

DRAINAGE REPORT

FOR

CASTLE ROCK COLLECTIVE

**LOT 2A-3A, BLOCK 3, THE MEADOWS FILING NO. 20,
PHASE 1 – AMENDMENT NO. 16**

Prepared for:

CASTLE PARK PROPERTIES, LLC.
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Submittal Date
08/28/2025

RLEG NO. 250305

Engineer's Statement:

I affirm that this report and plan for the Phase III drainage design of the Castle Rock Collective, Meadows Town Center, Lot 2A-3A, Block 3, The Meadows Filing No. 20 Phase 1 – Amendment No. 16, Town of Castle Rock, Colorado was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Castle Rock Drainage Design and Technical Criteria for the owners thereof. I understand that the Town of Castle Rock does not and will not assume liability for drainage facilities designed by others.

Kurt A, Lang, P.E.

PE No. 32249

Owner/Developer's Statement:

Castle Park Properties, LLC. hereby certifies that the drainage facilities for the Castle Rock Collective, Meadows Town Center, Lot 2A-3A, Block 3, The Meadows Filing No. 20 Phase 1 – Amendment No. 16, Town of Castle Rock, Colorado shall be constructed according to the design presented in this report. I understand that the Town of Castle Rock does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the Town of Castle Rock reviews drainage plans pursuant to the Municipal Code; but cannot, on behalf of Castle Rock Collective, Meadows Town Center, Lot 2A-3A, Block 3, The Meadows Filing No. 20 Phase 1 – Amendment No. 16, Town of Castle Rock, Colorado, guarantee that final drainage design review will absolve Castle Park Properties, LLC. and/or their successors and/or assigns of future liability for improper design.

Owner/Applicant

Date

Town of Castle Rock Approvals:

Engineering Division

Date

Development Services

Date

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I. GENERAL LOCATION AND DESCRIPTION

A. LOCATION

The Castle Rock Collective project, hereafter referred to as the Project, will be located on a parcel of land being a part of Lot 2A-3A, Block 3 of The Meadows Filing No. 20, Phase 1, Amendment No. 16 in the northeast quarter of Section 33, Township 7 South, Range 67 West of the 6th Principle Meridian, Town of Castle Rock, County of Douglas and State of Colorado. Meadows Parkway is adjacent to the southern boundary of the property, Bilberry Street exists to the west and Future Street to the east. Ubergrippen Indoor Climbing Crag exists to the north of the Project. A drive lane access to the site exists off Bilberry Street located off the northwest corner of the Project. This private drive lane is shared with the Ubergrippen to the north. Please refer to the vicinity map in Appendix E.

B. DESCRIPTION OF PROPERTY AND PROPOSED LAND USE

Currently, the boundaries of the parcel of land that the project site is located on (Lot 2A-3A, Block 3) is 1.618 acres (70,459 sq. ft.) and is undeveloped. The parcel of land that the project is situated on Lot 2A-3A, Block 3, has current existing topography slopes of approximately 3 percent falling from the southeast to the northwest. The Project proposes a 9,450 square-foot (0.22-acres) facility, a parking lot area and surrounding landscaped areas. Utility improvements will also take place throughout the site.

i. SCS Soil Group:

According to the U.S. Department of Agriculture Soil Conservation Service, the soil is made up of Bresser Sandy Loam (BrB), classified as hydrologic soil group “B”.

The National Cooperative Soil Survey Map outlines 100% of the site as Type B Bresser Sandy Loam soil. Type B soil type coefficients was used in hydrologic computations. Please refer to Appendix A for The National Cooperative Soil Survey Map for the Project.

ii. Irrigation facilities

There are no known irrigation facilities present on the site or near the project boundary.

II. DRAINAGE BASIN DESCRIPTION

Basin OS2 (0.090-acres) consists of concrete sidewalk and landscape area. Runoff for this basin is 0.10 cfs for the 5-year storm and 0.45 cfs for the 100-year storm. Runoff will flow offsite and into the existing curb and gutter of Bilberry Street where it will then be collected by existing inlets. This is an existing basin and flow path that will not be changed by the Project.

Basin OS1 (0.473-acres) consists of an off-site area that consists of landscaped and existing sidewalk that leads to the entrance of an existing pedestrian underpass underneath Meadows Blvd. Runoff for this basin is 0.30 cfs for the 5-year storm and 1.47 cfs for the 100-year storm. Runoff flows to the base of the existing pedestrian underpass underneath Meadows Blvd, across the concrete base of the underpass, to the other side of Meadows Blvd. at DP 3. From here, the runoff flows through a swale to the northwest where it is collected by an 18-inch FES located at DP 2.

Basin C (0.18-acres) consists of the building rooftop runoff. Runoff for this basin is 0.65 cfs for the 5-year storm and 1.34 cfs for the 100-year storm. Runoff will be collected via roof downspouts and transmitted underground via 6-inch PVC pipe to the existing manhole at DP 2.

Basin B (0.42-acres) consists of existing concrete sidewalk and landscaped area northeast of the building and parking lot. Runoff for this basin is 0.42 cfs for the 5-year storm and 1.67 cfs for the 100-year storm. Runoff from Basin OS1 will flow out of the existing concrete underpass and flow via swale across this basin. Runoff from Basin OS1 and B will be collected by an 18-inch FES located at DP 2. From here, this runoff will be conveyed via proposed and existing 18-inch RCP pipes to an existing 6-foot diameter manhole.

Basin A (0.92-acres) consists of a paved asphalt parking lot, concrete sidewalks and accessible parking, and a landscape island. Runoff for this basin is 3.34 cfs for the 5-year storm and 6.51 cfs for the 100-year storm. Runoff will sheet flow to the northwest where it will be conveyed via curb and gutter and then collected by an existing Type R inlet located at DP 1.

The 100-yr and 5-yr HGL's of the proposed pipe network system are designed to match the HGL elevations within the existing RCP pipe system located on the northwest side of the Project.

Detention and water quality is accounted for in the previously approved drainage report *Addendum No. 1 to The Meadows, Filing 20, Phase III, Drainage Report, including Filing 20, Phase I, Amendment 2, Block 2, Lot 1A and Block 3, Lot 1A, prepared by CVL Consultants of Colorado, May 15, 2008* (Appendix G). The report determined the volume of the Filing 20 regional detention pond for the Project as part of the original basin C15, which was originally designed to be a commercial development with a composite impervious value of 95%. The proposed composite imperviousness of the Project is less at 45.51%. Therefore, the pond has been oversized to account for any major storm occurring on the Project site. Runoff from the site is conveyed via an 84-inch RCP storm pipe that flows north to the Filing 20 regional detention pond. The pond has been designed to provide water quality treatment and detention for the major storm for the proposed Project. No additional improvements were proposed for water quality or detention for the Project on-site.

III. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

This report was prepared using the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual revised February 2025 and the Mile High Flood District's Urban Storm Drainage Criteria Manual revised March 2024.

B. DRAINAGE STUDIES, MASTER PLANS, SITE CONSTRAINTS

There are no studies or plans that constrain the site other than the existing report discuss in section IV.

C. HYDROLOGICAL CRITERIA

Since the site is less than 160 acres, the Rational Method was used to calculate all storm water runoff as opposed to the Colorado Urban Hydrograph Procedure. The intensity-frequency curves used in the Rational Method calculations were taken from the Town of Castle Rock's Storm Drainage Design and

Technical Criteria Manual. The Town of Castle Rock Storm Drainage Design & Technical Criteria Manual defines the Project's 1-hour point rainfall as 1.43 inches for the 5-year event and 2.60 inches for the 100-year event. All drainage facilities were analyzed and designed for both the minor (5-year) and major (100-year) storm events. Time of concentration calculations were used to determine the rainfall intensity. These calculations can be found in Appendix C.

D. HYDRAULIC CRITERIA

Hydraulic computations were performed to determine the capacity of the storm system. The design discharge is based on the peak flow rate calculated using the Rational Method. All inlets were sized using UDFCD UD-Inlet software and found in Appendix D. HGL calculations were determined using Storm Sewers for AutoCAD Civil 3D. These calculations can be found in Appendix D.

E. WATER QUALITY ENHANCEMENT

There is no water quality proposed for the Project due to the existing regional water quality pond located northwest of the Project. See the pond exhibit and completed MS4 and WQ worksheet attached in Appendix E.

IV. DRAINAGE CONCEPT

The Castle Rock Collective project includes 1.62 acres of the previously approved original drainage basin C15, which contains the 1.62 acres of the Project site. (See *Addendum No. 1 to The Meadows, Filing 20, Phase III, Drainage Report, including Filing 20, Phase I, Amendment 2, Block 2, Lot 1A and Block 3, Lot 1A, prepared by CVL Consultants of Colorado, May 15, 2008* (Appendix G)). It was designed conservatively to be a commercial site with 95% total imperviousness.

The Flood Insurance Rate Map (FIRM) Community Panel Number 08035C0169G shows that the site is in Zone "X" which is classified as an area determined to be outside the 500-year floodplain, is provided in Appendix A.

An existing 84-inch RCP storm pipe with an existing 8-foot diameter manhole has been previously installed within the Bilberry Street right-of-way near the site entrance as part of previous construction for the Meadows Filing No. 20 Phase 1 improvements.

To model the HGL's for the storm network, we used the existing HGL elevations from the Record Drawings of the CDs by Roth Lang Engineering Group for 'The Meadows Ubergripen Project'. An exhibit of the CD sheet of the existing 5-foot diameter manhole is included in Appendix G. The 5-year and 100-year HGL values and calculations are provided in Appendix D of this report.

V. STORMWATER MANAGMENT FACILITY DESIGN

There are no stormwater management facilities proposed for the project.

This project and the stormwater management design complies with the Town of Castle Rock Storm Drainage Technical Criteria Manual.

Per the four step processes of water quality outlined in Section 14.1 of the Manual, the project follows these steps herein. Per the first step, runoff to the Regional Detention Pond Filing No. 20 is reduced by the addition of landscape islands within the parking lot and landscaped and grass lined zones along the perimeter of the property. Per the second step, full-spectrum detention has been provided and analyzed for the site per the previously approved report, 'Addendum No. 1 to the Filing 20 Phase III Drainage Report for the Meadows Filing No. 20 prepared by CVL Consultants and included in this report. Sections of the report outline detention for the site. Per the third step, there are no open channels or streams proposed with the Project. Per the fourth step, the development is a potential source of illicit or irregular discharges of pollutants outlined in the Manual and is intended to be a commercial development. Potential pollutant sources for any landscape area include chemicals, fertilizers, and herbicides. Potential pollutant sources for the parking lot area include windshield washer fluid, salt, and other common vehicle pollutant discharges. Some of the structural and nonstructural control measures to contain said pollutants are identified below.

Structural Control Measures:

- Permanent covering of outdoor storage areas
- Spill containment and control
- Proper sanitary sewer connections
- Provision of designated storage and material handling areas
- Provision of proper waste receptacles
- Grease Storage & Handling – Store grease only in leak-proof, watertight containers with secure lids. Place storage away from storm drains, inlets, or paved drainage paths. Post clear signage and train staff on proper grease handling. Clean up spills immediately using dry absorbents. Do not rinse grease spills into outside areas or storm drains.

Non-Structural Control Measures:

- General good housekeeping practices
- Preventative maintenance
- Recycling programs
- Spill prevention and response
- Employee “awareness” education and training.

VI. CONCLUSIONS

A. COMPLIANCE WITH STANDARDS

This report is in compliance with the standards set forth in the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual and the Urban Drainage Flood Control criteria manuals.

B. VARIANCES

There are no variances for the Project.

C. COMPLIANCE TO PREVIOUS REPORTS

The calculations presented in this report complies with the determinations as set forth in the drainage reports titled Addendum No. 1 to The Meadows, Filing 20, Phase III, Drainage Report, including Filing 20, Phase 1, Amendment 2, Block 2, Lot 1A and Block 3, Lot 1A.

This “Master Study” assumed a percent compositeness of 95% for the Project area. The percent imperviousness calculated herein is 45.5%. This is a substantial reduction from the “Master Study” assumption that results in a reduction of design flows to the existing storm system and the existing regional detention and water quality pond.

REFERENCES

Addendum No. 1 to The Meadows, Filing 20, Phase III, Drainage Report, including Filing 20, Phase I, Amendment 2, Block 2, Lot 1A and Block 3, Lot1A, prepared by CVL Consultants of Colorado, May 15, 2008.

Drainage Criteria Manual, Volume 1, 2 and 3, Mile High Flood District; February 2025.

