

Engineering Review

10/16/2019 10:51:39 AM

dsdkuehster

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EPC Planning & Community
Development Department

Cursory comments only
provided. please include all
items for a FDR. See El
Paso County FDR Checklist
in the Criteria manual.

Drainage Letter 15905 Sniper Lane

Proposed Fountain Springs Addition No. 2
(Colorado Springs Police Department Firing Range)
El Paso County, Colorado

Prepared for:
Colorado Springs Police Department
Pat Rigdon, 1342, Commander
705 South Nevada Avenue
Colorado Springs,
CO 80903
Ph: 719-444-7439

Prepared by:

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Engineering Corporation

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Colorado Springs, Colorado 80904
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Kiowa Project No. 19007

August 13th, 2019

PPR-19-043

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List of Figures and Tables (Refer to the Appendix Table of Contents)

Add a section "4 step process" and provide in the text discuss each step.

STATEMENTS AND APPROVALS

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 City/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

Registered Engineer (PE #25057)
For and on Behalf of Kiowa Engineering Corporation

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: _____
xxx
Colorado Springs Police Department

Date

Print Name: _____

Address: _____

EL PASO COUNTY:

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

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

Date

I. GENERAL LOCATION AND DESCRIPTION

The Site is located north of and adjacent to Pikes Peak International Raceway (PPIR). The overall property, owned by North Park 200 LLC, is approximately 199.954 acres in size with the Colorado Springs Police Department (CSPD) shooting range parcel being approximately 17.21 acres of that total. The CSPD parcel was conveyed from North Park 200 LLC to the City of Colorado Springs. The site is located southwest of exit 122 on Interstate 25. A portion of the overall site is located within the city limits of Fountain as is the PPIR site. The portion of the property within the City of Fountain was due to the contiguous annexation of PPIR. The CSPD shooting range property is located within El Paso County and is anticipated to be annexed into the City of Fountain in the future. The site is located within the southern half of Section 5, Township 17 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The overall site is bounded to the east by Interstate 25 and its frontage road, to the south by PPIR, to the west and north by Colorado Springs Utilities property. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the development is in fair to good condition with numerous weeds and grasses throughout the site. The existing ground slopes within the overall property as well as the subject property generally northwest to southeast at slopes from 0.5 to 1.5 percent. Soils within the subject site are classified to be within Hydrologic Soils Group C (Limon Clay #47) as shown in the *El Paso County Soils Survey*.

The site lies within the Crooked Canyon Drainage Basin. Crooked Canyon is an unstudied basin and as such is classified as a miscellaneous drainage basin by El Paso County.

A major drainageway draining the property to the west runs along the southern boundary of the overall property and the northern boundary of PPIR. A small drainageway runs north to south on the western boundary of the overall property as well as the subject property. This drainageway drains to the above-mentioned major drainageway. The major drainageway is directed around the raceway of PPIR to the north and then east of the raceway. The drainageway turns south along the eastern side of the raceway where it is directed under Interstate-25 at Exit 122 and a short way south under the BNSF railroad. The drainageway converges with Fountain Creek just east of the Interstate and railroad.

The site is intended to become a training facility for Colorado Springs' first responders. The project includes four shooting ranges including three 50-yard ranges and a single 100-yard range along with classroom/instructional space.

The site has been previously studied with the proposed Colorado Training Institute for Public Safety (COTIPS) project, which was not constructed. The site layout of the shooting ranges has remained the same from the previous COTIPS project. The approved drainage report is still applicable in general to this project.

II. MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the Crooked Canyon Drainage Basin. The subject site currently sheet flows to the major drainageway, which then conveys the runoff to Fountain Creek. No offsite flow enters the subject site area as flows are directed south by the existing channel located along the western boundary of overall property and this site. The overall site is encumbered by a Zone A floodplain which is located just north of the subject site. The major drainageway to the south located generally between the overall property and PPIR is also shown as a Zone A floodplain. The floodplains are shown per FIRM map 08041C1160G (with an effective date of December 7, 2018). The floodplains have been located on the property per the FIRM maps.

There is currently offsite runoff that approaches the site from the west and is deflected by the channel along the western boundary. Offsite Basin OS1 conveys runoff by sheet flow from undeveloped land west of the site to the western property boundary, where it is turned south and directed to the drainageway on the north side of PPIR.

III. DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria Manual*. Recent topography was prepared for the site. The topography was compiled using two-foot contour intervals as presented on The Drainage Plan. Hydrological Calculations were performed to reflect Proposed Conditions. The Drainage Plan presents the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The peak flow data generated using the Rational Method was used to size the pipes to drain each range. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the sub-basins within the project. The onsite soils were assumed to be Hydrologic Soil Group C, based on the *Soil Survey*. The existing and proposed conditions are the effectively the same for the purposes of determining runoff coefficients.

Hydraulic calculations are provided for the proposed drainage facilities. No water quality facility was designed as the imperviousness between existing and proposed conditions remains effectively unchanged.

IV. DRAINAGE FACILITY DESIGN

The drainage of the proposed ranges is to be accomplished by generally sloping the ranges to south at approximately one percent. Along the southern berm of each range will be tipped to the west to capture runoff in the southwest corner of each range. Each range is then drained to the existing drainage channel along the western boundary of the project and the overall property. Runoff will then be directed south to the drainageway located north of PPIR.

The proposed drainage patterns for the site are shown on the Proposed Drainage Plan (Sheet DP-1) provided in the map pocket at the end of this report. The hydrologic and hydraulic calculations are provided in the Appendix.

