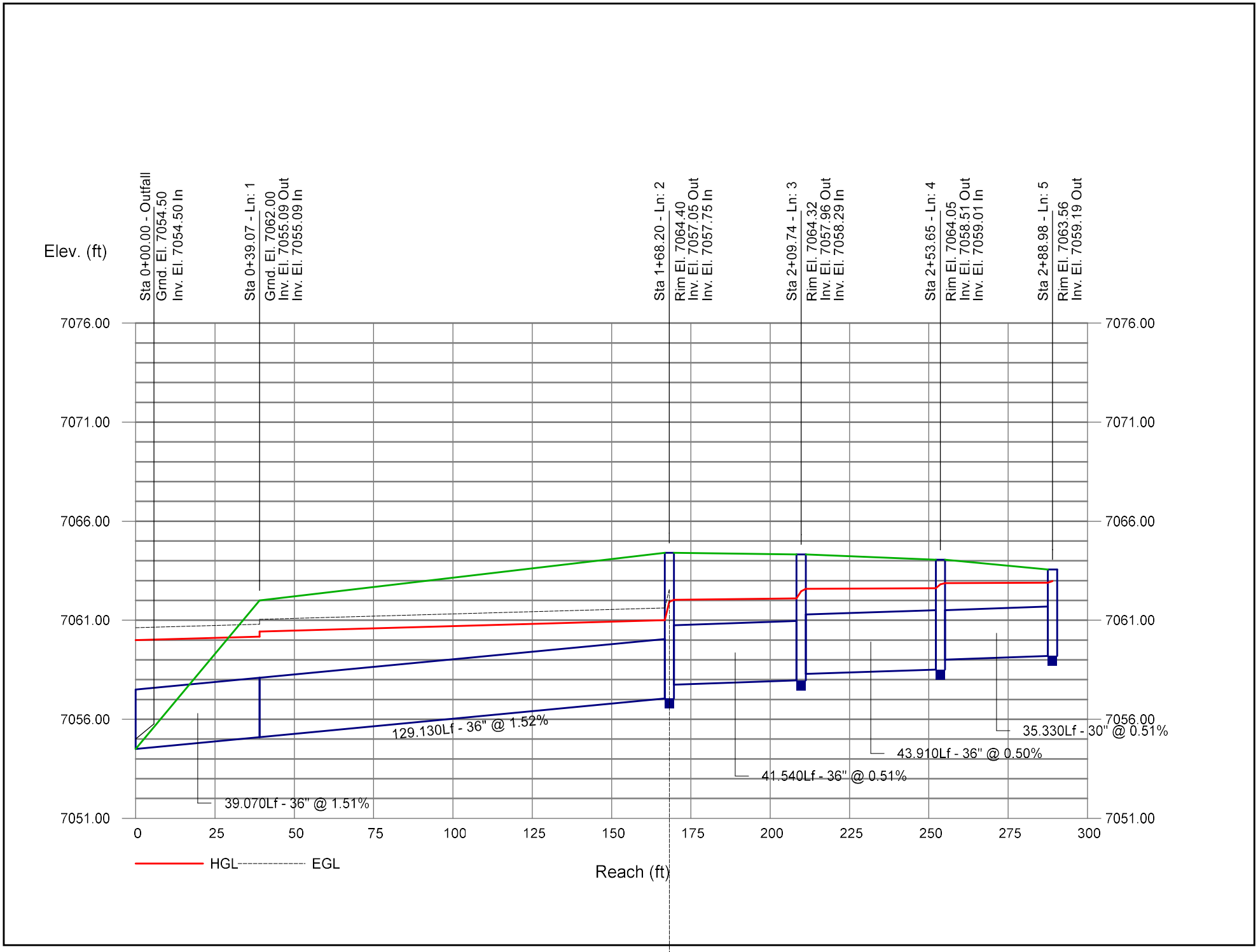
Project File: Storm 1 2 5 and 6.stm

Number of lines: 5

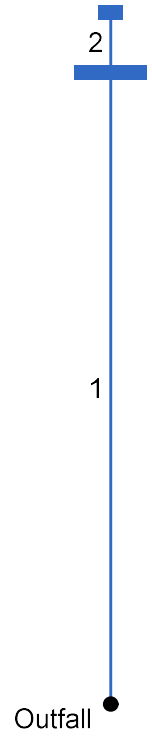
Date: 4/24/2018

Storm Sewer Profile

Proj. file: Storm 1 2 5 and 6.stm



Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Storm 3 and 4.stm	Number of lines: 2	Date: 4/24/2018

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	131.250	-90.000	Curb	29.40	0.00	0.00	0.0	7054.50	7.99	7064.99	30	Cir	0.013	1.50	7070.11	Storm 3
2	1	12.500	0.000	Curb	10.10	0.00	0.00	0.0	7065.99	1.52	7066.18	18	Cir	0.013	1.50	7071.67	Storm 3

