Final Drainage Report
Rocky Top Resources
Tract 7 Valley Garden Subdivision
1755 East Las Vegas
El Paso County, Colorado

PCD File No. PPR 1913

Prepared for:
Rocky Top Resources
1755 East Las Vegas
Colorado Springs, Colorado 80903
719-579-9103

Prepared by:

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Kiowa Project No. 17066
February 28, 2020

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Engineer's Statement:

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

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

Richard N. Wray
Registered Engineer #19310
For and on Behalf of Kiowa Engineering Corporation

2/28/2020
Date

Developer's Statement:

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

BY: _____ 2-28-20
Date

FREDRICK D. MARTIN
Printed

ADDRESS: Rocky Top Resources Inc.
1755 East Las Vegas
Colorado Springs, Colorado 80903

El Paso County:

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

Jennifer Irvine, P.E.
County Engineer/ECM Administrator

Approved
By: Elizabeth Nijkamp
Date:06/23/2020
El Paso County Planning & Community Development

I. General Location and Description of Project

The Rocky Top Resources project is a site development involving a portion of Tract 7 of the Garden Subdivision located in El Paso County, Colorado. The property subject to site development covers approximately 22 acres of the total 44.81 acres. Site development activities as proposed will not require that a re-plat be prepared however a rezone of the property is required.

The proposed site improvements will include grading, stormwater detention basin, office building, parking lot(s), onsite individual wastewater system (septic and leach field), landscaping and access driveways. The site presently operates as a waste wood, lawn waste and concrete recycling center. Recycled materials are used to make mulch, fine soil mulch and concrete base course. Approximately 22 acres of the parcel are not used for the active recycling and sales operations.

The site is a 44.8 -acre commercial recycling center site located at 1755 East Las Vegas in El Paso County, Colorado. The site is located within a portion of Sections 28 and 29, Township 14 South, Range 66 West of the 6th Principal Meridian, in Colorado Springs, Colorado. The El Paso County Assessor parcel number is 64291-01-029, 030 and 031. The parcel is legally described as Tract 7 in the Valley Gardens Subdivision. The location of the site is shown on the Vicinity Map (Figure 1). The site is bordered by East Las Vegas Street on the northeast, US Highway 24 Bypass right-of-way on the northwest, Spring Creek on the southeast and Fountain Creek on the southwest.

There are no public streets that will be constructed as part of the development of the site. Access off Las Vegas Avenue has already been designed as part of the City's Spring Creek/Royer Road/Las Vegas Street Roadway Design. The access is shown on the site development plan. A private full spectrum detention (FSD), basin will be constructed and will be operated and maintained by the property owner and subject to a private detention basin maintenance agreement. An operations and maintenance manual will be prepared for the FSD.

II. Previous Reports and References

The following reports and plans were reviewed in the process of preparing this drainage report:

1) *Spring Creek Road/Las Vegas Street Roadway Design Plan,* prepared by Felsburg Holt and Ullevig, March 2018.
2) *City of Colorado Springs and El Paso County Flood Insurance Study* prepared by the Federal Emergency Management Agency, dated December 2018.
3) *City of Colorado Springs and El Paso County Drainage Criteria Manual,* most current versions, Volumes 1 and 2.
4) *Soil Survey of El Paso County Area, Colorado*, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

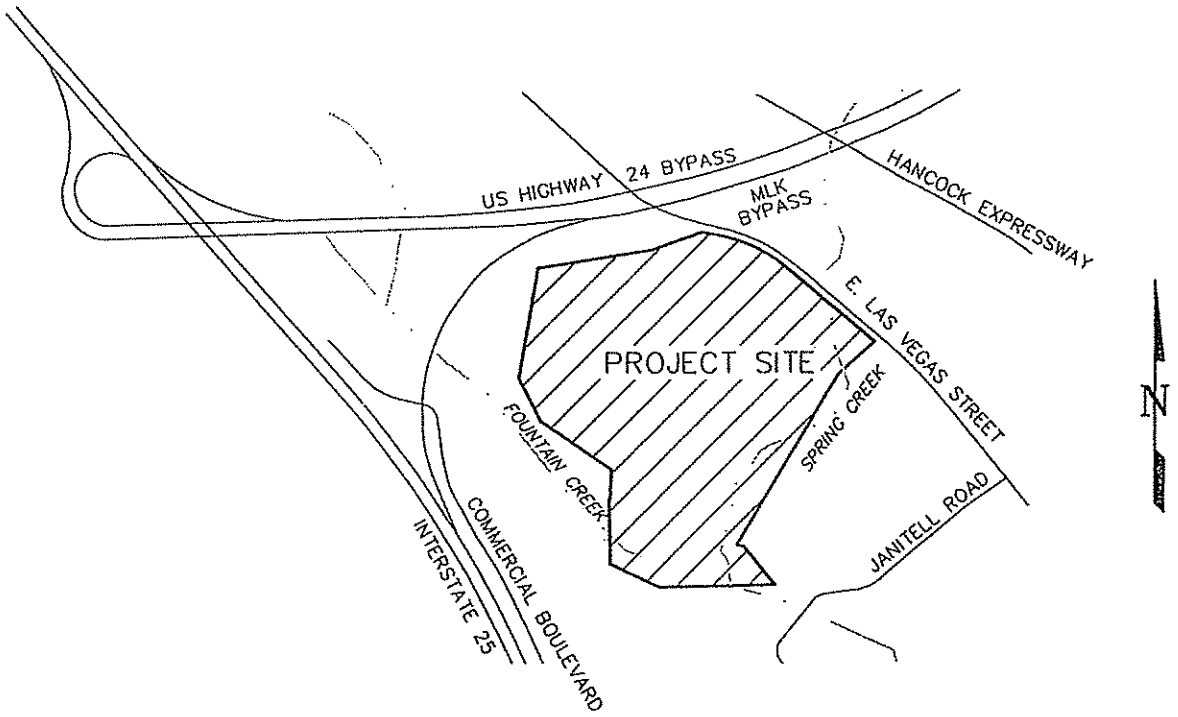


FIGURE 1
VICINITY MAP
NO SCALE

Reference 1 was reviewed to assess whether any facilities shown on the design plans would impact the site development. The access off Las Vegas will be constructed as part of the City's roadway improvement project.

Reference 2 was reviewed in order to assess whether the regulatory floodplains for Spring Creek and Fountain Creek impact any of the proposed buildings or the recycling operation itself. As a result of this review, there will be no habitable structures that will be constructed within the 100-year floodplain, and all grading associated with the FSD and site improvements will occur within the 500-year or the 100-year flood fringe. There will be no encroachment of fill into the floodway of either Spring or Fountain Creek.

III. Hydrology

Existing Basin Description: Existing sub-basins have been delineated on Exhibit 1. Four existing condition sub-basins occur within the Rocky Top property. Approximately one-third of the property now drains to the Spring Creek floodplain and the remaining portion of the property drains to the Fountain Creek floodplain. The is only one area of offsite drainage that enters the property at the north boundary which is the slope to the US 24 Bypass on ramp.

Soils within portion of the property subject to the recycling operations are classified to be within Hydrologic Soils Groups (HSG) A and B as shown in the El Paso County Soils Survey. The predominant soil covering 85 percent of the recycling operation are identified as Ustic Torrifluvents (HSG B), that is a loamy soil that is well drained. Soil covering the remainder of the recycling operation is identified as Ellicott (HSG A), loamy coarse sand that is somewhat excessively drained. These soils have a moderate to high infiltration rate when thoroughly wet. These soils have a low to moderate hazard of erosion. The existing vegetation is mostly native grasses within the portion of the property that is not used for the recycling operation. Along the Springs Creek and Fountain Creek drainageways cottonwoods, native shrubs and invasive species such as Russian olive and Dutch elm. There will be no disturbance to these areas as part of the site improvements. Within the active areas of the recycling operations the vegetative cover is sparse and there are numerous haul roads and gravel access drives. Vegetative cover outside of the active area of the recycling operation is 85 percent. Within the operations areas vegetative cover is less than 10 percent. Ground slopes are less than 2 percent in the active operations areas.

Existing Basin Descriptions: Total drainage area estimated to discharge to Fountain Creek and Spring Creek 44.8 acres. Developed runoff from the active area of the recycling operations is now being controlled by a temporary storage bas located near the southwest corner of the property. There is no discharge of runoff from the active portion of the site. The descriptions below are for present development condition and the discharges are for the pre-development condition.

Sub-basin A: This sub-basin is located at east corner of the property. This sub-basin is s direct flow area to Spring Creek. The colorant and colored mulch storage area operations is within this sub-basin. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek however the active portion associated with the colorant storage and processing lies outside of the 500-year floodplain. The colorant storage material is stored on an existing concrete

slab. The sub-basin covers 5.32 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 0.9 and 6.1 cubic feet per second, respectively.

Sub-basin B: This sub-basin is located at south corner of the property and is a direct flow basin to Spring Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There are no active operations associated with the recycling within this sub-basin. This sub-basin covers 7.51 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are 1.6 and 10.9 cubic feet per second, respectively for the pre-development condition.

Sub-basin C: This sub-basin is located at south corner of the property and is a direct flow basin to Fountain Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There are no active operations associated with the recycling within this sub-basin. This sub-basin covers 3.59 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 0.9 and 5.7 cubic feet per second, respectively for the pre-development condition.

Sub-basin D: This sub-basin covers the active areas of the recycling operations and discharges to the existing temporary storage basin located in sub-basin B. The retail office, waste concrete storage, waste concrete processing waste wood storage and yard waste storage and processing now existing in this sub-basin. This sub-basin lies within portion of the 500-year floodplain of Fountain Creek. The sub-basin covers 29.42 acres and has slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 4.4 and 28.6 cubic feet per second, respectively for the pre-development condition.

Proposed Basin Descriptions: Developed runoff from the active area of the recycling operations will be controlled by a proposed full spectrum detention basin. There will be no direct discharge to Spring or Fountain Creek other than from this sub-basin that lies outside of the active area of operations. The descriptions below are for the proposed development condition. The proposed condition sub-basins are shown on Exhibit 2.

Sub-basin 1: This sub-basin covers the active areas of the recycling operations and will discharge to a proposed extended detention basin. The new retail office, parking area and access driveways, waste concrete storage, waste concrete processing waste wood storage and yard waste storage and processing now existing in this sub-basin. This sub-basin lies within portion of the 500-year floodplain of Fountain Creek. The sub-basin covers 30.45 acres and will have slopes of 1 to 2 percent. The estimated 5- and 100-year discharges are 28.9 and 79.5 cubic feet per second, respectively.

Sub-basin 2: This sub-basin is located at east corner of the property and is a direct flow basin to Spring Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Spring Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 1.4 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are ..5 and 3.4 cubic feet per second, respectively.

Sub-basin 3: This sub-basin is located at southwest corner of the property and is a direct flow basin to Fountain Creek. This sub-basin lies within portion of the 100- and 500-year floodplain of Fountain Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 2.5 acres and has slopes of 2 to 4 percent. The estimated 5- and 100-year discharges are .5 and 3.2 cubic feet per second, respectively.

Sub-basin 4: This sub-basin is located at south corner of the property and is a direct flow basin to Fountain Creek. The Fountain Creek Greenway Trail passes through this sub-basin. This sub-basin lies within portion of the 100- and 500-year floodplain of Fountain Creek. There will be no active operations associated with the recycling within this sub-basin. This sub-basin covers 11.49 acres and has slopes of 2 to 5 percent. The estimated 5- and 100-year discharges are 2.0 and 13.2 cubic feet per second, respectively.

IV. Hydrology Calculations

Storm runoff for the site was estimated using the methods outlined in the *City of Colorado Springs and El Paso County, Drainage Criteria Manual.* Chapters 6 and 13 of DCM Volume 1 was used to assess the hydrologic characteristics of the site and for the design of the FSD. The topography for the site is presented with a one-foot contour interval at a horizontal scale of 1-inch to 100-feet. Exhibit 1 presents the existing drainage patterns for the area and Exhibit 2 presents the developed drainage patterns for the area, including the sub-basins and the corresponding flow rates. The flow rates for the sub-basins were estimated by using the Rational Method. The 5-year and 100-year recurrence intervals were determined. The calculations can be found within Appendix A of this report.

V. Hydraulic Calculations

The sizing of the onsite hydraulic structures was determined using the methods outlined in the *City of Colorado Springs and El Paso County, Drainage Criteria Manual.* The site will be drained primarily via sheet flow that is the collected in onsite swales. All runoff will outfall to the proposed extended detention basin. Discharge from the FSD will be directly to Springs Creek via a 30-inch RCP.

