DRAINAGE LETTER REPORT

for

ROCKY MOUNTAIN CYCLE PLAZA – PHASE 2
14605 STRUTHERS ROAD
LOTS 3-4, STRUTHERS RANCH SUBDIVISION FILING NO. 4

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

October 30, 2026

Prepared by:

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JPS Project No. 032203
PCD Filing No. PPR___

ROCKY MOUNTAIN CYCLE PLAZA – PHASE 2
DRAINAGE LETTER REPORT
TABLE OF CONTENTS

PAGE

DRAINAGE STATEMENT i

I. INTRODUCTION 1

II. EXISTING / PROPOSED DRAINAGE CONDITIONS 2

III. DRAINAGE PLANNING FOUR STEP PROCESS 5

IV. FLOODPLAIN IMPACTS 5

V. STORMWATER DETENTION AND WATER QUALITY 6

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES 6

VII. SUMMARY 6

APPENDICES

APPENDIX A Excerpts from Previous Drainage Report
APPENDIX B Hydrologic Calculations
APPENDIX C Hydraulic Calculations
APPENDIX D Figures
Sheet D1.1 Developed Drainage Plan

DRAINAGE STATEMENT

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 liability caused by negligent acts, errors or omissions on my part in preparing this report.

John P. Schwab, P.E. #29891

Developer's Statement:

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

By:

_____

Date

Hammers Construction, Inc.
1411 Woolsey Heights, Colorado Springs, CO 80915

El Paso County's Statement

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

Joshua J. Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

I. INTRODUCTION

A. Property Location and Description

Hammers Construction is planning to construct the proposed Rocky Mountain Cycle Plaza (RMCP) – Phase 2 building on the vacant 1.2-acre property along the southeast side of the existing RMCP building at 847 Struthers Ranch Road in northern El Paso County, Colorado. The Phase 2 property is described as Lots 3 and 4, Struthers Ranch Subdivision Filing No. 4 (El Paso County Assessor's Parcel Numbers 71363-03-012 and 71363-03-013).

The project consists of a new 7,750 square-foot, single-story dealership / storage building with associated parking and site improvements. The property is bounded by the existing 2.9-acre RMCP property along the northwest side (platted as Lot 1A, Struthers Ranch Subdivision Filing No. 4). Struthers Road is a fully improved, asphalt-paved arterial public street along the southwest boundary of the site, and existing developed single-family residential lots (platted as Struthers Ranch Filing No. 2) are located along the northeast and east boundaries of the site.

The property is zoned Planned Unit Development (PUD), and the proposed site development is fully consistent with the existing zoning of the site. Access to the site will be provided by the existing private driveway connection to Struthers Ranch Road along the north boundary of Lot 1A.

The site is located in the Black Forest Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing public storm sewer system along the west boundary of Lot 1A, flowing to the existing Struthers Ranch stormwater detention pond on the west side of Struthers Road.

This report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County subdivision drainage criteria.

B. Drainage Analysis Methods and Criteria

ITEM	DESCRIPTION	REFERENCE
Design Storm (initial/major)	5-year/100-year	CS/EPC DCM
Storm Runoff	Rational Method (Area<100acres)	CS/EPC DCM
Major Drainage Basin	Black Forest Creek	
Floodplain Impacts	Parcel is located outside any delineated FEMA floodplains	FIRM
Existing Downstream Facilities	Existing storm sewer system on east side of Struthers Road; Existing detention pond on west side of Struthers Road	

CS/EPC DCM = City of Colorado Springs & El Paso County Drainage Criteria Manual

C. References

JPS Engineering, Inc., "Final Drainage Report for Struthers Ranch Filing No. 2," October 14, 2004 (approved by El Paso County 10/20/04).

JPS Engineering, Inc., "Drainage Letter Report for Struthers Ranch Polaris, Lots 1-2, Struthers Ranch Subdivision Filing No. 4," revised April 7, 2023 (approved by El Paso County 5/4/23).

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

Subdivision Drainage Report

Drainage planning for this site was previously master planned during original development of the Struthers Ranch Subdivision, as detailed in the "Final Drainage Report (FDR) for Struthers Ranch Filing No. 2" by JPS Engineering, dated October 14, 2004. The project area at the southeast corner of Struthers Road and Struthers Ranch Road was identified as a future commercial development area in the original planning of the subdivision.

According to the original FDR, Basins D6A (3.0 acres) and D9A (3.18 acres) comprise the future commercial development areas on the south side of Struthers Ranch Road. The previously approved subdivision drainage planning assumed full commercial development within all of Basins D6A and D9A, with runoff coefficients of $C_5 = 0.90$ and $C_{100} = 0.90$, and impervious areas of 95 percent for the entirely of these basins. According to the Rational Method calculations in the original subdivision drainage report, developed peak flows from Basin D6A were calculated as $Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs, and peak flows from Basin D9A were calculated as $Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs.

As shown on the enclosed Struthers Ranch Subdivision Drainage Plan (Figure D1, Appendix A), the RMCP development site lies entirely within Basin D6A as delineated in the approved "Final Drainage Report for Struthers Ranch Filing No. 2." The site slopes downward to the southwest, with average grades of 1-4 percent. On-site soils are classified by SCS as type 71, "Pring" series coarse sandy loam soils. These soils have moderately rapid permeability and slow to medium surface runoff characteristics. The soils are classified as hydrologic soils group B.

Developed drainage from this commercial site sheet flows southwesterly to the existing storm sewer system along the east side of Struthers Road. Flows combine at the existing grated inlet on the east side of Struthers Road, where double 48-inch culverts convey developed flows across Struthers Road and into the existing detention pond. The previously approved drainage report for Struthers Ranch Filing No. 2 assumed full commercial development for this basin, which is consistent with the proposed site development. The existing detention pond was sized to account for fully developed flows from this commercial area.

Existing Drainage Conditions – "Struthers Ranch Polaris" Drainage Letter Report

Drainage planning for this specific site was previously included in the "Drainage Letter Report for Struthers Ranch Polaris, Lots 1-2, Struthers Ranch Subdivision Filing No. 4," by JPS Engineering, Inc., dated April 7, 2023 (see excerpts in Appendix A).

The approved Drainage Letter identifies the subject area of this project (Lots 3 and 4) as lying within "Basin B", and describes this site as follows:

> "The future commercial site development areas to the south in Lots 3-4 have been delineated as Basin B, which will generally drain northwesterly by sheet flow and curb and gutter to a future private storm sewer via a proposed 18" HDPE pipe conveying developed flows into Water Quality Pond A. Developed peak flows at Design Point B are calculated as $Q_5 = 4.7$ cfs and $Q_{100} = 9.0$ cfs. Basin B generally correlates with "Basin D9A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs). Developed flows from off-site Basin OB1 will continue to combine with Basin B at Design Point #B1, with peak flows calculated as $Q_5 = 5.9$ cfs and $Q_{100} = 12.2$ cfs."

The Drainage Letter Report identifies the combined developed flows from Lots 1-4, Struthers Ranch Subdivision Filings No. 4 as flowing into a private Water Quality Pond along the west edge of Lot 1. The 18" HDPE discharge pipe from Water Quality Pond A (along with overflows from the pond spillway) drains into the existing grated storm inlet along the east side of Struthers Road, and an existing double 48-inch RCP storm sewer conveys the flow from the grated storm inlet southwesterly across Struthers Road into the existing regional Struthers Ranch Detention Pond ("Detention Pond 11" per Black Forest Creek DBPS).

According to the approved Drainage Letter Report, developed flows from Basins A, OB1, and B combine at Design Point #1, with peak flows calculated as $Q_5 = 11.9$ cfs and $Q_{100} = 24.2$ cfs. For comparison with the original Subdivision FDR, the total flows from Basins D6A and D9A (equivalent to Design Point #1) were calculated as $Q_5 = 23.2$ cfs and $Q_{100} = 38.9$ cfs (significantly higher than the current developed flow calculations). As such, the developed flows are well below the previously master planned developed flows entering the regional detention pond.

Developed Drainage Plan – Rocky Mountain Cycle Plaza – Phase 2

As shown on the enclosed Drainage Plan (Figure D1.1, Appendix F), the site has been delineated as a single on-site drainage basin. Consistent with the previously approved Drainage Letter, The proposed Rocky Mountain Cycle Plaza (RMCP) – Phase 2 area (Lots 3-4) has been delineated as Basin B (1.41-acres). Surface drainage swales and a private storm sewer system will convey developed flows from Basin B to the proposed Water Quality Pond A along the west side of Lot 1A.

Site grades will slope to storm inlets at selected locations, collecting surface drainage and conveying stormwater to Water Quality Pond A. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building, and the curb, gutter, drainage swales, and private storm sewer system will convey developed flows northwesterly to the existing Water Quality Pond A.

