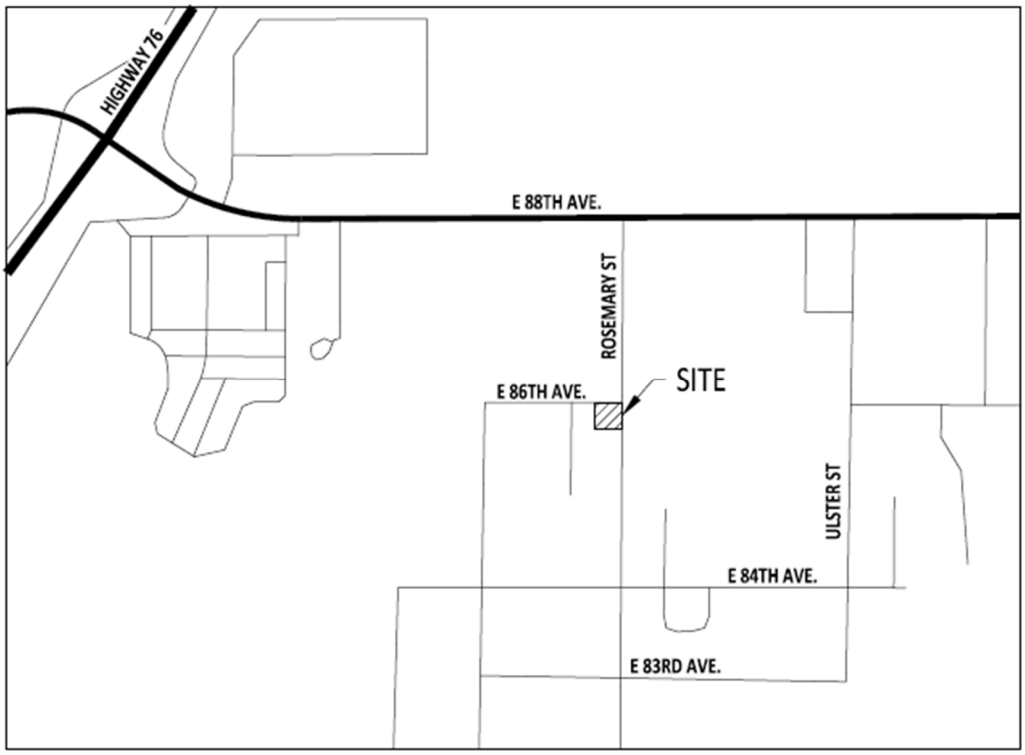
PRELIMINARY DRAINAGE STUDY

CARBAJAL AUTO DEALERSHIP

8581 Rosemary Street, Commerce City, CO



PREPARED BY
IAN LONG, EI
PROJECT ENGINEER
RAPTOR CIVIL ENGINEERING

REVIEWED BY
ERIC BURTZLAFF, PE
PRINCIPAL
RAPTOR CIVIL ENGINEERING

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

I HEREBY CERTIFY THAT THIS PRELIMINARY STUDY FOR CARBAJAL AUTO DEALERSHIP WAS PREPARED BY ME (OR UNDER MY SUPERVISION) IN ACCORDANCE WITH THE PROVISIONS OF THE COMMERCE CITY STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA FOR THE OWNERS THEREOF.

_____

ERIC BURTZLAFF, PE
LICENSED PROFESSIONAL ENGINEER
STATE OF COLORADO
NO. 50061

SEAL:

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

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1. GENERAL LOCATION AND DESCRIPTION

RCE has prepared the following Preliminary Drainage Study for a car dealership located at 8581 Rosemary Street, Commerce City, Colorado, hereby referred to as Carbajal Auto Dealership.

This report will demonstrate that the Carbajal Auto Dealership will not negatively impact downstream drainage nor the adjacent properties.

A. LOCATION

The subject property is currently a single parcel of land addressed 8581 Rosemary Street, Commerce City, Adams County, Colorado. The subject property consists of Lots 43-48, Block 46 of the Irondale Subdvision which is 0.456 acres. Right-of-way dedication is proposed for the project which brings the property size 0.41 acres. to The property is developed and currently consists of an existing single-family home with two existing garage structures. The property slopes southeast to northwest at roughly 1%.

The subject site is located within the Irondale Gulch drainage basin. There does not appear to be any drainage infrastructure directly adjacent to the site, however, per the Rosemary Street public improvement plans, a 30" storm drain pipe is to be installed in E. 86th Avenue directly adjacent to the site.

The subject site is bordered to the North by the East 86th Avenue right-of-way, the East by the Rosemary Street right-of-way, the West by an existing single-family home, and the South by an existing warehouse.

The subject site is located within the Northwest 1/4 of Section 28, Township 2 South, Range 67 West of the 6th Principal Meridian within the City of Commerce City, Adams County, Colorado.

B. DESCRIPTION OF PROPERTY

The subject site is 0.41 acres. The existing ground cover is roof coverage, small amounts of pavement, and low growing vegetation and grasses. According to USDA NRCS Custom Soil Resource website, the site is 100% map unit symbol number VoC, Vona sandy loam, 3 to 5 percent slopes, hydrologic soil group A. The site slopes at an average slope of 1% southwest to northeast toward the northwest corner of the property. The subject site is located within the Irondale Gulch drainage basin. There are no known regional water quality or detention facilities that serve the subject site. There are no known existing irrigation facilities located on the subject site. There is no known history of flooding on the subject site. There are no known easements located on the subject site per the ALTA survey for the site titled "ALTA/NSPS Land Title Survey; A Parcel of Land Situated in the Northwest 1/4 of Section 28, Township 2 South, Range 67 West of the 6th P.M.,

City of Commerce City, County of Adams, State of Colorado", provided by Falcon Surveying, dated 10/6/2022. There is no known environmental contamination on the subject site.

C. PROPOSED PROJECT DESCRIPTION

This development proposes a car dealership that will utilize existing structures located on the site, as well as associated driveways, asphalt parking lot, and drainage infrastructure including inlets, storm sewer, and a rain garden that provides water quality and detention for the site. Land use includes drive aisles, parking areas, pedestrian walkways, and landscaping.

D. FLOOD HAZARD

The subject site is located within FEMA Firm Map Number 08001C0607H dated March 5, 2007. The site is located within Zone X defined as areas outside of the 0.2% annual chance floodplain.

2. DRAINAGE BASINS AND SUB-BASINS

A. MAJOR BASIN DESCRIPTIONS

The site is located within the Irondale Gulch drainage basin.

The general topography of the area of the site slopes from east to west presumably to the South Platte River, which is located approximately 1,200 feet to the northwest of the site.

There are no known existing irrigation facilities that will be affected by drainage from the subject site.

B. SUB-BASIN DESCRIPTIONS

Historically, the subject site is divided into 1 sub-basin described as H1 in this drainage report/plan and one design point described as Design Point A. There are no off-site flows onto the subject property in the historic condition.

Basin H1 consists of 0.41 acres and slopes southeast to northwest towards the northwest property corner. This basin is historically 23.93% impervious. Basin H1 detailed information can be found below in Table 1.

Table 1 – Historic Summary Table

Basin	Area (ac)	C_5	C_{100}	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (cfs)	Q_{100} (cfs)
H1	0.41	0.23	0.58	2.08	4.52	0.20	1.07

Design Point A in the historic condition is the historic discharge location and represents on-site historic flows to this point. Historic design point info can be found below in Table 2.

Table 2 – Historic Design Point Summary Table

Design Point	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)
A	0.41	0.20	1.07

Refer to **Appendix H** for the Historic Drainage Plan.

In developed conditions the subject site is divided into 6 sub-basins described as D1, D2, D3, D4, U1, and U2 in this drainage study. There are two off-site sub-basins described as OS1 and OS2 in this drainage study. Basins D1, D2, D3, D4 are part of the subject property with a total area of 0.40 acres, or 97.6% of the total site area and are tributary to the proposed rain garden facility. Basins U1 and U2 are part of the subject property with a total area of 0.01 acres, or 2.4% of the total site area and are not tributary to the proposed rain garden facility.

Basin D1 consists of 0.21 acres and slopes generally from the outside edges to a proposed curb inlet located at the center of the basin. This basin, which is 79.91% impervious consists of roof coverage, paved areas, and landscape area. Basin D1 detailed information can be found below in Table 3.

Basin D2 consists of 0.02 acres and slopes south to north via a grass swale toward a proposed inlet located at the north side of the basin. This basin, which is 41.64% impervious consists of roof coverage and landscape area adjacent to the existing single-family home located on the property. Basin D2 detailed information can be found below in Table 3.

Basin D3 consists of 0.06 acres and slopes south to north via a concrete swale to a proposed inlet located at the north side of the basin. This basin, which is 11.30% impervious consists of landscape along the western property line. Basin D3 detailed information can be found below in Table 3.

Basin D4 consists of 0.11 acres and slopes east to west towards the proposed rain garden. A portion of this basin drains to a proposed chase drain that drains directly into the rain garden while the other section of the basin consists of the facility itself. This basin, which is 54.57% impervious consists of roof coverage, paved areas, landscape area, and the proposed rain garden. Basin D4 detailed information can be found below in Table 3.

Basin OS1 consists of 0.03 acres and slopes east to west directly into basin D1. This basin, which is 62.03% impervious consists of a small offsite paved area at the southeast corner of the site. Basin OS1 detailed information can be found below in Table 3.

Basin OS2 consists of 0.08 acres and slopes south to north to the proposed inlet located in basin D2. This basin, which is 5.72% impervious consists of offsite landscape area at the northeast corner of the property. Basin OS2 detailed information can be found below in Table 3.

Basin U1 consists of 0.01 acres and slopes west to east offsite to the Rosemary Street public right-of-way. This basin, which is 2.00% impervious consists of landscape area that drains undetained offsite. Basin U1 detailed information can be found below in Table 3.

Basin U2 consists of 0.00 acres and south to north to the East 86th Avenue public right-of-way. This basin, which is 16.75% impervious consists of a very small bypass area which was not able to be graded to the on-site rain garden facility. Basin U2 detailed information can be found below in Table 3.

Table 3 – Developed Summary Table

Basin	Area (ac)	C_5	C_{100}	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (cfs)	Q_{100} (cfs)
D1	0.21	0.69	0.81	3.80	8.24	0.55	1.40
D2	0.02	0.38	0.65	3.80	8.24	0.03	0.12
D3	0.06	0.13	0.53	3.45	7.48	0.02	0.22
D4	0.11	0.48	0.71	3.68	7.99	0.19	0.61
OS1	0.03	0.54	0.74	3.80	8.24	0.05	0.15
OS2	0.08	0.08	0.51	3.54	7.68	0.02	0.30
U1	0.01	0.05	0.49	3.80	8.24	0.00	0.03
U2	0.00	0.17	0.55	3.80	8.24	0.00	0.02

Design Point A in the developed condition is a proposed curb inlet that serves as the discharge point for basins D1 and OS1. Developed design point info can be found below in Table 4.

Design Point B in the developed condition is a proposed valley inlet that serves as the discharge point for basin D2 and OS2. Developed design point info can be found below in Table 4.

Design Point C in the developed condition is a proposed manhole that conveys combined flows from Design Points A and B. Developed design point info can be found below in Table 4.

Design Point D in the developed condition is a proposed valley inlet that serves as the discharge point for basin D3. Developed design point info can be found below in Table 4.

Design Point E in the developed condition represents the direct flow to the proposed rain garden facility from basin D4. Developed design point info can be found below in Table 4.

Design Point F in the developed condition represents the total flow to the proposed rain garden facility. Developed design point info can be found below in Table 4.

Table 4 – Developed Design Point Summary Table

Design Point	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)
A	0.23	0.60	1.55
B	0.10	0.05	0.41
C	0.33	0.65	1.97
D	0.06	0.02	0.22
E	0.11	0.19	0.61
F	0.49	0.87	2.79

Refer to **Appendix H** for the Developed Drainage Plan.

3. DRAINGE DESIGN CRITERIA

A. REGULATIONS

City policy requires on-site detention for all new development unless a regional detention facility is provided and sized to accommodate the 100-year storm event from a fully developed basin.

A proposed rain garden is proposed on-site to provide water quality and detention for the site per City requirements.

B. DEVELOPMENT CRITERIA REFERENCES AND CONSTRAINTS

The proposed drainage design complies with both the Commerce City Storm Drainage Design and Technical Criteria Manual (May 2023) and the Mile-High Flood District Drainage Criteria Manual.

The site is located within the Irondale Gulch drainage basin. There are no known adjacent drainage studies that affect the subject site.

The relatively flat topography of the site required several proposed inlets to capture flows and convey them to the proposed rain garden facility despite the small size of the site. Additionally, the small available footprint of the site required the use of a walled rain garden facility to provide sufficient volume for the developed condition. Additionally, a concrete chase was required to convey emergency overflows from the proposed rain garden in order to not drain over the public sidewalk.

C. HYDROLOGIC CRITERIA

Design Storm Frequencies

Per the Commerce City Storm Drainage Design and Technical Criteria Manual, the 5 and 100-year storm events are analyzed as the minor and major storm events, respectively.

Hydrologic Method

Since the site is under 160 acres, the Rational Method was used to calculated runoff in this report. Flowrates were calculated using the following Commerce City SDDTCM and MHFD criteria manual formulas. Refer to **Appendix D** for Hydrologic calculations for the site.

a) Runoff Coefficient and Impervious values are from Volume 1 Chapter 6 of MHFD drainage criteria manual table 6-3 "Recommended Percent Impervious Values".
b) The one-hour precipitation values are derived from Section 4.3 "Time-Intensity-Frequency Curves".
c) Time of Concentration is calculated using equation 504 for Urbanized Basins.
d) The rainfall intensity was calculated using equation 5-1 from Volume 1 Chapter 5 of MHFD drainage criteria manual along with aforementioned P values.
e) The peak flowrate is calculated Q = CIA.

D. HYDRAULIC CRITERIA

The Commerce City Storm Drainage Design and Technical Criteria Manual along with MHFD's criteria manual have been used to preliminarily size the on-site storm drain system. Sizing calculations for the underground storm system were conducted using the Hydraflow Storm Sewers Extension for AutoCAD. The proposed inlets on site were sized using MHFD's MHFD-Inlet software. These calculations are included in **Appendix F.**

The proposed open channels on site have been designed using the Hydraflow Express extension for AutoCAD. These calculations are provided in **Appendix G.**

E. STORMWATER QUALITY

The development will utilize the WQCV standard to meet the city's MS4 permit requirements. The development captures 0.40 acres of the 0.41-acre site, which equates to 97% of the property, and conveys it to the proposed rain garden facility that provides water quality for the development. This meets the minimum requirement of capturing 80% of the site or greater.

The development will satisfy MDCIA requirements by providing landscape areas and draining across them when possible and practicable. drainage in landscape areas. Runoff reduction volumes have not been taken into account when sizing the proposed rain garden facility.

4. DRAINAGE FACILITY DESIGN

A. GENERAL CONCEPT

A proposed rain garden is provided on-site to provide both water quality treatment and to capture the 100-year developed runoff from the project. Runoff from the site is captured by on-site inlets and conveyed to the pond via a proposed storm drain system, as well as directly sheet flowing to the rain garden facility. Ultimately, all runoff treated by the facility will be conveyed via a proposed outlet pipe to the future public storm system located in East 86th Avenue. Detailed design information can be found in **Appendix E.** Due to grading constraints, two offsite basins enter the proposed property from the Rosemary Street right-of-way.