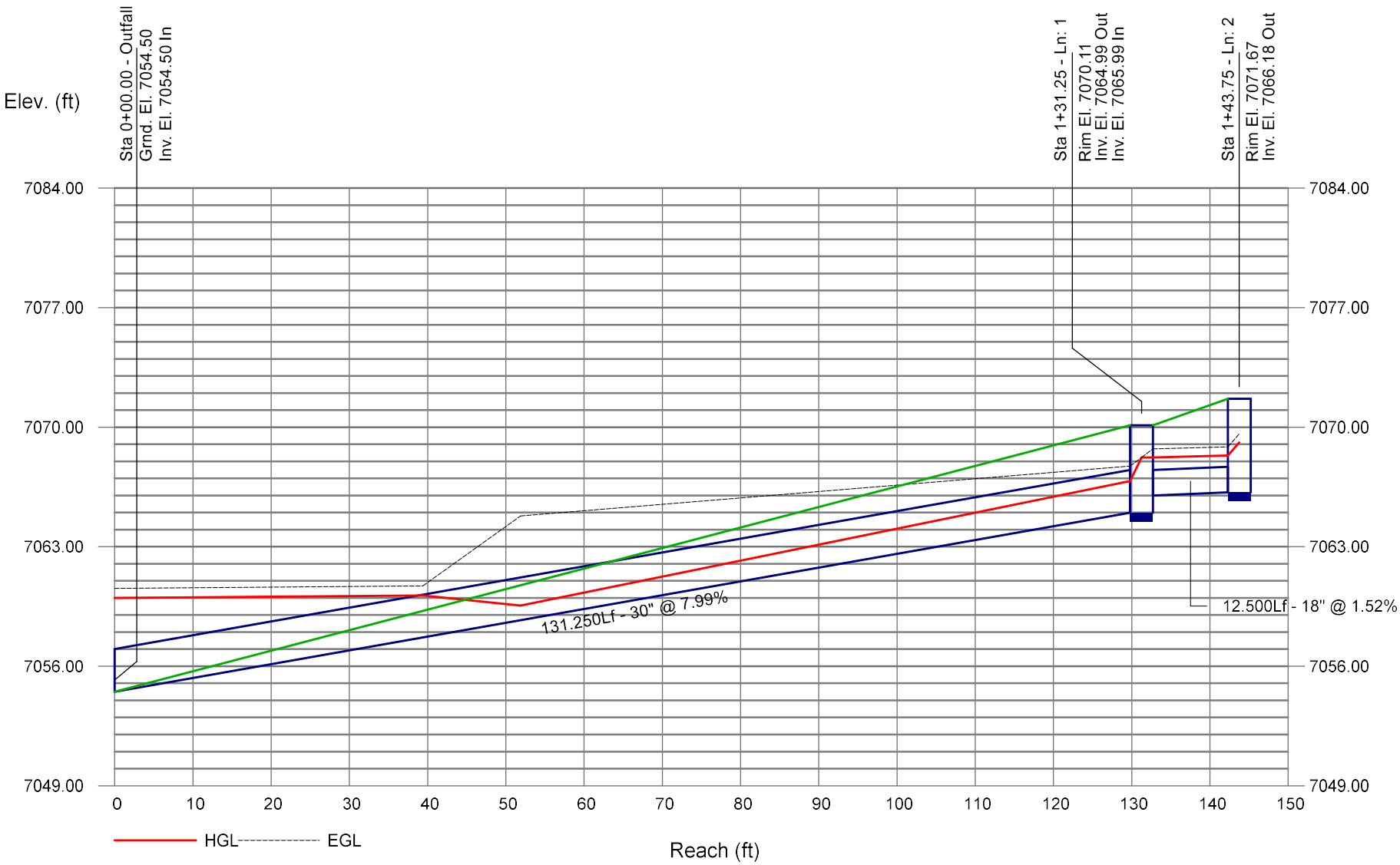
Project File: Storm 3 and 4.stm

Number of lines: 2

Date: 4/24/2018

Storm Sewer Profile

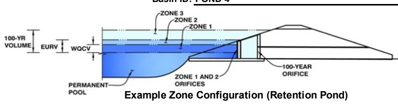
Proj. file: Storm 3 and 4.stm



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: STERLING RANCH FILING NO. 1

Basin ID: POND 4



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	27.63	acres		
Watershed Length =	1,720	ft		
Watershed Slope =	0.030	ft/ft		
Watershed Imperviousness =	53.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.494	acre-feet	Optional User Input 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	1.573	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	1.312	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.981	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.542	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.324	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.977	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	4.720	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 6.53 in.) =	13.003	acre-feet	6.53	inches
Approximate 2-yr Detention Volume =	1.241	acre-feet		
Approximate 5-yr Detention Volume =	1.821	acre-feet		
Approximate 10-yr Detention Volume =	1.991	acre-feet		
Approximate 25-yr Detention Volume =	2.082	acre-feet		
Approximate 50-yr Detention Volume =	2.317	acre-feet		
Approximate 100-yr Detention Volume =	2.781	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.494	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.079	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.209	acre-feet
Total Detention Basin Volume =	2.781	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 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)
Micropool	--	0.00	--	--	--	10	0.000		
	--	0.33	--	--	--	406	0.009	65	0.001
	--	1.00	--	--	--	2,912	0.067	1,151	0.026
	--	3.00	--	--	--	12,934	0.297	17,026	0.391
	--	5.00	--	--	--	27,336	0.628	57,296	1.315
	--	7.00	--	--	--	52,589	1.207	137,221	3.150
	--	9.00	--	--	--	57,186	1.313	246,996	5.670
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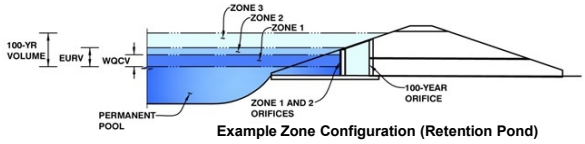
Detention Basin Outlet Structure Design

