

PHASE III DRAINAGE REPORT

CDR+J

**1100 S. Wilcox Street
Town of Castle Rock, Colorado
Project No. CD23-0039**

Prepared for:

Foundation Automotive Corp.

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**February 22, 2024
Job Number 21007**

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ENGINEER CERTIFICATIONS

I affirm that this report and plan for the phase III drainage design of CDR+J was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

Brian Krombein, PE
Colorado Registered Professional Engineer No. 34294
For and on behalf of Vermilion Peak Engineering

OWNER / DEVELOPER'S STATEMENT:

CARS-DB4, L.P. hereby certifies that the drainage facilities for CDR+J shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of CARS-DB4, L.P., guarantee that final drainage design review will absolve CARS-DB4, L.P. and/or their successors and/or assigns of future liability for improper design.

CARS-DB4, L.P.

Authorized Signature

TOWN OF CASTLE ROCK APPROVALS:

Utilities Department

Date

Development Services

Date

1.0 GENERAL LOCATION AND DESCRIPTION

Site Location

CDR+J (Chrysler Dodge Ram and Jeep) is a 4.02-acre automotive sales and service development located at the southeast corner of Wilcox Street and Brookside Circle in the Town of Castle Rock, Colorado. The site lies in the NW 1/4 of Section 14, Township 8 South, Range 67 West of the 6th Principal Meridian. It is currently platted as Lots 1 and 2, Block 1, First Amendment to Brookside Business Center Filing No. 2. The site is bounded on north and east by Brookside Circle, on the west by Wilcox Street and on the south by vacant commercial property. Vehicular access will be provided through three access points to Brookside Circle. A vicinity map is included at the rear of this report.

Description of Property

Historically, Lot 1 consists of a 12,000 sf automotive sales and service building surrounded by an asphalt parking lot. Lot 2 contains a regional detention facility which serves the vacant lot to the south and a portion of the dealerships located further south.

The National Resource Conservation Service soil survey of the Castle Rock, Colorado area, identifies the soil in the project area as Bresser sandy loam, cool, 5 to 9 percent slopes (BrD) which is a hydrologic type B soil, Loamy Alluvial Land (Lo), which is a type C soil and Newlin gravelly sandy loam (NeE), 8 to 30 percent slopes, which is a type B soil and Sandy wet alluvial land, which is a Type D soil.

According to FEMA Flood Insurance Rate Map 08035C0301G dated March 16, 2016 the project site is located entirely within Zone X which is defined as “areas determined to be outside the 0.2% annual chance floodplain”. No grading is proposed within a floodplain or floodway.

Proposed Land Use

The proposed redevelopment of the site consists of the expansion of the existing automotive sales and service building and the reconstruction/expansion of the surrounding parking lot and landscaped areas. It also includes construction of a new stormwater detention facility on Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4, located immediately to the east.

The seller of the east parcels (Lot 1 and 2, Second Amendment to Brookside Business Center Filing No. 4) prepared a Habitat Conservation Plan related to improvements near East Plum Creek. Said report has been approved by the US Fish & Wildlife Service. Therefore, disturbance is now allowed within Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4. The CDR+J project has been divided into the following two phases:

Phase 1 consists of an expansion of the existing auto dealership building on Lot 1, Block 1, First Amendment to Brookside Business Center Filing No. 2 plus reconstruction of the surrounding parking lot. Wilcox Street, adjacent to the project site, will also be improved with a median, detached sidewalk and northbound deceleration turn lane.

Phase 2 consists of construction of a parking lot expansion on Lot 2, Block 1, First Amendment to Brookside Business Center Filing No. 2, the extension of Brookside Circle and the construction of a regional detention and water quality facility on Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4.

2.0 DRAINAGE BASINS AND SUB-BASINS

Major Drainage Basins

In the existing condition, runoff from Lot 1, which contains the existing building and parking lot, drains to an onsite detention facility in the northeast portion of the parking lot.

Runoff is release at regulated rates to the public storm sewer in Brookside Circle which then carries flows northeasterly to a local drainageway which discharges to East Plum Creek approximately 900 feet northeast of the project site.

Lot 2 contains a regional detention facility designed to serve the vacant parcel immediately to the south as well as a portion of the auto dealership further south. It also releases regulated flows to the public storm sewer in Brookside Circle.

Minor Drainage Basins

The intent of this report is to verify that the redevelopment of the CDR+J property and associated detention facility meet the Town of Castle Rock's drainage design criteria. As such, the calculations provided include onsite and offsite drainage design including storm

sewer and detention and water quality design. Specific calculations for determining the sizes and type of onsite storm sewer features are provided in the appendix of this report.

The project site has been divided into 6 onsite and 5 offsite sub-basins for this drainage analysis. See the drainage plan at the rear of this report for a depiction of each basin.

Basin A (0.53 acres) contains the north and west portion of the building. Runoff from this basin will drain to a roof drain system at Design Point 1. Collected flows will be piped to the onsite storm sewer system which will drain to the proposed extended detention basin. The 5-year and 100-year runoff rates at Design Point 1 will be 2.0 cfs and 3.8 cfs, respectively. If the capacity of the roof drain system is exceeded overflow scuppers will release flows to surrounding basins B, C, D and E.

Basin B (1.44 acres) contains the parking lot and landscaped areas in the northwest portion of the site. Runoff from this basin will drain to a 15' Type R inlet in a 6" sump at Design Point 2. Collected flows will drain through storm sewer to the proposed extended detention basin. The 5-year and 100-year runoff rates at Design Point 2 will be 5.5 cfs and 10.6 cfs, respectively. If the inlet were to fail overflow would drain northerly to Brookside Circle.

Basin C (1.54 acres) contains the parking lot and landscaped areas in the south portion of the site. Runoff from this basin will drain to a 15' Type R inlet in a 6" sump at Design Point 3. Collected flows will drain through storm sewer to the proposed extended detention basin. The 5-year and 100-year runoff rates at Design Point 3 will be 6.0 cfs and 11.7 cfs, respectively. If the inlet were to fail overflow would drain on the surface toward the detention basin.

Basin D (0.31 acres) contains a portion of the parking lot and landscaped areas on the east side of the site. Runoff from this basin will drain to a 5' Type R inlet in a 6" sump at Design Point 4. Collected flows will drain through storm sewer to the proposed extended detention basin. The 5-year and 100-year runoff rates at Design Point 4 will be 1.2 cfs and 2.4 cfs, respectively. If the inlet were to fail overflow would drain on the surface toward the detention basin.

Basin E (0.52 acres) contains a portion of the parking lot and landscaped areas on the east side of the site. Runoff from this basin will drain to a 5' Type R inlet in a 6" sump at Design Point 5. Collected flows will drain through public storm sewer to the proposed extended detention basin. The 5-year and 100-year runoff rates at Design Point 5 will be 2.1 cfs and 4.0 cfs, respectively. If the inlet were to fail overflow would drain on the surface toward the detention basin.

Basin F (0.06 acres) contains a narrow strip of landscaped area on the northeast edge of the property. Runoff from this basin will sheetflow to Brookside Circle where it will be collected by an existing 10' Type R inlet in a sump. The 5-year and 100-year runoff rates at Design Point 6 will be 0.2 cfs and 0.5 cfs, respectively.

Basin OS5 contains existing and proposed pavement in the Brookside Circle and Wilcox Street rights-of-way. Runoff from this basin drains to an existing 10' Type R inlet in a 6" sump at Design Point 7. Collected flows drain northeasterly through existing public storm sewer to East Plum Creek. The developed 5-year and 100-year runoff rates at Design Point 7 will be 2.0 cfs and 4.9 cfs, respectively.

Basin OS1 (2.00 acres) contains the northwest portion of the existing auto dealership located 600 feet south of the project site. Runoff from this basin drains on the surface to Basin OS2. A local drainage swale then carries flows to the northeast corner of Basin OS2. The 5-year and 100-year runoff rates at Design Point 8 are 7.5 cfs and 14.8 cfs, respectively.

Basin OS2 (7.35 acres) contains the vacant parcel immediately south of the project site. Runoff from this basin will drain to a Type D inlet in an 18" sump in the interim condition during which the 5-year and 100-year runoff rates at Design Point 9 will be 6.1 cfs and 32.3 cfs, respectively. If the inlet were to fail, overflow would drain easterly on the surface toward the detention basin. When Basin OS2 develops the Type D inlet will be replaced by an onsite storm sewer system. The storm sewer downstream of the Type D inlet has been sized to accept developed flowrates of 27.3 cfs and 52.9 cfs and will convey these flows to the detention basin. Runoff calculations for this basin assume a future imperviousness of 95%.

Basin OS3 (6.29 acres) contains future commercial land in Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4. These parcels are currently owned by the owner of the CDR+J development and are planned to contain an auto body shop and a large parking lot. In the interim condition, runoff from Basin OS3 will continue to drain northeasterly toward Plum Creek. A portion of the flows will be intercepted by the proposed detention pond while a portion will continue to sheetflow directly to East Plum Creek. When these parcels develop, onsite flows must be collected and conveyed to the proposed detention basin to be constructed in Lots 1 and 2. The calculated fully developed flowrates at Design Point 10 are 23.9 cfs and 47.1 cfs, respectively. Runoff calculations for this basin assume a future imperviousness of 95%.

Basin OS4 (0.83 acres) contains the proposed extended detention basin to be constructed in Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4. Runoff from this facility will be released to East Plum Creek at regulated rates as described below in Sections 3.0 and 4.0. The cumulative, fully developed 5-year and 100-year runoff rates at Design Point 11 are calculated to be 56.7 cfs and 115.9 cfs, respectively. If the outlet structure were to fail an emergency overflow channel would carry flows directly to East Plum Creek.

3.0 DRAINAGE DESIGN CRITERIA

Regulations

This drainage study has been prepared to meet the requirements of the Town of Castle Rock as set forth in the “Town of Castle Rock Storm Drainage Design and Technical Criteria Manual” (Reference 1), and the “Urban Storm Drainage Criteria Manual” (Reference 2).

Stormwater detention and water quality treatment are required for the proposed development.

Existing Brookside Circle drains to East Plum Creek without passing through a detention and water quality facility. The proposed development includes improvements to Wilcox Street and Brookside Circle which will drain to the existing storm inlet in Brookside Circle, then through the existing storm sewer and open channel to East Plum Creek. We have calculated the proposed roadway impervious area as 0.30 acres and the existing tributary

existing roadway area as 0.43 acres. Because this total is less than 1 acre it qualifies for an exclusion from water quality enhancement and full-spectrum detention according to Section 13.1.5 of the Town 's drainage manual. We have applied for a technical criteria variance for this condition.

Drainage Studies, Master Plans, Site Constraints

Existing drainage studies affecting the project site include:

“Phase III Drainage Report, Medved-Brutyn Autoplex”, prepared by Rocky Mountain Consultants, Inc. in January 2000.

“Addendum #1, Phase III Drainage Report”, Medved Brutyn Autoplex”, prepared by Rocky Mountain Consultants, Inc. on December 17, 2001.

“Stormwater Master Plan Update 2017”, prepared by Castle Rock Water.

“East Plum Creek Watershed Master Plan, Preliminary Design Report”, prepared by CH2MHill in 2009.

“Plum Creek, West Plum Creek, and East Plum Creek Major Drainageway Plan”, prepared by Enginuity Engineering Solution in September 2016.

“Flood Hazard Area Delineation, East Plum Creek, East Plum Creek, West Plum Creek”, prepared by Enginuity Engineering Solution in November 2019.

“Low-Effect Habitat Conservation Plan for Preble’s Meadow Jumping Mouse, Brookside Business Center, Town of Castle Rock, Douglas County, Colorado”, prepared by CORE Consultants, Inc. in November 2021. (Habitat Conservation Plan)

The Habitat Conservation Plan discusses installation of stream-bank stabilization structures and their relationship to Preble’s Meadow Jumping Mouse habitat. It includes recommendations for habitat restoration and enhancement. This drainage report is in agreement with the Habitat Conservation Plan. This includes the installation of buried rip-rap just west of the East Plum Creek floodplain for the purpose of bank stabilization.

Hydrology

The hydrologic design for the site is based on the criteria established by the Town of Castle Rock. This report analyzes runoff anticipated during the 5- and 100-year storm events.

The Rational Method was used to calculate peak runoff rates for the sub-basins. Imperviousness percentages and runoff coefficients were determined using Mile High Flood District (MHFD) tables 6-3 and 6-5. Form SF-2 was used to determine times of concentration. Rainfall intensities were determined using Town figure 6-1. This figure was developed by the Town using distribution factors provided in the NOAA Atlas and also provided in Table RA-4 of the MHFD Manual. Runoff flow rates were determined using form SF-3. See hydrologic calculations in Appendix A.

Hydraulics

Specific hydraulic calculations for determining the sizes and type of onsite storm sewer features are provided in Appendix B. In compliance with the Town of Castle Rock Design Criteria the storm sewer system has been sized to collect runoff from the 100-year (and smaller) events, ponding depths within sumps will not exceed 6 inches in paved areas and 18 inches in undeveloped areas. Inlet sizing has been determined using the UD-Inlet software provided by MHFD. StormCAD software has been utilized to model and design the storm sewer system and has been provided in Appendix B.

Storage and Water Quality Enhancement

The proposed development must comply with the four-step process described in Section 14.1 of the Town's drainage manual.

- 1) Reduce Runoff Volume to the Maximum Extent Practicable: Due to the nature of the proposed development (auto dealership) paved parking and building will cover approximately 88% of the property. These areas have been broken up by interior and perimeter landscaped islands.
- 2) Provide Water Quality Capture Volume and Flood Control Detention Via Full-Spectrum Detention: This step will be satisfied by the construction of the detention and water quality facility in Lot 2, Second Amendment to Brookside Business Center Filing No. 4.
- 3) Utilize Stream Channel Stabilization Techniques: Bank stabilization using buried rip-rap is proposed along the west bank of East Plum Creek adjacent to Lot 2.

- 4) Undertake Source Control: This step will be addressed by keeping storage and handling of all automotive-related fluids contained within the building. This includes no outside vehicle maintenance. It also includes designated snow storage in landscaped areas. Vehicle washing will be accomplished through a drive-through portion of the building with effluent being drained through the sanitary sewer system.

Per town criteria, stormwater detention and the water quality capture volume must be provided for this development. The volume necessary for this function is described in Chapter 12, Volume 2, of the MHFD criteria manual. A regional extended detention basin is proposed on the east side of Lot 2, Second Amendment to Brookside Business Center Filing No. 4. The water quality capture volume (WQCV) will be slowly released through an orifice plate on the face of the outlet control structure. The WQCV has been designed to drain in 40 hours. The orifice plate on the outlet structure will also allow the Excess Urban Runoff Volume (EURV) to drain in 70 hours. When ponding depths exceed the EURV water surface the 100-year detention volume will be stored and drained through the outlet control structure's overflow grate and will be released at a maximum flowrate of 24.0 cfs. Flows will be piped to the existing ground surface at the edge of East Plum Creek, located immediately to the east. An emergency overflow weir has also been designed near the outlet control structure and has been sized to pass the 100-year developed flowrate in case of outlet structure failure. An emergency overflow channel consisting of buried rip-rap has been designed to convey the 100-year developed flowrate to East Plum Creek as well.

The Town of Castle Rock must comply with state CDPS General Permit COR080000. Therefore, the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, revised June 2019, states that stormwater must be treated whether by regional, sub-regional or on-site detention before it reaches a "major drainageway" (Chapter 14, Section 14.1; Stormwater Quality Design process and Chapter 13, Section 13.1; Storage). This requires water quality enhancement for new development. The Town and CDPS requirements are met for the proposed development by draining site runoff through the proposed extended detention basin.

The proposed drainage design meets the requirement of Section 14.2.2.1 which requires "at least 80-percent of the upstream imperviousness shall be disconnected and drain through a

receiving pervious area". All proposed impervious areas in the proposed CDR+J development will drain through the proposed extended detention basin.

Stormwater Conveyance Facilities

A layout of the storm sewer system is shown on the drainage plan. The vast majority of the proposed development, including the building and parking lot will drain to proposed storm sewer within the development. This storm sewer system will convey flows to the extended detention basin. Specific hydraulic calculations for determining the sizes and type of storm sewer features are provided in the appendix of this report.

Stormwater Storage Facilities

As mentioned above, the proposed extended detention basin will detain and release runoff to East Plum Creek at rates similar to historic runoff rates. The detention facility was designed to serve the tributary portion of Lot 1, Second Amendment to Brookside Business Center Filing No. 2, the CDR+J site and Lots 1 and 2, Second Amendment to Brookside Business Center Filing No. 4. This is a total area of 20.81 acres with an imperviousness of 88%. Proposed flowrates to the detention facility will be 56.7 cfs and 115.9 cfs during the 5-year and 100-year storm events, respectively. Peak release rates will be 0.3 cfs for the WQCV, 0.7 cfs for the EURV and 24.0 cfs during the 100-year storm event.

Water Quality Enhancement Best Management Practices

As mentioned above, a proposed extended detention basin will provide both stormwater detention and water quality capture volume for the 20.81 acres of tributary land including the CDR+J site. This basin has been designed in compliance with MHFD criteria (Extended Detention Basin Section T-5, MHFD, November 2015).

Floodplain Modification

No cut or fill is proposed within the East Plum Creek Floodplain. The outlet pipe from the proposed extended detention basin will outfall to East Plum Creek within a low-tailwater basin. The emergency overflow weir will also be located within the East Plum Creek floodplain. It will be protected by buried rip-rap and will be recessed into the west bank of the creek to avoid creating any fill within the floodplain.

Buried rip-rap will be installed along the west bank of East Plum Creek adjacent to Lot 2. Finished grades will match existing grades in all disturbed areas. The proposed rip-rap is

consistent with the assumptions of the Habitat Conservation Plan. Therefore, separate approvals from USFWS regarding Prebble Mouse habitat is not required.

Permitting and clearances from USFWA and USACE will be required for all floodplain modifications.

Phasing

As described in the introduction of this report, the CDR+J project will be constructed in two phases. Due to the delay in obtaining US Fish & Wildlife Service approval of the Habitat Conservation Plan no disturbance is allowed within Lot 2, Second Amendment to Brookside Business Center Filing No. 4 (Lot 2, Filing 4) at this time. Therefore, the proposed stormwater detention facility cannot be constructed until Phase 2 of this project.

We have developed the following interim drainage design to be constructed during Phase 1 of this project:

- The existing parking lot detention facility located in the northeast corner of the existing dealership on Lot 1, Block 1, First Amendment to Brookside Business Center Filing No. 2 (henceforth referred to as Lot 1, First Amendment, Filing 2) will be demolished.
- Lot 1 will be re-graded per the Phase 1 construction plans. This will provide a pad for the construction of the proposed building expansion. It will also direct runoff from nearly all of Lot 1, First Amendment, Filing 2 to the existing detention and water quality facility which is located on Lot 2, Block 1, First Amendment to Brookside Business Center Filing No. 2 (henceforth referred to as Lot 2, First Amendment, Filing 2).

Although the existing detention facility in Lot 2, First Amendment, Filing 2 was not designed to serve Lot 1, First Amendment, Filing 2 we have determined that it has adequate capacity to serve all of Lot 1, First Amendment, Filing 2 in the interim condition. According to “Phase III Drainage Report, Medved-Brutyn Autoplex”, prepared by Rocky Mountain Consultants, Inc. in January 2000 this existing detention facility was sized to serve 10.55 acres with an imperviousness of 95% within Lot 1, Second Amendment to Brookside Business Center Filing No. 2, plus the 0.95-acre pond area and 6.71 acres of upstream, tributary area. This 10.55-acre impervious area is delineated as Basins OS1 and

OS2 and the south edge of Basin A on the Final Drainage Plan. Of this area, only the 2.00 acres within Basin OS1 is currently developed. Therefore, the detention facility contains adequate volume to service an additional 8.55 acres of developed area having an imperviousness of 95%. We are proposing to drain nearly all 2.77 acres of Lot 1, First Amendment, Filing 2 through the detention facility during Phase 1 of this project. There is no need to adjust the release rates from the outlet control structure.

Once the Habitat Conservation Plan has been approved by the US Fish and Wildlife Service and the necessary permits have been obtained from the Town of Castle Rock then the new detention facility may be constructed in Lot 2, Filing 4 and the existing facility in Lot 2, Filing 2 may be demolished and replaced with a new parking lot.

Geotechnical Investigation and Sub-surface Collection System Design

According to the report titled, “Geotechnical Engineering Study and Pavement Design, 1520 South Wilcox Street, Castle Rock, Colorado 80104” prepared by Best Engineering Solutions and Technologies on May 12, 2021 groundwater was found at depths of 23 to 27 feet. This is well below any proposed excavation depths. Bedrock was not found in any boring depths of 15 to 40 feet.

Operation and Maintenance

The proposed storm sewer system and the detention and water quality facility will be owned and maintained by Foundation Automotive Corp. This business is the current owner of all lots which drain to the proposed detention facility. If a portion of these lots are sold in the future a maintenance agreement for the proposed storm sewer and detention facility will be required. These drainage facilities must be maintained according to the Operations and Maintenance Guidelines provided by the Town of Castle Rock. This document can be found on the Town of Castle Rock website at Crgov.com/stormwater. Maintenance of the extended detention basin begins with a twice annual inspection and maintenance activities as more fully described in the town guidelines. Significant maintenance can be expected once every 15 to 25 years.

Additional Permitting Requirements

A floodplain development is required for improvements within the East Plum Creek floodplain.

USFS and Section 404 clearances are required.

A no-rise/no-fill certification is provided at the rear of this drainage report.

4.0 CONCLUSIONS

Compliance With Standards

The proposed drainage design is in conformance with the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual and the Urban Storm Drainage Criteria Manual.

The proposed storm sewer and detention basin have been designed to accept fully developed runoff from the project site. Calculations located in Appendix C show the parameters used to make this determination.

Detention and water quality volumes for this site are provided in a proposed extended detention basin.

Variances

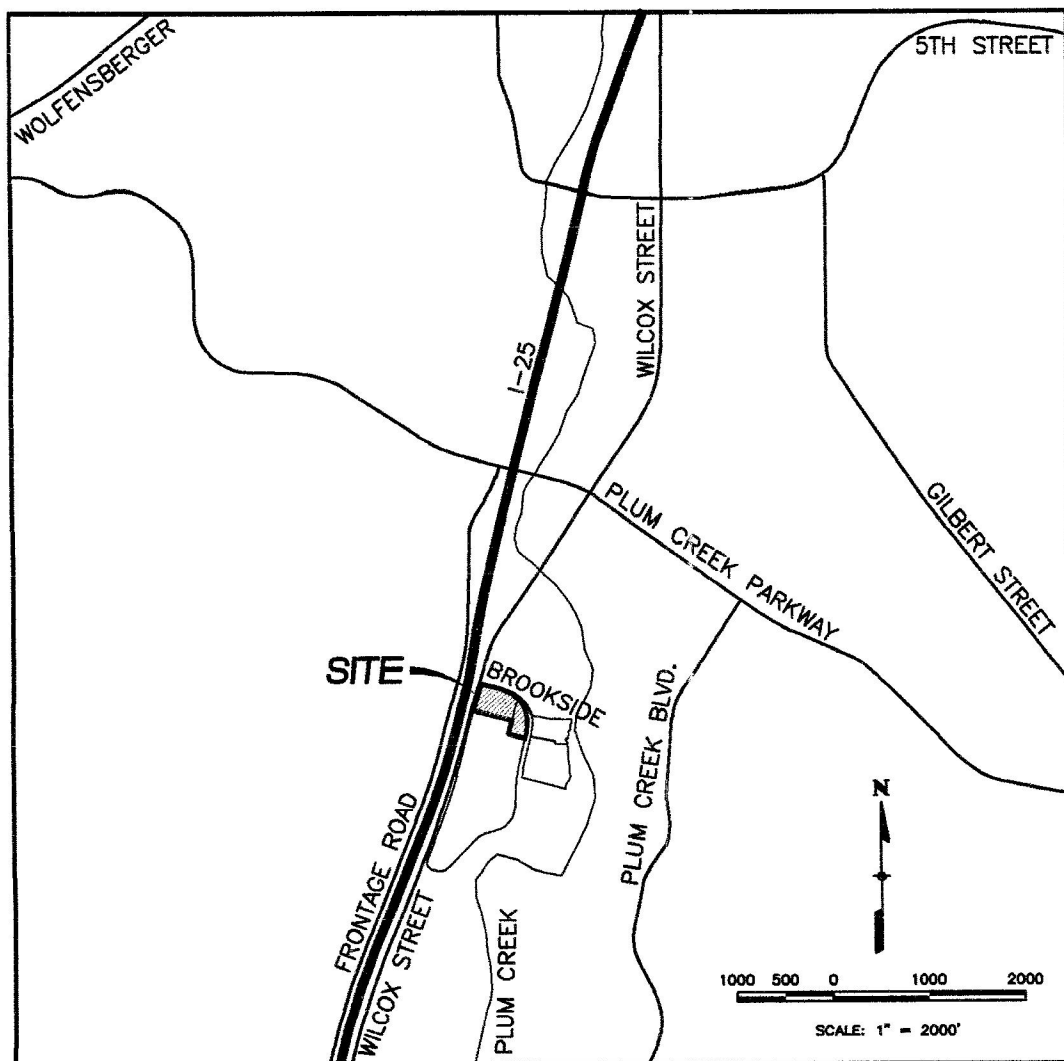
No variances are requested at this time.