The following is a description of the on-site drainage sub-basins:

Sub-basin A1 is the southern 50-yard range and is approximately 1.55 acres in area. This area has been assumed to be 45% impervious as it is outside of the gravel parking surface for the PPIR overflow parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 2.2 cfs and 5.9 cfs for the 5 and 100-year storms respectively.

Sub-basin A2 is the middle 50-yard range and is approximately 1.46 acres in area. This area has been assumed to be 45% impervious as it is outside of the gravel parking surface for the PPIR overflow parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 2.1 cfs and 5.5 cfs for the 5 and 100-year storms respectively.

Sub-basin A3 is the northern 50-yard range and is approximately 1.78 acres in area. This area has been assumed to be 45% impervious as it is outside of the gravel parking surface for the PPIR overflow parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 2.5 cfs and 6.7 cfs for the 5 and 100-year storms respectively.

Sub-basin A4 is the 100-yard range and is approximately 3.32 acres in area. This area has been assumed to be 45% impervious as it is outside of the gravel parking surface for the PPIR overflow

Existing conditions drainage discussion and map are needed.

Discuss OS-1, E-1, etc. what happens to these off site basins is there a berm or swale proposed. discuss and call it out on the plan.

Call out where the "assumed 45% impervious" comes from. What is the proposed surfacing of the ranges.

parking. Runoff from this basin will sheet flow to the southwest corner of the range. The anticipated runoff amounts are 4.6 cfs and 12.2 cfs for the 5 and 100-year storms respectively.

Sub-basin A5 is the outside portion of the northern 100-yard range including the area north of the berm. The remainder of the subbasin includes the eastern portion of the site including the proposed classroom and gravel parking (native) lot. It contains approximately 6.36 acres in area. Runoff from this basin will sheet flow to the southeast in the same pattern as the existing site currently drains. The anticipated runoff amounts are 7.6 cfs and 20.0 cfs for the 5 and 100-year storms respectively.

Sub-basin A6 is the outside berm of all four ranges including the northern, western and southern berms. It contains approximately 2.21 acres in area. Runoff from this basin will sheet flow to the existing drainage channel located west of the ranges. The anticipated runoff amounts are 2.6 cfs and 6.9 cfs for the 5 and 100-year storms respectively.

Sub-basin E1 includes the existing drainage channel along the western boundary and contains approximately 0.54 acres in area. Runoff from this basin will combine with the range runoff and offsite flow and flow south and then east around the proposed ranges in the existing drainage channels. The anticipated runoff amounts are 0.3 cfs and 1.5 cfs for the 5 and 100-year storms respectively.

Sub-basin OS1 includes the offsite area to the west that is tributary to the existing drainage channel running along the western property boundary. It contains approximately 32.64 acres in area. Runoff from this basin will sheet flow to the existing drainage channel located west of the ranges. The anticipated runoff amounts are 12.8 cfs and 66.8 cfs for the 5 and 100-year storms respectively.

A. STORMWATER DETENTION AND WATER QUALITY DESIGN

Detention and storm water quality measures are not required by the County in Volume 2 of the *City/County Drainage Criteria Manual* as there is no urbanization or increase in imperviousness for the project.

B. COST OF PROPOSED PUBLIC DRAINAGE FACILITIES

There are no public facilities proposed for the shooting ranges.

There is more than 1 acre of surfacing proposed, SWQCV/FSD needs to be provided.

C. DRAINAGE AND BRIDGE FEES

The site lies within the Crooked Canyon Creek Drainage Basin. The current drainage basin fee associated with the Crooked Canyon Creek Drainage Basin is \$5,540 per impervious acre. The current bridge fee associated with the Crooked Canyon Creek Drainage Basin is \$0 per impervious acre. As there is effectively no increase in imperviousness, no drainage fees are required.

Fees will be due on the increase in imperviousness. parking lot, shooting structures, range surfacing, access roads, etc.

V. CONCLUSIONS

This project will contain four shooting ranges and associated supporting facilities covering approximately 17.21 acres. Onsite Drainage will sheet flow within the ranges, generally, to the southwestern corner of each range. The runoff will then be directed in a pipe to the existing drainage channel located along the west side of the project and the western boundary of the overall property. The proposed development will not adversely impact or deteriorate improvements or natural drainageways downstream of the property.

call out the pipe on the drainage map/plan.

VI. REFERENCES

- 1) Final Drainage Report, Phase 1 Colorado Training Institute for Public Safety (Proposed Fountain Springs Addition No. 2), prepared by Kiowa Engineering Corporation, dated August 13, 2016.
- 2) City of Colorado Springs and El Paso County Flood Insurance Study, prepared by the Federal Emergency Management Agency, dated March 1997.
- 3) El Paso County Drainage Criteria Manual (Volumes 1 and 2) and Engineering Criteria Manual, current editions.
- 4) Soil Survey of El Paso County Area, Colorado, prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.

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Figure 2: Soils Map

FEMA Flood Insurance Rate Map (Panels 1160)

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Developed Condition – Runoff Coef, Time of Concentration and Runoff Calcs

APPENDIX B

Hydraulic Calculations

Culvert Sizing Calculations

APPENDIX C

Drainage Plans

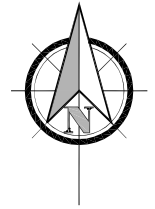
Sheet DP2 – Overall Phase 1 Drainage Plan