Project: STERLING RANCH FILING NO. 1

Basin ID: POND 4



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.32	0.494	Orifice Plate
Zone 2 (EURV)	5.38	1.079	Orifice Plate
Zone 3 (100-year)	6.69	1.209	Weir&Pipe (Restrict)
		2.781	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.37	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	19.40	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.79	3.58					
Orifice Area (sq. inches)	2.33	2.33	2.60					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.37	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	9.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.91	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.10	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	4.06	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	18.90	N/A	ft^2
Overflow Grate Open Area w/ Debris =	9.45	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 =	0.00	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 =	27.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.65	N/A	ft^2
Outlet Orifice Centroid =	1.19	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.50	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.33	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	34.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

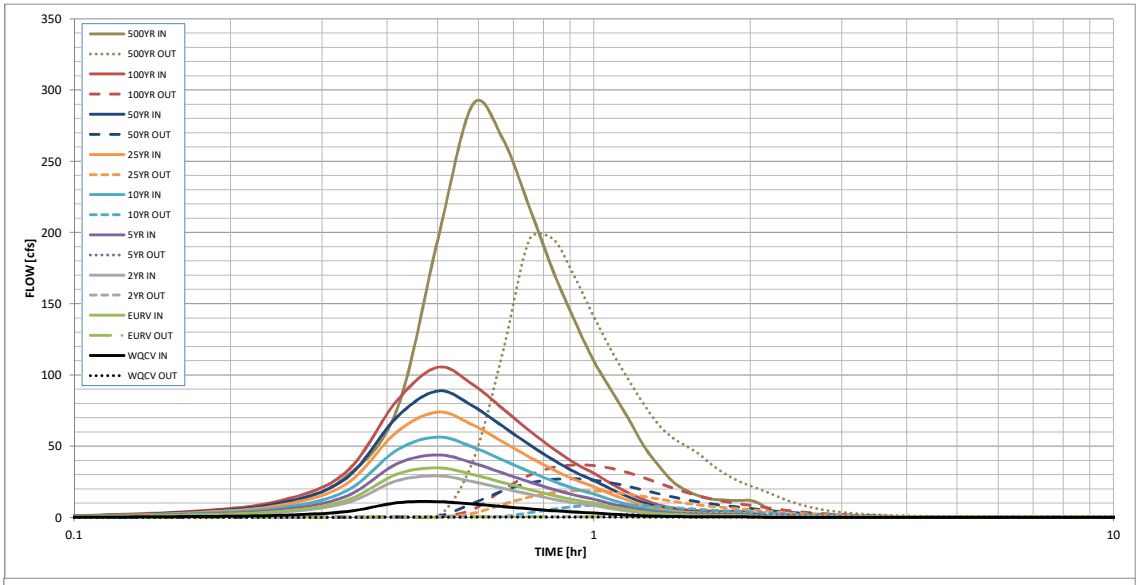
Calculated Parameters for Spillway

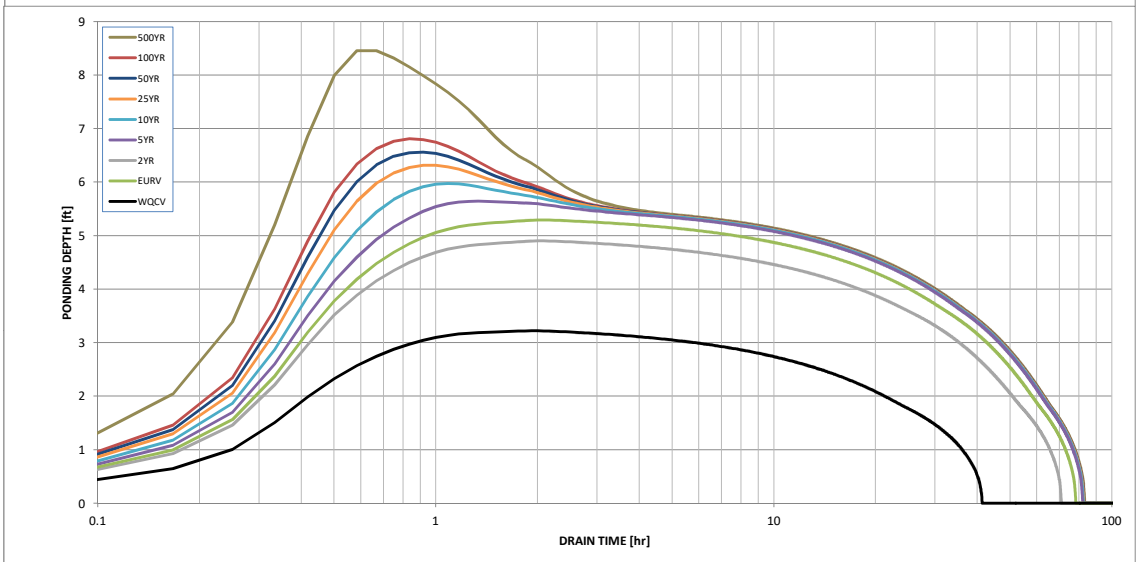
Spillway Design Flow Depth=	0.94	feet
Stage at Top of Freeboard =	9.27	feet
Basin Area at Top of Freeboard =	1.31	acres