Drainage Concept

Runoff generated onsite will be directed away from the building and toward onsite storm inlets which will collect flows and convey flows to the proposed extended detention basin to be constructed on Lot 2, Second Amendment to Brookside Business Center Filing No. 4. Flows will be released from the detention basin to East Plum Creek at regulated rates.

5.0 REFERENCES

1. Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, June 2019.
2. Urban Storm Drainage Criteria Manual, Mile High Flood District, Volume 1 - August 2018, Volume 2 - September 2017 Volume 3 - November 2019.
3. FEMA Flood Insurance Rate Map 08035C0301G, March 16, 2016
4. United States Department of Agriculture – Web Soil Survey, June 3, 2021, Soil Map – Castle Rock Area, Colorado; <http://websoilsurvey.nrcs.usda.gov/app/>
5. Phase III Drainage Report, Medved-Brutyn Autoplex, Rocky Mountain Consultants, Inc., January 2000.
6. Addendum #1, Phase III Drainage Report, Medved Brutyn Autoplex”, Rocky Mountain Consultants, Inc., December 17, 2001.
7. Stormwater Master Plan Update 2017, Castle Rock Water.
8. East Plum Creek Watershed Master Plan, Preliminary Design Report, CH2MHill, 2009.
9. Plum Creek, West Plum Creek, and East Plum Creek Major Drainageway Plan, Enginuity Engineering Solution, September 2016.
10. Flood Hazard Area Delineation, East Plum Creek, East Plum Creek, West Plum Creek, Enginuity Engineering Solution, November 2019.
11. Geotechnical Engineering Study and Pavement Design, 1520 South Wilcox Street, Castle Rock, Colorado 80104, Best Engineering Solutions and Technologies, May 12, 2021.
12. Low-Effect Habitat Conservation Plan for Preble’s Meadow Jumping Mouse, Brookside Business Center, Town of Castle Rock, Douglas County, Colorado, CORE Consultants, Inc., November 2021.

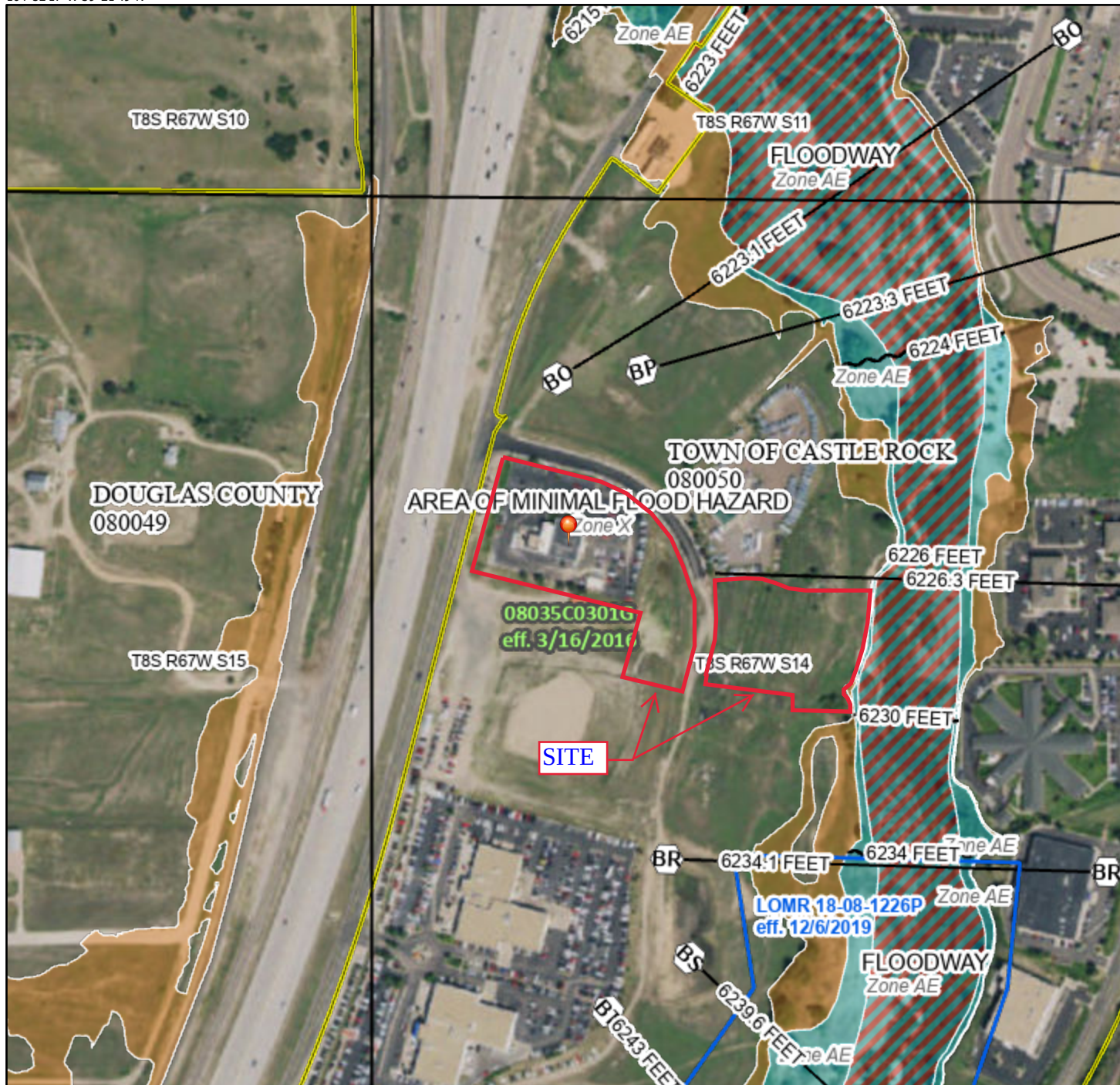


VICINITY MAP
SCALE: 1"=2000'

National Flood Hazard Layer FIRMeTte



104°52'17"W 39°21'49"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/2/2021 at 4:34 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Soil Map—Castle Rock Area, Colorado



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Castle Rock Area, Colorado

Survey Area Data: Version 14, Aug 31, 2021

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BrD	Bresser sandy loam, cool, 5 to 9 percent slopes	1.2	20.0%
Lo	Loamy alluvial land	2.1	34.7%
NeE	Newlin gravelly sandy loam, 8 to 30 percent slopes	1.6	26.3%
Se	Sandy wet alluvial land	1.1	18.9%
Totals for Area of Interest		6.0	100.0%

Castle Rock Area, Colorado

BrD—Bresser sandy loam, cool, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2tlpk

Elevation: 5,500 to 6,960 feet

Mean annual precipitation: 15 to 19 inches

Mean annual air temperature: 48 to 52 degrees F

Frost-free period: 100 to 130 days

Farmland classification: Not prime farmland

Map Unit Composition

Bresser, cool, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bresser, Cool

Setting

Landform: Interfluves

Landform position (two-dimensional): Shoulder, backslope

Landform position (three-dimensional): Interfluve

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Tertiary aged alluvium derived from arkose

Typical profile

Ap - 0 to 5 inches: sandy loam

Bt1 - 5 to 8 inches: sandy loam

Bt2 - 8 to 27 inches: sandy clay loam

Bt3 - 27 to 36 inches: sandy loam

C - 36 to 80 inches: loamy coarse sand

Properties and qualities

Slope: 5 to 9 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)

Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Ascalon

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Truckton

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 13, Jun 5, 2020

Castle Rock Area, Colorado

Lo—Loamy alluvial land

Map Unit Setting

National map unit symbol: jqzb

Elevation: 7,000 to 8,000 feet

Mean annual precipitation: 17 to 19 inches

Mean annual air temperature: 44 to 46 degrees F

Frost-free period: 115 to 120 days

Farmland classification: Not prime farmland

Map Unit Composition

Loamy alluvial land: 80 percent

Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Loamy Alluvial Land

Setting

Landform: Flood plains, swales

Down-slope shape: Linear

Across-slope shape: Linear

Typical profile

H1 - 0 to 20 inches: sandy loam

H2 - 20 to 40 inches: stratified loamy sand to clay loam

H3 - 40 to 60 inches: sand and gravel

Properties and qualities

Slope: 1 to 5 percent

Drainage class: Well drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.20 to 6.00 in/hr)

Depth to water table: About 48 to 72 inches

Frequency of flooding: FrequentNone

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

Available water capacity: Moderate (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: C

Ecological site: R049XY036CO - Overflow

Hydric soil rating: No

Minor Components

Bresser

Percent of map unit: 7 percent

Hydric soil rating: No

Sampson

Percent of map unit: 7 percent

Hydric soil rating: No

Sandy alluvial land

Percent of map unit: 5 percent

Fluvaquentic haplustolls

Percent of map unit: 1 percent

Landform: Terraces

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado

Survey Area Data: Version 13, Jun 5, 2020

Castle Rock Area, Colorado

NeE—Newlin gravelly sandy loam, 8 to 30 percent slopes

Map Unit Setting

National map unit symbol: jqzg

Elevation: 5,500 to 6,600 feet

Mean annual precipitation: 15 to 19 inches

Mean annual air temperature: 49 to 51 degrees F

Frost-free period: 120 to 135 days

Farmland classification: Not prime farmland

Map Unit Composition

Newlin and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Newlin

Setting

Landform: Terraces, mesas, plateaus

Landform position (three-dimensional): Riser

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Unconformable sandy and gravelly and/or mixed source alluvium

Typical profile

H1 - 0 to 8 inches: gravelly sandy loam

H2 - 8 to 17 inches: gravelly sandy clay loam

H3 - 17 to 22 inches: gravelly sandy loam

H4 - 22 to 60 inches: very gravelly sand

Properties and qualities

Slope: 8 to 30 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water capacity: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: B

Ecological site: R049XB215CO - Gravelly Foothill

Hydric soil rating: No

Minor Components

Bresser

Percent of map unit: 5 percent

Hydric soil rating: No

Satanta

Percent of map unit: 4 percent

Hydric soil rating: No

Stapleton

Percent of map unit: 4 percent

Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 2 percent

Landform: Swales

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado

Survey Area Data: Version 13, Jun 5, 2020

Castle Rock Area, Colorado

Se—Sandy wet alluvial land

Map Unit Setting

National map unit symbol: jr04

Elevation: 5,500 to 6,600 feet

Mean annual precipitation: 15 to 19 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 120 to 135 days

Farmland classification: Not prime farmland

Map Unit Composition

Sandy wet alluvial land: 80 percent

Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sandy Wet Alluvial Land

Setting

Landform: Drainageways, flood plains

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Weathered alluvium derived from arkose

Typical profile

H1 - 0 to 6 inches: coarse sand

H2 - 6 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 1 to 4 percent

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)

Depth to water table: About 0 to 24 inches

Available water supply, 0 to 60 inches: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8w

Hydrologic Soil Group: D

Hydric soil rating: No

Minor Components

Loamy wet alluvial land

Percent of map unit: 9 percent

Hydric soil rating: No

Sandy alluvial land

Percent of map unit: 9 percent

Hydric soil rating: No

Fluventic haplaquolls

Percent of map unit: 2 percent

Landform: Terraces

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado

Survey Area Data: Version 14, Aug 31, 2021

APPENDIX A

Hydrologic Computations

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only):	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Table 6-5. Runoff coefficients, *c*

Total or Effective % Impervious	NRCS Hydrologic Soil Group A						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.01	0.01	0.04	0.13	0.27
5%	0.02	0.02	0.02	0.03	0.07	0.15	0.29
10%	0.04	0.05	0.05	0.07	0.11	0.19	0.32
15%	0.07	0.08	0.08	0.1	0.15	0.23	0.35
20%	0.1	0.11	0.12	0.14	0.2	0.27	0.38
25%	0.14	0.15	0.16	0.19	0.24	0.3	0.42
30%	0.18	0.19	0.2	0.23	0.28	0.34	0.45
35%	0.21	0.23	0.24	0.27	0.32	0.38	0.48
40%	0.25	0.27	0.28	0.32	0.37	0.42	0.51
45%	0.3	0.31	0.33	0.36	0.41	0.46	0.54
50%	0.34	0.36	0.37	0.41	0.45	0.5	0.58
55%	0.39	0.4	0.42	0.45	0.49	0.54	0.61
60%	0.43	0.45	0.47	0.5	0.54	0.58	0.64
65%	0.48	0.5	0.51	0.54	0.58	0.62	0.67
70%	0.53	0.55	0.56	0.59	0.62	0.65	0.71
75%	0.58	0.6	0.61	0.64	0.66	0.69	0.74
80%	0.63	0.65	0.66	0.69	0.71	0.73	0.77
85%	0.68	0.7	0.71	0.74	0.75	0.77	0.8
90%	0.73	0.75	0.77	0.79	0.79	0.81	0.84
95%	0.79	0.81	0.82	0.83	0.84	0.85	0.87
100%	0.84	0.86	0.87	0.88	0.88	0.89	0.9
Total or Effective % Impervious	NRCS Hydrologic Soil Group B						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.07	0.26	0.34	0.44	0.54
5%	0.03	0.03	0.1	0.28	0.36	0.45	0.55
10%	0.06	0.07	0.14	0.31	0.38	0.47	0.57
15%	0.09	0.11	0.18	0.34	0.41	0.5	0.59
20%	0.13	0.15	0.22	0.38	0.44	0.52	0.61
25%	0.17	0.19	0.26	0.41	0.47	0.54	0.63
30%	0.2	0.23	0.3	0.44	0.49	0.57	0.65
35%	0.24	0.27	0.34	0.47	0.52	0.59	0.66
40%	0.29	0.32	0.38	0.5	0.55	0.61	0.68
45%	0.33	0.36	0.42	0.53	0.58	0.64	0.7
50%	0.37	0.4	0.46	0.56	0.61	0.66	0.72
55%	0.42	0.45	0.5	0.6	0.63	0.68	0.74
60%	0.46	0.49	0.54	0.63	0.66	0.71	0.76
65%	0.5	0.54	0.58	0.66	0.69	0.73	0.77
70%	0.55	0.58	0.62	0.69	0.72	0.75	0.79
75%	0.6	0.63	0.66	0.72	0.75	0.78	0.81
80%	0.64	0.67	0.7	0.75	0.77	0.8	0.83
85%	0.69	0.72	0.74	0.78	0.8	0.82	0.85
90%	0.74	0.76	0.78	0.81	0.83	0.84	0.87
95%	0.79	0.81	0.82	0.85	0.86	0.87	0.88
100%	0.84	0.86	0.86	0.88	0.89	0.89	0.9

2.4.1 Initial or Overland Flow Time

The initial or overland flow time, t_i , may be calculated using Equation 6-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}} \quad \text{Equation 6-3}$$

Where:

- t_i = overland (initial) flow time (minutes)
- C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
- L_i = length of overland flow (ft)
- S_o = average slope along the overland flow path (ft/ft).

Equation 6-3 is adequate for distances up to 300 feet in urban areas and 500 feet in rural areas. Note that in a highly urbanized catchment, the overland flow length is typically shorter than 300 feet due to effective man-made drainage systems that collect and convey runoff.

2.4.2 Channelized Flow Time

The channelized flow time (travel time) is calculated using the hydraulic properties of the conveyance element. The channelized flow time, t_c , is estimated by dividing the length of conveyance by the velocity. The following equation, Equation 6-4 (Guo 2013), can be used to determine the flow velocity in conjunction with Table 6-2 for the conveyance factor.

$$t_c = \frac{L_c}{60K\sqrt{S_o}} = \frac{L_c}{60V_t} \quad \text{Equation 6-4}$$

Where:

- t_c = channelized flow time (travel time, min)
- L_c = waterway length (ft)
- S_o = waterway slope (ft/ft)
- V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
- K = NRCS conveyance factor (see Table 6-2).

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration, t_c , is the sum of the initial (overland) flow time, t_i , and the channelized flow time, t_t , as per Equation 6-2.

2.4.3 First Design Point Time of Concentration in Urban Catchments

Equation 6-4 was solely determined by the waterway characteristics and using a set of empirical formulas. A calibration study between the Rational Method and the Colorado Urban Hydrograph Procedure (CUHP) suggests that the time of concentration shall be the lesser of the values calculated by Equation 6-2 and Equation 6-5 (Guo and Urbonas 2013).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}} \quad \text{Equation 6-5}$$

Where:

- t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
- L_t = length of channelized flow path (ft)
- i = imperviousness (expressed as a decimal)
- S_t = slope of the channelized flow path (ft/ft).

Equation 6-5 is the regional time of concentration that warrants the best agreement on peak flow predictions between the Rational Method and CUHP when the imperviousness of the tributary area is greater than 20 percent. It was developed using the UDFCD database that includes 295 sample urban catchments under 2-, 5-, 10-, 50, and 100-yr storm events (MacKenzie 2010). It suggests that both initial flow time and channelized flow velocity are directly related to the catchment's imperviousness (Guo and MacKenzie 2013).

The first design point is defined as a node where surface runoff enters the storm drain system. For example, all inlets are "first design points" because inlets are designed to accept flow into the storm drain.

Typically, but not always, Equation 6-5 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, add the travel time for each relevant segment downstream.

2.4.4 Minimum Time of Concentration

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

2.4.5 Common Errors in Calculating Time of Concentration

A common mistake in urbanized areas is to assume travel velocities that are too slow. Another common error is to not check the runoff peak resulting from only part of the catchment. Sometimes a lower portion of the catchment or a highly impervious area produces a larger peak than that computed for the whole catchment. This error is most often encountered when the catchment is long or the upper portion contains grassy open land and the lower portion is more developed.

set of one hour design point rainfall values, indicated in Table 6-1, apply to the Town.

**TABLE 6-1
1-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)**

2- YR	5-YR	10-YR	50-YR	100-YR
1.06	1.43	1.66	2.26	2.60

The one-hour rainfall depths are the basis of the Town's intensity-duration rainfall curves and are used to formulate design storm distributions.

6.1.2 Intensity-Duration Curves. Rainfall intensity based on storm duration for a variety of storm return periods can be found on Figure 6-1 at the end of this chapter. These curves were developed using distribution factors provided in the NOAA Atlas and also provided in Table RA-4 of the UDFCD Manual. These Intensity-Duration curves are based on Equation RA-3 in the Rainfall Section of the UDFCD Manual.

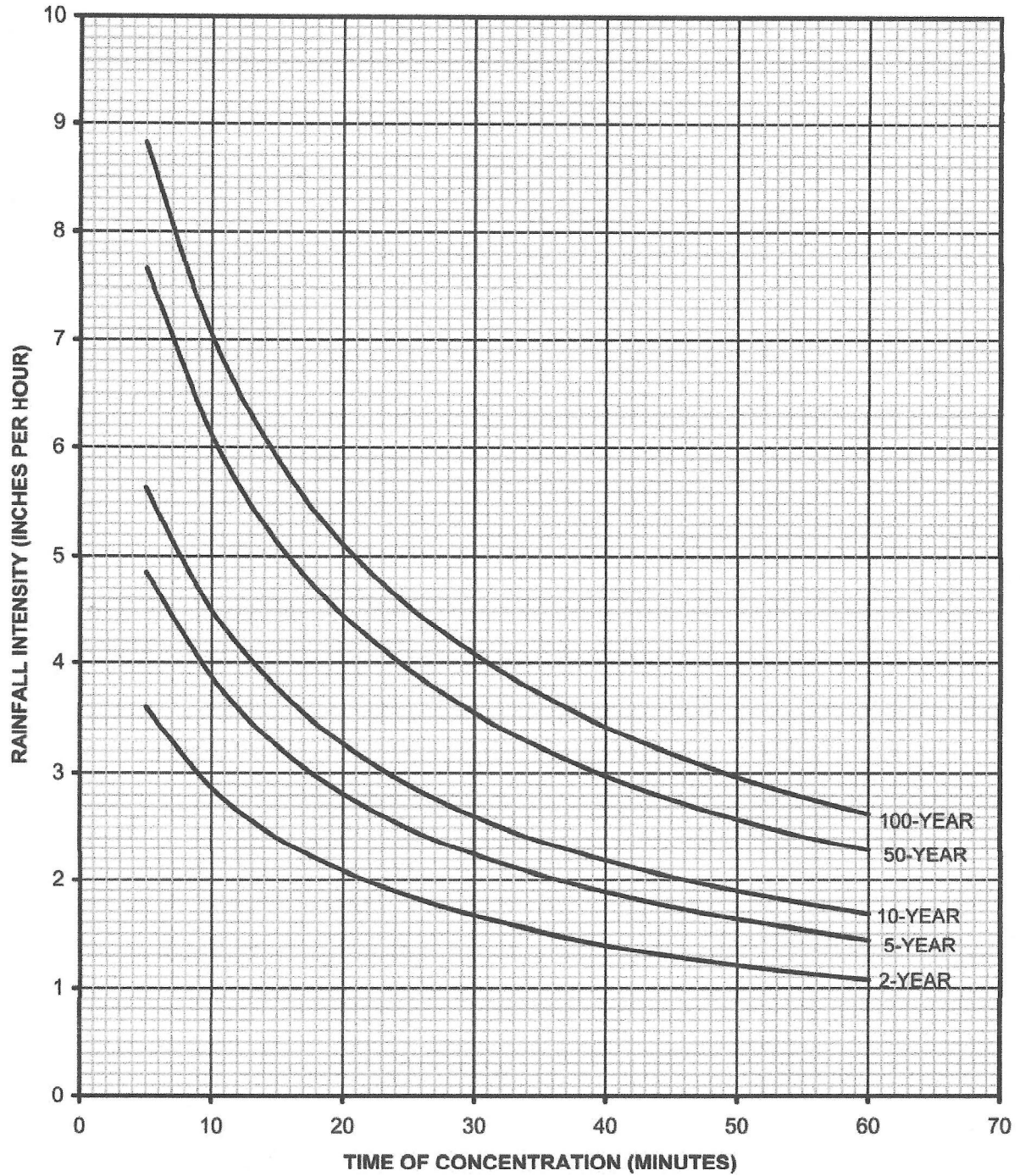
6.1.3 Six-hour Rainfall. In order to use the Colorado Urban Hydrograph Procedure (CUHP), two, three or six-hour rainfall distributions are required, depending on watershed area. Table RA-1 in the UDFCD Manual summarizes storm durations, area adjustments, and incremental rainfall depths to be used in CUHP based on watershed area. The UD-Raincurve Spreadsheet included in the UDFCD Manual shall be used to generate the rainfall distribution curves necessary for a CUHP model. In order to generate these distribution curves, the one-hour and six-hour rainfall depths for the design return periods are necessary. Since the Town of Castle Rock is not located within UDFCD boundaries, the rainfall depth-duration-frequency curves provided in the UDFCD Manual do not provide rainfall values for the entire Town. Therefore these values are provided in these Criteria. The 1-hour point values can be found in Table 6-1 of this chapter. The six-hour point values are as follows:

**TABLE 6-2
6-HOUR POINT RAINFALL VALUES FOR
THE TOWN OF CASTLE ROCK (INCHES)**

2- YR	5-YR	10-YR	50-YR	100-YR
1.5	2.0	2.2	3.0	3.4

The UD-Raincurve spreadsheet shall be used for all portions of the Town. Once the rainfall distribution curves are generated using the UDFCD UD-Raincurve Spreadsheet, the CUHP model is to be set up following the procedures provided in the Runoff chapter in Volume 1 of the UDFCD Manual.