APPENDIX

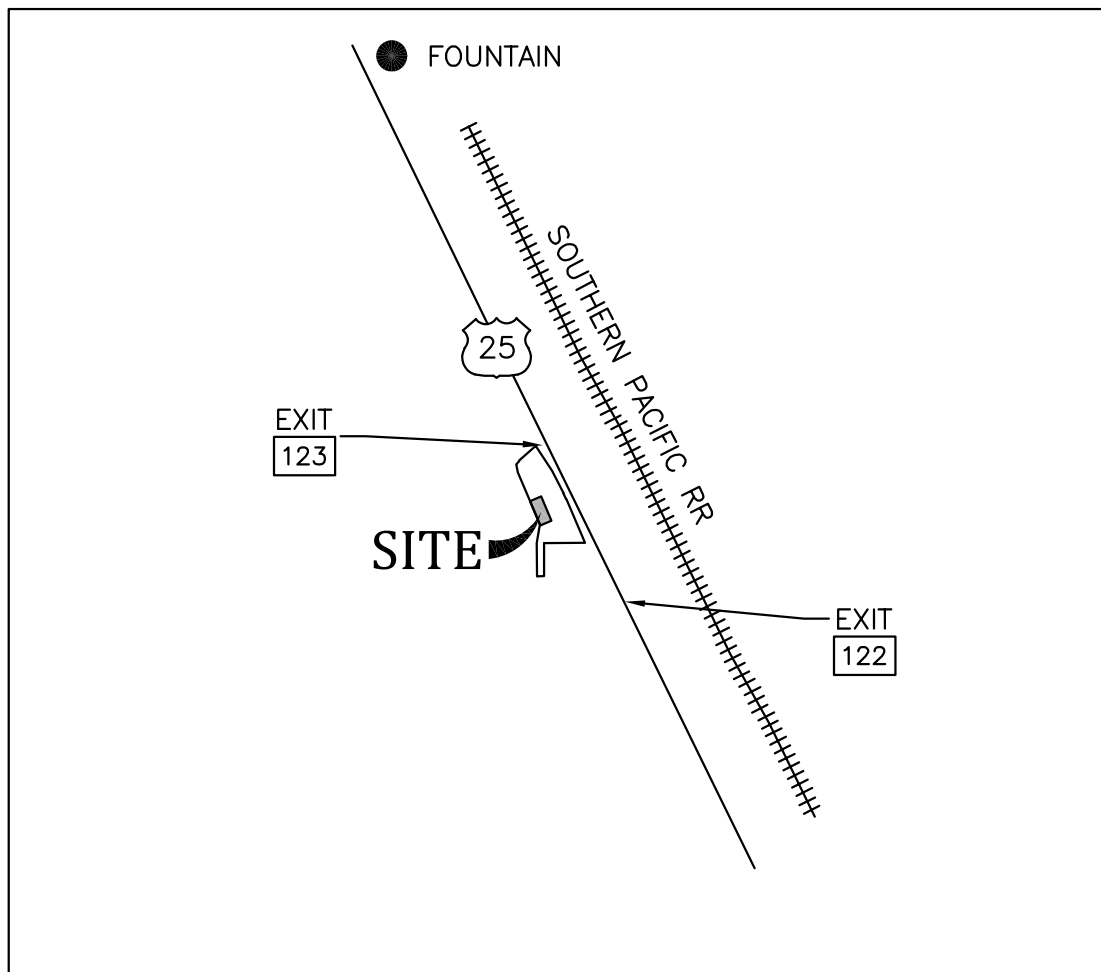
Figure 1: Vicinity Map

Figure 2: Soils Map

FEMA Flood Insurance Rate Map (Panels 1160)



