DRAINAGE REPORT

FOR

CE WELL PAD

Prepared For:

THE CITY OF LOVELAND
On Behalf of MRG, LP

Prepared By:

Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, CO 80111
(303) 353-3926
Contact: Sage Cabrera, P.E.
Phone: 303-353-3617
Project No. 65120236-10

September 2022

EXECUTIVE SUMMARY

A drainage analysis and design has been performed for the CE Well Pad in accordance with the City of Loveland - Public Works Department requirements. The grading and stormwater management systems provided in this report are based on the established hydrologic analysis. A zero-release stormwater[1] design has been provided for the CE Well Pad. Stormwater release below the design volumes[2] (i.e. 2.01 ac·ft for Drilling Phase and 1,719 cf for the Production Phase) will be removed from site via a vacuum truck in order to ensure that no contaminants from the well pad are permitted to leave the site without treatment[3]. Best Management Practices will be utilized throughout the life of the facility to ensure compliance with the City, State and Federal stormwater requirements.

[1] No stormwater runoff from the CE Pad will occur for stormwater volumes less than the design volumes. The stormwater design volumes vary depending on which phase of the project life cycle is being evaluated; the Drilling Phase (i.e. Construction Phase) or the Production Phase (i.e. Interim Reclamation Phase). Stormwater volumes in excess of the design volume will flow out of an emergency spillway located on the south side of the pad.

[2] The stormwater management systems for the CE Pad Drilling Phase have been designed to contain 150% of the 100-year, 1-hour storm event volume. The later Production (i.e. Interim Reclamation) Phase of the project has been designed to contain the Water Quality Capture Volume.

[3] Chemical contamination of the onsite stormwater runoff will not occur under normal conditions, rather it would only occur during an atypical, accidental spill type scenario.

September 5, 2022

Ms. Suzette Schaff, PE
City of Loveland
Public Works Department – Stormwater Engineering Division
2525 W. 1st Street
Loveland, CO 80537
Suzette.Schaff@CityofLoveland.org

RE: Drainage Report for the MRG CE Well Pad

Dear Ms. Schaff,

Merrick & Company is pleased to submit this drainage report on behalf of MRG, LP for your review. This report identifies and defines the stormwater mitigation measures intended for the CE Well Pad in order to provide point source stormwater control and offset the drainage impacts anticipated from this project. This drainage report, and the associated stormwater management designs presented herein, conform with the City of Loveland's Storm Drainage Criteria. The designs presented in this report serve to adequately protect the public health, safety, and general welfare of the City of Loveland's residents.

Should you have any questions or comments related to this Drainage Report, please feel free to contact me.

Sincerely,
Merrick & Company

Sage Cabrera, P.E.
Senior Project Engineer

TABLE OF CONTENTS

ENGINEER'S CERTIFICATION

"I hereby certify that this report for the final drainage design of the CE Well Pad was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Loveland Storm Drainage Criteria for the owners thereof."

_____

Sage Whelan-Cabrera, PE

State of Colorado No. 0046604

1 GENERAL LOCATION AND DESCRIPTION

1.1 INTRODUCTION AND PURPOSE

MRG, LP (MRG) intends on constructing a new oil and gas well site in the City of Loveland (CoL). This project is referred to as the CE Well Pad (CE Pad). Merrick & Company (M&C) has been contracted to conduct the grading and drainage analysis for this project. This report details the findings and recommendations for the grading and stormwater management systems for the CE Pad.

The abbreviations and acronyms used in this report are defined in Appendix B.

1.2 PROJECT LOCATION AND DESCRIPTION

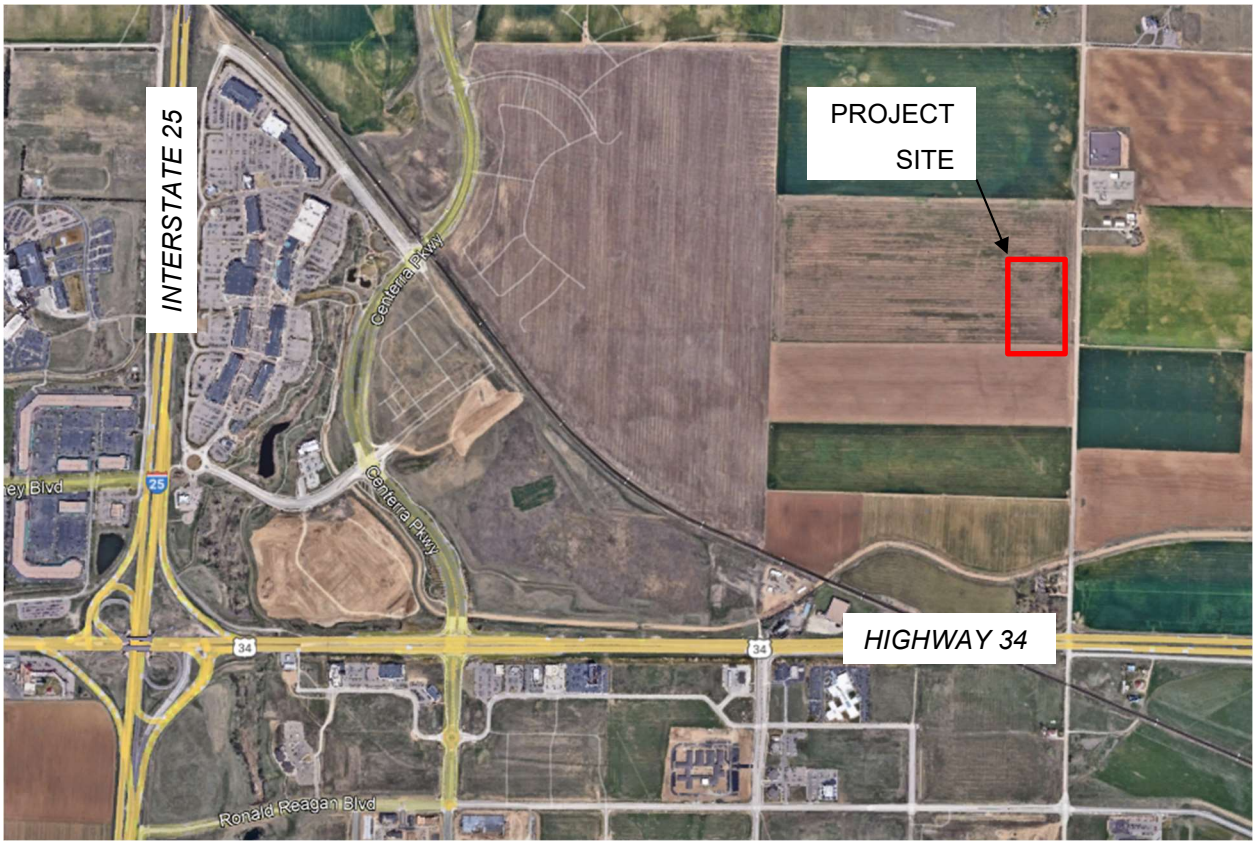
The CE Pad is located[4] in the SE ¼ of the NE ¼ of Section 11, Township 5 North, Range 68 West of the 6th Principal Meridian located in the City of Loveland, Larimer County, Colorado. The project site resides within the East I-25 Drainage Basin[5]. Figure 1 presents the vicinity map for the CE Pad. A General Location Map is provided in Appendix C.

The CE Pad will be constructed on agricultural land. As of the issuance of this report, the land north, south and west of the CE Pad is undeveloped farmland[6]. The project site lies north of U.S. Highway 34, south of East Crossroads Blvd., west of N County Road 3 and east of Centerra Parkway. Consideration to future planned development in the vicinity of the CE Pad was accounted for in the selection of this project site.

The CE Pad will be constructed in two distinct phases, the Drilling Phase[7] and the Production Phase[8]. Construction activities will occur during the initial Drilling Phase of the project. Once the construction activities are complete, the Drilling Pad will be reduced down in size from 7.5 acres to 2.0 acres. The land that is no longer required for the operation of the well pad will be reclaimed back to its “as found” condition.

[4] The project coordinates are Latitude: 40.415522, Longitude: -104.965803
[5] See the City of Loveland Master Drainage Plan in Appendix F (see CoL-MDP reference in Appendix A, Table 5)
[6] Outside of the setbacks and reverse setbacks for the project site, future plans have this land designated for residential housing.
[7] The first phase of the project, also referred to as the Construction Phase
[8] The second phase of the project, also referred to as the Interim Reclamation Phase

Figure 1: Vicinity Map of the CE Project Site[9]



2 DRAINAGE BASINS AND SUB-BASINS

The project site resides within the City of Loveland's East I-25 Drainage Basin[10]. The original CoL Master Drainage Plan has no facilities or required hydrologic flow patterns for this location, however an Amendment to the East I-25 Basin Drainage Master Plan (AI25-DMP) provided by M&C was accepted by CoL-PW in May of 2020. Excerpts from this amendment are provided in Appendix J[11]. The CE Pad project site does not reside within the FEMA floodplain[12] and there are no privately owned irrigation ditches in close proximity to the CE Pad that will receive runoff from the CE Project site, however the Loveland and Greeley Canal does reside roughly 2,000 ft

[9] Aerial image from Google Earth®
[10] See the City of Loveland Master Drainage Plan in Appendix F (see CoL-MDP reference in Appendix A, Table 5.
[11] Reference Appendix A, Table 4 for detailed information.
[12] See Appendix C for FEMA Flood Insurance Rate Map

from the southern boundary of the project site. Offsite flow originating from upgradient of the CE Pad will flow towards the project site.

2.1 EXISTING CONDITIONS

The CE Pad property covers an area of approximately 13.4 acres. The existing grade slopes from north to south with an average slope of 1.3%. Runoff from the site flows towards the south originating as sheet flow and then converting to shallow concentrated flow. The soils for this project site are predominately comprised of lean clays with varying amounts of sand[13]; these clays have a Type C[14] hydrologic soil classification. The existing groundcover consists of tilled farm fields[15]. Figure 2 shows the existing project site ground cover.

Figure 2: Photo of Project site (Looking West)

[13] The soil characterization was performed by Soilogic and is described in the document GTR-01 (defined in Appendix A, Table 4); excerpts from this report are provided in Appendix H.
[14] According to the National Resource Conservation Society (NRCS); see NRCS reference in Appendix A, Table 5. The NRCS hydrologic soil classification presented in Appendix E.
[15] The corresponding conveyance factor (K) for MHFD Rational Method calculations is 5.

Table 1 presents the existing condition sub-basins and the associated peak flows that were determined during the hydrologic analysis. The peak flow calculations indicated in Table 1 are provided in Appendix G on Sheet G.2.

Table 1: Existing Conditions Subbasin

Subbasin Description	Subbasin ID	5-Year Peak Flow	100-Year Peak Flow
Production Phase Existing Conditions Working Pad Surface Area	PE-1	0.2 cfs	4.4 cfs
Drilling & Production Phase Existing Conditions Upgradient Area	E-1	2.3 cfs	41.1 cfs

2.2 PROPOSED CONDITIONS

The first phase (Drilling Phase[16]) of the project will have a 7.5 acre Working Pad Surface (WPS). Following the Drilling Phase, the Production Phase[17] of the project will commence; during this phase, the pad size will be reduced down to a 2.0 acre WPS for the remainder of the life of the facility.

Stormwater originating from the WPS, or flowing onto the WPS from the adjacent stockpiles[18], will be captured and removed from site via a vacuum truck[19]. Stormwater originating upgradient of the CE Pad will be intercepted and redirected around the project site by a diversion ditch where it will be converted to sheet flow[20], then released and allowed to continue on with its historic flow patterns. Stormwater released from the WPS through the emergency spillway will flow off the property towards the south where it will continue on with its historic flow patterns. Reference Sections 4.1, 4.2 and 4.3 for a detailed description of the proposed stormwater management systems.

[16] i.e. Construction Phase
[17] i.e. Interim Reclamation Phase
[18] Runoff from the stockpiles onto the working pad surface can occur only during the Drilling Phase.
[19] This stormwater will be transported to a treatment facility where it will be tested for contaminants, treated (if necessary) then released.
[20] The intercepted runoff will be discharged as sheet flow for most storm events, however during the Drilling Phase, storm events greater than a 5-year storm will be released at flow depths greater than one inch, hence sheet flow release will not occur.

Table 2 presents the existing condition sub-basins and the associated peak flows that were determined during the hydrologic analysis. The peak flow calculations indicated in Table 2 are provided in Appendix G on Sheet G.2.

Table 2: Proposed Conditions Subbasins

Subbasin Description	Subbasin ID	5-Year Peak Flow	100-Year Peak Flow
Drilling Phase Proposed Conditions	D-1	9.8 cfs	30.8 cfs
Production Phase Proposed Conditions	P-1	2.5 cfs	7.7 cfs
Production Phase Proposed Conditions Subbasin for internal ditches	P-2	1.2 cfs	5.7 cfs

3 DRAINAGE DESIGN CRITERIA

3.1 GENERAL DESIGN CRITERIA

The criteria for the proposed stormwater management plan presented in this report is the "City of Loveland Storm Drainage Criteria Manual" (LSDCM[21]) and the Mile High Flood District's (MHFD) "Urban Storm Drainage Criteria Manual" (USDCM[21]) Volumes 1, 2, and 3. The LSDCM includes amendments to the USDCMs which supersedes the design criteria indicated in the USDCM. Specific design and analysis requirements for the CoL can be found in the "Drainage Planning Submittal Requirements" (Section 2.4) of the LSDCM.

The only notable deviation from the typical stormwater management approach indicated in the LSDCM is the use of a retention pond for the Drilling Phase and a sediment basin for the Production Phase, both of which will be evacuated following a significant storm event by a vacuum truck. This approach was chosen by MRG to provide an additional measure of environmental protection to ensure that chemically contaminated runoff does not flow off of the project site before being treated[22].

[21] Reference Appendix A, Table 4 for detailed information.

[22] Chemical contamination of the onsite stormwater runoff will not occur under normal conditions, rather it would only occur during an atypical, accidental spill type scenario.

3.2 HYDROLOGIC CRITERIA

The MHFD hydrologic modeling spreadsheet *UD-Rational 2.00* (UD-Rational[23]) was used to establish peak flows and time of concentration. The *MHFD Detention v 2.34* (UD-Detention[23]) was used to establish the required storage volume for the Drilling Phase retention area; the calculated 100-year volume was multiplied by a factor of 1.5 in accordance with CoL-PW criteria. SWMM5[23] was used to quantify the difference[24] in peak flow release for the Production Phase (see Section 4.2 for detailed information). The Water Quality Capture Volume (WQCV) equation[25] from LSDCM[26] was utilized to size the sediment basin area for the Production Phase.

3.3 HYDRAULICS CRITERIA

The MHFD hydraulic modeling spreadsheet *UD-Channel v1.04* (UD-Channel)[23] was used to establish the ditch hydraulic parameters, ditch sizing, and riprap sizing.