The capacities for proposed inlets and culverts were determined assuming inlet control, a 100-year storm and a maximum headwater to depth ratio of 1.2. The hydraulic capacities of the culverts were determined using the Urban Drainage and Flood Control District (UDFCD), UD-Culvert. The FSD outlet pipe is proposed to be reinforced concrete with flared-end section\. The outlets of all culverts will be protected with riprap which will be sized to meet the outlet velocity condition at each culvert. The riprap at the outlet of all the culverts has been sized to withstand the forces attributable to the 100-year design discharge. Inlets were sized using the UDFCD's UD-INLET spreadsheets. Hydraulic calculations are contained within Appendix B.

The size of the proposed FSD was determined using UDFCD's UD-Detention spreadsheets. The required water quality capture volume (WQCV), excess urban runoff volume (EURV) and the 100-year storage volume were estimated for the proposed. Per El Paso County requirements, one-half of the WQCV was added to the 100-year storage volume. The FSD'S

will be designed in accordance with the City of Colorado Springs DCM Volume 1, in combination with the UDFCD DCM Volumes 2 and 3. The FSD's will have a forebay(s), a low flow trickle channel and an outlet structure that will control the discharge of the WCQV, EURV and 100-year detention volume. Discharge from the FSD's during a 100-year inflow event will be limited to the rates of runoff for Hydrologic Soil Groups A and B. The FSD will have a forebay(s) with the required discharge rate and storage volume per Table T5 of Volume III of the UDFCD DCM. The FSD will concrete trickle channel(s) to carry the discharge from the forebay(s) to the principal outlet structure. The principal outlet structures will have perforated plates that will be designed to control the discharge of the WQCV and the EURV (stages 1 and 2). The 100-year discharge (stage 3), will be controlled to pre-development conditions using a 30-inch RCP with a restrictive orifice plate. An emergency spillway will be provided over the crest of the FSD's embankment sized to convey the maximum 100-year un-detained inflow from sub-basin 1 estimated at 79.5 cubic feet per second. Calculations supporting the design of the FSD's are contained in Appendix B.

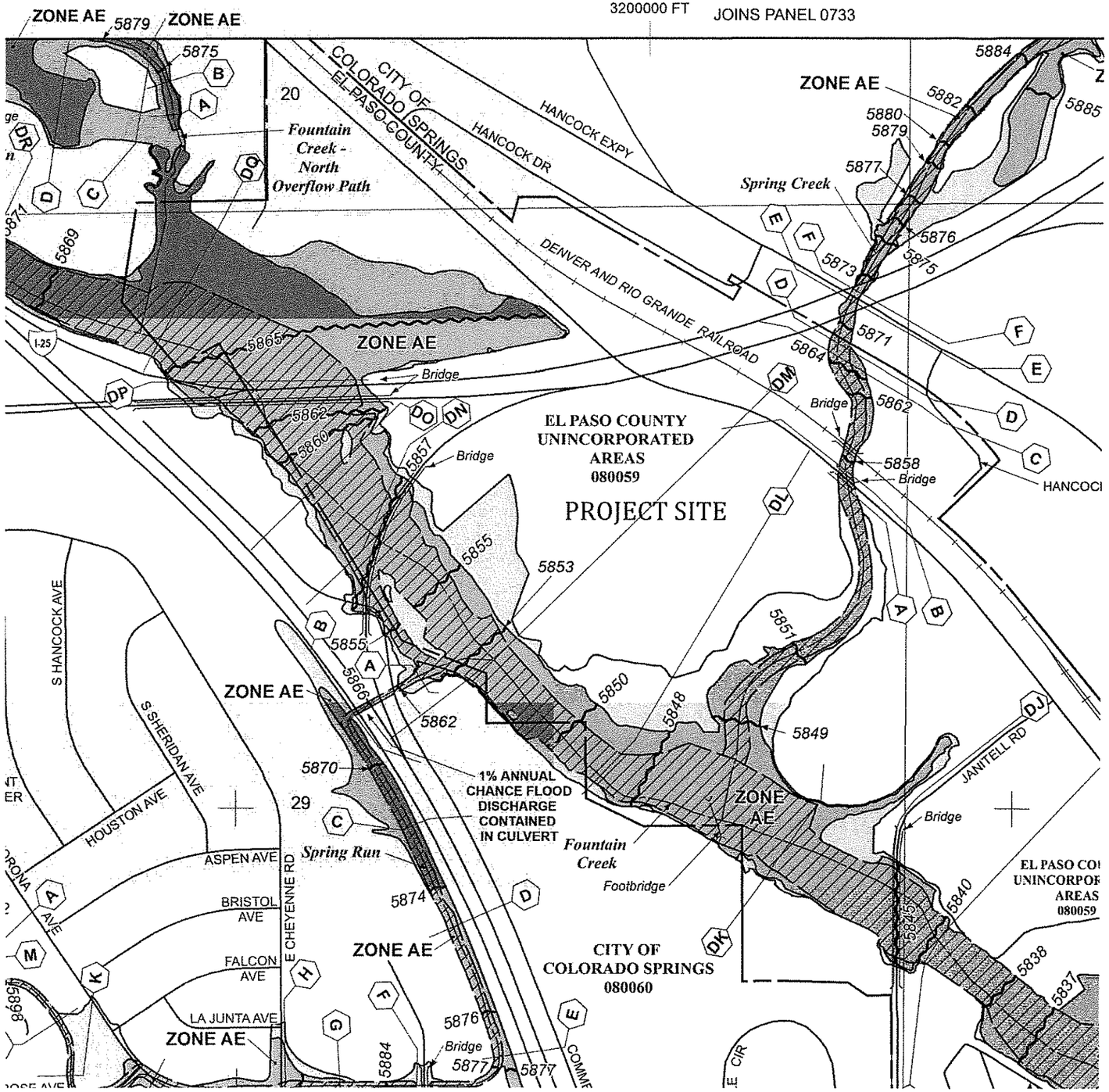
Earthwork at the site of the FSD basin will be completed initially so that the FSD could provide the function of a sediment trap. If the FSD is to be utilized as a sediment basin, the perforated plate that will control the discharges from the FSD will have to be blocked so that sediment laden construction stormwater runoff cannot pass through the outlet structure and into Spring Creek. The required sediment storage is estimated at 74,900 cubic feet. Notes have been added to the grading plan and to the details of the outlet structure stating the requirement that a ½-inch plywood board be placed over the perforated plate until such time that final stabilization BMPs have been installed.

VI. Floodplain Statement

The Floodplain Insurance Rate Map (FIRM) for El Paso County Flood Insurance Study (FIS) panel 0741G dated December 7, 2018 was reviewed to determine any potential regulatory floodplains within the property. The property is impacted by the 100-year and 500-year floodplains of Fountain and Spring creeks. Only a small portion of the active recycling operations lies within the 500-year floodplain. Grading will occur within the 100- and 500-year floodplain of Fountain and Spring creeks. The FSD will lie outside of the 100- year floodplain but a small portion will lie within the 500-year floodplain. FIRM panel 0741G is shown on Figure 2. No grading will occur within the floodway of Spring or Fountain creek.

VII. Grading and Erosion Control

The primary earth disturbing activity within the Rocky Top site will result from the construction of the FSD, new office building, driveways and parking areas. Outside of the areas of new construction no grading proposed to occur. It is the property owner's responsibility to monitor the condition of the temporary erosion control features. Should any of the erosion control facilities come into disrepair prior to the establishment of the native or natural erosion control measures, the developer is responsible for the maintenance and any associated costs. The developer is also responsible for the clean-up of offsite areas affected by any excessive erosion



MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

PANEL 0741G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 741 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0741	G
EL PASO COUNTY	080059	0741	G

FIGURE 2

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

MAP NUMBER
08041C0741G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

that may leave the site. Control of erosion from areas disturbed by utility construction or home building will be the responsibility of the respective contractor. All erosion control measures shall be installed and maintained in accordance with Volume 2 of the *City/County Drainage Criteria Manual*. Final grading and erosion control plans will be provided within the design plans to be prepared for this project.

The primary erosion control measure to be utilized in this project will include seeding and mulching of all the disturbed areas with the native seed mix. All areas disturbed by construction shall be seeded and mulched within sixty days after the rough grading has occurred. Cut and fill slopes will be reseeded and the slopes equal to or greater than three-to-one will be protected with erosion control fabric. Silt fence barriers will be placed along the site at the bottom of the re-vegetated and rough graded slopes. Inlet protection will be used around each of the proposed culverts and inlets.

VIII. Drainage and Bridge Fees

Tract 7 of the Valley Garden Subdivision lies within the Fountain Creek and Spring Creek drainage basins. Drainage fees will not be due for this site development application.

IX. Economic Analysis

Summarized on Table 1 is the cost estimate for the private drainage improvements associated with Rocky Top Resources project. No publicly maintained drainage facilities are required or proposed.

X. Best Management Plan Selection

The site will be developed to minimize wherever possible the rate of developed runoff that will leave the site and to provide water quality management for the runoff produced by the site as proposed on the development plan. The following steps were accounted for when the storm water collection and storage facilities were designed.

Step 1: Runoff reduction

Recycled asphalt (RCA) has been used as an alternative to concrete and asphalt within the proposed driveway areas within the active areas of the site. Runoff is reduced by approximately 15 percent as compared to a concrete surface. Some portions of the operations, such as the colorant additive and storage area, are protected by earthen berms that prevent direct discharge to the site or into the receiving drainageways. These berms act to slow the rate of runoff by increasing the time of concentration and provides for a lower effective impervious factor compared to areas that directly discharge.

Step 2: Stabilized drainageways

No major drainageways cross through the site. The banks of Fountain Creek and Spring Creek where they are adjacent to the site are presently stable. Discharge from the FSD will control runoff to pre-development conditions and therefore not expected to adversely impact the receiving drainageways.

TABLE 1: TRACT 7 VALLEY GARDEN SUBDIVISION
PRIVATE DRAINAGE IMPROVEMENT COST ESTIMATE
KIOWA PROJECT NUMBER 17066

ITEM	UNIT COST	UNIT	QUANTITY	TOTAL
PRIVATE DRAINAGE FACILITIES				
EDB DETENTION (1)	$35,000	AF	2.6	$91,000
30-INCH RCP	$97	LF	166	$16,102
CDOT TYPE D INLET	$5,731	EA	2	$11,462
SUBTOTAL				$118,564.00
CONTINGENCY (5 %)				$5,928.20
ENGINEERING (10 %)				$11,856.40
TOTAL				**$136,348.60**

(1) PER ACRE FOOT UNIT COST INCLUDES, GRADING, OUTLET STRUCTURE AND OUTLET STORM SEWER, FOREBAY, CONCRETE TRICKLE CHNNEL AND EMERGENCY SPILLWAY

Step 3: Water Quality Capture Volume

Runoff from the site will outfall to a FSD basin that will be sized to store and release at prescribed rates and time periods, the water quality capture volume (WQCV), the excess urban runoff volume (EURV) and the 100-year runoff volume. The FSD is design to operate as an extended detention basin (EDB). The discharge of the WQCV, EURV and the 100-year will be managed by means of a water quality outlet structure. The FSD will have a concrete trickle channel and forebay(s). The FSD has been designed to be on conformance with El Paso County engineering and drainage criteria.

Step 4: Industrial and Commercial BMP's

All chemical and fuels used in the recycling operations that are routinely stored on the site will have spill containment measure provided. A separate spill prevention and containment plan will be prepared by the operators of the facility. Access to the retail mulch, aggregate and soil drop-off and pickup are restricted to designated RAP driveways. Access to areas not part of the recycling operation is limited by the property owner by fencing and signage.

Appendix A
Hydrologic Calculations
Runoff Coefficient Calculations
Time of Concentration Calculations
Runoff Calculations

KIOWA ENGINEERING CORPORATION

JOB Rocky top Reservoir (1)
SHEET NO. _____ OF 3/10/19
CALCULATED BY RJW DATE 17 Oct
CHECKED BY _____ DATE _____
SCALE Hydrology

Hydrology - Existing Conditions (Pre-development)

SB #	C_5	C_{100}	Area (ac)	T_c (min)
A	.09	.36	5.32	45.5
B	↓	↓	7.51	29.4
C			3.59	25.3
D			28.42	55.5

T_c: See calcs sheets 2-4

Rainfall Intensity (Figure 6-5)

SB #	I_5	I_{100} (in/hr)
A	1.9	3.2
B	2.35	4.05
C	2.65	4.4
D	1.65	2.7

Time of Concentration Ex. Condition

Use longest flow path.