Developed flows along the northeast face of the new building will be intercepted by two grated storm inlets. Proposed private Inlet B1.1 (18" Nyoplast or equal) will intercept surface drainage from the area behind the southeast corner of the building, and proposed private Storm Drain SD-B1.1 (12" HDPE) will convey the flow from Inlet B1.1 northwesterly to the proposed Inlet B1.2. Proposed private Inlet B1.2 (18" Nyoplast or equal) will intercept surface drainage in the area behind the northeast corner of the building, and proposed private Storm Drain SD-B1.2 (12" HDPE) will convey the flow from Inlet B1.2 to the proposed Inlet B1.3.

Proposed private Inlet B1.3 (Type 16) will intercept surface drainage from the northeast parking area, and proposed private Storm Drain SD-B1.3 (12" HDPE) will convey the flow from Inlet B1.3 southwesterly to the proposed Inlet B1.4.

Proposed private Inlet B1.4 (Type 16) will intercept surface drainage from the parking area comprising the southwest part of the site, and proposed private Storm Drain SD-B1.4 (12" HDPE) will convey the flow from Inlet B1.4 into the adjoining roadside ditch along the northeast side of Struthers Road. The existing ditch flows northwesterly into the existing 18" HDPE storm sewer pipe conveying developed flows into the existing Water Quality Pond A.

Developed flows have been calculated based on the impervious areas associated with the proposed building and parking improvements. Developed peak flows at Design Point B are calculated as $Q_5 = 3.4$ cfs and $Q_{100} = 7.1$ cfs.

Basin B generally correlates with "Basin D9A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs). Developed flows from off-site Basin OB1 will continue to combine with Basin B at Design Point #B1, with peak flows calculated as $Q_5 = 4.4$ cfs and $Q_{100} = 10.4$ cfs. The current developed flow calculations at Design Point #B1 are lower than the developed flows anticipated in the previously approved Drainage Letter Report ($Q_5 = 5.9$ cfs and $Q_{100} = 12.2$ cfs).

Developed flows from Basins A, OB1, and B will continue to combine at Design Point #1, with peak flows calculated as $Q_5 = 9.9$ cfs and $Q_{100} = 21.4$ cfs. The current developed flow calculations Design Point #1are lower than the developed flows anticipated in the previously approved Drainage Letter Report ($Q_5 = 11.9$ cfs and $Q_{100} = 24.2$ cfs). As previously noted, the developed flows are well below the previously master planned developed flows entering the regional detention pond.

Hydrologic and hydraulic calculations for the site are detailed in the appendices (Appendix B and C), and peak flows are identified on Figure D1.1 (Appendix D).

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: Developed flows from this site (Lots 3 and 4) will be routed through the private Water Quality Pond A, which has a pervious bottom to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.
- Drainage basin fees were previously paid during recording of the subdivision plat, and these fees provided the applicable cost contribution towards regional drainage improvements.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The developed site will drain through the existing Water Quality Pond A along the west edge of Lot 1A. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial uses are proposed for this site.
- The commercial property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the existing Water Quality Pond A Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

IV. FLOODPLAIN IMPACTS

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0287G, dated December 7, 2018, the site is located beyond the limits of any delineated floodplains.

V. STORMWATER DETENTION AND WATER QUALITY

Stormwater detention for this site is provided in the existing regional stormwater detention pond constructed during initial development of the Struthers Ranch Subdivision. The Struthers Ranch Homeowners Association is the owner of the existing Struthers Ranch Detention Pond located within Tract C, Struthers Ranch Filing No. 2.

Water quality treatment for 100 percent of this site is provided in the existing private Water Quality Pond A. According to the previously approved "Drainage Letter for Struthers Ranch Polaris," a conservative impervious area of 95 percent was estimated for the future commercial development within Basin B (consistent with the original FDR). As detailed in Appendix B, the actual impervious area for the proposed development within Basin B has been calculated as 59.6 percent, which is well below the previous conservative assumptions.

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES

No public drainage improvements are required or proposed for this project.

The site lies completely within the Black Forest Creek Drainage Basin. Applicable drainage basin fees were paid at the time of original platting of Struthers Ranch Filing No. 2, so no drainage basin fees or bridge fees are applicable at this time.

VII. SUMMARY

The developed drainage patterns for the proposed Rocky Mountain Cycle Plaza – Phase 2 site development on Lots 3-4, Struthers Ranch Filing No. 4 will remain consistent with the established drainage plan for this subdivision. The grading and drainage plan for the proposed RMCP – Phase 2 site development fully conforms to the approved drainage plan for Struthers Ranch Filings No. 2 and 4, as well as the "Drainage Letter Report for Struthers Ranch Polaris."

Developed flows from the site will drain through the existing Private Water Quality Pond along the southwest side of Lot 1A, meeting stormwater quality requirements prior to discharge to the existing downstream public drainage system. Stormwater detention is provided by the existing Struthers Ranch Detention Pond which was designed to accept fully developed flows from the commercial area encompassing this site (Lots 1-4, Struthers Ranch Filing No. 4). Construction and proper maintenance of the on-site drainage facilities, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

EXCERPTS FROM PREVIOUS DRAINAGE REPORT

DRAINAGE LETTER REPORT

for

STRUTHERS RANCH POLARIS
847 STRUTHERS RANCH ROAD
LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

Prepared for:

Hammers Construction, Inc.
1411 Woolsey Heights
Colorado Springs, CO 80915

August 10, 2022
Revised October 21, 2022
Revised February 21, 2023
Revised April 7, 2023

Prepared by:

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JPS Project No. 032203
PCD Filing No. PPR2248

STRUTHERS RANCH POLARIS
DRAINAGE LETTER REPORT
TABLE OF CONTENTS

PAGE

DRAINAGE STATEMENT i

I. INTRODUCTION 1

II. EXISTING / PROPOSED DRAINAGE CONDITIONS 2

III. DRAINAGE PLANNING FOUR STEP PROCESS 5

IV. FLOODPLAIN IMPACTS 5

V. STORMWATER DETENTION AND WATER QUALITY 6

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES 7

VII. SUMMARY 7

APPENDICES

APPENDIX A	Excerpts from Subdivision Drainage Report
APPENDIX B	Hydrologic Calculations
APPENDIX C	Hydraulic Calculations
APPENDIX D	Water Quality Pond Calculations
APPENDIX E	Water Quality Pond Cost Estimate
APPENDIX F	Figures
Figure FIRM	Floodplain Map
Sheet D1	Struthers Ranch Subdivision - Developed Drainage Plan
Sheet D1.1	Struthers Ranch Polaris - Developed Drainage Plan

DRAINAGE STATEMENT

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 ac[illegible]ility for liability caused by negligent acts, errors or omissions on my part in preparin[illegible]

COLORADO REGISTERED JOHN P. SCHWAB 29891 4/7/23 PROFESSIONAL ENGINEER

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: _____ 4-12-23
Date

Hammers Construction, Inc.
1411 Woolsey Heights, Colorado Springs, CO 80915

El Paso County's Statement

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

Joshua Palmer, P.E.
County Engineer / ECM Administrator

Approved
By: Elizabeth Nijkamp, PE
Date:05/04/2023
El Paso County Department of Public Works

Date

Conditions:

I. INTRODUCTION

A. Property Location and Description

Hammers Construction is planning to construct a new Polaris dealership on the vacant 2.94-acre property at the southeast corner of Struthers Road and Struthers Ranch Road in northern El Paso County, Colorado. The property is described as Lots 1 and 2, Struthers Ranch Subdivision Filing No. 4 (El Paso County Assessor's Parcel Numbers 71363-03-010 and 71363-03-011).

The project consists of a new 12,000 square-foot, single-story Polaris dealership building with associated parking and site improvements. The property is bounded by Struthers Road on the southwest side and Struthers Ranch Road on the northwest side. Struthers Road is a fully improved, asphalt-paved arterial public street, and Struthers Ranch Road is a fully improved local public street. Existing platted residential lots are located along the northeast boundary of the parcel (Struthers Ranch Filing No. 2). The south boundary of the site adjoins vacant commercial properties (Lots 3 and 4, Struthers Ranch Subdivision Filing No. 4).

The property is zoned Planned Unit Development (PUD), and the proposed site development is fully consistent with the existing zoning of the site. Access to the site will be provided by the existing private driveway connection to Struthers Ranch Road along the north boundary of Lot 1.

The site is located in the Black Forest Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing public storm sewer system along the west boundary of the property, flowing to the existing Struthers Ranch stormwater detention pond on the west side of Struthers Road.