4 DRAINAGE FACILITY DESIGN

During the initial Drilling Phase of the project, an on-pad retention area will be provided for stormwater control (reference Appendix I, Sheet I.3). During the subsequent Production Phase, an on-pad sediment basin area will be provided for water quality enhancement (reference Appendix I, Sheet I.4).

The calculated increase in peak flow from the historic to the proposed runoff conditions for the Production Pad subject to a 100-year storm event is 2.9 cfs[27]. In accordance with the direction provided by the CoL[28], a sediment basin has been included to provide water quality control for the Production Phase facility.

---

[23] See Appendix A, Table 5 for reference information.

[24] To quantify the difference between the historic 100-year peak flow and the post-development 100-year peak flow.

[25] Reference Appendix G, Sheet G.22 for the WQCV equation.

[26] See Appendix A, Table 4 for reference information.

[27] The calculated historic condition runoff is 4.4 cfs; the calculated proposed condition runoff is 7.7 cfs. These calculations are presented in the MHFD Rational Method calculations provided in Appendix G, Sheet G.2 (PE-1 and P-1, respectively).

[28] The CoL-PW criteria requires water quality control for well pads whose development results in a change in peak flow runoff for the 100-year storm event less than 5.0 cfs above the historic (i.e. predevelopment) peak flows; for changes in peak flow runoff above 5.0 cfs, a dedicated detention pond shall be provided.

4.1 DRILLING PHASE

Appendix I, Sheet I.3 presents the plans for the proposed Drilling Phase grading and stormwater management systems. A 480 ft by 680 ft rectangular[29] working pad surface is planned for the first phase (i.e. Drilling Phase) of the project. Once the Rough Grade for the Drilling Phase is installed, the pad will be capped with 4-inches of CDOT Class 6 road base compacted to 95%[30] to complete the Finished Grade and provide a durable working pad surface[31].

The southern portion of the Drilling Phase Pad serves as part of the stormwater management system and has been designed to retain runoff originating from the working pad surface. This retention area[32] has been sized to store 2.01 ac·ft[33]. The stormwater impounded in the retention area will be removed via a vacuum truck[34]. A minimum of 1.0 foot of freeboard has been provided for the stormwater retention area.

A 65' wide emergency spillway located on the south side of the retention area (reference Appendix I, Sheet I.3) has been designed to release stormwater volumes which exceed 2.01 ac·ft. The spillway has been sized to release the 100-year peak flow rate of 30.8 cfs[35] at a flow depth above the spillway crest of 3.5-inches. The spillway invert has been set at elevation 4,973.5 ft. amsl and the water depth at the deepest portion of the water pool when the water surface is at this elevation is 2.9 feet.

During the Drilling Phase, a soil stockpile[36] will surround the pad on most sides (reference Appendix I, Sheet I.3). Precipitation which falls onto the "pad side" of the stockpiles will runoff onto the working pad surface where it will then flow over the pad towards the south to the retention area. Precipitation which falls on the "far side" of the eastern and southern stockpiles

[29] 7.5 acres

[30] Compacted thickness at 95% Standard Proctor.

[31] The imperviousness for the CDOT Class 6 gravel cap is 40%. Value taken from the USDCM Vol 1, Page 6-8, Table 6-3.

[32] With respect to erosion and sediment control, the Stormwater Retention Area will function as a sediment basin and will allow the majority of the sediment that is suspended in the stormwater runoff to settle out prior to transporting the water to a treatment facility.

[33] The Drilling Phase retention area has been designed to hold 150% of the 100-year, 1-hour storm event volume. Appendix G presents the MHFD Modified FAA calculations for the retention area sizing.

[34] This stormwater will be transported to a treatment facility where it will be tested for contaminants, treated (if necessary) then released.

[35] Reference Appendix G, Sheet G.2 for the 100-year peak flow calculations.

[36] The Drilling Phase soil stockpiles will be used during the interim reclamation phase (Production Phase) of the project to reclaim the unused areas back to its predeveloped condition.

will run to existing grade where it will then flow towards the south and off of the property. Runoff from the "far side" of the northern and western stockpiles will run down to the diversion ditch (reference Section 4.3 for more information on the diversion ditch).

4.2 PRODUCTION PHASE

Appendix I, Sheet I.4 presents the plans for the proposed Production Phase grading and stormwater management systems. Following the Drilling Phase of the project, a 2.0 acre working pad surface is planned for the project's Production Phase. Once the construction activities have concluded, approximately 5.5 acres of Drilling Phase WPS will be returned back to its "as found" condition. The remaining WPS will be retained for the life of the well pad.

The southern portion of the Production Phase Pad is intended to provide water quality control for the Production Pad. The calculated WQCV for the Production Pad is 1,719 ft^3 (reference Appendix G, Sheet G.22 for WQCV calculations). This sediment basin area has been sized to provide 6,921 ft^3 of storage, which equates to approximately 4 times the required WQCV[37]. This additional storage volume has been included to provide time for the vacuum truck to arrive and drain down the sediment basin in the event several small back-to-back storm events occur before the vacuum truck is available to drain down the sediment basin. The calculated depth in the sediment basin following a WQCV event at the deepest portion of the water pool is approximately 2.5-inches.

A 60' wide emergency spillway located on the south side of the retention area (reference Appendix I, Sheet I.4) has been designed to release stormwater volumes which exceed 6,921 ft^3. The depth of flow out of the spillway for storm events recurrence intervals less than or equal to a 100-year storm event is 1.5-inches or less above the spillway crest. Appendix G, Sheets G.4 – G.7 presents the calculations for the spillway hydraulics.

10-foot-tall visual mitigation berms will surround most of the CE Pad. Precipitation which lands on the "pad side" of the berms will flow to a ditch located at the base of the berm, then flow

[37] Based on typical rainfall data for the Denver Metropolitan area, roughly 2/3 of all storms in a given year will generate runoff volumes less than the WQCV.

around the perimeter of the pad before being released on the south side of the pad, immediately downstream of the spillway. This interior collection ditch has been designed to a depth of 1.0 foot, which includes 0.54 ft. of flow depth and 0.46 foot of freeboard[38]. Precipitation which lands on the "far side[39]" of the berms will run down the berm face to existing grade (for the southern and eastern berms) or to the diversion ditch (for the northern and western berms), where it will continue to flow towards the south before exiting the property.

4.2.1 POST-DEVELOPMENT AND MASTER DRAINAGE PLAN IMPACTS

M&C performed a hydrologic analysis to calculate how much of a reduction in peak flow discharge would occur between the historic and post-development conditions for the CE Production Pad. A hydrologic model using SWMM[40] and CUHP[40] was created to quantify the 100-year the peak flows. Table 3 provides the input parameters used to establish the peak flows. All other input parameters used in the modeling which are not indicated in Table 3 were identical.

Table 3: Production Phase Hydrologic Comparison

Hydrologic Parameters	Pre-development	Post-development
Percent Imperviousness	2%	45%
Initial Abstraction[41] – Pervious	0.29 inch	0.10 inch
Initial Abstraction[41] - Impervious	0.20 inch	0.05 inch
Average Slope	1.48%	1.30%
CE Pad Peak Discharge	**4.4 cfs**	**4.3 cfs**

The modeling showed that a 2.3% reduction in peak flow (relative to the historic peak discharge) is expected even though the Percent Imperviousness will increase during the Production Phase. This peak flow reduction occurs because of the storage effects of the sediment basin, which

[38] The minimum depth for the internal collection ditch with freeboard is 1.33 * flow depth = 1.33 * 0.54 ft = 0.72 ft.
[39] The portion of the berms farthest from the working pad surface.
[40] Reference Appendix A, Table 5 for reference information.
[41] The initial abstraction, referred to in the CUHP software as "Maximum Depression Storage", is the initial rainfall depth, measured in watershed inches, which is removed from the hydrologic calculations; it accounts for the hydrologic losses that occur when rainfall pools in a local area depression and cannot escape, hence there is no runoff generated from these depression losses.

reduces the total Production Phase runoff volume[42] by 23% and results in an attenuation of the peak flow below that of historic rates. Appendix G presents the output from the stormwater routing modeling effort.

The project site lies within Basin 41 in the AI25-DMP[43] document. Future runoff from Basin 41 is planned to report to Local Detention Pond 4. Basin 41 is reported as being 56.5 acres and has a corresponding 100-year peak flow of 182 cfs. The Production Phase footprint for the CE Pad is approximately 7.5 acres which includes the well pad area, access road, visual mitigation berms and the diversion ditch (reference Sheet I.4 in Appendix I, subbasin P-3). The CE Pad comprises 13.3% of the total area for Basin 41. Taking 13.3% of the reported 100-year peak flow implies that planned flow rate for the CE Pad site is 24.2 cfs. The calculated peak flow rate for the CE Production Pad area based on conservative assumptions is 20.2 cfs[44], hence stormwater runoff from the CE Pad will be less than what was assumed for sizing the Local Detention Pond 4.

4.3 DIVERSION DITCH

Upgradient offsite runoff that flows towards the CE Pad during both Drilling and Production Phases[45] will be intercepted by a diversion ditch located on the northern and western perimeter of the project site (reference Appendix I, Sheets I.3 and I.4). This ditch will redirect stormwater around the project site and discharged it immediately south of CE Pad, where it will continue on with its historical flow patterns. Due to the limited elevation provided at the CE Project Site, the diversion ditch begins to transition from being completely in cut (upstream) to running on grade with berms on either side (downstream, reference Figure 3); this transition occurs at the approximate halfway point along the ditch alignment. The diversion ditch was sized based on the upgradient existing conditions for a 100-year storm event; the corresponding calculated

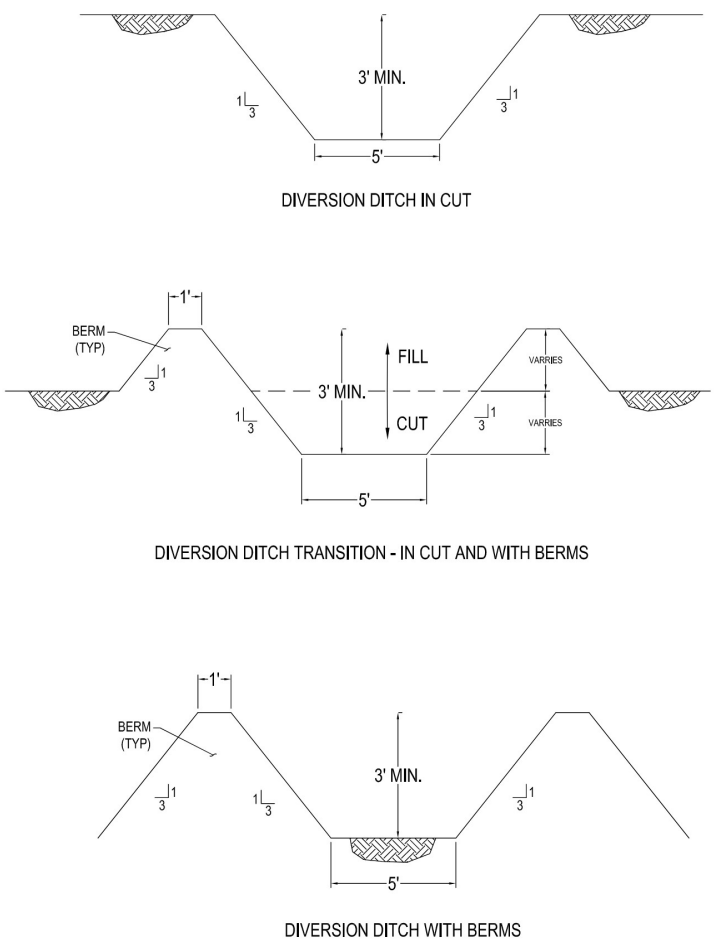
[42] The 100-year total runoff volume for the pre- and post-development Production Phase conditions were 14,089 ft^3 and 18,194 ft^3, respectively.
[43] Reference Appendix A, Table 4 for detailed information.
[44] Reference Appendix G, Sheet G.2 for 100-year peak flow calculations.
[45] The diversion ditch will be moved closer to the Production Phase pad during the Production Phase of the project.

peak flow[46] is 41.1 cfs. This peak flow exceeds the calculated peak flow expected for the fully developed, upgradient future conditions assuming the future developed conditions do not exceed the allowable release rate of 1.0 cfs/acre for the entire 32.1-acre sub-catchment area. A minimum of 1.0 foot of freeboard has been provided for the diversion ditch.

A 6 ft. wide by 20 ft. long stilling basin located at the discharge point of the diversion ditch will dissipate some of the potential energy prior to converting the concentrated flow into sheet flow through the use of level spreader[47] (i.e. flow spreader). The Drilling Phase level spreader is 18.0 ft. wide; the Production Phase level spreader is 105.0 wide.

[46] The peak flow calculation incorporated the Regional Time of Concentration calculation even though the current conditions have % imperviousness well below 20%, hence this calculation approach assumes future development imperviousness and provides a conservative estimate for peak flow.
[47] Appendix G provides the calculations for the sizing of the level spreader.

Figure 3: Diversion Ditch Details



5 SEDIMENT, EROSION CONTROL AND STORMWATER QUALITY

Temporary and permanent erosion control measures will be provided for the CE pad. The erosion and sediment control measures (CMs) chosen for the CE Project have been selected to effectively prevent or treat the erosion for the project site. Nonstructural[48] CMs have been selected preferentially; structural[48] CMs have been included to provide improved stormwater quality enhancement.

[48] Nonstructural control measures serve to prevent soil particles from being dislodged from the soil. Structural control measures serve to remove soil particles suspended in the runoff and to prevent the soil from leaving the project site.

5.1 TEMPORARY SEDIMENT AND EROSION CONTROL

The following erosions and sediment control measures are planned for the Drilling Phase[49] of the CE pad:

1. Sediment control logs (i.e. straw wattles)
2. Seeding, mulching and crimping
3. Silt fence
4. Surface roughening
5. Stilling Basin
6. Level Spreader
7. Vehicle Tracking Control
8. Concrete Washout Area
9. Temporary Sediment Basin[50]
10. Riprap outlet (i.e. spillway) protection[51]
11. Water application (dust control)

5.2 PERMANENT SEDIMENT AND EROSION CONTROL

The following erosions and sediment CMs are planned for the Production Phase[52] of the CE pad:

1. Sediment basin
2. Seeding, mulching and crimping
3. Stilling basin
4. Level spreader (i.e. flow spreader)
5. Riprap outlet (i.e. spillway) protection
6. Vegetated swales (i.e. grass-lined swales)

[49] Also referred to as the Construction Phase, the Drilling Phase includes the following sub-phases: Earthworks Phase, Drilling Phase, Completions & Stimulation Phase, and the Flowback Phase.
[50] The Temporary Sediment Basin is also referred to as the Stormwater Retention Area in this report.
[51] Also referred to as Buried Soil Riprap
[52] Also referred to as the Interim Reclamation Phase.