FIGURE 6-1
RAINFALL INTENSITY-DURATION CURVE
TOWN OF CASTLE ROCK



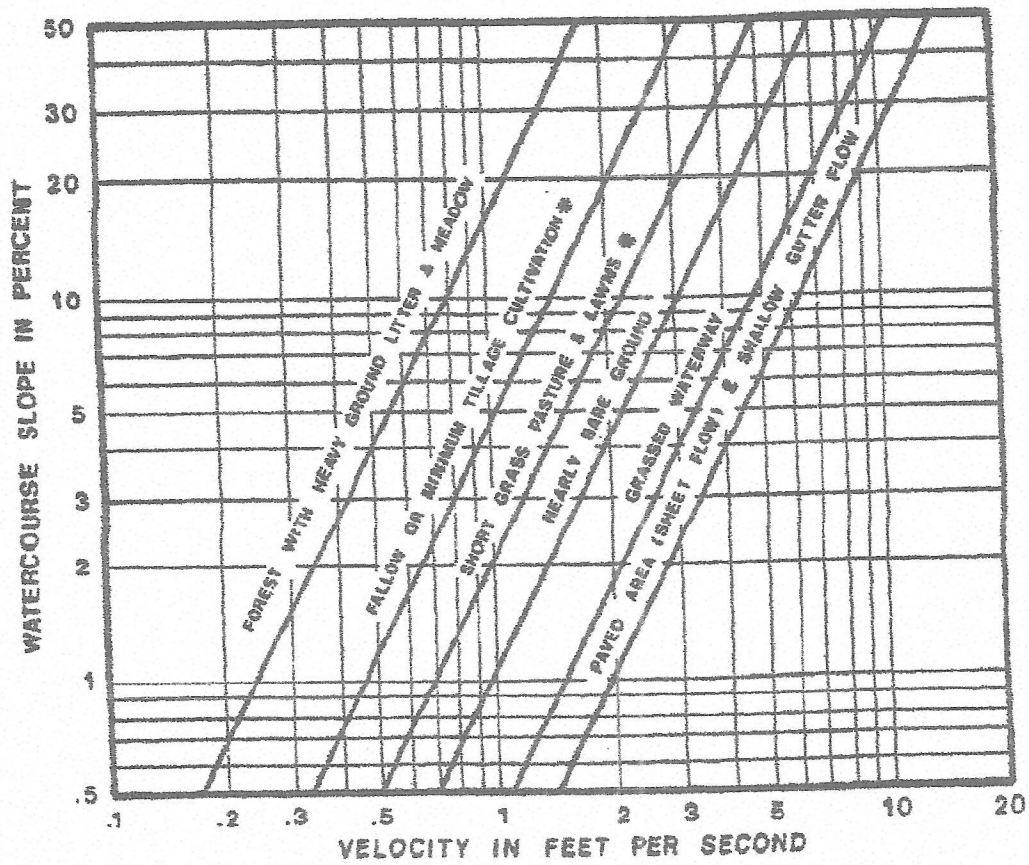


Figure RO-1—Estimate of Average Overland Flow Velocity for Use With the Rational Formula

COMPOSITE BASIN COEFFICIENTS

Subdivision First Amendment to Brookside Business Center Filing No. 2
Location 1100 S. Wilcox Street

Project Name: CDR+J
Project No. 21007
Calculated By: BK
Checked By: BK
Date: 9/10/21

Tributary to Detention 20.81 acres

Land Use	Imp.	Area	% Imp.
Downtown Business	95	20.03	91
Landscape/Open Space	2	0.78	0
TOTAL		20.81	88

Total Area Basin OS5: 0.86 acres

Land Use	Imp.	Area	% Imp.	C ₅	C ₁₀₀
Parking Lot/Roadway	100	0.56	65	* use Table RO-5 to obtain coefficient values.	
Rooftop	90	0.00	0		
Landscape/Open Space	2	0.30	1		
TOTAL		0.86	66	0.55	0.74

Note: Basins A-F, OS2 and OS3 have assumed imperviousness values of 95%.

STANDARD FORM SF-2 TIME OF CONCENTRATION

Subdivision
Location

First Amendment to Brookside Business Center Filing No. 2
1100 S. Wilcox Street

Project Name: CDR+J

Project No. 21007

Calculated By: BK

Checked By: BK

Date: 9/10/21

SUB-BASIN			INITIAL/OVERLAND			TRAVEL TIME				Tc CHECK			FINAL
DATA			(T _i)			(T _t)				(URBANIZED BASINS)			
BASIN ID	D.A. (AC)	C _s	L (FT)	S (%)	T _i (MIN)	L (FT)	S (%)	VEL. (FPS)	T _t (MIN)	COMP. T _c (MIN)	TOTAL LENGTH(FT)	MIN. T _c (MIN)	
A	0.53	0.81	45	2.0	2.8	440	1.0	2.0	3.7	6.5	485.0	10.6	6.5
B	1.44	0.81	65	6.0	2.4	520	1.0	2.0	4.3	6.7	585.0	9.2	6.7
C	1.54	0.81	115	2.0	4.5	450	4.5	4.0	1.9	6.4	565.0	9.2	6.4
D	0.31	0.81	100	6.0	2.9	50	4.0	4.0	0.2	3.1	150.0	9.0	5.0
E	0.52	0.81	160	6.0	3.7	40	0.7	1.7	0.4	4.1	200.0	9.0	5.0
F	0.06	0.01	10	33.0	2.0	135	1.0	2.0	1.1	3.1	145.0	9.0	5.0
OS1	2.00	0.81	140	4.5	3.8	250	1.0	2.0	2.1	5.9	390.0	9.1	5.9
OS2	7.35	0.81	100	4.0	3.3	400	2.0	2.8	2.4	5.7	500.0	9.1	5.7
OS3	6.29	0.81	100	4.0	3.3	400	2.0	2.8	2.4	5.7	500.0	9.1	5.7
OS4	0.83	0.01	25	2.0	7.9	165	0.5	1.5	1.8	9.8	190.0	9.1	9.1
OS5	0.86	0.55	20	2.0	3.6	750	4.5	4.0	3.1	6.7	770.0	9.4	6.7
NOTES													

NOTES:

$$T_i = (.395 * (1.1 - C_s) * (L)^{0.5}) / (S^{0.33})$$

$$T_t = L / 60V \text{ (Velocity From Fig. 6-4)}$$

$$T_c \text{ Check} = (26 - 17i) + L / \{60(14i + 9)\sqrt{S}\}$$

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision First Amendment to Brookside Business Center Filing No. 2
Location 1100 S. Wilcox Street
Design Storm 5 Year

Project Name: CDR+J
Project No. 21007
Calculated By: BK
Checked By:
Date: 12/22/23

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			COMMENTS
		Area Desig.	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	
North & west portion of roof	1	A	0.53	0.81	6.5	0.43	4.6	2.0													
NW portion of site	2	B	1.44	0.81	6.7	1.17	4.7	5.5							2.0						Roof drain to detention basin
South portion of site	3	C	1.54	0.81	6.4	1.25	4.8	6.0							5.5						15' Type R inlet in 6" sump
NE portion of parking lot	4	D	0.31	0.81	5.0	0.25	4.9	1.2							6.0						15' Type R inlet in 6" sump
Center-east portion of parking lot	5	E	0.52	0.81	5.0	0.42	4.9	2.1							1.2						15' Type R inlet in 6" sump
NE edge of property	6	F	0.06	0.81	5.0	0.05	4.9	0.2							2.1						5' Type R inlet in 6" sump
Existing offsite roadways	7	OS5	0.86	0.55	6.7	0.47	4.0	1.9	6.7	0.52	3.9	2.0		0.2							Drains to Brookside Cir (Basin OS5)
NW portion of existing dealership to the south	8	OS1	2.00	0.81	5.9	1.62	4.6	7.5							2.0						Existing 10' Type R inlet in 6" sump
Future commercial development of Lot 1, 2nd Amendment, Filing 2	9	OS2	7.35	0.81	5.7	5.95	4.9	29.2	11.9	7.57	3.6	27.3		7.5				720	2.0	6.0	Drains to Basin OS2
Future commercial development on Lot 1, 2nd Amendment, Filing 4	10	OS3	6.29	0.81	5.7	5.09	4.7	23.9							27.3			680	13.3	0.9	Type D inlet in 18" sump
Detention basin	11	OS4	0.83	0.01	9.1	0.01	4.0	0.0	12.8	16.19	3.5	56.7		23.9				180	2.0	1.5	Drains to Basin OS4
																					Regulated release to East Plum Creek
Interim Condition - Prior to development of Basin OS2	9	OS2	7.35	0.01	5.7	0.07	4.9	0.4	11.9	1.69	3.6	6.1			6.1						Type D inlet in 18" sump

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

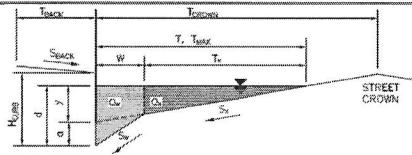
Subdivision First Amendment to Brookside Business Center Filing No. 2
Location 1100 S. Wilcox Street
Design Storm 100 Year

Project Name: CDR+J
Project No. 21007
Calculated By: BK
Checked By: _____
Date: 12/22/23

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME				COMMENTS
		Area Desig.	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Street Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)		
North & west portion of roof	1	A	0.53	0.87	6.5	0.46	8.2	3.8														
NW portion of site	2	B	1.44	0.87	6.7	1.25	8.5	10.6							3.8							Roof drain to detention basin
South portion of site	3	C	1.54	0.87	6.4	1.34	8.7	11.7							10.6							15' Type R inlet in 6" sump
NE portion of parking lot	4	D	0.31	0.87	5.0	0.27	8.8	2.4							11.7							15' Type R inlet in 6" sump
Center-east portion of parking lot	5	E	0.52	0.87	5.0	0.45	8.8	4.0							2.4							15' Type R inlet in 6" sump
NE edge of property	6	F	0.06	0.87	5.0	0.05	8.8	0.5							4.0							5' Type R inlet in 6" sump
Existing offsite roadways	7	OS5	0.86	0.74	6.7	0.64	7.1	4.5	6.7	0.69	7.1	4.9	0.5		4.9							Drains to Brookside Cir (Basin OS5)
NW portion of existing dealership to the south	8	OS1	2.00	0.87	5.9	1.74	8.5	14.8														Existing 10' Type R inlet in 6" sump
Future commercial development of Lot 1, 2nd Amendment, Filing 2	9	OS2	7.35	0.87	5.7	6.39	8.6	55.0	11.9	8.13	6.5	52.9		14.8				720	2.0	6.0		Drains to Basin OS2
Future commercial development on Lot 1, 2nd Amendment, Filing 4	10	OS3	6.29	0.87	5.7	5.47	8.6	47.1							52.9				680	13.3	0.9	Type D inlet in 18" sump
Detention basin	11	OS4	0.83	0.87	9.1	0.72	7.3	5.3	12.8	18.10	6.4	115.9		47.1				180	2.0	1.5		Drains to Basin OS4
																						Regulated release to East Plum Creek
Interim Condition - Prior to development of Basin OS2	9	OS2	7.35	0.44	5.7	3.23	8.6	27.8	11.9	4.97	6.5	32.3										
															32.3							Type D inlet in 18" sump

APPENDIX B

Hydraulic Computations

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)****Project:****Inlet ID:** DP 2**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$ 0.0 ft
 $S_{BACK} =$ ft/ft
 $n_{BACK} =$

$H_{CURB} =$ 6.00 inches
 $T_{CROWN} =$ 90.0 ft
 $W =$ 2.00 ft
 $S_x =$ 0.060 ft/ft
 $S_w =$ 0.083 ft/ft
 $S_o =$ 0.000 ft/ft
 $n_{STREET} =$ 0.016

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
$T_{MAX} =$	90.0	90.0	ft
$d_{MAX} =$	6.0	6.0	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

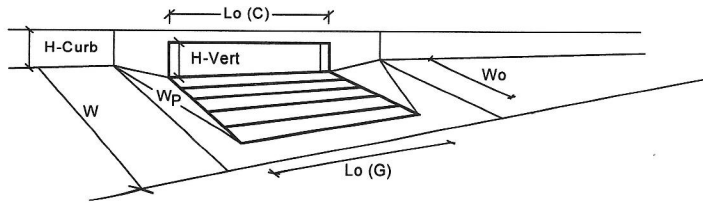
MAJOR STORM Allowable Capacity is based on Depth Criterion

$Q_{allow} =$

Minor Storm	Major Storm	
SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



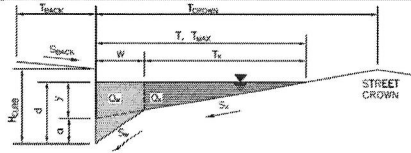
Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	3	3	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		$L_o (G)$ =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		$C_f (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		$C_o (G)$ =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		$L_o (C)$ =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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)		$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		$C_o (C)$ =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.57	0.57	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.79	0.79	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)			MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q_a =	13.5	13.5	cfs
		$Q_{PEAK REQUIRED}$ =	5.5	10.6	cfs

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

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

Project:

Inlet ID: DP 3

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} = 0.0$ ft
 $S_{BACK} =$ ft/ft
 $n_{BACK} =$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 40.0$ ft
 $W = 2.00$ ft
 $S_X = 0.030$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.000$ ft/ft
 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
$T_{MAX} =$	40.0	40.0	ft
$d_{MAX} =$	6.0	6.0	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

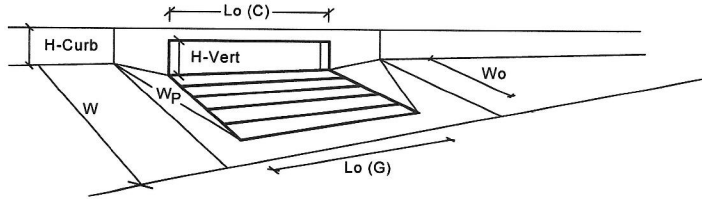
$Q_{allow} =$

Minor Storm	Major Storm
SUMP	SUMP

 cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

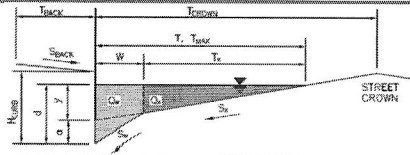


Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	8.0	inches
Grate Information			MINOR	MAJOR	☒ Override Depths
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L _o (C) =	15.00	15.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d _{grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{curb} =	0.33	0.50	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.57	0.75	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{curb} =	0.79	0.89	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)			MINOR	MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _a =	9.7	20.3	cfs
		Q _{PEAK REQUIRED} =	6.0	11.7	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)**

Project:

Inlet ID: DP 4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

$T_{BACK} = 0.0$ ft
 $S_{BACK} =$ ft/ft
 $n_{BACK} =$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 54.0$ ft
 $W = 2.00$ ft
 $S_x = 0.060$ ft/ft
 $S_w = 0.083$ ft/ft
 $S_o = 0.000$ ft/ft
 $n_{STREET} = 0.016$

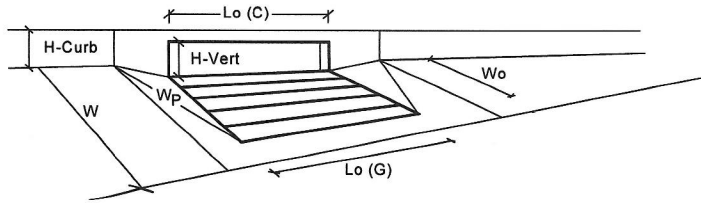
	Minor Storm	Major Storm	
$T_{MAX} =$	54.0	54.0	ft
$d_{MAX} =$	6.0	6.0	inches

$Q_{allow} =$

	Minor Storm	Major Storm	
	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		CDOT Type R Curb Opening	
Type of Inlet		CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a' from above)			
Number of Unit Inlets (Grate or Curb Opening)			
Water Depth at Flowline (outside of local depression)			
Grate Information			
Length of a Unit Grate			
Width of a Unit Grate			
Area Opening Ratio for a Grate (typical values 0.15-0.90)			
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)			
Grate Weir Coefficient (typical value 2.15 - 3.60)			
Grate Orifice Coefficient (typical value 0.60 - 0.80)			
Curb Opening Information			
Length of a Unit Curb Opening			
Height of Vertical Curb Opening in Inches			
Height of Curb Orifice Throat in Inches			
Angle of Throat (see USDCM Figure ST-5)			
Side Width for Depression Pan (typically the gutter width of 2 feet)			
Clogging Factor for a Single Curb Opening (typical value 0.10)			
Curb Opening Weir Coefficient (typical value 2.3-3.7)			
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)			
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth			
Depth for Curb Opening Weir Equation			
Combination Inlet Performance Reduction Factor for Long Inlets			
Curb Opening Performance Reduction Factor for Long Inlets			
Grated Inlet Performance Reduction Factor for Long Inlets			
Total Inlet Interception Capacity (assumes clogged condition)			
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)			

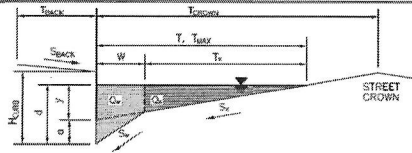
	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
a_{local} =	3.00	3.00	inches
No =	1	1	
Ponding Depth =	6.0	6.0	inches
	MINOR	MAJOR	Override Depths
$L_o (G)$ =	N/A	N/A	feet
W_o =	N/A	N/A	feet
A_{ratio} =	N/A	N/A	
$C_f (G)$ =	N/A	N/A	
$C_w (G)$ =	N/A	N/A	
$C_o (G)$ =	N/A	N/A	
	MINOR	MAJOR	
$L_o (C)$ =	5.00	5.00	feet
H_{vert} =	6.00	6.00	inches
H_{throat} =	6.00	6.00	inches
Theta =	63.40	63.40	degrees
W_p =	2.00	2.00	feet
$C_f (C)$ =	0.10	0.10	
$C_w (C)$ =	3.60	3.60	
$C_o (C)$ =	0.67	0.67	
	MINOR	MAJOR	
d_{grate} =	N/A	N/A	ft
d_{curb} =	0.33	0.33	ft
$RF_{Combination}$ =	0.77	0.77	
RF_{Curb} =	1.00	1.00	
RF_{Grate} =	N/A	N/A	
	MINOR	MAJOR	
Q_a =	5.4	5.4	cfs
$Q_{PEAK REQUIRED}$ =	1.2	2.4	cfs

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

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

Project:

Inlet ID: DP 5

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

$T_{BACK} = 0.0$ ft
 $S_{BACK} =$ ft/ft
 $n_{BACK} =$

$H_{CURB} = 6.00$ inches
 $T_{CROWN} = 44.0$ ft
 $W = 2.00$ ft
 $S_X = 0.007$ ft/ft
 $S_W = 0.083$ ft/ft
 $S_O = 0.000$ ft/ft
 $n_{STREET} = 0.016$

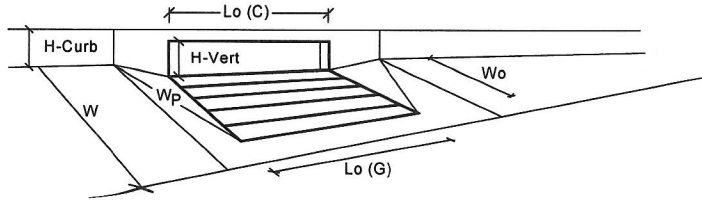
	Minor Storm	Major Storm	
$T_{MAX} =$	44.0	44.0	ft
$d_{MAX} =$	6.0	6.0	inches

$Q_{allow} =$

	Minor Storm	Major Storm	
	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



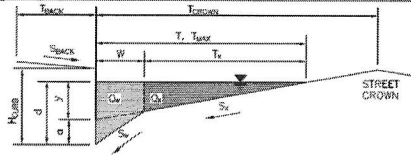
Design Information (Input)		CDOT Type R Curb Opening	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)			
Number of Unit Inlets (Grate or Curb Opening)			
Water Depth at Flowline (outside of local depression)			
Grate Information			
Length of a Unit Grate			
Width of a Unit Grate			
Area Opening Ratio for a Grate (typical values 0.15-0.90)			
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)			
Grate Weir Coefficient (typical value 2.15 - 3.60)			
Grate Orifice Coefficient (typical value 0.60 - 0.80)			
Curb Opening Information			
Length of a Unit Curb Opening			
Height of Vertical Curb Opening in Inches			
Height of Curb Orifice Throat in Inches			
Angle of Throat (see USDCM Figure ST-5)			
Side Width for Depression Pan (typically the gutter width of 2 feet)			
Clogging Factor for a Single Curb Opening (typical value 0.10)			
Curb Opening Weir Coefficient (typical value 2.3-3.7)			
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)			
Low Head Performance Reduction (Calculated)			
Depth for Grate Midwidth			
Depth for Curb Opening Weir Equation			
Combination Inlet Performance Reduction Factor for Long Inlets			
Curb Opening Performance Reduction Factor for Long Inlets			
Grated Inlet Performance Reduction Factor for Long Inlets			
Total Inlet Interception Capacity (assumes clogged condition)			
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)			

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
a _{local} =	3.00	3.00	Inches
No =	1	1	
Ponding Depth =	5.5	5.5	Inches
	MINOR	MAJOR	Override Depths
L _o (G) =	N/A	N/A	feet
W _o =	N/A	N/A	feet
A _{ratio} =	N/A	N/A	
C _f (G) =	N/A	N/A	
C _w (G) =	N/A	N/A	
C _o (G) =	N/A	N/A	
	MINOR	MAJOR	
L _o (C) =	5.00	5.00	feet
H _{vert} =	6.00	6.00	Inches
H _{throat} =	6.00	6.00	Inches
Theta =	63.40	63.40	degrees
W _p =	2.00	2.00	feet
C _f (C) =	0.10	0.10	
C _w (C) =	3.60	3.60	
C _o (C) =	0.67	0.67	
	MINOR	MAJOR	
d _{grate} =	N/A	N/A	ft
d _{curb} =	0.29	0.29	ft
RF _{Combination} =	0.71	0.71	
RF _{curb} =	1.00	1.00	
RF _{grate} =	N/A	N/A	
	MINOR	MAJOR	
Q _a =	4.4	4.4	cfs
Q _{PEAK REQUIRED} =	2.1	4.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)**

Project:

Inlet ID: DP 7

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK} =$ ft
 $S_{BACK} =$ ft/ft
 $n_{BACK} =$

$H_{CURB} =$ inches
 $T_{CROWN} =$ ft
 $W =$ ft
 $S_x =$ ft/ft
 $S_w =$ ft/ft
 $S_o =$ ft/ft
 $n_{STREET} =$

Max. Allowable Spread for Minor & Major Storm

Max. Allowable Depth at Gutter Flowline for Minor & Major Storm

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
$T_{MAX} =$	<input type="text" value="18.0"/>	<input type="text" value="18.0"/>	ft
$d_{MAX} =$	<input type="text" value="6.0"/>	<input type="text" value="6.0"/>	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

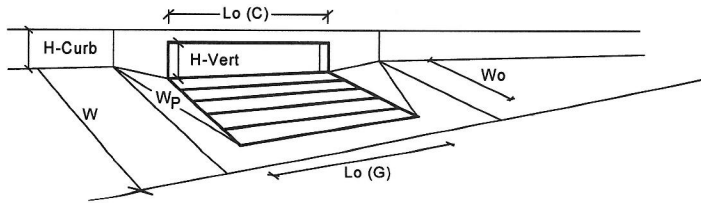
MAJOR STORM Allowable Capacity is based on Depth Criterion

$Q_{allow} =$

Minor Storm	Major Storm	
<input type="text" value="SUMP"/>	<input type="text" value="SUMP"/>	cfs

INLET IN A SUMP OR SAG LOCATION

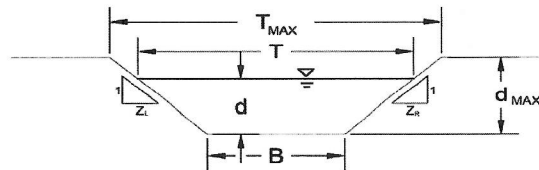
MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	5.8	5.8	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A _{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C _f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C _w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C _o (G) =	N/A	N/A	
Curb Opening Information		MINOR		MAJOR	
Length of a Unit Curb Opening		L _o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H _{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H _{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	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) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C _o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR		MAJOR	
Depth for Grate Midwidth		d _{grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d _{curb} =	0.32	0.32	ft
Combination Inlet Performance Reduction Factor for Long Inlets		RF _{Combination} =	0.55	0.55	
Curb Opening Performance Reduction Factor for Long Inlets		RF _{curb} =	0.92	0.92	
Grated Inlet Performance Reduction Factor for Long Inlets		RF _{grate} =	N/A	N/A	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		Q _a =	7.7	7.7	cfs
		Q _{PEAK REQUIRED} =	2.0	4.9	cfs