This report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County subdivision drainage criteria.

B. Drainage Analysis Methods and Criteria

ITEM	DESCRIPTION	REFERENCE
Design Storm (initial/major)	5-year/100-year	CS/EPC DCM
Storm Runoff	Rational Method (Area<100acres)	CS/EPC DCM
Major Drainage Basin	Black Forest Creek	
Floodplain Impacts	Parcel is located outside any delineated FEMA floodplains	FIRM
Existing Downstream Facilities	Existing storm sewer system on east side of Struthers Road; Existing detention pond on west side of Struthers Road	

CS/EPC DCM = City of Colorado Springs & El Paso County Drainage Criteria Manual

C. References

JPS Engineering, Inc., "Final Drainage Report for Struthers Ranch Filing No. 2," October 14, 2004 (approved by El Paso County 10/20/04).

JPS Engineering, Inc., "Drainage Letter Report for Struthers Ranch Subdivision Filing No. 4," February 22, 2006.

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

Subdivision Drainage Report

Drainage planning for this site was previously master planned during original development of the Struthers Ranch Subdivision, as detailed in the "Final Drainage Report (FDR) for Struthers Ranch Filing No. 2" by JPS Engineering, dated October 14, 2004 (see excerpts in Appendix A). The project area at the southeast corner of Struthers Road and Struthers Ranch Road was identified as a future commercial development area in the original planning of the subdivision.

According to the original FDR, Basins D6A (3.0 acres) and D9A (3.18 acres) comprise the future commercial development areas on the south side of Struthers Ranch Road. The previously approved subdivision drainage planning assumed full commercial development within all of Basins D6A and D9A, with runoff coefficients of $C_5 = 0.90$ and $C_{100} = 0.90$, and impervious areas of 95 percent for the entirely of these basins. According to the Rational Method calculations in the original subdivision drainage report, developed peak flows from Basin D6A were calculated as $Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs, and peak flows from Basin D9A were calculated as $Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs (see Appendix A).

As shown on the enclosed Struthers Ranch Subdivision Drainage Plan (Figure D1, Appendix F), the proposed Polaris development site lies entirely within Basin D6A as delineated in the approved "Final Drainage Report for Struthers Ranch Filing No. 2." The site slopes downward to the southwest, with average grades of 1-4 percent. On-site soils are classified by SCS as type 71, "Pring" series coarse sandy loam soils. These soils have moderately rapid permeability and slow to medium surface runoff characteristics. The soils are classified as hydrologic soils group B.

Developed drainage from this commercial site will sheet flow southwesterly to the existing storm sewer system along the east side of Struthers Road. Flows combine at the existing grated inlet on the east side of Struthers Road, where double 48-inch culverts convey developed flows across Struthers Road and into the existing detention pond. The previously approved drainage report for Struthers Ranch Filing No. 2 assumed full commercial development for this basin, which is consistent with the proposed site development. The existing detention pond was sized to account for fully developed flows from this commercial area.

The impervious area for the proposed Struthers Ranch Polaris development (delineated as Basin A within this report, which correlates with Basin D6A in the FDR) amounts to approximately 69 percent of the site (as tabulated on Sh. D1.1 and Appendix B), which is well below the impervious area of 95 percent assumed for full commercial development in the previously approved subdivision drainage report (see Appendix A).

Based on the previous construction of drainage improvements for the Struthers Ranch Subdivision, no significant impact on downstream drainage facilities is anticipated from this site development and replat. Proper erosion control measures will be required for development of the site, including silt fence along property boundaries to minimize off-site transport of construction sediment.

Existing Drainage Conditions

As shown on the enclosed Drainage Plan (Figure D1.1, Appendix F), the site has been delineated as two on-site drainage basins. The project area (Lots 1-2, Struthers Ranch Filing No. 4) has been delineated as Basin A, and the future development area to the southeast (Lots 3-4, Struthers Ranch Filing No. 4) has been delineated as Basin B. The site is impacted by an off-site basin consisting of the rear sides of the adjoining single-family residential lots (platted as part of Struthers Ranch Filing No 2) along the southeast boundary of the site, which has been delineated as Basin OB1.

Existing drainage from Basin A sheet flows southwesterly across the property, with peak flows calculated as $Q_5 = 0.8$ cfs and $Q_{100} = 5.8$ cfs. Basin A flows to the existing ditch along the east side of Struthers Road, and the ditch flows are captured in the existing grated storm inlet identified as Design Point #1.

Existing drainage from off-site Basin OB1 (back sides of adjoining developed single-family residential lots along northeast boundary of project site) sheet flows southwesterly into Basin B, and Basin B flows southwesterly to the existing ditch along the east side of Struthers Road, ultimately flowing into the existing grated storm inlet at Design Point #1. Existing flows from Basins OB1 and B combine at Design Point #B1, with peak flows calculated as $Q_5 = 1.9$ cfs and $Q_{100} = 7.0$ cfs.

Existing flows from Basins A, OB1, and B combine at Design Point #1, with peak flows calculated as $Q_5 = 2.5$ cfs and $Q_{100} = 12.0$ cfs. A double 48-inch RCP storm sewer conveys the flow from the grated storm inlet southwesterly across Struthers Road into the existing regional Struthers Ranch Detention Pond.

Developed Drainage Plan

Developed flows have been calculated based on the impervious areas associated with the proposed building and parking improvements. Surface drainage swales and a private storm sewer system will convey developed flows to the proposed Water Quality Pond A along the west boundary of the site. Site grades will slope to storm inlets and curb openings at selected locations, collecting surface drainage and conveying stormwater to

Water Quality Pond A. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building, and the curb, gutter, drainage swales, and private storm sewer system will convey developed flows southwesterly into Water Quality Pond A.

The proposed Polaris site development on Lots 1-2 has been delineated as Basin A, which drains by sheet flow and curb and gutter to the proposed Stormwater Quality Detention Basin along the west boundary of the site. Private Storm Inlet A1 (Type 16) will intercept surface drainage from the north side of the Polaris site, and Private Storm Sewer A1 (18") will convey this flow into the on-site Water Quality Pond A. The balance of the Polaris site will flow by drainage swales and curb and gutter into the south side of Water Quality Pond A.

Developed peak flows at Design Point A are calculated as $Q_5 = 8.9$ cfs and $Q_{100} = 17.7$ cfs. Basin A generally correlates with "Basin D6A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.0$ cfs and $Q_{100} = 24.3$ cfs).

The future commercial site development areas to the south in Lots 3-4 have been delineated as Basin B, which will generally drain northwesterly by sheet flow and curb and gutter to a future private storm sewer via a proposed 18" HDPE pipe conveying developed flows into Water Quality Pond A. Developed peak flows at Design Point B are calculated as $Q_5 = 4.7$ cfs and $Q_{100} = 9.0$ cfs. Basin B generally correlates with "Basin D9A" in the Final Drainage Report for Struthers Ranch Filing No. 2 ($Q_5 = 14.9$ cfs and $Q_{100} = 25.8$ cfs). Developed flows from off-site Basin OB1 will continue to combine with Basin B at Design Point #B1, with peak flows calculated as $Q_5 = 5.9$ cfs and $Q_{100} = 12.2$ cfs.

The 18" HDPE discharge pipe from Water Quality Pond A (along with overflows from the pond spillway) will drain into the existing grated storm inlet along the east side of Struthers Road, and the existing double 48-inch RCP storm sewer will continue to convey the flow from the grated storm inlet southwesterly across Struthers Road into the existing regional Struthers Ranch Detention Pond ("Detention Pond 11" per Black Forest Creek DBPS).

Developed flows from Basins A, OB1, and B combine at Design Point #1, with peak flows calculated as $Q_5 = 11.9$ cfs and $Q_{100} = 24.2$ cfs. As detailed in Appendix B, for comparison with the original Subdivision FDR, the total flows from Basins D6A and D9A (equivalent to Design Point #1) have been calculated as $Q_5 = 23.2$ cfs and $Q_{100} = 38.9$ cfs (significantly higher than the current developed flow calculations). As such, the developed flows are well below the previously master planned developed flows entering the regional detention pond.

Hydrologic and hydraulic calculations for the site are detailed in the appendices (Appendix B and C), and peak flows are identified on Figure D1.1 (Appendix F).

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: The majority of developed flows will be routed through the on-site detention basin, which will be grass-lined to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.
- Drainage basin fees were previously paid during recording of the subdivision plat, and these fees provided the applicable cost contribution towards regional drainage improvements.

Step 3: Provide Water Quality Capture Volume (WQCV)

- EDB: The majority of the developed site will drain through an on-site Private Extended Detention Basin (EDB) along the west boundary of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial uses are proposed for this site.
- The commercial property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the Extended Detention Basin (EDB) to minimize introduction of contaminants to the County's public drainage system.