Not to Scale



VICINITY MAP

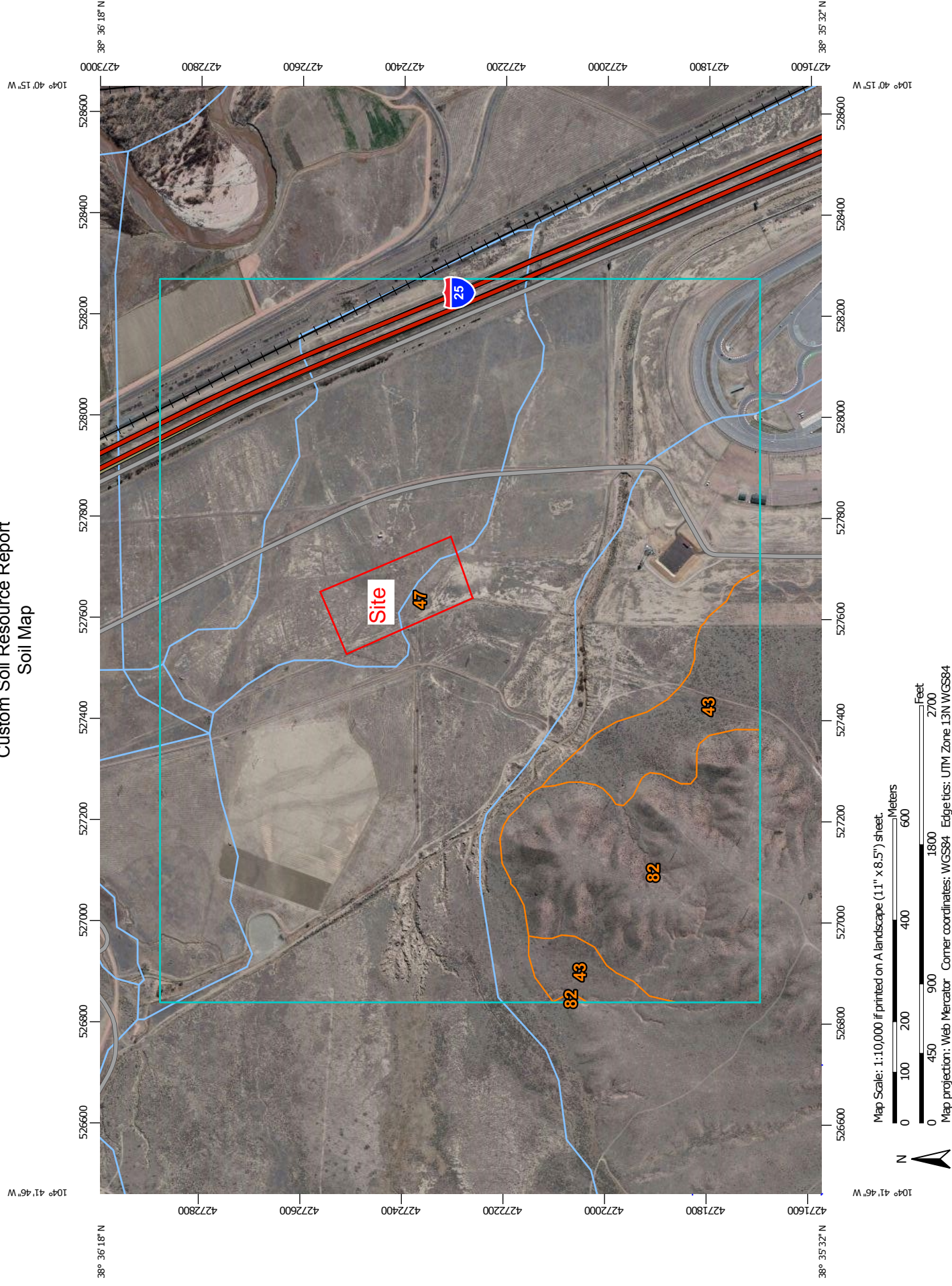
FIGURE 1

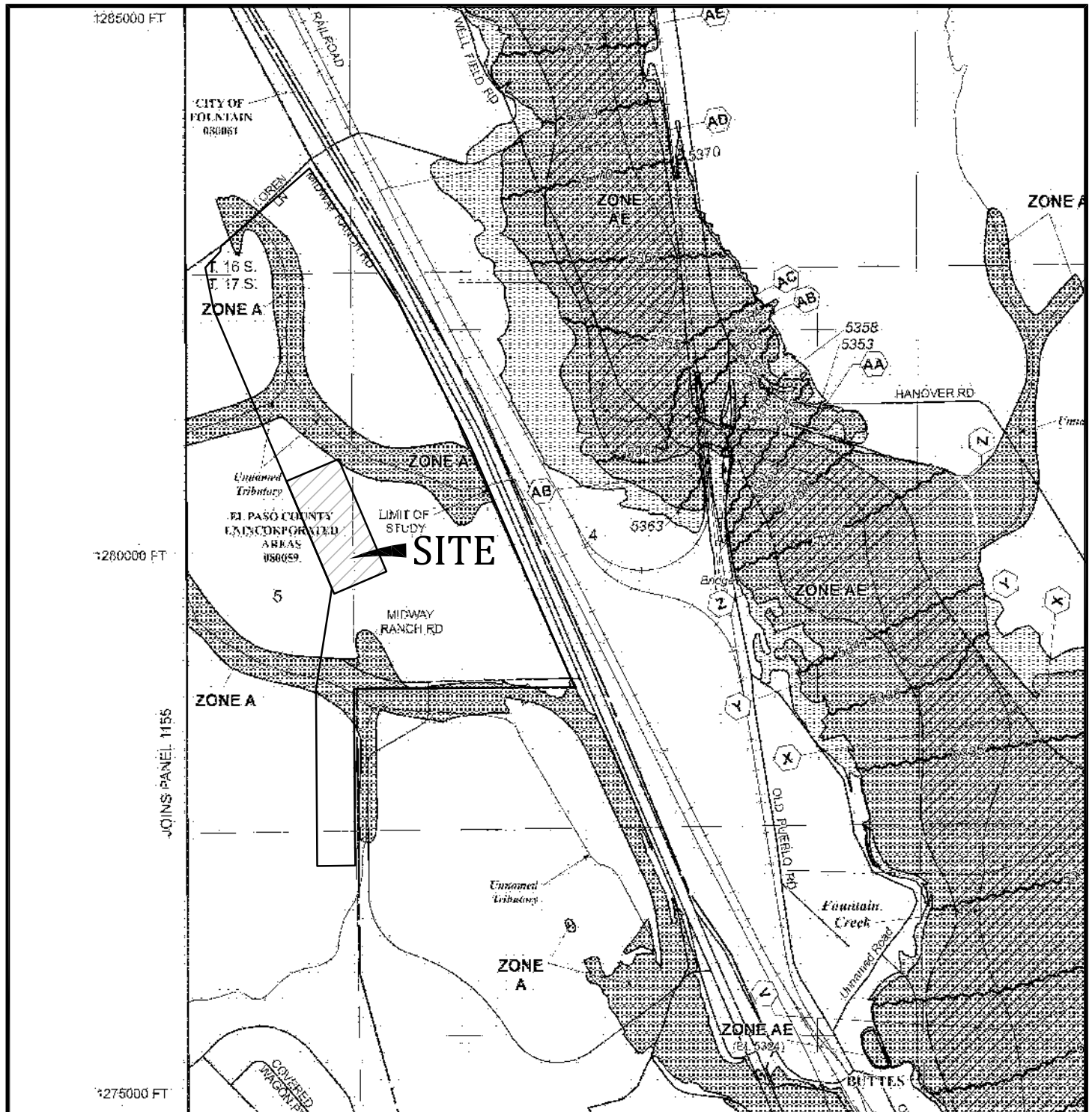
Colorado Springs Police Department
Final Drainage Report
Colorado Springs, Colorado