Sediment Basin

A sediment basin has been selected to allow the majority of the sediment suspended in the runoff to settle out prior to the water being removed from site by a vacuum truck. Removal of the runoff by a vacuum truck has been selected to provide an additional measure of environmental protection in the event an accidental, uncontained chemical spill were to occur on the CE Pad; this approach is intended to prevent chemical contaminants from mixing with stormwater runoff and flowing off of the project site. The sediment basin has been sized to contain four (4) times the WQCV; the WQCV volume for the sediment basin is 1,719 ft^3.

Seeding, Mulching and Crimping

Seeding, mulching and crimping will be provided to promote vegetative growth to reduce the runoff velocities on the berms, which in turn reduces erosion potential of the stormwater runoff.

Vegetated Swales

The swales and diversion ditch will be covered with native grasses to reduce the flow velocities and protect the swales/ditches from erosion.

Stilling Basin

A riprap lined stilling basin will be situated at the discharge end of the diversion channel to dissipate the energy of the water and reduce the velocities prior to releasing the runoff. A level spreader will be provided at the discharge end of the stilling basin.

Level Spreader

A level spreader (i.e. flow spreader) will be provided along the southern edge of the stilling basin. For smaller storm events, the level spreader will convert the concentrated flow into sheet flow immediately before discharging the water off of the property. For larger storm events, the level spreader will disperse the flow to reduce the erosion potential of the runoff prior to discharging it off property.

Riprap Outlet Protection

The downstream side of the spillway will be armored with riprap to protect against erosion.

6 CONCLUSIONS

The proposed drainage plan presented in this report meets or exceeds the stormwater design standards set forth in the LSDCM and the USDCMs. There are two primary difference from that of a typical CoL stormwater management facility. These differences are as follows:

1. The stormwater management for the CE Pad will have zero stormwater release for storm water volumes that are below the design volumes[53]; stormwater will be removed from the CE Pad's on-site retention or sediment basin areas via a vacuum truck.
2. The stormwater retention area has the capacity to store 150% of the 100-year storm volume.

Water quality enhancement is expected to exceed the historic conditions for the CE Pad site[54]. The post-development flows will be attenuated relative to historic flows, hence erosion stemming from stormwater release is expected to be reduced[54].

No CoL recommendations exist in the CoL-MDP[55] for this site, however it is Merrick's expectation are that the stormwater management designs provided for the CS Pad are conservative, as there will be no stormwater release from this site[54]. Accordingly, there are no irrigation companies or adjacent property owners that will be affected by the stormwater runoff from the CE Pad for post-development conditions[54].

The calculations performed for this report have been done diligently and prudently. The stormwater designs, as established by the analysis, are not expected to have an adverse impact on the existing CoL's drainage facilities or flow patterns. The drainage designs are sound and are not expected to place public safety or adjacent properties at risk.

[53] The design volume for the Drilling Phase is 2.01 ac·ft and is 1,719 ft^3 for the Production Phase.

[54] This statement applies for storm recurrence intervals less than or equal to the 100-year storm event for the Drilling Phase and water volumes less than or equal to the four times the WQCV for the Production Phase.

[55] See CoL-MDP reference in Appendix A, Table 6

Appendix A References, Software & Websites

Table 4: References

References	Abbreviation
"*Urban Storm Drainage Criteria Manual Volumes 1*" Prepared by the Mile High Flood District, revised March 2017.	USDCM-1
"*Urban Storm Drainage Criteria Manual Volumes 2*" Prepared by the Mile High Flood District, revised March 2017.	USDCM-2
"*Urban Storm Drainage Criteria Manual Volumes 3*" Prepared by the Mile High Flood District, revised March 2017.	USDCM-3
"*City of Loveland Storm Drainage Criteria Manual (Addendum to the Urban Storm Drainage Criteria Manuals Volume 1, 2, and 3)"*, Prepared by RESPEC, Inc., dated July 31, 2020	LSDCM
"*Preliminary Geotechnical Subsurface Exploration Report – Kinston Residential Community at Centerra – East Parcels*", Prepared by Soilogic, report number 20-1019, dated March 3, 2020.	GTR-01
"*Amendment to the East I-25 Basin Drainage Master Plan",* Prepared by Merrick and Company, dated May 2020	AI25-DMP

Table 5: Software

Software	Abbreviation
"*Channel Design – UD Channel v1.04*", XLS. Software by Mile High Flood District; released October 2006.	UD-Channel
"*Detention Design – UD Detention 2.34*", XLS. Software by Mile High Flood District; released January 2015. https://mhfd.org/resources/software/	UD-Detention
"*Peak Runoff Prediction by the Rational Method – UD RATIONAL-2.00*", XLS. Software by Mile High Flood District; released May 2017. https://mhfd.org/resources/software/	UD-Rational
"Colorado Urban Hydrograph Procedure – CUHP 2005 2.0.1" XLS. Software by Mile High Flood District; released November 2019. https://mhfd.org/resources/software/	CUHP
"AutoCAD Civil 3D – 2021", Software by Autodesk; released 2021.	CAD-C3D
"SWMM 5.1". Software by the Environmental Protection Agency; released July 2020. Storm Water Management Model (SWMM) | US EPA	SWMM5

Table 6: Websites

Website	Abbreviation
"City of Loveland Master Drainage Plan" for the City of Loveland, dated April 2011. 2011 Updated Stormwater Master Plan_CIP_Map-Default (lovgov.org)	CoL-MDP
"USDA/NRCS Web Soil Survey", by National Resource Conservation Society. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx	NRCS

Appendix B Abbreviations & Acronyms

ac	Acre
amsl	Above mean sea level
BMP	Best Management Practices
CDOT	Colorado Department of Transportation
cf	Cubic Feet
CFS	Cubic Feet per Second
CoL	City of Loveland, CO
CoL-PW	City of Loveland Public Works department
CM	Control Measures (for erosion and sediment control)
CMP	Corrugated Metal Pipe
DP	Design Point
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft.	Feet
fps	Feet per Second
in.	Inches
M&C	Merrick and Company
MHFD	Mile High Flood District
min.	Minutes
mi.	Miles
MRG	MRG, LP
NRCS	Natural Resources Conservation Service
RCP	Reinforced Concrete Pipe
sec	Second(s)
USDCM	Urban Storm Drainage Criteria Manual
WPS	Working Pad Surface
WQCV	Water Quality Capture Volume

Appendix C General Location Map

File Location:Q:\DEN\Projects\0178-00 CMD Centennial\Projects\0236-08 MRG Misc Oil and Gas\Design\CDs\Civil\DR\023608- GENERAL LOCATION MAP RevA.dwg Plot Date:8/29/2022 7:23 AM Last Saved By: TVANGORDON

SECTION: 11
TOWNSHIP: 5N
RANGE: 68W
6TH P.M.
LARIMER COUNTY, CO

LATITUDE: 40.415522
LONGITUDE: -104.965803

N

2000' 0 1000' 2000' 4000'
1" = 2000' HOR.

LEGEND

PROJECT LOCATION

GENERAL LOCATION MAP
SCALE: 1" = 2000'

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
0	DRAINAGE REPORT GLM	8/1/2022	TVG	TS	SWC

CALL BEFORE YOU DIG
811
Know what's below. Call before you dig.

CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

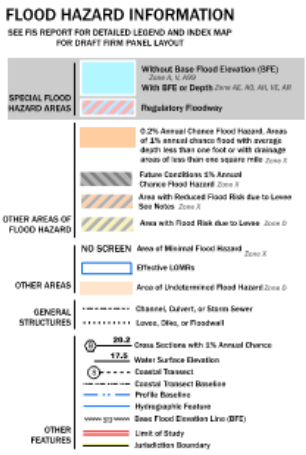
MERRICK
Engineering | Architecture | Design-Build | Surveying | Planning | Geospatial Solutions
5970 GREENWOOD PLAZA BLVD, GREENWOOD VILLAGE, CO, 80111
303-751-0741
www.merrick.com

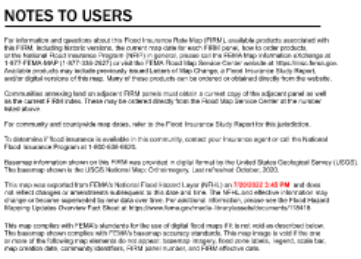
PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

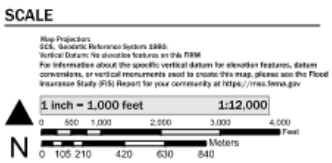
TITLE
MRG OIL AND GAS
CITY OF LOVELAND, COLORADO
GENERAL LOCATION MAP

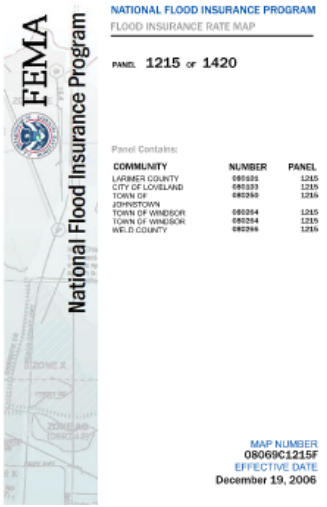
JOB NUMBER 65120236-10
DATE 6/22/2022
SHEET SHEET C.2
1 of 1

Appendix D FEMA Flood Insurance Rate Map









Appendix E NRCS Hydrologic Soil Classification

Hydrologic Soil Group—Larimer County Area, Colorado

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: Larimer County Area, Colorado
Survey Area Data: Version 16, Sep 2, 2021

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

Date(s) aerial images were photographed: Jun 8, 2021—Jun 12, 2021

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
115	Weld silt loam, 0 to 3 percent slopes	C	22.0	100.0%
Totals for Area of Interest			**22.0**	**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

Component Percent Cutoff: None Specified

Appendix F City of Loveland Master Drainage Map

CITY OF LOVELAND
MASTER DRAINAGE PLAN

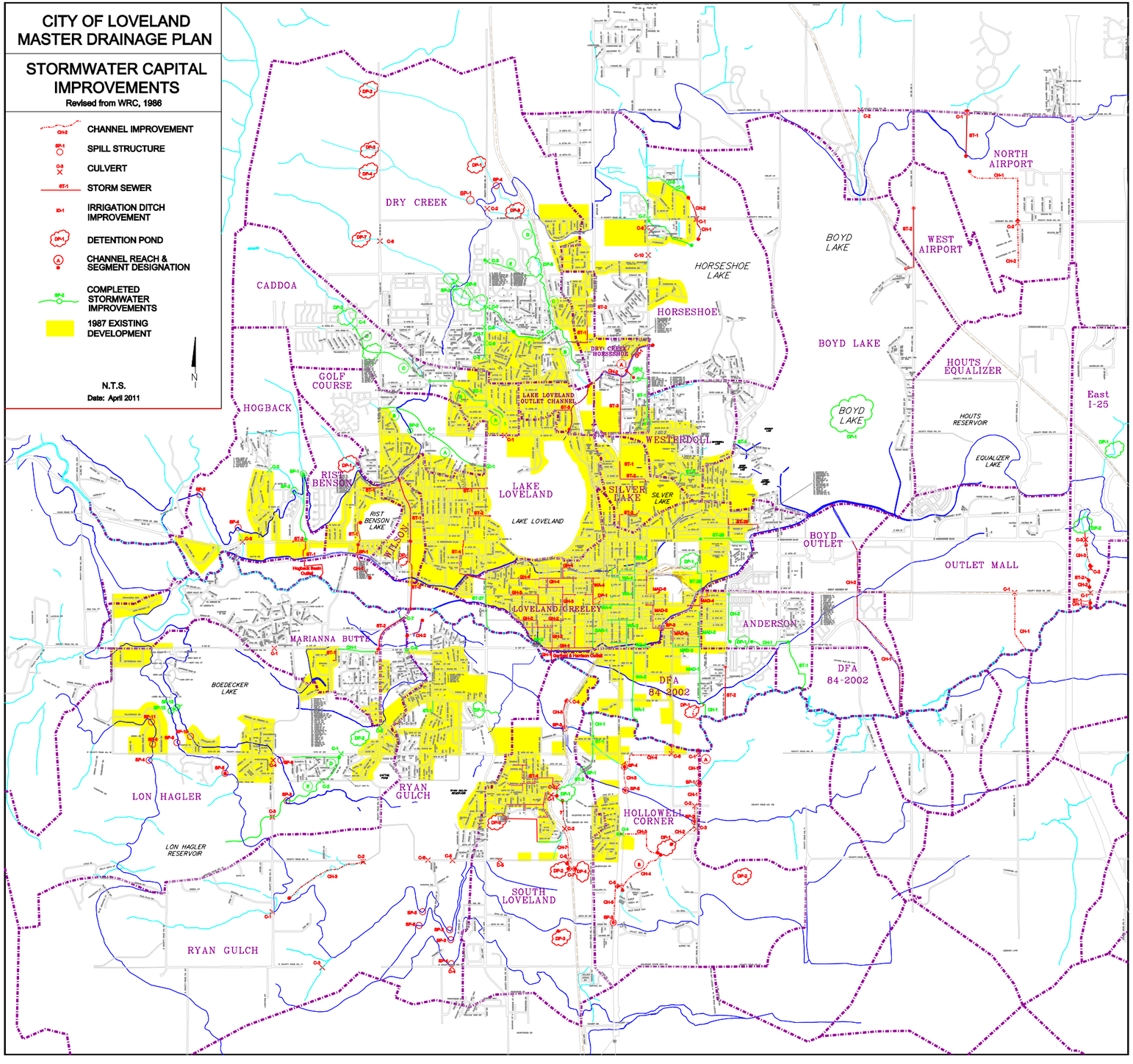
STORMWATER CAPITAL IMPROVEMENTS

Revised from WRC, 1986

- CH-2 — CHANNEL IMPROVEMENT
- SP-1 — SPILL STRUCTURE
- C-2 — CULVERT
- ST-1 — STORM SEWER
- ID-1 — IRRIGATION DITCH IMPROVEMENT
- DP-1 — DETENTION POND
- A — CHANNEL REACH & SEGMENT DESIGNATION
- SP-2 — COMPLETED STORMWATER IMPROVEMENTS
- 1987 EXISTING DEVELOPMENT

N.T.S.