SB4D: Per Exhibit 1:

* Flow path 1 : 1430'
* Flow path 2 : 1510 ←

SB D initial travel time: L = 300' (overland)

$$t_t = \frac{.395(1.1 - C_5)\sqrt{L}}{S^{.33}}$$

L = 300'
C_5 = .09
S = 67 − 60/300 = .02

$$t_t = \frac{.395(1.1-.09)\sqrt{300}}{(.02)^{.33}} = \frac{6.91}{.275} = 25.1 \text{ min}$$

SB A:

Flowpath (4)

L_o = 100' S = 61 − 59/110 = .018'/'
L_{TOT} = 730'

$$t_t = \frac{.395(1.09)\sqrt{110}}{((.018)^{.33}} = \frac{4.51}{.27} = 16.7$$

SB B:

Flowpath (5)

L_{TOT} = 1020'
Overland L = 210' S = 54.5 − 41/210 = .064'/'

$$t_t = \frac{.395(1.01)\sqrt{210}}{(.064)^{.33}} = 5.78/.403 = 14.3 \text{ min}$$

* See Exhibit 1

Time of Concentration Exist. Conditions cont'd

SB C: $L_{TOT} = 820'$

*Flowpath (6) Overland $L = 150'$ $S = \frac{53-42}{300} = .037'/_{'}$

$$t_t = \frac{.395(1.01)\sqrt{150}}{(.035)^{.33}} = 4.84/.32 = \underline{14.8}$$

Travel Time $V = C_v(S_w)^{.5}$

SB A: Slope S_w $\frac{61-55}{(1510-300)} = \frac{6}{1210} = .005'/_{'}$

C_v = (Table 4-7) = 10

$V = 10(.005)^{.5} = .70$ fps

$t_t = 1210/.70 = 1729$ sec = 28.8

SB B: $S = .005$ (Spring creek) $L = 1020-210 = 810$

$C_v = 15$ $V = 15(.005)^{.5} = 1.06$

$t_t = 810/1.06 = 760$ sec $= 12.7$ min

SB C: $S = .005$ (Fountain Creek) $L = 820-150 = 670$

$V = 15(.005)^{.5} = 1.06$

$t_t = 670/1.06 = 632$ s $= \underline{10.5 \text{ min}}$

SB D: $L = 1560-300 = 1260$ $S = 6/1260 = .0048'/_{'}$

$V = 10(.0048)^{.5} = .69$

$t_t = 1260/.69 = 1826$ s $= \underline{30.4 \text{ min}}$

Time of Concentration Ex. Cond. Cont'd

$T_c = t_i + t_t$

SBA: $T_c = 16.7 + 28.8 = 45.5$ min

SBB: $T_c = 16.7 + 12.7 = 29.4$ min

SBC: $T_c = 14.8 + 10.5 = 25.3$ min

SBD: $T_c = 25.1 + 30.4 = 55.5$ min

Rainfall Intensity Per Figure 6-5

SBA: $I_5 = 1.09$ "/hr $I_{100} = 3.2$ "/hr

SBB: $I_5 = 2.35$ "/hr $I_{100} = 4.05$ "/hr

SBC: $I_5 = 2.65$ "/hr $I_{100} = 4.4$ "/hr

SBD: $I_5 = 1.65$ "/hr $I_{100} = 2.7$ "/hr

SUB-WATERSHED RUNOFF CALCULATIONS PRE-DEVELOPMENT CONDITIONS
PROJECT: Rocky Top Resources
PROJECT NO: 17066
RATIONAL METHOD FORMULA: Q=CIA

SUB-BASIN NO.	AREA (AC)	RUNOFF COEFFICIENTS C5	C100	RAINFALL INTENSITY I5 (INCHES/HR)	I100	RUNOFF (CFS) Q5	Q100
A	5.32	0.09	0.36	1.90	3.20	0.9	6.1
B	7.51	0.09	0.36	2.35	4.05	1.6	10.9
C	3.59	0.09	0.36	2.65	4.40	0.9	5.7
D	29.42	0.09	0.36	1.65	2.70	4.4	28.6

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resource 1
SHEET NO. _____ OF 17066
CALCULATED BY _____ DATE 3/10/19
CHECKED BY RGW DATE _____
SCALE Hydrology - Proposed

Hydrology - Proposed Conditions

SB	Area(ac)	C_5	C_{100}	Tc(min)	I_5	I_{100}
1	30.45	.45	.60	25.5	2.1	4.35
2	1.40	.09	.34	10	4.0	6.8
3	2.50	.09	.34	36.3	2.15	3.6
4	11.49	.09	.34	42.9	1.95	3.25

Runoff Coefficients: SB 1

50% of Site: Light Industrial C_5=.59 C_{100}=.70

50% of Site: poor to Fair grasses: C_5=.30 C_{100}=.50

SB #1 Wtd ~~Runoff Coeff.~~

5-YR C_5 = .5(.59) + .30(.50) = .45

C_{100} = .5(.70) + .50(.50) = .60

Tc: SB 1: L = 1450' T_c = 1450/180 + 10 = 18.1

SB 4: L = 950' T_c = 950/180 + 10 = 15.3

SB 3: L = 1450 T_c = 1450/180 + 10 = 18.1

Initial Travel Time

$$t_i = \frac{.395(1-C_5)\sqrt{L}}{S^{.33}}$$

SB # 1:

$L_o = 100'$ $S = .04$ $C_5 = .45$

$$t_i = \frac{.395(1.1-.45)\sqrt{100}}{(.04)^{.33}} = \frac{2.57}{.35} = 7.4 \text{ min}$$

SB # 2: $L_o = 0'$ ∴ $t_i = 0$

SB # 3: $L_o = 100'$ $S = .01$ $C_5 = .09$

$$t_i = \frac{.395(1.1-.09)\sqrt{100}}{.01^{.33}} = \frac{3.99}{.218} = 18.2 \text{ min}$$

SB # 4: $L = 300'$ (this SB remains undeveloped)

$S = .015$ $C = .09$

$$t_i = \frac{.395(1-.09)\sqrt{300}}{.015^{.33}} = \frac{6.91}{.25} = 27.6 \text{ min}$$

T_c: SB # 1: 7.4 + 18.1 = 25.5

SB # 2: 10 min

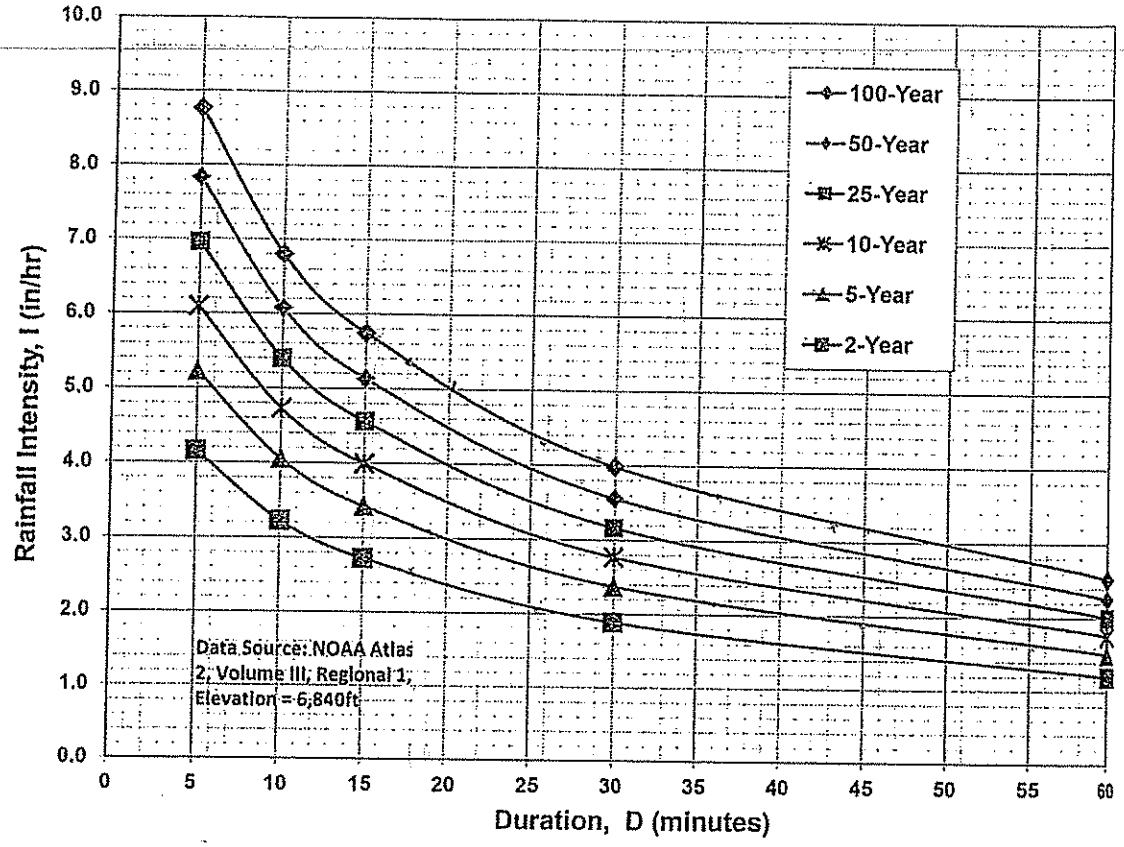
SB # 3: 18.2 + 18.1 = 36.3

SB # 4: 27.6 + 15.3 = 42.9

SUB-WATERSHED RUNOFF CALCULATIONS PROPOSED DEVELOPMENT CONDITIONS
PROJECT: Rocky Top Resources
PROJECT NO: 17066
RATIONAL METHOD FORMULA: Q=CIA

SUB-BASIN NO.	AREA (AC)	RUNOFF COEFFICIENTS C5	C100	RAINFALL INTENSITY I5 (INCHES/HR)	I100	RUNOFF (CFS) Q5	Q100
1	30.45	0.45	0.6	2.1	4.4	28.8	79.5
2	1.4	0.09	0.36	4.0	6.8	0.5	3.4
3	2.5	0.09	0.36	2.2	3.6	0.5	3.2
4	11.49	0.09	0.36	1.95	3.2	2.0	13.2

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis--Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet Per Second) 10-Year	50-Year	100-Year	500-Year
Sand Creek East Fork Subtributary					
At confluence with Sand Creek East Fork	5.92	610	1,480	1,970	3,800
Sand Creek West Fork					
At confluence with Sand Creek[1]	5.17	3,459	4,727	5,162	5,542
Above Platte Avenue	--[2]	3,510	5,490	6,810	9,600
Security Creek					
Upstream of confluence with Windmill Gulch	3.7	2,700	4,300	5,400	10,100
South Shooks Run					
At confluence with Fountain Creek	7.82	2,640	4,230	5,570	8,000
South Valley Dry Creek					
Above confluence with Dry Creek	0.15	--[2]	--[2]	162	229
Spring Creek					
At confluence with Fountain Creek	6.7	960	1,790	2,340	4,340
Spring Run					
At Interstate 25	3.63	890	1,350	1,660	2,340
Sutherland Creek					
At confluence with Fountain Creek	5.09	1,810	3,400	4,700	7,500
Templeton Gap Floodway					
At Academy Boulevard	2.49	2,820	4,180	5,040	6,800
Approximately 2,300 feet above Academy Boulevard	2.14	2,440	3,610	4,340	5,850

[1]Discharges are reduced because of losses at Platte Avenue

[2]Data not available

Appendix B
Hydraulic Calculations

MATCH EFFECTIVE FIRM BOUNDARIES
SPRING CREEK CROSS SECTION A
STA. 1700
BFE=5851.7

KIOWA NOTES:
1. CROSS SECTION LABELING THIS SHEET ADDED BY KIOWA ENGINEERING.
2. MATCH TO EFFECTIVE FIS FLOODPLAIN PROVIDED BY KIOWA ENGINEERING.

NOTE:

1. TOPOGRAPHY FROM CSU FIMS. VERTICAL DATUM NGVD 29.
2. CORRELATE WORKMAP STATIONS TO THE FLOOD PROFILE STATIONS BY ADDING THE FOLLOWING INCREMENTS TO THE APPROPRIATE ALIGNMENT.