B. SPECIFIC DETAILS

Water quality and detention for the site is provided via a proposed on-site rain garden. The required detention volume for the site was determined using MHFD's Detention spreadsheet. The total required detention volume for the site is 0.043 acre-feet, or 1,873 cubic feet. The proposed pond provides the required 100-yr detention volume at a ponding depth of 2.33'. A proposed outlet structure controls outflows from the pond, including providing the required 12-hr water quality drain time via a perforated PVC underdrain and utilizing a restrictor plate on the outlet pipe to provide the required allowable outflow flowrate from the pond. The pond outfalls via an 18" storm pipe that connects to a future public 30" storm main located in East 86th Avenue. Emergency overflow for the facility will overtop the proposed north retaining wall through a 4' wide weir and is conveyed to a sidewalk chase drain that will convey flows to the East 86th Avenue right-of-way. Due to grading constraints, two offsite basins enter the site from the Rosemary Street public right-of-way and are conveyed to the proposed rain garden facility. Maintenance access for the facility will be provided by an access ramp that will allow maintenance personnel to access the bottom of the pond. A proposed drainage easement has been proposed to allow for maintenance access to the facility. Detailed calculations for the rain garden have been provided in **Appendix E.** The proposed drainage design for this site has been designed to comply with all local, state, and federal requirements.

5. CONCLUSIONS

A. COMPLIANCE WITH STANDARDS

All requirements set forth by the City of Commerce City Storm Drainage Design and Technical Criteria Manual (May 2023) and FEMA floodplain regulations have been met with this development. Water quality and detention are provided by the proposed on-site rain garden facility to meet the City's MS4 requirements by providing water quality treatment for 97% of the

site. Outflows from the proposed rain garden facility will be discharged to the future public storm system and emergency overflows will be conveyed to the public right-of-way. Operations and maintenance access for the proposed detention facility has been provided via a maintenance access ramp. The facility is also included within a Drainage Easement that will allow for maintenance personnel to enter the property for operations and maintenance purposes. The undetained area for this project is minimal and is conveyed to the public right-of-way. The proposed development does not negatively impact downstream drainage nor the adjacent properties.

6. REFERENCES

Mile High Flood District Storm Drainage Criteria Manual (Volumes 1, 2, and 3), Revision dates vary

Commerce City Storm Drainage Design and Technical Criteria Manual, May 2023.

7. APPENDICES

A. NRCS WEB SOIL SURVEY
B. FEMA FLOOD MAP
C. GEOTECHNICAL REPORT (BY OTHERS)
D. HYDROLOGIC COMPUTATIONS
E. RAIN GARDEN COMPUTATIONS
F. HYDRAULIC COMPUTATIONS
G. OPEN CHANNEL FLOW COMPUTATIONS
H. DRAINAGE PLANS

APPENDIX A: NRCS WEB SOIL SURVEY

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Adams County Area, Parts of Adams and Denver Counties, Colorado

April 7, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:430 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 5 10 20 30

Feet: 0 20 40 80 120

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

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: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 19, Sep 1, 2022

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

MAP LEGEND

MAP INFORMATION

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
VoC	Vona sandy loam, 3 to 5 percent slopes	0.9	100.0%
Totals for Area of Interest		**0.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Adams County Area, Parts of Adams and Denver Counties, Colorado

VoC—Vona sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 34xc
Elevation: 4,000 to 5,600 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 125 to 155 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Vona and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Vona

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

H1 - 0 to 7 inches: sandy loam
H2 - 7 to 22 inches: sandy loam
H3 - 22 to 60 inches: loamy sand

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 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: 10 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Truckton

Percent of map unit: 10 percent
Hydric soil rating: No

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APPENDIX B: FEMA FLOOD MAP

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

National Flood Hazard Layer FIRMette

FEMA

104°54'18"W 39°51'22"N

104°53'41"W 39°50'55"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

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
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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 4/11/2023 at 1:05 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.

APPENDIX C: GEOTECHNICAL REPORT (BY OTHERS)

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

Cole Garner Geotechnical
1070 W. 124th Ave, Ste. 300
Westminster, CO 80234
303.996.2999

April 20, 2020

Paragon Engineering Consultants, Inc.
801 West Mineral Avenue, Suite 202
Littleton, Colorado 80120

Attn: Mr. Jeff Cooper

Re: **Proposal for Geotechnical Engineering Services**
Proposed Carbajal Automotive Dealership
8581 Rosemary Street
Commerce City, Colorado
CGG Proposal No. P20.22.107

Dear Mr. Cooper:

Cole Garner Geotechnical (CGG) appreciates the opportunity to submit this proposal to perform geotechnical engineering services for the proposed automotive dealership.

A. PROJECT INFORMATION – Based on information provided, we understand that the project will include redevelopment of the site into an automotive dealership. Existing development on the lot consists of a one-story residential building as well as two detached garages. We understand that the residence and one of the garages (southwest garage) will remain in place. The detached garage on the northwest portion of the lot will be moved to the north side of the garage located on the southwest portion of the site. A new foundation and slab-on-grade floor will be required for the relocated garage.

Other major site development will include construction of asphalt and/or concrete paved parking and drive lane areas. A stormwater retention pond will be constructed in the northwest portion of the site. Construction of proposed stormwater improvements will be performed following City of Commerce City standards. If our assumptions above are not accurate, or if you have additional useful information, please inform us as soon as possible.

B. SCOPE OF SERVICES – Our proposed scope of services includes Field Investigation, Engineering Analyses, and Report Preparation.

Field Investigation: The purpose of our geotechnical engineering services will be to evaluate the subsurface soil, bedrock, and groundwater conditions to provide geotechnical parameters for design and construction of the planned improvements.

We propose to advance a total of five (5) test borings within the proposed improvement areas, as outlined below. The borings will be drilled in the approximate locations as shown on the attached

Boring Location Diagram. The depth and location of test borings may be further adjusted depending upon actual site and subsurface conditions encountered.

Structure or Site feature	Geotechnical Exploration Scope	
	Borings	Proposed Boring Depths (ft)
Retention Pond (RP2 to be utilized for detached garage relocation)	RP1 and RP2	20 to 35
Pavements	P1 through P3	5

Our basic scope of services **does not** include surveying, however, we can retain the services of a surveyor for an additional fee, upon request. If surveying is not possible, the borings will generally located in the field by our field personnel using a measuring wheel from existing site features, provided scaled drawings are available.

CGG will contact the Utility Notification Center of Colorado (UNCC) a minimum of 48 hours prior to commencing field exploration. ***It should be noted that not all underground utilities may be identified, especially non-metallic pipes (such as HDPE, concrete or PVC) or those pipes without tracer wires. We request that the current landowner/contractor review our proposed boring locations so that they may inform us of conflicts with known utilities. CGG cannot be responsible for damage to underground utilities that cannot be located using these conventional methods, but can contract private underground utility locating services for an additional fee, if requested.***

During the drilling operations, CGG field personnel will log the borings, record the results of penetration tests in general accordance with locally recognized standards, and obtain samples for further laboratory evaluation. The depth to groundwater will be noted during exploration, if encountered. It is common for groundwater levels to fluctuate after drilling; therefore, we plan to leave the borings open until we can measure a relatively stable depth to groundwater (typically 24 to 72 hours). The borings will then be backfilled with the drilling cuttings. Drilling and sampling will be conducted in general accordance with applicable locally recognized standards.

At the completion of drilling operations, soil and/or bedrock samples will be returned to our laboratory where they will be examined by the project geotechnical engineer. At that time, the field descriptions will be confirmed or modified, boring logs will be drafted, and an applicable laboratory-testing program will be formulated.

We plan to perform percolation testing (or double-ring infiltrometer, if possible) of the soils at the approximate base of the proposed retention ponds. Testing will be performed adjacent to each of the proposed retention pond boring locations in general accordance with applicable standards.

Laboratory Testing: Relatively undisturbed samples will be tested for moisture content and dry density. Disturbed samples will be tested for liquid limit, plasticity index, gradation/-#200. Laboratory testing will be conducted in accordance with ASTM or other applicable locally recognized standards.

Engineering Analyses and Report Preparation: The information obtained from the field exploration and laboratory-testing program will be used to evaluate the subsurface conditions at the project site. From these determinations, engineering analyses will be performed in order to formulate recommendations for the design and construction of the development. Based upon our analyses, a geotechnical engineering report will be prepared containing recommendations for development of the project. The following information will be provided in the report:

- A brief review of our field and laboratory procedures, and the results of testing conducted;
- A discussion of the general subsurface conditions including soil/bedrock and groundwater conditions;
- Unsatisfactory soil conditions and recommended remedial measures;
- Current depth to groundwater, and recommended dewatering methods including subsurface drainage systems (if applicable);
- Design and construction recommendations for building foundations, including subgrade preparation, minimum dimensional requirements, maximum allowable bearing pressures, lateral earth pressures, and anticipated performance;
- Design and construction recommendations for the potential use of slab-on-grade interior floors, including subgrade preparation, anticipated performance, and the use of structural floors, if needed;
- Seismic Site Classification;
- Soil corrosivity;
- Pavement structural section alternatives for light and heavy duty sections, both asphalt and Portland cement concrete, considering a design life of 20-years, and;
- Results of percolation or infiltration testing for the use in design of stormwater systems; and
- Recommendations for earthwork construction.

A PDF-formatted copy of the report will be submitted, based upon the scope of services and limitations described herein. The report will be signed by a professional engineer responsible for the geotechnical services. Hard copies can be provided upon request.

C. SCHEDULE- We plan to commence field operations within 5 working days of after receiving written authorization. We have assumed that fieldwork may be performed during regular business hours and will take approximately 1 business day to complete, provided there are no weather delays. We estimate that laboratory testing may take up to 15 working days. Based on this schedule we anticipate providing a written report within **25 working days (five weeks)** from the notice to proceed; however,

we estimate that preliminary design information can be provided within about 5 working days following completion of field work, if requested.

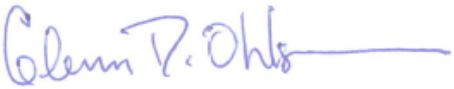
D. COMPENSATION - Our fees for conducting the geotechnical services outlined above will be **$3,650** lump sum, payable 30 days after invoice. Should additional services be requested, they will be invoiced according to our standard unit rates.

E. AUTHORIZATION - If this proposal meets with your approval, work may be initiated by executing the attached Agreement for Services and returning it to our office.

We appreciate the opportunity to provide this proposal and look forward to working with you on this project. If you have any questions or comments regarding this proposal or require additional services, please contact us.

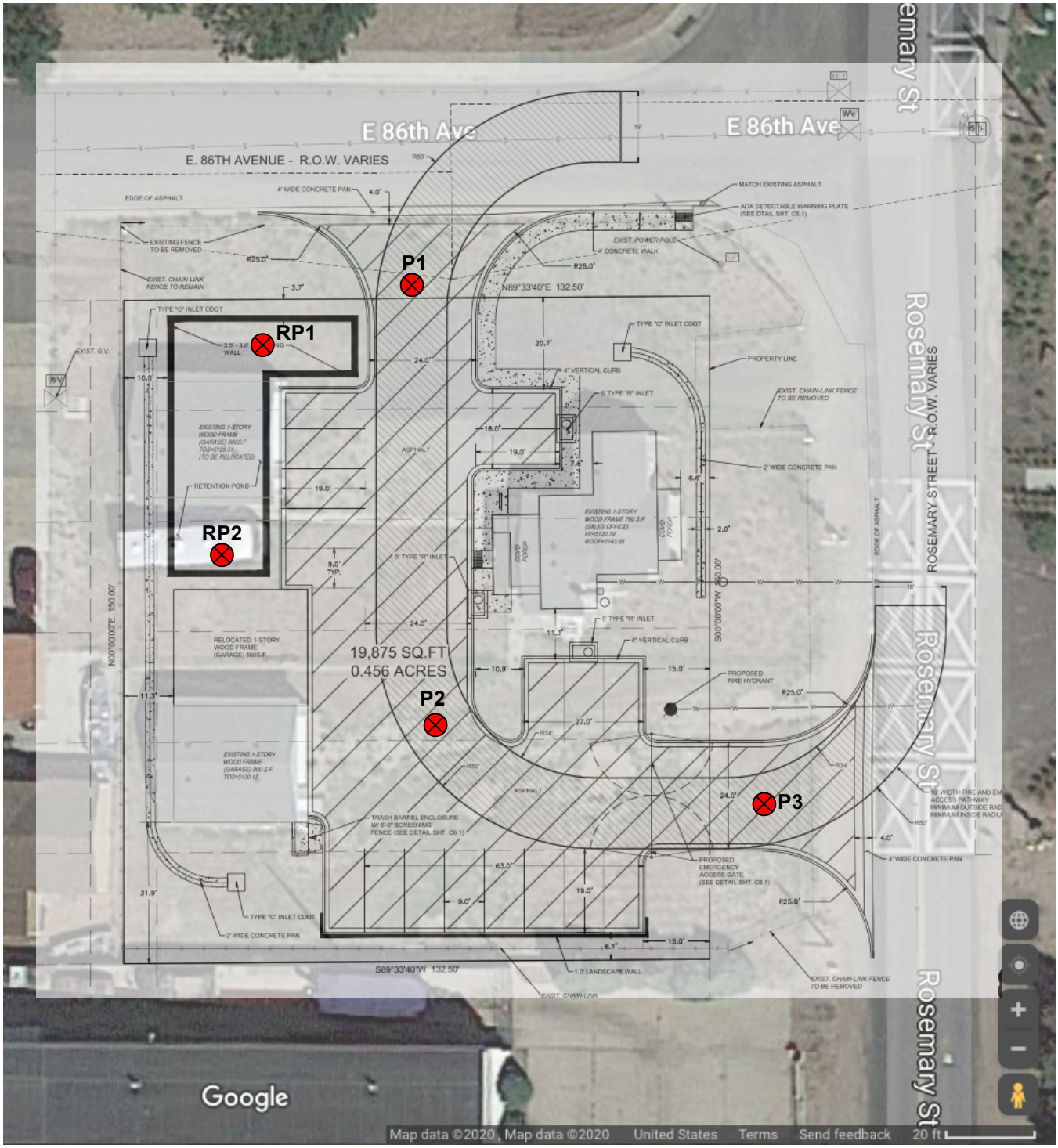
Sincerely,

Cole Garner Geotechnical



Glenn D. Ohlsen, P.E.
Project Engineer

Attachments: Agreement for Services



APPROXIMATE BORING LOCATIONS

(P1 – PAVEMENT BORING, TYP.)

(RP1 – RETENTION POND BORING, TYP.; PERCOLATION/INFILTRATION TESTING TO BE PERFORMED ADJACENT TO EACH BORING; RP2 TO BE UTILIZED FOR RELOCATED GARAGE)

FIGURE 1 - BORING LOCATION DIAGRAM
CARBAJAL AUTOMOTIVE DEALERSHIP
8581 ROSEMARY STREET
COMMERCE CITY, COLORADO
CGG PROPOSAL NO. P20.22.107

Cole Garner Geotechnical
1070 W. 124th Ave., Suite 300
Westminster, CO 80234
(303) 996-2999

AGREEMENT FOR SERVICES

This **AGREEMENT** is between _____ ("Client") and PCH Group, LLC dba Cole Garner Geotechnical ("Consultant") for Services to be provided by Consultant for Client, for **Proposed Carbajal Automotive Dealership – 8581 Rosemary Street, Commerce City, CO** ("Project") as described in the Project Information section of Consultant's Proposal dated **April 20, 2020** ("Proposal") unless the Project is otherwise described in Exhibit B to this Agreement (which section or Exhibit is incorporated into this Agreement).