Date: April 2011



APPROXIMATE CE PAD PROJECT LOCATION

Appendix G Hydraulic and Hydrologic Calculations

Calculation of Peak Runoff using Rational Method

Designer: Sage Cabrera
Company: Merrick and Company
Date: 8/24/2022
Project: MRG - CE Pad
Location: Loveland, CO

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

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

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.41	1.69	2.03	2.36	2.66	

Rainfall Intensity Equation Coefficients =	a	b	c
	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Drilling Proposed (D-1)	10.2	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4984.0	4976.5	0.025	16.14	656.00	4976.50	4971.00	0.008	10	0.92	11.94	28.08	26.15	26.15	1.70	2.40	2.87	3.45	4.01	4.52		5.90	9.8	13.55	20.08	25.16	**30.8**	
Production Existing (PE-1)	2.3	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	300.0	4981.0	4976.2	0.016	28.08	192.00	4976.20	4973.80	0.012	5	0.56	5.72	33.81	28.74	33.81	1.46	2.06	2.47	2.97	3.45	3.89		0.03	0.2	0.83	2.25	3.19	**4.4**	
Production Proposed (P-1)	2.3	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4980.7	4975.0	0.019	17.67	212.00	4975.00	4974.00	0.005	10	0.69	5.14	22.81	21.71	21.71	1.88	2.66	3.18	3.82	4.44	5.01		1.47	2.5	3.39	5.02	6.29	**7.7**	
Prod Prop - Int Swale (P-2)	1.99	C	25.4	0.18	0.24	0.32	0.46	0.52	0.59	0.67	300.0	4990.0	4982.0	0.027	19.41	312.00	4982.00	4974.20	0.025	10	1.58	3.29	22.70	24.30	22.70	1.84	2.59	3.11	3.73	4.34	4.89		0.66	1.2	1.97	3.43	4.48	**5.7**	
Upgradient - Existing (E-1)	32.1	C	2.0	0.01	0.05	0.15	0.33	0.40	0.49	0.59	300.0	5014.0	5010.3	0.012	30.60	2526.00	5010.30	4972.80	0.0148	5	0.61	69.11	99.71	62.89	62.89	0.98	1.38	1.65	1.99	2.31	2.60		0.33	2.3	7.79	21.06	29.88	**41.1**	
Prod Reginal (P-3)	7.5	C	45.0	0.34	0.40	0.46	0.57	0.62	0.67	0.73	300.0	4985.2	4983.5	0.006	26.34	1200.00	4983.50	4972.20	0.009	15	1.46	13.74	40.08	31.82	31.82	1.52	2.14	2.56	3.08	3.58	4.03		3.88	6.45	8.91	13.21	16.54	**20.2**	

DETENTION VOLUME BY THE MODIFIED FAA METHOD

Project: MRG - CE Pad: Drilling Phase Retention Area Stormwater Volume Calculations

Basin ID:

(For catchments less than 160 acres only. For larger catchments, use hydrograph routing method)
(NOTE: for catchments larger than 90 acres, CUHP hydrograph and routing are recommended)

Determination of MINOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	45.00	percent
Catchment Drainage Area	A =	10.200	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	10	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	21.71	minutes
Allowable Unit Release Rate	q =	0.00	cfs/acre
One-hour Precipitation	P_1 =	1.69	inches
Design Rainfall IDF Formula $i = C_1 * P_1/(C_2+T_c)^{C_3}$			
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.786	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.44	
Inflow Peak Runoff	Qp-in =	14.28	cfs
Allowable Peak Outflow Rate	Qp-out =	**0.00**	cfs
Mod. FAA Minor Storage Volume =		27,596	**cubic feet**
Mod. FAA Minor Storage Volume =		**0.634**	**acre-ft**

1 <- Enter Rainfall Duration Incremental Increase Value Here (e.g. 5 for 5-Minutes)

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)
0	0.00	0.000	0.00	0.00	0.000	0.000
1	7.31	0.045	1.00	0.00	0.000	0.045
2	6.83	0.084	1.00	0.00	0.000	0.084
3	6.41	0.119	1.00	0.00	0.000	0.119
4	6.05	0.150	1.00	0.00	0.000	0.150
5	5.73	0.177	1.00	0.00	0.000	0.177
6	5.45	0.202	1.00	0.00	0.000	0.202
7	5.20	0.225	1.00	0.00	0.000	0.225
8	4.97	0.246	1.00	0.00	0.000	0.246
9	4.76	0.265	1.00	0.00	0.000	0.265
10	4.57	0.283	1.00	0.00	0.000	0.283
11	4.40	0.299	1.00	0.00	0.000	0.299
12	4.24	0.315	1.00	0.00	0.000	0.315
13	4.10	0.329	1.00	0.00	0.000	0.329
14	3.96	0.343	1.00	0.00	0.000	0.343
15	3.84	0.356	1.00	0.00	0.000	0.356
16	3.72	0.368	1.00	0.00	0.000	0.368
17	3.61	0.380	1.00	0.00	0.000	0.380
18	3.51	0.391	1.00	0.00	0.000	0.391
19	3.41	0.401	1.00	0.00	0.000	0.401
20	3.32	0.411	1.00	0.00	0.000	0.411
21	3.24	0.421	1.00	0.00	0.000	0.421
22	3.16	0.430	0.99	0.00	0.000	0.430
23	3.08	0.439	0.97	0.00	0.000	0.439
24	3.01	0.447	0.95	0.00	0.000	0.447
25	2.95	0.455	0.93	0.00	0.000	0.455
26	2.88	0.463	0.92	0.00	0.000	0.463
27	2.82	0.471	0.90	0.00	0.000	0.471
28	2.76	0.478	0.89	0.00	0.000	0.478
29	2.70	0.485	0.87	0.00	0.000	0.485
30	2.65	0.492	0.86	0.00	0.000	0.492
31	2.60	0.498	0.85	0.00	0.000	0.498
32	2.55	0.505	0.84	0.00	0.000	0.505
33	2.51	0.511	0.83	0.00	0.000	0.511
34	2.46	0.517	0.82	0.00	0.000	0.517
35	2.42	0.523	0.81	0.00	0.000	0.523
36	2.38	0.529	0.80	0.00	0.000	0.529
37	2.34	0.534	0.79	0.00	0.000	0.534
38	2.30	0.540	0.79	0.00	0.000	0.540
39	2.26	0.545	0.78	0.00	0.000	0.545
40	2.23	0.550	0.77	0.00	0.000	0.550
41	2.19	0.555	0.76	0.00	0.000	0.555
42	2.16	0.560	0.76	0.00	0.000	0.560
43	2.13	0.565	0.75	0.00	0.000	0.565
44	2.09	0.570	0.75	0.00	0.000	0.570
45	2.06	0.574	0.74	0.00	0.000	0.574
46	2.04	0.579	0.74	0.00	0.000	0.579
47	2.01	0.583	0.73	0.00	0.000	0.583
48	1.98	0.588	0.73	0.00	0.000	0.588
49	1.95	0.592	0.72	0.00	0.000	0.592
50	1.93	0.596	0.72	0.00	0.000	0.596
51	1.90	0.600	0.71	0.00	0.000	0.600
52	1.88	0.604	0.71	0.00	0.000	0.604
53	1.86	0.608	0.70	0.00	0.000	0.608
54	1.83	0.612	0.70	0.00	0.000	0.612
55	1.81	0.616	0.70	0.00	0.000	0.616
56	1.79	0.619	0.69	0.00	0.000	0.619
57	1.77	0.623	0.69	0.00	0.000	0.623
58	1.75	0.627	0.69	0.00	0.000	0.627
59	1.73	0.630	0.68	0.00	0.000	0.630
60	1.71	0.634	0.68	0.00	0.000	0.634

Mod. FAA Minor Storage Volume (cubic ft.) = 27,596
Mod. FAA Minor Storage Volume (acre-ft.) = 0.6335

Determination of MAJOR Detention Volume Using Modified FAA Method

Design Information (Input):

Catchment Drainage Imperviousness	I_a =	45.00	percent
Catchment Drainage Area	A =	10.200	acres
Predevelopment NRCS Soil Group	Type =	C	A, B, C, or D
Return Period for Detention Control	T =	100	years (2, 5, 10, 25, 50, or 100)
Time of Concentration of Watershed	Tc =	21.71	minutes
Allowable Unit Release Rate	q =	0.00	cfs/acre
One-hour Precipitation	P_1 =	2.66	inches
Design Rainfall IDF Formula $i = C_1 * P_1/(C_2+T_c)^{C_3}$			
Coefficient One	C_1 =	28.50	
Coefficient Two	C_2 =	10	
Coefficient Three	C_3 =	0.786	

Determination of Average Outflow from the Basin (Calculated):

Runoff Coefficient	C =	0.59	
Inflow Peak Runoff	Qp-in =	30.1	cfs
Allowable Peak Outflow Rate	Qp-out =	**0.00**	cfs
Mod. FAA Major Storage Volume =		58,242	**cubic feet**
Mod. FAA Major Storage Volume =		**1.337**	**acre-ft**

Rainfall Duration minutes (input)	Rainfall Intensity inches / hr (output)	Inflow Volume acre-feet (output)	Adjustment Factor "m" (output)	Average Outflow cfs (output)	Outflow Volume acre-feet (output)	Storage Volume acre-feet (output)
0	0.00	0.000	0.00	0.00	0.000	0.000
1	11.51	0.095	1.00	0.00	0.000	0.095
2	10.75	0.178	1.00	0.00	0.000	0.178
3	10.10	0.251	1.00	0.00	0.000	0.251
4	9.53	0.316	1.00	0.00	0.000	0.316
5	9.02	0.374	1.00	0.00	0.000	0.374
6	8.58	0.427	1.00	0.00	0.000	0.427
7	8.18	0.474	1.00	0.00	0.000	0.474
8	7.82	0.518	1.00	0.00	0.000	0.518
9	7.49	0.559	1.00	0.00	0.000	0.559
10	7.20	0.597	1.00	0.00	0.000	0.597
11	6.93	0.631	1.00	0.00	0.000	0.631
12	6.68	0.664	1.00	0.00	0.000	0.664
13	6.45	0.695	1.00	0.00	0.000	0.695
14	6.24	0.724	1.00	0.00	0.000	0.724
15	6.04	0.751	1.00	0.00	0.000	0.751
16	5.86	0.777	1.00	0.00	0.000	0.777
17	5.68	0.801	1.00	0.00	0.000	0.801
18	5.52	0.824	1.00	0.00	0.000	0.824
19	5.37	0.846	1.00	0.00	0.000	0.846
20	5.23	0.867	1.00	0.00	0.000	0.867
21	5.10	0.888	1.00	0.00	0.000	0.888
22	4.97	0.907	0.99	0.00	0.000	0.907
23	4.85	0.926	0.97	0.00	0.000	0.926
24	4.74	0.943	0.95	0.00	0.000	0.943
25	4.64	0.961	0.93	0.00	0.000	0.961
26	4.53	0.977	0.92	0.00	0.000	0.977
27	4.44	0.993	0.90	0.00	0.000	0.993
28	4.35	1.009	0.89	0.00	0.000	1.009
29	4.26	1.023	0.87	0.00	0.000	1.023
30	4.17	1.038	0.86	0.00	0.000	1.038
31	4.09	1.052	0.85	0.00	0.000	1.052
32	4.02	1.065	0.84	0.00	0.000	1.065
33	3.94	1.079	0.83	0.00	0.000	1.079
34	3.87	1.091	0.82	0.00	0.000	1.091
35	3.80	1.104	0.81	0.00	0.000	1.104
36	3.74	1.116	0.80	0.00	0.000	1.116
37	3.68	1.128	0.79	0.00	0.000	1.128
38	3.62	1.139	0.79	0.00	0.000	1.139
39	3.56	1.150	0.78	0.00	0.000	1.150
40	3.50	1.161	0.77	0.00	0.000	1.161
41	3.45	1.172	0.76	0.00	0.000	1.172
42	3.40	1.182	0.76	0.00	0.000	1.182
43	3.35	1.192	0.75	0.00	0.000	1.192
44	3.30	1.202	0.75	0.00	0.000	1.202
45	3.25	1.212	0.74	0.00	0.000	1.212
46	3.20	1.222	0.74	0.00	0.000	1.222
47	3.16	1.231	0.73	0.00	0.000	1.231
48	3.12	1.240	0.73	0.00	0.000	1.240
49	3.07	1.249	0.72	0.00	0.000	1.249
50	3.03	1.258	0.72	0.00	0.000	1.258
51	3.00	1.266	0.71	0.00	0.000	1.266
52	2.96	1.275	0.71	0.00	0.000	1.275
53	2.92	1.283	0.70	0.00	0.000	1.283
54	2.88	1.291	0.70	0.00	0.000	1.291
55	2.85	1.299	0.70	0.00	0.000	1.299
56	2.82	1.307	0.69	0.00	0.000	1.307
57	2.78	1.315	0.69	0.00	0.000	1.315
58	2.75	1.322	0.69	0.00	0.000	1.322
59	2.72	1.330	0.68	0.00	0.000	1.330
60	2.69	1.337	0.68	0.00	0.000	1.337

Mod. FAA Major Storage Volume (cubic ft.) = 58,242
Mod. FAA Major Storage Volume (acre-ft.) = 1.3370

UDFCD DETENTION BASIN VOLUME ESTIMATING WORKBOOK Version 2.34, Released November 2013

CE DRILLING PHASE SPILLWAY CALCULATIONS - BCW

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	30.80 cfs
Crest Elevation	2.66 ft
Tailwater Elevation	0.00 ft
Crest Surface Type	Gravel
Crest Breadth	0.01 ft
Crest Length	50.0 ft

Results	
Headwater Elevation	3.00 ft
Headwater Height Above Crest	0.34 ft
Tailwater Height Above Crest	-2.66 ft
Weir Coefficient	3.09 ft^(1/2)/s
Submergence Factor	1.000
Adjusted Weir Coefficient	3.09 ft^(1/2)/s
Flow Area	17.1 ft²
Velocity	1.80 ft/s
Wetted Perimeter	50.7 ft
Top Width	50.00 ft

This spillway calculation is based on a Broad Crested Weir equation. Merrick evaluated the flow capacity of this spillway by establishing spillway capacity based on both a Broad Crested Weir (BCW) calculation and a Rectangular Weir (REC) calculation, then used the lower of the two calculated flow rates as the basis for establishing the flow capacity of this weir.

CE DRILLING PHASE SPILLWAY CALCULATIONS - REC

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	30.80 cfs
Crest Elevation	2.65 ft
Tailwater Elevation	0.00 ft
Weir Coefficient	3.00 ft^(1/2)/s
Crest Length	50.0 ft
Number Of Contractions	0

Results	
Headwater Elevation	3.00 ft
Headwater Height Above Crest	0.35 ft
Tailwater Height Above Crest	-2.65 ft
Flow Area	17.4 ft²
Velocity	1.77 ft/s
Wetted Perimeter	50.7 ft
Top Width	50.00 ft

This spillway calculation is based on a Rectangular Weir equation. Merrick evaluated the flow capacity of this spillway by establishing spillway capacity based on both a Broad Crested Weir (BCW) calculation and a Rectangular Weir (REC) calculation, then used the lower of the two calculated flow rates as the basis for establishing the flow capacity of this weir.

CE PRODUCTION PHASE SPILLWAY CALCULATIONS - BCW

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	7.70 cfs
Crest Elevation	2.86 ft
Tailwater Elevation	0.00 ft
Crest Surface Type	Gravel
Crest Breadth	0.01 ft
Crest Length	50.0 ft

Results	
Headwater Elevation	3.00 ft
Headwater Height Above Crest	0.14 ft
Tailwater Height Above Crest	-2.86 ft
Weir Coefficient	3.09 ft^(1/2)/s
Submergence Factor	1.000
Adjusted Weir Coefficient	3.09 ft^(1/2)/s
Flow Area	6.8 ft²
Velocity	1.14 ft/s
Wetted Perimeter	50.3 ft
Top Width	50.00 ft

This spillway calculation is based on a Broad Crested Weir equation. Merrick evaluated the flow capacity of this spillway by establishing spillway capacity based on both a Broad Crested Weir (BCW) calculation and a Rectangular Weir (REC) calculation, then used the lower of the two calculated flow rates as the basis for establishing the flow capacity of this weir.