Kiowa
Engineering Corporation

1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

Custom Soil Resource Report Soil Map





FEMA FLOOD INSURANCE RATE MAP
 PANEL NO. 08041C0729 G
 EFFECTIVE DATE: DECEMBER 7, 2018



APPROXIMATE
 SCALE: 1"=1,300'

FIGURE 3

Colorado Springs Police Department
 Final Drainage Report
 Colorado Springs, Colorado

Kiowa
 Engineering Corporation

1604 South 21st Street
 Colorado Springs, Colorado 80904
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APPENDIX A

Hydrologic Calculations

Developed Condition – Runoff Coeff, Time of Concentration and Runoff Calcs

CSPD Shooting Ranges

Runoff Coefficient and Percent Impervious Calculation

| Basin / DP | Basin or DP Area (DP contributing basins) | Soil Type | OF | | HI | | RO | | CO | | DR | | Area 5 LandUse | | Basin % Imperv | Basin Runoff Coef | |
|------------|---|-----------|----------|---------------|--------|---------------------|----------|---------------|--------|---------------------|----------|---------------|----------------|---------------------|----------------|-------------------|------------------|
| | | | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | | C ₅ | C ₁₀₀ |
| A1 | 67,537 sf | 1.55ac | 45% | 1.55ac | 100% | 45% | 2% | 0% | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| A2 | 63,696 sf | 1.46ac | 45% | 1.46ac | 100% | 45% | 2% | 0% | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| A3 | 77,526 sf | 1.78ac | 45% | 1.78ac | 100% | 45% | 2% | 0% | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| A4 | 144,530 sf | 3.32ac | 45% | 3.32ac | 100% | 45% | 2% | 0% | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| A5 | 276,967 sf | 6.36ac | 45% | 6.21ac | 98% | 44% | 2% | 0% | 0% | 2% | 90% | 0.15ac | 0% | 0% | 0% | 0.38 | 0.59 |
| A6 | 96,306 sf | 2.21ac | 45% | 2.21ac | 100% | 45% | 2% | 0% | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| E1 | 23,307 sf | 0.54ac | 45% | 0.00ac | 0% | 0% | 2% | 0.54ac | 100% | 2% | 90% | 0% | 0% | 0% | 0% | 0.16 | 0.51 |
| OS1 | 1,421,756 sf | 32.64ac | 45% | 0.00ac | 0% | 0% | 2% | 32.64ac | 100% | 2% | 90% | 0% | 0% | 0% | 0% | 0.16 | 0.51 |
| Onsite (H) | 749,870 sf | 17.21ac | 45% | 16.67ac | 97% | 44% | 2% | 0.54ac | 3% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| Onsite (P) | 749,870 sf | 17.21ac | 45% | 16.52ac | 96% | 43% | 2% | 0.54ac | 3% | 1% | 90% | 0.15ac | 0% | 0% | 0% | 0.37 | 0.59 |
| DP 1 | 353,289 sf | 8.11ac | 45% | 8.11ac | 100% | 45% | 2% | 0.00 ac | 0% | 0% | 90% | 0% | 0% | 0% | 0% | 0.37 | 0.59 |
| DP2 | 2,075,319 sf | 47.64ac | 45% | 15.00ac | 31% | 14% | 2% | 32.64 ac | 69% | 1% | 90% | 0.00 ac | 0% | 0% | 0% | 0.24 | 0.54 |

Basin Runoff Coefficient is based on % Imperviousness Calculation

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

| Runoff Coefficients and Percents Impervious | | | | |
|---|-----|--------------------|----------------|------------------|
| Hydrologic Soil Type: | CD | Runoff Coef Method | | |
| | | % | C ₅ | C ₁₀₀ |
| Land Use | Abb | | | |
| Commercial Area | CO | 95% | 0.82 | 0.89 |
| Drives and Walks | DR | 100% | 0.90 | 0.96 |
| Streets - Gravel (Packed) | GR | 80% | 0.63 | 0.74 |
| Historic Flow Analysis | HI | 2% | 0.16 | 0.26 |
| Lawns | LA | 0% | 0.15 | 0.25 |
| Off-site flow-Undeveloped | OF | 45% | 0.37 | 0.44 |
| Park | PA | 7% | 0.19 | 0.29 |
| Streets - Paved | PV | 100% | 0.90 | 0.92 |
| Roofs | RO | 90% | 0.75 | 0.83 |
| User Input 1 | US1 | 40% | 0.35 | 0.42 |
| User Input 2 | US2 | 65% | 0.49 | 0.65 |