1. **Scope of Services.** The scope of Consultant's services is described in the Scope of Services section of the Proposal ("Services"), unless Services are otherwise described in Exhibit B to this Agreement (which section or exhibit is incorporated into this Agreement). Portions of the Services may be subcontracted. Consultant's Services do not include the investigation or detection of, nor do recommendations in Consultant's reports address the presence or prevention of biological pollutants (e.g., mold, fungi, bacteria, viruses, or their byproducts) occupant safety issues, such as vulnerability to natural disasters, terrorism, or violence. If Services include purchase of software, Client will execute a separate software license agreement. Consultant's findings, opinions, and recommendations are based solely upon data and information obtained by and furnished to Consultant at the time of the Services.

2. **Acceptance.** Client agrees that execution of this Agreement is a material element of the consideration Consultant requires to execute the Services, and if Services are initiated by Consultant prior to execution of this Agreement as an accommodation for Client at Client's request, both parties shall consider that commencement of Services constitutes formal acceptance of all terms and conditions of this Agreement. Additional terms and conditions may be added or changed only by written amendment to this Agreement signed by both parties. In the event Client uses a purchase order or other form to administer this Agreement, the use of such form shall be for convenience purposes only and any additional or conflicting terms it contains are stricken. This Agreement shall not be assigned by either party without prior written consent of the other party, however, Client may assign this agreement to an Affiliate of Client.

3. **Change Orders.** Client or their representative may request changes to the scope of Services by altering or adding to the Services to be performed. If Client so requests, Consultant will return to Client a statement (or supplemental proposal) of the change setting forth an adjustment to the Services and fees for the requested changes. Following Client's review, Client shall provide written acceptance. If Client does not follow these procedures, but instead directs, authorizes, or permits Consultant to perform changed or additional work, the Services are changed accordingly and Consultant will be paid for this work according to the fees stated or its current fee schedule. If project conditions change materially from those observed at the site or described to Consultant at the time of proposal, Consultant is entitled to a change order equitably adjusting its Services and fee.

4. **Compensation and Terms of Payment.** Client shall pay compensation for the Services performed at the fees stated in the Compensation section of the Proposal unless fees are otherwise stated in Exhibit C to this Agreement (which section or Exhibit is incorporated into this Agreement). If not stated in either, fees will be according to Consultant's current fee schedule. Fee schedules are valid for the calendar year in which they are issued. Consultant may invoice Client at least monthly and payment is due upon receipt of invoice. Client shall notify Consultant in writing, at the address below, within 15 days of the date of the invoice if Client objects to any portion of the charges on the invoice, and shall promptly pay the undisputed portion. Client shall pay a finance fee of 1.5% per month, but not exceeding the maximum rate allowed by law, for all unpaid amounts 30 days or older. Client agrees to pay all collection-related costs that Consultant incurs, including attorney fees. Consultant may suspend Services for lack of timely payment.

5. **Third Party Reliance.** This Agreement and the Services provided are for Consultant and Client's sole benefit and exclusive use with no third party beneficiaries intended, with the exception of assignment to a financial partner or affiliate. Reliance upon the Services and any work product is limited to Client, and is not intended for third parties. For a limited time period not to exceed three months from the date of the report, Consultant will issue additional reports to others agreed upon with Client, however Client understands that such reliance will not be granted until those parties sign and return Consultant's reliance agreement and Consultant receives the agreed-upon reliance fee.

6. **Indemnification.** Consultant agrees to indemnify and hold harmless Client against any claim, loss, liability, duty, obligation or damage to the extent arising out of the negligent acts or omissions of Consultant, its contractors, subcontractors, guests, invitees, employees or agents, in connection with the performance of Consultant's obligations under this Agreement. This section shall survive expiration or termination of this Agreement.

7. **Warranty.** Consultant will perform the Services in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same locale. **CONSULTANT MAKES NO WARRANTIES OR GUARANTEES, PRESS OR IMPLIED, RELATING TO CONSULTANT'S SERVICES AND CONSULTANT DISCLAIMS ANY IMPLIED WARRANTIES OR WARRANTIES IMPOSED BY LAW, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

8. **Insurance.** Consultant represents that it now carries, and will continue to carry: (i) workers' compensation insurance in accordance with the laws of the states having jurisdiction over Consultant's employees who are engaged in the Services, and employer's liability insurance ($1,000,000); (ii) commercial general liability insurance ($1,000,000 occ/$2,000,000 agg); (iii) automobile liability insurance ($1,000,000 B.I. and P.D. combined single limit); and (iv) professional liability insurance ($2,000,000 claim/agg). Certificates of Insurance will be provided upon request. Client and Consultant shall waive subrogation against the other party on all general liability and property coverage.

9. **CONSEQUENTIAL DAMAGES.** NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR LOSS OF PROFITS OR REVENUE; LOSS OF USE OR OPPORTUNITY; LOSS OF GOOD WILL; COST OF SUBSTITUTE FACILITIES, GOODS, OR SERVICES; COST OF CAPITAL; OR FOR ANY SPECIAL, CONSEQUENTIAL, INDIRECT, PUNITIVE, OR EXEMPLARY DAMAGES.

10. **Dispute Resolution.** Client and Consultant agree that all claims, disputes or other matters in question arising out of or relating to this Agreement, shall be subject to litigation, if not resolved in another manner acceptable to both parties. The venue for such litigation shall be the Colorado court system having jurisdiction for the subject development at the time of performance**.**

11. **Governing Law.** This Agreement and its terms shall be governed by the laws of the State of Colorado and each party agrees that jurisdiction and venue shall be in the federal courts of Colorado. If any action or proceeding is instituted to enforce or interpret any provision of this Agreement, the prevailing party shall be entitled to recover its reasonable attorneys' fees and costs from the losing party.

12. **Subsurface Explorations.** Subsurface conditions throughout the site may vary from those depicted on logs or discrete borings, test pits, or other exploratory services. Client understands Consultant's layout of boring and test locations is approximate and that Consultant may deviate a reasonable distance from those locations. Consultant will take reasonable precautions to reduce damage to the site when performing Services; however, Client accepts that invasive services such as drilling or sampling may damage or alter the site. Site restoration is not provided unless specifically included in the Services. Consultant shall not be responsible for damage to on-site utilities not located through the Utility Notification Center of Colorado.

13. **Testing and Observations.** Client understands that testing and observation are discrete sampling procedures, and that such procedures indicate conditions only at the depths, locations, and times the procedures were performed. Consultant will provide test results and opinions based on tests and field observations only for the work tested. Client understands that testing and observation are not continuous or exhaustive and are conducted to reduce – not eliminate – project risk. Client agrees to the level or amount of testing performed and the associated risk. Client is responsible (even if delegated to contractor) for notifying and scheduling Consultant so Consultant can perform these Services. Consultant shall not be responsible for the quality and completeness of contractor's work or their adherence to the project documents, and Consultant's performance of testing and observation services shall not relieve contractor in any way from its responsibility for defects discovered in its work, or create a warranty or guarantee. Consultant will not supervise or direct the work performed by contractor or its subcontractors and is not responsible for their means and methods.

14. **Sample Disposition, Affected Materials, and Indemnity.** Samples are consumed in testing or disposed of upon completion of tests (unless stated otherwise in the Services). Client shall furnish or cause to be furnished to Consultant all documents and information known or available to Client that relate to the identity, location, quantity, nature, or characteristic of any hazardous waste, toxic, radioactive, or contaminated materials ("Affected Materials") at or near the site, and shall immediately transmit new, updated, or revised information as it becomes available. Client agrees that Consultant is not responsible for the disposition of Affected Material unless specifically provided in the Services, and that Client is responsible for directing such disposition. In the event that test samples obtained during the performance of Services (i) contain substances hazardous to health, safety, or the environment, or (ii) equipment used during the Services cannot reasonably be decontaminated, Client shall sign documentation (if necessary) required to ensure the equipment and/or samples are transported and disposed of properly, and agrees to pay Consultant the fair market value of this equipment and reasonable disposal costs. In no event shall Consultant be required to sign a hazardous waste manifest or take title to any Affected Materials. Client shall have the obligation to make all spill or release notifications to appropriate governmental agencies. The Client agrees that Consultant neither created nor contributed to the creation or existence of any Affected Materials conditions at the site. Accordingly, Client waives any claim against Consultant and agrees to indemnify and save Consultant, its agents, employees, and related companies harmless from any claim, liability or defense cost, including attorney and expert fees, for injury or loss sustained by any party from such exposures allegedly arising out of Consultant's non-negligent performance of services hereunder, or for any claims against Consultant as a generator, disposer, or arranger of Affected Materials under federal, state, or local law or ordinance.

15. **Confidentiality.** By signing this Agreement, Consultant agrees to comply with the terms of the Confidential Disclosure Agreement attached as Exhibit "A". Consultant Agrees to have all employees, sub-contractors and agents comply with the terms of the Confidential Disclosure Agreement.

16. **Assignment of Work Product.** Upon final payment by Client to Consultant of all amounts due under the this Agreement, Consultant shall assign to Client, in writing if requested by Client, all work product produced by Consultant in connection with the performance of its obligations under this Agreement (the "Work Product"). Client agrees that Work Product so assigned shall not be used by Client or Client in connection with any other project other than the project related to this Agreement.

17. **Utilities.** Client shall provide the location and/or arrange for the marking of private utilities and subterranean structures. Consultant shall take reasonable precautions to avoid damage or injury to subterranean structures or utilities. Consultant shall not be responsible for damage to subterranean structures or utilities that are not called to Consultant's attention, are not correctly marked, including by a utility locate service, or are incorrectly shown on the plans furnished to Consultant.

18. **Site Access and Safety.** Client shall secure all necessary site related approvals, permits, licenses, and consents necessary to commence and complete the Services and will execute any necessary site access agreement. Consultant will be responsible for supervision and site safety measures for its own employees, but shall not be responsible for the supervision or health and safety precautions for any other parties, including Client, Client's contractors, subcontractors, or other parties present at the site.

19. **Termination.** Either party may terminate this Agreement or the Services upon written notice to the other. In such case, Consultant shall be paid costs incurred and fees earned to the date of termination plus reasonable costs of closing the project.

20. Limitation of Liability. Client and Consultant have evaluated the risks and rewards associated with this project, including Consultant's Fee relative to the risks assumed, and agree to allocate certain of the risks so, to the fullest extent permitted by law, the total aggregate liability of Consultant (and its related entities and employees) to Client, its other design and construction professionals and third parties granted reliance is limited to the greater of **$25,000** or its fee for any and all injuries, damages, claims, losses, or expenses (including attorney and expert fees) arising out of Consultant's services or this agreement regardless of cause(s) or the theory of liability, including negligence, indemnity, or other recovery. Upon written request from Client, Consultant may negotiate a higher limitation of liability amount for an additional fee.

Consultant: **PCH Group, LLC** **dba Cole Garner Geotechnical** By: _____ Name/Title: **Glenn D. Ohlsen, P.E. / Project Engineer** Address: **1070 West 124th Avenue, Suite 300** **Westminster, Colorado 80234** Phone: **303-996-2999** Date: **4/20/2020**	Client: _____ By: _____ Print Name: _____ Title:_____ Date: _____ Client Phone #: _____ Client Email: _____ **Billing Info: (If different from above)** Bill To: _____ Billing Address: _____ Billing City/State/Zip:_____ Billing Contact Name: _____ Billing Phone #: _____ Billing Email: _____

APPENDIX D: HYDROLOGIC COMPUTATIONS

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

COMPOSITE RUNOFF CALCULATIONS

PROJECT NAME: 8581 Rosemary St
CALCULATED BY: ISL

DATE: 11/7/2023

RAPTOR CIVIL ENGINEERING

"C" Factors for Composite Analysis

	Roof	Walk/Drive	Gravel	Landscape
C2	0.74	0.74	0.30	0.01
C5	0.77	0.77	0.36	0.05
C10	0.80	0.80	0.43	0.15
C25	0.82	0.82	0.54	0.33
C50	0.83	0.83	0.59	0.40
C100	0.85	0.85	0.65	0.49
I (%)	90%	90%	40%	2%

Runoff Coefficients derived from MHFD Volume 1, Chapter 6 (Runoff), Table 6-3 & 6-4 for NRCS Group C&D Soils.

Basin ID	Basin Area (ac)	Basin Area (sf)	Roof Area (sf)	Walk/Drive Area (sf)	Gravel Area (sf)	Landscape Area (sf)	Composite Imperviousness	C 2yr	C 5yr	C 10yr	C 25yr	C 50yr	C 100yr
H1	0.41	17713	2515	801	2544	11853	**23.93%**	0.19	**0.23**	0.31	0.45	0.51	**0.58**
D1	0.21	9128	1867	6214	0	1047	**79.91%**	0.65	**0.69**	0.72	0.77	0.78	**0.81**
D2	0.02	948	317	110	0	521	**41.64%**	0.34	**0.38**	0.44	0.55	0.60	**0.65**
D3	0.06	2403	0	254	0	2149	**11.30%**	0.09	**0.13**	0.22	0.38	0.45	**0.53**
D4	0.11	4680	395	2401	0	1884	**54.57%**	0.44	**0.48**	0.54	0.62	0.66	**0.71**
OS1	0.03	1095	0	747	0	348	**62.03%**	0.51	**0.54**	0.59	0.67	0.70	**0.74**
OS2	0.08	3308	0	140	0	3168	**5.72%**	0.04	**0.08**	0.17	0.35	0.42	**0.51**
U1	0.01	369	0	0	0	369	**2.00%**	0.01	**0.05**	0.15	0.33	0.40	**0.49**
U2	0.00	185	0	31	0	154	**16.75%**	0.13	**0.17**	0.26	0.41	0.48	**0.55**
Subject Property	0.41	17713	2579	9010	0	6124	**59.58%**						
Total Site	0.51	22116	2579	9897	0	9640	**51.64%**						

Overland Flow Time *Channelized Flow Time*

Basin ID	Overland Flow Length (ft)	Overland Flow Slope (ft/ft)	Overland Flow Time (min)	Channelized Flow Length (ft)	Channelized Flow Slope (ft/ft)	Channelized Flow Time (min)	**Time of Concentration* (min)**
H1	166	0.01	22.25	0	1.00	0.00	**22.25**
D1	25	0.01	3.70	35	0.01	0.29	**3.99**
D2	18	0.09	2.65	0	1.00	0.00	**2.65**
D3	24	0.03	5.99	129	0.01	0.98	**6.97**
D4	30	0.02	5.03	83	0.01	0.58	**5.61**
OS1	38	0.05	3.59	0	1.00	0.00	**3.59**
OS2	27	0.04	6.04	60	0.02	0.35	**6.40**
U1	10	0.06	3.31	0	1.00	0.00	**3.31**
U2	2	0.02	1.88	0	1.00	0.00	**1.88**

Time of Concentration is derived from MHFD Volume 1, Chapter 6 (Runoff), Section 2.4
Minimum Time of Concentration is 5 mins

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1-hour rainfall depth (in)=	0.84	1.12	1.37	1.75	2.08	2.43

Rainfall depth is derived from MHFD-Detention spreadsheet v4.03, P values

Rainfall Intensity (in/hr)

Basin ID	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
H1	1.56	**2.08**	2.55	3.25	3.87	**4.52**
D1	2.85	**3.80**	4.65	5.94	7.06	**8.24**
D2	2.85	**3.80**	4.65	5.94	7.06	**8.24**
D3	2.59	**3.45**	4.22	5.39	6.40	**7.48**
D4	2.76	**3.68**	4.50	5.75	6.84	**7.99**
OS1	2.85	**3.80**	4.65	5.94	7.06	**8.24**
OS2	2.66	**3.54**	4.33	5.53	6.58	**7.68**
U1	2.85	**3.80**	4.65	5.94	7.06	**8.24**
U2	2.85	**3.80**	4.65	5.94	7.06	**8.24**

Peak Flow (cfs)