CE PRODUCTION PHASE SPILLWAY CALCULATIONS - REC

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	7.70 cfs
Crest Elevation	2.86 ft
Tailwater Elevation	0.00 ft
Weir Coefficient	3.00 ft^(1/2)/s
Crest Length	50.0 ft
Number Of Contractions	1

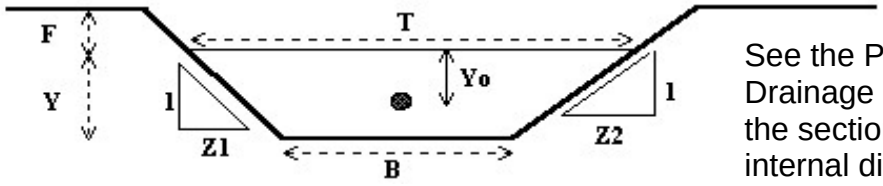
Results	
Headwater Elevation	3.00 ft
Headwater Height Above Crest	0.14 ft
Tailwater Height Above Crest	-2.86 ft
Flow Area	6.9 ft²
Velocity	1.11 ft/s
Wetted Perimeter	50.3 ft
Top Width	50.00 ft

This spillway calculation is based on a Rectangular Weir equation. Merrick evaluated the flow capacity of this spillway by establishing spillway capacity based on both a Broad Crested Weir (BCW) calculation and a Rectangular Weir (REC) calculation, then used the lower of the two calculated flow rates as the basis for establishing the flow capacity of this weir.

Normal Flow Analysis - Trapezoidal Channel

Project: MRG CE Production Phase - Internal Ditches

Channel ID:



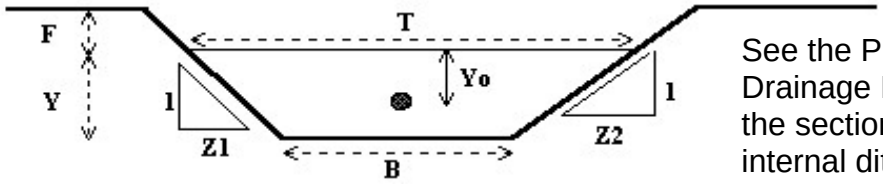
See the Production Phase Drainage Map on Sheet I.4 for the section location for this internal ditch calculation.

Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Manning's n	n =	0.032	
Bottom Width	B =	3.00	ft
Left Side Slope	Z1 =	2.00	ft/ft
Right Side Slope	Z2 =	2.00	ft/ft
Freeboard Height	F =	0.34	ft
Design Water Depth	Y =	**0.66**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**5.7**	cfs
Froude Number	**Fr =**	**0.50**	
Flow Velocity	**V =**	**2.01**	fps
Flow Area	A =	2.83	sq ft
Top Width	T =	5.63	ft
Wetted Perimeter	P =	5.94	ft
Hydraulic Radius	R =	0.48	ft
Hydraulic Depth	D =	0.50	ft
Specific Energy	Es =	0.72	ft
Centroid of Flow Area	Yo =	0.29	ft
Specific Force	Fs =	0.07	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**MRG CE - Drilling Phase**
Channel ID:	**Diversion Ditch**



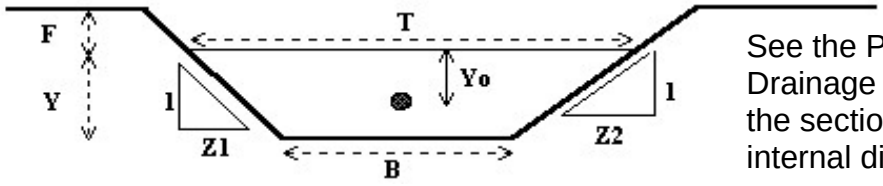
See the Production Phase Drainage Map on Sheet I.3 for the section location for this internal ditch calculation.

Design Information (Input)			
Channel Invert Slope	So =	0.0073	ft/ft
Manning's n	n =	0.032	
Bottom Width	B =	5.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.28**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**41.1**	cfs
Froude Number	**Fr =**	**0.67**	
Flow Velocity	**V =**	**3.62**	fps
Flow Area	A =	11.37	sq ft
Top Width	T =	12.70	ft
Wetted Perimeter	P =	13.12	ft
Hydraulic Radius	R =	0.87	ft
Hydraulic Depth	D =	0.89	ft
Specific Energy	Es =	1.49	ft
Centroid of Flow Area	Yo =	0.55	ft
Specific Force	Fs =	0.68	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**MRG CE - Drilling Phase**
Channel ID:	**Downstream Diversion Ditch**



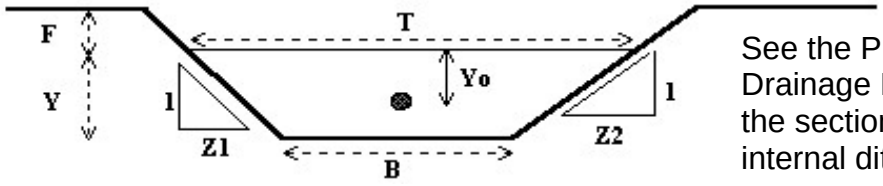
See the Production Phase Drainage Map on Sheet I.3 for the section location for this internal ditch calculation.

Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Manning's n	n =	0.032	
Bottom Width	B =	5.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.41**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**41.1**	cfs
Froude Number	**Fr =**	**0.56**	
Flow Velocity	**V =**	**3.15**	fps
Flow Area	A =	13.04	sq ft
Top Width	T =	13.47	ft
Wetted Perimeter	P =	13.93	ft
Hydraulic Radius	R =	0.94	ft
Hydraulic Depth	D =	0.97	ft
Specific Energy	Es =	1.57	ft
Centroid of Flow Area	Yo =	0.60	ft
Specific Force	Fs =	0.74	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**MRG CE - Production Phase**
Channel ID:	**Upstream Diversion Ditch**



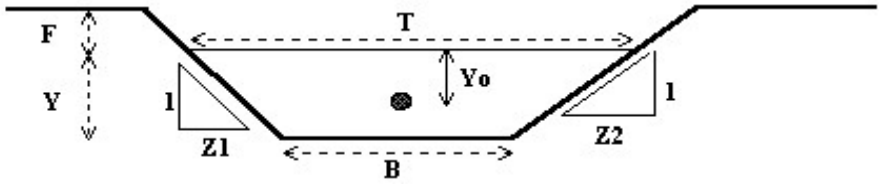
See the Production Phase Drainage Map on Sheet I.4 for the section location for this internal ditch calculation.

Design Information (Input)			
Channel Invert Slope	So =	0.0060	ft/ft
Manning's n	n =	0.032	
Bottom Width	B =	5.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.35**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**41.1**	cfs
Froude Number	**Fr =**	**0.61**	
Flow Velocity	**V =**	**3.37**	fps
Flow Area	A =	12.21	sq ft
Top Width	T =	13.09	ft
Wetted Perimeter	P =	13.53	ft
Hydraulic Radius	R =	0.90	ft
Hydraulic Depth	D =	0.93	ft
Specific Energy	Es =	1.53	ft
Centroid of Flow Area	Yo =	0.57	ft
Specific Force	Fs =	0.70	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**MRG CE - Production Phase**
Channel ID:	**Downstream Diversion Ditch**



Design Information (Input)			
Channel Invert Slope	So =	0.0050	ft/ft
Manning's n	n =	0.032	
Bottom Width	B =	5.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	1.00	ft
Design Water Depth	Y =	**1.41**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**41.0**	cfs
Froude Number	**Fr =**	**0.56**	
Flow Velocity	**V =**	**3.15**	fps
Flow Area	A =	13.01	sq ft
Top Width	T =	13.46	ft
Wetted Perimeter	P =	13.92	ft
Hydraulic Radius	R =	0.94	ft
Hydraulic Depth	D =	0.97	ft
Specific Energy	Es =	1.56	ft
Centroid of Flow Area	Yo =	0.60	ft
Specific Force	Fs =	0.73	kip

CE DRILLING PHASE LEVEL SPREADER CALCULATIONS - REC

Project Description	
Solve For	Headwater Elevation

Input Data	
Discharge	41.10 cfs
Crest Elevation	1.00 ft
Tailwater Elevation	0.00 ft
Weir Coefficient	3.00 ft^(1/2)/s
Crest Length	18.0 ft
Number Of Contractions	0

Results	
Headwater Elevation	1.83 ft
Headwater Height Above Crest	0.83 ft
Tailwater Height Above Crest	-1.00 ft
Flow Area	15.0 ft²
Velocity	2.74 ft/s
Wetted Perimeter	19.7 ft
Top Width	18.00 ft

Sheet G.13

CE PRODUCTION PHASE LEVEL SPREADER CALCULATION - REC

Project Description	
Solve For	Headwater Elevation

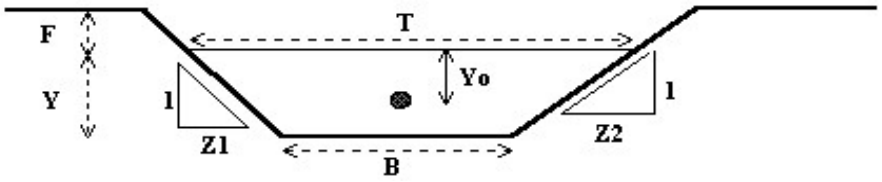
Input Data	
Discharge	41.10 cfs
Crest Elevation	1.00 ft
Tailwater Elevation	0.00 ft
Weir Coefficient	3.00 ft^(1/2)/s
Crest Length	105.0 ft
Number Of Contractions	0

Results	
Headwater Elevation	1.26 ft
Headwater Height Above Crest	0.26 ft
Tailwater Height Above Crest	-1.00 ft
Flow Area	27.0 ft²
Velocity	1.52 ft/s
Wetted Perimeter	105.5 ft
Top Width	105.00 ft

Sheet G.14

Design of Riprap Channel Cross Section

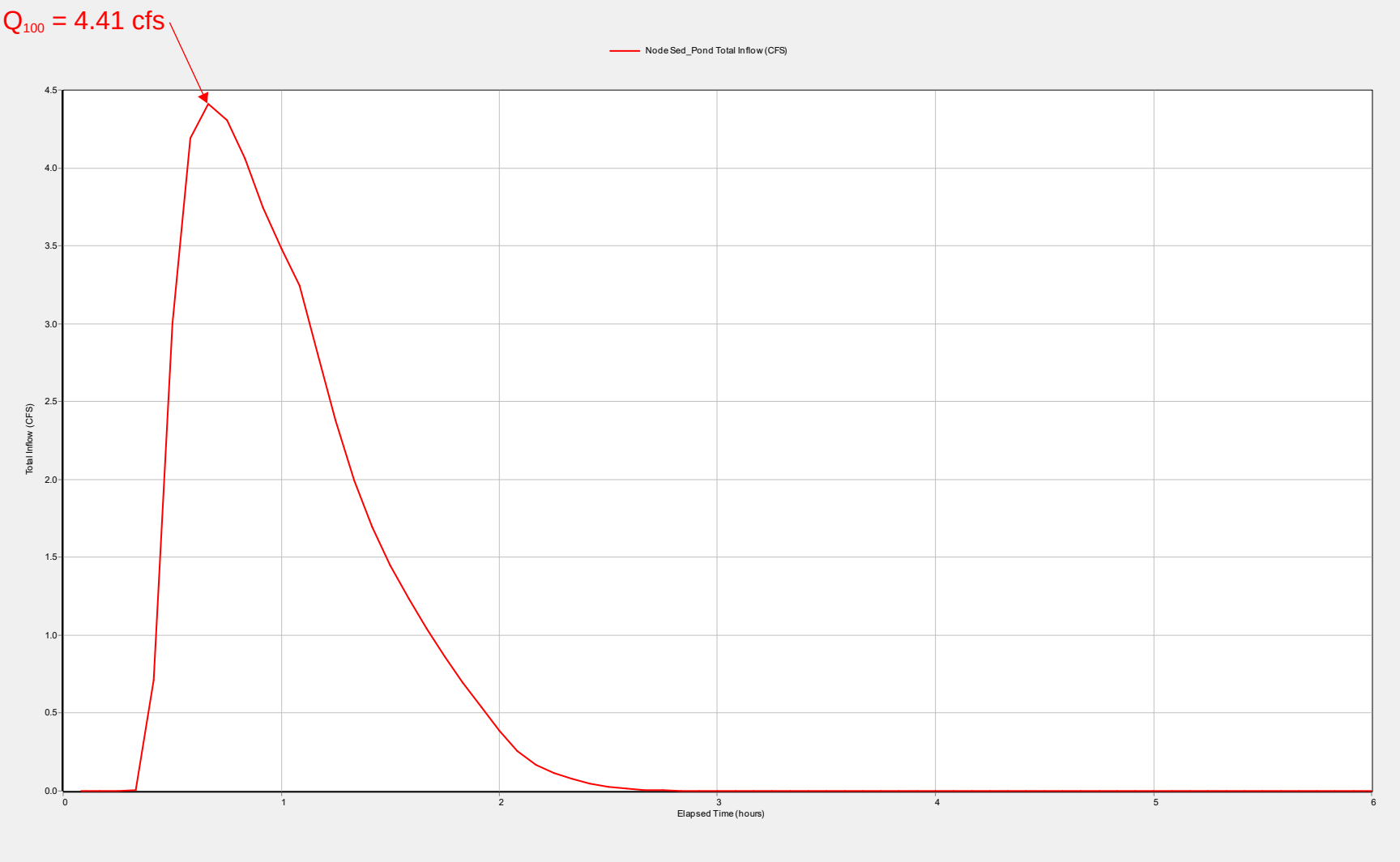
Project: MRG CE
Channel ID: Stilling Basin Riprap Sizing



Design Information (Input)			
Channel Invert Slope	So =	0.0073	ft/ft
Bottom Width	B =	5.0	ft
Left Side Slope	Z1 =	3.0	ft/ft
Right Side Slope	Z2 =	3.0	ft/ft
Specific Gravity of Rock	Ss =	2.65	
Radius of Channel Centerline	Ccr =	0.0	ft
Design Disharge	**Q =**	**41.1**	**cfs**
Flow Condition (Calculated)			
Riprap Type (Straight Channel)	**Type =**	**L**	
Intermediate Rock Diameter (Straight Channel)	**D50 =**	**9**	**inches**
Calculated Manning's n (Straight Channel)	**n =**	**0.0377**	
Riprap Type (Outside Bend of Curved Channel)	**Type =**		
Intermediate Rock Dia. (O.B. of Curved Channel)	**D50 =**		**inches**
Calculated Manning's N (Curved Channel)	**n =**		
Water Depth	Y =	1.40	ft
Top Width of Flow	T =	13.4	ft
Flow Area	A =	12.9	sq ft
Wetted Perimeter	P =	13.9	ft
Hydraulic Radius (A/P)	R =	0.9	ft
Average Flow Velocity (Q/A)	V =	3.2	fps
Hydraulic Depth (A/T)	D =	1.0	ft
Froude Number (max. = 0.8)	Fr =	0.58	
Channel Radius / Top Width	Ccr/T =	8.00	
Riprap Design Velocity Factor For Curved Channel	Kv =	1.00	
Riprap Sizing Velocity For Curved Channel	V_{Kv} =	3.2	fps
Riprap Sizing Paramenter for Straight Channel	**K =**	**1.00**	
Riprap Sizing Paramenter for Outside Bend of Curve	**K_{curve} =**	**1.00**	
*** Superelevation (dh)	dh =	0.02	ft
Discharge (Check)	**Q =**	**41.5**	**cfs**