CSPD Shooting Ranges

Time of Concentration Calculation

| Sub-Basin Data | | | Time of Concentration Estimate | | | | | | | | | | | Min. Tc in Urban | | Final t _c |
|----------------------|------------------------------|---------|--------------------------------|---|-------|----------------|-------------------------------|-------|-----------|----|------------|----------------|------------------|------------------|----------------------|----------------------|
| Basin / Design Point | Contributing Basins | Area | C ₅ | Initial/Overland Time (t _i) | | | Travel Time (t _t) | | | | | Comp. | Tc Check (urban) | | | |
| | | | | Length | Slope | t _i | 18 | Slope | Land Type | Cv | Velocity | t _t | t _c | Total Length | t _c Check | |
| A1 | Site outside Ranges (East) | 1.55ac | 0.37 | 201f | 66.7% | 1.5 min. | 4051f | 0.6% | SP | 7 | 0.6 ft/sec | 12.2 min. | 13.7 min. | 4251f | 12.4 min. | 12.4 min. |
| A2 | | 1.46ac | 0.37 | 201f | 66.7% | 1.5 min. | 4051f | 0.6% | SP | 7 | 0.6 ft/sec | 12.2 min. | 13.7 min. | 4251f | 12.4 min. | 12.4 min. |
| A3 | | 1.78ac | 0.37 | 351f | 66.7% | 1.9 min. | 4401f | 0.5% | SP | 7 | 0.5 ft/sec | 14.8 min. | 16.8 min. | 4751f | 12.6 min. | 12.6 min. |
| A4 | | 3.32ac | 0.37 | 321f | 66.7% | 1.9 min. | 5801f | 0.5% | SP | 7 | 0.5 ft/sec | 19.5 min. | 21.4 min. | 6121f | 13.4 min. | 13.4 min. |
| A5 | | 6.36ac | 0.38 | 321f | 66.7% | 1.8 min. | 16021f | 0.5% | GW | 15 | 1.1 ft/sec | 25.2 min. | 27.0 min. | 16341f | 19.1 min. | 19.1 min. |
| A6 | | 2.21ac | 0.37 | 321f | 66.7% | 1.9 min. | 16021f | 0.5% | GW | 15 | 1.1 ft/sec | 25.2 min. | 27.0 min. | 16341f | 19.1 min. | 19.1 min. |
| E1 | Site outside Ranges (West) | 0.54ac | 0.16 | 321f | 0.5% | 12.2 min. | 12461f | 0.5% | GW | 15 | 1.1 ft/sec | 19.6 min. | 31.8 min. | 12781f | 17.1 min. | 17.1 min. |
| OS1 | | 32.64ac | 0.16 | 1001f | 2.0% | 13.6 min. | 37801f | 0.9% | SP | 7 | 0.7 ft/sec | 94.9 min. | 108.5 min. | 38801f | 31.6 min. | 31.6 min. |
| Onsite | A1-A4 A1-A5, E1 & OS1 | 17.21ac | 0.37 | 1001f | 2.0% | 10.6 min. | 37801f | 0.9% | SP | 7 | 0.7 ft/sec | 94.9 min. | 105.5 min. | 38801f | 31.6 min. | 31.6 min. |
| DP1 | | 8.11ac | 0.37 | 1001f | 2.0% | 10.6 min. | 37801f | 0.9% | SP | 7 | 0.7 ft/sec | 94.9 min. | 105.4 min. | 38801f | 31.6 min. | 31.6 min. |
| DP2 | | 47.64ac | 0.24 | 321f | 66.7% | 2.2 min. | 16021f | 0.5% | GW | 15 | 1.1 ft/sec | 25.2 min. | 27.4 min. | 16341f | 19.1 min. | 19.1 min. |

Equations:

$$t_i (\text{Overland}) = 0.395(1.1 - C_5)L^{0.5}S^{-0.333}$$

C₅ = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Table 6-7: Conveyance Coef (City CS DCM, Vol 1)

| Type of Land Surface | Land Type | Cv |
|----------------------|-----------|-----|
| Grassed Waterway | GW | 15 |
| Heavy Meadow | HM | 2.5 |
| Nearly Bare Ground | NBG | 10 |
| Paved Area | PV | 20 |
| Riprap (Not Buried) | RR | 6.5 |
| Short Pasture/Lawns | SP | 7 |
| Tillage/Fields | TF | 5 |

$$\text{Velocity (Travel Time)} = CvS^{0.5}$$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

CSPD Shooting Ranges Runoff Calculation

| Basin / Design Point | Contributing Basins | Drainage Area | C ₅ | C ₁₀ | C ₁₀₀ | Time of Concentration | i ₅ | i ₁₀ | i ₁₀₀ | Q ₅ | Q ₁₀ | Q ₁₀₀ | Basin / DP |
|-------------------------|-------------------------|------------------|----------------|-----------------|------------------|--------------------------|----------------|-----------------|------------------|----------------|-----------------|------------------|------------|
| A1 | Site outside ranges (E) | 1.55 ac | 0.37 | 0.44 | 0.59 | 12.4 min. | 3.8 in/hr | 4.4 in/hr | 6.4 in/hr | 2.2 cfs | 3.0 cfs | 5.9 cfs | A1 |
| A2 | | 1.46 ac | 0.37 | 0.44 | 0.59 | 12.4 min. | 3.8 in/hr | 4.4 in/hr | 6.4 in/hr | 2.1 cfs | 2.8 cfs | 5.5 cfs | A2 |
| A3 | | 1.78 ac | 0.37 | 0.44 | 0.59 | 12.6 min. | 3.8 in/hr | 4.4 in/hr | 6.3 in/hr | 2.5 cfs | 3.4 cfs | 6.7 cfs | A3 |
| A4 | | 3.32 ac | 0.37 | 0.44 | 0.59 | 13.4 min. | 3.7 in/hr | 4.3 in/hr | 6.2 in/hr | 4.6 cfs | 6.2 cfs | 12.2 cfs | A4 |
| A5 | | 6.36 ac | 0.38 | 0.44 | 0.59 | 19.1 min. | 3.2 in/hr | 3.7 in/hr | 5.3 in/hr | 7.6 cfs | 10.3 cfs | 20.0 cfs | A5 |
| A6 | | 2.21 ac | 0.37 | 0.44 | 0.59 | 19.1 min. | 3.2 in/hr | 3.7 in/hr | 5.3 in/hr | 2.6 cfs | 3.6 cfs | 6.9 cfs | A6 |
| E1 | Site outside ranges (W) | 0.54 ac | 0.16 | 0.26 | 0.51 | 17.1 min. | 3.3 in/hr | 3.9 in/hr | 5.6 in/hr | 0.3 cfs | 0.5 cfs | 1.5 cfs | E1 |
| OS1 | | 32.64 ac | 0.16 | 0.26 | 0.51 | 31.6 min. | 2.4 in/hr | 2.8 in/hr | 4.0 in/hr | 12.8 cfs | 24.0 cfs | 66.8 cfs | OS1 |
| Onsite | Phase 1 A2-A5 All | 17.21 ac | 0.37 | 0.43 | 0.59 | 31.6 min. | 2.4 in/hr | 2.8 in/hr | 4.0 in/hr | 15.2 cfs | 20.9 cfs | 41.0 cfs | Onsite |
| DP1 | | 8.11 ac | 0.37 | 0.44 | 0.59 | 31.6 min. | 2.4 in/hr | 2.8 in/hr | 4.0 in/hr | 7.3 cfs | 9.9 cfs | 19.4 cfs | DP1 |
| DP2 | | 47.64 ac | 0.24 | 0.33 | 0.54 | 19.1 min. | 3.2 in/hr | 3.7 in/hr | 5.3 in/hr | 36.0 cfs | 57.4 cfs | 137.5 cfs | DP2 |