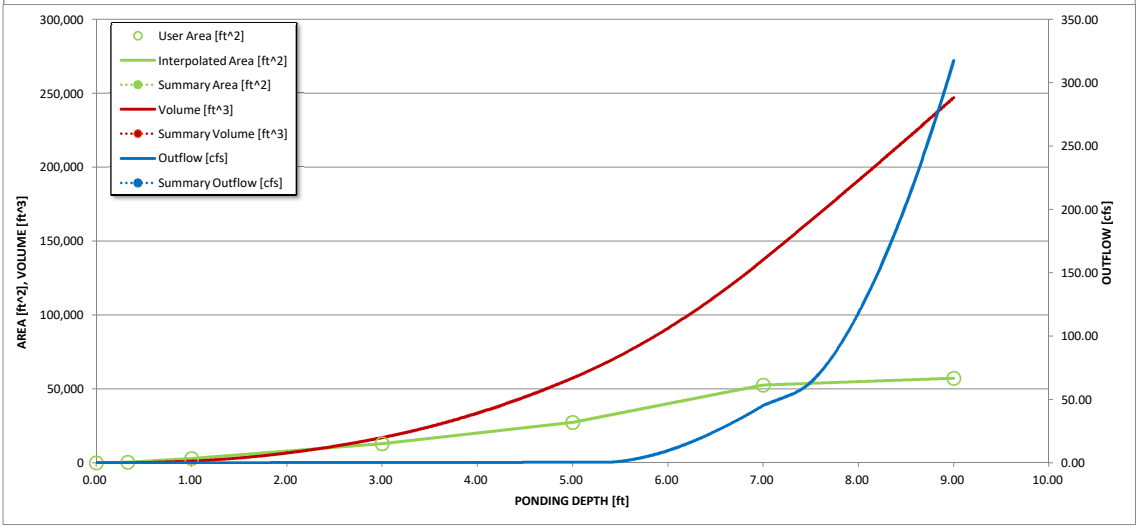
Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	6.53
Calculated Runoff Volume (acre-ft) =	0.494	1.573	1.312	1.981	2.542	3.324	3.977	4.720	13.003
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.494	1.573	1.312	1.982	2.543	3.326	3.980	4.723	13.012
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.20	0.40	0.90	1.16	1.48	2.09
Predevelopment Peak Q (cfs) =	0.0	0.0	0.4	5.5	11.0	24.8	32.1	40.9	57.7
Peak Inflow Q (cfs) =	11.0	34.8	29.1	43.8	56.3	73.9	88.6	105.3	289.7
Peak Outflow Q (cfs) =	0.2	0.4	0.4	2.8	9.0	18.6	27.1	36.8	195.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.8	0.7	0.8	0.9	3.4
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.4	1.0	1.4	1.9	3.2
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) =	38	70	64	72	70	68	66	64	48
Time to Drain 99% of Inflow Volume (hours) =	**40**	75	68	78	77	76	76	75	65
Maximum Ponding Depth (ft) =	3.22	5.29	4.90	5.64	5.97	6.32	6.56	6.81	8.46
Area at Maximum Ponding Depth (acres) =	0.33	0.71	0.61	0.81	0.91	1.01	1.08	1.15	1.28
Maximum Volume Stored (acre-ft) =	0.460	1.510	1.253	1.776	2.060	2.386	2.647	2.915	4.956

Detention Basin Outlet Structure Design







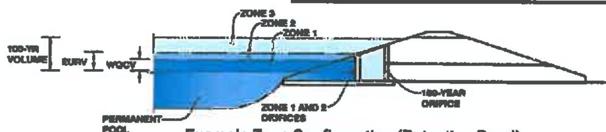
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Revision to Pond W-2 Sterling Ranch Filing No. 1 MDDP

Basin ID: East Vollmer Road, Homestead backyards and Landscape area 3:1 Pond slope



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF	
Watershed Area =	5.87	acres
Watershed Length =	575	ft
Watershed Slope =	0.024	ft/ft
Watershed Imperviousness =	70.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.108	acre-feet
Excess Urban Runoff Volume (EURV) =	0.451	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.376	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.500	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.634	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.799	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.922	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.083	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.353	acre-feet
Approximate 5-yr Detention Volume =	0.470	acre-feet
Approximate 10-yr Detention Volume =	0.593	acre-feet
Approximate 25-yr Detention Volume =	0.637	acre-feet
Approximate 50-yr Detention Volume =	0.663	acre-feet
Approximate 100-yr Detention Volume =	0.710	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.108	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.344	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.259	acre-feet
Total Detention Basin Volume =	0.710	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Depth Increment = 0.5 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)
7086	Media Surface	--	0.00	--	--	--	6,035	0.139		
7087		--	1.00	--	--	--	8,554	0.196	7,209	0.165
7088		--	2.00	--	--	--	11,312	0.260	17,115	0.393
7089		--	3.00	--	--	--	14,295	0.328	30,031	0.689
7090		--	4.00	--	--	--	17,480	0.401	45,918	1.054
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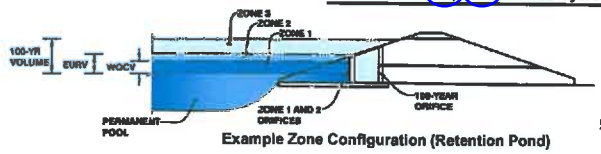
W-2 or W-9?