FOUNTAIN CREEK	260,340 FEET
FOUNTAIN CREEK SOUTH OVERFLOW	625 FEET
FOUNTAIN CREEK NORTH OVERFLOW	1,036 FEET

LEGEND
- EFFECTIVE FLOODWAY
- ONE-FOOT PROPOSED FLOODWAY
- 100 YR EFFECTIVE FLOODPLAIN
- 100 YR PROPOSED FLOODPLAIN
- 100 YR PROPOSED OVERFLOW FLOODPLAIN
- 500 YR EFFECTIVE FLOODPLAIN
- 500 YR PROPOSED FLOODPLAIN
- 500 YR PROPOSED OVERFLOW FLOODPLAIN
- 5200 BASE FLOOD ELEVATION
- (123) OVERFLOW STATION
- 30150 CROSS SECTION NUMBER

200 0 200 400
1 inch = 200 feet

DR DQ DP DO DN DM DL DK

SPRING CREEK

CITY OF COLORADO SPRINGS
EL PASO COUNTY

A B

E. LAS VEGAS ST.

S. CIRCLE DR

CIRCLE MOBILE HOME PARK

JANITELL RD.

EL PASO COUNTY
CITY OF COLORADO SPRINGS

SEE DWG 3
STA. 160+50
MATCHLINE

MATCHLINE
STA. 96+50
SEE DWG 5

DESIGN: GGS, LEH, JMB DETAIL: LEH, KHM, RT CHECK: MRG	PROJECT NUMBER: 501007 DATE: JUNE 2013	WHPacific	1536 Cole Blvd. Suite 150 Lakewood, Colorado 80401 Phone: 303.450.3550 Fax: 303.450.9788	CITY OF COLORADO SPRINGS DEPARTMENT OF PUBLIC WORKS ENGINEERING CITY OF COLORADO SPRINGS, COLORADO	FOUNTAIN CREEK FLOODPLAIN RESTUDY FLOODPLAIN BOUNDARIES	STATION: 160+50 - 96+50	DRAWING NUMBER: 4

FOUNTAIN CREEK

HEC-RAS Plan: FC_Mar 2013 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
NOF to SOF	17515	10 YR	7900.00	5851.04	5858.87	5856.39	5859.29	0.001224	5.45	2056.30	746.04	0.40
NOF to SOF	17515	50 YR	14300.00	5851.04	5860.41	5858.45	5861.05	0.001583	7.08	3105.49	784.62	0.46
NOF to SOF	17515	100 YR	18000.00	5851.04	5861.09	5859.11	5861.86	0.001760	7.86	3572.82	799.56	0.49
NOF to SOF	17515	500 YR	29079.86	5851.04	5862.76	5860.70	5863.89	0.002178	9.78	4716.88	821.45	0.55
NOF to SOF	17430		Bridge									
NOF to SOF	17374	10 YR	7900.00	5851.07	5858.11	5856.01	5858.43	0.001865	5.17	1915.74	658.32	0.40
NOF to SOF	17374	50 YR	14300.00	5851.07	5859.71	5857.84	5860.16	0.001866	6.18	2827.19	671.72	0.42
NOF to SOF	17374	100 YR	18000.00	5851.07	5860.42	5858.23	5860.96	0.001934	6.72	3237.50	677.86	0.43
NOF to SOF	17374	500 YR	29079.86	5851.07	5862.19	5859.43	5862.97	0.002097	8.05	4342.69	809.28	0.46
NOF to SOF	17342	10 YR	7900.00	5851.00	5857.63	5856.99	5858.28	0.003165	7.47	1641.44	576.51	0.55
NOF to SOF	17342	50 YR	14300.00	5851.00	5859.29	5858.15	5860.02	0.002925	8.49	2630.63	602.51	0.55
NOF to SOF	17342	100 YR	18000.00	5851.00	5860.00	5858.68	5860.82	0.003005	9.14	3057.05	606.84	0.56
NOF to SOF	17342	500 YR	29079.86	5851.00	5861.71	5859.98	5862.82	0.003265	10.81	4117.32	650.83	0.61
NOF to SOF	17284	10 YR	7900.00	5849.90	5856.74	5856.74	5857.99	0.005437	10.07	1199.10	506.45	0.74
NOF to SOF	17284	50 YR	14300.00	5849.90	5858.09	5858.09	5859.72	0.006205	12.31	1897.40	541.28	0.82
NOF to SOF	17284	100 YR	18000.00	5849.90	5858.72	5858.72	5860.51	0.006367	13.21	2243.93	558.95	0.84
NOF to SOF	17284	500 YR	29079.86	5849.90	5860.20	5860.20	5862.47	0.006942	15.51	3103.63	604.52	0.90
NOF to SOF	17250	10 YR	7900.00	5846.00	5853.97	5852.49	5855.77	0.005717	10.77	733.68	201.62	0.72
NOF to SOF	17250	50 YR	14300.00	5846.00	5856.59	5855.32	5858.54	0.005658	12.03	1622.20	492.72	0.71
NOF to SOF	17250	100 YR	18000.00	5846.00	5857.71	5857.40	5859.52	0.005049	12.09	2182.25	507.56	0.67
NOF to SOF	17250	500 YR	29079.86	5846.00	5859.95	5859.16	5861.86	0.004676	13.25	3379.58	577.67	0.67
NOF to SOF	16973	10 YR	7900.00	5846.00	5851.63	5851.31	5853.27	0.015396	10.30	767.02	189.94	0.90
NOF to SOF	16973	50 YR	14300.00	5846.00	5853.29	5853.23	5855.93	0.017802	13.03	1097.60	204.59	0.99
NOF to SOF	16973	100 YR	18000.00	5846.00	5854.49	5854.49	5857.21	0.015127	13.27	1408.15	333.23	0.93
NOF to SOF	16973	500 YR	29079.86	5846.00	5856.95	5856.95	5859.86	0.011496	14.23	2407.92	461.67	0.85
NOF to SOF	16672	10 YR	7900.00	5845.00	5850.82	5848.92	5851.33	0.002679	5.71	1382.79	314.84	0.48
NOF to SOF	16672	50 YR	14300.00	5845.00	5852.93	5850.39	5853.66	0.002734	6.85	2101.63	377.85	0.49
NOF to SOF	16672	100 YR	18000.00	5845.00	5853.81	5851.09	5854.67	0.002849	7.49	2476.43	459.04	0.50
NOF to SOF	16672	500 YR	29079.86	5845.00	5856.15	5852.95	5857.31	0.002847	8.76	3597.06	491.92	0.51
NOF to SOF	16643	10 YR	7900.00	5845.00	5850.78	5848.99	5851.23	0.001953	5.51	1624.07	458.18	0.46
NOF to SOF	16643	50 YR	14300.00	5845.00	5852.95	5850.41	5853.50	0.001710	6.28	2739.78	581.51	0.43
NOF to SOF	16643	100 YR	18000.00	5845.00	5853.87	5851.06	5854.48	0.001700	6.72	3271.63	602.04	0.43
NOF to SOF	16643	500 YR	29079.86	5845.00	5856.29	5852.78	5857.04	0.001597	7.62	4721.54	627.38	0.42
NOF to SOF	16625		Bridge									
NOF to SOF	16607	10 YR	7900.00	5845.00	5850.64	5848.88	5851.01	0.004136	5.08	1618.90	476.35	0.45
NOF to SOF	16607	50 YR	14300.00	5845.00	5852.83	5850.24	5853.24	0.002943	5.26	2795.29	569.97	0.39
NOF to SOF	16607	100 YR	18000.00	5845.00	5853.73	5850.82	5854.20	0.002701	5.58	3314.58	581.52	0.38
NOF to SOF	16607	500 YR	29079.86	5845.00	5856.13	5852.26	5856.73	0.002267	6.29	4732.52	612.32	0.37
NOF to SOF	16560	10 YR	7900.00	5845.00	5848.89	5848.89	5850.40	0.008999	10.17	846.12	261.59	0.94
NOF to SOF	16560	50 YR	14300.00	5845.00	5850.45	5850.45	5852.52	0.008618	12.15	1341.66	357.77	0.95
NOF to SOF	16560	100 YR	18000.00	5845.00	5851.50	5851.35	5853.54	0.007024	12.23	1776.52	496.09	0.87
NOF to SOF	16560	500 YR	29079.86	5845.00	5855.14	5853.25	5856.42	0.002672	10.30	3826.99	591.11	0.58
NOF to SOF	16544	10 YR	7900.00	5843.00	5847.68	5847.68	5849.59	0.016934	11.09	712.37	236.42	1.02
NOF to SOF	16544	50 YR	14300.00	5843.00	5850.23	5849.59	5851.94	0.009038	10.78	1408.89	298.89	0.78
NOF to SOF	16544	100 YR	18000.00	5843.00	5851.74	5850.42	5853.28	0.006373	10.36	1948.21	451.88	0.67
NOF to SOF	16544	500 YR	29079.86	5843.00	5855.12	5852.77	5856.36	0.003454	9.62	3692.94	577.39	0.53
NOF to SOF	16431	10 YR	7900.00	5838.70	5847.05	5843.88	5847.80	0.002578	6.96	1135.11	175.60	0.46
NOF to SOF	16431	50 YR	14300.00	5838.70	5850.20	5846.25	5851.27	0.002542	8.39	1833.51	285.74	0.47
NOF to SOF	16431	100 YR	18000.00	5838.70	5851.55	5847.34	5852.76	0.002490	9.05	2254.68	358.75	0.48
NOF to SOF	16431	500 YR	29079.86	5838.70	5854.67	5850.62	5856.04	0.002259	10.15	3850.74	813.49	0.47
NOF to SOF	16191	10 YR	7900.00	5837.00	5846.06	5843.00	5847.07	0.003338	8.08	978.23	130.30	0.52
NOF to SOF	16191	50 YR	14300.00	5837.00	5848.75	5845.73	5850.43	0.004247	10.48	1461.61	254.72	0.59
NOF to SOF	16191	100 YR	18000.00	5837.00	5850.04	5847.08	5851.93	0.004164	11.28	1843.06	347.71	0.60
NOF to SOF	16191	500 YR	29079.86	5837.00	5853.45	5851.22	5855.34	0.003317	12.04	3334.51	664.89	0.56
Main DS	15913	10 YR	7900.00	5835.00	5844.97	5842.35	5846.03	0.004141	8.53	1069.94	208.30	0.55
Main DS	15913	50 YR	14300.00	5835.00	5847.72	5845.41	5849.21	0.004125	10.40	1681.86	248.32	0.57
Main DS	15913	100 YR	18000.00	5835.00	5849.07	5846.48	5850.73	0.004031	11.15	2032.61	270.82	0.58
Main DS	15913	500 YR	29400.00	5835.00	5851.87	5849.32	5854.22	0.004519	13.64	2827.58	292.77	0.63
Main DS	15241	10 YR	7900.00	5831.00	5841.41	5839.00	5842.41	0.007213	8.05	990.11	169.57	0.57
Main DS	15241	50 YR	14300.00	5831.00	5844.12	5841.57	5845.64	0.007064	9.97	1503.65	223.98	0.59
Main DS	15241	100 YR	18000.00	5831.00	5845.13	5842.64	5847.03	0.007817	11.19	1749.88	304.27	0.63
Main DS	15241	500 YR	29400.00	5831.00	5848.04	5846.29	5850.33	0.007578	12.79	2821.89	596.70	0.64
Main DS	14715	10 YR	7900.00	5828.82	5840.15	5835.08	5840.60	0.001749	5.50	1623.53	339.83	0.33
Main DS	14715	50 YR	14300.00	5828.82	5843.37	5837.75	5843.84	0.001554	6.02	3079.64	513.41	0.32

PROJECT SITE

Table EDB-4. EDB component criteria

	On-Site EDBs for Watersheds up to 1 Impervious Acre[1]	EDBs with Watersheds between 1 and 2 Impervious Acres[1]	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration	EDBs should not be used for watersheds with less than 1 impervious acre.	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe[2] configuration
Minimum Forebay Volume		1% of the WQCV	2% of the WQCV	3% of the WQCV	3% of the WQCV
Maximum Forebay Depth		12 inches	18 inches	18 inches	30 inches
Trickle Channel Capacity		≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity
Micropool		Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2	Area ≥ 10 ft^2
Initial Surcharge Volume		Depth ≥ 4 inches	Depth ≥ 4 inches	Depth ≥ 4 in. Volume ≥ 0.3% WQCV	Depth ≥ 4 in. Volume ≥ 0.3% WQCV

[1] EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

[2] Round up to the first standard pipe size (minimum 8 inches).

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources
SHEET NO. _____ OF 17066
CALCULATED BY _____ DATE 3/10/19
CHECKED BY _____ DATE RLW
SCALE Water Quality Calcs

Per Table EDB-4, UDFCD Vol 3.