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

DP 9



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Maximum Allowable Top Width of Channel for Minor & Major Storm

Maximum Allowable Water Depth in Channel for Minor & Major Storm

A, B, C, D, or E =	D
n =	see details below
S_o =	0.0100 ft/ft
B =	5.00 ft
Z1 =	4.00 ft/ft
Z2 =	4.00 ft/ft

Choose One:

- ☐ Non-Cohesive
☒ Cohesive
☐ Paved

	Minor Storm	Major Storm
T_{MAX} =	20.00	20.00
d_{MAX} =	1.50	1.50

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm
Q_{allow} =	63.6	63.6
d_{allow} =	1.50	1.50

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

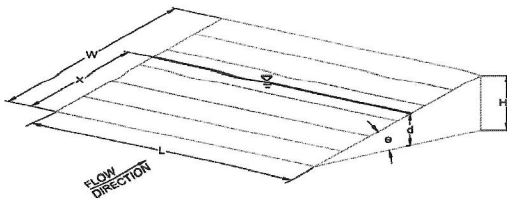
	Minor Storm	Major Storm
Q_o =	6.1	32.3
d =	0.65	1.17

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

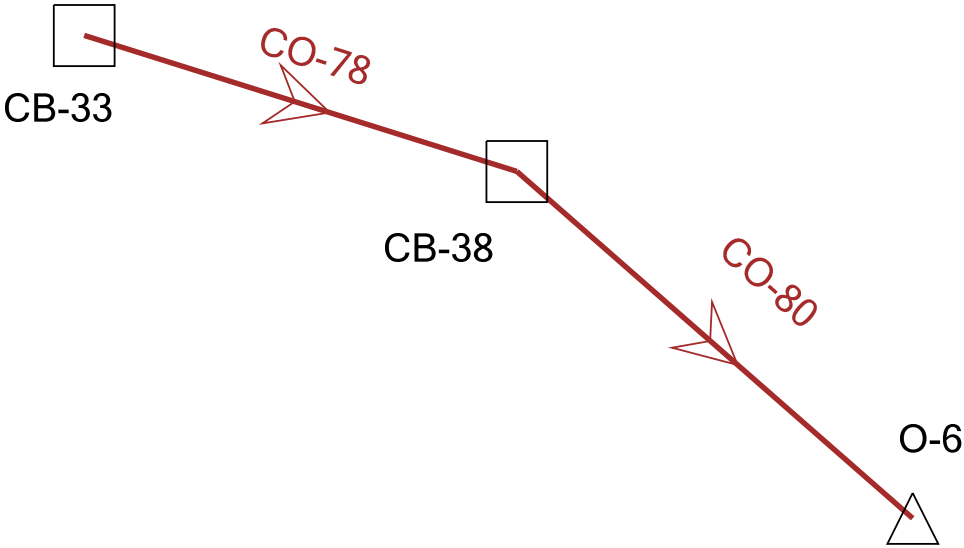
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

MHFD-Inlet, Version 5.01 (April 2021)
AREA INLET IN A SWALE

DP 9

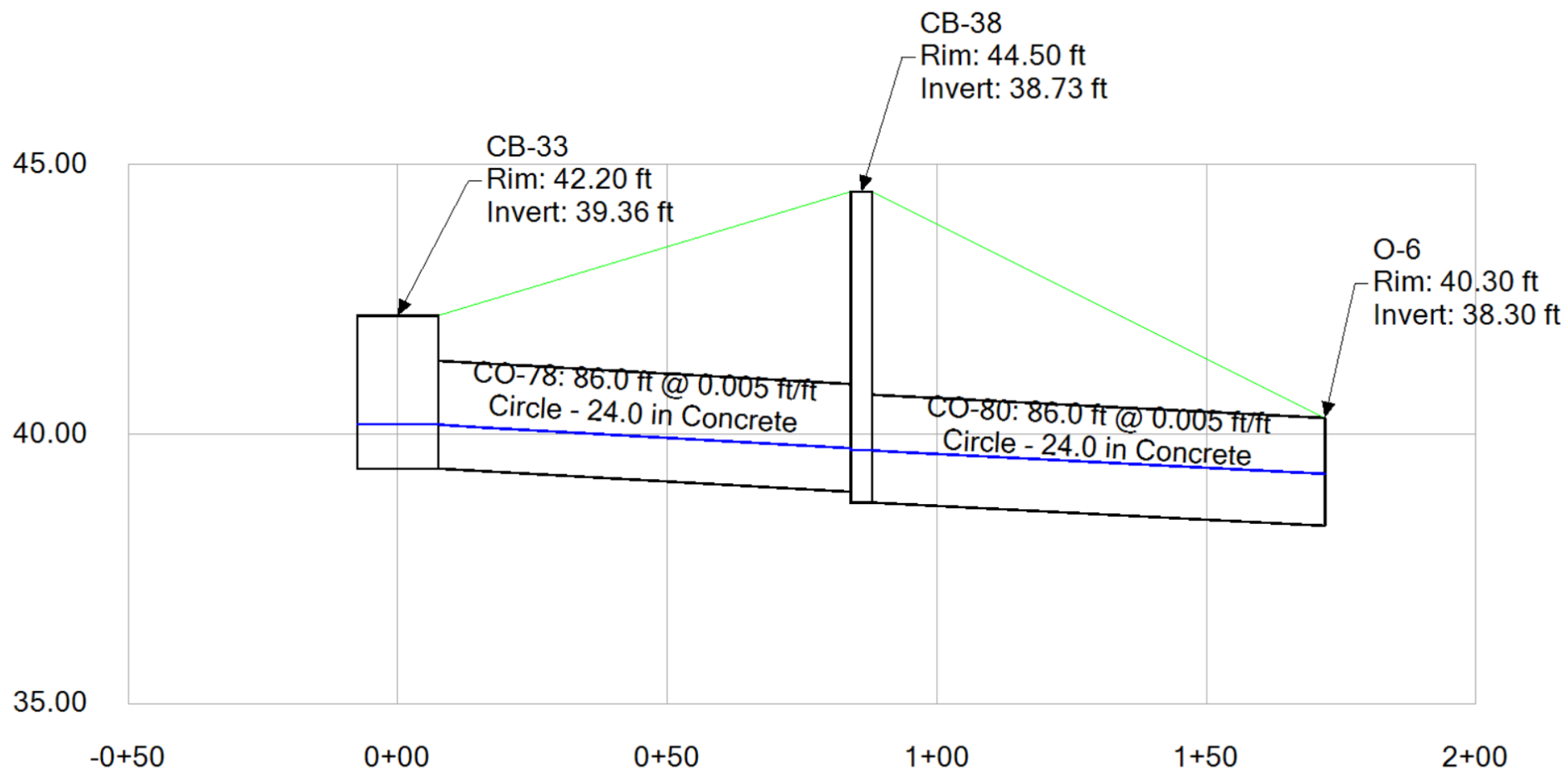
Inlet Design Information (Input)																												
Type of Inlet CDOT Type D (In Series)	Inlet Type = CDOT Type D (In Series)																											
Angle of Inclined Grate (must be ≤ 30 degrees) Width of Grate Length of Grate Open Area Ratio Height of Inclined Grate Clogging Factor Grate Discharge Coefficient Orifice Coefficient Weir Coefficient	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>θ =</td><td>0.00</td><td>degrees</td></tr> <tr><td>W =</td><td>3.00</td><td>ft</td></tr> <tr><td>L =</td><td>6.00</td><td>ft</td></tr> <tr><td>A_{RATIO} =</td><td>0.70</td><td></td></tr> <tr><td>H_B =</td><td>0.00</td><td>ft</td></tr> <tr><td>C_r =</td><td>0.38</td><td></td></tr> <tr><td>C_d =</td><td>0.78</td><td></td></tr> <tr><td>C_o =</td><td>0.52</td><td></td></tr> <tr><td>C_w =</td><td>1.67</td><td></td></tr> </table>	θ =	0.00	degrees	W =	3.00	ft	L =	6.00	ft	A _{RATIO} =	0.70		H _B =	0.00	ft	C _r =	0.38		C _d =	0.78		C _o =	0.52		C _w =	1.67	
θ =	0.00	degrees																										
W =	3.00	ft																										
L =	6.00	ft																										
A _{RATIO} =	0.70																											
H _B =	0.00	ft																										
C _r =	0.38																											
C _d =	0.78																											
C _o =	0.52																											
C _w =	1.67																											
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">MINOR</th> <th style="text-align: center;">MAJOR</th> <th></th> </tr> </thead> <tbody> <tr> <td>d =</td> <td style="text-align: center;">0.65</td> <td style="text-align: center;">1.17</td> <td></td> </tr> <tr> <td>Q_a =</td> <td style="text-align: center;">15.5</td> <td style="text-align: center;">35.5</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td>Q_b =</td> <td style="text-align: center;">0.0</td> <td style="text-align: center;">0.0</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td>C% =</td> <td style="text-align: center;">100</td> <td style="text-align: center;">100</td> <td style="text-align: right;">%</td> </tr> </tbody> </table>		MINOR	MAJOR		d =	0.65	1.17		Q _a =	15.5	35.5	cfs	Q _b =	0.0	0.0	cfs	C% =	100	100	%							
	MINOR	MAJOR																										
d =	0.65	1.17																										
Q _a =	15.5	35.5	cfs																									
Q _b =	0.0	0.0	cfs																									
C% =	100	100	%																									
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) Total Inlet Interception Capacity (assumes clogged condition) Bypassed Flow Capture Percentage = Q _a /Q _o																												

Scenario: Base



Phase 1 HGLs

Elevation (ft)



Phase 1

5-year HGLS

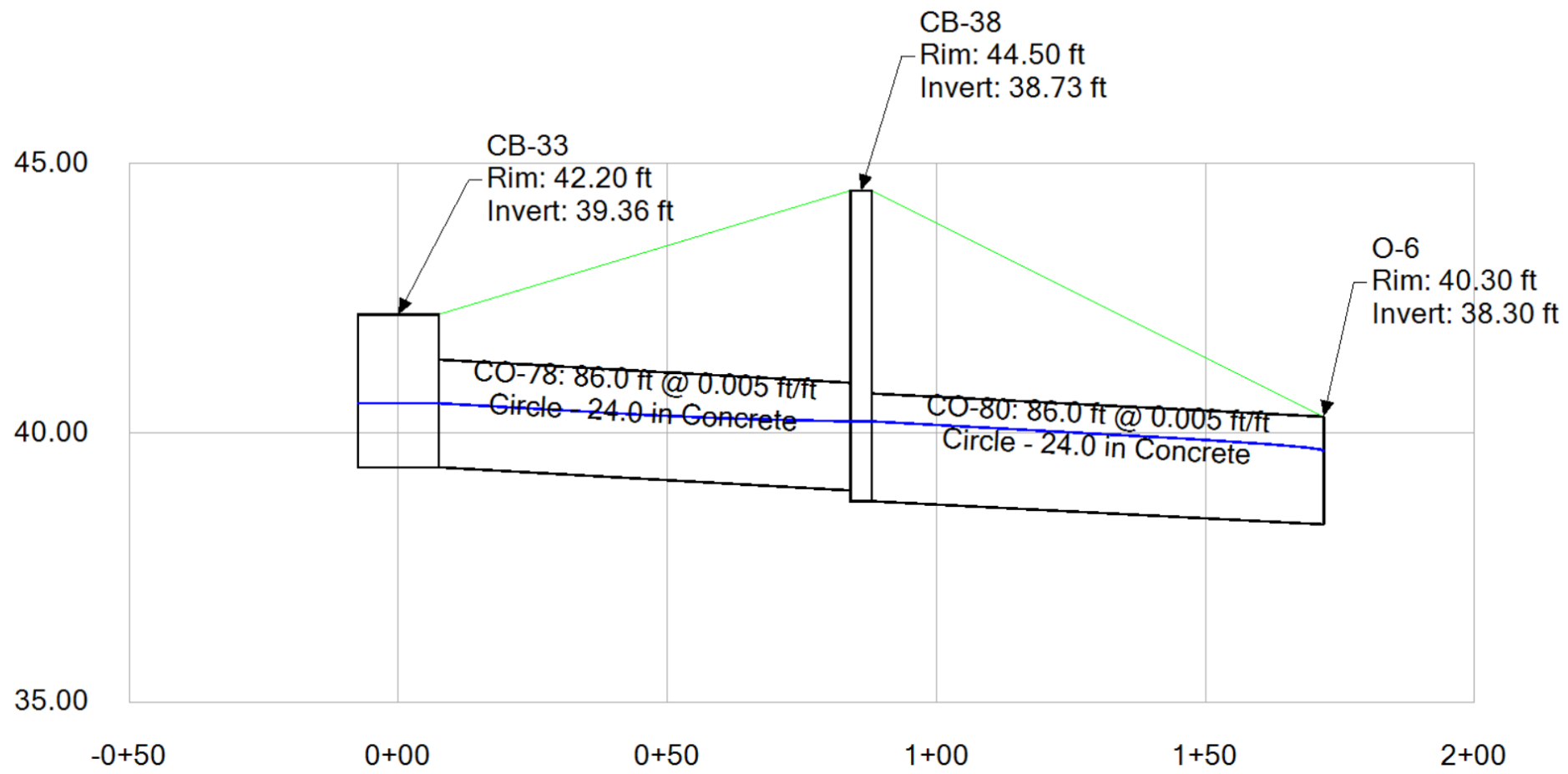
Conduit FlexTable: HGL Table

Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
CO-78	5.50	24.0	86.0	0.005	4.62	39.36	40.19	38.93	39.74	16.00
CO-80	7.50	24.0	86.0	0.005	5.01	38.73	39.70	38.30	39.26	16.00

Phase 1

5-year HGLs

Elevation (ft)



Station (ft)

Phase 1

100-year HGLs

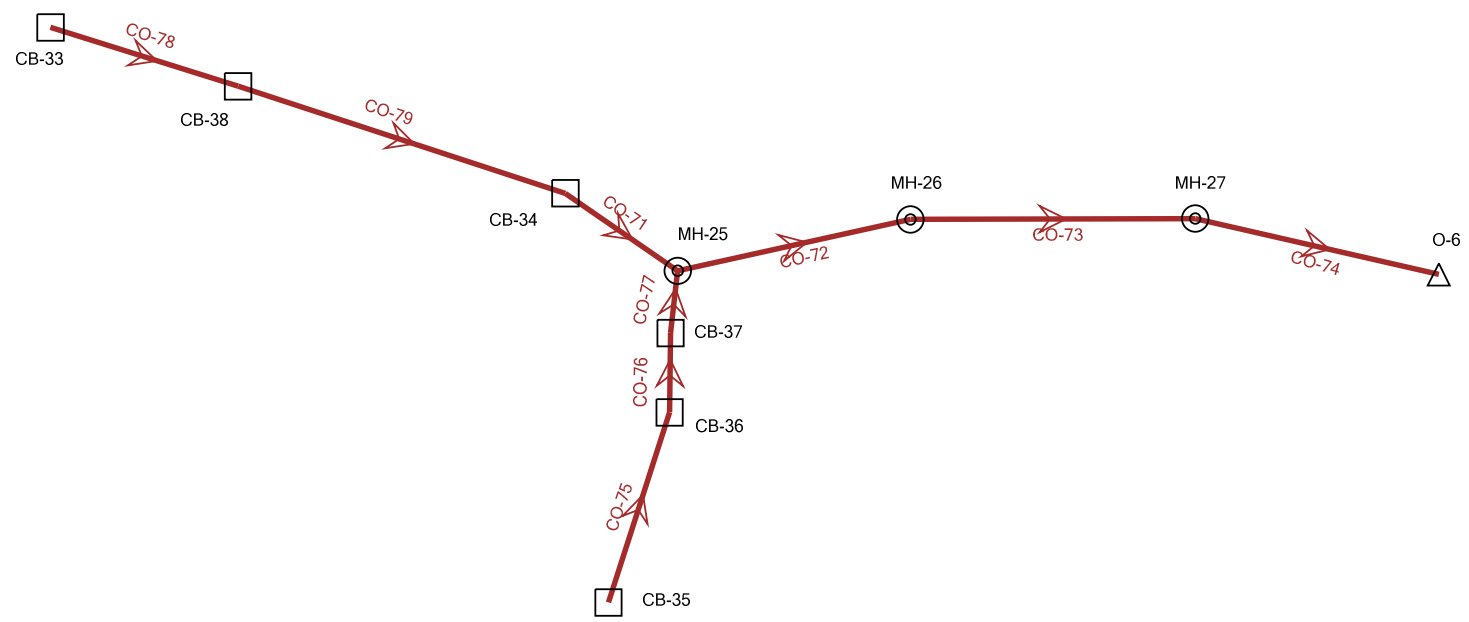
Conduit FlexTable: HGL Table

Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
CO-78	10.60	24.0	86.0	0.005	5.44	39.36	40.55	38.93	40.21	16.00
CO-80	14.40	24.0	86.0	0.005	5.76	38.73	40.21	38.30	39.67	16.00

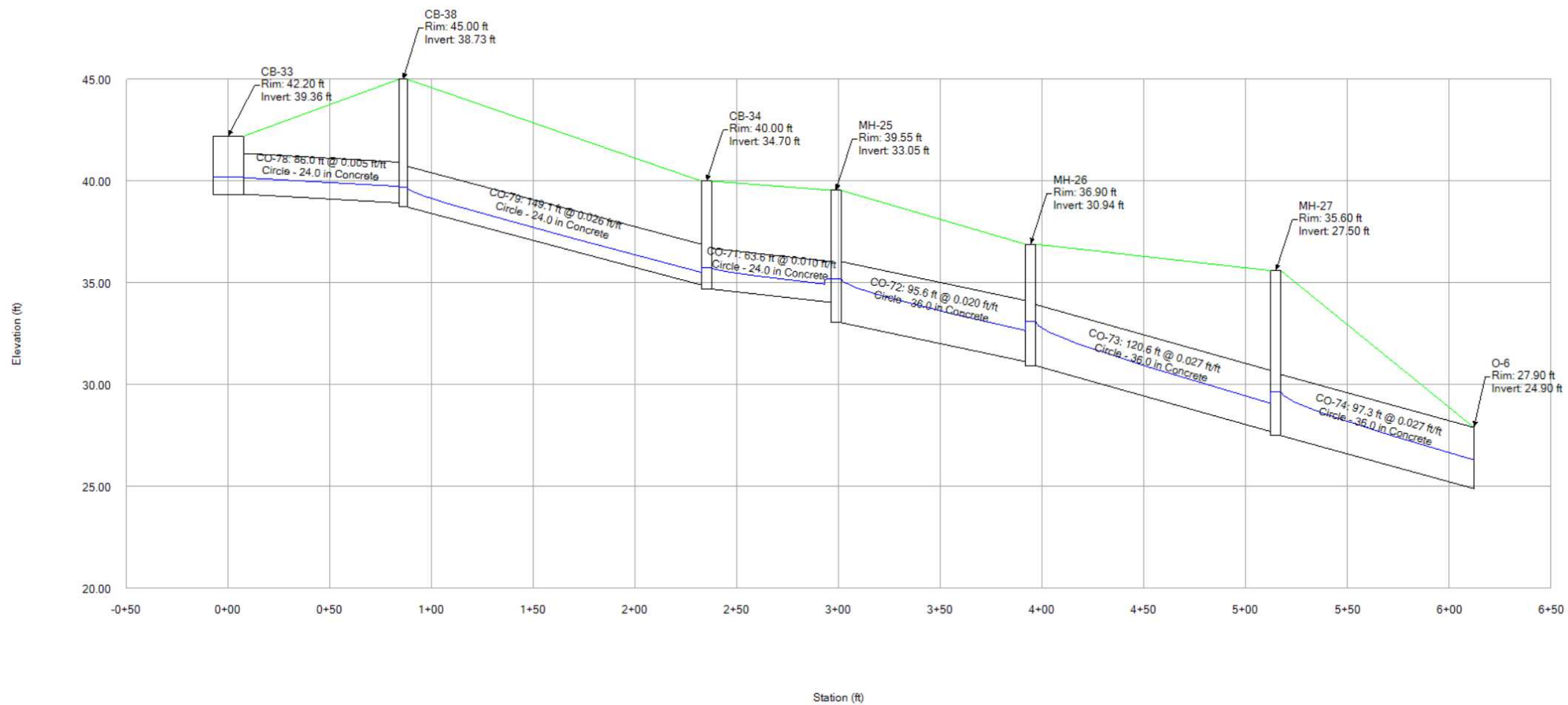
Phase 1

100-year HGLs

Scenario: Base

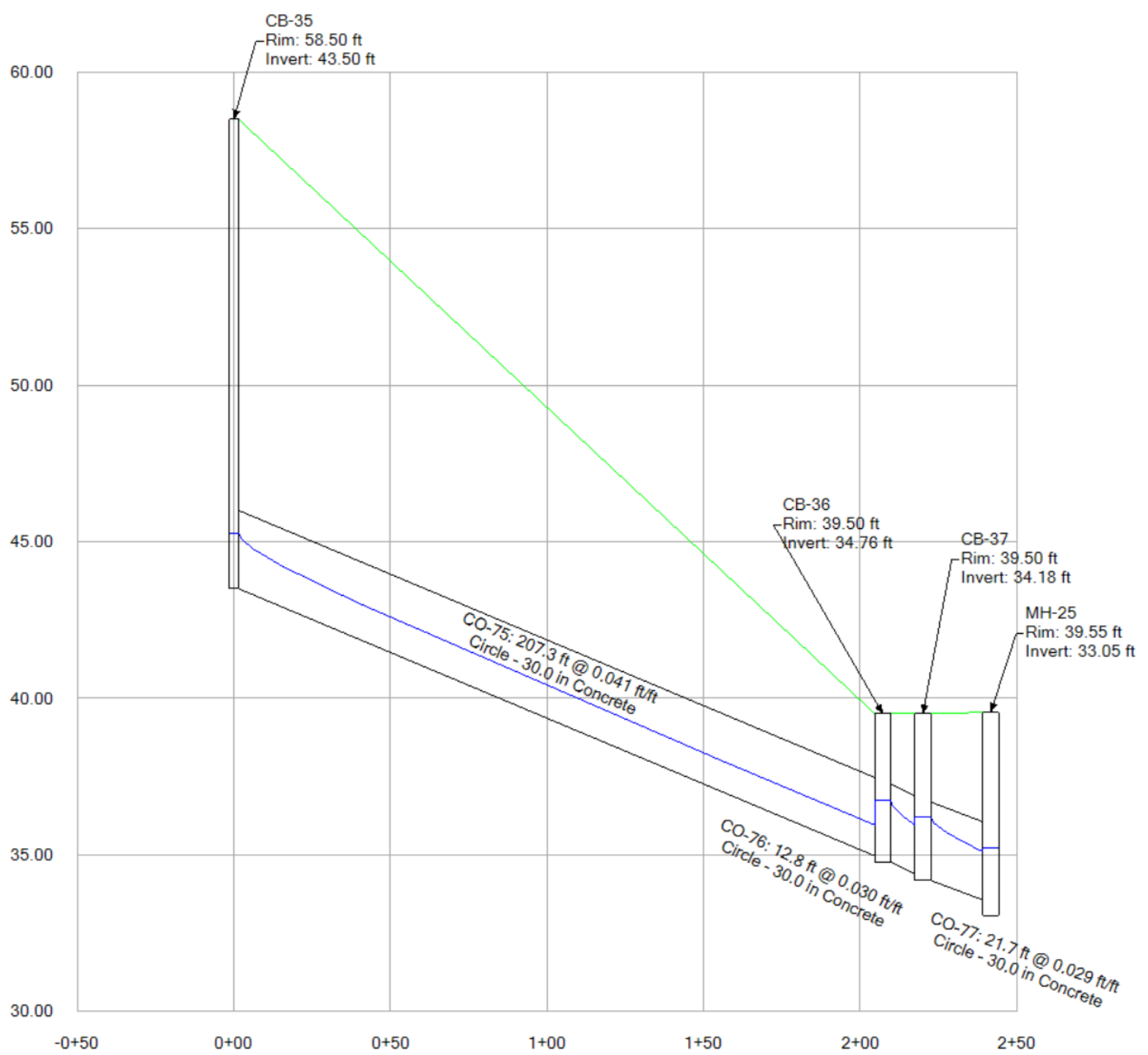


Phase 2 HGLs



Phase 2
5-year HGLs

Elevation (ft)