IV. FLOODPLAIN IMPACTS

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0287G, dated December 7, 2018, the site is located beyond the limits of any delineated floodplains.

V. STORMWATER DETENTION AND WATER QUALITY

Stormwater detention for this site is provided in the existing regional stormwater detention pond constructed during initial development of the Struthers Ranch Subdivision. The Struthers Ranch Homeowners Association is the owner of the existing Struthers Ranch Detention Pond located within Tract C, Struthers Ranch Filing No. 2. There currently appears to be a need for removal of excess vegetation within the pond to ensure proper operation of the detention facilities. The developer will need to coordinate with the HOA to ensure that the required maintenance is performed on the existing regional detention pond.

An on-site private Water Quality Pond will be constructed to meet stormwater quality improvements for this project site in accordance with current El Paso County drainage criteria.

As detailed in the detention pond calculations in Appendix D, the required Water Quality Capture Volume (WQCV) has been calculated as 0.13 acre-feet. The water quality capture volume has been calculated based on the actual impervious area of the proposed site development within Basin A (calculated as 69%), along with the typical single-family residential impervious area of 40% within the adjoining developed Basin OB1, and a conservative estimated impervious area of 95 percent for the anticipated future commercial development within Basin B (consistent with the original FDR).

The proposed Water Quality Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention_v4.05" software package. Calculations and details for the proposed Water Quality Basin are enclosed in Appendix D, and design parameters for the Water Quality Basin are summarized as follows:

Water Quality Basin	Tributary Drainage Basin	Tributary Area (ac)	Impervious Percentage	Min. WQCV (af)	Design Volume (af)
A	A,OB1,B	5.62	68.1	0.13	0.25

The proposed on-site Water Quality Pond A provides a storage volume of 0.25 acre-feet, which meets the required WQCV volume.

The proposed water quality pond will include concrete forebays, trickle channels, and an outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The water quality pond will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream public drainage system.

The new on-site Water Quality Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the southwest parking lot.

VI. PUBLIC IMPROVEMENTS / DRAINAGE BASIN FEES

No public drainage improvements are required or proposed for this project. As detailed in Appendix E, the proposed private Water Quality Pond A has an estimated cost of approximately $65,846.

The site lies completely within the Black Forest Creek Drainage Basin. Applicable drainage basin fees were paid at the time of original platting of Struthers Ranch Filing No. 2, so no drainage basin fees or bridge fees are applicable at this time.

VII. SUMMARY

The developed drainage patterns for the proposed site development on Lots 1-2, Struthers Ranch Filing No. 4 will remain consistent with the established drainage plan for this subdivision. The grading and drainage plan for the proposed Polaris site development fully conforms to the approved drainage plan for Struthers Ranch Filings No. 2 and 4.

Developed flows from the site will drain through a Private Water Quality Pond at the southwest corner of the property prior to discharging to the existing downstream public drainage system. Stormwater detention is provided by the existing Struthers Ranch Detention Pond which was designed to accept fully developed flows from the commercial area encompassing this site (Lots 1-4, Struthers Ranch Filing No. 4). The proposed on-site Water Quality Pond will be constructed to meet current stormwater quality requirements. Construction and proper maintenance of the on-site drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

STRUTHERS RANCH POLARIS
RATIONAL METHOD

EXISTING CONDITIONS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
A	A	2.74	0.080	0.350	100	0.030	13.0	275	15	0.047	3.25	1.4	14.4	14.4	3.59	6.02	0.79	5.77
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	B	1.41	0.080	0.350	100	0.030	13.0	585	15	0.018	2.01	4.8	17.8	17.8	3.26	5.48	0.37	2.70
OB1,B	B1	2.88	0.192	0.427									16.5	16.5	3.38	5.67	1.87	6.98
Tt DP-B1 to DP1								225	15	0.036	2.85	1.3						
A,OB1,B	**1**	**5.62**	**0.138**	**0.389**									**17.8**	**17.8**	**3.27**	**5.48**	**2.53**	**11.98**

DEVELOPED CONDITIONS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
A	A	2.74	0.649	0.773	60	0.083	3.2	490	20	0.027	3.29	2.5	5.6	5.6	4.99	8.37	8.87	17.73
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	B	1.41	0.859	0.930	100	0.030	3.1	500	20	0.02	2.83	2.9	6.0	6.0	4.89	8.22	5.93	10.78
OB1,B	B1	2.88	0.574	0.710									14.6	14.6	3.56	5.98	5.89	12.24
Tt DP-B1 to DP1								225	20	0.036	3.79	1.0						
A,OB1,B	**1**	**5.62**	**0.610**	**0.741**									**15.6**	**15.6**	**3.47**	**5.82**	**11.88**	**24.23**

DEVELOPED CONDITIONS - COMPARISON WITH SUBDIVISION DRAINAGE REPORT ("FINAL DRAINAGE REPORT FOR STRUTHERS RANCH FILING NO. 2" BY JPS DATED 10/14/04)

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
D6A	D6A	3.00	0.900	0.900			0.0	300	15	0.04	3.00	1.7	1.7	5.0	5.17	8.68	13.96	23.43
D9A	D9A	3.18	0.900	0.900			0.0	620	15	0.005	1.06	9.7	9.7	9.7	4.17	7.00	11.93	20.03
D6A,D9A	**1**	**6.18**	**0.900**	**0.900**									**9.7**	**9.7**	**4.17**	**7.00**	**23.18**	**38.92**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA

STRUTHERS RANCH POLARIS
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS

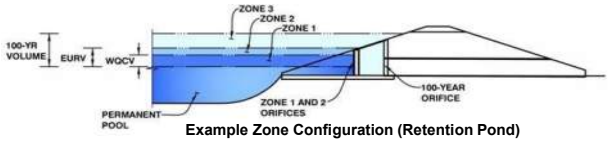
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A	2.74	1.90	PAVED/IMPERVIOUS	100	0.84	LANDSCAPED	0.00				69.343
OB1	1.47	1.47	SF RESIDENTIAL	40							40.000
B	1.41	1.34	PAVED/IMPERVIOUS	100	0.07	LANDSCAPED	0.00				95.000
OB1,B	2.88										66.927
A,OB1,B	5.62										68.105

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Struthers Ranch Polaris**

Basin ID: **Water Quality Pond A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	5.62	acres
Watershed Length =	825	ft
Watershed Length to Centroid =	400	ft
Watershed Slope =	0.024	ft/ft
Watershed Imperviousness =	68.10%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.125	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.419	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.370	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.500	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.611	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.743	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.859	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.998	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.293	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.327	acre-feet		
Approximate 5-yr Detention Volume =	0.436	acre-feet		
Approximate 10-yr Detention Volume =	0.553	acre-feet		
Approximate 25-yr Detention Volume =	0.595	acre-feet		
Approximate 50-yr Detention Volume =	0.619	acre-feet		
Approximate 100-yr Detention Volume =	0.665	acre-feet		