Sheet G.15

SWMM 5 OUTPUT - PRODUCTION AREA HISTORIC PEAK FLOW



Sheet G.16

SWMM 5 OUTPUT - PRODUCTION AREA HISTORIC MAX VOLUME

Table - Node Sed_Pond

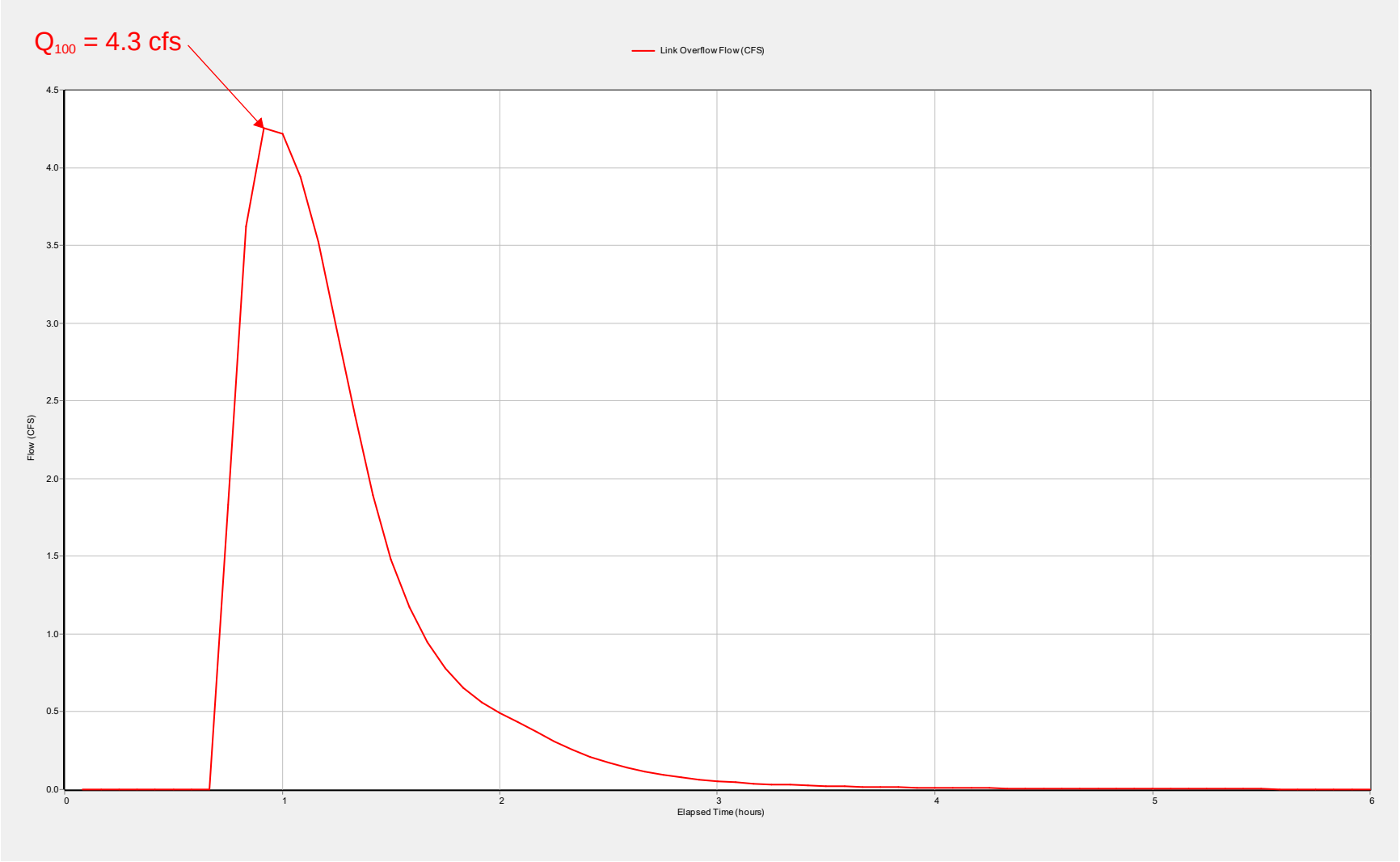
Days	Hours	Volume (ft3)	Total Inflow (CFS)
0	00:05:00	0.00	0.00
0	00:10:00	0.00	0.00
0	00:15:00	0.00	0.00
0	00:20:00	1.05	0.01
0	00:25:00	98.42	0.71
0	00:30:00	632.29	3.00
0	00:35:00	1729.48	4.19
0	00:40:00	3031.82	4.41
0	00:45:00	4342.75	4.31
0	00:50:00	5599.67	4.06
0	00:55:00	6772.13	3.75
0	01:00:00	7855.67	3.48
0	01:05:00	8863.99	3.24
0	01:10:00	9774.94	2.81
0	01:15:00	10553.18	2.38
0	01:20:00	11208.94	2.00
0	01:25:00	11761.33	1.69
0	01:30:00	12231.82	1.45
0	01:35:00	12633.49	1.23
0	01:40:00	12974.31	1.04
0	01:45:00	13259.43	0.86
0	01:50:00	13492.62	0.69
0	01:55:00	13677.19	0.54
0	02:00:00	13815.85	0.39
0	02:05:00	13911.88	0.25

Sheet G.17

Days	Hours	Volume (ft3)	Total Inflow (CFS)
0	02:10:00	13974.82	0.17
0	02:15:00	14017.27	0.12
0	02:20:00	14045.90	0.08
0	02:25:00	14064.56	0.05
0	02:30:00	14076.07	0.03
0	02:35:00	14082.51	0.01
0	02:40:00	14085.56	0.01
0	02:45:00	14086.89	0.00
0	02:50:00	14087.61	0.00
0	02:55:00	14088.05	0.00
0	03:00:00	14088.40	0.00
0	03:05:00	14088.66	0.00
0	03:10:00	14088.86	0.00
0	03:15:00	14088.99	0.00
0	03:20:00	14089.08	0.00
0	03:25:00	14089.13	0.00
0	03:30:00	14089.15	0.00
0	03:35:00	14089.16	0.00
0	03:40:00	14089.16	0.00
0	03:45:00	14089.16	0.00
0	03:50:00	14089.16	0.00
0	03:55:00	14089.16	0.00
0	04:00:00	14089.16	0.00
0	04:05:00	14089.16	0.00
0	04:10:00	14089.16	0.00
0	04:15:00	14089.16	0.00

Sheet G.18

SWMM 5 OUTPUT - PRODUCTION AREA POST-DEVELOPMENT PEAK FLOW



Sheet G.19

SWMM 5 OUTPUT - PRODUCTION AREA POST-DEVELOPMENT MAX VOLUME

Table - Node Sed_Pond

Days	Hours	Volume (ft3)
0	00:05:00	0.00
0	00:10:00	17.72
0	00:15:00	95.31
0	00:20:00	329.06
0	00:25:00	971.39
0	00:30:00	2429.40
0	00:35:00	4615.15
0	00:40:00	6833.52
0	00:45:00	8830.41
0	00:50:00	10569.31
0	00:55:00	12040.97
0	01:00:00	13286.16
0	01:05:00	14372.75
0	01:10:00	15282.73
0	01:15:00	15974.61
0	01:20:00	16479.09
0	01:25:00	16832.16
0	01:30:00	17091.79
0	01:35:00	17292.99
0	01:40:00	17455.82
0	01:45:00	17592.40
0	01:50:00	17711.15
0	01:55:00	17817.98
0	02:00:00	17918.69
0	02:05:00	18006.06

Sheet G.20

Days	Hours	Volume (ft3)
0	02:10:00	18068.18
0	02:15:00	18112.17
0	02:20:00	18142.76
0	02:25:00	18163.41
0	02:30:00	18177.13
0	02:35:00	18185.94
0	02:40:00	18190.94
0	02:45:00	18193.20
0	02:50:00	18193.81
0	02:55:00	18193.81
0	03:00:00	18193.81
0	03:05:00	18193.81
0	03:10:00	18193.81
0	03:15:00	18193.81
0	03:20:00	18193.81
0	03:25:00	18193.81
0	03:30:00	18193.81
0	03:35:00	18193.81
0	03:40:00	18193.81
0	03:45:00	18193.81
0	03:50:00	18193.81
0	03:55:00	18193.81
0	04:00:00	18193.81
0	04:05:00	18193.81
0	04:10:00	18193.81
0	04:15:00	18193.81

Sheet G.21

CE PAD - WATER QUALITY CAPTURE VOLUME CALCULATION

CE WQCV

α	1.0	
b	1.067	
i	0.45	
A	2.3	acre
WQCV	**0.2**	inches
V	**0.04**	ac-ft
V	**1718.9**	ft^3
V*1.1	**1891**	

Chapter 3, MHFD Volume 3 Uban Storm Drainage Critria Manual

$$WQCV = a(0.91I^3 - 1.19I^2 + 0.78I)$$

Chapter 3, City of Loveland Volume 3 City of Loveland Storm Drainage Criteria (Addendum to USDCM 1-3)

3.0 Calculation of the WQCV

Equation 3.1

Delete Equation 3-1

Add Equation 3-1:
WQCV=a ($0.91I^3$ -$1.19I^2$+0.78*I*) b
Where b = 1.067 (COL adjustment factor for the 0.64 inch, 80^{th} percentile of COL runoff producing storms)
And I =Imperviousness (percent expressed as a decimal).

Paragraph below Table 3-2:

Delete Sentence starting with "For areas beyond this region…"

Add For COL, use a precipitation depth of 0.64 inches for the WQCV event.

Appendix H Geotechnical Report Excerpts

PRELIMINARY GEOTECHNICAL SUBSURFACE EXPLORATION REPORT
KINSTON RESIDENTIAL COMMUNITY AT CENTERRA – EASTERN PARCELS
LOVELAND, COLORADO
SOILOGIC # 20-1019
March 3, 2020

March 3, 2020

McWhinney
2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538

Attn: Mr. Jeff Breidenbach

Re: Preliminary Geotechnical Subsurface Exploration Report
Kinston Residential Community at Centerra – Eastern Parcels
Loveland, Colorado
Soilogic Project # 20-1019

Mr. Breidenbach:

Soilogic, Inc. (Soilogic) personnel have completed the preliminary geotechnical subsurface exploration you requested for the eastern parcels of the proposed Kinston Residential Community at Centerra development to be constructed in Loveland, Colorado. The results of our preliminary exploration are included with this report.

The subsurface materials encountered in the completed test borings typically consisted of a thin mantle of vegetation and topsoil underlain by dark to light brown/beige/rust lean clay with varying amounts of sand. The lean clay varied from medium stiff to hard in terms of consistency and typically exhibited no to low swell potential at in-situ moisture and density conditions (although eight samples of lean clay obtained from borings generally on the western portion of these parcels at depths of approximately 2, 4 and 9 feet below ground surface exhibited moderate to high swell potential) and extended to the bottom of borings B-5 through B-12, B-15, B-17, B-21 and B-22 at a depth of approximately 15 feet below present site grades. In general, most of the expansive lean clay soils generally appear to be present within the upper 6-8 feet of ground surface. At the locations of all remaining borings, the lean clay extended to depths between of about 7 to 14½ feet below ground surface, where it was underlain by gray/olive/beige/rust siltstone/sandstone or siltstone/ sandstone/claystone bedrock. The bedrock varied from medium hard to very hard in terms of hardness, exhibited low swell potential at in-situ moisture and density conditions and extended to the bottom of these borings at a depth of about 15 feet below ground surface.

Groundwater was not encountered in any of the borings to the depth explored (approximately 15 feet below ground surface) when checked immediately after completion of drilling. Groundwater was not encountered in the remainder of the completed site borings to the depths explored at that time. When checked between 16 and 17 days after drilling, all borings remained dry to the approximate depths explored at that time. Groundwater level information is recorded in the upper right-hand corner of the attached boring logs.

Based on the subsurface conditions encountered in the completed site borings, results of laboratory testing and type of construction proposed, we expect lightly-loaded residential structures could be constructed with conventional spread footing foundations and floor slabs bearing on lean clay, siltstone/sandstone/claystone bedrock and/or properly placed and compacted fill with no to low swell potential. If/where moderately to highly expansive near-surface lean clay soils are encountered at the time of site-specific subsurface explorations, overexcavation/backfill procedures could be considered to develop low volume change (LVC) potential foundation and floor slab support. Expansive lean clay soils appear to be present on the western portion of these parcels extending to depths on the order of approximately 6 to 8 feet below present site grade. Lean clay soils and interbedded bedrock exhibiting no to low swell potential were identified underlying the expansive soils in those areas outlined above and on the remaining portions of the site. Full-depth basement construction and extending garage and other upper-level footing foundations through any expansive near-surface lean clay to bear on lean clay soils or bedrock with no to low swell potential at greater depth could also be considered, however, overexcavation/backfill procedures would still be required beneath at-grade floor slabs in the affected areas.

Based on the results of completed laboratory testing, the site lean clay and thoroughly-processed siltstone/sandstone and siltstone/sandstone/claystone bedrock appear suitable for use as fill to develop structural areas of the site. The City of Loveland requires a minimum of 12 inches of subbase material meeting an R-20 classification or chemical stabilization of the upper 12 inches of pavement subgrade soils be completed for public roadways prior to surfacing in order to develop a suitable paving platform. In our opinion, chemical stabilization of the upper 12 inches of subgrade would be less susceptible to moisture-induced strength loss than removal and replacement with R-20 materials. A final

pavement exploration will be required for the development after the water and sanitary sewer utilities have been installed and the streets have been graded to approximate finish subgrade elevation in accordance with LCUASS (Loveland) standards. Preliminary pavement section design estimates are included with this report. Other preliminary opinions and recommendations concerning design criteria and construction details for the proposed site improvements are also included.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the enclosed information or if we can be of further service to you in any way, please do not hesitate to contact us.

Very Truly Yours,
Soilogic, Inc.