Phase 2

5-year HGLs

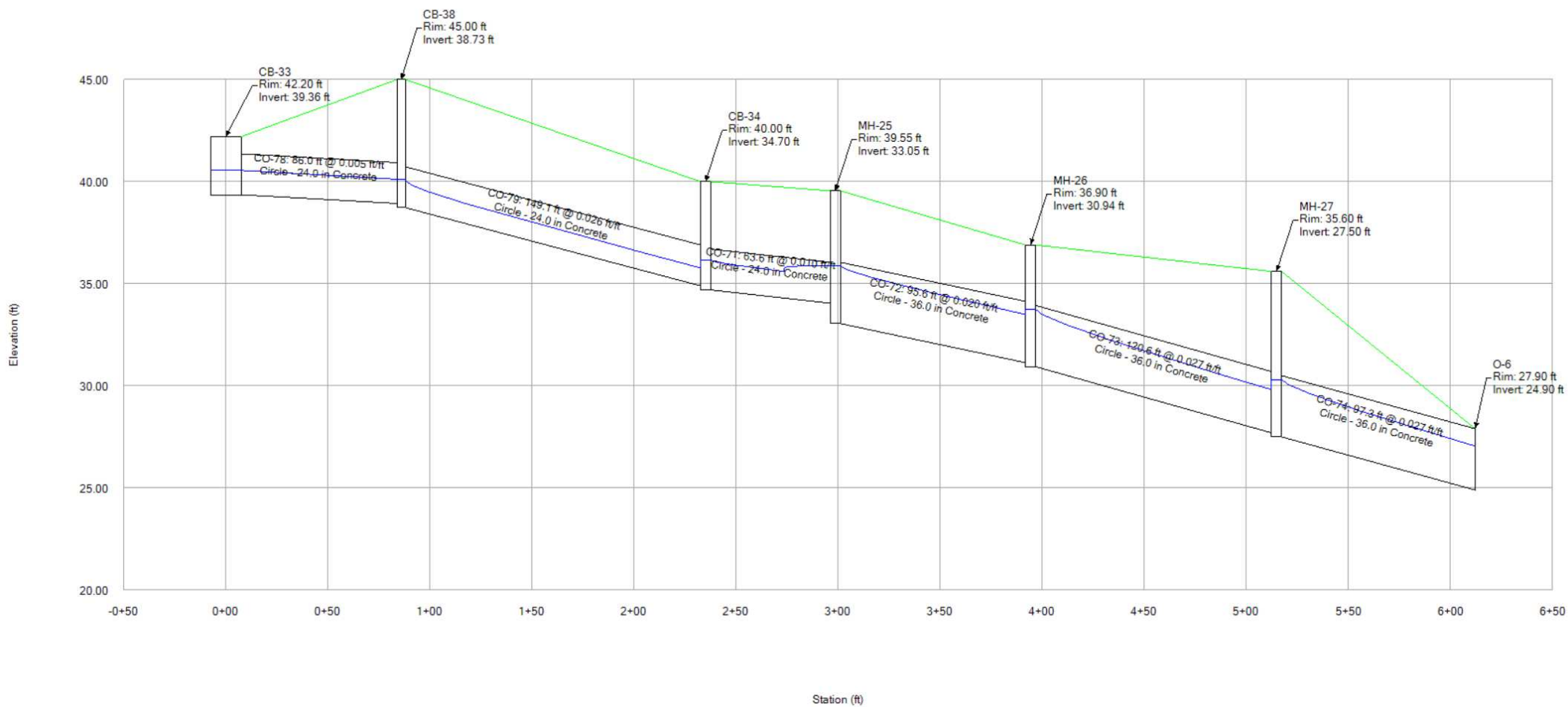
Station (ft)

Conduit FlexTable: HGL Table

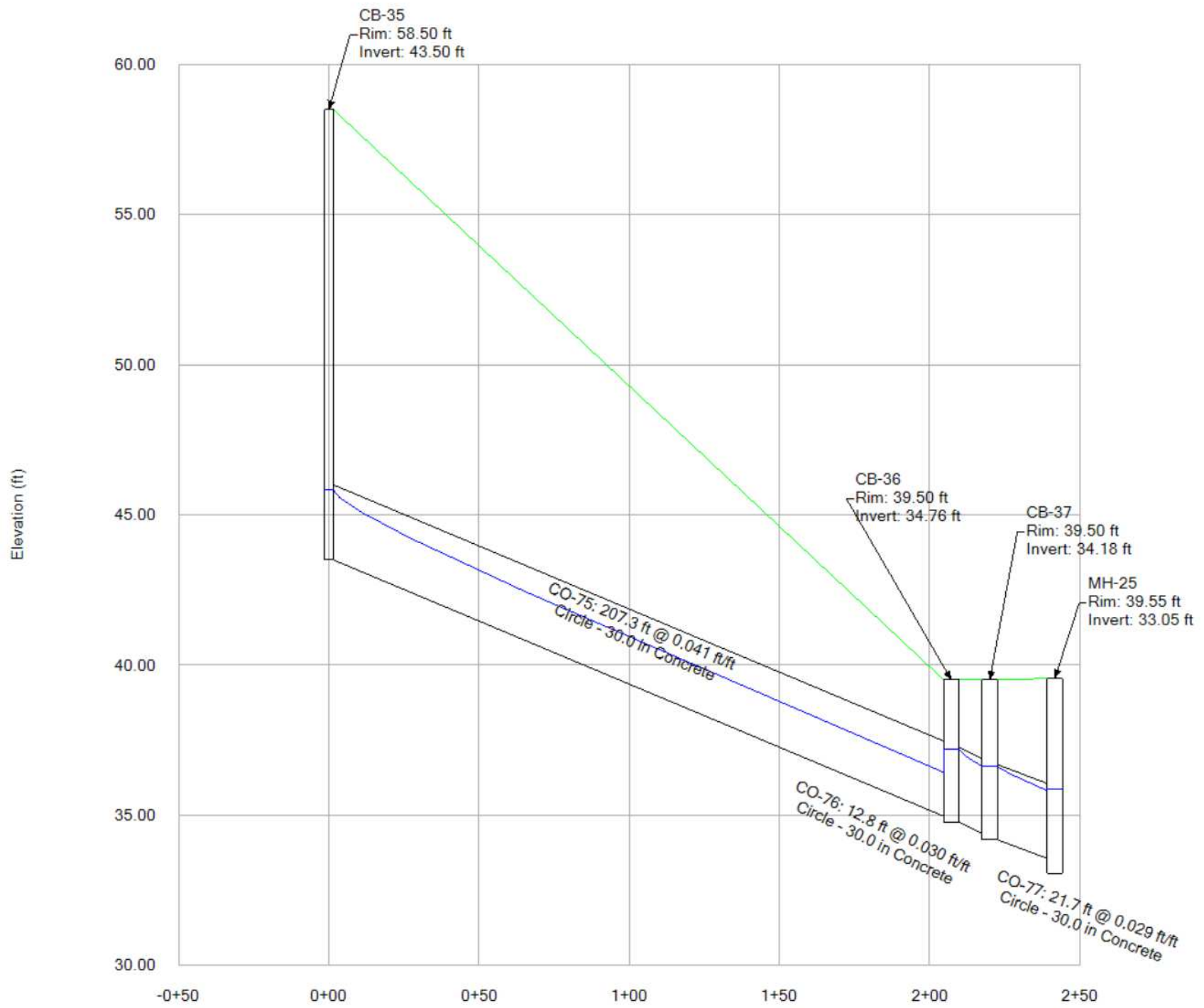
Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
of	8.70	24.0	63.6	0.010	6.79	34.70	35.75	34.05	35.21	22.87
50.9	44.10	36.0	95.6	0.020	13.11	33.05	35.21	31.14	32.66	94.25
CO-73	44.10	36.0	120.6	0.027	14.64	30.94	33.10	27.70	29.08	109.33
CO-74	44.10	36.0	97.3	0.027	14.61	27.50	29.66	24.90	26.31	109.02
CO-75	27.30	30.0	207.3	0.041	15.19	43.50	45.28	34.96	35.95	83.26
CO-76	33.30	30.0	12.8	0.030	14.18	34.76	36.72	34.38	35.94	70.67
CO-77	35.40	30.0	21.7	0.029	14.29	34.18	36.20	33.55	35.09	69.95
CO-78	5.50	24.0	86.0	0.005	4.62	39.36	40.19	38.93	39.74	16.00
CO-79	7.50	24.0	149.1	0.026	9.10	38.73	39.70	34.90	35.52	36.26

Phase 2

5-yr HGLs



Phase 2
100-year HGLs



Phase 2

100-yr HGLs

Station (ft)

Conduit FlexTable: HGL Table

Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
CO-71	16.80	24.0	63.6	0.010	7.96	34.70	36.18	34.05	35.87	22.87
CO-72	85.40	36.0	95.6	0.020	15.10	33.05	35.87	31.14	33.49	94.25
CO-73	85.40	36.0	120.6	0.027	17.11	30.94	33.76	27.70	29.82	109.33
CO-74	85.40	36.0	97.3	0.027	17.07	27.50	30.32	24.90	27.06	109.02
CO-75	52.90	30.0	207.3	0.041	17.96	43.50	45.83	34.96	36.42	83.26
CO-76	64.60	30.0	12.8	0.030	16.32	34.76	37.18	34.38	36.61	70.67
CO-77	68.60	30.0	21.7	0.029	16.24	34.18	36.62	33.55	35.81	69.95
CO-78	10.60	24.0	86.0	0.005	5.44	39.36	40.55	38.93	40.10	16.00
CO-79	14.40	24.0	149.1	0.026	10.88	38.73	40.10	34.90	35.78	36.26

Phase 2

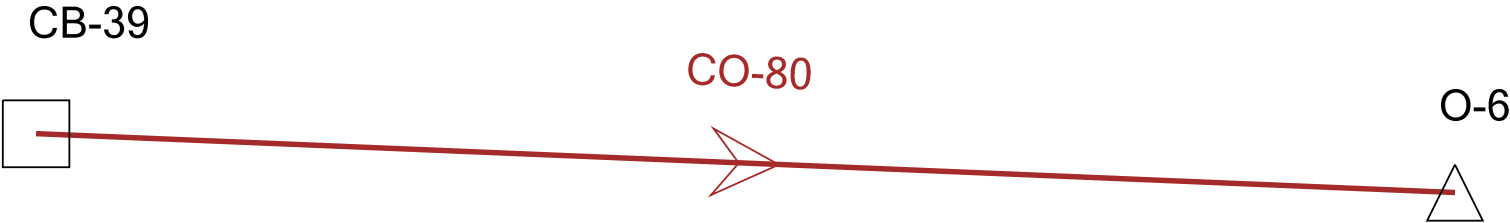
100-yr HGLs

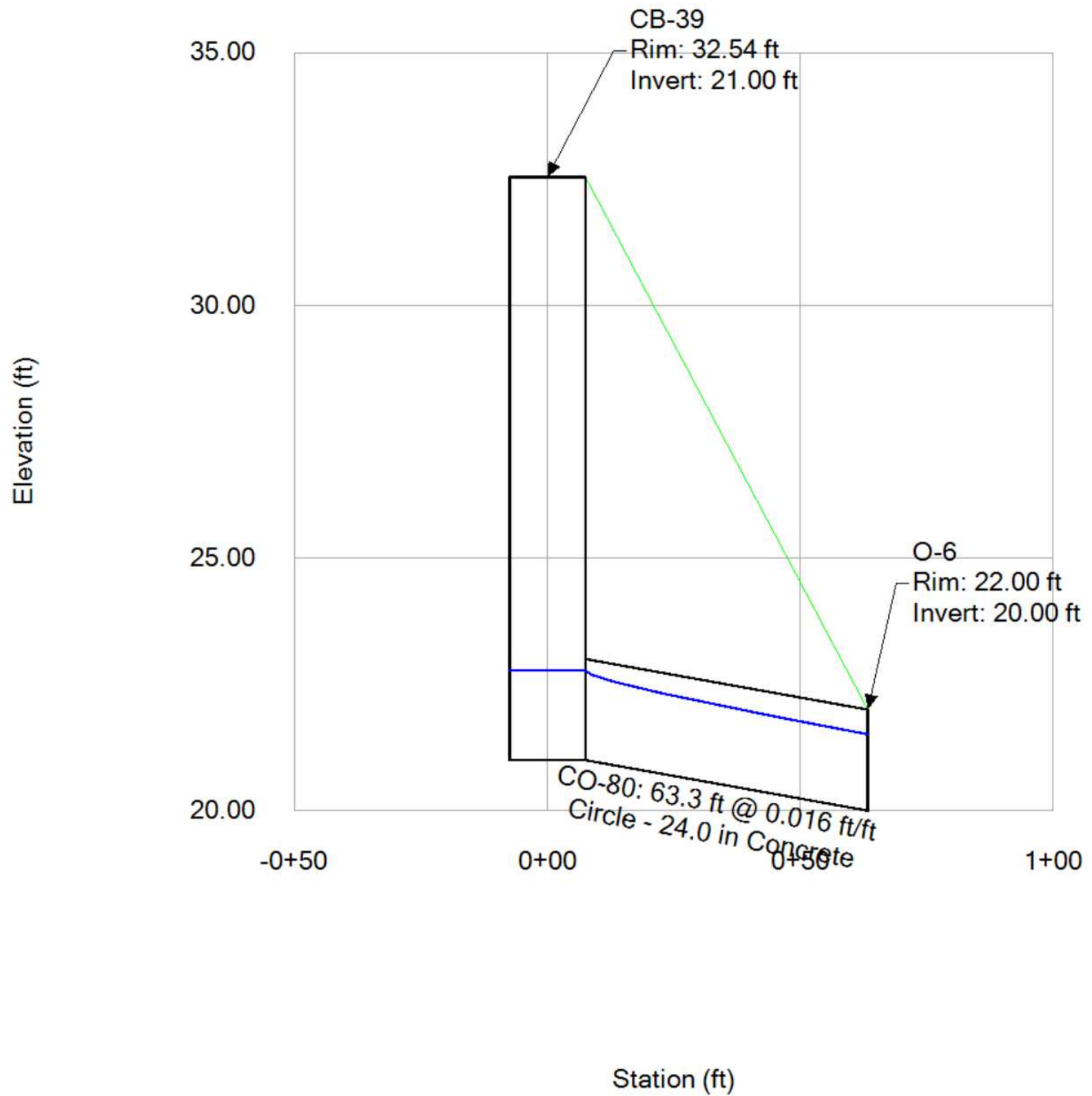
Conduit FlexTable: HGL Table

Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
CO-80	25.40	24.0	76.8	0.013	9.37	21.00	22.77	20.00	21.62	25.81

100-yr HGLs

Scenario: Base





Conduit FlexTable: HGL Table

Label	Flow (cfs)	Diameter (in)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Velocity (ft/s)	Invert (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Full Flow) (cfs)
CO-80	25.40	24.0	63.3	0.016	10.23	21.00	22.77	20.00	21.51	28.42

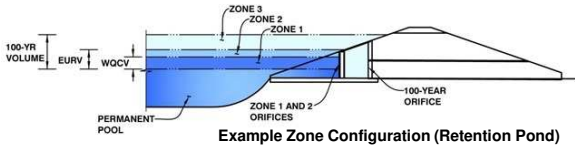
APPENDIX C
Water Quality Enhancement
Best Management Practices

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: CDR+J

Basin ID:



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.71	0.668	Orifice Plate
Zone 2 (EURV)	6.67	1.324	Orifice Plate
Zone 3 (100-year)	8.54	1.109	Weir&Pipe (Restrict)
Total (all zones)		3.101	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = feet

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

Calculated Parameters for Plate

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = 6.55 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = 26.20 inches
Orifice Plate: Orifice Area per Row = 3.08 sq. inches (diameter = 1-15/16 inches)

WQ Orifice Area per Row = 2.139E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.18	4.37					
Orifice Area (sq. inches)	3.08	3.08	3.08					

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

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orifice

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

Vertical Orifice Area = Not Selected Not Selected ft²
Vertical Orifice Centroid = N/A N/A feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe))

Calculated Parameters for Overflow Weir

Overflow Weir Front Edge Height, H_o = Zone 3 Weir Not Selected ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 8.00 N/A feet
Overflow Weir Gate Slope = 4.00 N/A H:V
Horiz. Length of Weir Sides = 4.00 N/A feet
Overflow Gate Type = Type C Gate N/A
Debris Clogging % = 50% N/A %

Height of Gate Upper Edge, H_u = 7.55 N/A feet
Overflow Weir Slope Length = 4.12 N/A feet
Gate Open Area / 100-yr Orifice Area = 13.88 N/A
Overflow Gate Open Area w/o Debris = 22.96 N/A ft²
Overflow Gate Open Area w/ Debris = 11.48 N/A ft²

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Depth to Invert of Outlet Pipe = Zone 3 Restrictor Not Selected ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 24.00 N/A inches
Restrictor Plate Height Above Pipe Invert = 12.50 N/A inches

Outlet Orifice Area = 1.65 N/A ft²
Outlet Orifice Centroid = 0.60 N/A feet
Half-Central Angle of Restrictor Plate on Pipe = 1.61 N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage = 9.06 ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = 10.00 feet
Spillway End Slopes = 4.00 H:V
Freeboard above Max Water Surface = 1.00 feet

Spillway Design Flow Depth = 1.44 feet
Stage at Top of Freeboard = 11.50 feet
Basin Area at Top of Freeboard = 0.79 acres
Basin Volume at Top of Freeboard = 4.89 acre-ft

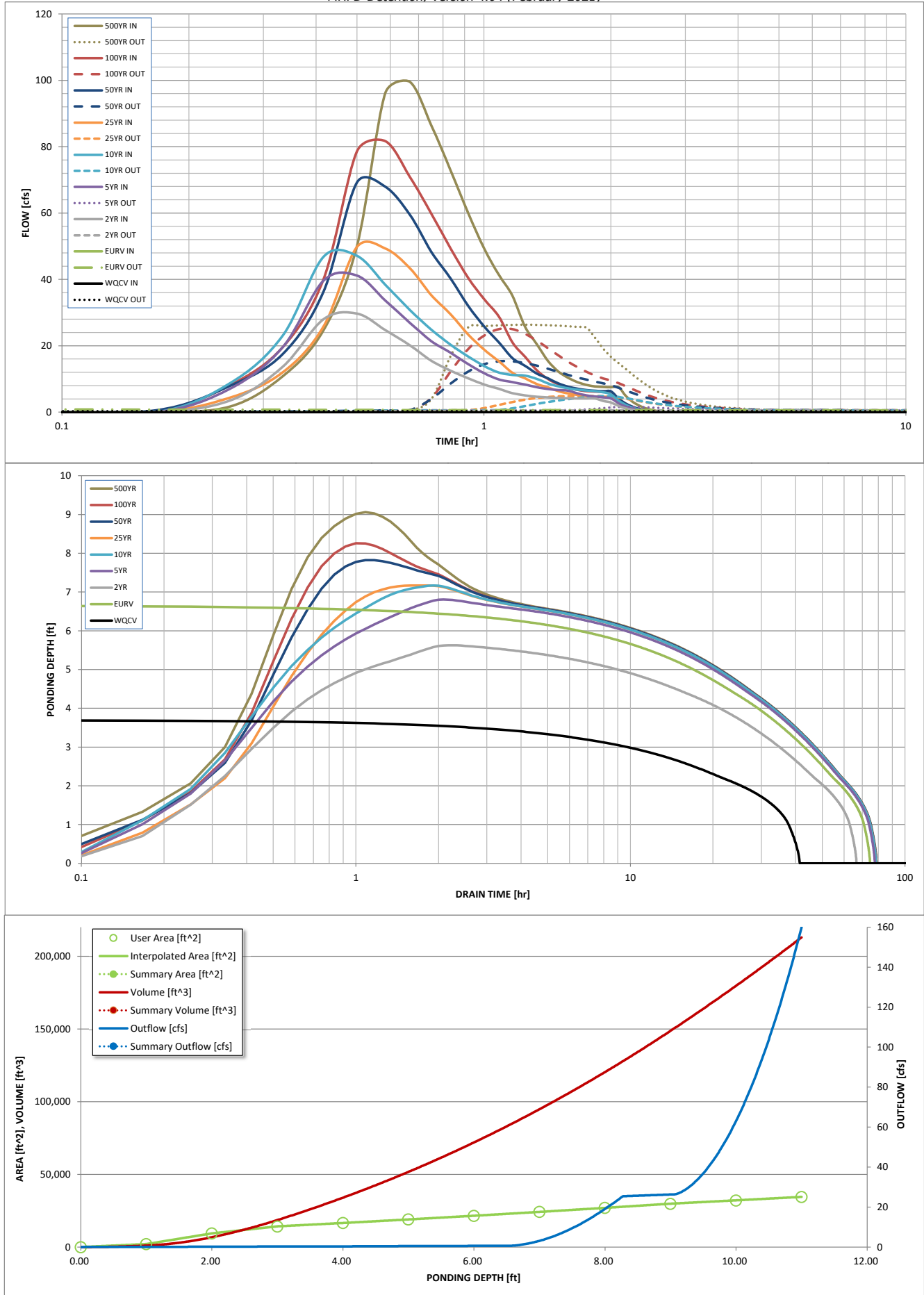
Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
One-Hour Rainfall Depth (in) =	0.668	1.992	1.553	2.201	2.609	2.681	3.710	4.341	5.325
CUHP Runoff Volume (acre-ft) =	N/A	N/A	1.553	2.201	2.609	2.681	3.710	4.341	5.325
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.6	6.0	9.2	12.7	23.2	30.4	40.3
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.03	0.29	0.44	0.61	1.11	1.46	1.94
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	29.7	41.2	47.1	49.9	69.3	81.7	99.6
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.6	1.7	4.9	4.9	15.4	25.1	26.4
Peak Inflow Q (cfs) =	N/A	N/A	N/A	0.3	0.5	0.4	0.7	0.8	0.7
Peak Outflow Q (cfs) =	N/A	N/A	N/A	0.3	0.5	0.4	0.7	0.8	0.7
Ratio Peak Outflow to Predevelopment Q =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Structure Controlling Flow =	N/A	0.01	N/A	0.0	0.2	0.2	0.6	1.1	1.1
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Gate 2 (fps) =	38	67	60	70	69	69	66	65	62
Time to Drain 97% of Inflow Volume (hours) =	40	71	64	74	74	74	74	73	72
Time to Drain 99% of Inflow Volume (hours) =	3.71	6.67	5.63	6.81	7.17	7.17	7.83	8.26	9.06
Maximum Ponding Depth (ft) =	0.36	0.53	0.47	0.54	0.57	0.57	0.61	0.63	0.69
Area at Maximum Ponding Depth (acres) =	0.671	1.996	1.473	2.066	2.271	2.271	2.652	2.919	3.455
Maximum Volume Stored (acre-ft) =									

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)



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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.27	1.71
	0:15:00	0.00	0.00	3.51	7.07	8.74	4.39	7.94	8.18	10.84
	0:20:00	0.00	0.00	13.72	19.61	23.10	12.03	17.51	19.62	24.77
	0:25:00	0.00	0.00	28.07	39.69	46.90	25.88	36.44	40.17	50.10
	0:30:00	0.00	0.00	29.72	41.16	47.12	49.86	69.28	78.62	96.15
	0:35:00	0.00	0.00	24.76	33.68	38.46	49.38	67.96	81.72	99.63
	0:40:00	0.00	0.00	20.22	27.00	30.87	43.44	59.58	71.03	86.51
	0:45:00	0.00	0.00	15.55	21.44	24.89	35.31	48.35	59.89	72.88
	0:50:00	0.00	0.00	12.54	17.90	20.36	29.50	40.31	49.36	60.05
	0:55:00	0.00	0.00	10.26	14.51	16.83	23.44	32.05	40.54	49.35
	1:00:00	0.00	0.00	8.35	11.77	13.95	18.89	25.87	34.06	41.45
	1:05:00	0.00	0.00	7.06	9.89	11.98	15.40	21.11	28.88	35.17
	1:10:00	0.00	0.00	5.77	9.11	11.26	11.93	16.36	21.11	25.79
	1:15:00	0.00	0.00	5.08	8.32	11.04	10.20	14.01	16.73	20.49
	1:20:00	0.00	0.00	4.68	7.53	10.06	8.50	11.66	12.63	15.48
	1:25:00	0.00	0.00	4.45	7.02	8.69	7.46	10.22	10.01	12.27
	1:30:00	0.00	0.00	4.31	6.69	7.79	6.35	8.68	8.44	10.34
	1:35:00	0.00	0.00	4.21	6.49	7.18	5.65	7.71	7.39	9.05
	1:40:00	0.00	0.00	4.14	5.65	6.79	5.19	7.08	6.73	8.25
	1:45:00	0.00	0.00	4.11	5.08	6.53	4.90	6.68	6.35	7.78
	1:50:00	0.00	0.00	4.11	4.71	6.35	4.75	6.46	6.21	7.61
	1:55:00	0.00	0.00	3.40	4.48	6.01	4.65	6.33	6.15	7.54
	2:00:00	0.00	0.00	2.92	4.16	5.35	4.61	6.27	6.15	7.54
	2:05:00	0.00	0.00	1.89	2.69	3.49	3.01	4.09	4.03	4.93
	2:10:00	0.00	0.00	1.19	1.69	2.22	1.93	2.62	2.58	3.16
	2:15:00	0.00	0.00	0.73	1.04	1.37	1.21	1.64	1.61	1.98
	2:20:00	0.00	0.00	0.41	0.62	0.81	0.72	0.98	0.96	1.18
	2:25:00	0.00	0.00	0.22	0.36	0.45	0.42	0.57	0.56	0.69
	2:30:00	0.00	0.00	0.09	0.17	0.20	0.20	0.28	0.27	0.33
	2:35:00	0.00	0.00	0.03	0.05	0.06	0.06	0.08	0.08	0.10
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Forebay Sizing Calculations

Minimum Forebay Volume = 2% WQCV

WQCV = 29,098 cf

85.4 cfs drains to forebay; 47.1 cfs will drain to a future forebay on the south end of the pond

This equal 64.4% of the developed flowrate.