Define Zones and Basin Geometry

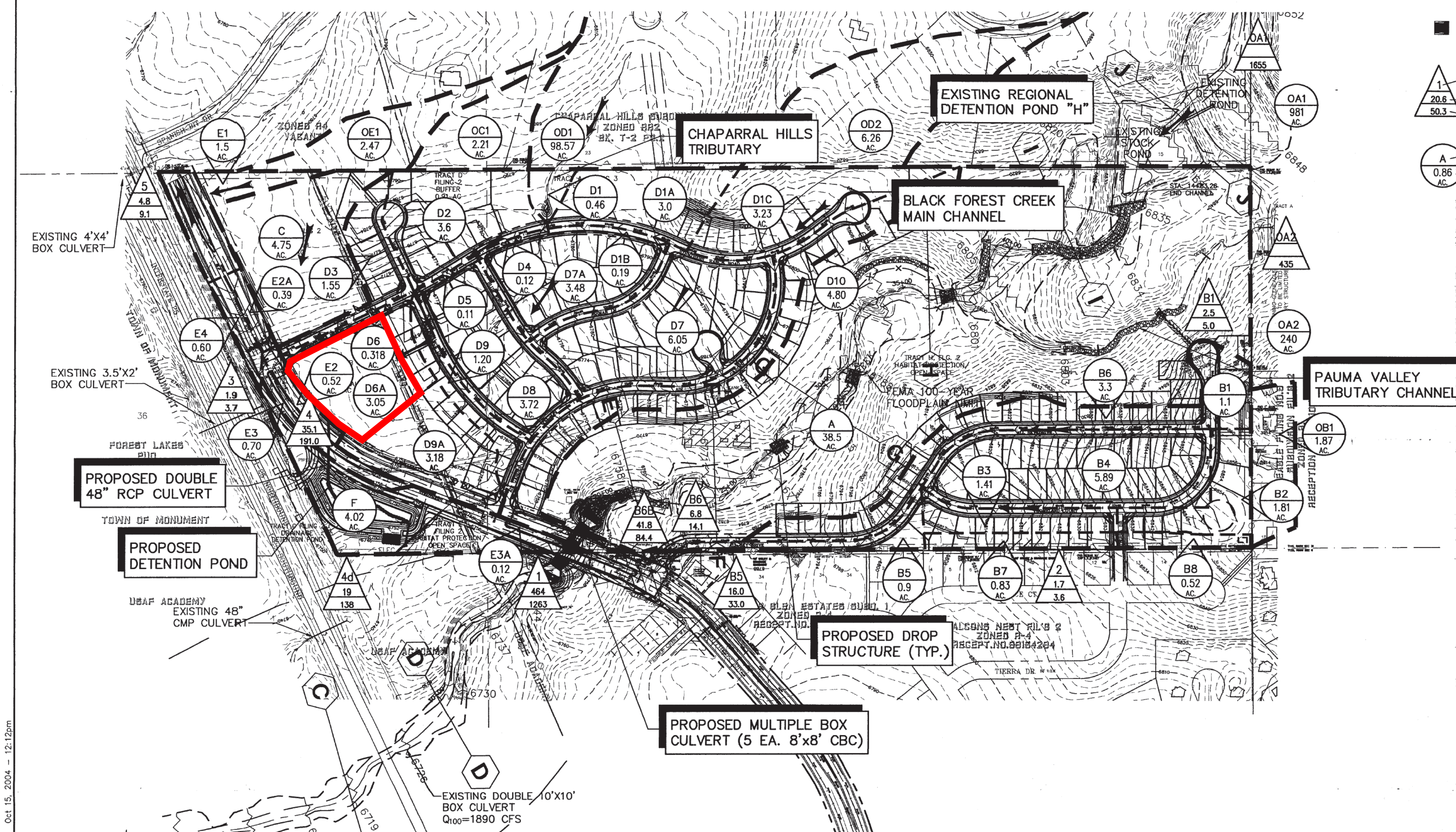
Zone 1 Volume (WQCV) =	0.125	acre-feet
Zone 2 Volume (User Defined - Zone 1) =	0.000	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.125	acre-feet

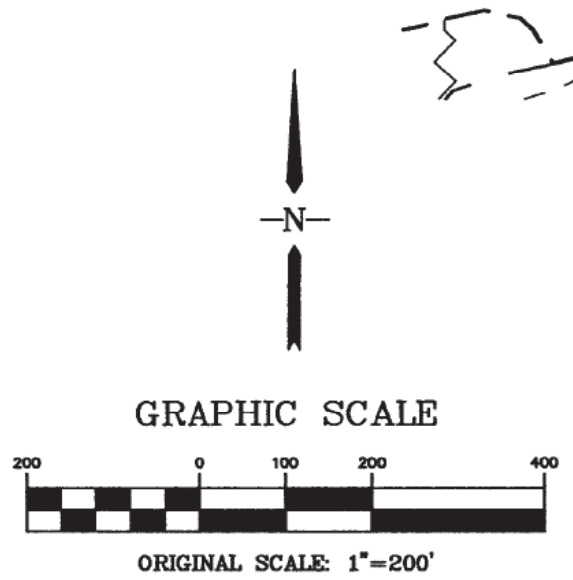
Total detention volume is less than 100-year volume.

Depth Increment = 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	--	--	--	10	0.000		
Bot EL=6752.0	--	1.00	--	--	--	1,433	0.033	721	0.017
	--	3.00	--	--	--	2,456	0.056	4,610	0.106
EL=6756.0	--	5.00	--	--	--	3,626	0.083	10,692	0.245
Top EL=6758.0	--	7.00	--	--	--	4,500	0.103	18,818	0.432
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SEE COMPOSITE IMPERVIOUS AREA CALCULATIONS ON PRECEDING PAGE (...WATER QUALITY POND A IS DESIGNED FOR THE COMBINED FLOW FROM DEVELOPED BASINS A, OB1, AND B)





LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- PROPOSED DROP STRUCTURE
- DESIGN POINT (1); Q_5 (cfs) (20.6); Q_{100}(cfs) (50.3)
- BASIN DESIGNATION (A); BASIN AREA (ACRES) (0.86 AC.)

NOTES:

1. DEVELOPMENT SHALL FOLLOW ALL REQUIREMENTS OF THE APPROVED HABITAT CONSERVATION PLAN (HCP) AND ASSOCIATED ENVIRONMENTAL PERMITS.

2. PERIMETER DRAINS SHALL BE REQUIRED FOR ALL HOMES WITH BASEMENTS.

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

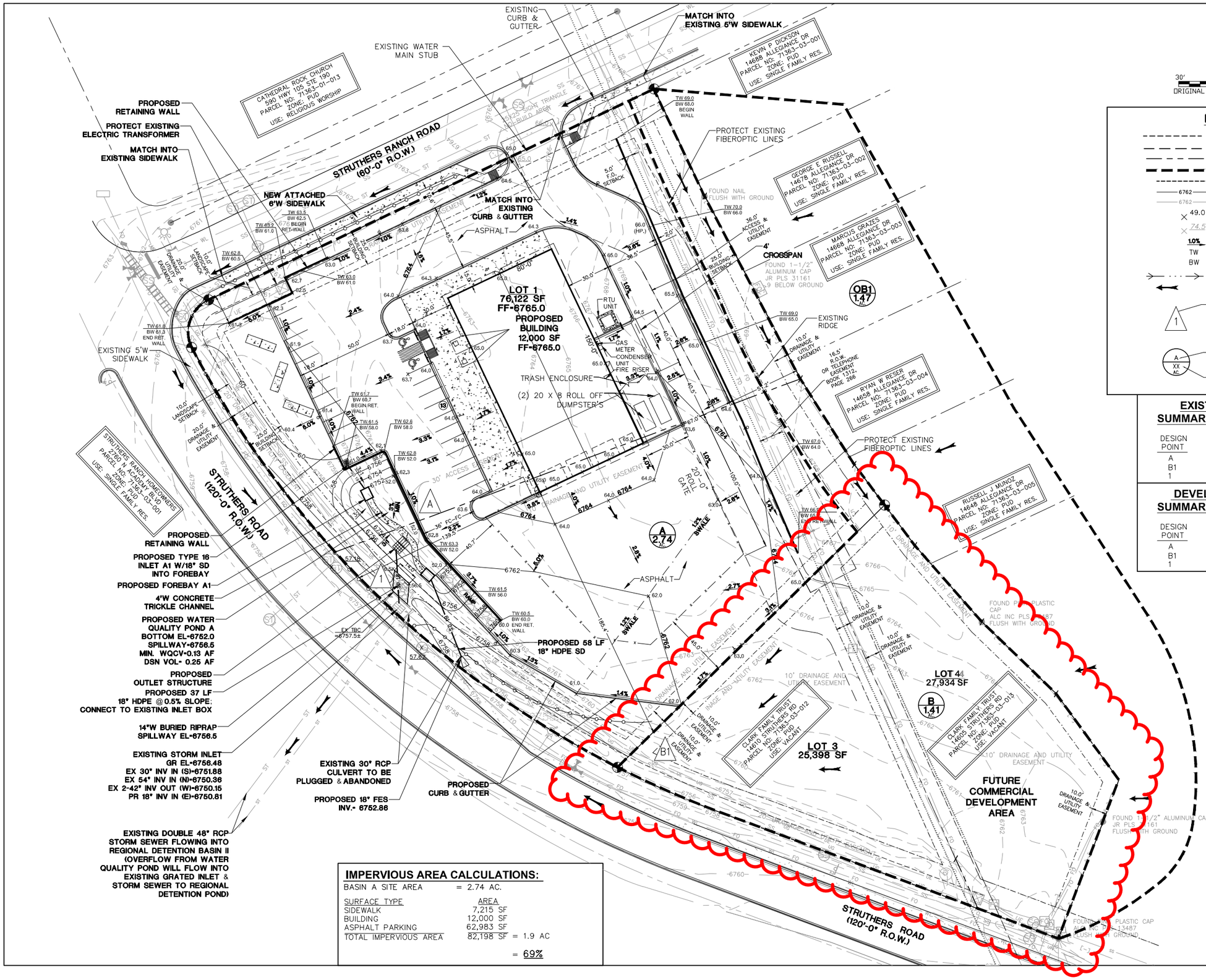
STRUTHERS RANCH SUBDIVISION

No.	REVISION	BY	DATE
E	EPC COMMENTS	JPS	4/8/04
F	EPC COMMENTS	JPS	5/7/04
G	EPC COMMENTS	JPS	5/25/04
H	EPC COMMENTS	JPS	9/2/04
I	RE-SUBMITTAL TO EPC	JPS	9/30/04

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: MJP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: PINNACLE	CHECKED: JPS
CREATED: 9/11/00	LAST MODIFIED: 10/15/04
PROJECT NO: 080006	MODIFIED BY: MJP
SHEET: D1	

J:\jpsprojects\080006.struthers\dwg\civil\D1.dwg Oct 15, 2004 - 12:12pm



IMPERVIOUS AREA CALCULATIONS:

BASIN A SITE AREA = 2.74 AC.