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Revision to Pond W-2 Sterling Ranch Filing No.1 MDDP

Basin ID: East Vollmer Road, Homestead Backyards and Landscape area 3:1 Pond slope



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.69	0.108	Filtration Media
Zone 2 (EURV)	2.21	0.344	Circular Orifice
Zone 3 (100-year)	3.07	0.259	Weir&Pipe (Restrict)
		0.710	Total

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

Underdrain Orifice Invert Depth =	3.30	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	1.49	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.06	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 =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.69	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.21	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	3.92	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.08	N/A	ft^2
Vertical Orifice Centroid =	0.16	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.21	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.91	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.91	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.21	N/A	feet
Over Flow Weir Slope Length =	2.91	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.08	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	5.93	N/A	ft^2
Overflow Grate Open Area w/ Debris =	2.96	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 =	3.55	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	7.80		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.73	N/A	ft^2
Outlet Orifice Centroid =	0.38	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.44	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.08	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	12.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	0.67	feet

Calculated Parameters for Spillway

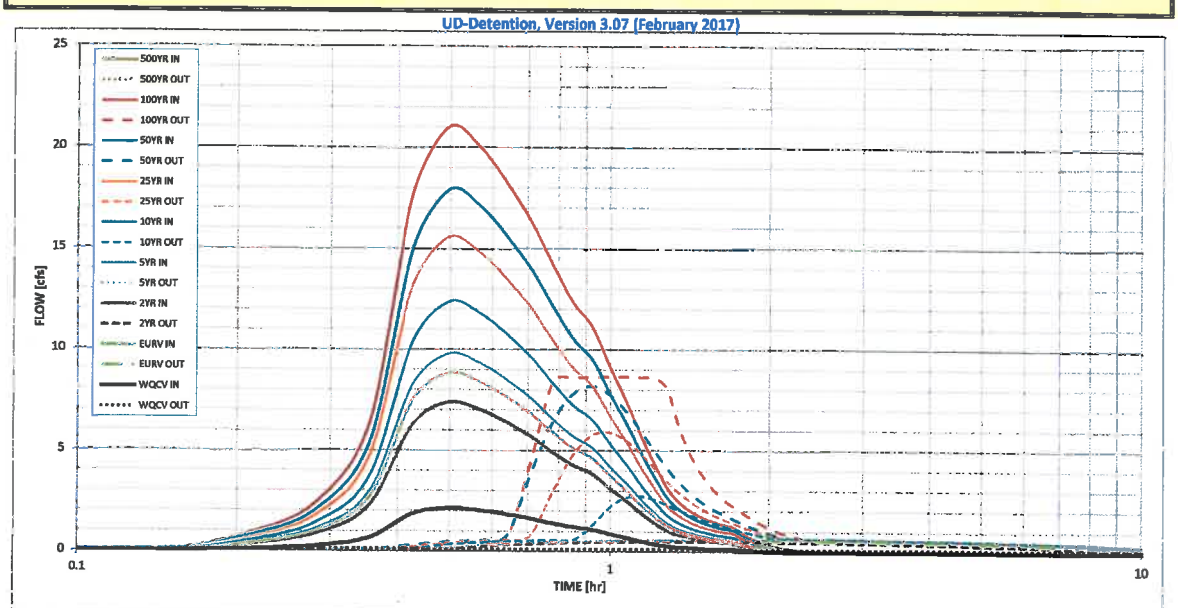
Spillway Design Flow Depth=	0.64	feet
Stage at Top of Freeboard =	4.39	feet
Basin Area at Top of Freeboard =	0.40	acres