Therefore, the required volume of the proposed forebay = WQCV x 64% x 2% = 372 cf

Provided volume using a 2' depth = 404 cf

Design notch to release 2% of 100-year flowrate

Q₁₀₀ = 85.4 cfs

2% x Q₁₀₀ = 1.7 cfs

$Q = CLH^{3/2}$

C = 3.32

H = 2.0'

$L = 1.7 / (3.32 * 2^{3/2}) = 0.18' = 2.2"$

Use 3" minimum width

Micropool Sizing Calculations

Micropool Depth = 2.5'

Minimum area = 10 sf

Provided area = 64 sf

Manhole Sizing

Connection of 18" RCP to 24" RCP

Required manhole size is 4' diameter

Connection of 30" RCP to existing 36" RCP

Required manhole size is 5' diameter

Worksheet for emergency overflow channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.33000	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	115.90	ft ³ /s

Results

Normal Depth	0.55	ft
Flow Area	6.78	ft ²
Wetted Perimeter	14.58	ft
Hydraulic Radius	0.47	ft
Top Width	14.44	ft
Critical Depth	1.34	ft
Critical Slope	0.01343	ft/ft
Velocity	17.09	ft/s
Velocity Head	4.54	ft
Specific Energy	5.09	ft
Froude Number	4.40	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.55	ft
Critical Depth	1.34	ft
Channel Slope	0.33000	ft/ft

Worksheet for emergency overflow channel

GVF Output Data

Critical Slope

0.01343 ft/ft

East Plum Creek Bank Protection

Rip-Rap Sizing Calculations

$$D50 \geq [VS^{0.17}/4.5 (Gs - 1)^{0.66}]^2$$

S = Existing channel slope = 0.92%

V = Mean channel velocity = 9.5 ft/s

Gs = Specific gravity of stone = 2.6

(S and V were obtained from "East Plum Creek Watershed Amended Flood Hazard Area Delineation, August 2013", prepared by CH2MHill)

$$D50 \geq 0.70 \text{ feet} = 8.4''$$

Therefore, use Type L rip-rap with D50 = 9"

$$\text{Thickness} = 2 \times D50 = 18''$$

Permanent Water Quality Determination Worksheet (Taken from 2019 SDDTCM Sections 13.1.4 and 13.1.5)

Project:	CDR+J	Project#	CD23-0039	Applicant:	Foundation Automotive Corp.
Section	Questions	Response	Check those that apply	Instructions	
1	Non-applicable Sites				
1.1	Will the project result in a temporary disturbance of greater than one acre?	No Yes	☒ ☐	Proceed to section 1.2. Proceed to section 2.	
1.2	Is the project part of a larger common plan of development or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules, but remain related and are within 1/4 mile of each other? (A common plan of development will generally be documented on a site development plan, master plan, or equivalent, for the property/project)	No Yes	☐ ☐	Proceed to section 1.3. Proceed to section 2.	
1.3	Is the project within the Cherry Creek Watershed?	Yes No	☐ ☐	Permanent water quality control measures may be required. Refer to Water Quality Control Regulation 72.7 for details and allowable exclusions. Permanent water quality control measures are not required.	
2	Applicable Site Types and Exclusions by Variance				
2.1	Does the project have more than 35% impervious area on the existing site?	No Yes	☐ ☒	Project is an applicable Development Site. Proceed to section 3. Proceed to 2.2.	
2.2	Does the project have greater than 75% impervious area on the existing site?	No Yes	☐ ☒	Project is an applicable Redevelopment Site. Proceed to section 3. Project is an applicable Constrained Redevelopment Site. Proceed to 2.3.	
2.3	Will 100% of the runoff from the existing and proposed site be captured and treated using one or more of the allowable design standards for permanent water quality?	Yes No	☐ ☒	No further action required. Proceed to 2.4.	
2.4	Do any other water quality exclusions apply to the site?	No Yes	☐ ☒	Portions of the project are excluded. Proceed with design in accordance with Constrained Redevelopment standards and apply for variance for <u>Constrained Redevelopment Sites</u> . Proceed to section 3. Following approval of other exclusions, design remaining site in accordance with Constrained Redevelopment standards and apply for variance for <u>Constrained Redevelopment Sites</u> .	
3	Applicable Sites with Other Exclusions by Variance				
3.1	Category 1: Roadways, bridges and trails only				
3.1.1	Is the project a bike or pedestrian trail?	Yes No	☐ ☒	Proceed to next line. Proceed to 3.1.2.	
	Is the trail for a roadway?	Yes No	☐ ☐	Proceed to 3.1.2. Project is excluded. Submit variance for <u>Trails Excluded from Permanent Water Quality Requirements</u> .	
3.1.2	Is the project primarily used for parking or access to parking?	Yes No	☐ ☒	This exclusion does not apply. Permanent water quality is required. Proceed to 3.1.3.	
3.1.3	Does the project add impervious area?	No Yes	☐ ☒	Project is excluded. Submit variance for <u>Pavement Management Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.1.4.	

Section	Questions	Response	Check those that apply	Instructions
3.1.4	Does the project add more than 8.25 feet of paved width at any location to the existing roadway?	No Yes	☐ ☒	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Does the project add more than one acre of paved area per mile to an existing roadway?	No Yes	☒ ☐	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Does the project increase the width by two times or more, on average, of the original roadway area?	No Yes	☐ ☐	Existing areas of site are excluded only. Submit variance for <u>Existing Roadway Surfaces Only Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.
3.2	Category 2: Non-residential and non-commercial projects only			
3.2.1	Is the project associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and the movement and placement of drilling equipment?	Yes No	☐ ☐	Project is excluded. Submit variance for <u>Oil and Gas Exploration Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.2.
3.2.2	Is the project for stream stabilization?	Yes No	☐ ☐	Project is excluded. Submit variance for <u>Stream Stabilization Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.3.
3.2.3	Is the project for installation or maintenance of aboveground or underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity including activities to install, replace or maintain utilities under roadways or other paved areas that return the surface to the same condition?	Yes No	☐ ☐	Project is excluded. Submit variance for <u>Aboveground and Underground Utilities Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.4.
3.2.4	Is the project on undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the project?	Yes No	☐ ☐	Project is excluded. Submit variance for <u>Sites with Land Disturbances to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.5.
3.2.5	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No Yes	☐ ☐	Project is excluded. Submit study along with variance for <u>Non-residential and Non-commercial Infiltration Conditions Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.
3.3	Category 3: Residential, Agricultural and Commercial projects			
3.3.1	Is the project a single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling unit?	Yes No	☐ ☒	Proceed to next line. Proceed to 3.3.2.
	Is the project site greater than 10% impervious?	No Yes	☐ ☐	Project is excluded. Submit variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Is the project site greater than 20% impervious?	Yes No	☐ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No Yes	☐ ☐	Project is excluded. Submit study along with variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.

Section	Questions	Response	Check those that apply	Instructions
3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	Yes No	☐ ☒	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	Yes No	☐ ☒	This portion of the project is excluded. Submit variance for <u>Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Is the remaining untreated impervious area greater than 20% of the site?	Yes No	☐ ☒	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is the remaining untreated impervious area greater than one acre?	Yes No	☒ ☐	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	No Yes	☐ ☐	Document justification demonstrating that it is not practicable to capture runoff from this portion of the site in the drainage report . No further action is needed. This exclusion does not apply. Permanent water quality is required.



Summary of Water Quality Conformance to MS4 Permit

The purpose of this worksheet is to document conformance with the Town of Castle Rock's MS4 permit with regard to permanent water quality on land disturbance projects.

Project Name CDR+J

Project Owner Foundation Automotive Corp.

Project Location 1100 S. Wilcox Street

ToCR Project Number CD23-0039

Total Site Area 5.12 acres

Total Size of Common Plan of Development 20.81 acres

Check all that apply:

☒ **Project within Plum Creek Basin**

☐ **Project within Cherry Creek Basin**

Estimated construction completion date November 2024

1. The water quality control measure(s) for applicable development sites shall meet one of the following base design standards as per the SDDTCM Section 14.4. Please select all design standards that were applied to meet conformance with the MS4 on this site.

- ☒ WQCV standard
- ☐ Pollutant removal standard
- ☐ Runoff reduction standard
- ☐ Applicable site draining to regional WQVC control measure (accepts drainage prior to discharging to WOTS)
- ☐ Applicable site draining to regional WQVC control facility (with receiving pervious area control measure upstream of WOTS)
- ☒ Constrained redevelopment sites standard
 - Imperviousness of existing site 2.42 / 20.81 (Imp. Ac/Site Ac) = 11.6 %
 - Variance required TCV No. TCV22-0083
- ☐ Existing control measure with WQCV per previous criteria standards
 - Reference Construction Permit No. _____
- ☐ Cherry Creek Basin only, choose one: ☐ Tier 1 ☐ Tier 2 ☐ Tier 3
- ☐ No control measures provided (See Permanent WQ Worksheet for applicability)

Summary of Water Quality Conformance to MS4 Permit

2. Was an exclusion to water quality applied as per SDDTCM Section 13.1.5? ☒ Yes ☐ No

i. If yes, please select all that apply, provide total excluded impervious area(s) and submit variance, as applicable: TCV No. TCV22-0083

☐ Pavement management site

Excluded impervious area: _____ acres

☒ Excluded roadway redevelopment

Excluded impervious area: 017 acres

☒ Excluded existing roadway areas

Excluded impervious area: 0.39 acres

☐ Above ground and below ground utilities

☐ Large lot single family home

☐ Non-residential and non-commercial infiltration

Excluded impervious area: _____ acres

☐ Land disturbance for land to remain undeveloped

Excluded impervious area: _____ acres

☐ Stream Stabilization Sites

Excluded impervious area: _____ acres

☐ Trails

Excluded impervious area: _____ acres

☐ Oil and Gas Exploration

3. For Development and Redevelopment sites, following any exclusions claimed above, was any portion of the site excluded up to 20% of the site and not to exceed one acre? ☐ Yes ☒ No

If yes, complete the following:

Excluded area: _____ acres

Total Site area: _____ acres, _____ % site excluded

4. For Constrained sites, was any portion of the site excluded up to 50% of the site and not to exceed 50% of the impervious area? ☐ Yes ☒ No

If yes, complete the following:

Excluded area: _____ acres

Excluded impervious area: _____ acres

Total Site area: _____ acres, _____ % site excluded

Total Impervious area: _____ acres, _____ % impervious excluded



FLOODPLAIN DEVELOPMENT PERMIT

FDP _____

Date 1/21/22

All information is required. No action can be taken on this application until all information is provided. PLEASE PRINT LEGIBLY.

Project Name: CDR+J	☐ New Construction
Subdivision: First Amendment to Brookside Business Center Filing No. 2	☒ Substantial Improvement (>50%)
Parcel #: 2505-142-05-006	☐ Improvement (<50%)
Location/Address: 1100 S. Wilcox Street	☐ Other: _____

PERMIT TYPE:

- ☐ Zero Net Impact
☒ No-Rise
☐ Floodplain Modification Study
☐ CLOMR / LOMR
☐ CLOMR-F / LOMR-F
☐ LOMA
☐ Other: _____

DEVELOPMENT TYPE:

- ☐ Single Family Residential
☐ Multi-Family Residential
☐ Manufactured Home
☒ Non-Residential
☐ Combined Use
☐ Other: _____

ACTIVITY TYPE: (check all that apply)

- ☒ Channel Modification
☐ Utility
☐ Transportation
☐ Fill
☐ Excavation
☐ Other: _____

Drainageway: East Plum Creek	☒ Floodway ☐ Floodway Fringe ☐ N/A ¹
FIRM Panel(s): 08035C0301G	100-yr BFE ² : 6226.3
Lowest Finished Floor Elev. ² : 6248.37	Lowest Utility/Roadway Crossing Elev. ² : 6238.60

1. No surface disturbance.
2. Separate table/exhibit may be submitted for areas with multiple elevations. If not applicable, write N/A.

PROPERTY OWNER	ENGINEER / CONTRACTOR
Company: Foundation Automotive Corp.	Company: Vermilion Peak Engineering
Address: 1100 S. Wilcox Street	Address: 1745 Shea Center Drive, 4th Floor
City: Castle Rock State: CO Zip: 80104	City: Highlands Ranch State: CO Zip: 80129
Contact Name: Doug Keith Phone: 701-390-0211	Contact Name: Brian Krombein, PE Phone: 7204026070
Email: dougk@foundation auto.com	Email: brian2@vermilionpeak.com
Signature: Below Date: 1/24/22	Signature: Below Date: 1/21/22

CARS-DB4, L.P.
a Delaware limited partnership

By: CARS-DBSPE4, INC.
a Delaware corporation
its General Partner

By: 
Name: Daniel Garces
Title: SVP & Director of Acquisitions



By signing above, the applicant(s) certifies the following:

1. To the best of my/our knowledge, the information provided herein is correct.
2. The appropriate study/report, and all attachments, have been submitted to Town for review and approval (see Floodplain Development Review Checklist for review submittal requirements);
3. I/we understand any approval obtained from the Town does not alleviate my/our need to fully comply with the requirements any other applicable federal, state, or local laws or regulations.

PERMIT APPROVAL (Town Use Only)

Drainageway: _____ FDP _____

Project Name: _____

Permit Approved: ☐ Yes ☐ No Date: _____ By: _____

☐ Encroachment (no hydraulic impact) ☐ Modification (Regulatory) FEMA Case #: _____
☐ Modification (Non-Regulatory) ☐ Other: _____

Outside Consultant Review Fee: Actual Cost + \$25 = \$ _____ (to be collected at permit issuance)

REQUIRED FOR:

☐ CD Approval ☐ Construction Permit ☐ Building Permit ☐ GESC Permit ☐ Other: _____

Certificate of Occupancy Issued: _____

COMPLIANCE	PRE-CONSTRUCTION	POST-CONSTRUCTION
Min. 2' Freeboard	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved
No-Rise Certificate	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved
Elevation Certificate	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved
Floodproofing Certificate	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved
Fill Certificate	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved
Other:	☐ Required ☐ Submitted ☐ Approved	☐ Required ☐ Submitted ☐ Approved

COMMENTS

ENVIRONMENTAL PERMITTING	COMPLIANCE
US Army Corps of Engineers	☐ Submitted ☐ N/A
US Fish & Wildlife Service	☐ Submitted ☐ N/A
Other:	☐ Submitted ☐ N/A

APPENDIX D

Referenced Information

LOW-EFFECT HABITAT CONSERVATION PLAN
FOR
PREBLE'S MEADOW JUMPING MOUSE
DRAFT

BROOKSIDE BUSINESS CENTER
TOWN OF CASTLE ROCK, DOUGLAS COUNTY, COLORADO

Prepared for

U.S. Fish and Wildlife Service
Colorado Ecological Services
P.O. Box 25486, DFC (MS 65412)
Denver, CO 80225-0486

On behalf of

St. Charles Town Company
1850 Platte Street, 2nd Floor
Denver, CO 80202

Prepared by

CORE Consultants, Inc.
3473 South Broadway
Englewood, CO 80113

November 2021

grasses and forbs was estimated to be between 45% and 65% of the Plan/Permit Area. Therefore, exotic plant infestation(s) in excess of 45% of the mitigated areas post-construction would represent a significant digression in the effort to restore and enhance the PMJM habitat.

6.3.4 Drought

Should damage to or loss of PMJM habitat occur within the term of the permit as a result of drought, the Applicant will assess the extent of the damage and institute the following measures within one year of the documentation of habitat damage or loss. Costs associated with habitat damage due to drought would stem from labor and materials costs for additional restoration as well as costs for supplemental water to the reseeded and replanted areas.

- Prepare a report assessing the habitat damage or loss
- Identify and implement specific actions to restore damage and improve habitat conditions, particularly in areas that have been enhanced for the benefit of PMJM but have not yet met the success criteria

6.3.5 Restoration Shortfall

Should the habitat restoration and enhancement fall short of meeting the success criteria described in Section 6.1.4 within the first five years of mitigation efforts, the Applicant or other designated party will assess the present condition of the habitat mitigation area and establish a suitable plan to meet or exceed the success criteria. Annual vegetation monitoring and utilization of the adaptive management triggers outlined in Section 6.2.1 are expected to minimize the likelihood of restoration shortfall after five years. Additionally, the ecological function uplift from the planned mitigation outlined in Section 5 exceeds the minimum need by approximately 6% (see Table 5.6), furthering reducing the potential for restoration shortfall.

6.3.6 Required Bank Stabilization and Channel Improvements to East Plum Creek

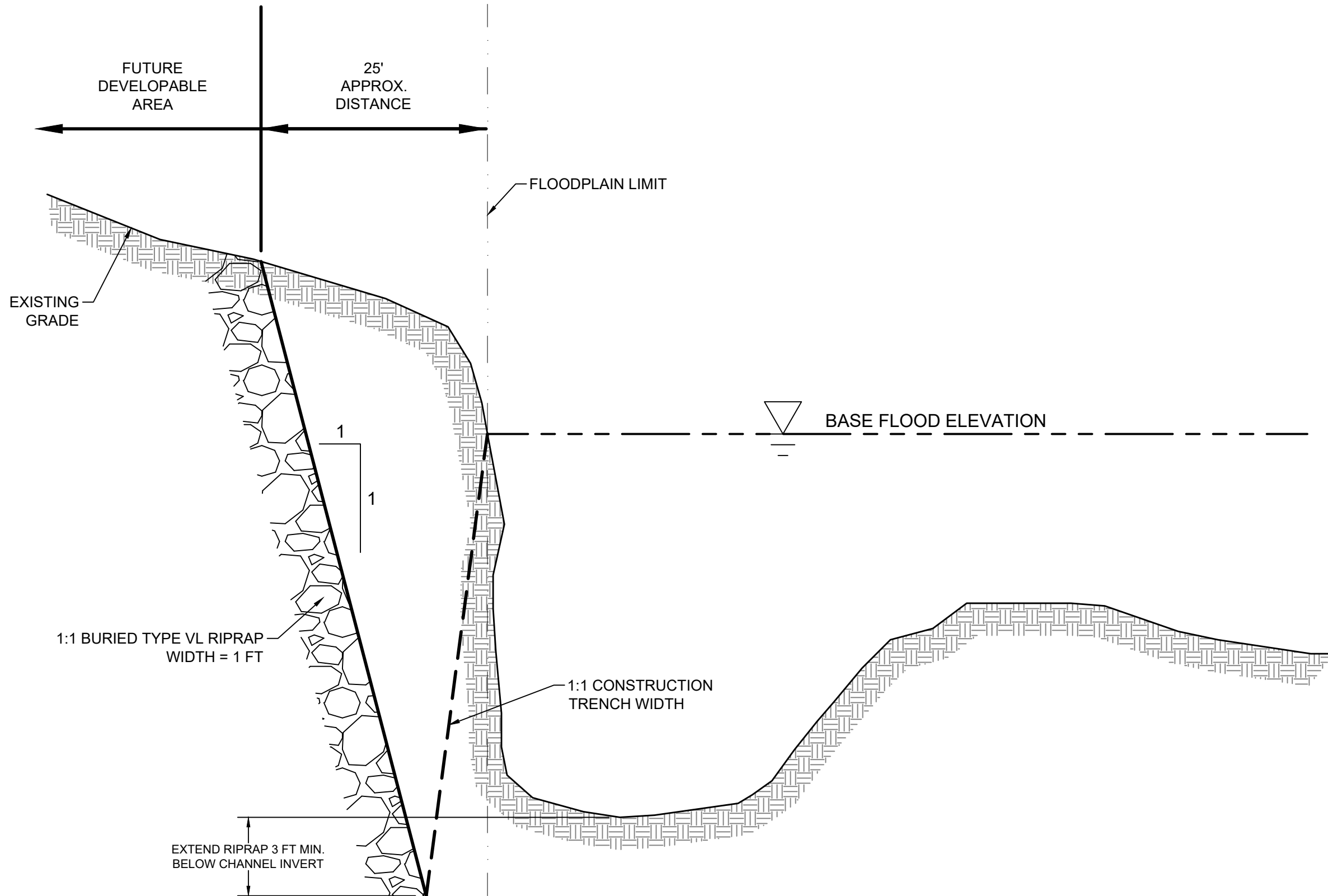
The easterly property line of the Plan/Permit Area is adjacent to East Plum Creek. According to the East Plum Creek Watershed Master Plan Preliminary Design Report (Master Plan; CH2M Hill 2009), Reach 6 of the East Plum Creek borders the property. There are steep floodplain banks that reach heights of 10 to 20 feet (three to six meters) above the low flow channel. In order to alleviate lateral and vertical migration of East Plum Creek, protective measures will need to be put in place at time of development of the Plan/Permit Area.

The Master Plan calls for drop structures along this portion of the creek, which will have to be installed for channel stabilization. For development of this site, the Town of Castle Rock will require below-grade cutoff walls to be constructed to address vertical migration of the channel.

Buried riprap armoring will be utilized to address lateral migration. The channel has an approximate 500 foot section (River Station 553+00 to 558+00) that will require buried riprap to be placed at a 1:1 slope from the flowline elevation of the channel to the 100-year base flood elevation to prevent further lateral migration of the channel into the developable area. This 500-foot (150-meter) section of the channel has meandered out of the floodplain banks, near oxbows where the trajectory of the stream is toward the embankments adjacent to the Plan/Permit Area. Refer to the Floodplain Exhibit and Plum Creek Typical Cross-Section Exhibit (Appendix E) for approximate locations of improvements and detail of riprap armoring. Impacts from stream bank stabilization will be temporary and occur only within areas identified as temporary or permanent disturbance areas in Figure 6.1.