SURFACE TYPE	AREA
SIDEWALK	7,215 SF
BUILDING	12,000 SF
ASPHALT PARKING	62,983 SF
TOTAL IMPERVIOUS AREA	82,198 SF = 1.9 AC

= 69%

ORIGINAL SCALE: 1"=30' (24"x36" SHEET)
CONTOUR INTERVAL:1'

LEGEND

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- EASEMENT LINE
- 6762 PROPOSED CONTOUR
- 6762 EXISTING CONTOUR
- 49.0 PROPOSED SPOT ELEVATION (FLOWLINE)
- 74.5 EXIST. SPOT ELEVATION
- 1.0% PROPOSED SLOPE
- TW TOP OF RETAINING WALL
- BW BOTTOM OF RETAINING WALL
- FLOWLINE
- FLOW DIRECTION ARROW
- DESIGN POINT
- BASIN DESIGNATION
- BASIN AREA (ACRES)

EXISTING CONDITIONS SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A	0.8	5.8
B1	1.9	7.0
1	2.5	12.0

DEVELOPED CONDITIONS SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
A	8.9	17.7
B1	5.9	12.2
1	11.9	24.2

DETENTION POND CONTOUR AREAS

CONTOUR	AREA (SF)
6752	1,433 SF
6754	2,456 SF
6756	3,626 SF

STRUTHERS RANCH POLARIS

LOTS 1-2, STRUTHERS RANCH SUBDIVISION FILING NO. 4

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO 1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE
A			
B			
C			
D			

HORZ. SCALE: 1"=30'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 05/27/20	LAST MODIFIED: 04/07/23
PROJECT NO: 032203	MODIFIED BY: PV

SHEET: D1.1

APPENDIX B

HYDROLOGIC CALCULATIONS

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.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

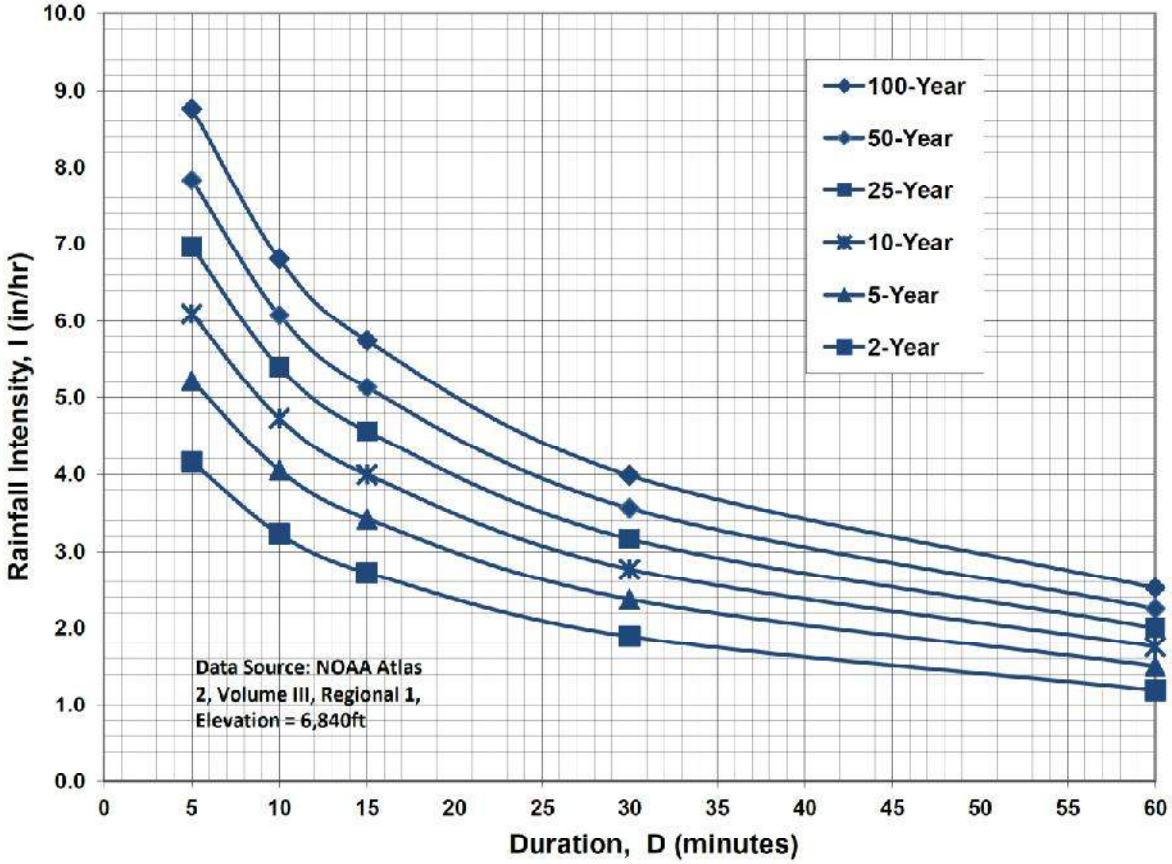
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

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.

ROCKY MOUNTAIN CYCLE PLAZA - STRUTHERS RANCH SUBDIVISION FILING NO. 4
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	1.90	PAVED/IMPERVIOUS	0.9	0.84	LANDSCAPED	0.08				0.649
OB1	1.47	1.47	SF RESIDENTIAL	0.3							0.300
B	**1.41**	**0.84**	**PAVED/IMPERVIOUS**	**0.9**	**0.57**	**LANDSCAPED**	**0.08**				**0.569**
OB1,B	2.88										0.431
A,OB1,B	5.62										0.537

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A	2.74	1.90	PAVED/IMPERVIOUS	0.96	0.84	LANDSCAPED	0.35				0.773
OB1	1.47	1.47	SF RESIDENTIAL	0.5							0.500
B	**1.41**	**0.84**	**PAVED/IMPERVIOUS**	**0.96**	**0.57**	**LANDSCAPED**	**0.35**				**0.713**
OB1,B	2.88										0.604
A,OB1,B	5.62										0.687

STRUTHERS RANCH POLARIS
COMPOSITE IMPERVIOUS AREAS

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
A	2.74	1.90	PAVED/IMPERVIOUS	100	0.84	LANDSCAPED	0.00				69.343
OB1	1.47	1.47	SF RESIDENTIAL	40							40.000
B	**1.41**	**0.84**	**PAVED/IMPERVIOUS**	**100**	**0.57**	**LANDSCAPED**	**0.00**				**59.574**
OB1,B	2.88										49.583
A,OB1,B	5.62										59.217

ROCKY MOUNTAIN CYCLE PLAZA - STRUTHERS RANCH SUBDIVISION FILING NO. 4
RATIONAL METHOD

EXISTING CONDITIONS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
A	A	2.74	0.080	0.350	100	0.030	13.0	275	15	0.047	3.25	1.4	14.4	14.4	3.59	6.02	0.79	5.77
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	B	1.41	0.080	0.350	100	0.030	13.0	585	15	0.018	2.01	4.8	17.8	17.8	3.26	5.48	0.37	2.70
OB1,B	B1	2.88	0.192	0.427									16.5	16.5	3.38	5.67	1.87	6.98
Tt DP-B1 to DP1								225	15	0.036	2.85	1.3						
A,OB1,B	**1**	**5.62**	**0.138**	**0.389**									**17.8**	**17.8**	**3.27**	**5.48**	**2.53**	**11.98**

DEVELOPED CONDITIONS

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
A	A	2.74	0.649	0.773	60	0.083	3.2	490	20	0.027	3.29	2.5	5.6	5.6	4.99	8.37	8.87	17.73
OB1	OB1	1.47	0.300	0.500	100	0.020	11.6					0.0	11.6	11.6	3.90	6.55	1.72	4.82
B	**B**	**1.41**	**0.569**	**0.713**	**100**	**0.030**	**6.7**	**500**	**20**	**0.02**	**2.83**	**2.9**	**9.7**	**9.7**	**4.18**	**7.01**	**3.35**	**7.05**
OB1,B	B1	2.88	0.431	0.604									14.6	14.6	3.56	5.98	4.42	10.41
Tt DP-B1 to DP1								365	15	0.02	2.12	2.9						
A,OB1,B	**1**	**5.62**	**0.537**	**0.687**									**17.4**	**17.4**	**3.29**	**5.53**	**9.94**	**21.35**