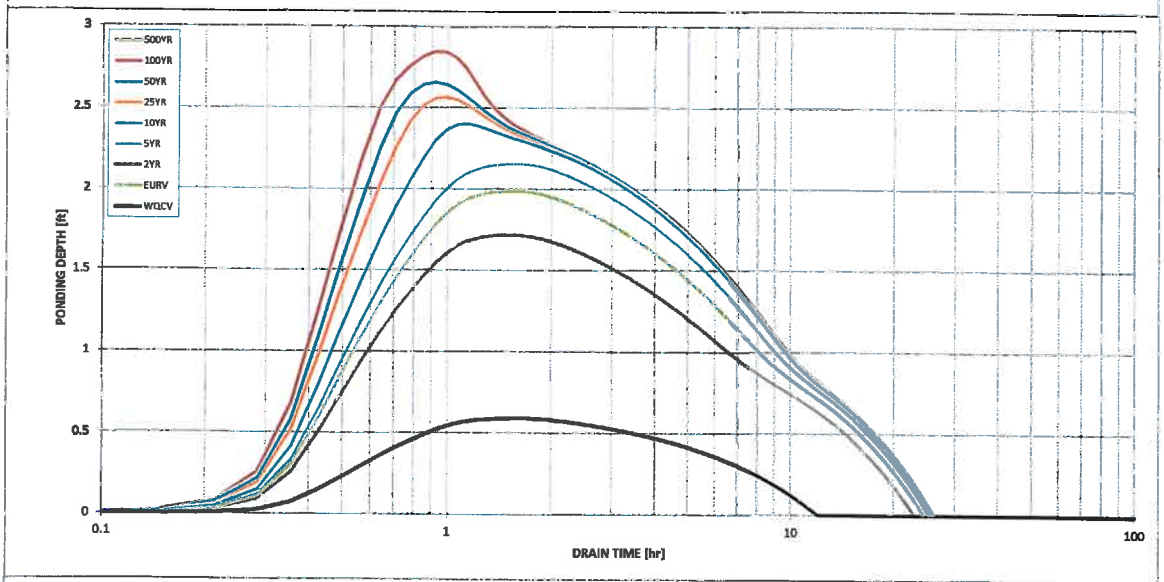
Routed Hydrograph Results

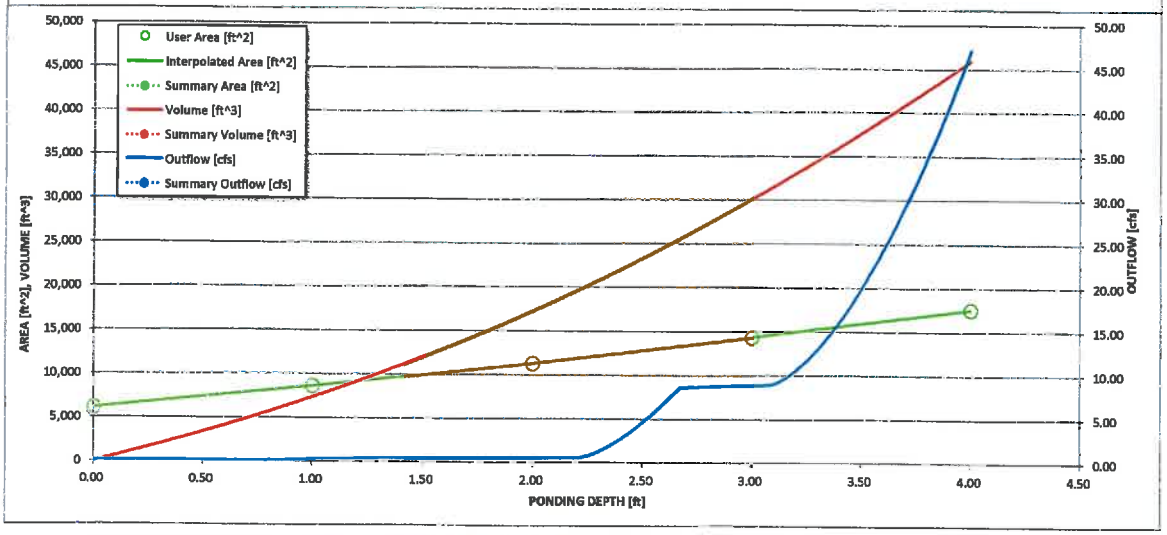
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	0.00
Calculated Runoff Volume (acre-ft) =	0.108	0.451	0.376	0.500	0.634	0.799	0.922	1.083	0.000
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.107	0.451	0.376	0.500	0.634	0.800	0.923	1.083	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.03	0.25	0.81	1.11	1.49	0.00
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.5	4.7	6.5	8.7	0.0
Peak Inflow Q (cfs) =	2.1	8.8	7.4	9.8	12.4	15.5	17.9	21.0	#N/A
Peak Outflow Q (cfs) =	0.1	0.6	0.5	0.6	2.7	5.9	8.2	8.7	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.0	1.8	1.3	1.2	1.0	#N/A
Structure Controlling Flow =	Filtration Media	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	#N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.4	0.9	1.3	1.3	#N/A
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) =	12	23	22	24	24	23	23	23	#N/A
Time to Drain 99% of Inflow Volume (hours) =	12	24	23	25	25	25	25	25	#N/A
Maximum Ponding Depth (ft) =	0.59	1.99	1.72	2.15	2.40	2.56	2.66	2.84	#N/A
Area at Maximum Ponding Depth (acres) =	0.17	0.26	0.24	0.27	0.29	0.30	0.30	0.32	#N/A
Maximum Volume Stored (acre-ft) =	0.092	0.390	0.323	0.435	0.505	0.552	0.579	0.638	#N/A