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$$i_2 = -1.19 \ln(T_c) + 6.035$$

$$i_5 = -1.50 \ln(T_c) + 7.583$$

$$i_{10} = -1.75 \ln(T_c) + 8.847$$

$$i_{100} = -2.52 \ln(T_c) + 12.735$$

Q = C i A

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

APPENDIX B
Hydraulic Calculations
Culvert Sizing Calculations

CSPD Shooting Ranges Pipe Diameter Calculations

| Pipe # | 100yr Flow | Design Flow | Contributing Flows | Manning 'n' | Pipe Slope | Calculated Pipe Diameter | Pipe Diameter | Minimum Slope of Pipe | Full Pipe Flow Velocity | Head above Pipe Flowline | H | Pipe Inlet Control Capacity | Mannings Pipe Capacity | Capacity Check |
|--------|------------|-------------|--------------------|-------------|------------|--------------------------|---------------|-----------------------|-------------------------|--------------------------|------|-----------------------------|------------------------|----------------|
| A1 | 5.9 cfs | 2.2 cfs | | 0.013 | 0.5% | 11-inch | 12-inch | 0.38% | 3.2 ft/sec | | ---- | ---- | 2.5 cfs | OK |
| A2 | 5.5 cfs | 2.1 cfs | | 0.013 | 0.5% | 11-inch | 12-inch | 0.35% | 3.2 ft/sec | | ---- | ---- | 2.5 cfs | OK |
| A3 | 6.7 cfs | 2.5 cfs | | 0.013 | 0.5% | 12-inch | 12-inch | 0.49% | 3.2 ft/sec | | ---- | ---- | 2.5 cfs | OK |
| A4 | 12.2 cfs | 4.6 cfs | | 0.013 | 0.5% | 15-inch | 18-inch | 0.19% | 4.2 ft/sec | | ---- | ---- | 7.4 cfs | OK |

Equations:

Pipe Dia= $((2.16Qn)/(S^{0.5}))^{0.375}$

Q = Discharge in cubic feet per second

n = Manning's roughness coefficient

RCP=0.013, CMP=0.024, HDPE (smooth)=0.012

S = Slope of the pipe

R_h = Hydraulic Radius

Flow Velocity = $(1.49/n)R_h^{2/3}S^{1/2}$

Pipe Capacity = $(1.49/n)AR_h^{2/3}S^{1/2}$

A = Cross-sectional area of pipe

A= $p(D^2/4)$

D = Inside Diameter of Pipe

R_h = A_w/W_p

A_w = $p(d^2/4)$

A_w = Water Cross Sectional Area

d = Water (Flow) Depth Within Pipe

W_p = pd (For Capacity Calculation)

W_p=Wetted Perimeter of Pipe

Orifice Equation:

Q = $CA(2gH)^{0.5}$

C = Orifice coefficient (dimensionless)