Watershed with over 5 imp. Acres (Includes RAP)

Forebay Release = 2% of Undetained Inflow
Qundetained = 98.7 ∴ Release = .02(98.7) = 2.0 cfs

Forebay Volume =
.03(WQCV) = .015AF = 632 cf.

Maximum Forebay depth = 18"

Trickle Channel Cap:
≥ Forebay Release 2.0 cfs

Micropool Area ≥ 10sf

Initial Surcharge ≥ 4", use 12"

Volume = .3%(WQCV) = .0145
= 63.2 cfs

Surcharge Volume provided.
(8' x 8' x 1') = 64 cf

Micro-pool area provide = 8' x 8' = 64 sf

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources
SHEET NO. 0 OF 17006
CALCULATED BY _____ DATE 3/10/19
CHECKED BY _____ DATE _____
SCALE WQ Calculations

Total Acreage 44.8 Ac

Area of Active Recycling operations = 30.5 Ac

Impervious Acreage

		% Imp.
- Concrete pads: Existing	3.38 Ac ✓	95
- Area of Bldgs		90
new bldg 5400 sf		
- Bldgs to remain: 1500		
6900 sf = .16 Ac ✓		
- Concrete Drives:		95
- Las Vegas Access 5950 sf.		
- Main parking & driveway 10200		
16150 = .37 Ac ✓		
- Recycled Asphalt:	3.44 Ac	80%

Total Paved/Bldgs: 7.35 Ac

Balance - piles, native grasses poor-to-fair: 23.1 30%
23.5 Ac

$$\text{Wtd \% Imp} = \frac{(3.38+.37).95 + .16(90) + 3.44(.80) + 23.5(.30)}{30.5 \text{ Ac}}$$

$$= 13.5 / 30.5 = .44 \text{ use } 44\%$$

for UD-Detention

Imp Ac = 3.38 + .16 + .37 = 3.91 Ac

Rocky Top Resoruces
Volume Calculation

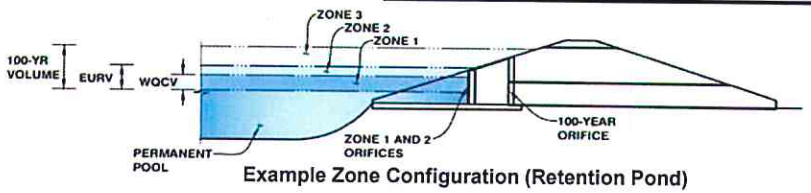
Stage	Elevation	Area sq. ft.	Area Acres	Avg. Area	Increment	Incremental Volume	Cumulative Volume
0	49	0	0.00				
				0.05	1	0.05	0.05
1	50	4,384	0.10				
				0.32	1	0.32	0.37
2	51	23,531	0.54				
				0.58	1	0.58	0.96
3	52	27,393	0.63				
				0.68	1	0.68	1.63
4	53	31473	0.72				
				0.77	1	0.77	2.40
5	54	35415	0.81				
				0.86	1	0.86	3.26
6	55	39560	0.91				
				1.02	1	1.02	4.28
7	56	49000	1.12				
				1.35	1	1.35	5.63
8	57	69000	1.58				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Rocky Top Resources

Basin ID: FSD Design Drainage area 30.45



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	30.45	acres
Watershed Length =	1,360	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	44.00%	percent
Percentage Hydrologic Soil Group A =	15.0%	percent
Percentage Hydrologic Soil Group B =	85.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.483	acre-feet
Excess Urban Runoff Volume (EURV) =	1.429	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.111	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	1.524	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	2.089	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.991	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	3.648	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	4.499	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	6.381	acre-feet
Approximate 2-yr Detention Volume =	1.040	acre-feet
Approximate 5-yr Detention Volume =	1.432	acre-feet
Approximate 10-yr Detention Volume =	1.914	acre-feet
Approximate 25-yr Detention Volume =	2.148	acre-feet
Approximate 50-yr Detention Volume =	2.272	acre-feet
Approximate 100-yr Detention Volume =	2.579	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
48	--	1.00	--	--	--	5	0.000	2	0.000
49	--	2.00	--	--	--	10	0.000	10	0.000
50	--	3.00	--	--	--	4,384	0.101	2,207	0.051
51	--	4.00	--	--	--	23,531	0.540	16,164	0.371
52	--	5.00	--	--	--	27,393	0.629	41,626	0.956
53	--	6.00	--	--	--	31,473	0.723	71,059	1.631
54	--	7.00	--	--	--	35,415	0.813	104,503	2.399
55	--	8.00	--	--	--	39,560	0.908	141,991	3.260
56	--	9.00	--	--	--	49,000	1.125	186,271	4.276
57	--	10.00	--	--	--	69,000	1.584	245,271	5.631
58	--	11.00	--	--	--	84,000	1.928	321,771	7.387
59	--	12.00	--	--	--	102,000	2.342	414,771	9.522
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
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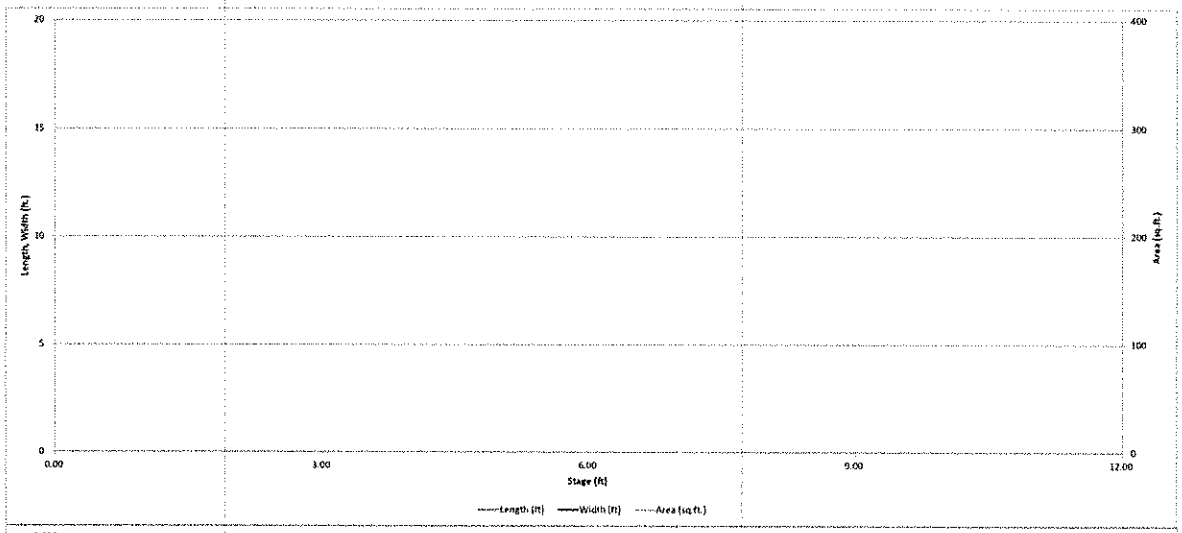
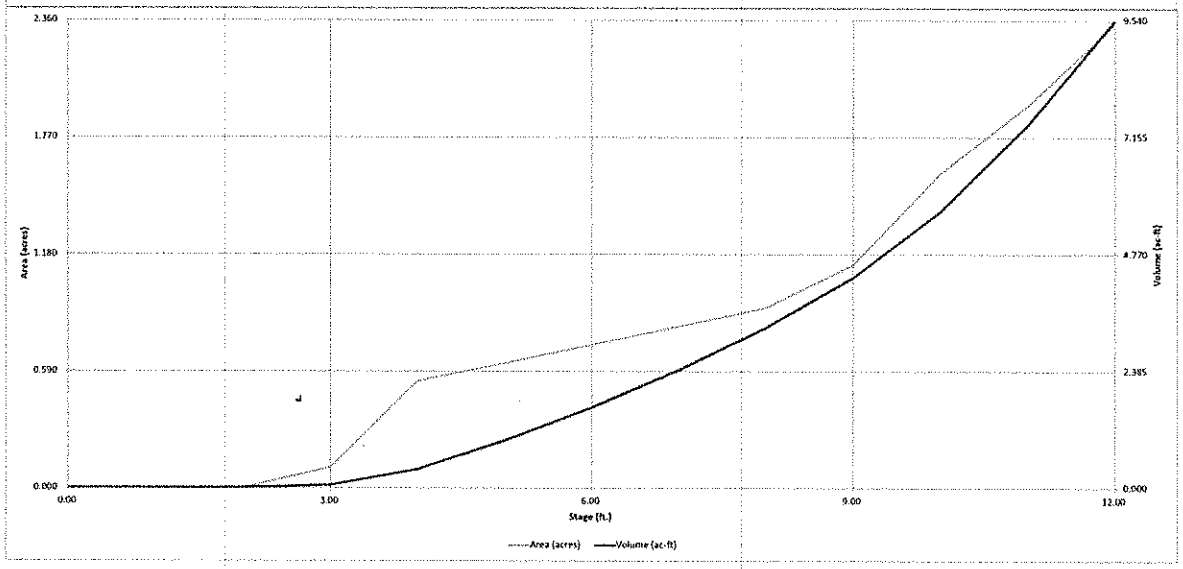
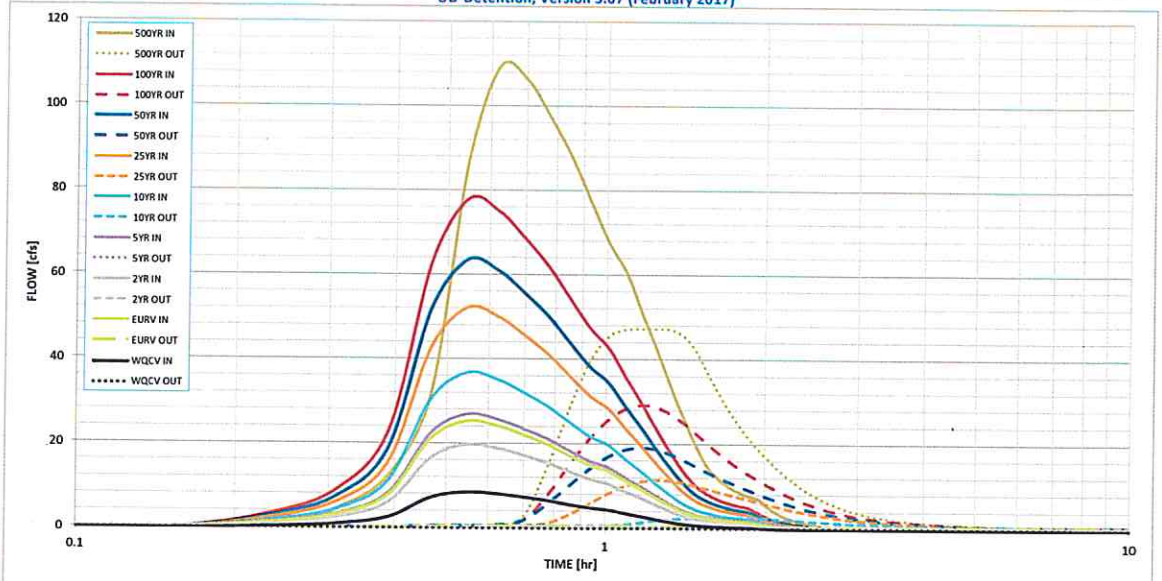
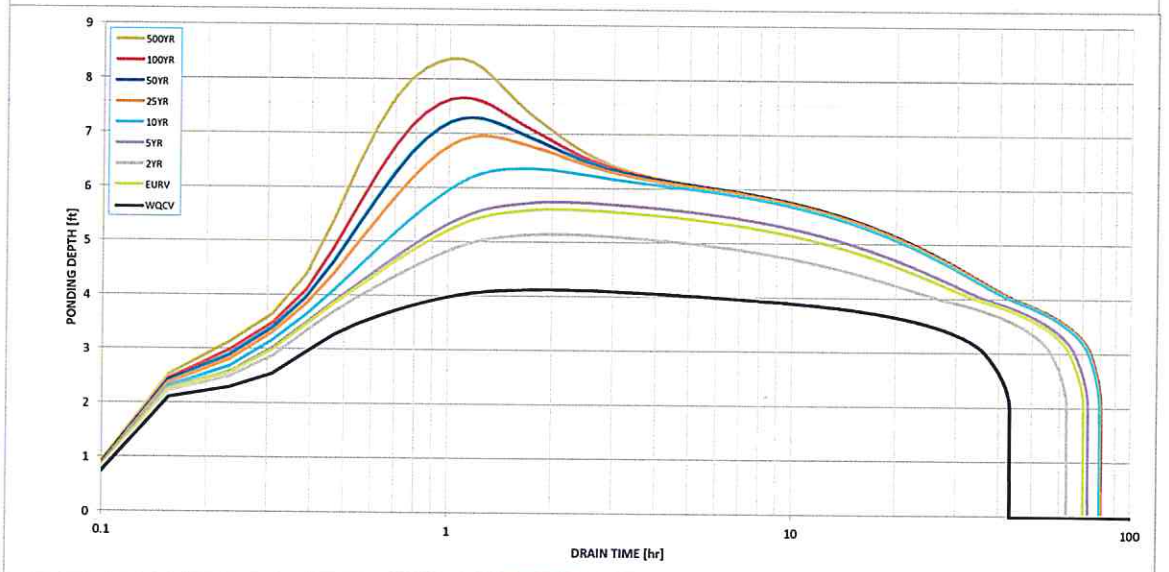

Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

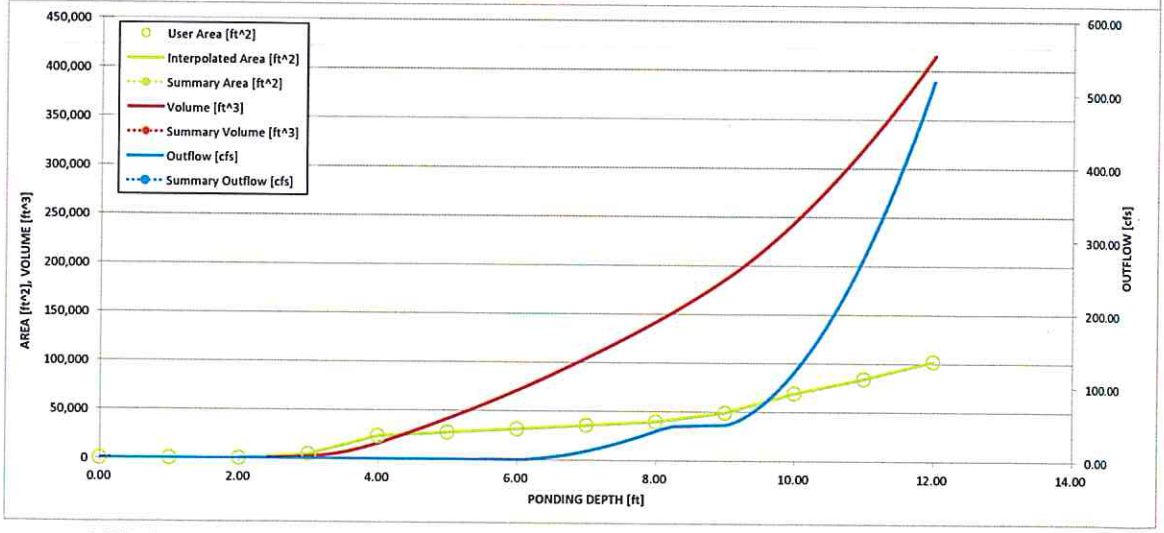

Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







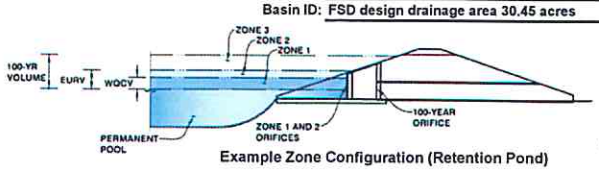
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Rocky Top Resources

Basin ID: FSD design drainage area 30.45 acres



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.21	0.483	Orifice Plate
Zone 2 (EURV)	5.72	0.946	Orifice Plate
(100+1/2WQCV)	7.51	1.392	Weir&Pipe (Restrict)
		2.820	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.94	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	23.80	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.98	3.96					
Orifice Area (sq. inches)	1.00	1.50	8.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	4.50	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	70%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	7.00	N/A	feet
Over Flow Weir Slope Length =	4.61	N/A	feet
Grate Open Area / 100-yr Orifice Area =	7.43	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	25.81	N/A	ft^2
Overflow Grate Open Area w/ Debris =	7.74	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	20.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.48	N/A	ft^2
Outlet Orifice Centroid =	0.94	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	9.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	1.07	feet
Stage at Top of Freeboard =	11.07	feet
Basin Area at Top of Freeboard =	1.96	acres

Routed Hydrograph Results

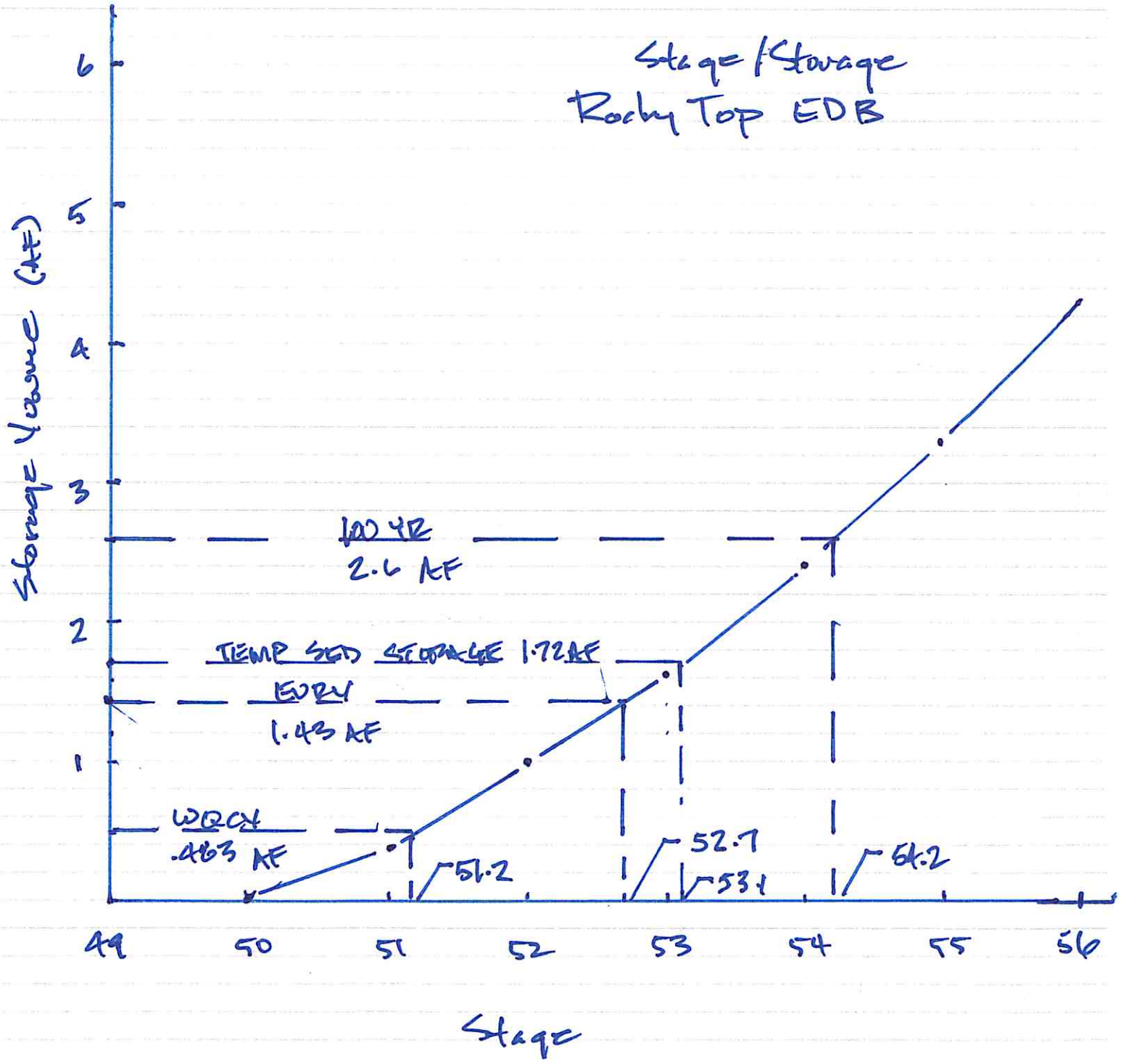
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.483	1.429	1.111	1.524	2.089	2.991	3.648	4.499	6.381
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.482	1.427	1.110	1.523	2.087	2.989	3.645	4.496	6.369
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.19	0.62	0.88	1.22	1.89
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	0.6	5.8	18.8	26.8	37.1	57.6
Peak Inflow Q (cfs) =	8.6	25.1	19.6	26.8	36.6	52.1	63.4	77.9	109.4
Peak Outflow Q (cfs) =	0.3	0.5	0.5	0.5	2.6	11.4	19.0	29.1	47.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	0.4	0.6	0.7	0.8	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.4	0.7	1.1	1.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	65	59	67	72	70	68	65	60
Time to Drain 99% of Inflow Volume (hours) =	42	69	61	71	77	76	76	75	73
Maximum Ponding Depth (ft) =	4.14	5.61	5.15	5.74	6.35	6.96	7.29	7.66	8.37
Area at Maximum Ponding Depth (acres) =	0.55	0.69	0.64	0.70	0.75	0.81	0.84	0.87	0.99
Maximum Volume Stored (acre-ft) =	0.448	1.350	1.045	1.447	1.890	2.359	2.639	2.948	3.611

Kiowa Engineering Corporation

Project Name: Rocky Top Res. Project No: 17066

Description: EDB Design

By: 2/15/2020 Date: RCW



Kiowa Engineering Corporation

Project Name: Rocky Top Resources Project No: 17066

Description: Sediment basin Volume Calcs

By: [illegible] Date: 2/20/20

Sediment Volume:

Disturbed Area = 15.5 Ac

Per SB Standards:

Req'd Volume = 3600 cf/ac

Additional Increase of % Imp = 20% 1230 cf.

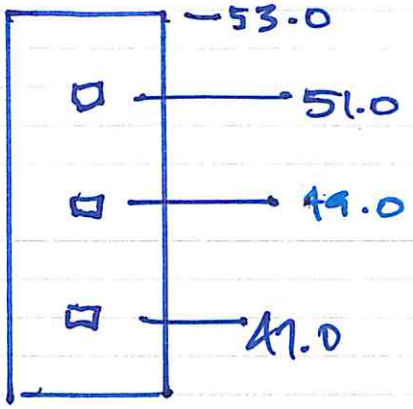
Total Required = 4830 cf.

Total Volume = 4830 (15.5) = 74865 cf = 1.72 AF

Check perforated plate:

Elevation @ trickle channel = 49.0

∴ Sed level = 53.1

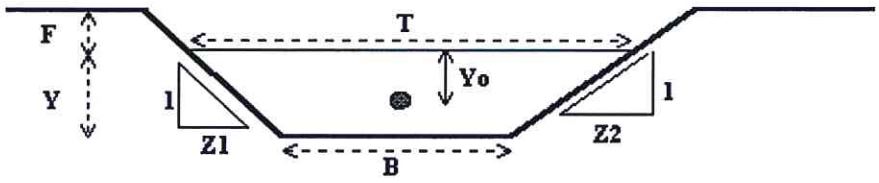


Will need to block all openings while FSD acts as a SB.