If additional channel improvement activities by the Town of Castle Rock or other relevant party result in impacts to areas that have been enhanced and/or designated as Open Space Property for PMJM habitat, the respective party would be responsible for associated mitigation at a higher mitigation-to-impacts ratio than the original ratios for mitigation in this HCP. The Applicant would coordinate with the Town of

11/16/2021 8:24 AM ; X:\19-049 BROOKSIDE BUSINESS CENTER\CIVIL\CAD\EXHIBITS\2021 - FLOODPLAIN EXHIBITS\SECTION EXHIBIT.DWG;



1

PLUM CREEK - TYPICAL CROSS SECTION

NTS

BROOKSIDE BUSINESS CENTER
CASTLE ROCK, CO

EXHIBITS
TYPICAL SECTION

DATE: 08/26/21
DESIGNED BY: JF
DRAWN BY: JF
CHECKED BY: AK

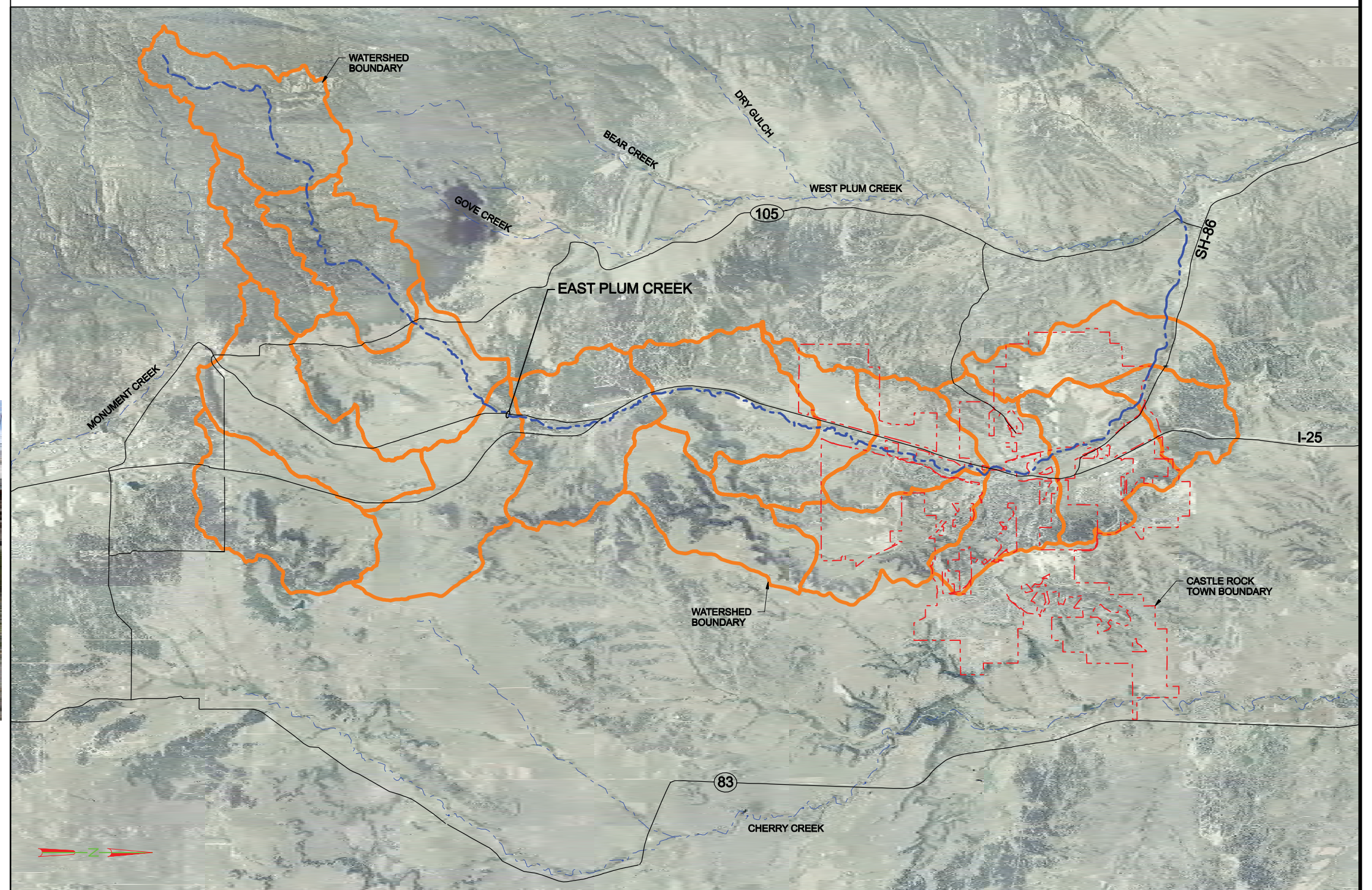
JOB NO.
19-049

SHEET
2 OF 2

EAST PLUM CREEK WATERSHED

Amended Flood Hazard Area Delineation

August 2013



PREPARED FOR:



Pedestrian Crossing	27198	27198	6111.7	7,446	12,854	17,342	25,726	6121.6	6122.9	6123.9	6125.4	413	6126.2	6124.4	317	239	78	2072.0	8.4
	27298	27298	6113.4	7,446	12,854	17,342	25,726	6123.2	6124.8	6125.9	6127.6	330	6128.7	6126.3	259	152	107	1934.2	9.0
	27498	27498	6115.0	7,446	12,854	17,342	25,726	6126.0	6129.0	6130.6	6133.4	385	6134.9	6130.8	163	70	93	1539.6	11.3
	27698	27698	6117.0	7,446	12,854	17,342	25,726	6128.8	6132.1	6134.2	6137.4	462	6136.2	6134.4	155	99	56	1953.2	8.9
	27785	27785	6118.2	7,446	12,854	17,342	25,726	6130.1	6133.6	6136.0	6139.8	390	6136.8	6136.6	241	174	68	3355.8	5.2
	27786	27786																	
	27855	27855	6118.3	7,446	12,854	17,342	25,726	6129.9	6133.7	6136.2	6140.1	382	6136.9	6136.5	241	174	68	3042.8	5.7
	27898	27898	6119.0	7,446	12,854	17,342	25,726	6130.0	6133.8	6136.3	6140.2	427	6137.0	6136.9	308	217	91	3588.5	4.8
	27957	27957	6121.0	7,446	12,854	17,342	25,726	6130.2	6133.8	6136.3	6140.2	413	6137.2	6137.0	257	226	31	3022.9	5.7
	28098	28098	6122.0	7,446	12,854	17,342	25,726	6131.0	6134.3	6136.6	6140.4	403	6137.5	6137.2	280	219	61	3157.0	5.5
	28298	28298	6124.0	7,446	12,854	17,342	25,726	6132.2	6134.1	6136.7	6140.5	333	6138.4	6137.2	260	180	80	2352.2	7.4
	28498	28498	6124.4	7,446	12,854	17,342	25,726	6133.5	6136.1	6137.9	6141.1	147	6142.9	6138.2	126	60	65	1287.9	13.5
	28732	28732	6125.7	7,446	12,854	17,342	25,726	6136.3	6139.1	6140.9	6143.3	129	6144.9	6141.8	129	57	73	1542.8	11.2
	28878.83	28878.83	6128.2	7,446	12,854	17,342	25,726	6137.4	6141.1	6143.8	6148.2	162	6145.8	6143.9	136	94	42	1710.2	10.1

Notes:

1. Top width has been adjusted to include a shallow right overbank flow path. Water from the upstream cross section can get to this location so it has been included in the Flood Plain.

HEC-RAS Reach: East Plum Creek above Split

East Plum Creek south of Wolfensberger Road

Reference Location	River Station	Cross Section	Thalweg Elevation (ft.)	Peak Flow (cfs)				Water Surface Elevation (ft.)				100-Year Floodplain		100-Year Floodway (1.0 ft. rise in EGL)					
				10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	Width (ft.)	Energy Grade Line (ft.)	Floodway Elevation (ft.)	Width (ft.)	Dist. Left (ft.)	Dist. Right (ft.)	Area (sq ft.)	Velocity (ft./sec)
Wolfensberger Street Bridge	29076.4	29076.4	6129.9	7,248	12,548	16,954	23,351	6139.6	6143.1	6145.7	6150.3	203	6146.8	6146.0	148	113	35	1995.3	8.5
	29147.7	29147.7	6134.5	7,248	12,548	16,954	23,351	6139.7	6143.1	6145.7	6150.2	197	6147.4	6146.1	142	71	71	1540.4	11.0
	29344.2	29344.2	6136.8	7,248	12,548	16,954	23,351	6143.7	6145.7	6147.6	6151.2	190	6149.2	6147.9	145	131	14	1574.4	10.8
	29578.4	29578.4	6138.7	7,248	12,548	16,954	23,351	6145.2	6147.5	6149.2	6152.3	234	6150.5	6150.1	191	100	90	2042.0	8.3
	29822.1	29822.1	6140.5	7,248	12,548	16,954	23,351	6146.1	6148.5	6150.0	6151.9	147	6153.9	6150.0	112	56	56	1006.4	16.9
	29875.0	29875.0		7,248	12,548	16,954	23,351	6149.3	6152.1	6154.0	6156.4		6155.6	6154.6					
	29955.9	29955.9	6140.8	7,248	12,548	16,954	23,351	6149.3	6152.1	6154.0	6156.4	175	6155.6	6154.6	128	67	62	1635.5	10.4
	30228.1	30228.1	6142.8	7,248	12,548	16,954	23,351	6151.1	6153.9	6155.9	6158.4	193	6157.3	6156.5	139	74	65	1797.0	9.4
	30800.2	30800.2	6147.8	7,248	12,548	16,954	25,192	6154.6	6157.3	6159.2	6161.7	263	6160.5	6159.9	210	114	96	2115.7	8.0

Pedestrian Bridge	31436.6	31436.6	6152.6	7,248	12,548	16,954	25,192	6159.7	6162.0	6163.6	6166.1	252	6165.0	6163.9	180	55	125	1779.1	9.5
	31459.0	31459.0		7,248	12,548	16,954	25,192	6160.7	6162.9	6164.6	6167.2		6165.8	6165.5					
	31489.9	31489.9	6153.0	7,248	12,548	16,954	25,192	6160.7	6162.9	6164.6	6167.2	254	6165.8	6165.5	196	63	133	2138.1	7.9
	31577.0	31577.0	6153.9	7,248	12,548	16,954	25,192	6161.3	6163.6	6165.3	6168.0	256	6166.3	6166.3	206	42	165	2234.6	7.6
5th Street Bridge	32022.4	32022.4	6156.3	7,248	12,548	16,954	25,192	6164.3	6166.4	6167.9	6170.4	368	6169.3	6168.6	263	60	203	2265.8	7.5
	32057.0	32057.0		7,248	12,548	16,954	25,192	6166.0	6168.0	6169.3	6171.7		6170.1	6170.0					
	32098.0	32098.0	6156.7	7,248	12,548	16,954	25,192	6166.0	6168.0	6169.3	6171.7	385	6170.1	6170.0	263	60	203	2409.7	7.0
	32439.9	32439.9	6158.8	6,533	11,261	15,164	22,402	6167.4	6169.3	6170.7	6172.9	293	6172.4	6171.4	182	100	82	1618.2	9.4
I-25 Bridge	33085.6	33085.6	6164.0	6,533	11,261	15,164	22,402	6173.4	6175.5	6176.9	6179.0	478	6178.9	6177.6	153	119	34	1418.0	10.7
	33198.0	33198.0		6,533	11,261	15,164	22,402	6174.7	6176.9	6178.5	6180.5		6180.6	6179.0					
	33291.3	33291.3	6166.0	6,533	11,261	15,164	22,402	6174.7	6176.9	6178.5	6180.5	206	6180.6	6179.0	173	95	78	1502.5	10.1
	33901.0	33901.0	6172.0	6,533	11,261	15,164	22,402	6180.1	6182.2	6183.7	6186.3	554	6184.1	6184.0	399	99	300	2539.1	6.0
Plum Creek Parkway Bridge	34158.9	34158.9	6176.0	6,533	11,261	15,164	22,402	6182.2	6183.6	6184.8	6187.0	411	6186.3	6185.5	411	182	229	2256.7	6.7
	34595.8	34595.8	6182.0	6,533	11,261	15,164	22,402	6188.1	6189.7	6190.6	6191.7	249	6192.7	6190.6	216	35	181	1375.0	11.0
	35014.0	35014.0	6184.0	6,533	11,261	15,164	22,402	6193.1	6194.7	6196.0	6198.2	398	6197.2	6197.0	257	20	237	2001.9	7.6
	35328.6	35328.6	6185.0	6,533	11,261	15,164	22,402	6195.4	6197.0	6198.0	6199.5	227	6200.5	6198.5	210	124	86	1526.1	9.9
Wilcox Street Bridge	35456.8	35456.8	6185.0	6,533	11,261	15,164	22,402	6196.8	6198.8	6200.2	6202.3	240	6201.3	6200.2	210	116	94	1760.4	8.6
	35589.8	35589.8	6187.0	6,533	11,261	15,164	22,402	6197.0	6198.9	6200.2	6202.1	189	6202.3	6200.2	160	36	124	1311.6	11.6
	35680.8	35680.8		6,533	11,261	15,164	22,402	6198.5	6200.9	6202.5	6205.0		6203.7	6202.7					
	35765.0	35765.0	6188.0	6,533	11,261	15,164	22,402	6198.5	6200.9	6202.5	6205.0	198	6203.7	6202.7	194	34	160	1823.6	8.3
	35856.7	35856.7	6190.0	6,533	11,261	15,164	22,402	6198.9	6200.9	6202.3	6204.5	152	6205.7	6202.6	110	36	74	938.1	16.2
	36130.7	36130.7	6194.0	6,533	11,261	15,164	22,402	6204.9	6207.4	6209.2	6211.9	147	6213.7	6209.2	120	67	53	1197.5	12.7
	36403.5	36403.5	6197.0	6,533	11,261	15,164	22,402	6208.3	6211.6	6213.9	6217.6	181	6215.3	6214.5	175	56	119	2170.1	7.0
	36492.8	36492.8	6197.0	6,533	11,261	15,164	22,402	6208.7	6212.0	6214.3	6218.4	223	6215.6	6214.8	173	46	127	2054.0	7.4
	36644.3	36644.3	6198.0	6,533	11,261	15,164	22,402	6209.7	6212.8	6215.1	6219.6	390	6216.5	6215.5	144	63	81	1678.9	9.0
	36736.2	36736.2	6199.0	6,533	11,261	15,164	22,402	6210.0	6213.0	6215.1	6219.0	356	6217.3	6215.5	157	77	81	1642.7	9.2
	36744.5	36744.5	6199.2	6,533	11,261	15,164	22,402	6209.0	6211.6	6213.6	6215.4	305	6218.1	6214.4	149	75	74	1377.4	11.0
	36762.0	36762.0	6200.0	6,533	11,261	15,164	22,402	6209.9	6212.6	6214.7	6221.1	125	6219.1	6214.9	125	54	71	1071.9	14.2
Wilcox Street Bridge	36782.6	36782.6	6202.5	6,533	11,261	15,164	22,402	6211.6	6214.7	6216.7	6219.9	99	6221.4	6216.8	99	53	46	943.1	16.1
	36818.0	36818.0		6,533	11,261	15,164	22,402	6214.8	6218.7	6221.6	6227.1		6223.0	6221.5					
	36854.5	36854.5	6203.9	6,533	11,261	15,164	22,402	6214.8	6218.7	6221.6	6227.1	442	6223.0	6221.5	438	330	107	2613.3	8.0
	36922.2	36922.2	6204.0	6,533	11,261	15,164	22,402	6215.9	6220.1	6223.0	6227.3	538	6223.2	6223.0	536	331	205	5656.7	2.7

Design velocity in East
Plum Creek at proposed
bank protection

East Douglas Lane Bridge	37102.0	37102.0	6205.0	6,533	11,261	15,164	22,402	6216.0	6220.2	6223.1	6227.4	513	6223.2	6223.0	512	268	244	5647.0	2.7
	37489.6	37489.6	6206.0	6,533	11,261	15,164	22,402	6216.1	6220.2	6223.1	6227.4	614	6223.5	6223.1	613	481	132	4608.4	3.3
	37890.3	37890.3	6208.0	6,533	11,261	15,164	22,402	6217.4	6220.9	6223.4	6227.5	429	6224.2	6223.3	343	134	209	2986.5	5.1
	38744.7	38744.7	6214.4	6,533	11,261	15,164	22,402	6222.6	6224.6	6226.3	6228.8	254	6228.9	6226.3	215	29	186	1589.7	9.5
	39554.8	39554.8	6220.5	6,533	11,261	15,164	22,402	6231.0	6233.0	6234.1	6236.2	329	6236.0	6234.5	212	162	51	1796.4	8.4
	40279.7	40279.7	6226.2	6,533	11,261	15,164	22,402	6236.2	6238.4	6240.0	6242.0	425	6241.8	6240.7	196	62	134	1911.0	7.9
	40859.8	40859.8	6231.7	6,533	11,261	15,164	22,402	6240.3	6242.6	6244.0	6246.3	326	6245.5	6244.6	163	98	65	1615.7	9.4
	41648.5	41648.5	6237.8	6,533	11,261	15,164	22,402	6246.2	6248.2	6249.6	6251.6	984	6251.0	6250.4	224	55	169	1938.9	7.8
	42381.1	42381.1	6244.4	6,533	11,261	15,164	22,402	6252.7	6254.4	6255.6	6257.5	487	6256.4	6256.6	274	254	20	2337.7	6.5
	43062.1	43062.1	6251.2	6,533	11,261	15,164	22,402	6257.1	6258.9	6259.9	6261.6	545	6260.8	6260.5	226	196	30	1726.0	8.8
	43726.6	43726.6	6254.6	6,533	11,261	15,164	22,402	6261.6	6263.3	6264.4	6265.9	476	6265.4	6265.2	275	44	231	2052.3	7.4
	44400.8	44400.8	6259.0	6,533	11,261	15,164	22,402	6266.5	6268.0	6269.1	6270.6	628	6270.6	6269.9	268	47	221	1914.8	7.9
	45078.4	45078.4	6265.3	6,533	11,261	15,164	22,402	6272.2	6273.9	6275.1	6276.5	397	6276.0	6275.8	292	87	204	2158.3	7.0
	45765.0	45765.0	6270.1	6,533	11,261	15,164	22,402	6277.6	6279.1	6280.1	6281.7	437	6281.3	6280.7	280	82	198	1941.3	7.8
	46714.5	46714.5	6275.8	6,533	11,261	15,164	22,402	6283.5	6285.3	6286.4	6288.0	271	6287.8	6287.3	186	20	166	1555.9	9.8
	47606.0	47606.0	6284.4	6,533	11,261	15,164	22,402	6290.1	6291.7	6292.8	6294.7	348	6294.5	6293.5	215	161	54	1458.3	10.4
	48196.0	48196.0	6288.9	6,533	11,261	15,164	22,402	6297.1	6300.0	6300.0	6300.6	382	6302.0	6300.0	283	42	241	2042.4	8.9
	48265.0	48265.0		6,533	11,261	15,164	22,402	6305.2	6306.6	6307.5	6308.6		6308.3	6308.3					
	48314.6	48314.6	6289.8	6,533	11,261	15,164	22,402	6305.2	6306.6	6307.5	6308.6	496	6308.3	6308.3	340	102	238	4322.7	4.7
	48519.4	48519.4	6290.6	6,533	11,261	15,164	22,402	6305.5	6307.2	6308.4	6310.1	663	6308.6	6309.2	386	82	304	4930.8	3.1
	48761.3	48761.3	6292.0	6,533	11,261	15,164	22,402	6305.6	6307.4	6308.6	6310.5	432	6308.9	6309.4	290	58	232	3393.4	4.5
	49431.4	49431.4	6297.7	6,533	11,261	15,164	22,402	6306.5	6308.7	6310.1	6312.2	590	6310.5	6310.6	296	181	115	2749.1	5.5
	50299.6	50299.6	6303.2	6,533	11,261	15,164	22,402	6311.3	6313.0	6313.8	6315.6	222	6316.8	6314.5	190	125	65	1395.2	10.9
	51106.9	51106.9	6309.1	6,378	11,008	14,813	21,889	6318.1	6320.1	6321.5	6323.7	482	6322.4	6322.0	315	38	277	2399.1	6.2
	51629.3	51629.3	6314.3	6,378	11,008	14,813	21,889	6322.5	6323.7	6324.7	6326.3	381	6325.9	6325.7	292	234	58	1895.2	7.8
	52433.3	52433.3	6320.9	6,378	11,008	14,813	21,889	6329.1	6330.1	6331.2	6332.7	309	6332.5	6331.3	200	94	106	1442.5	10.3
	52874.2	52874.2	6324.0	6,378	11,008	14,813	21,889	6331.5	6333.6	6334.8	6336.6	440	6335.7	6335.5	319	89	230	2463.0	6.9
	53065.6	53065.6	6324.9	6,378	11,008	14,813	21,889	6334.5	6336.0	6336.3	6338.1	318	6337.8	6336.6	230	57	173	1608.8	9.4
	53108.0	53108.0		6,378	11,008	14,813	21,889												
	53159.9	53159.9	6325.6	6,378	11,008	14,813	21,889	6339.3	6340.5	6341.1	6341.0	609	6342.1	6342.0	340	164	176	3225.4	6.4
	53593.0	53593.0	6327.9	6,378	11,008	14,813	21,889	6339.8	6341.3	6342.1	6343.4	229 ¹	6343.8	6342.5	179	77	102	1726.1	8.6
	53949.0	53949.0	6330.5	6,378	11,008	14,813	21,889	6340.6	6342.7	6344.1	6347.0	246 ²	6345.5	6344.5	183	160	23	1604.8	9.2

Excerpts from:

**PHASE III DRAINAGE REPORT
and
STORM WATER MANAGEMENT PLAN**

for

**MEDVED-BRUTYN AUTOPLEX
BROOKSIDE BUSINESS CENTER
FILING NO. 2, 1st AMENDMENT**

Prepared For:

CARO LAND COMPANY
11001 W. I-25 Frontage Road North
Wheat Ridge, Colorado 80033
(303) 421-0100

Prepared By:

ROCKY MOUNTAIN CONSULTANTS, INC.
8301 E. Prentice Ave., Suite 101
Englewood, Colorado 80111
(303) 741-6000

Revised: January 13, 2000
Revised: December 07, 1999
Revised: November 12, 1999
Date: August 1999
RMC Reference No. 3471.001.00

RMC RMC RMC RMC RMC RMC RMC RMC

Parking Lot Flow and Gutter Capacity

The Town of Castle Rock standard 6" vertical curb and gutter section will be used on all curb and gutter within the development. The peak runoff rates for the minor and major storm events at design points 7 and 8 were determined in Appendix B, and the gutter flow capacity at these points was not exceeded. In addition, flow will be routed over the site through paved swales through the proposed parking lot areas. The paved swales will transport flow towards the proposed inlets, and generally have a minimum invert slope of 2% and a maximum invert slope of 5%. A table of gutter flow capacity at varying flow depths is included in Appendix C.

Rip Rap Protection and Temporary Swale Calculations

Rip rap erosion protection is provided at all storm sewer outlets and pond discharge locations. The extent and size of the rip rap protection was determined using the Urban Drainage Method outlined in the Town of Castle Rock standards. The calculations for each outlet and discharge location are included in Appendix C.

The temporary swales proposed on the rough grading plan for the Phase 3 area were also modeled using Flow Master to ensure adequate capacity. The calculations for the temporary swale capacities are also included in Appendix C.

Detention Ponds and Outlet Structures

As previously discussed, Pond 1 has been designed for the full build out condition of the entire on-site area tributary area to the pond. In addition, it is proposed that the runoff from the off-site basin OS1 is also routed through Pond 1 with this Phase 1 construction. In the future, Phase 3 construction may allow the runoff from basin OS1 to be routed to the east through the Phase 3 area, with discharge directly to East Plum Creek. If the flow from basin OS1 is routed directly to East Plum Creek, the outlet of Pond 1 will be modified to reduce release rates to reflect the modified tributary area basin size. Until that time, Pond 1 will provide both storm detention and water quality enhancement for runoff from basin OS1.

Using the Empirical Method, the stormwater detention volume of Pond 1 was found to be 1.08 ac-ft for the 10 year storm event, and 1.87 ac-ft for the 100 year storm event. Based on the area tributary to Pond 1 (including basin OS1 and all of basin A), a Water Quality Capture Volume (WQCV) of 0.49 ac-ft will also be needed in the pond. Therefore, the total detention volume of Pond 1 will be 1.57 ac-ft for the 10 year storm event (WQCV plus 10 year Empirical Method detention volume), and 2.36 ac-ft for the 100 year storm event (WQCV plus 100 year Empirical Method detention volume). The pond will have a Type 2 outlet structure (Standard Figure 1301, Ref. 4) that also provides water quality enhancement (40 hour release of 2 year storm). The 10 year release rate will be approximately 4.1 cfs, and the 100 year release rate will be approximately 15.5 cfs. The

Detention Pond and WQCV Sizing

Pond 1 Sizing (for fully developed basin)

<u>Basin A</u>	<u>area (ac)</u>	<u>% Imp</u>															
A1	2.12	95	<u>Total Area</u> 18.2	<u>Wtd % Imp</u> 64.4	<u>K 100</u> 0.1027	<u>Vol 100</u> 1.87	<u>WQCV</u> 0.49	<u>Tot Vol 100</u> 2.36	<u>Q 100/Acre</u> 0.85	<u>Tot Q 100</u> 15.5							
A2	3.33	95															
A3	3.72	95															
A4	1.38	95															
A5	0.95	2															
OS1	6.71	25															
					<u>K 10</u> 0.0592	<u>Vol 10</u> 1.08	<u>WQCV</u> 0.49	<u>Tot Vol 10</u> 1.57	<u>Q 10/Acre</u> 0.23	<u>Tot Q 10</u> 4.2							

A % impervious of 25% was assumed for Off-site basin 1 that consists of highway area.