Phase III Drainage Report for The Meadows Filing No. 20, by RG Consulting Engineers, Inc., Revised: October 2004

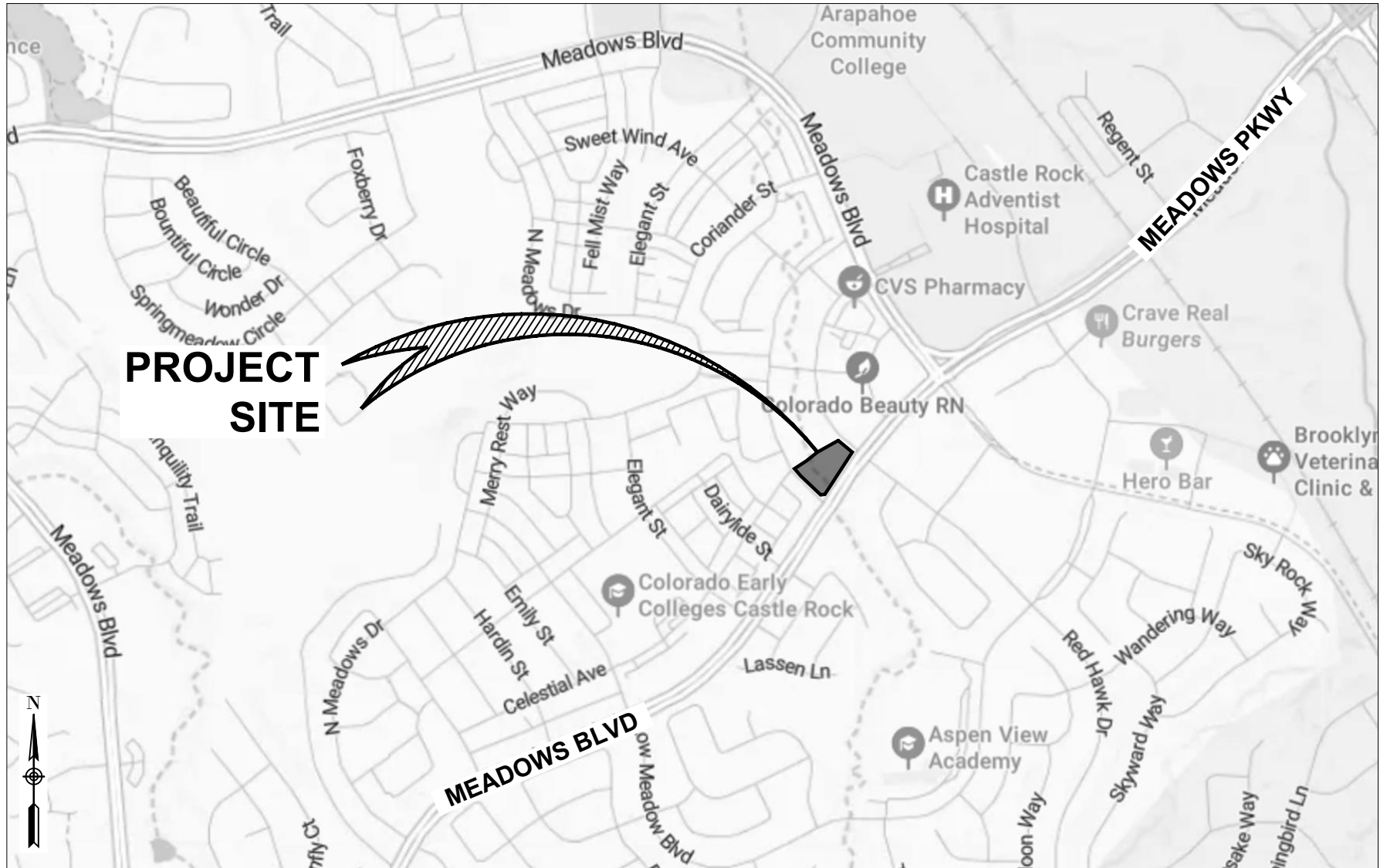
Town of Castle Rock Public Works Regulations, Town of Castle Rock, February 1999.

Town of Castle Rock Storm Drainage Design and Technical Criteria Manual, Town of Castle Rock, Revised March 2024.

Web Soil Survey of Castle Rock Area, Colorado, U.S. Department of Agriculture, Soil Conservation Service.

VICINITY MAP

SCALE: 1" = 1000'



Custom Soil Resource Report Soil Map



Custom Soil Resource Report

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot

 Sinkhole

 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot

 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

Water Features

 Streams and Canals

Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 16, Aug 24, 2023

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BrB	Bresser sandy loam, cool, 1 to 3 percent slopes	1.9	100.0%
Totals for Area of Interest		1.9	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.

Custom Soil Resource Report

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.

Castle Rock Area, Colorado

BrB—Bresser sandy loam, cool, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tlpj

Elevation: 5,500 to 6,500 feet

Mean annual precipitation: 15 to 19 inches

Mean annual air temperature: 48 to 52 degrees F

Frost-free period: 100 to 130 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Bresser, cool, and similar soils: 90 percent

Minor components: 10 percent

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

Description of Bresser, Cool

Setting

Landform: Hillslopes, terraces

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope, tread

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Tertiary aged alluvium derived from arkose

Typical profile

Ap - 0 to 5 inches: sandy loam

Bt1 - 5 to 8 inches: sandy loam

Bt2 - 8 to 27 inches: sandy clay loam

Bt3 - 27 to 36 inches: sandy loam

C - 36 to 80 inches: loamy coarse sand

Properties and qualities

Slope: 1 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

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

Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e

Land capability classification (nonirrigated): 4s

Hydrologic Soil Group: B

Ecological site: R049XB210CO - Sandy Foothill

Hydric soil rating: No

Minor Components

Truckton

Percent of map unit: 5 percent

Landform: Hillslopes, terraces

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope, tread

Down-slope shape: Linear

Across-slope shape: Linear

Ecological site: R049XB210CO - Sandy Foothill

Hydric soil rating: No

Sampson

Percent of map unit: 5 percent

Landform: Terraces, alluvial fans

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope, tread

Down-slope shape: Linear

Across-slope shape: Linear

Ecological site: R049XC202CO - Loamy Foothill 14-19 PZ

Hydric soil rating: No

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables shown on this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Floodway Data table shown on this FIRM.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2010.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

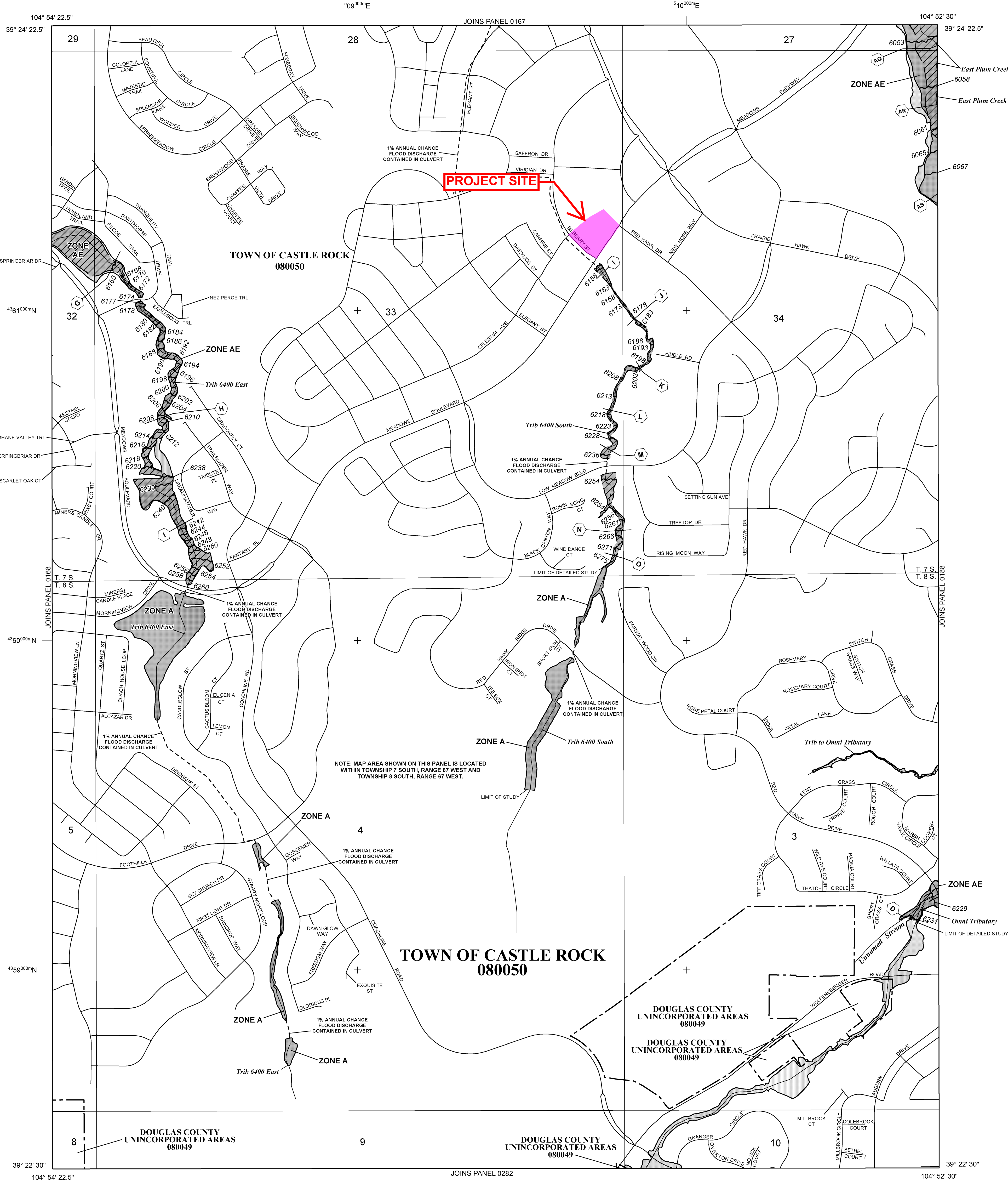
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations** and **floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

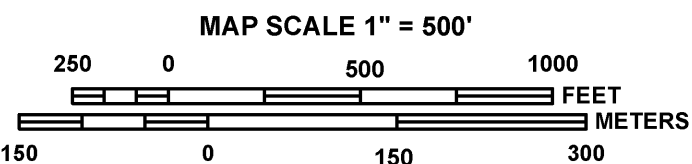
For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.
- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently deteriorated. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.
- OTHER FLOOD AREAS**
- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- OTHER AREAS**
- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- (EL 987)
- *Referenced to the North American Vertical Datum of 1988
- Cross section line
- Transect line
- 45° 02' 08", 93° 02' 12"
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 1000-meter Universal Transverse Mercator grid values, zone 13
- DX5510 X
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5
- River Mile
- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- SEPTEMBER 30, 2005
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
- MARCH 16, 2016: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.
- For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.
- To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0169G

FIRM

FLOOD INSURANCE RATE MAP

DOUGLAS COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 169 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CASTLE ROCK, TOWN OF	080050	0169	G
DOUGLAS COUNTY	080049	0169	G

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

MAP NUMBER
08035C0169G
MAP REVISED
MARCH 16, 2016

Federal Emergency Management Agency

APPENDIX B – TABLES AND FIGURES

6.0 Introduction

This chapter summarizes methodology for determining rainfall and runoff information for the design of stormwater management facilities in the Town. The methodology is based on the procedures presented in the UDFCD Manual in the Rainfall and Runoff chapters. The design procedures outlined in the UDFCD Manual, supplemented by the information provided in this chapter, apply to all projects in the Town.

6.0.1 Stormwater Quality Considerations. One of the most significant impacts of urbanization is the increase in peak flow rates, runoff volumes, and frequency of runoff from impervious areas. This increase in runoff can lead to severe stream erosion, habitat disruption, and increased pollutant loading. At the same time, with proper planning, the increased runoff volumes can be managed to create or supplement existing wetland areas or riparian habitats, which may provide significant benefits to the watershed. The increase in runoff from development is especially pronounced when drainage systems are designed to quickly and “efficiently” convey runoff from paved areas and roofs directly into inlets and storm sewers, discharging eventually into drainageways that are typically designed to convey flows at maximum acceptable velocities. Whether for one site or for a whole watershed, this increase in runoff and acceleration of flood peaks is reflected accurately by the hydrologic methods discussed herein.

As discussed in Chapter 14, Stormwater Quality, effective stormwater management today seeks to disconnect impervious surfaces, slow down flows, and convey runoff over vegetated ground surfaces, leading to filtering, infiltration, and attenuation of flows. These principles can also be reflected in the hydrologic variables discussed in this chapter, yielding longer times of concentration and reduced peak runoff. Specifically, Section 6.6 provides design guidance to account for the hydrologic effects of Minimizing Directly Connected Impervious Areas.

6.1 Design Rainfall

Rainfall data to be used in the Town of Castle Rock is based on the *National Oceanic and Atmospheric Administration Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado* (NOAA Atlas), published in 1973. Precipitation depth maps shown in the NOAA Atlas were used to determine representative one-hour and six-hour point rainfall values for the Town. Following the guidelines in the NOAA Atlas, these point values were used to develop two-hour and three-hour values as well as the intensity-duration curves for use in the Town. The Rainfall chapter of the UDFCD Manual provides additional discussion on the use of rainfall data obtained from the NOAA Atlas.