Basin ID	Q 2yr	Q 5yr	Q 10yr	Q 25yr	Q 50yr	Q 100yr
H1	0.12	**0.20**	0.32	0.60	0.80	**1.07**
D1	0.39	**0.55**	0.70	0.95	1.16	**1.40**
D2	0.02	**0.03**	0.04	0.07	0.09	**0.12**
D3	0.01	**0.02**	0.05	0.11	0.16	**0.22**
D4	0.13	**0.19**	0.26	0.39	0.49	**0.61**
OS1	0.04	**0.05**	0.07	0.10	0.12	**0.15**
OS2	0.01	**0.02**	0.06	0.15	0.21	**0.30**
U1	0.00	**0.00**	0.01	0.02	0.02	**0.03**
U2	0.00	**0.00**	0.01	0.01	0.01	**0.02**

Peak Flow is derived from the Rational Method Equation

APPENDIX E: RAIN GARDEN COMPUTATIONS

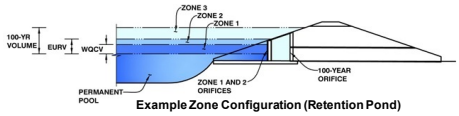
8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: 8581 Rosemary St

Basin ID: Detention Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	RG	
Watershed Area =	0.41	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	59.58%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.006	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.030	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.014	acre-feet		inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.020	acre-feet		inches
10-yr Runoff Volume (P1 = 1.37 in.) =	0.025	acre-feet		inches
25-yr Runoff Volume (P1 = 1.75 in.) =	0.033	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	0.043	acre-feet		inches
100-yr Runoff Volume (P1 = 2.43 in.) =	0.054	acre-feet		inches
500-yr Runoff Volume (P1 = 3.35 in.) =	0.083	acre-feet		inches
Approximate 2-yr Detention Volume =	0.014	acre-feet		
Approximate 5-yr Detention Volume =	0.019	acre-feet		
Approximate 10-yr Detention Volume =	0.024	acre-feet		
Approximate 25-yr Detention Volume =	0.032	acre-feet		
Approximate 50-yr Detention Volume =	0.038	acre-feet		
Approximate 100-yr Detention Volume =	0.043	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.006	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.023	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.014	acre-feet
Total Detention Basin Volume =	0.043	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

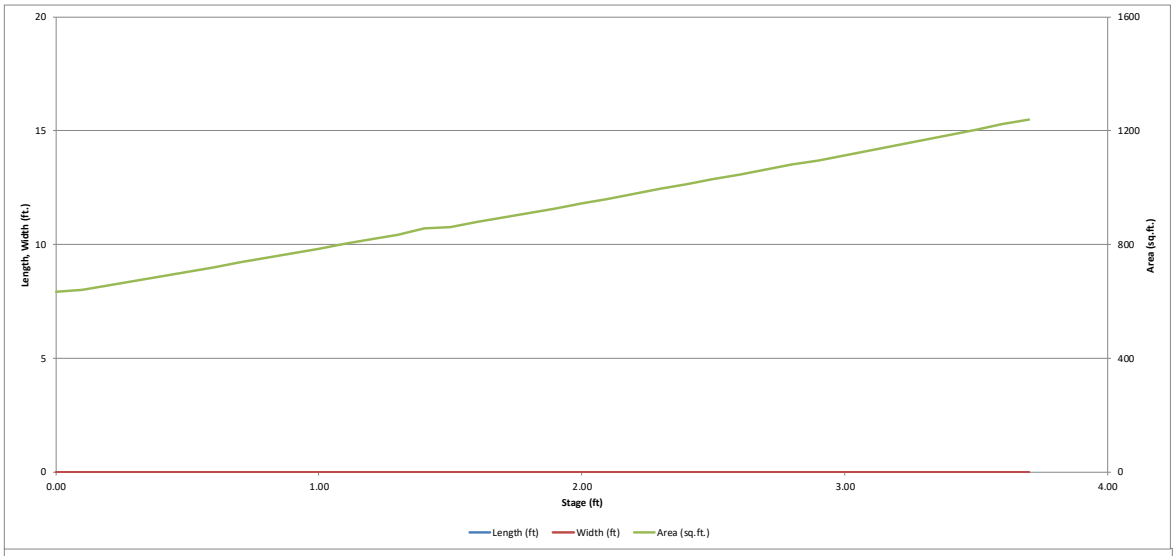
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

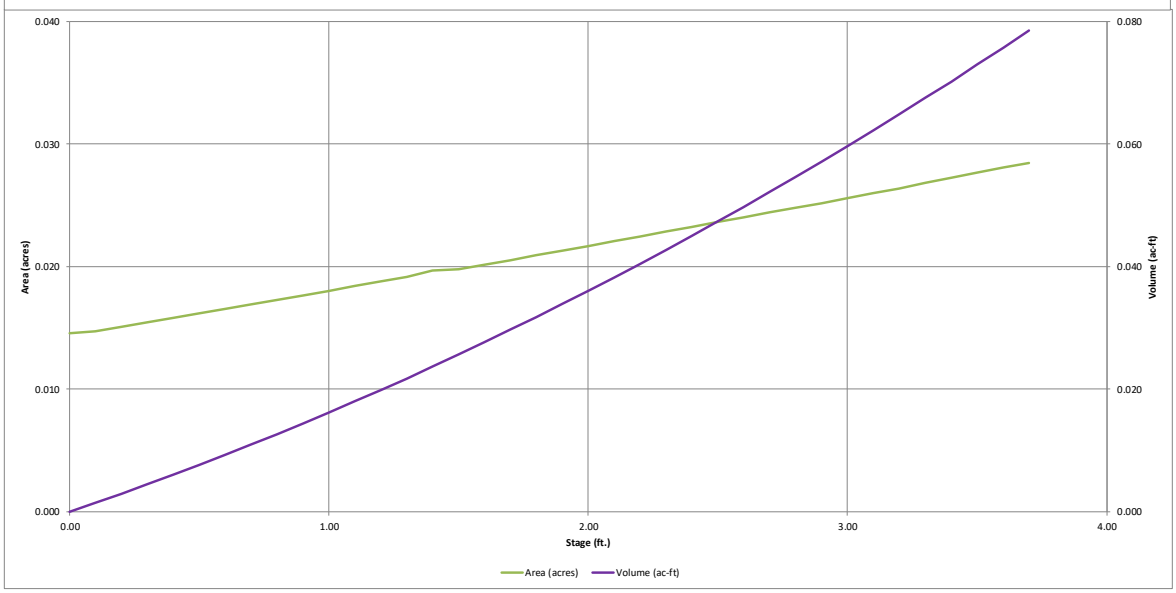
Depth Increment = 0.10 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	635	0.015		
5125.7	--	0.10	--	--	--	641	0.015	64	0.001
5125.8	--	0.20	--	--	--	656	0.015	129	0.003
5125.9	--	0.30	--	--	--	672	0.015	195	0.004
5126	--	0.40	--	--	--	688	0.016	263	0.006
5126.1	--	0.50	--	--	--	704	0.016	333	0.008
5126.2	--	0.60	--	--	--	720	0.017	404	0.009
5126.3	--	0.70	--	--	--	736	0.017	477	0.011
5126.4	--	0.80	--	--	--	752	0.017	551	0.013
5126.5	--	0.90	--	--	--	769	0.018	627	0.014
5126.6	--	1.00	--	--	--	785	0.018	705	0.016
5126.7	--	1.10	--	--	--	802	0.018	784	0.018
5126.8	--	1.20	--	--	--	818	0.019	865	0.020
5126.9	--	1.30	--	--	--	834	0.019	948	0.022
5127	--	1.40	--	--	--	856	0.020	1,032	0.024
5127.1	--	1.50	--	--	--	861	0.020	1,118	0.026
5127.2	--	1.60	--	--	--	878	0.020	1,205	0.028
5127.3	--	1.70	--	--	--	894	0.021	1,294	0.030
5127.4	--	1.80	--	--	--	911	0.021	1,384	0.032
5127.5	--	1.90	--	--	--	927	0.021	1,476	0.034
5127.6	--	2.00	--	--	--	944	0.022	1,569	0.036
5127.7	--	2.10	--	--	--	961	0.022	1,665	0.038
5127.8	--	2.20	--	--	--	978	0.022	1,762	0.040
5127.9	--	2.30	--	--	--	995	0.023	1,860	0.043
5128	--	2.40	--	--	--	1,012	0.023	1,961	0.045
5128.1	--	2.50	--	--	--	1,029	0.024	2,063	0.047
5128.2	--	2.60	--	--	--	1,046	0.024	2,166	0.050
5128.3	--	2.70	--	--	--	1,063	0.024	2,272	0.052
5128.4	--	2.80	--	--	--	1,081	0.025	2,379	0.055
5128.5	--	2.90	--	--	--	1,096	0.025	2,488	0.057
5128.6	--	3.00	--	--	--	1,114	0.026	2,598	0.060
5128.7	--	3.10	--	--	--	1,132	0.026	2,711	0.062
5128.8	--	3.20	--	--	--	1,149	0.026	2,825	0.065
5128.9	--	3.30	--	--	--	1,168	0.027	2,941	0.068
5129	--	3.40	--	--	--	1,186	0.027	3,058	0.070
5129.1	--	3.50	--	--	--	1,204	0.028	3,178	0.073
5129.2	--	3.60	--	--	--	1,223	0.028	3,299	0.076
5129.3	--	3.70	--	--	--	1,241	0.028	3,422	0.079

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



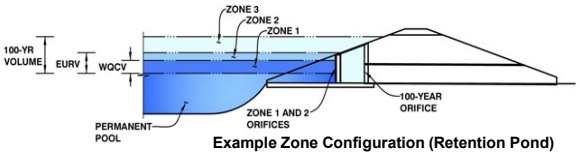


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 8581 Rosemary St

Basin ID: Detention Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.43	0.006	Filtration Media
Zone 2 (EURV)	1.70	0.023	Rectangular Orifice
Zone 3 (100-year)	2.33	0.014	Weir&Pipe (Restrict)
Total (all zones)		0.043	

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

Underdrain Orifice Invert Depth =	2.03	ft (distance below the filtration media surface)	Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Diameter =	0.39	inches	Underdrain Orifice Centroid =	0.02	feet

Calculated Parameters for Underdrain

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)

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected			Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.43	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.01	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.04	N/A	feet
Vertical Orifice Height =	1.00	N/A	inches				
Vertical Orifice Width =	2.00		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	1.70	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	3.67	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	19.81	N/A	
Horiz. Length of Weir Sides =	3.67	N/A	feet	Overflow Grate Open Area w/o Debris =	10.22	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.11	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.13	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.52	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.70	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.16	feet
Spillway Crest Length =	4.00	feet	Stage at Top of Freeboard =	4.36	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.03	acres
Freeboard above Max Water Surface =	0.50	feet	Basin Volume at Top of Freeboard =	0.08	acre-ft

Calculated Parameters for Spillway

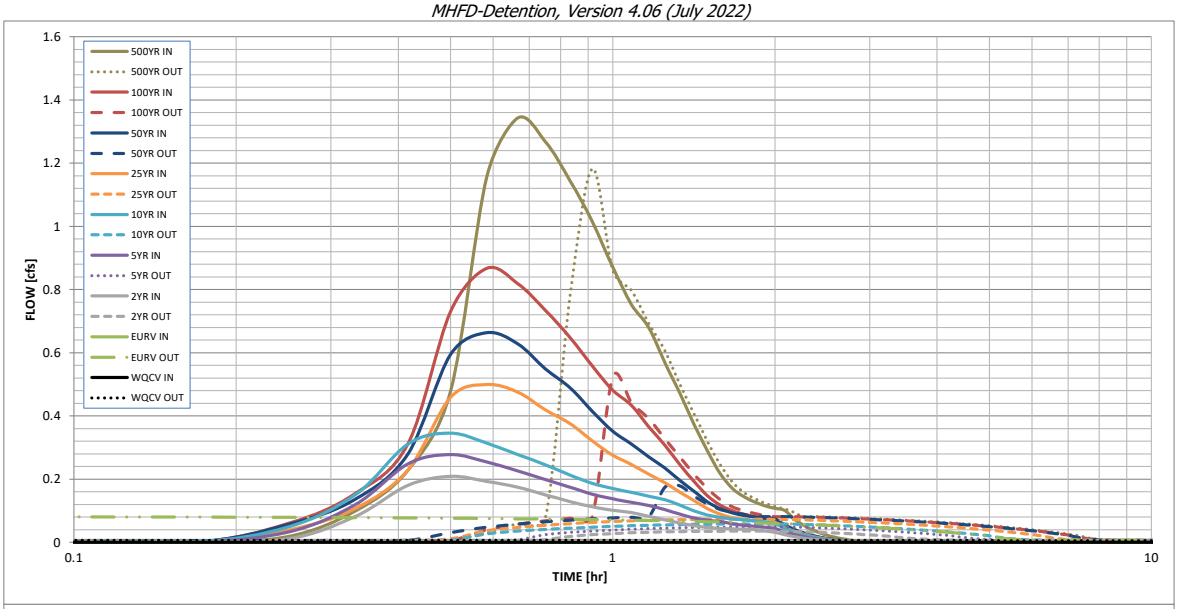
Routed Hydrograph Results

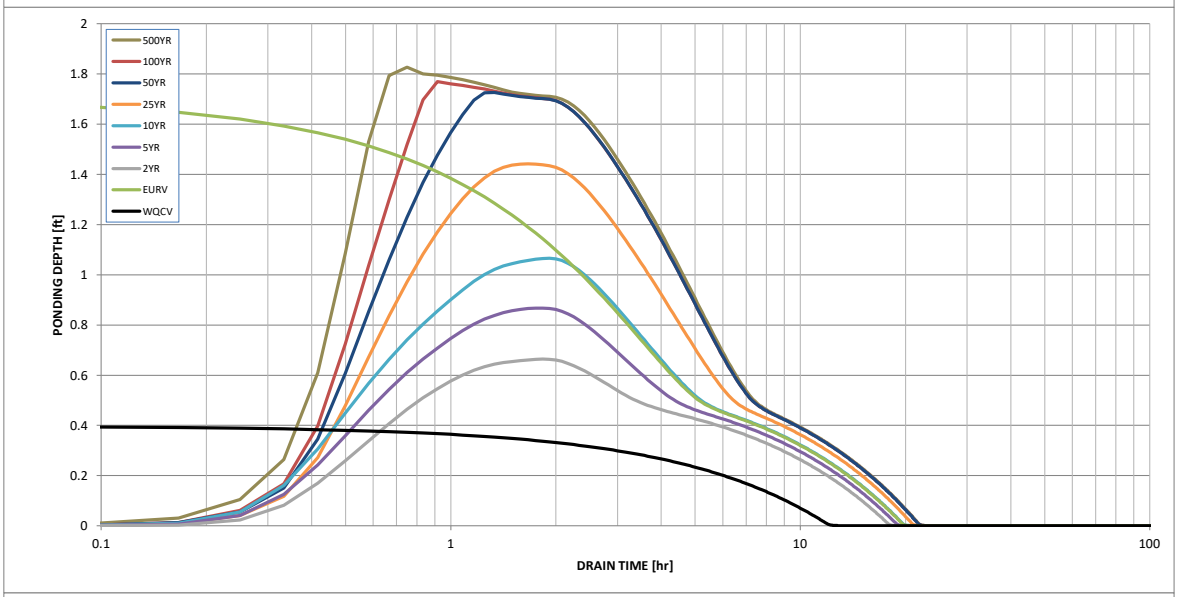
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