Critical Flow Analysis - Trapezoidal Channel

Project: 17066 Rocky Top Resources

Channel ID: Spillway design Q over spillway =100 cfs



Design Information (Input)		
Bottom Width	B =	20.00 ft
Left Side Slope	Z1 =	4.00 ft/ft
Right Side Slope	Z2 =	4.00 ft/ft
Design Discharge	Q =	**80.00** cfs

Critical Flow Condition (Calculated)		
Critical Flow Depth	**Y =**	**0.75** ft
Critical Flow Area	A =	17.25 sq ft
Critical Top Width	T =	26.00 ft
Critical Hydraulic Depth	D =	0.66 ft
Critical Flow Velocity	V =	4.64 fps
Froude Number	**Fr =**	**1.00**
Critical Wetted Perimeter	P =	26.18 ft
Critical Hydraulic Radius	R =	0.66 ft
Critical (min) Specific Energy	Esc =	1.08 ft
Centroid on the Critical Flow Area	Yoc =	0.34 ft
Critical (min) Specific Force	Fsc =	1.09 kip

$Q/b = 80/20 = 4.0$

Figure 13-12c. Emergency Spillway Protection

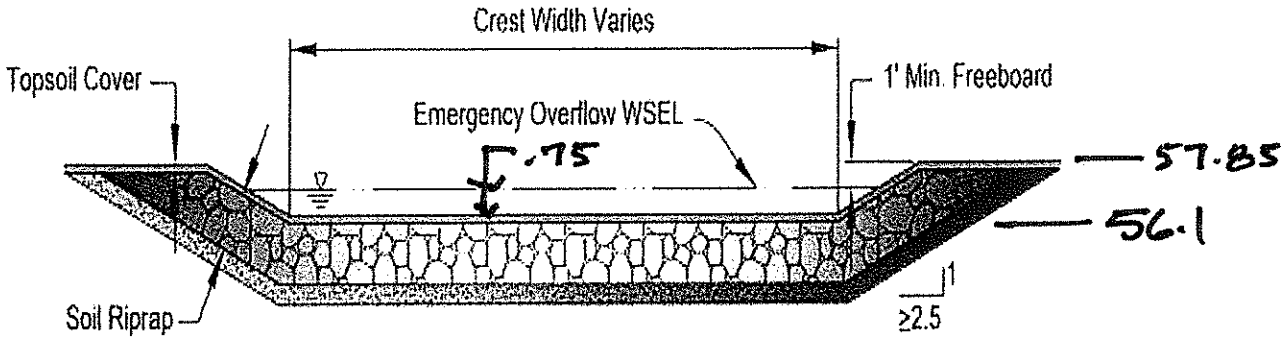
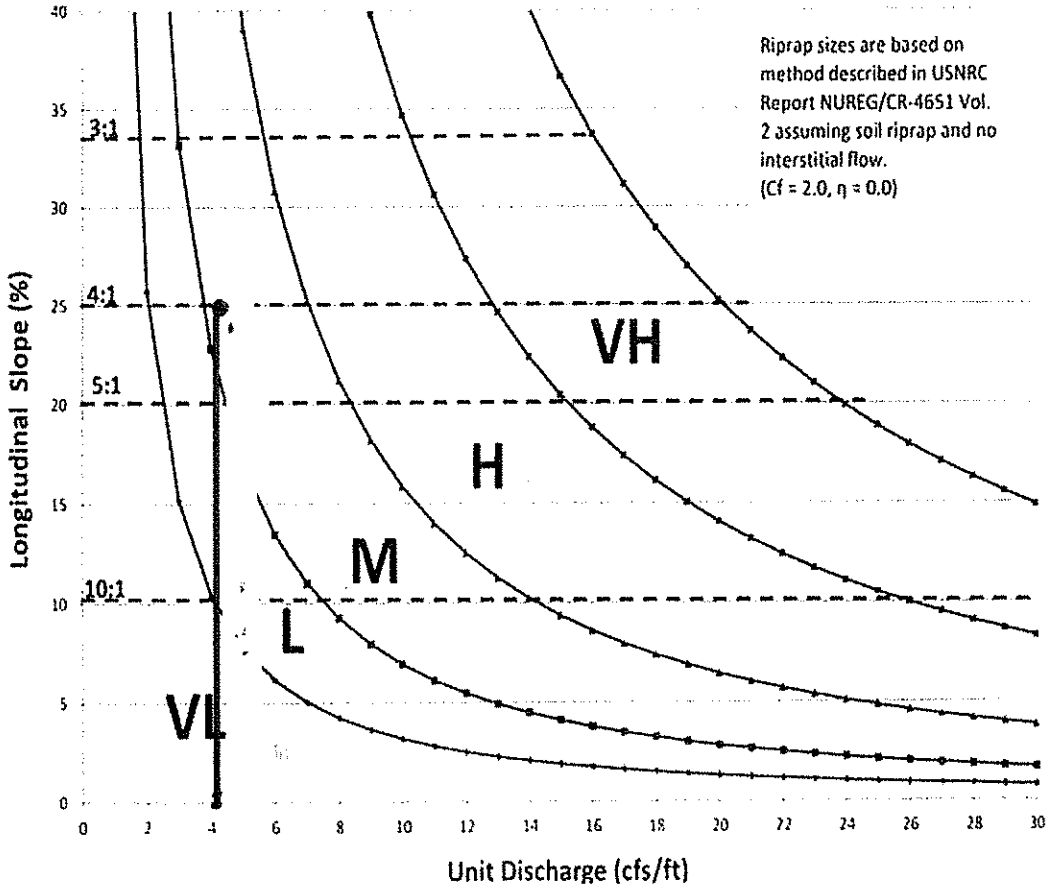


Figure 13-12d. Riprap Types for Emergency Spillway Protection



* TYPE M SOIL/RIPRAP

KIOWA ENGINEERING CORPORATION

JOB Rocky Top Resources

SHEET NO. _____ OF 17066

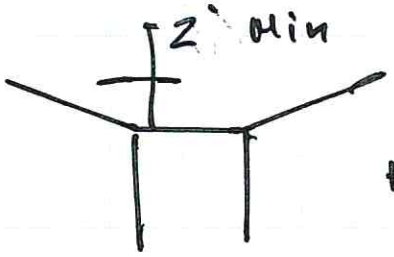
CALCULATED BY _____ DATE 5-10-19

CHECKED BY _____ DATE RDW

SCALE Hydraulics

Type 'C' Inlet @ entries to EDB

Assume 40 cfs (1/2 Q_{100} to each inlet) Q_{TOT} = 79.5 cfs



35" x 35" opening; std grate

A = 5.83 sf

$Q = C C_B A \sqrt{2gH}$ $C = .6$; $C_B = .75$

$Q = .6(.75)\sqrt{2g(2)}(5.83) = 29.7$ cfs low

Tay Type D inlet

35" x 80" = 19.4 sf.

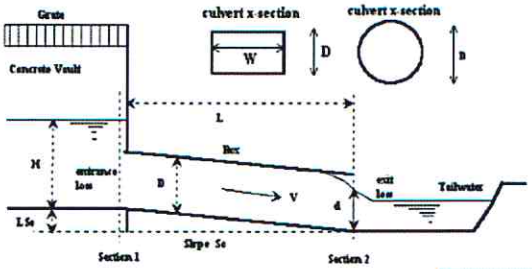
Level grate: H = 1.5

$Q = .6(.75)(19.4)\sqrt{2g(1.5)}$ = 86 cfs ∴ ok

use 30" RCP out: @ 5% elev. Q = 48 cfs

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Rocky Top Resources
Basin ID: 30-inch RCP
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	30	inches
	Inlet Edge Type (choose from pull-down list)		Square End with Headwall	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		1.5 : 1 Bevel w/ 45 Deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	49.5	ft. elev.
	Outlet Elevation at Culvert Invert OR Slope of Culvert (ft v./ft h.)	Outlet Elev =	49	ft. elev.
	Culvert Length in Feet	L =	60	ft.
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.47
Sum of All Loss Coefficients	K_s =	1.97
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	0.0152

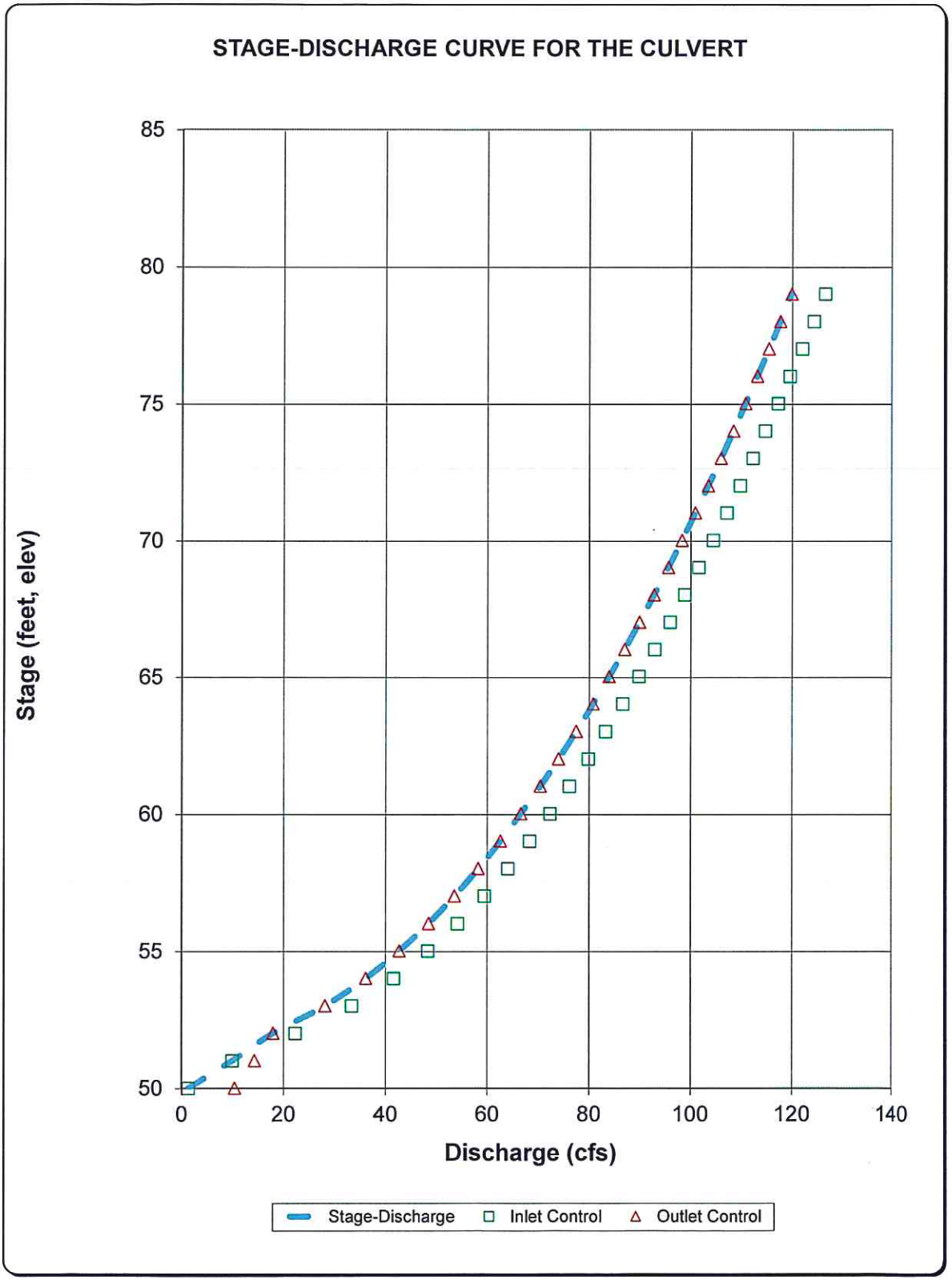
Calculations of Culvert Capacity (output):