6.1.1 One-hour Rainfall. There is very little variation in the NOAA Atlas isopluvial (equal precipitation depth) map within the Town of Castle Rock; therefore, one

Chapter 6. Hydrology

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

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

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

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

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

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

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

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

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

TABLE 6-3. RECOMMENDED IMPERVIOUSNESS BY SURFACE TYPES

SURFACE TYPES		IMPERVIOUSNESS
Roadways and Paved Streets		95%
Concrete Driveways and Walks		95%
Roofs		95%
Gravel	No Traffic (Pedestrian Use)	40%
	Low-traffic Areas (Maintenance Paths and Substations)	60%
	High-traffic Areas (Roadways and Parking)	80%
Disturbed Soil (Including Lawns, Managed/Active Turf, Landscaped Areas with Water-Wise Vegetation, and Uncompacted Gravel/Mulch Planting Beds)		20%
Undisturbed or Decompacted Soil (Native Grasses and Open Space Areas)		5%
Artificial Turfs ¹	Landscape Applications (without Subgrade Drainage Layer)	25% – 45%
	Sport Fields (with Underdrain Pipe System)	60% – 80%
Water Surfaces (Lakes/Reservoirs/Irrigation Ponds)		100%
Solar Fields ²	Grass Cover (Varies with Panel Orientation Relative to Ground Contours)	10% – 45%
	Gravel Cover (Varies with Panel Orientation Relative to Ground Contours)	50% – 75%
Historic Flow Analysis, Greenbelts, Agricultural		5%
Newly Graded Areas		65%
Stormwater Control Measures ³	Retention Ponds & Constructed Wetland Ponds	100%
	Rooftop Systems – Blue Roofs	95%
	Rooftop Systems – Green Roofs (extensive)	65%
	Rooftop Systems – Green Roofs (intensive)	50%
	Permeable Pavement – CGP/PGP/RGP	55%
	Permeable Pavement – PICP	45%
	Extended Detention Basins	25%
	Receiving Pervious Areas (incl. Grass Buffers & Grass Swales)	20%
	Bioretention & Sand Filters	10%

¹ Consult with the manufacturer to get a recommended value.

² Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures for determining percent imperviousness based on panel width, panel spacing, and panel orientation relative to ground contours and how to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

³ See MHFD's technical memorandum regarding *Evaluation of Percent Imperviousness for Stormwater Control Measures* for background information.

4.5 RAINFALL INTENSITY

The calculated rainfall intensity, I , is the average rainfall rate in inches per hour over a duration equal to t_c . Obtain 1-hour point precipitation depths from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for the average return periods of interest and apply Equation 5-1 in the *Rainfall* chapter using t_c as the storm duration, t_d . Use the centroid of the catchment to determine the 1-hour point precipitation depths. The MHFD-Rational and MHFD-Inlet Excel workbooks automatically calculate rainfall intensity based on 1-hour point precipitation depths for a specified location.

4.6 RUNOFF COEFFICIENTS

Any watershed can be conceptualized as a combination of pervious and impervious surfaces. Pervious surfaces allow water to infiltrate into the ground, while impervious surfaces do not allow for infiltration. In urban hydrology, the relationships between pervious and impervious surfaces is important. Urbanization increases impervious area, causing rainfall-runoff relationships to change significantly. In the absence of stormwater management controls that infiltrate or detain runoff, urbanization increases peak runoff rates, volumes, and frequency of runoff and decreases the time to peak.

When analyzing a catchment for planning or design purposes, estimates of the existing and probable future imperviousness of the drainage area are needed. In some cases, the pre-development (i.e., historic) condition also must be analyzed. Table 6-2 provides recommended imperviousness values based on land use types and is appropriate for master planning analysis and conceptual design. Note that the land use classifications in Table 6-2 incorporate roads that are included within the land use. Table 6-3 provides recommended imperviousness values for different surface types and is appropriate for use during later stages of design when the layout of different types of impervious and pervious areas on the site is known and the area of each surface type can be quantified.

The runoff coefficient, C , represents the integrated effects of infiltration, evaporation, depression storage, and interception, all of which affect the rate and volume of runoff. Determining representative runoff coefficients requires judgment based on the experience and expertise of the engineer.

Volume-based runoff coefficients were derived to improve consistency between CUHP and the Rational Method for peak flow predictions (Guo 2013; Guo and Urbonas 2013). The coefficients developed by Dr. Guo were recalibrated using CUHP Version 2.0.0 (Rapp et al. 2017). Using imperviousness, expressed as a decimal, and the Natural Resources Conservation Service (NRCS) Hydrologic Soil Group (HSG), the equations in Table 6-5 can be used to calculate runoff coefficients for design storm return periods for the Rational Method.

TABLE 6-5. RUNOFF COEFFICIENT EQUATIONS BASED ON NRCS HSG AND STORM RETURN PERIOD

NRCS HSG	STORM RETURN PERIOD						
	WQE & 2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.840I^{1.302}$	$C_A = 0.861I^{1.276}$	$C_A = 0.873I^{1.232}$	$C_A = 0.884I^{1.124}$	$C_A = 0.854I + 0.025$	$C_A = 0.779I + 0.110$	$C_A = 0.645I + 0.254$
B	$C_B = 0.835I^{1.169}$	$C_B = 0.857I^{1.088}$	$C_B = 0.807I + 0.057$	$C_B = 0.628I + 0.249$	$C_B = 0.558I + 0.328$	$C_B = 0.465I + 0.426$	$C_B = 0.366I + 0.536$
C/D	$C_{C/D} = 0.834I^{1.122}$	$C_{C/D} = 0.815I + 0.035$	$C_{C/D} = 0.735I + 0.132$	$C_{C/D} = 0.560I + 0.319$	$C_{C/D} = 0.494I + 0.393$	$C_{C/D} = 0.409I + 0.484$	$C_{C/D} = 0.315I + 0.588$

APPENDIX C – HYDROLOGY

COMPOSITE IMPERVIOUSNESS & RUNOFF COEFFICIENT CALCULATIONS - DEVELOPED CONDITIONS

SUB-BASIN	PROPOSED LAND USE ^a (sf)						TOTAL AREA (sf)	TOTAL AREA (acres)	COMPOSITE PERCENT IMPERVIOUS <i>i</i>	RUNOFF COEFFICIENTS ^b HYDROLOGIC SOIL GROUP B ^c				NOTES
	PAVED	DRIVE AND WALKS	ROOF	LANDSCAPE	GRAVEL					C ₂	C ₅	C ₁₀	C ₁₀₀	
OS1	-	1,779	-	18,838	-		20,617	0.473	9.6%	0.05	0.07	0.13	0.47	
OS2	-	570	-	3,344	-		3,914	0.090	14.8%	0.09	0.11	0.18	0.50	
A	33,609			6,404			40,013	0.919	84.3%	0.69	0.71	0.74	0.82	
B		3,467		14,717			18,184	0.417	18.8%	0.12	0.14	0.21	0.51	
C			7,918				7,918	0.182	90.0%	0.74	0.77	0.79	0.85	
Total	33,609	5,816	7,918	43,303	-	-	90,646	2.081	51.67%	0.39	0.42	0.48	0.67	Composite Site

NOTES:

a. UDFCD, USDCM Volume 1, Table 6-3

b. UDFCD, USDCM Volume 1, Table 6-4 and Table 6-5

$$C_2 = 0.84i^{1.169} \quad C_5 = 0.86i^{1.088} \quad C_{10} = 0.81i + 0.057 \quad C_{100} = 0.47i + 0.426$$

c. WSS shows predominately Type B Soil for the proposed project development area

d. Bilberry Street Amenity Zone Collected by Filing 20 Regional Pond

*Total excludes Basin OS1 and only totals areas within the boundaries of Lot 2A-3A, Block 3, The Meadows Filing No. 20, Phase 1 - Amendment No. 16

TIME OF CONCENTRATIONS - DEVELOPED CONDITIONS

BASIN DATA			INITIAL/OVERLAND TIME (t_i) ^a			TRAVEL TIME (t_t) ^b					TIME OF CONC. (t_c) ^d	FIRST DESIGN POINT TIME OF CONC. IN URBAN CATCHMENT (t_c) ^e			FINAL (t_c) ^{f, g}	CONVEYANCE REMARKS
SUB-BASIN	AREA (acres)	C _s	LENGTH L_i (ft)	SLOPE S_o (ft/ft)	t_i (minutes)	LENGTH L_t (ft)	SLOPE S_t (ft/ft)	CONVEYANCE FACTOR K ^c	VELOCITY V_t (ft/s)	t_t (minutes)	t_c (minutes)	LENGTH L_i (ft)	IMPERVIOUS i (decimal)	t_c (minutes)	t_c (minutes)	
OS1	0.47	0.07	190	0.030	17.9	115	0.010	20	2.0	0.96	18.8	115	0.096	25.44	18.8	
OS2	0.09	0.11	10	0.030	3.9			20	-	-	3.9	-	0.148	23.48	5.0	
A	0.92	0.71	180	0.030	6.5	100	0.020	20	2.8	0.59	7.1	100	0.843	12.13	7.1	
B	0.42	0.14	100	0.030	12.1	80	0.030	20	3.5	0.38	12.5	80	0.188	23.47	12.5	
C	0.18	0.77	114	0.020	5.1	75	0.020	20	2.8	0.44	5.6	75	0.900	11.11	5.6	

NOTES:

a. UDFCD, USDCM Volume 1, Equation 6-3: $t_i = 0.395(1.1 - C_s) * \sqrt{L_i / S_o}$

b. UDFCD, USDCM Volume 1, Equation 6-4: $t_t = L_t / 60 * K * \sqrt{S_o} = L_t / 60 * V_t$

c. UDFCD, USDCM Volume 1, Table 6-2: Heavy Meadow = 2.5, Tillage/field = 5, Short Pasture & Lawn = 7, Nearly Bare Ground = 10, Grassed Waterway = 15, Paved Areas & Shallow Paved Swales = 20

d. UDFCD, USDCM Volume 1, Equation 6-2: $t_c = t_i + t_t$

e. UDFCD, USDCM Volume 1, Equation 6-5: $t_t = (26 - 17i) + (L_t / 60(24i + 12) * \sqrt{S_t})$

f. UDFCD, USDCM Volume 1, Section 2.4.3, "The time of concentration shall be the lesser of the values calculated by Equation 6-2 and Equation 6-5."

g. UDFCD, USDCM Volume 1, Section 2.4.4, "Use a minimum t_c value of 5 minutes for urbanized areas."

STORM DRAINAGE SYSTEM DESIGN (RATIONAL METHOD PROCEDURE) - DEVELOPED CONDITIONS
DESIGN STORM: 5-YEAR

[illegible]

NOTES:

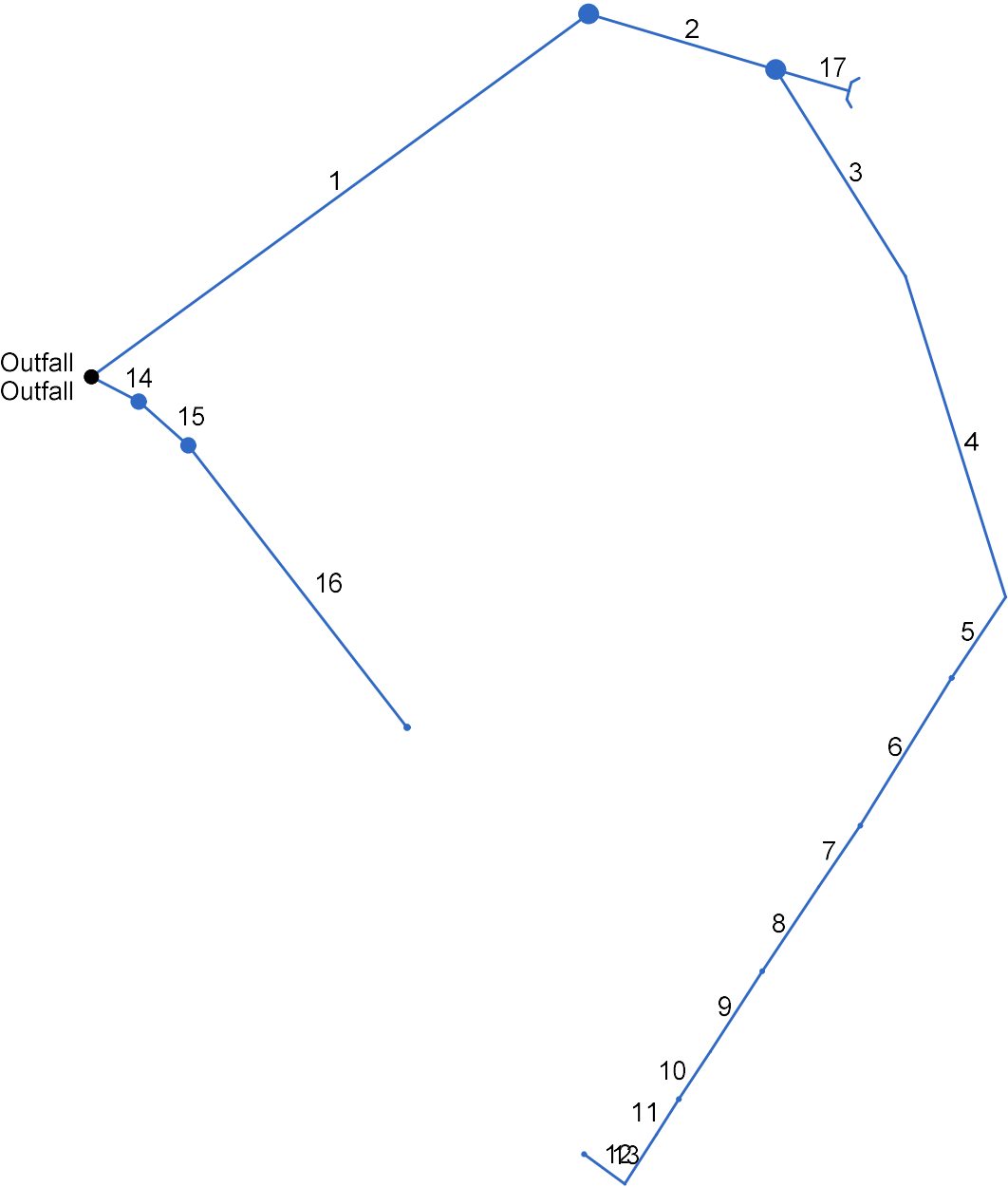
a. Town of Castle Rock Storm Drainage Design and Technical Criteria Manual Table 6-1: P1 for Town of Castle Rock, 100-year (2.60), 10-year (1.66), 5-year (1.43), 2-year (1.06).