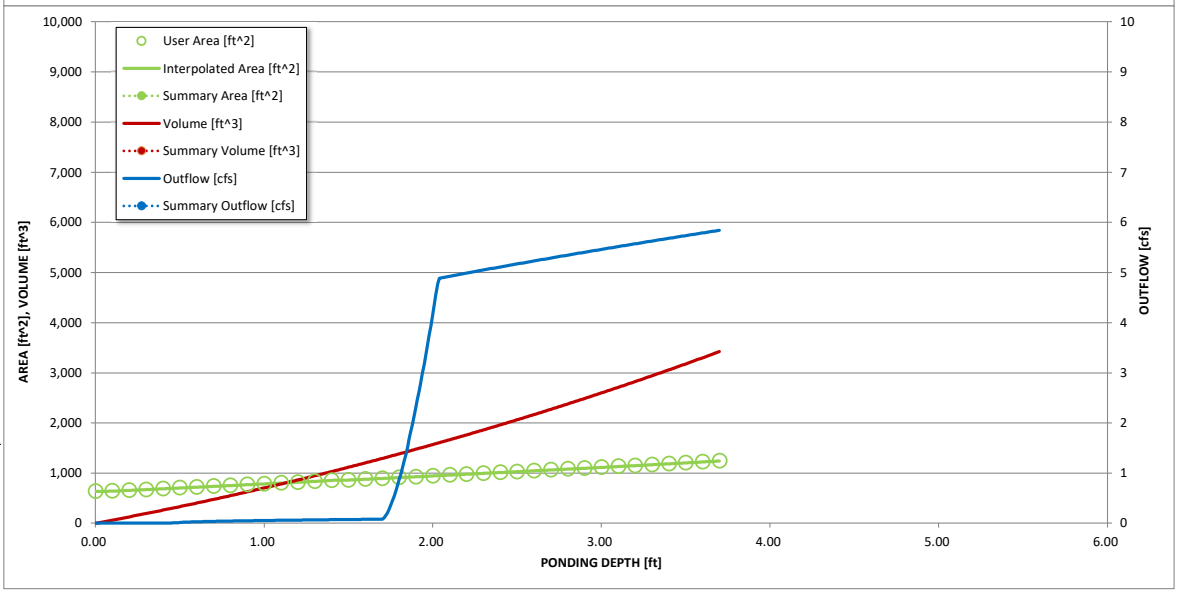
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.84	1.12	1.37	1.75	2.08	2.43	3.35
CUHP Runoff Volume (acre-ft) =	0.006	0.030	0.014	0.020	0.025	0.033	0.043	0.054	0.083
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.014	0.020	0.025	0.033	0.043	0.054	0.083
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.0	0.0	0.1	0.2	0.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.12	0.20	0.32	0.60	0.80	1.07	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.29	0.49	0.78	1.46	1.95	2.61	1.12
Peak Inflow Q (cfs) =	N/A	N/A	0.2	0.3	0.3	0.5	0.7	0.9	1.3
Peak Outflow Q (cfs) =	0.01	0.08	0.04	0.049	0.06	0.07	0.18	0.52	1.18
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.24	0.18	0.12	0.22	0.49	2.6
Structure Controlling Flow =	Filtration Media	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir
Max Velocity through Grate 1 (fps) =	N/A	0.01	N/A	N/A	N/A	N/A	0.0	0.0	0.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	12	18	17	18	18	19	19	19	17
Time to Drain 99% of Inflow Volume (hours) =	**12**	19	18	19	19	21	21	21	20
Maximum Ponding Depth (ft) =	0.40	1.72	0.66	0.87	1.07	1.44	1.72	1.77	1.83
Area at Maximum Ponding Depth (acres) =	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Maximum Volume Stored (acre-ft) =	0.006	0.030	0.010	0.014	0.017	0.024	0.030	0.031	0.032

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

APPENDIX F: HYDRAULIC COMPUTATIONS

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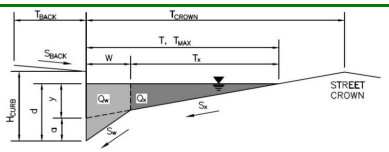
ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: **Carbajal Auto Dealership**
Inlet ID: **Design Point A**



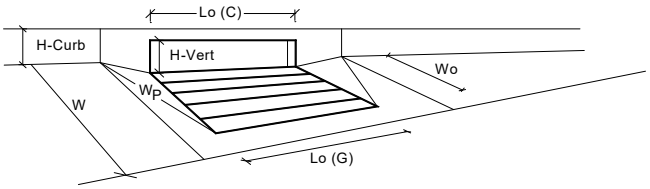
Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.016	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	25.6	25.6	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

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

INLET IN A SUMP OR SAG LOCATION

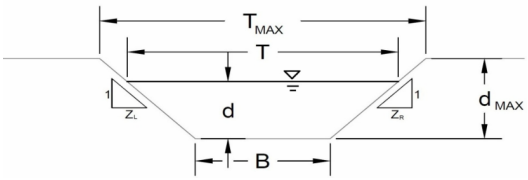
MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	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	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
Open Area 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
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**5.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.6	1.6	cfs

AREA INLET IN A SWALE

Carbajal Auto Dealership
Design Point B



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)	A, B, C, D, or E =		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.030	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	10.30	ft/ft
Right Side Sloe	Z2 =	80.65	ft/ft

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**37.56**	**37.56**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.40**	**0.40**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**17.5**	**17.5**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**0.40**	**0.40**	**ft**

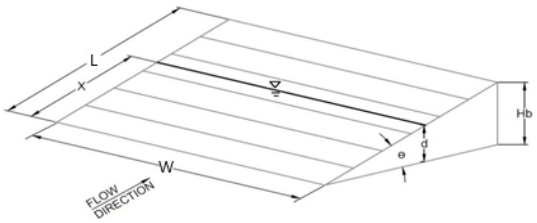
Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.1**	**0.4**	**cfs**
Water Depth	**d** =	**0.04**	**0.10**	**ft**

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'

Inlet Design Information (Input)

Type of Inlet: User-Defined — Inlet Type = User-Defined

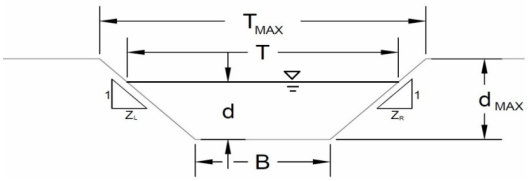


Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00 degrees
Width of Grate	W =	1.73 ft
Length of Grate	L =	3.00 ft
Open Area Ratio	A_{RATIO} =	0.43
Height of Inclined Grate	H_B =	0.00 ft
Clogging Factor	C_f =	0.50
Grate Discharge Coefficient	C_d =	N/A
Orifice Coefficient	C_o =	0.60
Weir Coefficient	C_w =	3.30

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.04	0.10	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**0.2**	**0.5**	**cfs**
Bypassed Flow	Q_b =	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C%** =	**100**	**100**	**%**

AREA INLET IN A SWALE

Carbajal Auto Dealership
Design Point D



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)	A, B, C, D, or E =		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.013	
Channel Invert Slope	S_O =	0.0100	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	5.78	ft/ft
Right Side Sloe	Z2 =	3.12	ft/ft

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

Choose One:
- ○ Non-Cohesive
- ○ Cohesive
- ◉ Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**2.14**	**2.14**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.24**	**0.24**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Top Width Criterion	Q_{allow} =	**0.7**	**0.7**	**cfs**
MAJOR STORM Allowable Capacity is based on Top Width Criterion	d_{allow} =	**0.24**	**0.24**	**ft**

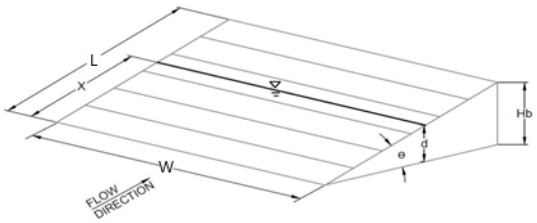
Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.0**	**0.2**	**cfs**
Water Depth	**d** =	**0.06**	**0.16**	**ft**

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'

Inlet Design Information (Input)

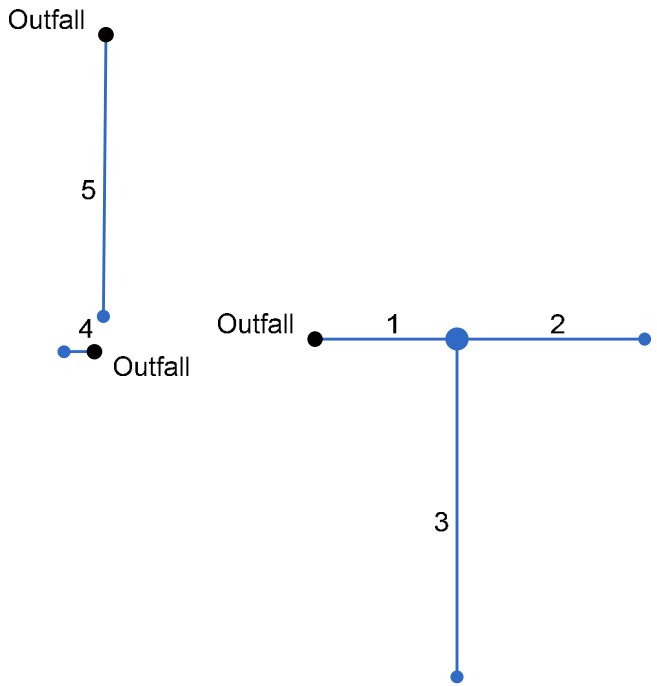
Type of Inlet: User-Defined — Inlet Type = User-Defined



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00 degrees
Width of Grate	W =	1.73 ft
Length of Grate	L =	3.00 ft
Open Area Ratio	A_{RATIO} =	0.43
Height of Inclined Grate	H_B =	0.00 ft
Clogging Factor	C_f =	0.50
Grate Discharge Coefficient	C_d =	N/A
Orifice Coefficient	C_o =	0.60
Weir Coefficient	C_w =	3.30

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.06	0.16	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**0.3**	**1.1**	**cfs**
Bypassed Flow	Q_b =	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C%** =	**100**	**100**	**%**

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: 5-yr.stm	Number of lines: 5	Date: 11/7/2023

Storm Sewer Tabulation

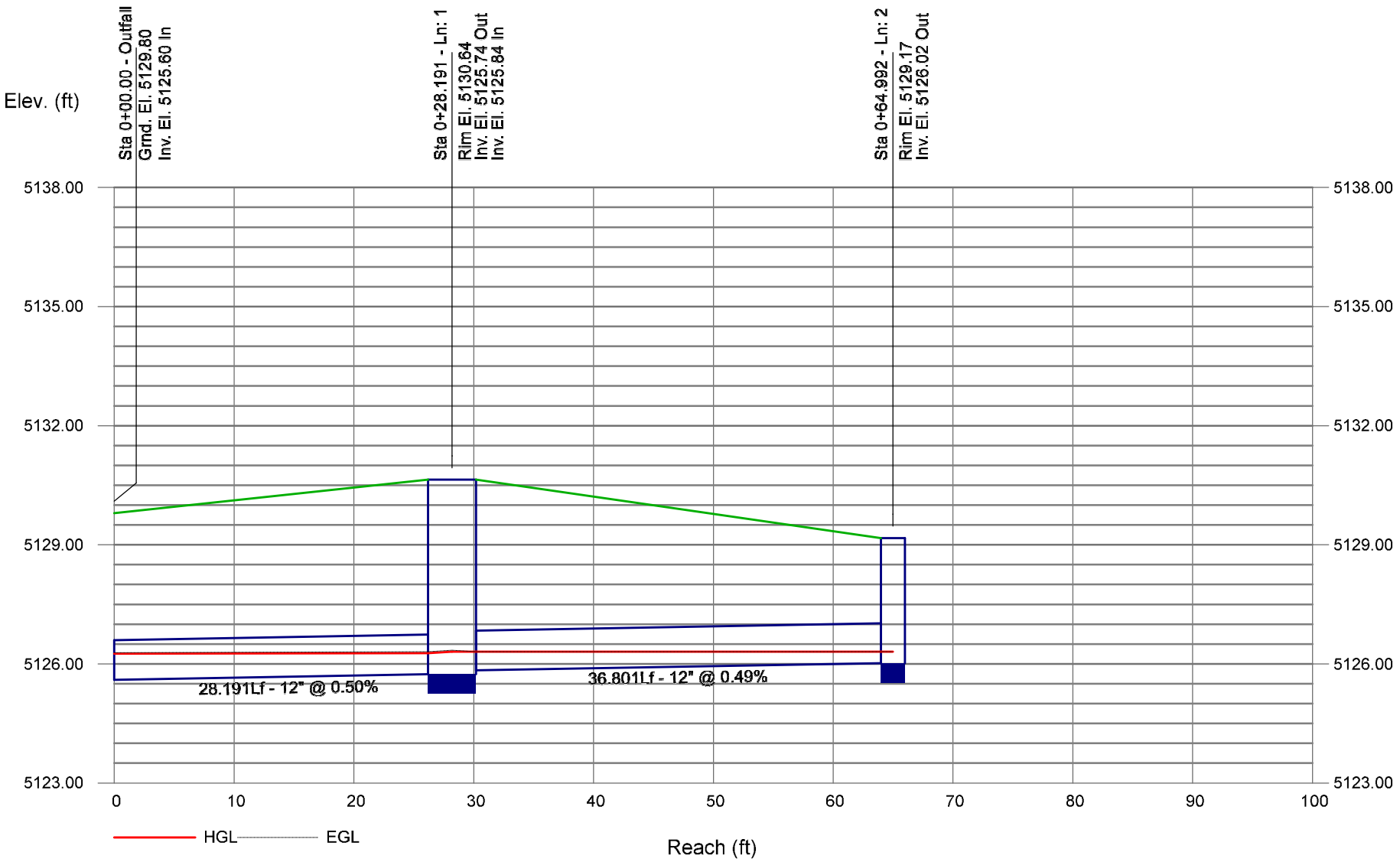
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	28.191	0.00	0.00	0.00	0.00	0.00	0.0	3.0	0.0	0.65	2.51	1.37	12	0.50	5125.60	5125.74	5126.26	5126.27	5129.80	5130.64	SD3
2	1	36.801	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.05	2.49	0.21	12	0.49	5125.84	5126.02	5126.31	5126.31	5130.64	5129.17	SD2
3	1	66.929	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.60	2.54	2.20	12	0.51	5125.84	5126.18	5126.31	5126.50	5130.64	5129.44	SD1
4	End	5.848	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.02	2.54	0.04	12	0.51	5125.60	5125.63	5126.26	5126.26	5129.80	5128.25	SD4
5	End	55.744	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.05	12.50	0.78	18	1.42	5122.68	5123.47	5122.95	5123.55	5128.71	5127.30	SD5