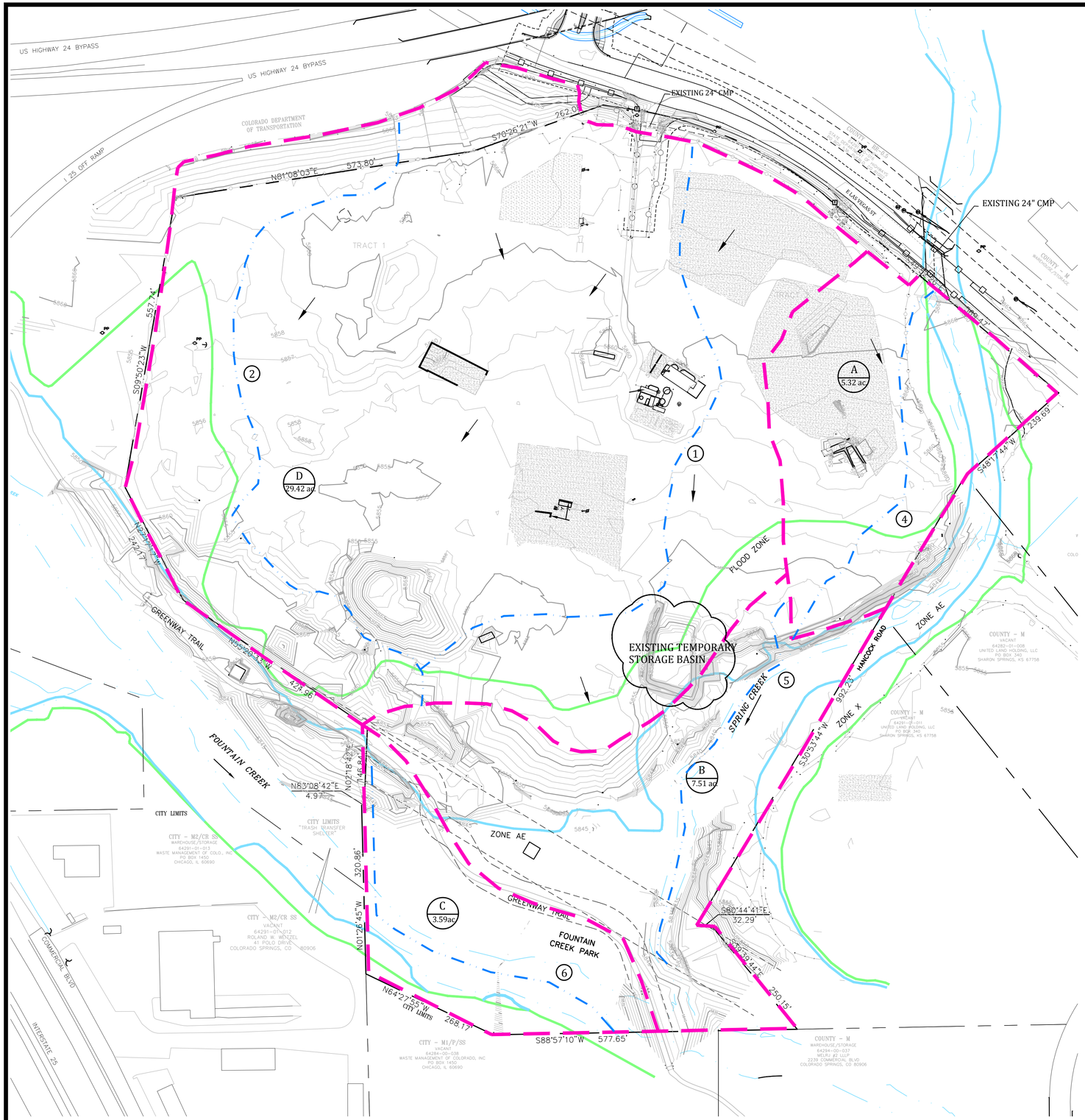
Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
50.00	49.00	1.40	10.45	**1.40**	Min. Energy. Eqn.	INLET
51.00	49.00	10.00	14.34	**10.00**	Regression Eqn.	INLET
52.00	49.00	22.40	17.99	**17.99**	Regression Eqn.	OUTLET
53.00	49.00	33.40	28.17	**28.17**	Regression Eqn.	OUTLET
54.00	49.00	41.70	36.16	**36.16**	Regression Eqn.	OUTLET
55.00	49.00	48.40	42.77	**42.77**	Regression Eqn.	OUTLET
56.00	49.00	54.20	48.51	**48.51**	Regression Eqn.	OUTLET
57.00	49.00	59.50	53.63	**53.63**	Regression Eqn.	OUTLET
58.00	49.00	64.10	58.29	**58.29**	Orifice Eqn.	OUTLET
59.00	49.00	68.40	62.63	**62.63**	Orifice Eqn.	OUTLET
60.00	49.00	72.40	66.67	**66.67**	Orifice Eqn.	OUTLET
61.00	49.00	76.20	70.48	**70.48**	Orifice Eqn.	OUTLET
62.00	49.00	79.90	74.09	**74.09**	Orifice Eqn.	OUTLET
63.00	49.00	83.30	77.54	**77.54**	Orifice Eqn.	OUTLET
64.00		86.70	80.84	**80.84**	Orifice Eqn.	OUTLET
65.00		89.90	84.01	**84.01**	Orifice Eqn.	OUTLET
66.00		93.00	87.07	**87.07**	Orifice Eqn.	OUTLET
67.00		96.00	90.01	**90.01**	Orifice Eqn.	OUTLET
68.00		98.90	92.87	**92.87**	Orifice Eqn.	OUTLET
69.00		101.70	95.65	**95.65**	Orifice Eqn.	OUTLET
70.00		104.50	98.35	**98.35**	Orifice Eqn.	OUTLET
71.00		107.20	100.96	**100.96**	Orifice Eqn.	OUTLET
72.00		109.80	103.52	**103.52**	Orifice Eqn.	OUTLET
73.00		112.30	106.01	**106.01**	Orifice Eqn.	OUTLET
74.00		114.80	108.45	**108.45**	Orifice Eqn.	OUTLET
75.00		117.30	110.84	**110.84**	Orifice Eqn.	OUTLET
76.00		119.60	113.17	**113.17**	Orifice Eqn.	OUTLET
77.00		122.00	115.46	**115.46**	Orifice Eqn.	OUTLET
78.00		124.30	117.70	**117.70**	Orifice Eqn.	OUTLET
79.00		126.50	119.91	**119.91**	Orifice Eqn.	OUTLET

Processing Time: 00.38 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Rocky Top Resources
Basin ID: 30-inch RCP





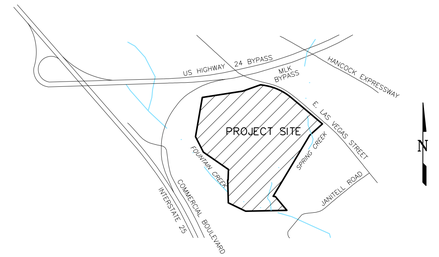


FIGURE 1
VICINITY MAP
NO SCALE

SPRING CREEK HYDROLOGY
Q_{10} = 960 cfs
Q_{50} = 1,790 cfs
Q_{100} = 2,340 cfs
Q_{500} = 4,340 cfs

FOUNTAIN CREEK HYDROLOGY
Q_{10} = 7,900 cfs
Q_{50} = 14,300 cfs
Q_{100} = 18,000 cfs
Q_{500} = 29,080 cfs

SUMMARY OF DISCHARGES-PREDEVELOPMENT

SUB-BASIN	AREA	Q5	Q100
	ac	cfs	cfs
A	5.32	0.9	6.1
B	7.51	1.6	10.9
C	3.59	0.9	5.7
D	29.42	4.4	28.6

LEGEND

- BASIN BOUNDARY
- A / XX ac. — BASIN # / AREA IN ACRES
- DP1 — DESIGN POINT
- FLOW DIRECTION
- 100 YEAR FLOODPLAIN
- 500 YEAR FLOODPLAIN
- FLOWPATH
- 1 — FLOWPATH NUMBER
- EXISTING CONCRETE PAVEMENT

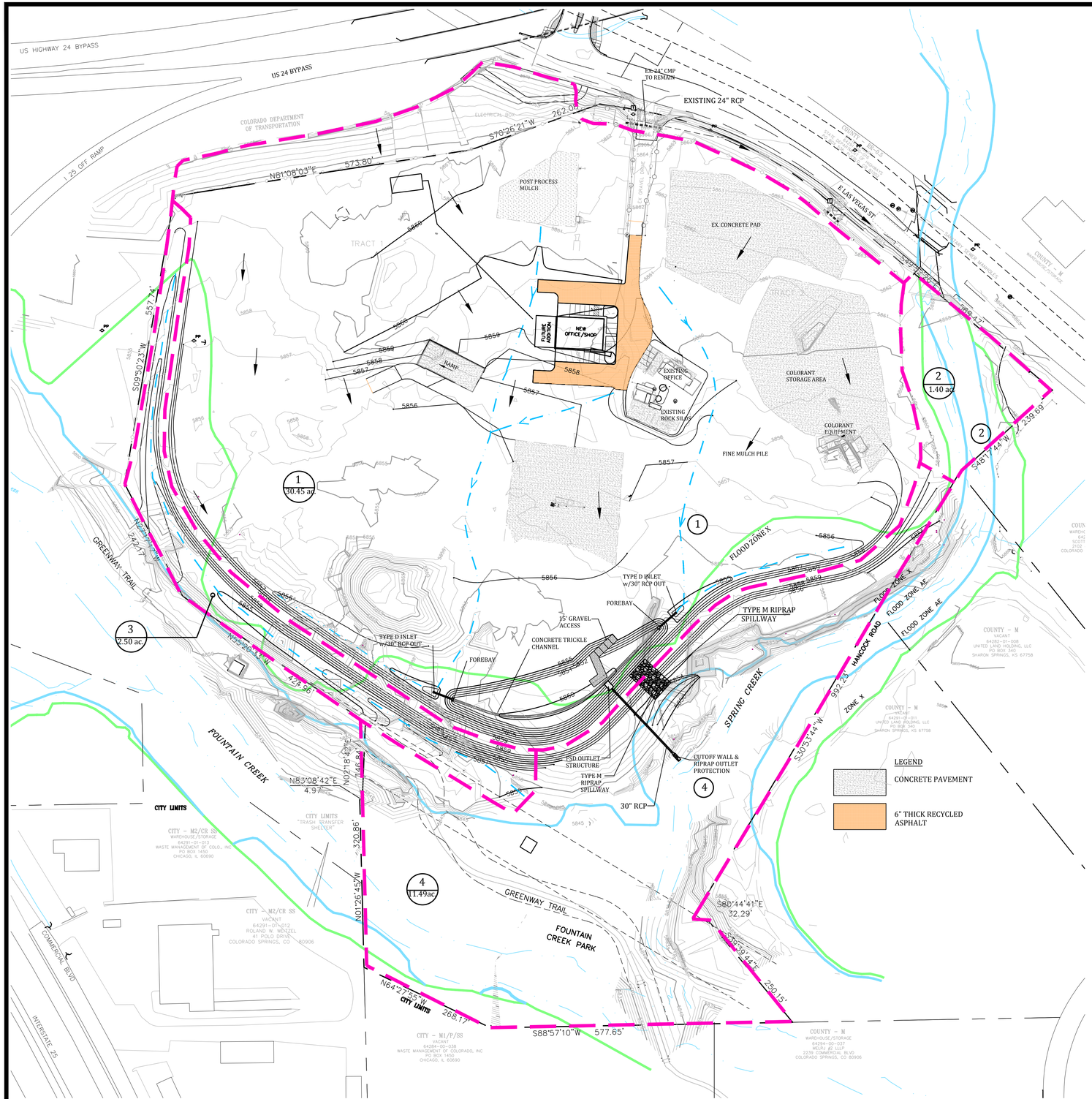
0 100' 200'
SCALE: 1"=100'

Kiowa Engineering Corporation
Celebrating 30 years
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

ROCKY TOP RESOURCES
EXISTING DRAINAGE PLAN
TRACT 7 GARDEN VALLEY SUBDIVISION
1755 EAST LAS VEGAS STREET
COLORADO SPRINGS, COLORADO

Project No.:	17066
Date:	02/2020
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

EXH. 1



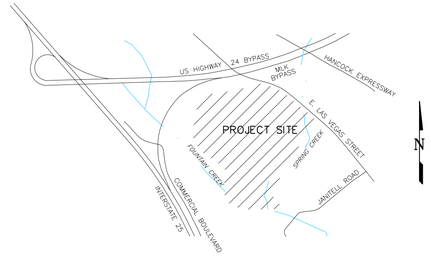


FIGURE 1
VICINITY MAP
NO SCALE

FULL SPECTRUM DETENTION
WQCV = 0.48 AF
EURV = 1.43 AF
100 YEAR + ½ WQCV = 2.82 AF

SPRING CREEK HYDROLOGY
Q_{10} = 960 cfs
Q_{50} = 1,790 cfs
Q_{100} = 2,340 cfs
Q_{500} = 4,340 cfs

FOUNTAIN CREEK HYDROLOGY
Q_{10} = 7,900 cfs
Q_{50} = 14,300 cfs
Q_{100} = 18,000 cfs
Q_{500} = 29,080 cfs

SUMMARY OF DISCHARGES

SUB-BASIN	AREA ac	Q5 cfs	Q100 cfs
1	30.45	28.8	79.5
2	1.40	0.5	3.4
3	2.50	0.5	3.2
4	11.49	2.0	13.2

LEGEND
- BASIN BOUNDARY
- A / XX ac — BASIN # / AREA IN ACRES
- DP1 — DESIGN POINT
- FLOW DIRECTION
- 100 YEAR FLOODPLAIN
- 500 YEAR FLOODPLAIN
- FLOWPATH
- 3 — FLOWPATH NUMBER

0 100' 200'
SCALE: 1"=100'

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Celebrating 30 years
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ROCKY TOP RESOURCES
PROPOSED DRAINAGE PLAN
TRACT 7 VALLEY GARDEN SUBDIVISION
1755 EAST LAS VEGAS STREET
COLORADO SPRINGS, COLORADO

Project No.:	17066
Date:	2/2020
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

EXH. 2