b. UDFCD, USDCM Volume 1, Equation 5-1: $I = (28.5 * P_1) / (10 + T_c)^{0.786}$

c. UDFCD, USDCM Volume 1, Equation 6-1: $Q = C/A$

APPENDIX D – HYDRAULICS

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



Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	18	0.85	6143.50	6143.84	0.34	0.30	2.83	0.12	6143.96	0.000	136.714	6145.70	6146.04	0.34**	0.30	2.79	0.12	6146.17	0.000	0.000	n/a	0.83	n/a
2	18	0.85	6145.94	6146.23	0.29*	0.24	3.47	0.12	6146.36	0.000	43.371	6146.34	6146.68	0.34**	0.30	2.79	0.12	6146.80	0.000	0.000	n/a	0.71	n/a
3	8	0.61	6146.54	6146.94	0.40*	0.22	2.83	0.12	6147.06	0.499	54.086	6146.81	6147.21	0.40	0.22	2.83	0.12	6147.33	0.500	0.500	0.270	0.30	0.04
4	8	0.61	6146.81	6147.24	0.43	0.20	2.54	0.15	6147.39	0.000	74.788	6147.56	6147.93 j	0.37**	0.20	3.10	0.15	6148.08	0.000	0.000	n/a	0.81	0.12
5	8	0.61	6147.56	6147.93	0.37*	0.20	3.10	0.15	6148.08	0.000	21.625	6147.77	6148.14	0.37**	0.20	3.10	0.15	6148.29	0.000	0.000	n/a	0.50	0.07
6	8	0.50	6147.96	6148.31	0.35*	0.19	2.68	0.11	6148.42	0.491	38.669	6148.15	6148.50	0.35	0.19	2.69	0.11	6148.61	0.493	0.492	0.190	0.50	0.06
7	8	0.50	6148.35	6148.74	0.39*	0.21	2.39	0.09	6148.82	0.364	16.479	6148.41	6148.79	0.38	0.21	2.40	0.09	6148.88	0.368	0.366	0.060	0.15	0.01
8	8	0.50	6148.41	6148.81	0.40	0.22	2.30	0.08	6148.89	0.330	22.632	6148.52	6148.87	0.35	0.19	2.69	0.11	6148.98	0.493	0.411	0.093	0.50	0.06
9	8	0.50	6148.75	6149.13	0.38*	0.21	2.43	0.09	6149.22	0.378	21.190	6148.83	6149.21	0.38	0.21	2.43	0.09	6149.30	0.378	0.378	0.080	0.15	0.01
10	8	0.50	6148.83	6149.22	0.39	0.17	2.33	0.13	6149.35	0.000	12.708	6148.92	6149.25 j	0.33**	0.17	2.90	0.13	6149.38	0.000	0.000	n/a	0.50	n/a
11	8	0.50	6149.12	6149.46	0.34*	0.18	2.77	0.12	6149.58	0.534	9.292	6149.17	6149.51	0.34	0.18	2.79	0.12	6149.63	0.542	0.538	0.050	0.15	0.02
12	8	0.18	6149.17	6149.53	0.36	0.19	0.94	0.01	6149.54	0.059	13.102	6149.23	6149.53	0.30	0.15	1.17	0.02	6149.55	0.107	0.083	0.011	1.00	0.02
13	8	0.18	6149.24	6149.55	0.31	0.16	1.12	0.02	6149.57	0.094	11.204	6149.29	6149.56	0.27	0.13	1.38	0.03	6149.59	0.165	0.130	0.015	1.00	0.03
14	24	1.25	6143.33	6143.72	0.39	0.43	2.90	0.13	6143.85	0.441	11.900	6143.30	6143.83	0.53	0.66	1.89	0.06	6143.88	0.131	0.286	0.034	0.50	0.03
15	18	0.74	6145.06	6145.23	0.17*	0.11	6.62	0.11	6145.34	0.000	14.730	6146.02	6146.34	0.32**	0.28	2.69	0.11	6146.45	0.000	0.000	n/a	0.50	n/a
16	10	0.31	6146.69	6146.85	0.16*	0.07	4.40	0.09	6146.93	0.000	79.247	6149.01	6149.25	0.24**	0.13	2.37	0.09	6149.34	0.000	0.000	n/a	1.00	n/a
17	18	0.24	6146.34	6146.68	0.34	0.12	0.79	0.06	6146.75	0.000	16.815	6146.46	6146.64	0.18**	0.12	2.00	0.06	6146.70	0.000	0.000	n/a	1.00	n/a

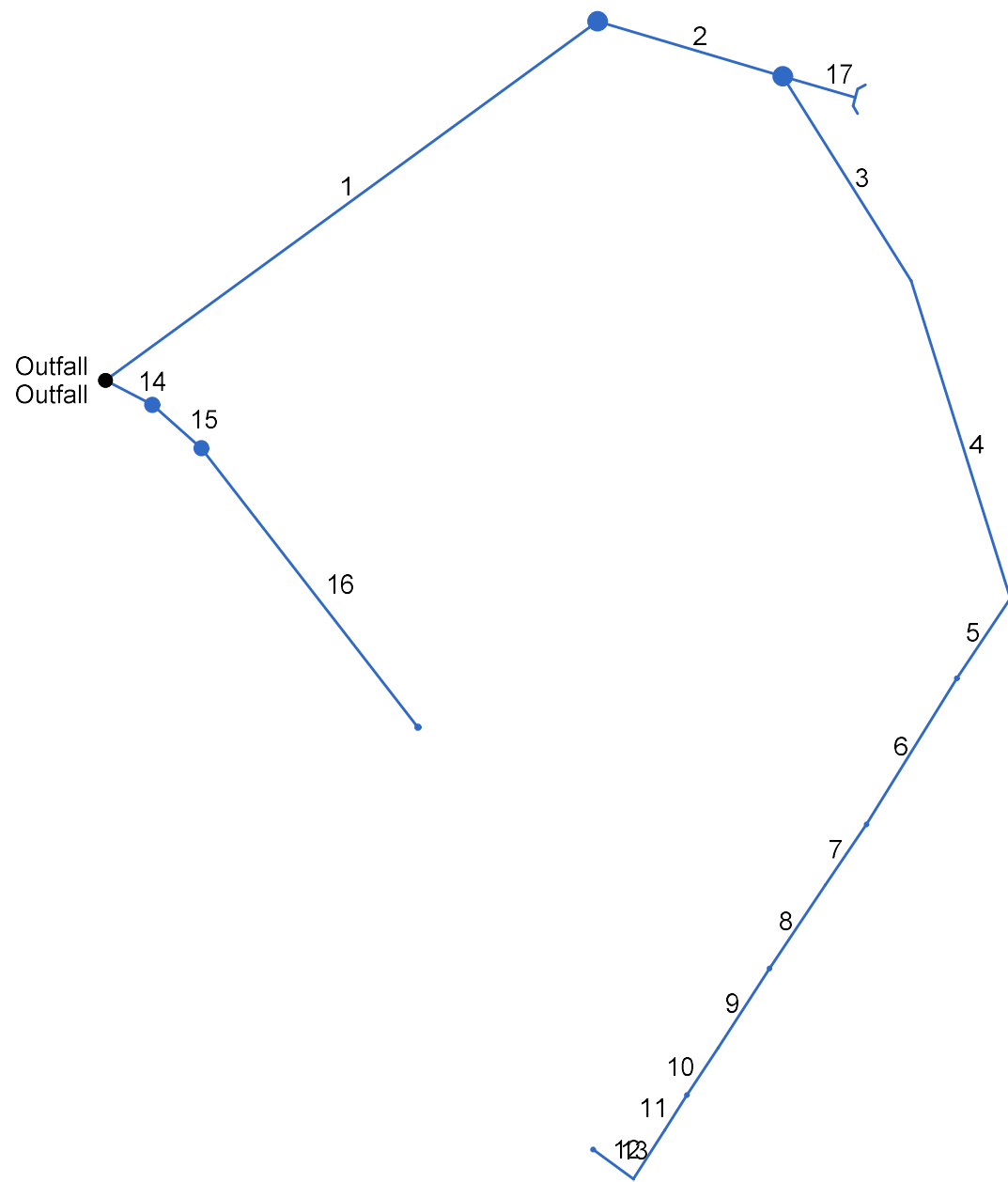
Project File: 5-YR.stm

Number of lines: 17

Run Date: 4/8/2024

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

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

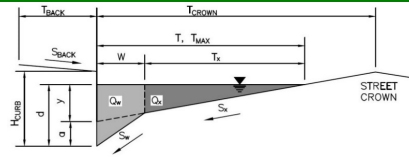


Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream										Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)				
	(in)	(cfs)									(ft)											(K)	(ft)		
1	18	4.95	6143.50	6145.00	1.50	1.04	2.80	0.12	6145.12	0.222	136.714	6145.70	6146.56 j	0.85**	1.04	4.76	0.35	6146.91	0.577	0.400	n/a	0.83	n/a		
2	18	4.95	6145.94	6146.68	0.74*	0.87	5.68	0.35	6147.03	0.000	43.371	6146.34	6147.20	0.85**	1.04	4.76	0.35	6147.55	0.000	0.000	n/a	0.71	n/a		
3	8	1.66	6146.54	6147.21	0.67*	0.35	4.76	0.35	6147.56	1.589	54.086	6146.81	6148.07	0.67	0.35	4.76	0.35	6148.42	1.610	1.599	0.865	0.30	0.11		
4	8	1.66	6146.81	6148.18	0.67	0.35	4.76	0.35	6148.53	1.610	74.788	6147.56	6149.38	0.67	0.35	4.76	0.35	6149.73	1.610	1.610	1.204	0.81	0.28		
5	8	1.66	6147.56	6149.67	0.67	0.35	4.76	0.35	6150.02	1.610	21.625	6147.77	6150.01	0.67	0.35	4.76	0.35	6150.37	1.610	1.610	0.348	0.50	0.18		
6	8	1.43	6147.96	6150.19	0.67	0.35	4.10	0.26	6150.45	1.195	38.669	6148.15	6150.65	0.67	0.35	4.10	0.26	6150.91	1.195	1.195	0.462	0.50	0.13		
7	8	1.43	6148.35	6150.78	0.67	0.35	4.10	0.26	6151.04	1.195	16.479	6148.41	6150.98	0.67	0.35	4.10	0.26	6151.24	1.195	1.195	0.197	0.15	0.04		
8	8	1.43	6148.41	6151.02	0.67	0.35	4.10	0.26	6151.28	1.195	22.632	6148.52	6151.29	0.67	0.35	4.10	0.26	6151.55	1.195	1.195	0.270	0.50	0.13		
9	8	1.43	6148.75	6151.42	0.67	0.35	4.10	0.26	6151.68	1.195	21.190	6148.83	6151.67	0.67	0.35	4.10	0.26	6151.94	1.195	1.195	0.253	0.15	0.04		
10	8	1.43	6148.83	6151.71	0.67	0.35	4.10	0.26	6151.97	1.195	12.708	6148.92	6151.87	0.67	0.35	4.10	0.26	6152.13	1.195	1.195	0.152	0.50	0.13		
11	8	1.43	6149.12	6152.00	0.67	0.35	4.10	0.26	6152.26	1.195	9.292	6149.17	6152.11	0.67	0.35	4.10	0.26	6152.37	1.195	1.195	0.111	0.15	0.04		
12	8	0.78	6149.17	6152.15	0.67	0.35	2.23	0.08	6152.22	0.356	13.102	6149.23	6152.19	0.67	0.35	2.23	0.08	6152.27	0.355	0.355	0.047	1.00	0.08		
13	8	0.78	6149.24	6152.27	0.67	0.35	2.23	0.08	6152.35	0.356	11.204	6149.29	6152.31	0.67	0.35	2.23	0.08	6152.39	0.355	0.355	0.040	1.00	0.08		
14	24	3.22	6143.33	6145.33	2.00*	3.14	1.03	0.02	6145.35	0.020	11.900	6143.30	6145.33	2.00	3.14	1.02	0.02	6145.35	0.020	0.020	0.002	0.50	0.01		
15	18	1.74	6145.06	6145.34	0.28	0.23	7.60	0.18	6145.52	0.000	14.730	6146.02	6146.52	0.50**	0.51	3.42	0.18	6146.70	0.000	0.000	n/a	0.50	n/a		
16	10	0.81	6146.69	6146.94	0.25*	0.14	5.81	0.15	6147.10	0.000	79.247	6149.01	6149.41	0.40**	0.26	3.16	0.15	6149.56	0.000	0.000	n/a	1.00	0.15		
17	18	3.29	6146.34	6147.20	0.85	0.79	3.16	0.27	6147.46	0.000	16.815	6146.46	6147.15	0.69**	0.79	4.14	0.27	6147.42	0.000	0.000	n/a	1.00	n/a		
Project File: 100-YR.stm														Number of lines: 17					Run Date: 4/8/2024						
Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box																									