Project File: 5-yr.stm | Number of lines: 5 | Run Date: 11/7/2023

NOTES:Known Qs only ; c = cir e = ellip b = box

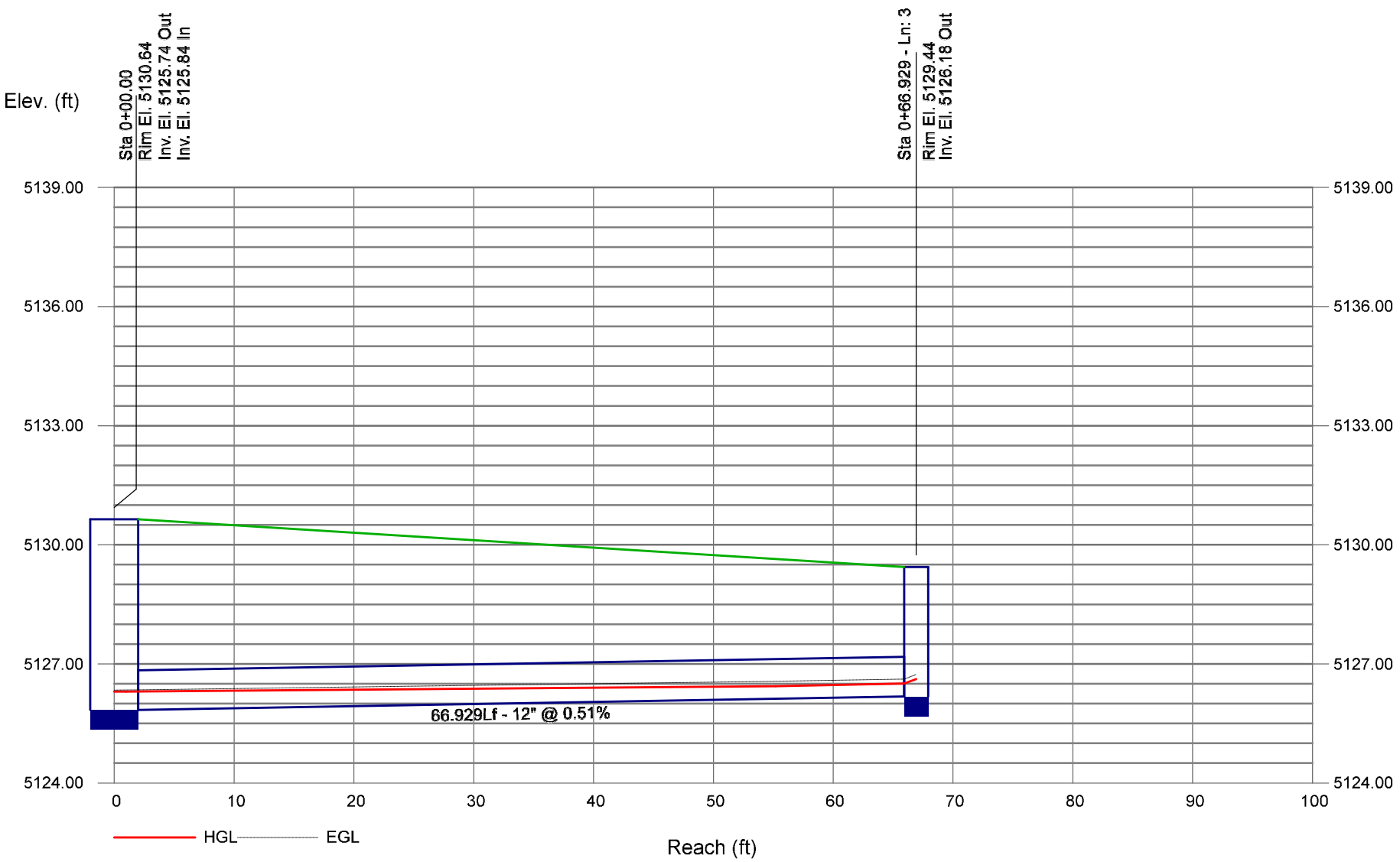
Storm Sewer Profile

Proj. file: 5-yr.stm



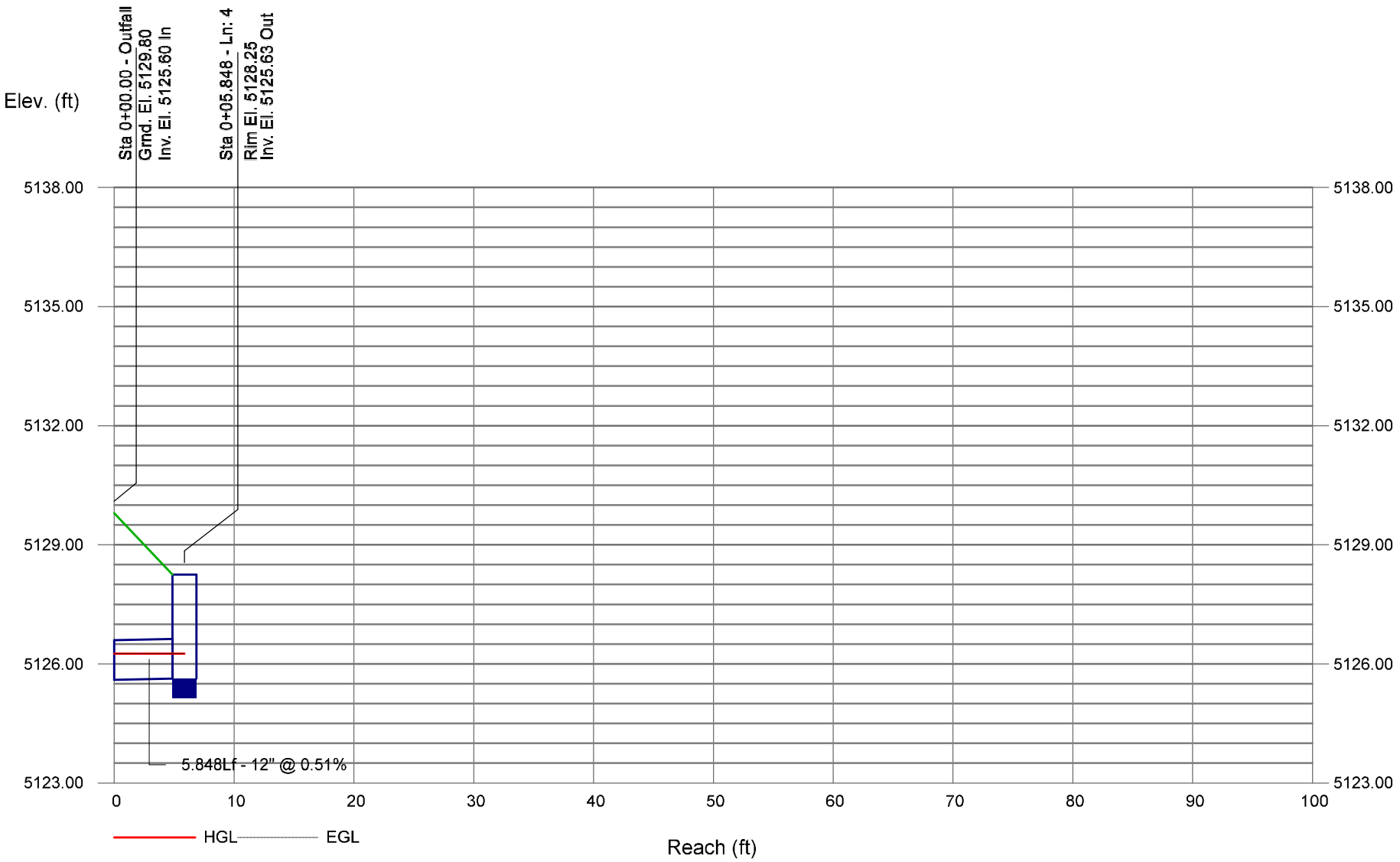
Storm Sewer Profile

Proj. file: 5-yr.stm



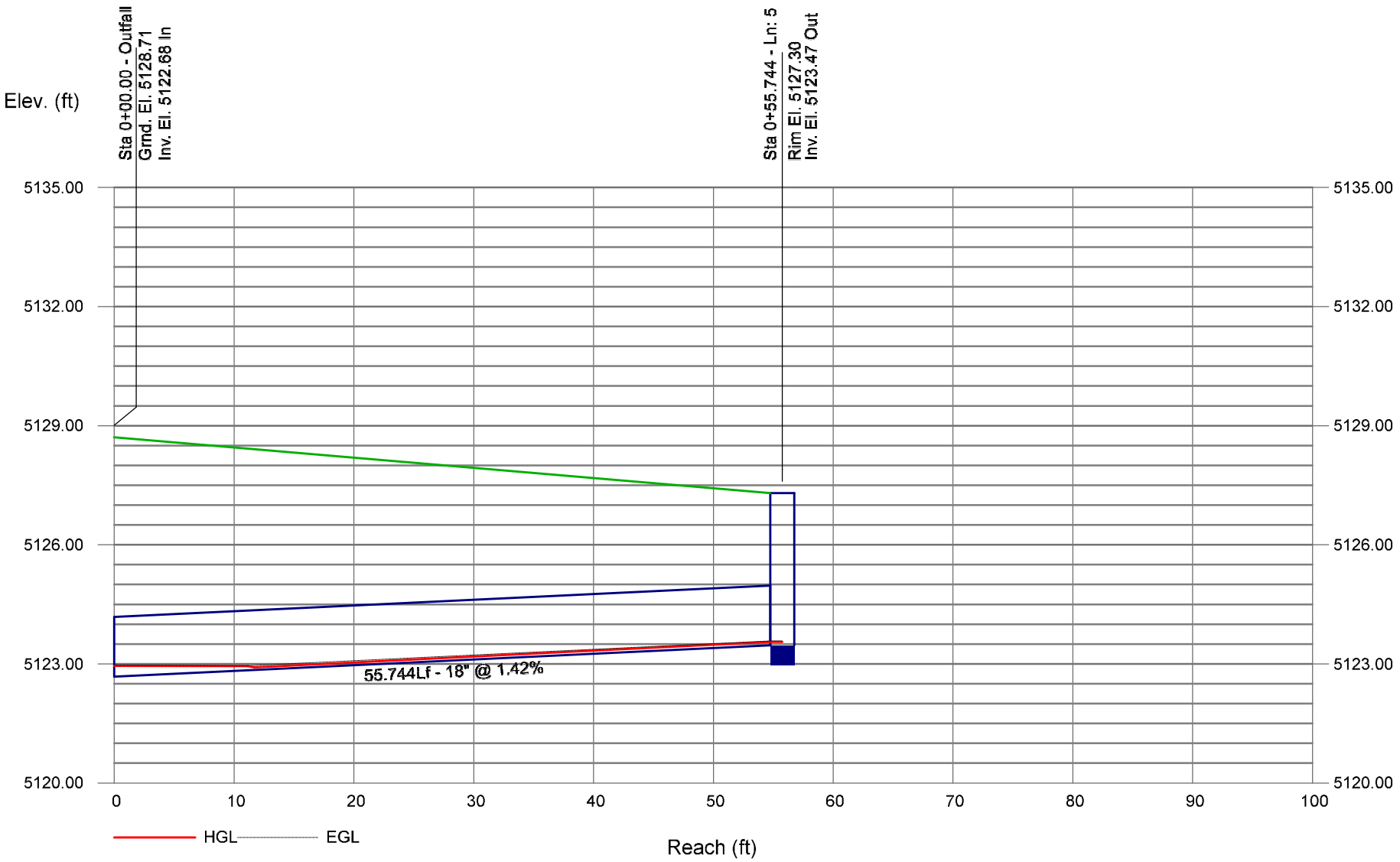
Storm Sewer Profile

Proj. file: 5-yr.stm



Storm Sewer Profile

Proj. file: 5-yr.stm



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	28.191	0.00	0.00	0.00	0.00	0.00	0.0	1.2	0.0	1.96	2.51	2.50	12	0.50	5125.60	5125.74	5127.93	5128.02	5129.80	5130.64	SD3
2	1	36.801	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.41	2.49	0.52	12	0.49	5125.84	5126.02	5128.11	5128.12	5130.64	5129.17	SD2
3	1	66.929	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	1.55	2.54	1.97	12	0.51	5125.84	5126.18	5128.11	5128.24	5130.64	5129.44	SD1
4	End	5.848	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.22	2.54	0.28	12	0.51	5125.60	5125.63	5127.93	5127.93	5129.80	5128.25	SD4
5	End	55.744	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.52	12.50	2.42	18	1.42	5122.68	5123.47	5122.95	5123.74	5128.71	5127.30	SD5