Pond 2 Sizing (for fully developed basin)

<u>Basin B</u>	<u>area (ac)</u>	<u>% Imp</u>															
B1	2.01	95	<u>Total Area</u> 19.3	<u>Wtd % Imp</u> 87.8	<u>K 100</u> 0.1372	<u>Vol 100</u> 2.64	<u>WQCV</u> 0.70	<u>Tot Vol 100</u> 3.35	<u>Q 100/Acre</u> 0.85	<u>Tot Q 100</u> 16.4							
B2	2.10	95															
B3	1.66	95															
B4	2.21	95															
B5	3.05	95															
B6	6.72	95	<u>K 10</u> 0.0815								<u>Vol 10</u> 1.57	<u>WQCV</u> 0.70	<u>Tot Vol 10</u> 2.27	<u>Q 10/Acre</u> 0.23	<u>Tot Q 10</u> 4.4		
B7	1.50	2															

FROM TCR STANDARDS

$$K_{100} = ((1.78)(\% \text{ Imp}) - (0.002)(\% \text{ Imp})^2 - 3.56) / 1000$$

$$K_{10} = ((0.95)(\% \text{ Imp}) - 1.90) / 1000$$

$$WQCV = (\% \text{ Imp})(\text{TRIB AREA}) / 2400$$

Stage vs. Storage - Pond 1

	<u>Size</u>	<u>Area</u>	<u>Outlet Pipe or Culvert</u>			<u>Alpha</u>
			<u>Dimen (in)</u>	<u>Size (ft)</u>	<u>Area</u>	
10 Yr. Orifice	10.5	0.6013	Plate Culvert	7.25 18	0.604 1.767	0.666 1.7665
Adj Area					1.101	

Pond 1 - in Lot 2, Block 1 behind existing dealership with 4:1 sides

Using 3 term geometric average

<u>Stage (Elev)</u>	<u>WS Area</u>	<u>Incr Vol</u>	<u>Cumm Stor (cf)</u>	<u>Stor (AC*FT)</u>	<u>10 yr orifice</u>	<u>Proposed</u>	<u>Culv - orf control</u>	<u>Total Q</u>
					<u>Inv Elev =</u>	<u>weir box</u>	<u>(dia above)</u>	
					36.48	38.62	32.5	
						Box Dim, one side =	3	
	33	615	0	0.0	0.00			0.0
	34	2750	1555	1555.2	0.04	0.00	6.89	0.0
	35	6225	4371	5926.0	0.14	0.00	8.97	0.0
	36	11260	8619	14545.0	0.33	0.00	10.65	0.0
WQCV - WSE	36.48	15090	6302	20846.7	0.48	0.00	11.37	0.0
	37	19540	15211	29756.1	0.68	0.00	12.10	0.9
	38	25013	22220	51976.3	1.19	0.00	13.39	3.3
10 YR - WSE	38.62	26911	16093	68069.2	1.56	0.00	14.13	4.1
	39	28060	26522	78498.2	1.80	6.54	14.57	11.1
100 YR - WSE	39.82	30854	34632	102701.2	2.36	36.68	15.47	15.5
	40	31453	29740	108238.6	2.48	45.23	15.66	15.7

From Above, 10 YR WSE = 6238.62

10 YR Release = 4.1 cfs

10 YR Total Detention Volume = 1.56 ac. ft

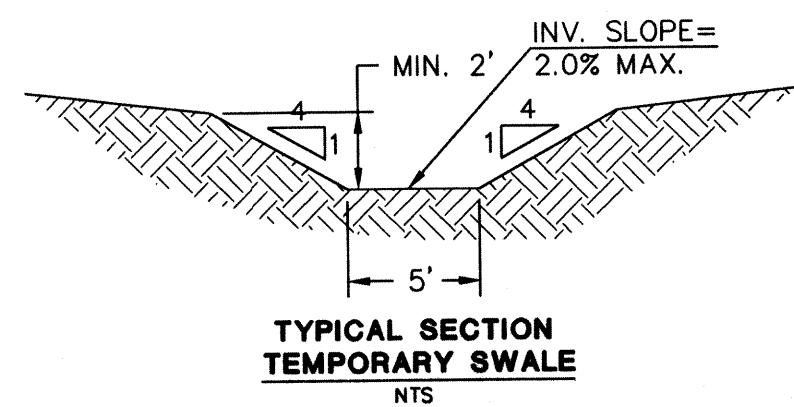
100 YR WSE = 6239.82

100 YR Release = 15.5 cfs

100 YR Total Detention Volume = 2.36 ac. ft

WQCV = 0.48 ac. ft

WQCV WSE = 6236.48



CONSTRUCTION PHASES AND DESCRIPTIONS

PHASE 1 CONSTRUCTION WILL CONSIST OF:

- CONSTRUCTION OF BUILDING, ENTRANCE, PARKING LOT SURFACE, CURB/GUTTER, AND ASSOCIATED SURFACE IMPROVEMENTS BASED ON LAYOUT SHOWN ON THIS PLAN IN BASINS A1, B1, AND B2
- OVER LOT GRADING AS SHOWN ON THIS PLAN OF PHASE 2 AREA IN BASINS B3, B4, AND B5
- ROUGH GRADING AS SHOWN ON THIS PLAN OF PHASE 3 AREA IN BASINS A2, A3, AND PORTION OF A4, WITH TEMPORARY SWALES AS SHOWN
- STORM SEWER AND INLETS AS SHOWN ON THIS PLAN CALLED OUT WITH "PHASE 1"
- CONSTRUCTION OF POND 1 OUTLET STRUCTURE AND ASSOCIATED STORM SEWER CONNECTION (POND 1 DETENTION VOLUME AND RELEASE RATES BASED ON FULLY DEVELOPED CONDITIONS OF ALL ON-SITE TRIBUTARY BASINS: A1, A2, A3, A4, AND A5)
- CONSTRUCTION OF POND 2 WITH OUTLET STRUCTURE AND OUTFALL CULVERT DISCHARGING TO PLUM CREEK (POND 2 DETENTION VOLUME AND RELEASE RATES BASED ON FULLY DEVELOPED CONDITIONS OF ALL TRIBUTARY BASINS: B1, B2, B3, B4, B5, B6, AND B7)

PHASE 2 CONSTRUCTION WILL CONSIST OF:

- BUILDING, PARKING LOT SURFACE, CURB/GUTTER, AND ASSOCIATED SURFACE IMPROVEMENTS BASED ON LAYOUT SHOWN ON THIS PLAN IN BASINS B3, B4, AND B5
- STORM SEWER AND INLETS AS SHOWN ON THIS PLAN CALLED OUT WITH "PHASE 2", CONNECTING TO PHASE 1 STORM SEWER SYSTEM AND DISCHARGING TO POND 2.

BENCHMARK: WEST 1/4 CORNER OF SECTION 14, TOWNSHIP 8 SOUTH, RANGE 66 WEST OF THE SIXTH PRINCIPAL MERIDIAN. ELEVATION: 6263.11

PHASE 1 DISCHARGE TABLE

DESIGN POINT	CONTRIBUTING BASINS	CONTRIBUTING AREA (ACRES)	5-YEAR (CFS)	100-YEAR (CFS)	COMMENTS
1	A1	2.12	9.0	17.0	FRONT PORTION-PHASE 1
2	A1,A2	5.45	7.9	11.9	PHASE 3-UNDEVELOPED
3	OS1	6.71	10.1	19.2	OFFSITE THRU 24" CULVERT
4	OS1,A3	10.43	10.0	25.6	PHASE 3-UNDEVELOPED
5	A4	1.38	0.7	4.4	UNDEVELOPED AREA
6	A1-A5,OS1	18.2	18.6	48.5	PHASE 1-FLOW TO POND 1
7	B1	2.01	8.6	16.1	REAR PROTION-PHASE 1
8	B2	2.10	9.0	16.8	REAR PROTION-PHASE 1
9	B3	1.66	0.9	5.4	REAR PROTION-PHASE 2
11	B5	3.00	1.6	9.7	FRONT PORTION-PHASE 2
10	B4,B5	5.21	2.5	14.6	REAR PORTION-PHASE 2
12	B3,B4,B5,B6	13.59	5.3	32.3	FUTURE MAINTENANCE AREA
13	B1-B7	19.20	15.2	53.2	PHASE 1-FLOW TO POND 2

PHASE 1 DETENTION POND SUMMARY

POND	10 YR TOTAL STORAGE VOLUME (AC - FT)	10 YR RELEASE RATE (CFS)	100 YR TOTAL STORAGE VOLUME (AC - FT)	10 YR RELEASE RATE (CFS)
1	1.57	4.1	2.36	15.5
2	2.27	4.4	3.35	16.3

TOTAL STORAGE VOLUME IS WQCV PLUS EMPIRICAL METHOD DETENTION VOLUME

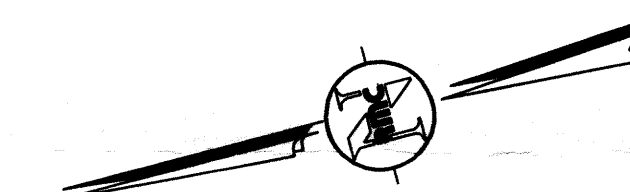
LEGEND

--- BASIN BOUNDARY

C
3.34 0.45

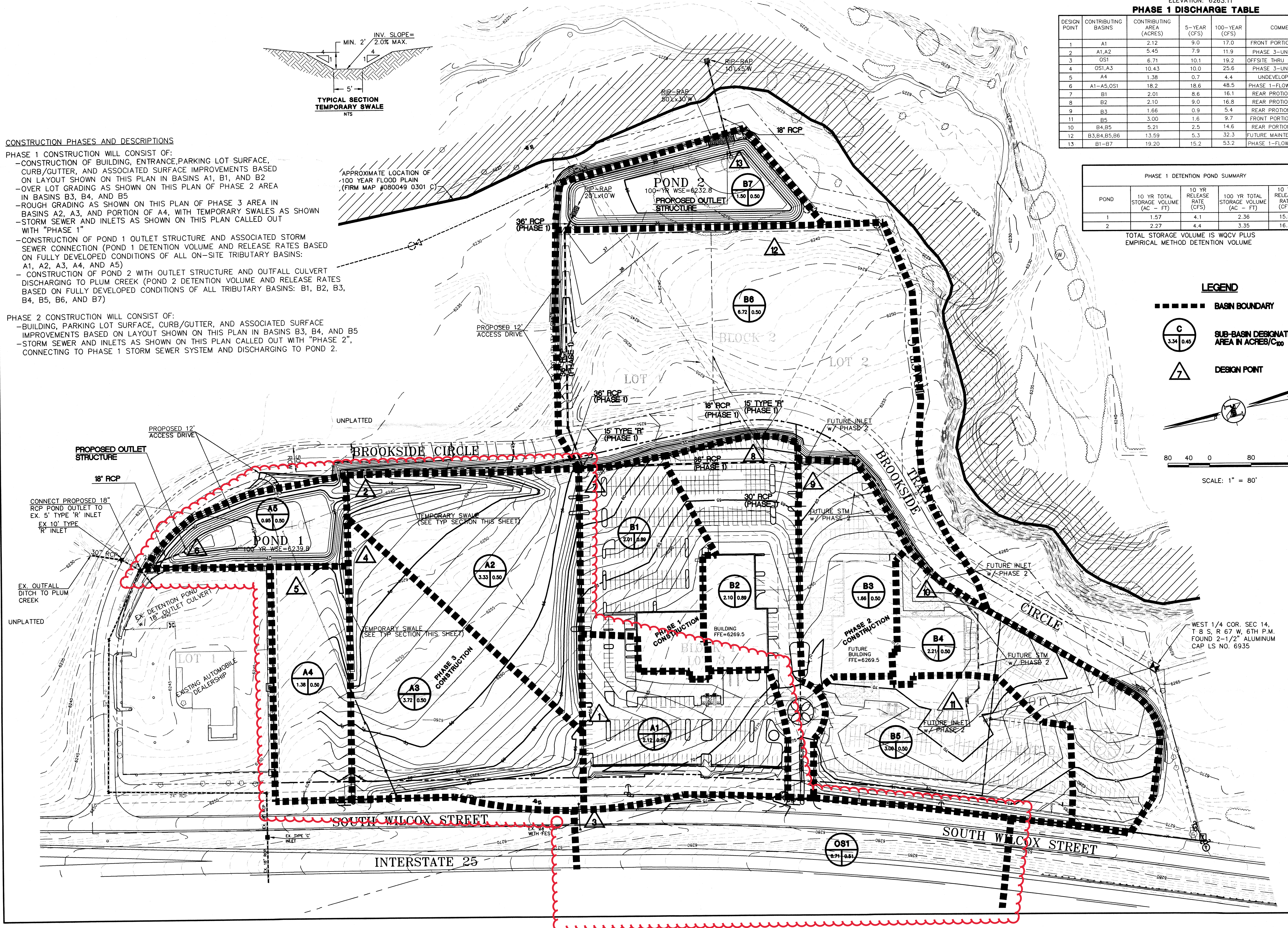
SUB-BASIN DESIGNATION
AREA IN ACRES/C₁₀₀

7
DESIGN POINT



80 40 0 80 160

SCALE: 1" = 80'



RMC
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FAX (303) 741-6106

ROCKY MOUNTAIN CONSULTANTS, INC.
CIVIL AND ENVIRONMENTAL ENGINEERING • PLANNING

NO.	REVISIONS	DATE	BY
1	REVISIONS	11/12/99	pac
2	CITY COMMENTS	12/07/99	pac
3	PER CITY COMMENTS	1/12/00	pac

MEDVED-BRUTYN AUTOPLEX
BROOKSIDE BUSINESS CENTER FILING NO. 2, 1st AMENDMENT
PHASE 1 CONSTRUCTION DRAINAGE PLAN

DATE: AUGUST '99
DESIGNED BY: PMB
DRAWN BY: MDS
CHECKED BY: MTN

JOB NO.
3471.001.00
SHEET
01 OF 01

MEDVED-BRUTYN-AUTOPLEX

APPENDIX E

Drainage Report Checklist



Phase III Drainage Report Checklist

The Phase III Drainage Report must be in conformance with the latest Town of Castle Rock Storm Drainage Design and Technical Criteria Manual available on the Town's website.

The Phase III Drainage Report must be signed and sealed by a Professional Engineer licensed in the State of Colorado. The purpose of the Phase III Drainage Report is to update the concepts, and to present the design details on construction plans for the drainage facilities discussed in the Phase II Drainage Report.

The preparer should contact and work with the Town Stormwater Engineering Staff regarding any design, master planning and existing system questions (720-733-6000). The following outline sets forth the **required minimum** content to be provided in the Phase III Drainage Report that shall be submitted with the Planned Development Plan or Straight Zoning documents. A copy of this checklist must be submitted with the Phase III Drainage Report.

Please see Chapter 4 of the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual for additional details and information. Please check off the following items to assure your report is complete. Appropriate notations shall be provided with the checklist. For example, if a specific item is not addressed or not applicable, an explanation needs to be provided.

Included	N/A	
		I. COVER SHEET
X		A. Name of Project, including legal name of development
X		B. Address
X		C. Owner
X		D. Developer
X		E. Engineer
X		F. Submittal date and revision dates as applicable
X		II. GENERAL LOCATION AND DESCRIPTION
X		A. Site Location
X		B. Description of Property and Land Use
X		III. DRAINAGE BASIN AND SUB-BASINS
X		A. Major Drainage Basins
X		B. Minor Drainage Basins
X		IV. DRAINAGE DESIGN CRITERIA
X		A. Regulations
X		B. Drainage Studies, Master Plans, Site Constraints
X		C. Hydrology
X		D. Hydraulics
X		E. Water Quality Enhancement

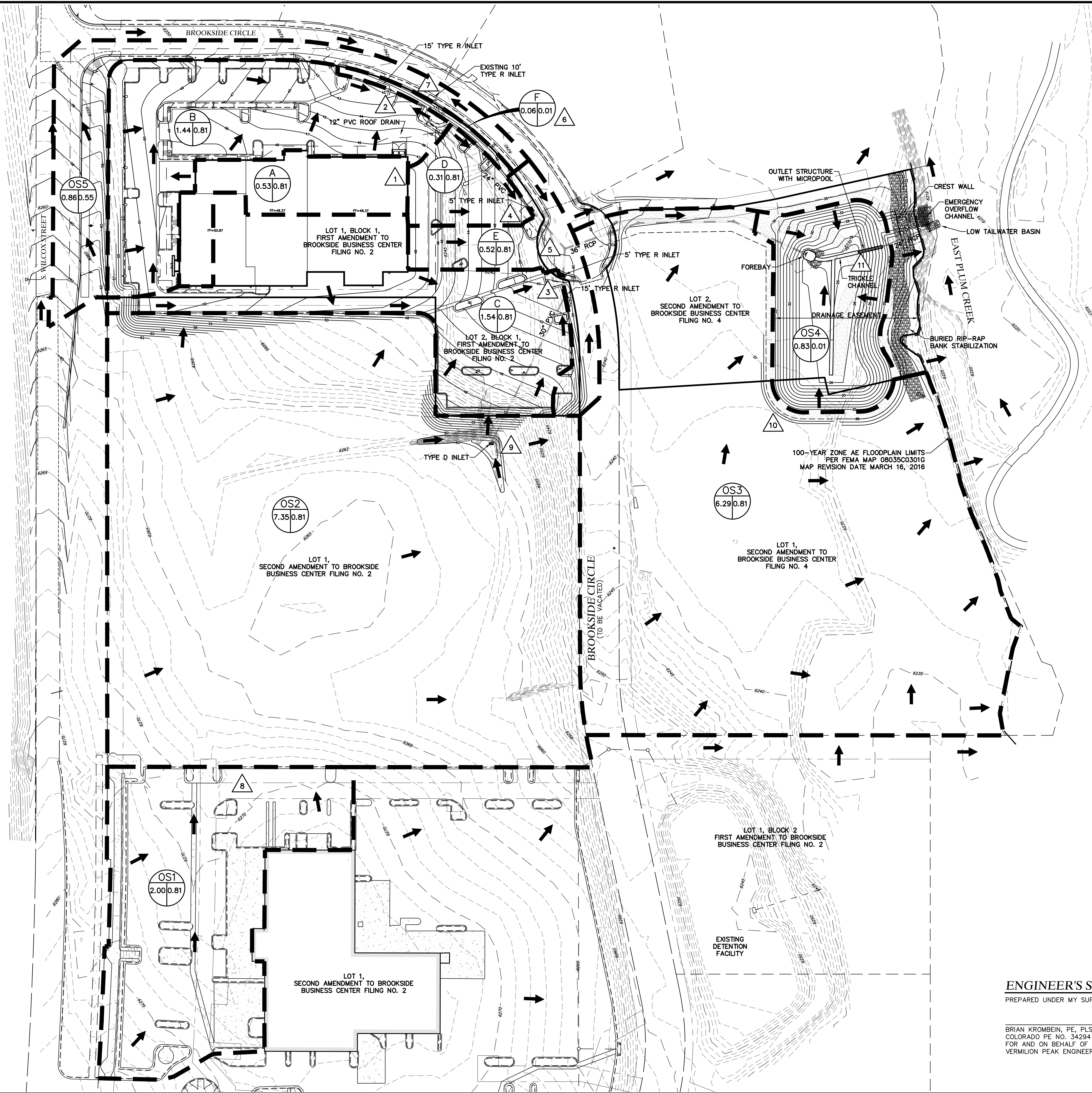
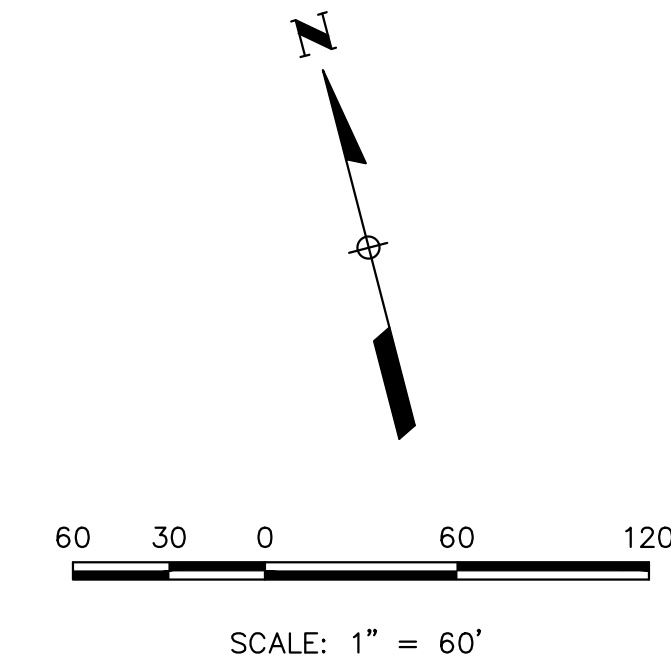
Phase III Drainage Report Checklist

Included	N/A	
		V. STORMWATER MANAGEMENT FACILITY DESIGN
X		A. Stormwater Conveyance Facilities
X		B. Stormwater Storage Facilities
X		C. Water Quality Enhancement Best Management Practices
X		D. Floodplain Modification
X		E. Additional Permitting Requirements
X		F. General
X		VI. CONCLUSIONS
X		A. Compliance with Standards
X		B. Variances
X		C. Drainage Concept
X		VII. REFERENCES
X		VIII. APPENDICES
X		A. Hydrologic Computations
X		B. Hydraulic Computations
X		C. Water Quality Enhancement Best Management Practices
X		D. Referenced Information
	X	OVERALL DRAINAGE PLAN (IN POCKET)
X		DETAILED DRAINAGE PLANS (IN POCKET)

Notes/Comments:

APPENDIX F

Drainage Map



LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- DRAINAGE FLOW DIRECTION
- EXISTING CURB & GUTTER
- 1" SPILL CURB
- 2" CATCH CURB
- CONCRETE PAVEMENT
- EXISTING STORM SEWER
- PROPOSED STORM SEWER
- SUB-BASIN BOUNDARY
- DESIGN POINT
- A = BASIN DESIGNATION
- B = AREA IN ACRES
- C = 5 YEAR RUNOFF COEFFICIENT
- D = 100 YEAR RUNOFF COEFFICIENT

	WATER QUALITY AND DETENTION				
	Volume Required	Volume Provided *	Elevation	Release	
	Cubic Ft	Acre-Ft	Cubic Ft	Acre-Ft	(FT)
Forebay	372	0.0085	404	0.0093	6224.33
Micropool	25	0.0006	160	0.0037	6221.00
Water Quality	29,098	0.668	29,098	0.668	6227.21
EURV	86,772	1.992	86,772	1.992	6230.17
100 year + 1/2 WQ	149,629	3.435	149,629	3.435	6232.54

RUNOFF TABLE

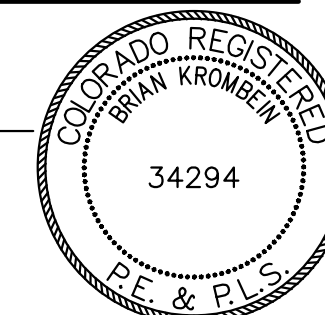
DRAINAGE BASIN	DESIGN POINT	CUMULATIVE CONTRIBUTING BASIN (ACRES)	CUMULATIVE Q _s cfs	CUMULATIVE Q ₁₀₀ cfs
A	1	0.53	2.0	3.8
B	2	1.44	5.5	10.6
C	3	1.54	6.0	11.7
D	4	0.31	1.2	2.4
E	5	0.52	2.1	4.0
F	6	0.06	0.2	0.5
OS5	7	0.92	2.0	4.9
OS1	8	2.00	7.5	14.8
OS2	9	9.35	27.3	52.9
OS3	10	6.29	23.9	47.1
OS4	11	20.81	56.7	115.9

ENGINEER'S STATEMENT

PREPARED UNDER MY SUPERVISION

BRIAN KROMBEIN, PE, PLS
COLORADO PE NO. 34294
FOR AND ON BEHALF OF
VERMILION PEAK ENGINEERING LLC

DATE



PHASE III DRAINAGE PLAN
CDR+J
SITE DEVELOPMENT PLAN
PROJECT NO. CD21-0052
DATE: DECEMBER 22, 2023
SHEET 1 OF 1

Vermilion
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