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

Project:

Inlet ID: **DP 2****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

T_{BACK}	=	10.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

H_{CURB}	=	6.00	inches
T_{CROWN}	=	60.0	ft
W	=	0.50	ft
S_x	=	0.030	ft/ft
S_w	=	0.083	ft/ft
S_0	=	0.000	ft/ft
n_{STREET}	=	0.020	

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T_{MAX}	60.0	60.0	ft
d_{MAX}	6.0	6.0	inches
	☐	☐	

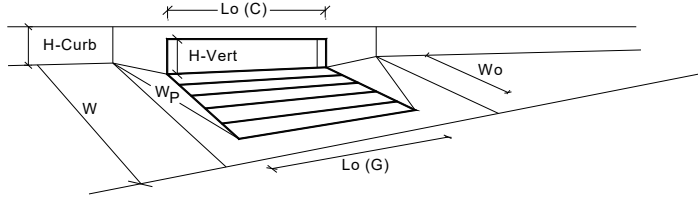
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

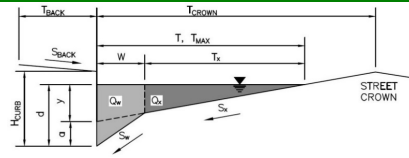
MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type = CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
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		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _p =	0.50	0.50	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} =	0.46	0.46	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	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _s =	5.9	5.9	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)		Q _{PEAK REQUIRED} =	0.8	1.6	cfs

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

Project:

Inlet ID: **DP 6****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

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

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

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

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

Street Longitudinal Slope - Enter 0 for sump condition

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

T_{BACK}	=	10.0	ft
S_{BACK}	=	0.020	ft/ft
n_{BACK}	=	0.020	

H_{CURB}	=	6.00	inches
T_{CROWN}	=	15.0	ft
W	=	0.50	ft
S_X	=	0.020	ft/ft
S_W	=	0.083	ft/ft
S_O	=	0.000	ft/ft
n_{STREET}	=	0.020	

Max. Allowable Spread for Minor & Major Storm

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

Check boxes are not applicable in SUMP conditions

	Minor Storm	Major Storm	
T_{MAX}	15.0	15.0	ft
d_{MAX}	6.0	6.0	inches

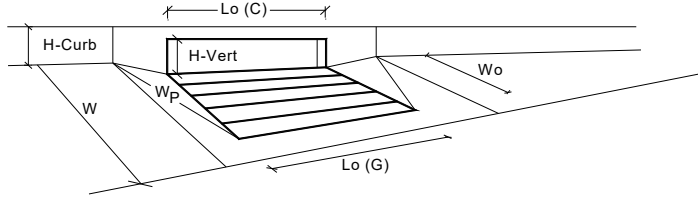
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow}	SUMP	SUMP	cfs

INLET IN A SUMP OR SAG LOCATION

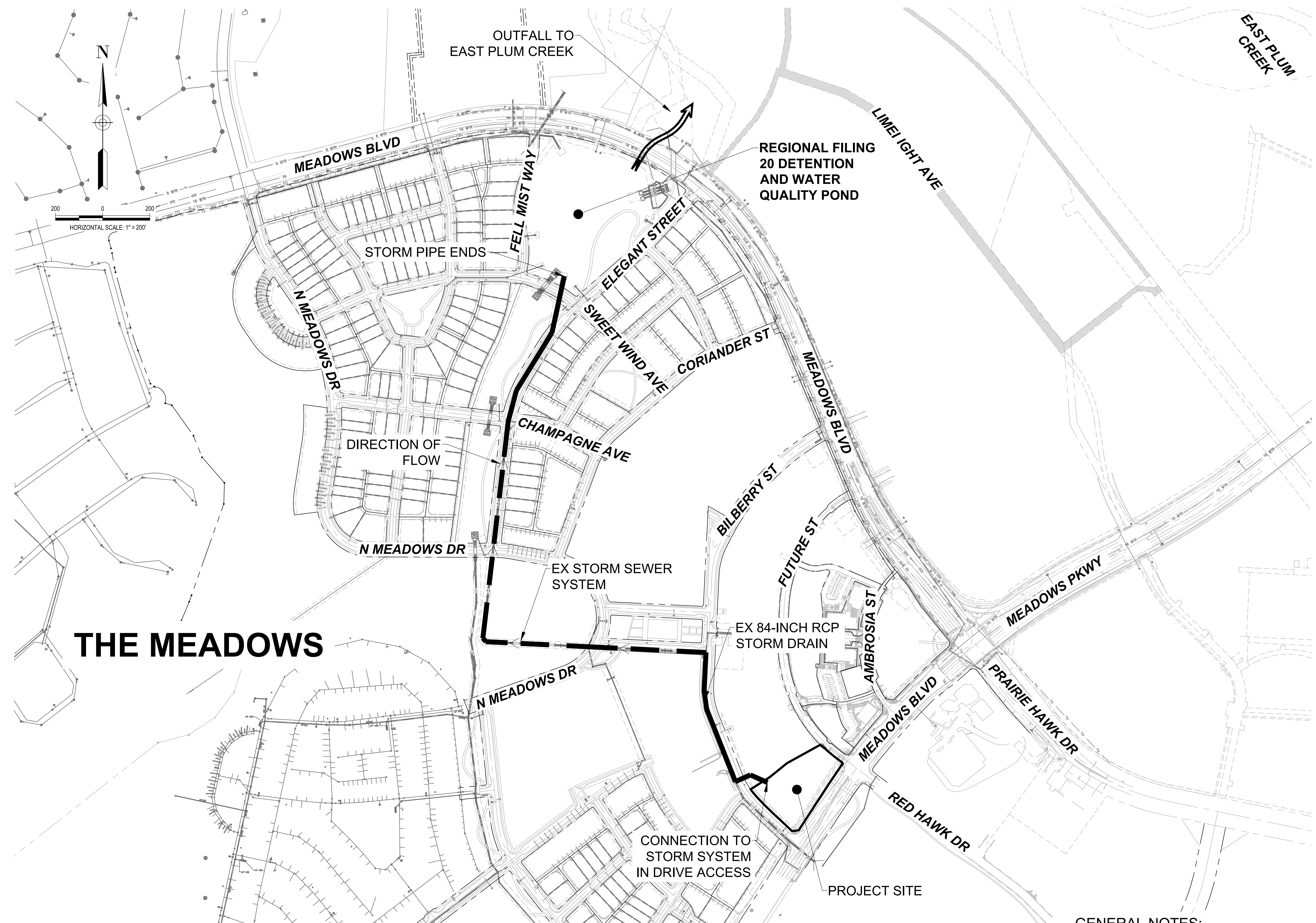
MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)		MINOR		MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type = CDOT Type R Curb Opening			
Local Depression (additional to continuous gutter depression 'a' from above)		a _{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	4.0	4.0	inches
Grate Information		MINOR		MAJOR	
Length of a Unit Grate		L _o (G) =	N/A	N/A	feet
Width of a Unit Grate		W _o =	N/A	N/A	feet
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		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W _p =	0.50	0.50	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} =	0.29	0.29	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	
Total Inlet Interception Capacity (assumes clogged condition)		MINOR		MAJOR	
		Q _s =	3.0	3.0	cfs
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)		Q _{PEAK REQUIRED} =	0.8	1.9	cfs

APPENDIX E – DETENTION WATER QUALITY

DETENTION WATER QUALITY EXHIBIT



THE MEADOWS



Summary of Water Quality Conformance to MS4 Permit

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

Project Name Castle Rock Collective

Project Owner _____

Project Location Castle Rock Collective

ToCR Project Number _____

Total Site Area 1.6 acres **acres**

Total Size of Common Plan of Development unknown **acres**

Check all that apply:

☒ **Project within Plum Creek Basin**

☐ **Project within Cherry Creek Basin**

Estimated construction completion date Spring 2027

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

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

Summary of Water Quality Conformance to MS4 Permit

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

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

- ☐ Pavement management site
Excluded impervious area: _____ acres
- ☐ Excluded roadway redevelopment
Excluded impervious area: _____ acres
- ☐ Excluded existing roadway areas
Excluded impervious area: _____
- ☐ Above ground and below ground utilities
- ☐ Large lot single family home
- ☐ Non-residential and non-commercial infiltration
Excluded impervious area: _____ acres
- ☐ Land disturbance for land to remain undeveloped
Excluded impervious area: _____ acres
- ☐ Stream Stabilization Sites
Excluded impervious area: _____ acres
- ☐ Trails
Excluded impervious area: _____ acres
- ☐ Oil and Gas Exploration

NA

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

If yes, complete the following:

Excluded area: _____ acres

Total Site area: _____ acres, _____ % site excluded

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

If yes, complete the following:

Excluded area: _____ acres

Excluded impervious area: _____ acres

Total Site area: _____ acres, _____ % site excluded

Total Impervious area: _____ acres, _____ % impervious excluded

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

Project:

Project #:

Applicant:

[illegible]

Section	Question	Response	Instructions
3	Applicable Sites with Other Exclusions by Variance		
3.1	Category 1: Roadways, bridges and trails only		
3.1.1	Is the project a bike or pedestrian trail?	☐ Yes ☐ No	Proceed to next line. Proceed to 3.1.2.
	Is the trail for a roadway?	☐ Yes ☐ No	Proceed to 3.1.2. Project is excluded. Submit variance for <u>Trails Excluded from Permanent Water Quality Requirements</u> .
3.1.2	Is the project primarily used for parking or access to parking?	☐ Yes ☐ No	This exclusion does not apply. Permanent water quality is required. Proceed to 3.1.3.
3.1.3	Does the project add impervious area?	☐ No ☐ Yes	Project is excluded. Submit variance for <u>Pavement Management Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.1.4.
3.1.4	Does the project add more than 8.25 feet of paved width at any location to the existing roadway?	☐ No ☐ Yes	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Does the project add more than one acre of paved area per mile to an existing roadway?	☐ No ☐ Yes	Project is excluded. Submit variance for <u>Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Does the project increase the width by _____, on average, of the original roadway area?	☐ No ☐ Yes	Existing areas of site are excluded only. Submit variance for <u>Existing Roadway Surfaces Only Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.
3.2	Category 2: Non-residential and non-commercial projects only		
3.2.1	Is the project associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and the movement and placement of drilling equipment?	☐ Yes ☐ No	Project is excluded. Submit variance for <u>Oil and Gas Exploration Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.2.
3.2.2	Is the project for stream stabilization?	☐ Yes ☐ No	Project is excluded. Submit variance for <u>Stream Stabilization Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.3.
3.2.3	Is the project for installation or maintenance of aboveground or underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity including activities to install, replace or maintain utilities under roadways or other paved areas that return the surface to the same condition?	☐ Yes ☐ No	Project is excluded. Submit variance for <u>Aboveground and Underground Utilities Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.4.
3.2.4	Is the project on undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the project?	☐ Yes ☐ No	Project is excluded. Submit variance for <u>Sites with Land Disturbances to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to 3.2.5.
3.2.5	Will the post-project condition result in _____ charge during the 80th percentile storm runoff event?	☐ No ☐ Yes	Project is excluded. Submit study along with variance for <u>Non-residential and Non-commercial Infiltration Conditions Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.

Section	Question	Response	Instructions
3.3	Category 3: Residential, Agricultural and Commercial projects		
3.3.1	Is the project a single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling unit?	☐ Yes ☒ No	Proceed to next line. Proceed to 3.3.2.
	Is the project site greater than 10% impervious?	☐ No ☐ Yes	Project is excluded. Submit variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . Proceed to next line.
	Is the project site greater than 20% impervious?	☐ Yes ☐ No	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	☐ No ☐ Yes	Project is excluded. Submit study along with variance for <u>Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements</u> . This exclusion does not apply. Permanent water quality is required.
3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	☒ Yes ☐ No	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	☐ Yes ☐ No	This portion of the project is excluded. Submit variance for <u>Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements</u> . Proceed to next line. Proceed to next line.
	Is the remaining untreated impervious area greater than 20% of the site?	☐ Yes ☐ No	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is the remaining untreated impervious area greater than one acre?	☐ Yes ☐ No	This exclusion does not apply. Permanent water quality is required. Proceed to next line.
	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	☐ No ☐ Yes	Document justification demonstrating that it is not practicable to capture runoff from this portion of the site in the drainage report . No further action is needed. This exclusion does not apply. Permanent water quality is required.