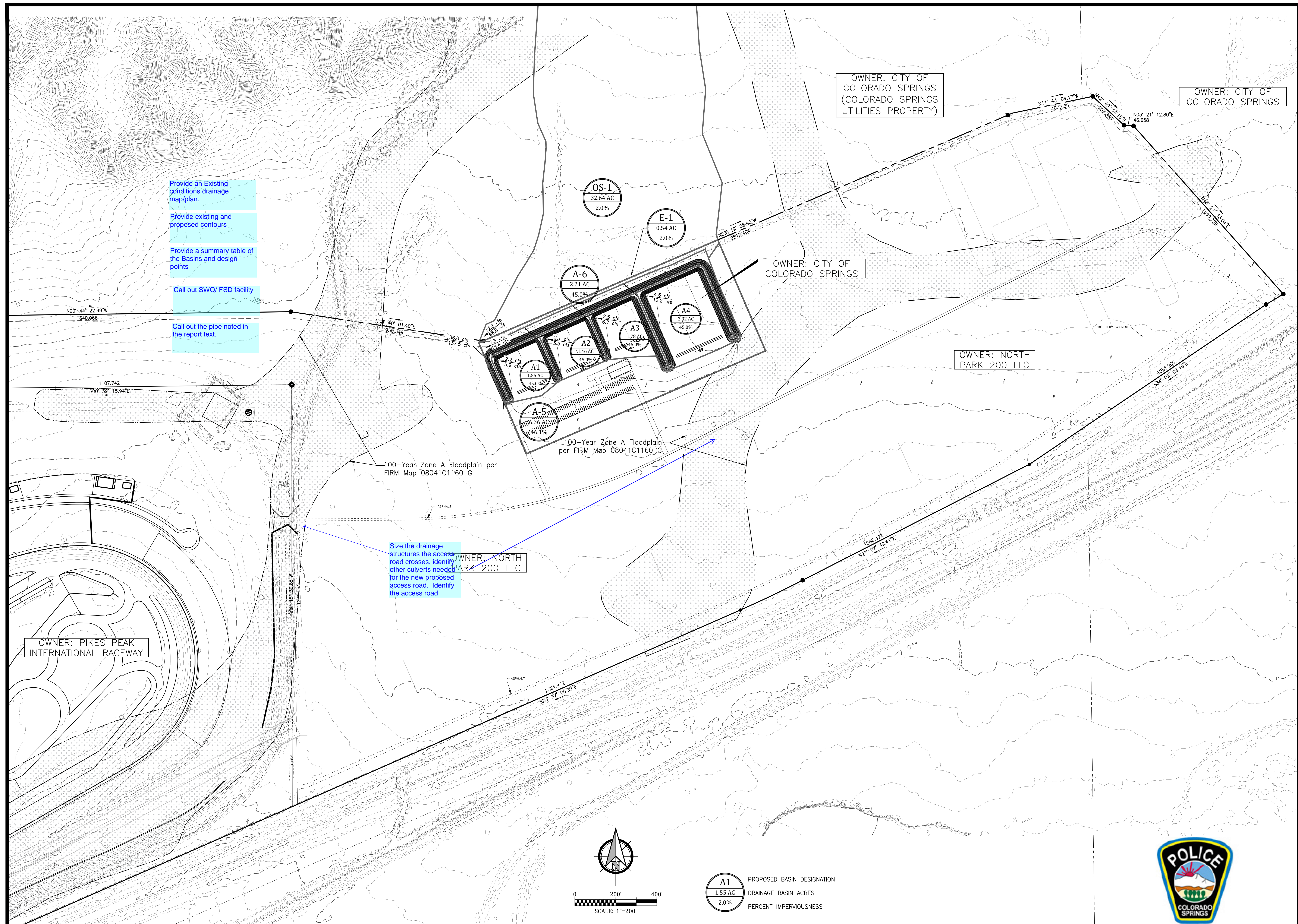
C = 0.65

A = Cross-sectional area of opening, in sf

g = Gravitational accel constant, 32.2 ft/sec²

H = Head above centerline of pipe, ft

APPENDIX C
Drainage Plans
Sheet DR-1 – Proposed Drainage Plan




HB&A
Architecture
AND
Planning

| | |
|--------------|-----------------|
| Project No.: | 19007 |
| Date: | August 13, 2019 |
| Design: | AWMc |
| Drawn: | MJK |
| Check: | AWMc |
| Revisions: | |


Drainage Letter_V1.pdf Markup Summary

Locked (19)

Engineering Review
10/16/2019 10:34:39 AM
d.kuehster
steve.kuehster@el-paso.com
(719) 520-0813
EPC Planning & Community
Development Department


Subject: EPC ENG Review
Page Label: 1
Lock: Locked
Author: Steve Kuehster
Date: 10/17/2019 12:17:25 PM
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Cursory comments only
provided. please include all
items for a FDR. See El
Paso County FDR Checklist
in the Criteria manual.

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Date: 10/17/2019 12:17:27 PM
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Cursory comments only provided. please include all items for a FDR. See El Paso County FDR Checklist in the Criteria manual.

August 13th, 2019
PPR-19-043

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Date: 10/17/2019 12:17:28 PM
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PPR-19-043

DESIGN
The current drainage basin
is 55.540 acre immovable across
the site. The current drainage basin
is 55.540 acre immovable across
the site.

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Date: 10/17/2019 12:17:31 PM
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There is more than 1 acre of surfacing proposed, SWQCV/FSD needs to be provided.

water quality facility was
discussed. The current drainage basin
is 55.540 acre immovable across
the site. The current drainage basin
is 55.540 acre immovable across
the site.

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Author: Steve Kuehster
Date: 10/17/2019 12:17:45 PM
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Discuss OS-1, E-1, etc. what happens to these off site basins is there a berm or swale proposed. discuss and call it out on the plan.

Add a section "4 step process" and provide in the text discuss each step.

Existing conditions drainage discussion and map are needed.

Call out where the "assumed 45% impervious" comes from. What is the proposed surfacing of the ranges.

Jennifer Irvine, P.E.

Fees will be due on the increase in imperviousness, parking lot, shooting structures, range surfacing, access roads, etc.

p

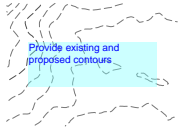
then be directed in a pipe to the existing drainage map/plan and the western boundary of the overall project impact or deteriorate improvements or is.

Call out the pipe on the drainage map/plan.

Kiewit Engineering Corporation

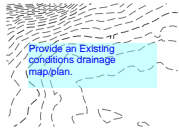
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Author: Steve Kuehster
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call out the pipe on the drainage map/plan.



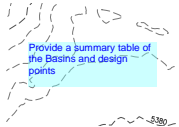
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Provide existing and proposed contours



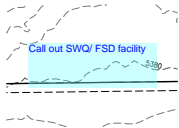
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Provide an Existing conditions drainage map/plan.



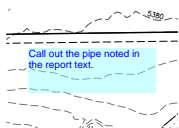
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Provide a summary table of the Basins and design points



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Call out SWQ/ FSD facility



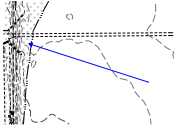
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Call out the pipe noted in the report text.



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Author: Steve Kuehster
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Size the drainage structures the access road crosses. identify other culverts needed for the new proposed access road. Identify the access road



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Author: Steve Kuehster
Date: 10/17/2019 12:22:39 PM
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