Project File: 100-yr.stm

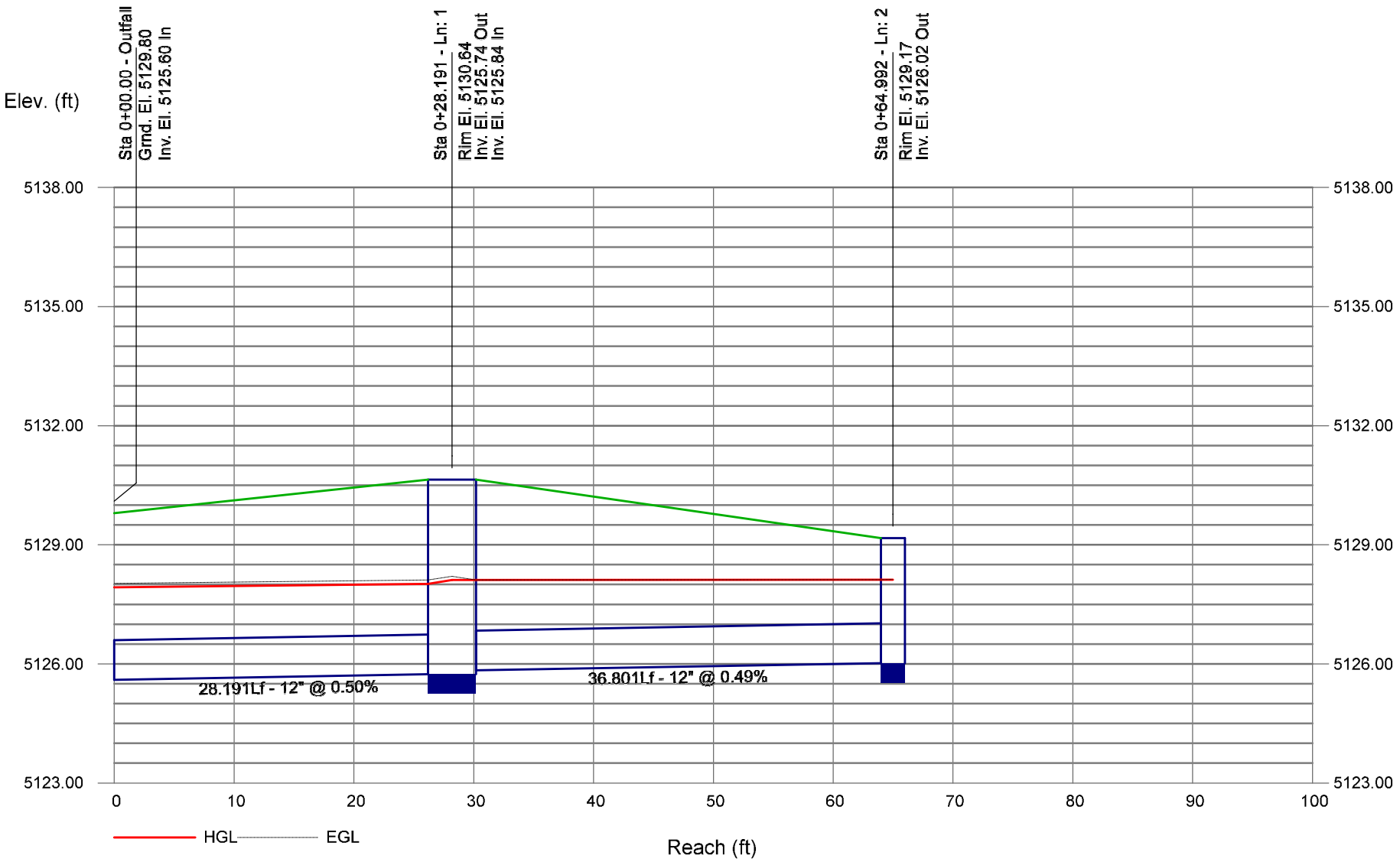
Number of lines: 5

Run Date: 11/7/2023

NOTES:Known Qs only ; c = cir e = ellip b = box

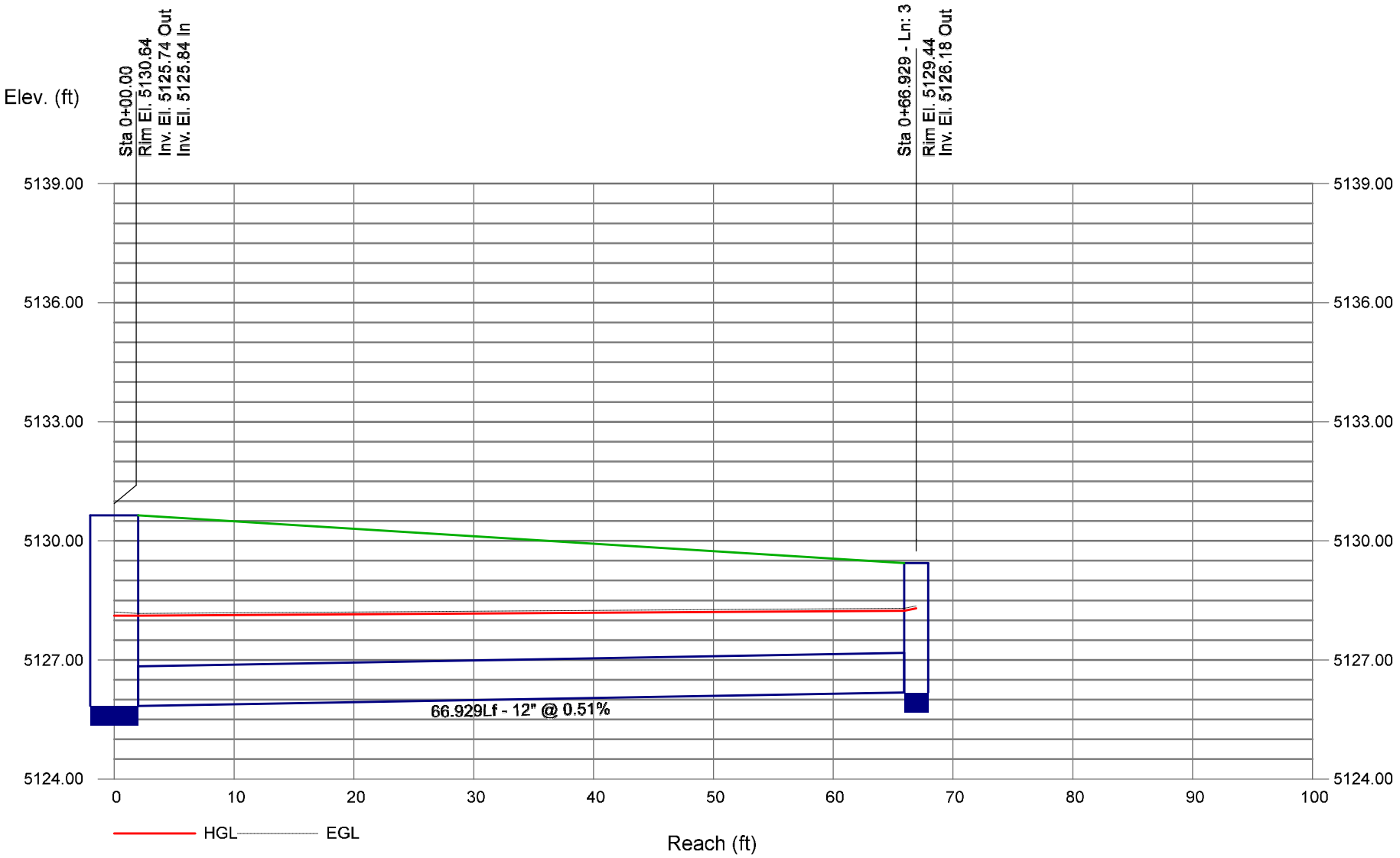
Storm Sewer Profile

Proj. file: 100-yr.stm



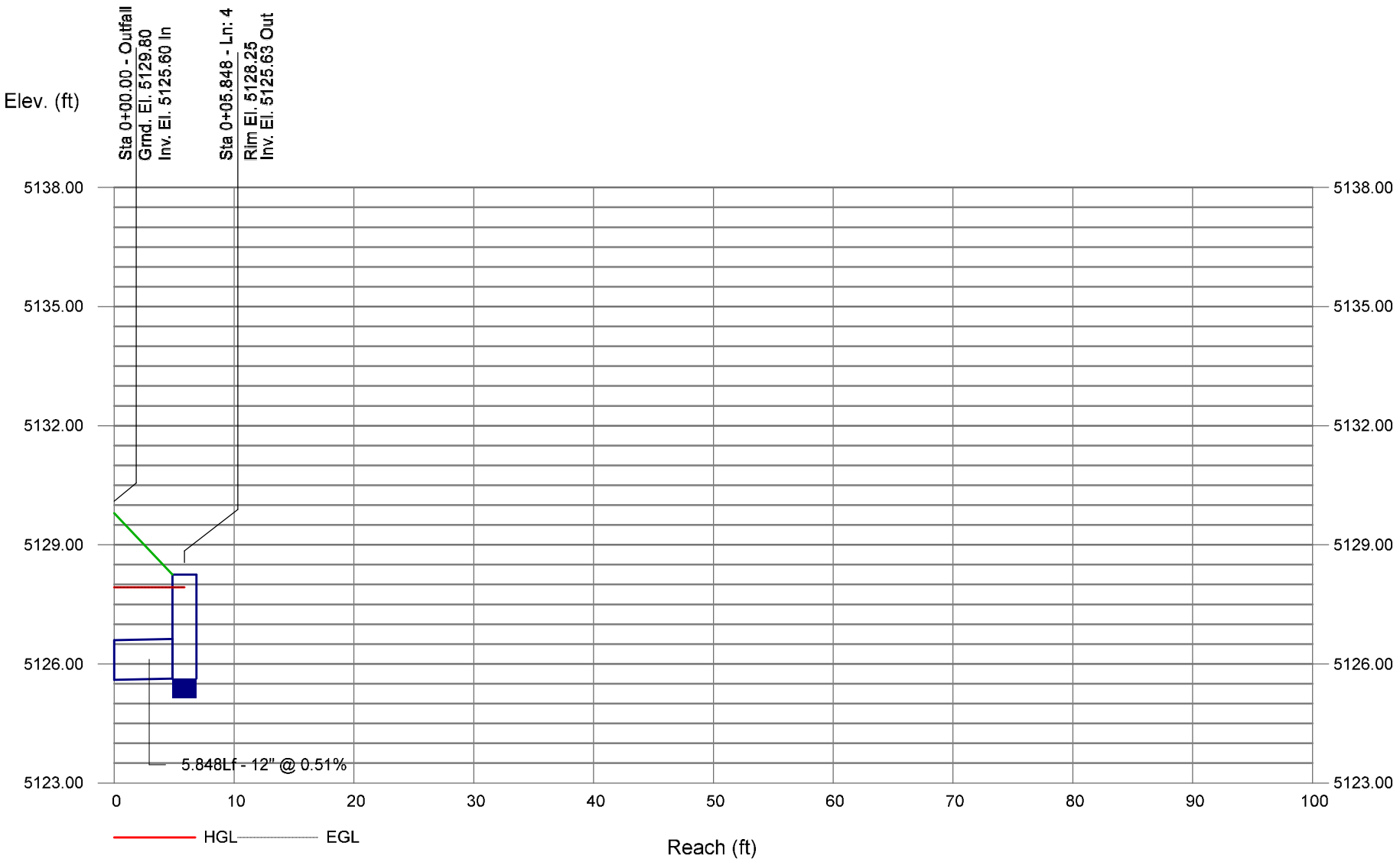
Storm Sewer Profile

Proj. file: 100-yr.stm



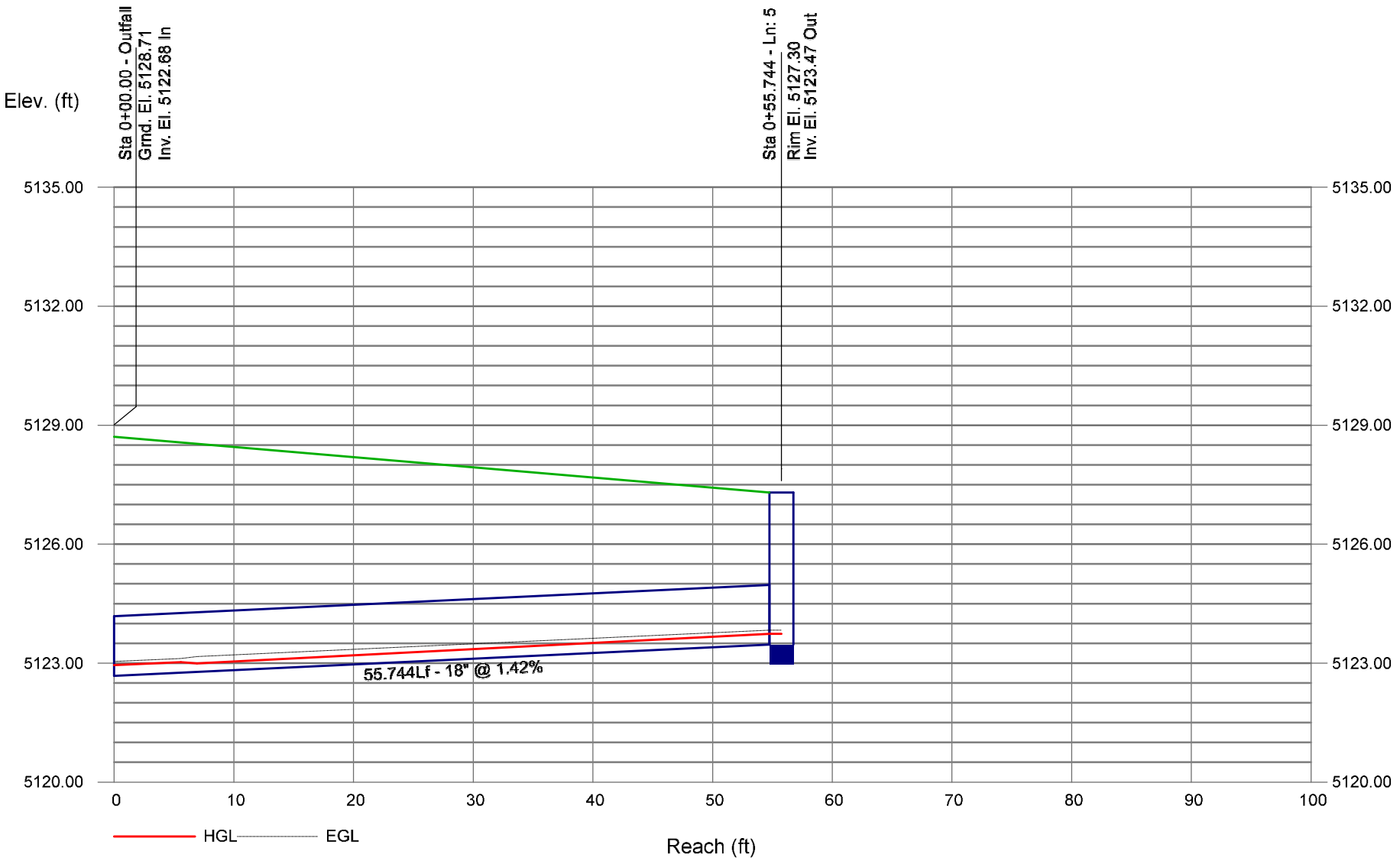
Storm Sewer Profile

Proj. file: 100-yr.stm



Storm Sewer Profile

Proj. file: 100-yr.stm



APPENDIX G: OPEN CHANNEL FLOW COMPUTATIONS

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Nov 7 2023

Curb Cut D4

Rectangular

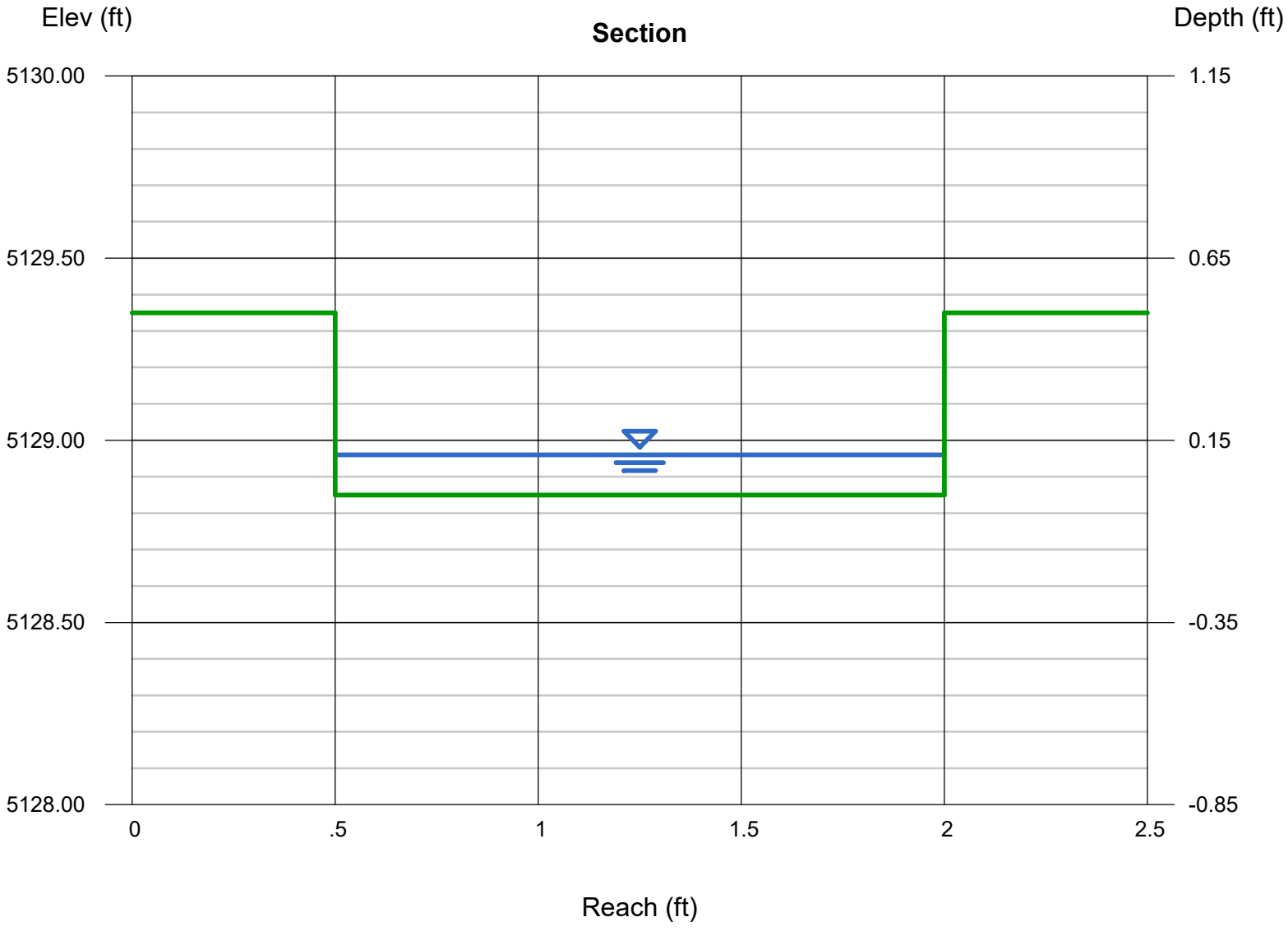
Bottom Width (ft)	= 1.50
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 5128.85
Slope (%)	= 3.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.61

Highlighted

Depth (ft)	= 0.11
Q (cfs)	= 0.610
Area (sqft)	= 0.17
Velocity (ft/s)	= 3.70
Wetted Perim (ft)	= 1.72
Crit Depth, Yc (ft)	= 0.18
Top Width (ft)	= 1.50
EGL (ft)	= 0.32