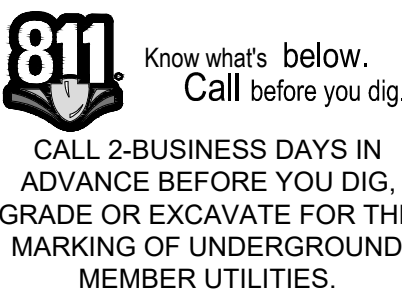
APPENDIX F – DRAINAGE MAP

Plotted by: Collin Miller Date: 8/29/2025 10:02 AM

File Name: S:_Projects\250305 - Meadows Restaurant\CADD\Sheet Sals\CDs\CD12.10 - DRAINAGE PLAN.dwg

GENERAL NOTES:

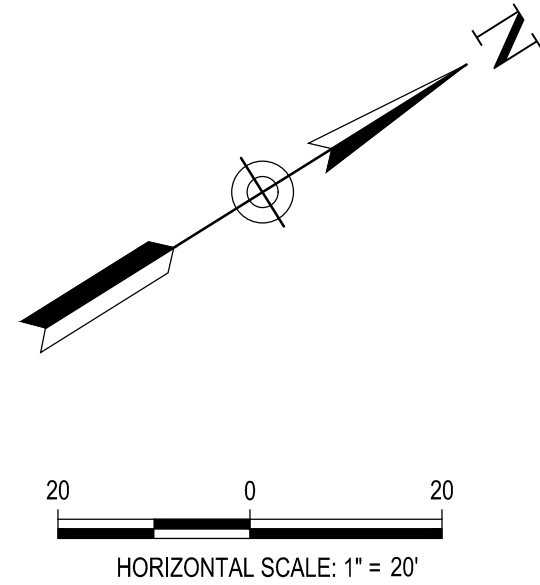
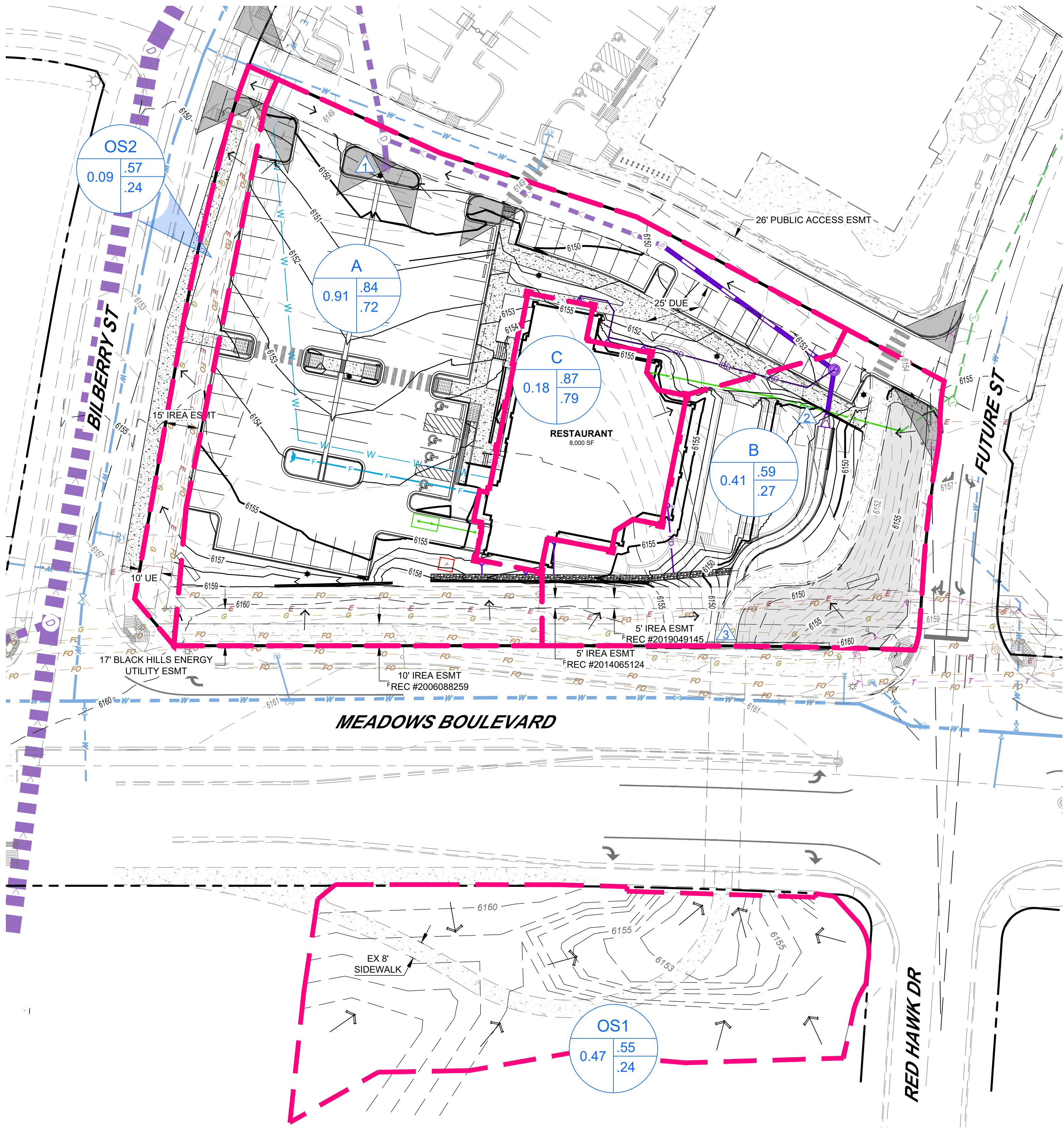
- SITE IS NOT LOCATED WITHIN A 100-YEAR FLOODPLAIN PER FEMA FIRM MAP #08035CD169G. 03/16/2016.
- THERE ARE NO MAJOR DRAINAGE-WAYS OR IRRIGATION DITCHES THAT TRAVEL THROUGH THE SITE.



BENCHMARK

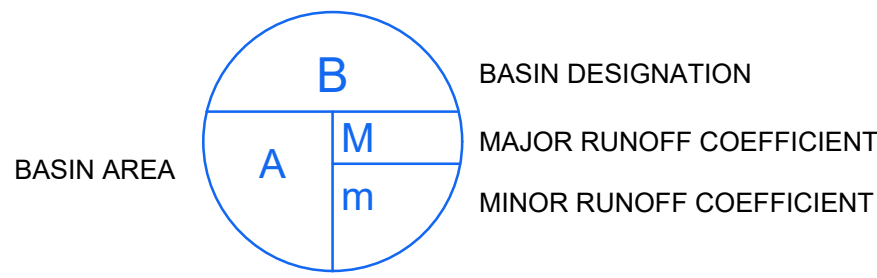
SITE BENCHMARK IS DOUGLAS COUNTY CONTROL MONUMENT 2.015030. RECOVERED 3.25" ALUMINUM CAP LOCATED 410' MORE OR LESS EAST OF THE RAILROAD TRACKS AND 3200' MORE OR LESS NORTH OF MEADOWS PARKWAY.
ELEVATION = 6082.17 (NAVD 88).

ARCHITECTURAL ELEVATION 100.00' = SURVEYED ELEVATION 0000.00'



LEGEND:

- 5280 --- EXISTING CONTOUR
- 5280 --- PROPOSED CONTOUR
- BASIN BOUNDARY
- EMERGENCY OVERFLOW PATH
- △ DESIGN POINT
- ← FLOW DIRECTION



BASIN SUMMARY:

DRAINAGE BASIN	BASIN AREA (acres)	5-YEAR RUNOFF (cfs)	100-YEAR RUNOFF (cfs)
OS1	0.47	0.30	1.47
OS2	0.09	0.10	0.45
A	0.92	3.34	6.51
B	0.42	0.42	1.67
C	0.18	0.65	1.34

PROFESSIONAL ENGINEER CERTIFICATION

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY; AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.

KURT A. LANG
COLORADO P.E., 32249

TOWN OF CASTLE ROCK APPROVAL

PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES' APPROVAL

APPROVED BY:

DEVELOPMENT SERVICES

DATE

CASTLE ROCK COLLECTIVE

DRAINAGE PLAN

ISSUE DATE: 08/29/25		
DATE	REVISIONS	BY

DESIGNED BY: CRM

DRAWN BY: CRM

JOB NUMBER: 250305

PRELIMINARY
NOT FOR
CONSTRUCTION

SHEET NUMBER:

1 OF 1

PREPARED FOR:

APPENDIX G – EXISTING STUDIES, MAPS, REFERENCES

**Approved Phase III Final Drainage Report for The Meadows
Filing No. 20 (Project Ref. No. CRDC-0304A).**

PHASE III FINAL DRAINAGE REPORT

FOR

THE MEADOWS FILING NO. 20

Volume 1 of 2

Prepared For:

Castle Rock Development Company
3033 East First Avenue, Suite 410
Denver, Colorado 80206

Prepared by:

RG Consulting Engineers, Inc.
1331 17th Street, Suite 710
Denver, CO 80202

June 2004

Revised August 2004

Revised September 2004

Revised October 2004

Project Reference No. CRDC-0304A

RGCE Job No. 820.0001



rg consulting engineers, inc.

RUNOFF COEFFICIENTS

Subdivision: The Meadows Filing No. 20

Calculated by: VJV

Job No.: 820.0001

Checked by: FJB

Date: September 16, 2004

Building/Surface Type	Percent Imperv.	Runoff Coefficients (Type B Soil)			Runoff Coefficients (Type C/D Soil)		
		5yr	10yr	100yr	5yr	10yr	100yr
Carriage Condos	48%	0.34	0.40	0.52	0.39	0.44	0.59
Mansion Condos	61%	0.41	0.46	0.56	0.46	0.51	0.63
Stacked Rowhouses	63%	0.44	0.48	0.58	0.48	0.53	0.65
Uphill Townhouses	64%	0.44	0.48	0.58	0.48	0.53	0.65
Back Yard Rowhouses	63%	0.44	0.48	0.58	0.48	0.53	0.65
Small Cottages	43%	0.32	0.38	0.51	0.37	0.44	0.59
Mid Cottages	43%	0.32	0.38	0.51	0.37	0.44	0.59
Village Houses	47%	0.34	0.40	0.52	0.39	0.44	0.59
Estates	50%	0.35	0.40	0.52	0.40	0.46	0.60
Commercial	95%	0.81	0.83	0.88	0.82	0.84	0.89
Roads/Flatwork	100%	0.90	0.92	0.96	0.90	0.92	0.96
Roof	90%	0.73	0.75	0.81	0.75	0.77	0.83
Grass	0%	0.08	0.15	0.35	0.15	0.25	0.50
School	50%	0.35	0.40	0.52	0.40	0.46	0.60

Note : Runoff Coefficients for soil type A were not shown. All soil for The Meadows Filing No. 20 is either type B or type C/D.

Carriage Condos, Mansion Condos, Stacked Rowhouses, Back Yard Rowhouses, Small Cottages, Mid Cottages, Village Houses, and Estates are all products used throughout Meadows Filing No. 20. The overall percent imperviousness was calculated for each product using the imperviousness for Roads/Flatwork, Roof, and Grass per average lot area. See product type exhibits on following pages.

An overall percent impervious value of 95% is anticipated for the Project site.

Approved Phase III Final Drainage Report for The Meadows Filing No. 20 (Project Ref. No. CRDC-0304A).

BASIN OSC4 HAS BEEN CALCULATED IN THIS REPORT AS AN UNDEVELOPED BASIN WITH AN IMPERVIOUS PERCENTAGE OF 5%. THIS HAS BEEN DONE TO PUSH INLET IMPROVEMENTS LIKELY REQUIRED AT INTERSECTION OF BILBERRY AND MERCANTILE STREET TO BE DESIGNED BY EITHER FUTURE DEVELOPMENT OF BLOCK 3 LOT 2 OR EXTENSION OF MERCANTILE STREET FROM FUTURE STREET TO BILBERRY STREET. NOTE THAT CONSTRUCTION OF BILBERRY STREET WILL NOT WARRANT IMPROVEMENTS AS BASIN C15 WILL BE OVERLOT GRADED IN THE INTERIM WHERE THIS REPORT HAS MODELED THIS AREA AS FULLY DEVELOPED. PLEASE NOTE THAT ANTICIPATED RUNOFF FOR BASIN OSC4 WITH AN IMPERVIOUSNESS OF 100% HAS BEEN PROVIDED IN THE REPORT SF2 AND SF3 FORMS, AS WELL AS NOTED IN THE BASIN SUMMARY TABLE ON THIS MAP.

GREEN HATCH REPRESENTS MEADOWS UBERGRIPPEN SITE.

ANTICIPATED AND DESIGNED VALUES FOR MEADOWS D1 TRAINING CENTER PROJECT SITE (TAKEN FROM ORIGINAL 2004 REPORT) DICTATE AN OVERALL COMPOSITE PERCENT IMPERVIOUSNESS OF 95%, WHICH IS LESS THAN THE CURRENT PROPOSED PERCENT COMPOSITE IMPERVIOUSNESS OF THE PROJECT OF 45.5%.

BLUE HATCH REPRESENTS PROPOSED RESTAURANT PROJECT SITE.

Approved Phase III Final Drainage Report for The Meadows Filing No. 20 (Project Ref. No. CRDC-0304A).