DEVELOPED CONDITIONS - COMPARISON WITH SUBDIVISION DRAINAGE REPORT ("FINAL DRAINAGE REPORT FOR STRUTHERS RANCH FILING NO. 2" BY JPS DATED 10/14/04)

					Overland Flow			Channel flow										
BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
D6A	D6A	3.00	0.900	0.900			0.0	300	15	0.04	3.00	1.7	1.7	5.0	5.17	8.68	13.96	23.43
D9A	D9A	3.18	0.900	0.900			0.0	620	15	0.005	1.06	9.7	9.7	9.7	4.17	7.00	11.93	20.03
D6A,D9A	**1**	**6.18**	**0.900**	**0.900**									**9.7**	**9.7**	**4.17**	**7.00**	**23.18**	**38.92**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA

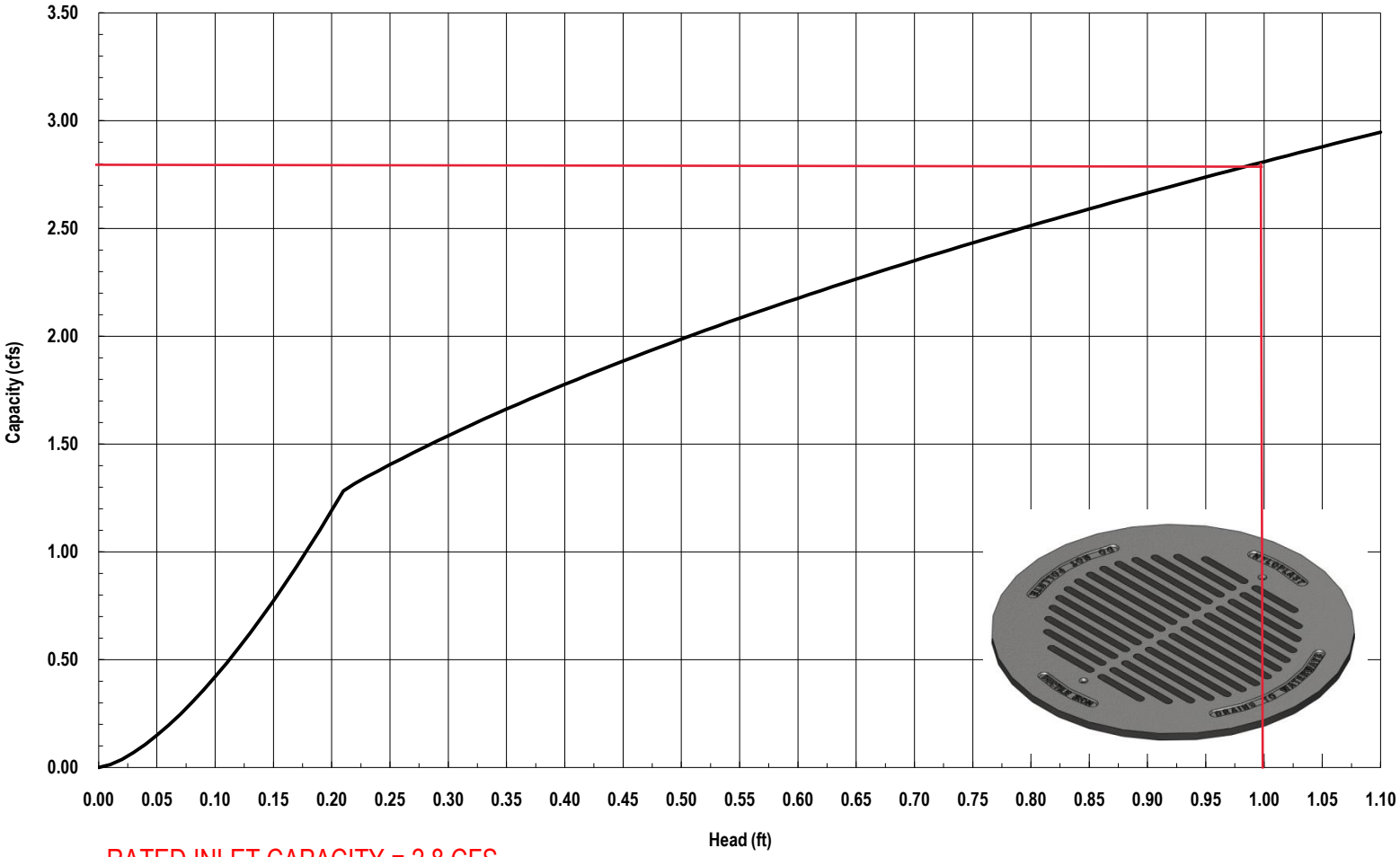
APPENDIX C

HYDRAULIC CALCULATIONS

ROCKY MOUNTAIN CYCLE PLAZA - PHASE 2
STORM INLET SIZING SUMMARY

	BASIN FLOW			INLET FLOW					
INLET	DP	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET FLOW % OF BASIN	Q5 FLOW (CFS)	Q100 FLOW (CFS)	INLET CONDITION / TYPE	INLET SIZE	INLET CAPACITY (CFS)
B1.1	B1	4.4	10.4	10	0.4	1.0	SUMP NYOPLAST	18" DIA.	1.4
B1.2	B1	4.4	10.4	10	0.4	1.0	SUMP NYOPLAST	18" DIA.	1.4
B1.3	B1	4.4	10.4	10	0.4	1.0	SUMP TYPE 16	SINGLE	6.3
B1.4	B1	4.4	10.4	70	3.1	7.3	SUMP TYPE 16	SINGLE	7.6

Nyloplast 18" Drop In Grate Inlet Capacity Chart



RATED INLET CAPACITY = 2.8 CFS
W/ 50% CLOGGING FACTOR
DESIGN INLET CAPACITY = 1.4 CFS

Nyloplast®
3130 Verona Avenue • Buford, GA 30518
(866) 888-8479 / (770) 932-2443 • Fax: (770) 932-2490
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MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet B1.3
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.4
Major Q_{Known} (cfs)	1.0

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstrea

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0

Watershed Characteristics

Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	

Watershed Profile

Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.4**
Major Total Design Peak Flow, Q (cfs)	**1.0**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet B1.4
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	Denver No. 16 Combination

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	3.1
Major Q_{Known} (cfs)	7.3

Bypass (Carry-Over) Flow from Upstream am (left) to downstream (right) in order for byp

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0

Watershed Characteristics

Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	

Watershed Profile

Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

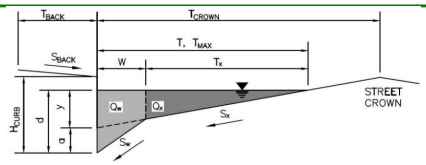
Minor Total Design Peak Flow, Q (cfs)	**3.1**
Major Total Design Peak Flow, Q (cfs)	**7.3**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A

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

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

Project: **ROCKY MOUNTAIN CYCLE PLAZA - PHASE 2**

Inlet ID: **Inlet B1.3**



Gutter Geometry:

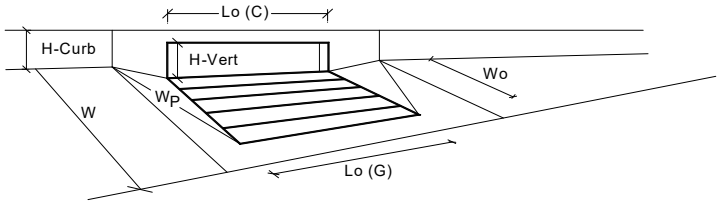
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	40.0	40.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



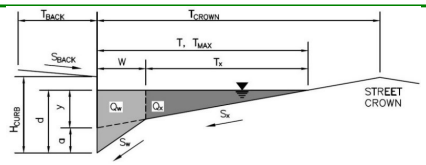
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.6	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.52	0.57	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.38	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.6**	**6.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.4	1.0	cfs

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

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

Project: **ROCKY MOUNTAIN CYCLE PLAZA - PHASE 2**

Inlet ID: **Inlet B1.4**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	1.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	50.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.011	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	50.0	50.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