Darrel DiCarlo, P.E.
Senior Project Engineer

Reviewed by:

Wolf von Carlowitz, P.E.
Principal Engineer


JANUARY 2020
PROJECT #19-1280
BORING LOCATION DIAGRAM
SOILOGIC
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-10
B-11
B-12
B-13
B-14
B-15
B-16
B-17
B-18
B-19
B-20
B-21
B-22
B-23
B-24
NE
NW
SE
SW
N COUNTY ROAD 3
PROJECT SITE
11
12
N
NOT TO SCALE
KINSTON RESIDENTIAL COMMUNITY AT CENTERRA PRELIMINARY EXPLORATION
(EAST PARCELS)
LOVELAND, COLORADO

KINSTON AT CENTERRA EAST PARCELS PRELIMINARY EXPLORATION

NORTH COUNTY ROAD 3, LARIMER COUNTY (LOVELAND), COLORADO
Project # 20-1019
March 2020

LOG OF BORING B-16

Sheet	1/1	Drilling Rig:	CME 45	Water Depth Information	
Start Date	2/11/2020	Auger Type:	4" CFA	During Drilling	None
Finish Date	2/11/2020	Hammer Type:	Automatic	After Drilling	None
Surface Elev.	-	Field Personnel:	JL / BM	17 Days After Drilling	None

USCS	SOIL DESCRIPTION	Depth (ft)	Sampler	"N"	MC (%)	DD (pcf)	Estimated q_u (psf)	% Swell @ 500 psf	Swell Pressure (psf)	Atterberg Limits LL	Atterberg Limits PI	% Passing # 200 Sieve (%)
	4 - 6" VEGETATION & TOPSOIL	-										
		1										
		-										
		2										
		-										
		3										
		-										
		4										
		-										
		5	**CS**	**17**	**9.9**	**107.3**	**9000+**	**1.5%**	-	-	-	-
		-										
CL	LEAN CLAY with varying amounts of SAND brown, light brown/beige, rust stiff	6										
		-										
		7										
		-										
		8										
		-										
		9										
		-										
		10	**CS**	**15**	**15.7**	**108.6**	**9000+**	-	-	-	-	-
		-										
		11										
		-										
		12										
		-										
		13										
		-										
		14										
		-										
	SILTSTONE/SANDSTONE/CLAYSTONE	**15**	**CS**	**36**	**15.8**	**115.6**	**9000+**	-	-	-	-	-
	BOTTOM OF BORING @ 15.0'	-										
		16										
		-										
		17										
		-										
		18										
		-										
		19										
		-										
		20										
		-										
		21										
		-										
		22										
		-										
		23										
		-										
		24										
		-										
		25										

Appendix I Drainage Map and Proposed Plans

SECTION LINE

1/4 SECTION LINE

50' EXISTING MAGELLAN ESMT

5020

5010

5000

4990

4980

4970

E – 1
32.1 | 0.05 | 0.49

BASIN E-1 TIME OF CONCENTRATION PATH
L = 2,826 FT
t = 62.9 MIN

4980
4980
4980
4990
4990
4980
4980
4980
4980
4980

DRILLING PHASE WORKING PAD SURFACE

D – 1
10.2 | 0.4 | 0.67

PROPERTY LINE

BASIN E-1 DESIGN POINT

SECTION LINE

14' UTILITY EASEMENT
80' WAPA EASEMENT

COUNTY ROAD 3

1/4 SECTION LINE

N

150' 0 75' 150' 300'
1" = 150' HOR.

A
B | C
D

DRAINAGE BASIN
A: BASIN ID
B: BASIN ACREAGE
C: MINOR EVENT RUNOFF COEFFICIENT C5
D: MAJOR EVENT RUNOFF COEFFICIENT C100

LEGEND:

- DRAINAGE BASIN BOUNDARY
- 5555 PROPOSED MAJOR CONTOUR
- 5555 PROPOSED MINOR CONTOUR
- 5555 EXISTING MAJOR CONTOUR
- 5555 EXISTING MINOR CONTOUR
- PROPERTY LINE
- TIME OF CONCENTRATION PATH
- SURFACE FLOW DIRECTION ARROW (EXISTING CONDITIONS)

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
A	ISSUED FOR REVIEW	9/1/2022	TVG	SWC	TS

CALL BEFORE YOU DIG
811
Know what's below. Call before you dig.

CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

MERRICK®
Engineering | Architecture | Design-Build | Surveying | Planning | Geospatial Solutions
5970 GREENWOOD PLAZA BLVD, GREENWOOD VILLAGE, CO. 80111
303-751-0741
www.merrick.com

PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

TITLE
MRG, LP OIL AND GAS CE PAD
CITY OF LOVELAND, COLORADO
CE DRAINAGE MAP
UPGRADIENT SUBBASIN

JOB NUMBER 65120236-10
DATE 9/1/2022
SHEET I.2
1 of 4

A
B | C
D

DRAINAGE BASIN
A: BASIN ID
B: BASIN ACREAGE
C: MINOR EVENT RUNOFF COEFFICIENT C5
D: MAJOR EVENT RUNOFF COEFFICIENT C100

LEGEND:

- DRAINAGE BASIN BOUNDARY
- 5555 PROPOSED MAJOR CONTOUR
- 5555 PROPOSED MINOR CONTOUR
- 5555 EXISTING MAJOR CONTOUR
- 5555 EXISTING MINOR CONTOUR
- PROPERTY LINE
- TIME OF CONCENTRATION PATH
- SURFACE FLOW DIRECTION ARROW (PROPOSED CONDITIONS)
- SURFACE FLOW DIRECTION ARROW (EXISTING CONDITIONS)

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
A	ISSUED FOR REVIEW	9/1/2022	TVG	SWC	TS

CALL BEFORE YOU DIG
811
Know what's below. Call before you dig.

CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

MERRICK®
Engineering | Architecture | Design-Build | Surveying | Planning | Geospatial Solutions
5970 GREENWOOD PLAZA BLVD, GREENWOOD VILLAGE, CO. 80111
303-751-0741
www.merrick.com

PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

TITLE
MRG, LP OIL AND GAS CE PAD
CITY OF LOVELAND, COLORADO
CE DRAINAGE MAP
DRILLING PHASE

JOB NUMBER 65120236-10
DATE 9/1/2022
SHEET I.3
2 of 4

File Location:O:\DEN\Projects\0178-00 CMD Centennial Projects\0236-08 MRG Misc Oil and Gas\Design\CDs\Civil\DRI\023608- DRILLING PHASE DRAINAGE PLAN RevA.dwg Plot Date:9/1/2022 12:24 PM Last Saved By: TSCARLETT

BASIN P-3 TIME OF CONCENTRATION PATH
L = 1,500FT
t = 31.8 MIN

SECTION LOCATION FOR UPSTREAM DITCH CAPACITY CALCULATION SHOWN ON SHEET G.11

DIVERSION DITCH

7.52 AC

ACCESS ROAD

SECTION LINE

BASIN PE-1 TIME OF CONCENTRATION PATH
L = 492FT
t = 33.8 MIN

80' WAPA EASEMENT

14' UTILITY EASEMENT

INTERNAL SERVICE ROAD

SECTION LOCATION FOR DOWNSTREAM DITCH CAPACITY CALCULATION SHOWN ON SHEET G.12

PRODUCTION PHASE WORKING PAD SURFACE

INTERNAL DITCH

SECTION LOCATION FOR DITCH CAPACITY CALCULATION SHOWN ON SHEET G.8

BASIN P-1 TIME OF CONCENTRATION PATH
L = 512FT
t = 21.7 MIN

COUNTY ROAD 3

INTERNAL DITCH

EXISTING 23' GRAVEL ROAD

SEDIMENT BASIN AREA

50' ROW WEST OF SECTION LINE

VISUAL MITIGATION BERMS

INTERNAL SERVICE ROAD

EMERGENCY SPILLWAY

¼ SECTION LINE

STILLING BASIN AND LEVEL SPREADER LOCATION (SEE DETAILS ON SHEET I.5)

SUBBASIN P-2 DESIGN POINT

SUBBASIN PE-1 AND P-1 DESIGN POINT

SUBBASIN P-3 DESIGN POINT

P-2 | 1.99 | 0.24 | 0.59

P-3 | 7.5 | 0.40 | 0.67

PE-1 | 2.3 | 0.05 | 0.49

P-1 | 2.3 | 0.4 | 0.67

N

60' 0 30' 60' 120'

1" = 60' HOR.

A
B | C
D

DRAINAGE BASIN
A: BASIN ID
B: BASIN ACREAGE
C: MINOR EVENT RUNOFF COEFFICIENT C5
D: MAJOR EVENT RUNOFF COEFFICIENT C100

LEGEND:

- DRAINAGE BASIN BOUNDARY
- 5555 PROPOSED MAJOR CONTOUR
- 5555 PROPOSED MINOR CONTOUR
- 5555 EXISTING MAJOR CONTOUR
- 5555 EXISTING MINOR CONTOUR
- PROPERTY LINE
- TIME OF CONCENTRATION PATH
- SUBBASIN P-2
- SURFACE FLOW DIRECTION ARROW (PROPOSED CONDITIONS)
- SURFACE FLOW DIRECTION ARROW (EXISTING CONDITIONS)

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
A	ISSUED FOR REVIEW	9/1/2022	TVG	SWC	TS

CALL BEFORE YOU DIG
811
Know what's below. Call before you dig.

CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

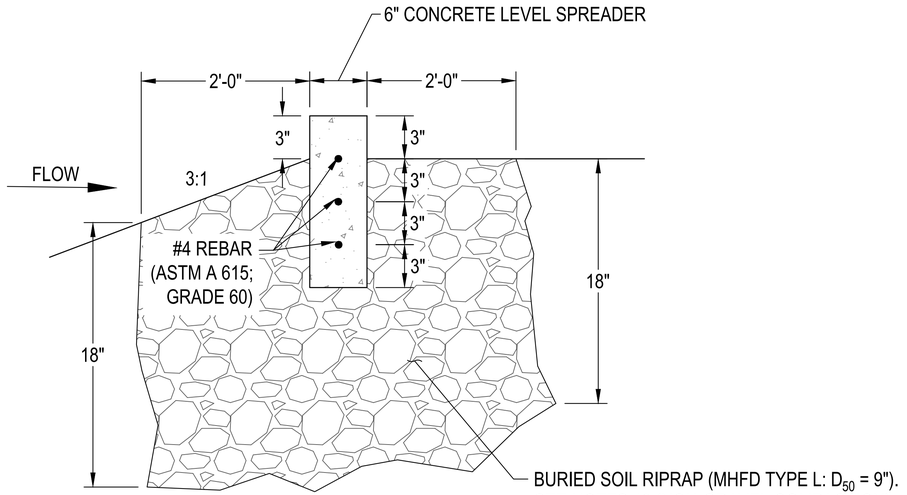
MERRICK®
Engineering | Architecture | Design-Build | Surveying | Planning | Geospatial Solutions
5970 GREENWOOD PLAZA BLVD, GREENWOOD VILLAGE, CO, 80111
303-751-0741
www.merrick.com

PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

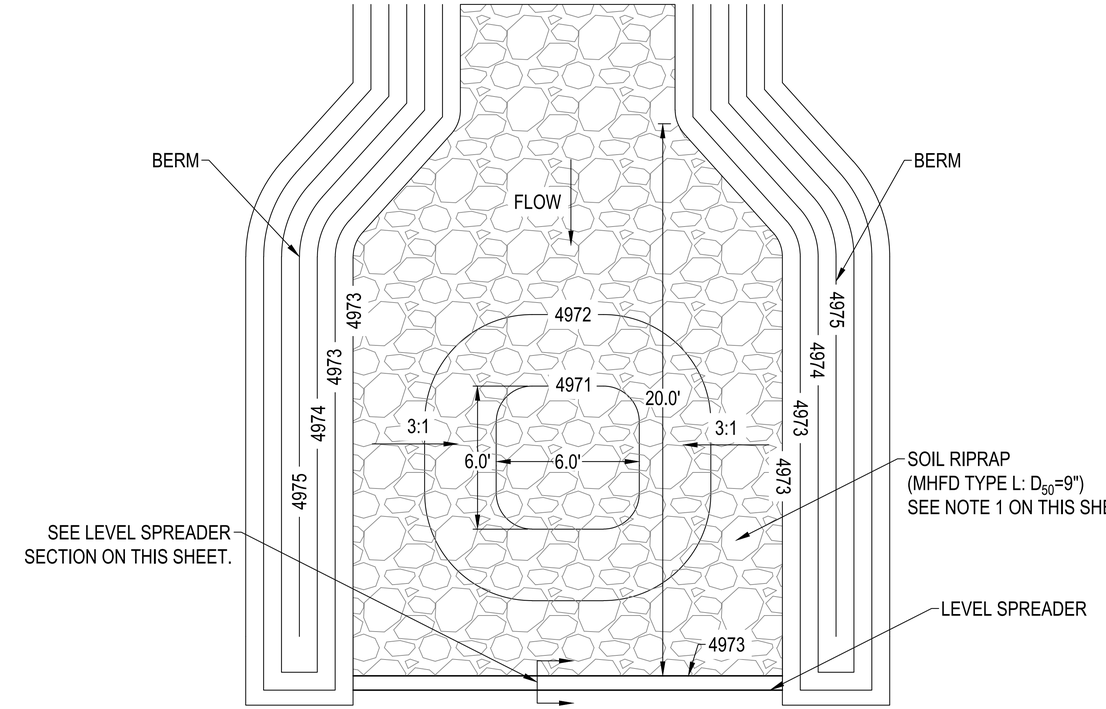
TITLE

MRG, LP OIL AND GAS CE PAD
CITY OF LOVELAND, COLORADO
CE DRAINAGE MAP
PRODUCTION PHASE

JOB NUMBER 65120236-10
DATE 9/1/2022
SHEET I.4
3 of 4



CONCRETE LEVEL SPREADER SECTION



STILLING BASIN AND LEVEL SPREADER DETAIL - PLAN VIEW

NOTES

1. REFERENCE MILE HIGH FLOOD DISTRICT "DIVISION 31 EARTHWORK - RIPRAP, BOULDERS, AND BEDDING" CONSTRUCTION SPECIFICATION (SECTION 31 37 00) FOR SOIL RIPRAP EXECUTION AND PLACEMENT. RIPRAP LAYER TO HAVE 18" THICKNESS. TOP OF RIPRAP TO HAVE 4" OF TOPSOIL COVER.

REV	REVISION DESCRIPTION	DATE	CHND	CHKD	APPR
A	ISSUED FOR REVIEW	9/1/2022	TVG	SWC	TS

CALL BEFORE YOU DIG
811
Know what's below.
Call before you dig.