LEGEND

- A = BASIN DESIGNATION
B = BASIN AREA (A.C.)
C = MINOR RUNOFF COEFFICIENT
D = MAJOR RUNOFF COEFFICIENT
- △ DESIGN POINT DESIGNATION
- EXISTING MAJOR CONTOUR
--- EXISTING MINOR CONTOUR
--- PROPOSED MAJOR CONTOUR
--- PROPOSED MINOR CONTOUR
- FLOW ARROW
- MAJOR BASIN
MAJOR SUBBASIN
- PROPOSED STORM PIPE
- PROPOSED TYPE-R INLET
- FILING 20 BOUNDARY

FILING 20, BLOCKS 1, 2, AND 3

	VOLUME REQUIRED		VOLUME PROVIDED		ELEVATION (FEET)	RELEASE RATE (CFS)
	CUBIC FT	ACRE-FT	CUBIC FT	ACRE-FT		
WATER QUALITY	42,431	1.0	373,745	8.58	6076.48	
10 YEAR	83,821	1.9	1,311,156	30.10		N.A.
10 YEAR + WQ	126,252	2.9	1,684,901	38.68	6081.89	
100 YEAR	155,477	3.6	2,112,660	48.50		N.A.
100 YEAR + WQ	155,477	3.6	2,112,660	48.50	6083.80	

*FOR REGIONAL POND, LOCATED IN FILING 20 AT INTERSECTION OF MEADOWS BOULEVARD AND ELEGANT STREET. WQ IS INCLUDED IN 100 YEAR VOLUME

BLOCK 2, LOT 1A AND TRACT A

	VOLUME REQUIRED		VOLUME PROVIDED		ELEVATION (FEET)	RELEASE RATE (CFS)
	CUBIC FT	ACRE-FT	CUBIC FT	ACRE-FT		
WATER QUALITY	2,435	0.06	373,745	8.58	N.A.	
10 YEAR	4,811	0.11	1,311,156	30.10		N.A.
10 YEAR + WQ	7,246	0.17	1,684,901	38.68	N.A.	
100 YEAR	8,923	0.20	2,112,660	48.50		N.A.
100 YEAR + WQ	8,923	0.20	2,112,660	48.50	N.A.	

*FOR REGIONAL POND, LOCATED IN FILING 20 AT INTERSECTION OF MEADOWS BOULEVARD AND ELEGANT STREET. WQ IS INCLUDED IN 100 YEAR VOLUME

BLOCK 3, LOT 1A AND TRACT A

	VOLUME REQUIRED		VOLUME PROVIDED		ELEVATION (FEET)	RELEASE RATE (CFS)
	CUBIC FT	ACRE-FT	CUBIC FT	ACRE-FT		
WATER QUALITY	1,714	0.04	373,745	8.58	N.A.	
10 YEAR	3,387	0.08	1,311,156	30.10		N.A.
10 YEAR + WQ	5,101	0.12	1,684,901	38.68	N.A.	
100 YEAR	6,282	0.14	2,112,660	48.50		N.A.
100 YEAR + WQ	6,282	0.14	2,112,660	48.50	N.A.	

*FOR REGIONAL POND, LOCATED IN FILING 20 AT INTERSECTION OF MEADOWS BOULEVARD AND ELEGANT STREET. WQ IS INCLUDED IN 100 YEAR VOLUME

DESIGN POINT SUMMARY

D.P.	Q _s (cfs)	Q ₁₀₀ (cfs)
1	5.5	10.8
2	2.9	5.7
3	8.1	15.9
4	2.1	4.2
5	10.0	19.7
6	8.0	15.9
7	18.0	35.6
8	4.3	8.4
9	2.0	3.9
10	23.2	45.8
10a	7.9	15.7
11	14.1	27.9
12	3.3	14.2
13	16.8	40.8
14	1.5	2.9
15	17.9	43.1
16	38.5	83.7
17	11.5	22.7
18	2.0	3.9
19	12.8	25.2
20	1.4	2.7
21	3.2	6.4
22	4.4	8.7
23	16.6	32.8
24	18.3	36.2
25	34.3	67.6
26	2.0	5.4
27	0.9	3.6
28	30.3	61.2

BASIN SUMMARY

BASIN	Q _s (cfs)	Q ₁₀₀ (cfs)
A05	5.5	10.8
A10	2.9	5.7
A11	2.1	4.2
A15	8.0	15.9
A16	4.3	8.4
A20	2.0	3.9
A21	2.2	4.3
A25	14.1	27.9
OSA1	3.3	14.2
OSA2	1.5	2.9
OSA3	5.9	11.6
B05	0.3	0.5
C04	9.7	19.1
C05	2.0	3.9
C10	1.5	2.9
C15	16.9	33.4
C20	2.1	4.2
C21	1.4	2.7
C25	0.9	1.9
OSC1	1.9	3.8
OSC2	2.3	4.5
OSC3	1.7	3.4
OSC4	0.4	2.2
OSC4 *	2.0	4.0

SEE NOTE PROVIDED ON PLAN VIEW CONCERNING FLOW FOR BASIN OSC4*

Approved Addendum No. 1 to the Filing 20 Phase III Drainage Report (2004 Report) for The Meadows Filing No. 20 which includes: Filing No. 20 Phase 1, Amendment 2 (PWP 08-013) Block 2, Lot 1A (PWP 08-011) and Block 3, Lot 1A (PWP 08-012)

**ADDENDUM NO. 1 TO THE FILING 20
PHASE III DRAINAGE REPORT**

For

JUN 13 2008

THE MEADOWS FILING 20 TO INCLUDE:

**Filing No. 20 Phase 1,
Amendment 2 (PWP 08-013)
Block 2, Lot 1A (PWP 08-011)
Block 3, Lot 1A (PWP 08-012)**

*Located north of Meadows Boulevard and west of Meadows Boulevard
Sections 33 and 34, Township 7 South, Range 67 West,
Town of Castle Rock*

Prepared for:

Castle Rock Development Company
3033 E. First Avenue Ste. 410
Denver, CO 80206

Prepared by:

CVL Consultants of Colorado, Inc.
7901 E. Belleview Ave, Suite 150
Englewood, CO 80111
Phone (720) 482-9526

February 22, 2008
April 22, 2008
May 15, 2008

Approved Addendum No. 1 to the Filing 20 Phase III Drainage Report (2004 Report) for The Meadows Filing No. 20 which includes: Filing No. 20 Phase 1, Amendment 2 (PWP 08-013) Block 2, Lot 1A (PWP 08-011) and Block 3, Lot 1A (PWP 08-012)

55 acres and is this basin will now onto Meadows Boulevard and be captured by an existing Type-R curb inlet located in Meadows Boulevard between Future Street and Bilberry Street and released undetained into the Tributary to Plum Creek.

Sub-basin A25, a portion of Block 2, Lot 2, is 4.63 acres and is planned for future commercial development. In the future, runoff from this basin will collect in a private storm system and be conveyed to the Filing 20 regional detention pond via an existing and proposed public storm drain system. In the interim, before the lot develops, the runoff will be collected in Temporary Sediment Pond D and then be routed into the existing public storm system to the existing Filing 20 regional detention pond.

Sub-basin OSA1 is a 0.87-acre offsite basin that is planned for future Bilberry Street. Runoff from this basin will be captured by an existing Type-R curb inlet located at the intersection of Bilberry Street and Meadows Boulevard. This flow will then be routed to the existing Filing 20 regional detention pond by an existing public storm drain system.

DESCRIPTION OF ORIGINAL
OFFSITE BASIN HEREIN LABELED
AS 'SUB-BASIN OSA2' IS
PROPOSED RESTAURANT
PROJECT SITE.

Sub-basin OSA2 is a 0.37-acre offsite basin that is planned for future Bilberry Street. Runoff from this basin will be captured by an existing Type-R curb inlet located at the intersection of Bilberry Street and Meadows Boulevard. This flow will then be routed to the existing Filing 20 regional detention pond by an existing public storm drain system.

Sub-basin OSA3 is a 1.55-acre offsite basin that is part of Meadows Boulevard. Runoff from this basin will be captured by an existing Type-R curb inlet located between Bilberry Street and Future Street in Meadows Boulevard. This flow will then be routed undetained to the Tributary to Plum Creek.

Sub-basin B05 is 0.07 acres and is planned for future commercial development. Runoff from this basin will be captured by an existing Type-R curb inlet located at the intersection of Meadows Boulevard and Meadows Boulevard. This flow will then be routed through an existing storm system along the northeastern side of Meadows Boulevard and released undetained into the Tributary to East Plum Creek.

Sub-basin C04 is 2.56 acres and is planned for part of Block 3, Lot 1A, Tract A, Lot 1 Remainder, and Lot 1B. A proposed Type-13 combination inlet located at the northwestern corner of the proposed parking lot at DP17 will collect runoff from this basin. This flow will be routed to the Filing 20 regional detention pond via a proposed and existing public storm system.

FINAL WEIGHTED COMPOSITE BASIN COEFFICIENTS

Subdivision The Meadows Filing 20
Location Castle Rock

Project No. 30101307
Calculated By: ACS
Checked By: BRH
Date: 5/16/2008

Storm Drain Line B

Sub-Basin ID	Surface Description	Area (ac)	Percent Impervious (%)	Weighted Percent Impervious (%)	Weighted Runoff Coefficient (5yr)	Weighted Runoff Coefficient (100yr)
B05	Commercial	0.07	95%	95.0%	0.82	0.89
		0.07		95.0%	0.82	0.89