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Nov 7 2023

Pond Emergency Overflow Sidewalk Chase

Rectangular

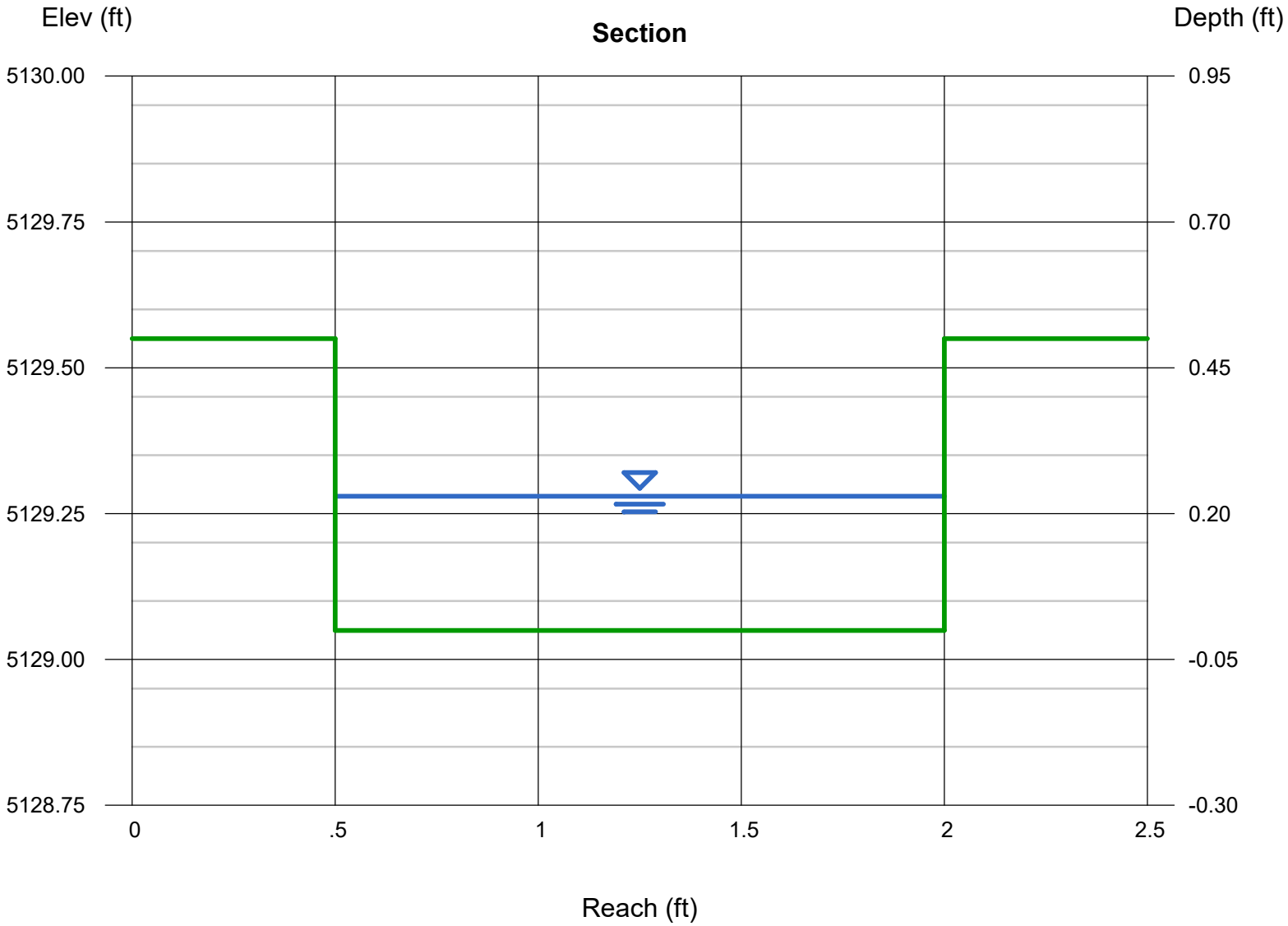
Bottom Width (ft)	= 1.50
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 5129.05
Slope (%)	= 5.23
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.79

Highlighted

Depth (ft)	= 0.23
Q (cfs)	= 2.790
Area (sqft)	= 0.35
Velocity (ft/s)	= 8.09
Wetted Perim (ft)	= 1.96
Crit Depth, Yc (ft)	= 0.48
Top Width (ft)	= 1.50
EGL (ft)	= 1.25



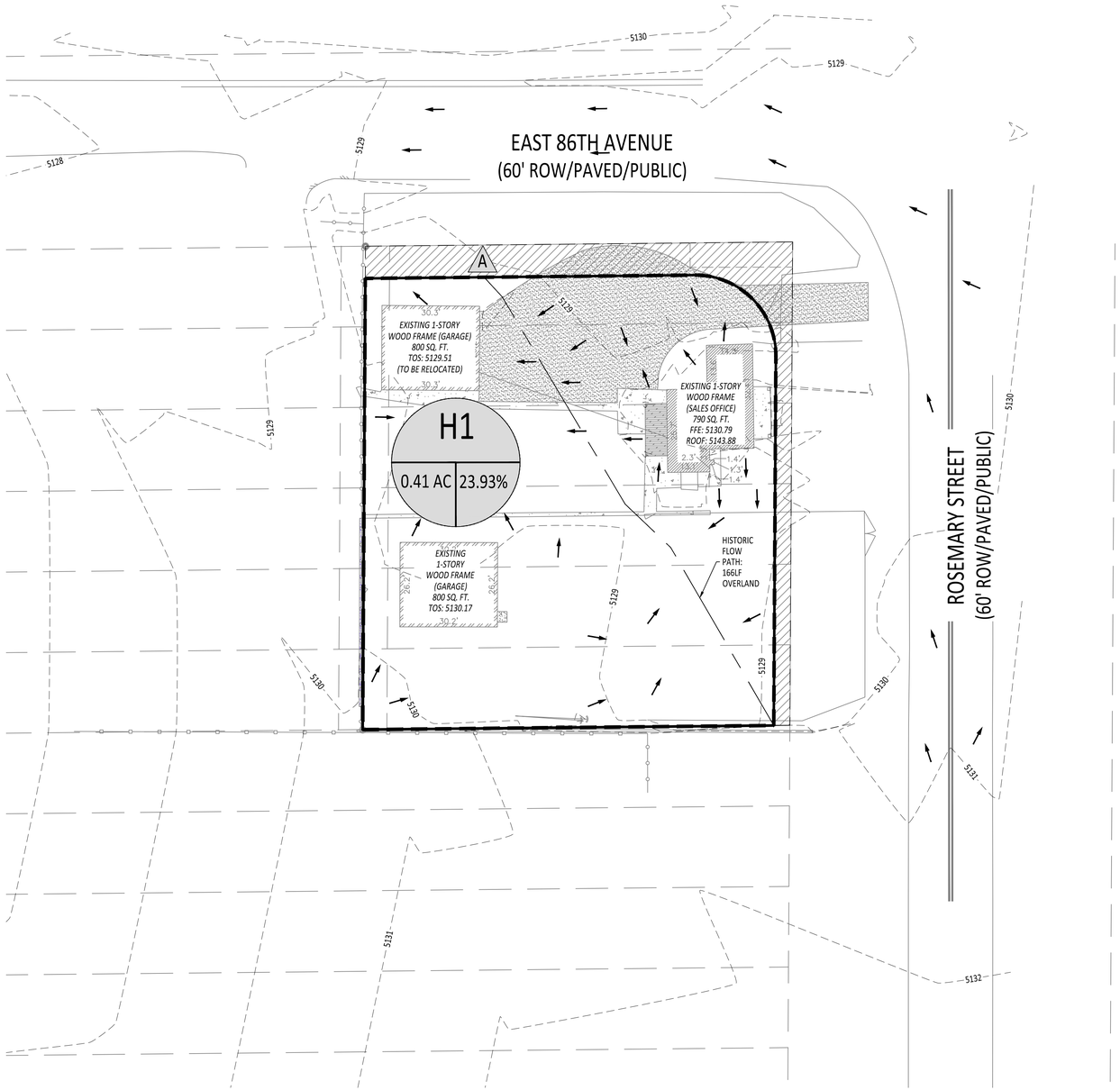
APPENDIX H: DRAINAGE PLANS

8620 Wolff Ct, Suite 250
Westminster, CO 80031
720.774.7736
www.raptor-civil.com

CARBAJAL AUTO DEALERSHIP

DRAINAGE PLANS

LOCATED IN THE NORTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 SOUTH, RANGE 67 WEST OF THE 6TH P.M.
CITY OF COMMERCE CITY, COUNTY OF ADAMS, STATE OF COLORADO
ADDRESS: 8581 ROSEMARY ST, COMMERCE CITY, CO, 80022



Historic Summary Runoff Table				
Design Point	**Contributing Basin (sf)**	**Contributing Area (acres)**	**5 year Runoff (cfs)**	**100 year Runoff (cfs)**
A	H1	0.41	0.20	1.07

DRAINAGE NOTES:
REFER TO DRAINAGE REPORT PREPARED BY RAPTOR CIVIL ENGINEERING FOR THIS PROJECT FOR ALL STORM SYSTEM CALCULATIONS.

NORTH

0' 10' 20' 40'
SCALE: 1"=20'

LEGEND:
- PROPERTY LINE
- ROW DEDICATION
- EXISTING CONTOUR

DRAINAGE LEGEND:
- BASIN BOUNDARY LINE
- A = BASIN DESIGNATION (A / B = AREA IN ACRES / I = % IMPERVIOUSNESS)
- BASIN FLOW ARROW
- D = DESIGN POINT DESIGNATION

RAPTOR
CIVIL ENGINEERING
WORK@RAPTOR-CIVIL.COM
WWW.RAPTOR-CIVIL.COM
720-774-7736

CARBAJAL AUTO DEALERSHIP
DRAINAGE PLANS
CITY OF COMMERCE CITY, COUNTY OF ADAMS, STATE OF COLORADO

22-37

FOR CONSTRUCTION

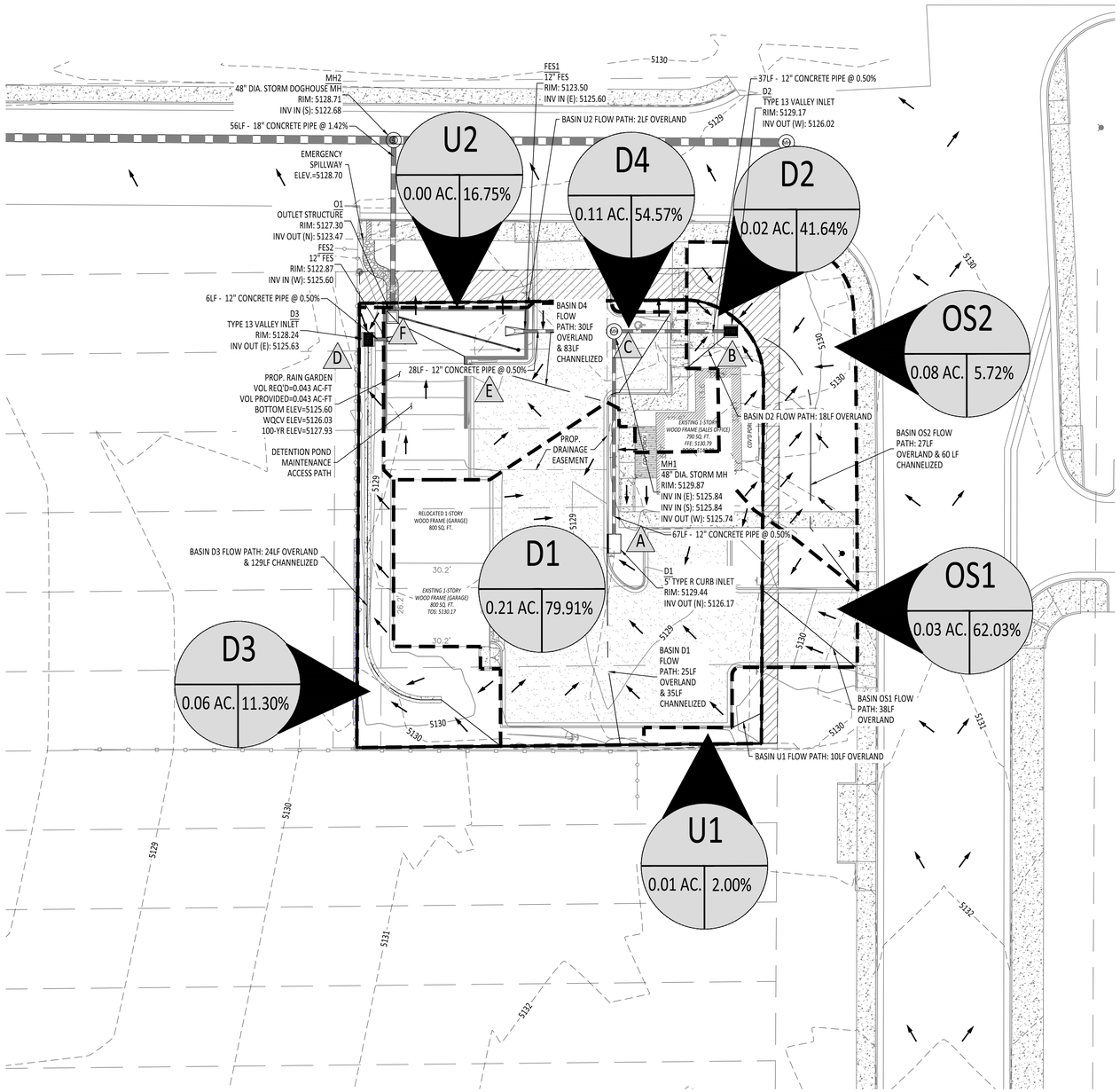
REVISION BLOCK		
#	DATE	BY

HISTORIC DRAINAGE PLAN
1

CARBAJAL AUTO DEALERSHIP

DRAINAGE PLANS

LOCATED IN THE NORTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 SOUTH, RANGE 67 WEST OF THE 6TH P.M.
CITY OF COMMERCE CITY, COUNTY OF ADAMS, STATE OF COLORADO
ADDRESS: 8581 ROSEMARY ST, COMMERCE CITY, CO, 80022



Developed Summary Runoff Table				
Design Point	**Contributing Basin (s)**	**Contributing Area (acres)**	**5 year Runoff (cfs)**	**100 year Runoff (cfs)**
A	D1,OS1	0.23	0.60	1.55
B	D2,OS2	0.10	0.05	0.41
C	D1,D2,OS1,OS2	0.33	0.65	1.97
D	D3	0.06	0.02	0.22
E	D4	0.11	0.19	0.61
F	D1,D2,D3,D4,OS1,OS2	0.49	0.87	2.79

DRAINAGE NOTES:
REFER TO DRAINAGE REPORT PREPARED BY RAPTOR CIVIL ENGINEERING FOR THIS PROJECT FOR ALL STORM SYSTEM CALCULATIONS.

NORTH

0' 10' 20' 40'

SCALE: 1"=20'

LEGEND:

- PROPERTY LINE
- ASPHALT
- CONCRETE
- RETAINING WALL
- FENCE
- EXISTING CONTOUR
- PROPOSED CONTOUR

DRAINAGE LEGEND:

- BASIN BOUNDARY LINE
- A = BASIN DESIGNATION
  B = AREA IN ACRES
  I = % IMPERVIOUSNESS
- BASIN FLOW ARROW
- D = DESIGN POINT DESIGNATION

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CITY OF COMMERCE CITY, COUNTY OF ADAMS, STATE OF COLORADO

22-37

FOR CONSTRUCTION

REVISION BLOCK

#	DATE	BY

DEVELOPED DRAINAGE PLAN
2

SHEET 2 OF 2