CITY APPROVAL
ACCEPTED BY: _____
CITY ENGINEER (or Designee) DATE

MERRICK®
Engineering | Architecture | Design-Build | Surveying | Planning | Geospatial Solutions
5970 GREENWOOD PLAZA BLVD, GREENWOOD VILLAGE, CO, 80111
303-751-0741
www.merrick.com

PE STAMP
ISSUED FOR REVIEW
FOR AND ON BEHALF OF MERRICK & COMPANY

TITLE
MRG, LP OIL AND GAS CE PAD
CITY OF LOVELAND, COLORADO
CE DETAIL SHEET

JOB NUMBER 65120236-10
DATE 9/1/2022
SHEET I.5
4 of 4

Appendix J Excerpts from the Amendment to the East I-25 Drainage Master Plan

Amendment to the
East I-25 Basin Drainage Master Plan

May 2020

Prepared For:

City of Loveland & Kinston Metropolitan District

Prepared By:

Tyler Scarlett
Clare Harris

Reviewed By:

Gloria Lee, PE

Merrick Job No. 65120213A

5970 Greenwood Plaza Blvd
Greenwood Village, CO 80111
Phone: (303) 751-0741
Fax: (303) 752-4451

Basin 30 is 112.4 acres in size and is located just north of the Union Pacific Railroad and east of Basins 11 and 12. The future land use is proposed to be single family residential. Given the land use being a less dense residential area of the property, an imperviousness of 60% has been assumed.

Drainage from Basin 30 will be directed south into proposed Local Detention Pond 3. The peak 100-year flow from Basin 30 is estimated to be 433 cfs.

Basin 31 is 33.4 acres in size and is located north of Basin 30. The projected future land use is single family residential with an assumed imperviousness of 60%.

Drainage from Basin 31 will be routed south via storm sewer through Basin 30 and into proposed Local Detention Pond 3. The 100-year peak flow from Basin 31 is estimated to be 117 cfs.

Basin 40 is 63.3 acres in size and is located east of basin 30 along the southeastern border of the Kinston development. The projected future land use is single family residential with an assumed imperviousness of 60%.

Drainage from Basin 40 will be directed southeast into proposed Local Detention Pond 4. The peak 100-year flow from Basin 40 is estimated to be 172 cfs.

Basin 41 is 56.5 acres in size and is located north of Basin 40 and west of County Road 3. The future land use of Basin 41 is single family residential with an assumed imperviousness of 60%.

Drainage from Basin 41 will be directed via storm sewer through a portion of basin 40 and into proposed Local Detention Pond 4. The peak 100-year flow from this basin is estimated to be 182 cfs.

state required drain time of 120 hours was deemed acceptable based off the requirements set forth by the GLIC.

The proposed outfall for Local Detention Pond 3 would be storm sewer constructed parallel to the Union Pacific Railroad through the neighboring property to the south of the Kinston development. This outfall storm sewer will be a challenge because there are potentially many utility conflicts in this area of the Kinston planned development.

(4) Tributary to Local Detention Pond 4

The proposed basins tributary to Local Detention Pond 4 are shown in the table below:

Table 6.6 – Proposed Basins Tributary to Pond 4

Proposed Basins Tributary to Pond 4 - Proposed CUHP Model Output			
Basin	Basin Area (AC)	Imperviousness (%)	100-YR Peak Flow (CFS)
40	63.3	60	172
41	56.5	60	182
42	100.4	60	338
43	8.7	60	39

The required volume for Local Detention Pond 4 in a 100-year storm event is 40.6 ac-ft. The maximum inflow is 714.3 cfs. The required volume for this pond is based on the maximum release rate of 9.16 cfs calculated from the release rate of 0.04 cfs per acre set by the GLIC as the downstream receiving water. The pond will have very long (greater than 120 hours) drain time based on the low release rates allowed by the GLIC. From conversations with the City of Loveland Stormwater Department, not meeting the state required drain time of 120 hours was deemed acceptable based off the requirements set forth by the GLIC.

The proposed outfall for Local Detention Pond 4 is into the GLIC, the preferred method of conveying the stormwater to the GLIC would be within the right-of-way of County Road 3.

PROJECT: AMENDMENT TO EAST I-25 BASIN DRAINAGE MASTER PLAN

PROJECT NO. 65120213

Developed Composite C-Factor and Impervious Analysis

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
12	Single Family Residential	9.2	65				
	Total Area	**9.2**	**65**	**0.51**	**0.57**	**0.61**	**0.75**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
20	Single Family Residential	5.0	65				
	Total Area	**5.0**	**65**	**0.51**	**0.57**	**0.61**	**0.75**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
30	Single Family Residential	112.4	60				
	Total Area	**112.4**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
31	Single Family Residential	33.4	60				
	Total Area	**33.4**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
40	Single Family Residential	63.3	60				
	Total Area	**63.3**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

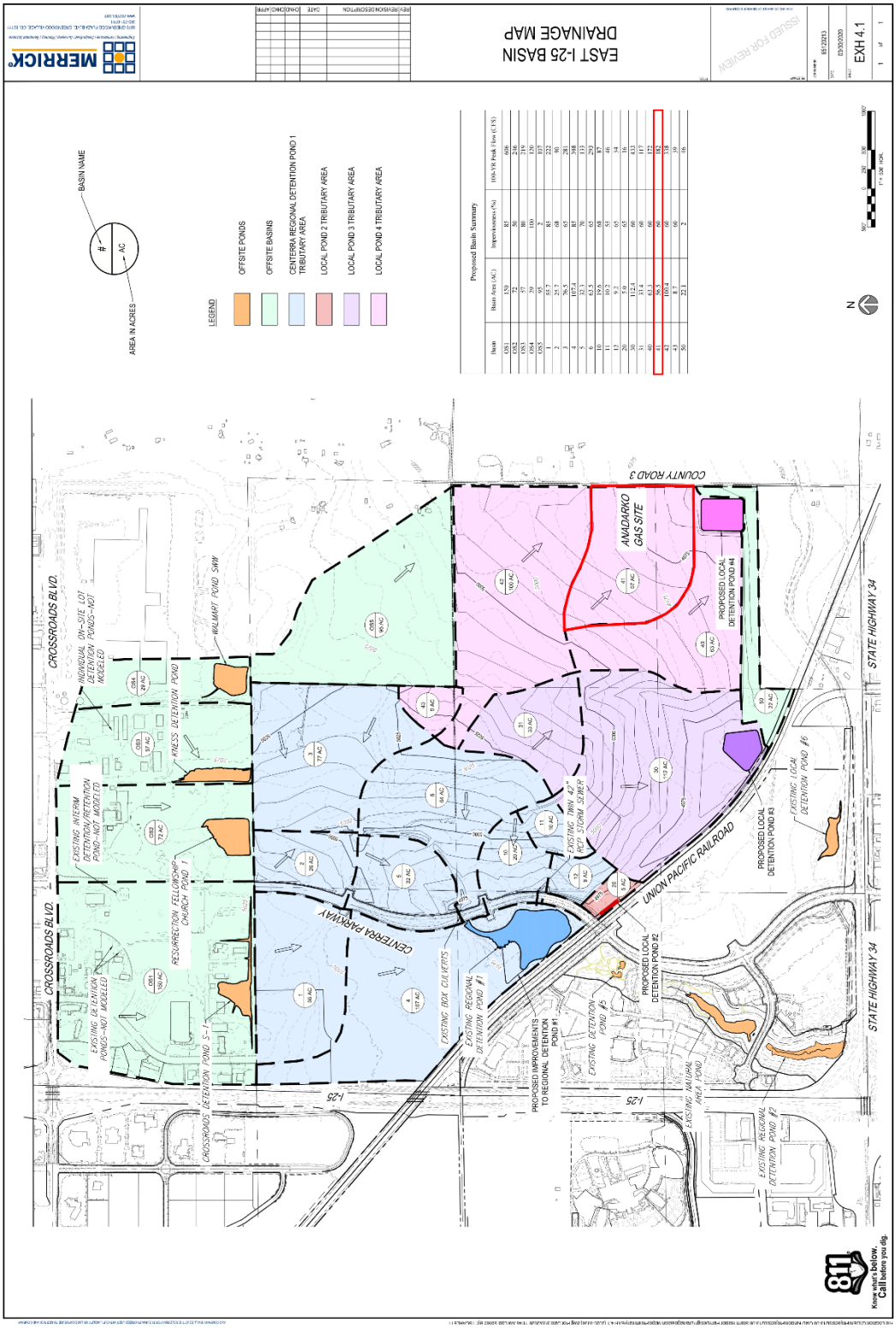
Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
41	Single Family Residential	56.5	60				
	Total Area	**56.5**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
42	Single Family Residential	100.4	60				
	Total Area	**100.4**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

Basin	Land Use	Area (acres)	I (%)	C2	C5	C10	C100
43	Single Family Residential	8.7	60				
	Total Area	**8.7**	**60**	**0.47**	**0.53**	**0.58**	**0.73**

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
OS1	OS1	RG2	0.234	0.279	0.672	0.011	85.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.95	0.35	84.53
OS2	OS2	RG2	0.113	0.137	0.431	0.012	50.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.85	0.23	49.10
OS3	OS3	RG2	0.089	0.227	0.445	0.017	80.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.94	0.33	79.44
OS4	OS4	RG2	0.045	0.114	0.369	0.011	100.0	0.50	0.15	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS5	OS5	RG2	0.148	0.350	0.720	0.011	2.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.04	0.02	1.80
1	1	RG2	0.087	0.170	0.417	0.010	85.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.95	0.35	84.53
2	2	RG2	0.040	0.147	0.265	0.013	68.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.92	0.29	67.30
3	3	RG2	0.120	0.213	0.417	0.012	65.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.91	0.29	64.27
4	4	RG2	0.168	0.284	0.720	0.012	85.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.95	0.35	84.53
5	5	RG2	0.050	0.123	0.237	0.015	70.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.92	0.30	69.31
6	6	RG2	0.099	0.152	0.303	0.026	65.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.91	0.29	64.27
10	10	RG2	0.031	0.095	0.208	0.032	68.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.92	0.29	67.30
11	11	RG2	0.016	0.057	0.114	0.040	55.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.88	0.25	54.15
12	12	RG2	0.014	0.066	0.161	0.018	65.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.91	0.29	64.27
20	20	RG2	0.008	0.057	0.114	0.008	65.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.91	0.29	64.27
30	30	RG2	0.176	0.208	0.492	0.018	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
31	31	RG2	0.052	0.133	0.322	0.016	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
40	40	RG2	0.099	0.265	0.549	0.011	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
41	41	RG2	0.088	0.199	0.455	0.014	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
42	42	RG2	0.157	0.265	0.530	0.014	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
43	43	RG2	0.014	0.053	0.104	0.022	60.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.90	0.27	59.24
50	50	RG2	0.035	0.085	0.152	0.020	2.0	0.50	0.15	3.00	0.50	0.0018	0.00	0.04	0.02	1.80

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
OS1		0.076	0.323	14.6	5.10	7.6	3.41	8.5	482	544,500	2.51	1,369,359	35.0	606	1,360,074	4.04
OS2		0.089	0.202	15.3	3.87	8.0	2.74	6.5	221	261,360	2.09	547,526	35.0	246	545,227	3.42
OS3		0.077	0.216	14.9	3.96	7.7	2.80	6.6	180	206,910	2.45	507,877	35.0	219	505,106	3.84
OS4		0.073	0.165	13.4	3.19	6.9	2.25	5.3	102	105,270	2.70	284,018	30.0	120	276,723	4.12
OS5		0.156	0.198	56.3	10.07	29.3	7.12	16.8	79	344,850	1.54	529,391	55.0	107	529,225	1.12
1		0.076	0.216	14.1	3.84	7.3	2.71	6.4	185	202,191	2.51	508,488	35.0	222	504,811	3.98
2		0.081	0.144	15.6	3.23	8.1	2.28	5.4	77	93,291	2.31	215,532	35.0	90	212,990	3.51
3		0.082	0.232	14.9	4.15	7.7	2.93	6.9	241	277,695	2.27	631,584	35.0	281	629,032	3.68
4		0.076	0.290	16.4	5.16	8.5	3.65	8.6	306	389,862	2.51	980,461	35.0	398	975,529	3.70
5		0.080	0.161	11.7	2.94	6.1	2.08	4.9	130	117,249	2.33	273,695	30.0	133	265,439	4.12
6		0.082	0.213	9.9	3.12	5.1	2.21	5.2	301	230,505	2.27	524,256	30.0	293	513,339	4.62
10		0.081	0.128	10.4	2.52	5.4	1.78	4.2	89	71,148	2.31	164,374	30.0	87	156,787	4.42
11		0.086	0.088	8.9	2.10	4.6	1.48	3.5	54	37,026	2.15	79,777	30.0	46	73,483	4.56
12		0.082	0.089	12.8	2.38	6.7	1.68	4.0	34	33,396	2.27	75,955	30.0	34	72,045	3.67
20		0.082	0.068	16.1	2.34	8.3	1.65	3.9	15	18,150	2.27	41,280	35.0	16	39,593	3.26
30		0.084	0.268	13.0	4.18	6.8	2.95	7.0	404	408,012	2.21	903,584	35.0	433	894,754	3.85
31		0.084	0.155	15.1	3.30	7.9	2.33	5.5	104	121,242	2.21	268,503	35.0	117	265,249	3.49
40		0.084	0.207	22.2	5.02	11.5	3.55	8.4	134	229,779	2.21	508,869	40.0	172	506,725	2.71
41		0.084	0.196	17.6	4.16	9.2	2.94	6.9	150	205,095	2.21	454,204	35.0	182	451,623	3.22
42		0.084	0.254	16.7	4.77	8.7	3.37	7.9	281	364,452	2.21	807,116	35.0	338	802,439	3.36
43		0.084	0.085	9.6	2.12	5.0	1.50	3.5	43	31,581	2.21	69,939	30.0	39	64,822	4.43
50		0.156	0.103	22.6	3.28	11.7	2.32	5.5	46	80,223	1.54	123,153	35.0	46	121,692	2.07


EAST I-25 BASIN
DRAINAGE MAP
EXH 4.1
LEGEND
OFFSITE PONDS
OFFSITE BASINS
CENTERRA REGIONAL DETENTION POND 1 TRIBUTARY AREA
LOCAL POND 2 TRIBUTARY AREA
LOCAL POND 3 TRIBUTARY AREA
LOCAL POND 4 TRIBUTARY AREA
BASIN NAME
AREA IN ACRES
Proposed Basin Summary
CROSSROADS BLVD.
COUNTY ROAD 3
STATE HIGHWAY 34
I-25
UNION PACIFIC RAILROAD
CENTERRA PARKWAY
ANADARKO GAS SITE
WALMART POND SWM
KNESS DETENTION POND
RESURRECTION FELLOWSHIP CHURCH POND 1
CROSSROADS DETENTION POND S-1
EXISTING INTERIM DETENTION/RETENTION PONDS-NOT MODELED
EXISTING INDIVIDUAL ON-SITE LOT DETENTION PONDS-NOT MODELED
EXISTING 78MN 42" RCP STORM SEWER
EXISTING BOX CULVERTS
EXISTING REGIONAL DETENTION POND #1
PROPOSED IMPROVEMENTS TO REGIONAL DETENTION POND #1
EXISTING DETENTION POND #5
EXISTING NATURAL AREA POND
EXISTING REGIONAL DETENTION POND #2
PROPOSED LOCAL DETENTION POND #1
PROPOSED LOCAL DETENTION POND #2
PROPOSED LOCAL DETENTION POND #3
PROPOSED LOCAL DETENTION POND #4
EXISTING LOCAL DETENTION POND #6
Know what's below. Call before you dig.