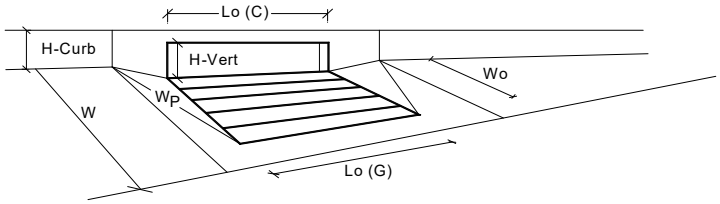
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	8.0	8.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.50	8.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.69	0.69	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.50	0.50	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	1.00	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	1.00	1.00	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**7.6**	**7.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	3.1	7.3	cfs

ROCKY MOUNTAIN CYCLE PLAZA - PHASE 2
STORM SEWER SIZING SUMMARY

	PIPE FLOW			PIPE CAPACITY		
PIPE	INLETS	Q5 FLOW (CFS)	Q100 FLOW (CFS)	MIN. PIPE SIZE	MIN. PIPE SLOPE	PIPE CAPACITY (CFS)
B1.1	B1.1	0.4	1.0	12	0.5%	2.5
B1.2	B1.1-B1.2	0.9	2.1	12	0.5%	2.5
B1.3	B1.1-B1.3	1.3	3.1	12	1.0%	3.6
B1.4	B1.1-B1.4	4.4	10.4	12	9.0%	10.7

ASSUMPTIONS:
1. STORM DRAIN PIPE ASSUMED TO BE RCP OR HDPE

Hydraulic Analysis Report

Project Data

Project Title: Project - RMCP - Phase 2 - Storm Drains

Designer: JPS

Project Date: Thursday, October 29, 2026

Project Units: U.S. Customary Units

Notes:

Channel Analysis: SD-B1.1-B1.2

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

Result Parameters

Flow: 2.5193 cfs

Area of Flow: 0.7854 ft^2

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 3.2077 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.6797 ft

Critical Velocity: 4.4319 ft/s

Critical Slope: 0.0077 ft/ft

Critical Top Width: 0.93 ft

Calculated Max Shear Stress: 0.3120 lb/ft^2

Calculated Avg Shear Stress: 0.0780 lb/ft^2

Channel Analysis: SD-B1.3

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

Result Parameters

Flow: 3.5628 cfs

Area of Flow: 0.7854 ft^2

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 4.5363 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.8057 ft

Critical Velocity: 5.2542 ft/s

Critical Slope: 0.0103 ft/ft

Critical Top Width: 0.79 ft

Calculated Max Shear Stress: 0.6240 lb/ft^2

Calculated Avg Shear Stress: 0.1560 lb/ft^2

Channel Analysis: SD-B1.4

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0900 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

Result Parameters

Flow: 10.6884 cfs

Area of Flow: 0.7854 ft^2

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 13.6089 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.9953 ft

Critical Velocity: 13.6163 ft/s

Critical Slope: 0.0850 ft/ft

Critical Top Width: 0.14 ft

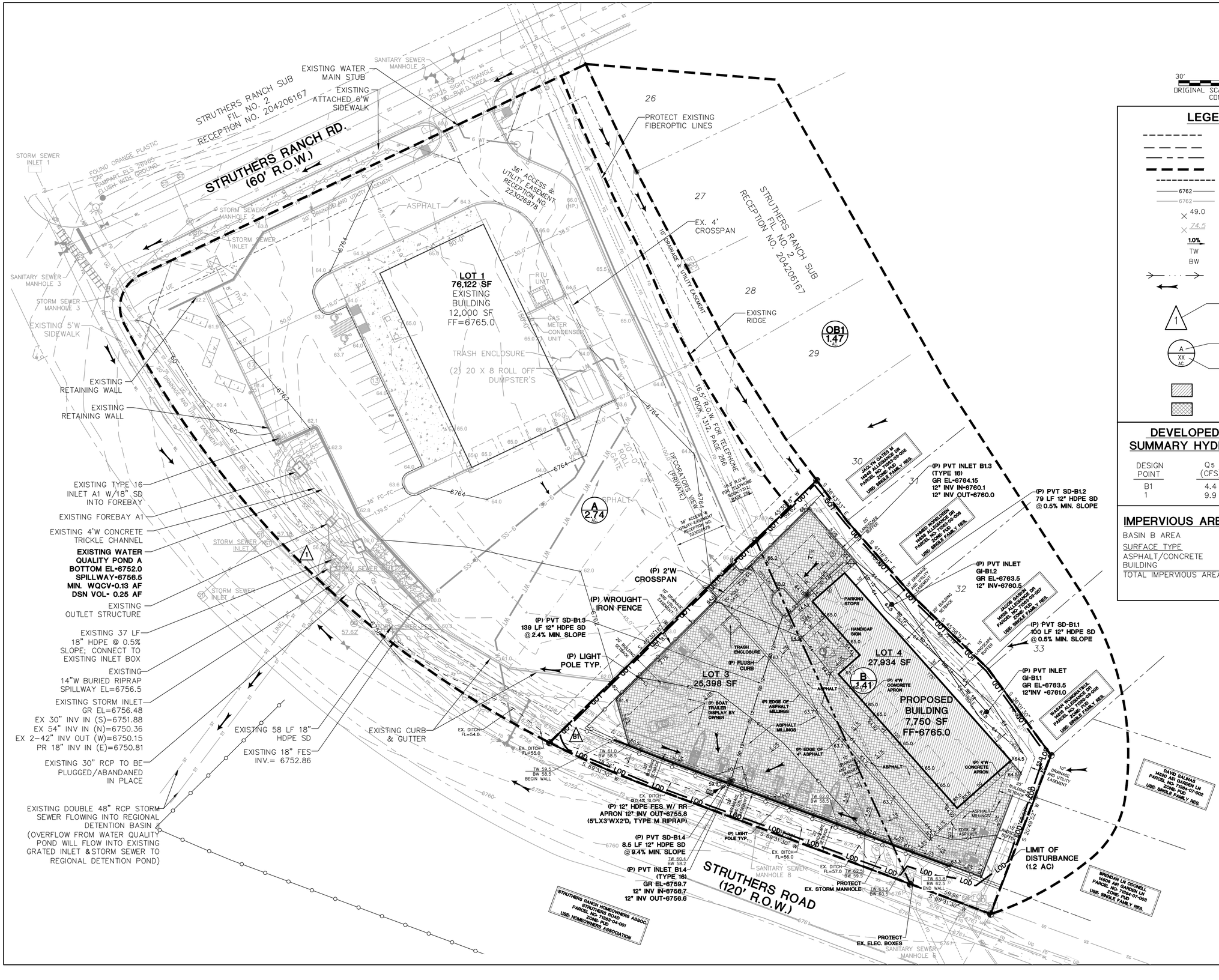
Calculated Max Shear Stress: 5.6160 lb/ft^2

Calculated Avg Shear Stress: 1.4040 lb/ft^2

Water Quality Treatment Summary Table		
Basin ID(s)	**PCM Tributary Area (ac)**	**PCM ID**
B	1.41	Water Quality Pond A

APPENDIX D

FIGURES



N

30' 0 30' 60'

ORIGINAL SCALE: 1"=30' (24"x36" SHEET)
CONTOUR INTERVAL:1'

LEGEND

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- EASEMENT LINE
- 6762 PROPOSED CONTOUR
- 6762 EXISTING CONTOUR
- 49.0 PROPOSED SPOT ELEVATION (FLOWLINE)
- 74.5 EXIST. SPOT ELEVATION
- 1.0% PROPOSED SLOPE
- TW TOP OF RETAINING WALL
- BW BOTTOM OF RETAINING WALL
- FLOWLINE
- FLOW DIRECTION ARROW
- 1 DESIGN POINT
- A / XX AC. BASIN DESIGNATION
- BASIN AREA (ACRES)
- BUILDING AREAS
- PAVED/SIDEWALK AREAS

DEVELOPED CONDITIONS SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
B1	4.4	10.4
1	9.9	21.4

IMPERVIOUS AREA CALCULATIONS:

BASIN B AREA = 1.41 AC.

SURFACE TYPE	AREA
ASPHALT/CONCRETE	28,774 SF
BUILDING	7,750 SF
TOTAL IMPERVIOUS AREA	36,524 SF
	= 0.84 AC
	= 59.6%

ROCKY MOUNTAIN CYCLE PLAZA - PHASE 2
LOTS 3-4, STRUTHERS RANCH SUBDIVISION FILING NO. 4

DEVELOPED DRAINAGE PLAN

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO 1-800-922-1987
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE
A			
B			
C			
D			

HORZ. SCALE: 1"=30'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 09/09/26	LAST MODIFIED: 10/30/26
PROJECT NO: 032203	MODIFIED BY: PV

SHEET: D1.1