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

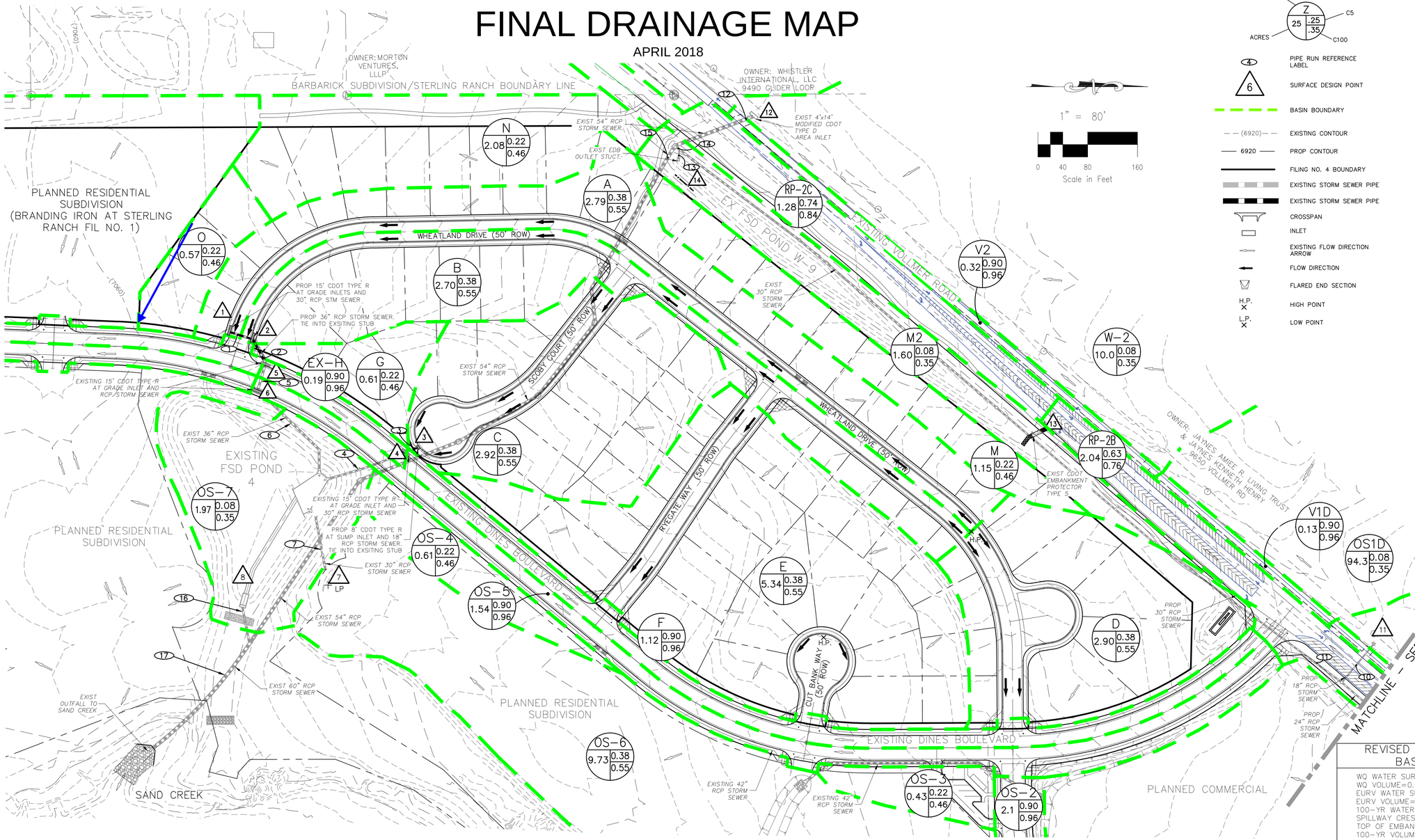
DRAINAGE MAP

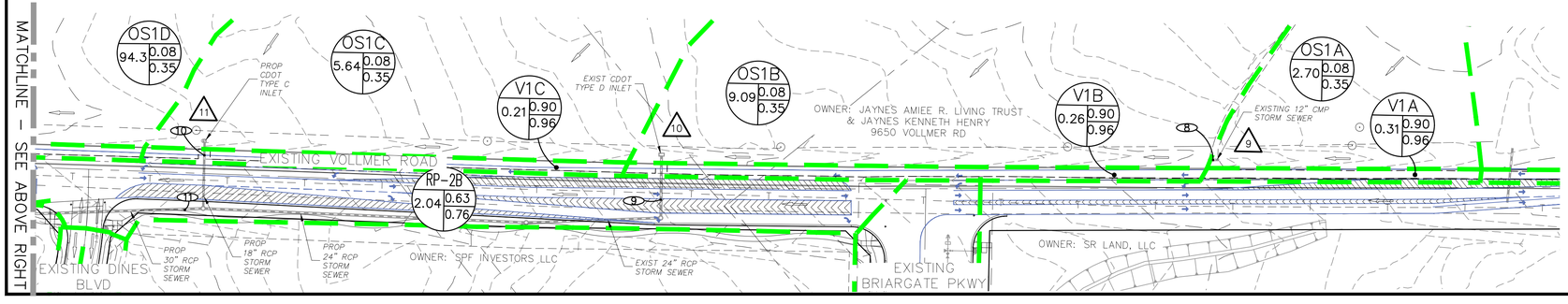
HOMESTEAD AT STERLING RANCH FILING NO. 1

COUNTY OF EL PASO, STATE OF COLORADO

FINAL DRAINAGE MAP

APRIL 2018





LEGEND

BASIN DESIGNATION (Z / 25 / .25 / .35 / C5 / C100 / ACRES)

- PIPE RUN REFERENCE LABEL
- SURFACE DESIGN POINT
- BASIN BOUNDARY
- (6920) EXISTING CONTOUR
- 6920 PROP CONTOUR
- FILING NO. 4 BOUNDARY
- EXISTING STORM SEWER PIPE
- EXISTING STORM SEWER PIPE
- CROSSPAN
- INLET
- EXISTING FLOW DIRECTION ARROW
- FLOW DIRECTION
- FLARED END SECTION
- H.P. HIGH POINT
- L.P. LOW POINT

1" = 80'

0 40 80 160

Scale in Feet

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q_5	Q_{100}
OS2	2.10	8.9	15.9
OS3	0.43	0.4	1.3
OS4	0.61	0.5	1.9
OS5	1.54	5.6	10.0
OS6	9.73	12.5	30.4
OS7	1.97	0.7	5.3
A	2.79	3.6	8.7
B	2.70	3.6	8.6
C	2.92	4.2	10.1
D	2.90	4.3	10.4
E	5.34	8.2	19.9
F	1.12	4.3	7.7
G	0.61	0.5	1.9
EX-H	0.19	0.9	1.6
M	1.15	1.0	3.6
M2	1.60	0.4	3.2
N	2.08	1.6	5.7
O	0.57	0.5	1.8
W-2	10.00	2.7	19.7
OS1 HISTORIC	111.70	18.9	136.8
SUB-BASIN OS1A	2.70	0.7	5.3
SUB-BASIN OS1B	9.09	2.4	17.8
SUB-BASIN OS1C	5.64	1.5	11.1
SUB-BASIN OS1D	94.3	16.3	119.5
V1A	0.31	1.4	2.6
V1B	0.26	1.2	2.2
V1C	0.21	1.0	1.7
V1D	0.13	0.6	1.1
V2	0.32	1.5	2.7
RP-2B	2.04	4.9	9.9
RP-2C	1.28	4.3	8.2

DESIGN POINT SUMMARY				
DESIGN POINT	Q_5	Q_{100}	BASIN	STRUCTURE
1	3.6	8.7	A	15' AT-GRADE INLET
2	3.6	8.6	B	15' AT-GRADE INLET
3	4.2	10.1	C	8' SUMP INLET
4	16.1	36.7	D, E, F	15' AT-GRADE INLET
5	4.2	19.7	G, EX-H, FLOWBY DP4	EX 15' AT-GRADE INLET
6	14.1	26.7	OS2, OS3, OS4, OS5	EX 15' AT-GRADE INLET
7	12.6	30.5	OS6	EX 18' RCP
8	49.2	105.3	OS7, PR4, PR6, PR7	EX FDS POND 4
9	1.6	7.0	OS1A, V1A	EX 12" CMP CULVERT
10	4.8	26.3	OS1B, V1B, DP6	EX 2.9'x5.7' CDOT TYPE D INLET
11	2.2	12.3	OS1C, V1C,	EX 2.9'x2.9' CDOT TYPE C INLET
12	18.9	133.7	OS1D, V1D, W-2, V2	EX 4'x14' MOD CDOT TYPE D INLET
13	2.8	5.6	RP-2B	EX CDOT EMBANKMENT PROTECTOR TYPE 5
14	8.9	21.2	M, M2, RP2C, DP13	EX FSD POND W-9

STORM SEWER SUMMARY				
PIPE RUN	Q_5	Q_{100}	PIPE SIZE	CONTRIBUTING PIPES/DP'S
1	3.6	8.7	30" RCP	DP1
2	7.1	17.2	36" RCP	DP2, PR1
3	4.2	10.1	18" RCP	DP3
4	16.8	29.4	30" RCP	DP4, PR3
5	10.8	30.0	36" RCP	DP5, PR2
6	21.0	44.6	36" RCP	DP6, PR5
7	12.6	30.5	24" RCP	DP7
8	1.6	7.0	12" CMP	DP9
9	4.8	26.3	24" RCP	DP10
10	2.2	12.3	18" RCP	DP11
11	7.0	38.6	30" RCP	PR5, PR6
12	18.9	133.7	54" RCP	DP12
13	0.6	8.7	18" RCP	OUTFLOW EDB POND W-9
14	7.6	47.2	30" RCP	PR7, PR9
15	23.8	164.1	54" RCP	PR8, PR10
16	2.7	36.2	30" RCP	OUTFLOW EDB POND 4
17	26.5	200.3	60" RCP	PR11, PR12

REVISED POND 4 FSD BASIN DATA	REVISED POND W-9 FSD BASIN DATA
WQ WATER SURFACE EL = 7056.39	WQ WATER SURFACE EL = 7086.59
WQ VOLUME=0.046 AC-FT	WQ VOLUME=0.092 AC-FT
EURV WATER SURFACE EL = 7058.46	EURV WATER SURFACE EL = 7087.99
EURV VOLUME=1.510 AC-FT	EURV VOLUME=0.390 AC-FT
100-YR WATER SURFACE EL=7059.98	100-YR WATER SURFACE EL=7088.84
SPILLWAY CREST EL=7060.0	SPILLWAY CREST EL=7088.84
TOP OF EMBANKMENT EL=7063.0	TOP OF EMBANKMENT EL=7090.5
100-YR VOLUME=2.915 AC-FT	100-YR VOLUME=0.638 AC-FT
100-YR INFLOW = 105.3 CFS	100-YR INFLOW = 21.2 CFS
100-YR RELEASE = 36.8 CFS	100-YR RELEASE = 8.7 CFS

1" = 80'

0 40 80 160

Scale in Feet

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COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

HOMESTEAD AT STERLING RANCH FIL NO. 1

FINAL DRAINAGE MAP

PROJECT NO. 09-005

DESIGNED BY: CMN
DRAWN BY: CMN
CHECKED BY: VAS

SCALE: HORIZONTAL: 1"=80' VERTICAL: N/A

DATE: 4/12/2018

SHEET 1 OF 1

FDM01