Summary of Basin B: 0.07 Ac. 95.0% Impervious

Summary Onsite Basin B
0.07 95.0%

Storm Drain Line C

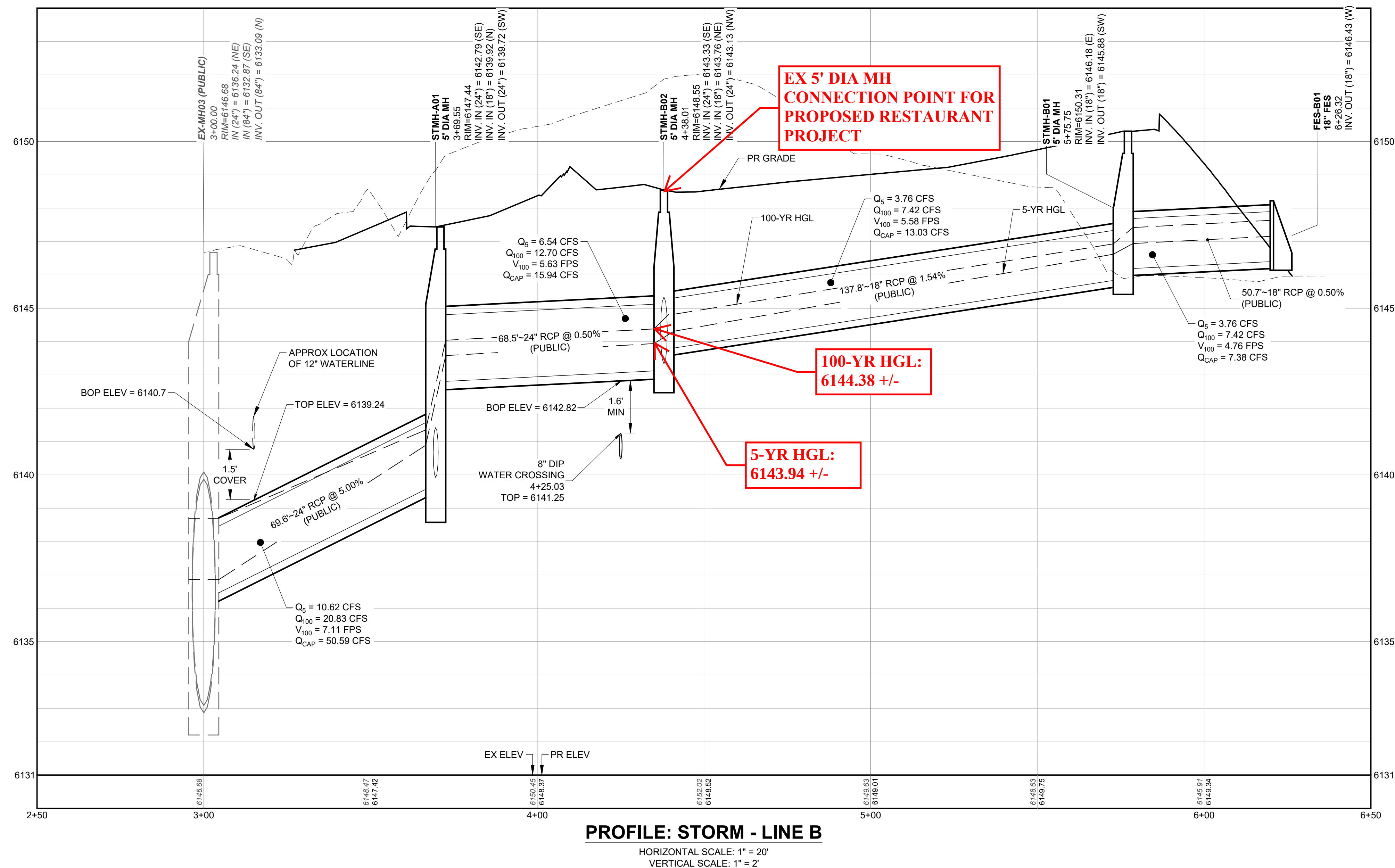
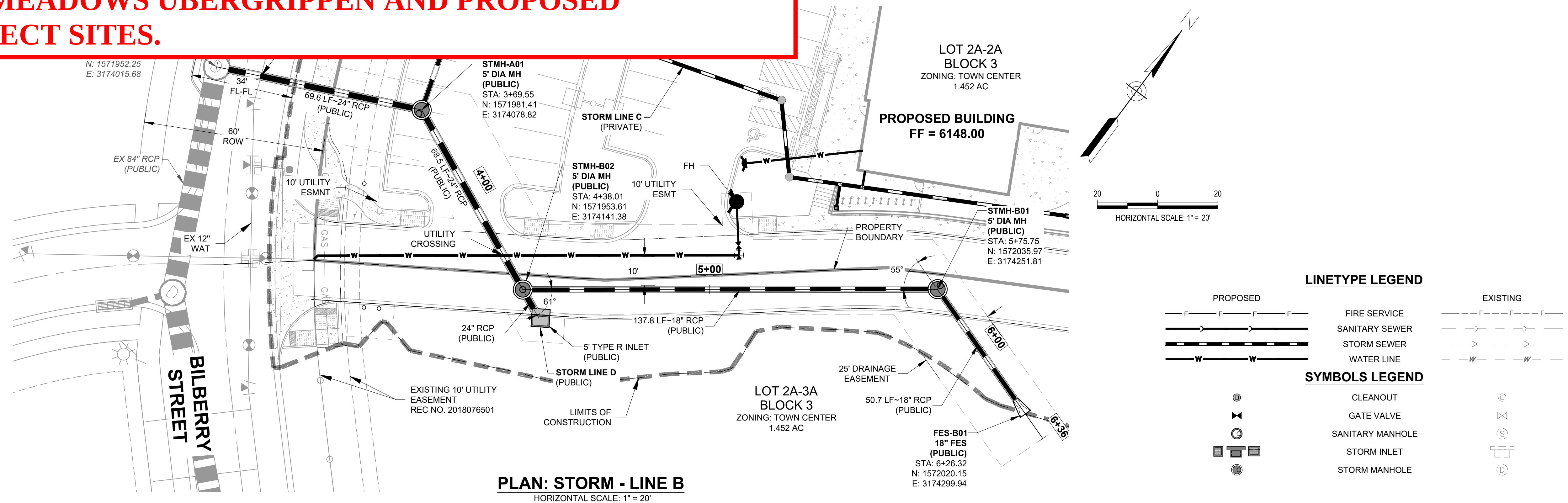
Sub-Basin ID	Surface Description	Area (ac)	Percent Impervious (%)	Weighted Percent Impervious (%)	Weighted Runoff Coefficient (5yr)	Weighted Runoff Coefficient (100yr)
C04	Commercial	2.56	95%	95.0%	0.82	0.89
		2.56		95.0%	0.82	0.89
C05	Commercial	0.50	95%	95.0%	0.82	0.89
		0.50		95.0%	0.82	0.89
C10	Commercial	0.37	95%	95.0%	0.82	0.89
		0.37		95.0%	0.82	0.89
C15	Commercial	5.12	95%	95.0%	0.82	0.89
		5.12		95.0%	0.82	0.89
C20	Commercial	0.62	95%	95.0%	0.82	0.89
		0.62		95.0%	0.82	0.89
C21	Commercial	0.34	95%	95.0%	0.82	0.89
		0.34		95.0%	0.82	0.89
C25	Commercial	0.25	95%	95.0%	0.82	0.89
		0.25		95.0%	0.82	0.89

Summary Onsite Basin C
9.76 Ac. 95.0%

PREVIOUS REPORT USED A TOTAL PERCENT COMPOSITE IMPERVIOUSNESS OF 95% (COMMERCIAL DEVELOPMENT). THIS VALUE IS GREATER THAN WHAT IS TO BE DEVELOPED FOR THE PROPOSED RESTAURANT PROJECT, WHERE I=45.5%.

Approved Addendum No. 1 to the Filing 20 Phase III Drainage Report (2004 Report) for The Meadows Filing No. 20 which includes: Filing No. 20 Phase 1, Amendment 2 (PWP 08-013) Block 2, Lot 1A (PWP 08-011) and Block 3, Lot 1A (PWP 08-012)

**EXISTING HGL FROM RECORD DRAWING OF EXISTING STORM MAIN IN
DRIVE ACCESS TO MEADOWS UBERGRIPPEN AND PROPOSED
RESTAURANT PROJECT SITES.**



BASIS OF BEARINGS

THE EAST LINE OF SECTION 33, TOWNSHIP 7 SOUTH, RANGE 67 WEST OF THE 6TH PRINCIPAL MERIDIAN, BEING MONUMENTED AT THE NORTHEAST CORNER BY A NO. 6 REBAR WITH 3-1/4" ALUMINUM CAP MARKED "AZTEC PLS 38064" AND AT THE SOUTHEAST CORNER BY A NO. 6 REBAR WITH 3-1/4" ALUMINUM CAP MARKED "AZTEC PLS 33204", ASSUMED TO BEAR SOUTH 01°03'47" EAST.

BENCHMARK

**SITE BENCHMARK IS DOUGLAS COUNTY CONTROL MONUMENT
2.015030. RECOVERED 3.25" ALUMINUM CAP LOCATED 410'
MORE OR LESS EAST OF THE RAILROAD TRACKS AND 3200'
MORE OR LESS NORTH OF MEADOWS PARKWAY.
ELEVATION = 6082.17 (NAVD 88).**

PROFESSIONAL ENGINEER CERTIFICATION

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY; AND THAT I AM FULLY RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATIVE TO SAID PLANS.



KURT A. LANG
COLORADO P.E., 32249

**TOWN OF CASTLE ROCK APPROVAL
DEVELOPMENT SERVICES**

APPROVED

DATE OF DEVELOPMENT SERVICES APPR
TOWN OF
by Dena Paulin

APPROVED BY
CASA DE ROCK
COLORADO

5-CD19-0044 Plans for Approval.pdf

Record Document on File

ROTH LANG
ENGINEERING GROUP LLC

7853 E. ARAPAHOE COURT, SUITE 2500
CENTENNIAL, CO 80112
PHONE: 303-841-9365

MEADOWS UBERGRIPPEN
PUBLIC IMPROVEMENT CONSTRUCTION PLANS
STORM LINE B - PLAN & PROFILE

UBERGRIPPEN REAL ESTATE VENTURE CASTLE ROCK, LLC
8610 E. 21ST AVENUE
DENVER, COLORADO 80238

[illegible]

DESIGNED BY:	DRT
--------------	-----

DRAWN BY:	DRT
-----------	-----

OB NUMBER:	190501
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SHEET NUMBER:

C9.11

12 OF 31

**REFERENCE MATERIAL FOR REGIONAL POND
PROVIDING WATER QUALITY FOR PROJECT SITE**

PHASE III FINAL DRAINAGE REPORT

FOR

THE MEADOWS FILING NO. 20

Volume 1 of 2

Prepared For:

Castle Rock Development Company
3033 East First Avenue, Suite 410
Denver, Colorado 80206

Prepared by:

RG Consulting Engineers, Inc.
1331 17th Street, Suite 710
Denver, CO 80202

June 2004

Revised August 2004

Revised September 2004

Revised October 2004

Project Reference No. CRDC-0304A

RGCE Job No. 820.0001



rg consulting engineers, inc.

Rock standards. Summary tables and schematic drawings from the StormCAD program are included in Appendix C for the 5 year and 100 year storm illustrating that the design criteria are met.

Major Drainage Channels

The two major drainage channels upstream of culvert 1 and culvert 2 were designed using the Manning's Formula Method in Flow Master for irregular channels (see Appendix C). The major drainage channels have a bottom width of 20 feet, a slope of 1.15 to 1.2 percent, and Froude numbers less than 0.80. These major drainage channels will have boulder edged low-flow channels (see Low Flow Channel section in Appendix C) which has been included in the Flow Master sections. All major drainage channels will be maintained by the Town of Castle Rock. All channels were designed to include 1 foot of free board. In addition, to determine the effect of backwater through the culverts, a HEC-RAS calculation was performed to show the hydraulic grade line through the channel.

Culverts

The two concrete box culverts sizes and headwater elevations were determined using the CulvertMaster computer program. The necessary culvert sizes were determined to ensure that design criteria outlined in the Public Works Regulations (Ref. 4) were met. These were also checked using the HEC-RAS computer program.

Detention Ponds & Water Quality

The design as outlined in the Phase I Master Drainage Report for The Meadows (Ref. 1) called for two regional detention ponds within The Meadows Filing No. 20, (see Master Drainage Report Supplemental Material in Appendix D). Due to layout constraints, The Meadows Filing No. 20 will install one larger Regional Detention Pond which is designed to detain the required detention and water quality capture volume (WQCV) for The Meadows Filing No. 18 and Filing No. 20 and release flow at historical rates (see Appendix C). UDSWM routing was used to determine release rates below historic release rates. This routing method was found to be the appropriate method because of the flows from historic Basins 201, 202 and 203 that are routed through the pond. These offsite basins are part of 6400 South Tributary routing and will also be released at historic rates when development occurs in this area.

The Regional Detention Pond was designed using UDSWM for the required detention and current Town of Castle Rock Standards for the WQCV (see Appendix C). The required 10-year and 100-year detention from UDSWM are 30.10 acre-feet and 48.50 acre-feet, respectively. The required WQCV was determined to be 8.58 acre-feet. Since the onsite detention pond is considered regional, the WQCV is included in the 100 year detention volume and will be added to the 10 year detention volume. The total required 10 year and 100 year detention volumes, including WQCV, for the Regional Detention Pond are 38.68 acre-feet and 48.50 acre-feet, respectively (see Appendix C). The method used to calculate the incremental volume provided in the Regional Detention Pond was modeled after the Urban Drainage Estimating Detention Volume Workbook Stage-Storage for Irregular Geometry spreadsheet.

The pond releases flow into the existing 20'x12' concrete box culvert which conveys the flow north underneath Meadows Boulevard. The release out of the pond and through the existing concrete box culvert needs to be at or below historical rates. The historical flow rate for the 10 year and 100 year storm north of the existing 20'x12' concrete box culvert are 307 cfs and 1012 cfs, respectively (see UDSWMM output for conveyance element 108 in Appendix G). The developed release rates out of the Regional Detention Pond for the 10-year and 100-year storm are 203 cfs and 991 cfs, respectively (see Appendix C). The developed 10 year and 100 year flows are below the historical 10 year and 100 year flows. Therefore, no downstream properties north of Meadows Boulevard will be negatively impacted by The Meadows Filing No. 18 or Filing No. 20 development.

Detention facilities, emergency spillways and water quality features of the outlet structure have been designed in conformance with the most recent Urban Drainage and Flood Control District criteria (Ref. 5), draft issue of March 2001, published issue of July 2001. Calculations are included in Appendix C.

Storm Sewer and Inlets

The layout of the proposed storm sewer system is shown on the Proposed Drainage Plan included with this report (see Pocket in Volume I). Design points have been placed at the proposed inlet locations to determine the approximate amount of runoff intercepted by each inlet. Runoff calculations for all inlet design points are shown on Standard Forms SF-2 and SF-3, and are included in Appendix B. Included in Appendix C are the calculations for inlet sizes and street capacities.

CONCLUSION

This Phase III Drainage Report was prepared in compliance with the Town of Castle Rock Public Works Regulations drainage improvement design criteria. Proposed drainage improvements for the site have been discussed. Regional detention for The Meadows Filing No. 18 and Filing No. 20 will be provided onsite in Regional Detention Pond. The major storm (100-year) system was designed to ensure the protection of property from significant damage during the major storm event. It has been shown that no downstream properties will be adversely affected from the development of The Meadows Filing No. 18 or Filing No. 20.

Regional Detention Pond - Required Detention and Water Quality Capture Volume

Subdivision: The Meadows Filing No. 20

Calculated by: VJV

Checked by: FJB

Job No.: 820.0001

Date: September 16, 2004

$$WQCV = IA/2400$$

100 Yr Storm

Basin(s)	Area, A (ac)	Impervious, I (%)	WQCV (ac-ft)	WQCV (cu-ft)
A-N	324.38	45.93	6.21	270,428
OS1	61.31	20.00	0.51	22,256
OS2	13.80	45.00	0.26	11,271
OS3	96.00	40.00	1.60	69,696
Total			8.58	373651

Required Detention for the 100 Yr Storm 48.50 ac-ft
Release Rate 991 cfs
(from UDSWMM Output**)

Required Detention for the 10 Yr Storm 30.10 ac-ft
Release Rate 203 cfs
(from UDSWMM Output**)

*Total Required Detention for the 100 Yr Storm 48.50 ac-ft

* - Water quality does not need to be added to the 100 year detention volume for regional detention ponds.

Total Required Detention for the 10 Yr Storm 38.68 ac-ft

100 Yr Historic Flows 1012 cfs

10 Yr Historic Flows 307 cfs

**Includes flows from Red Hawk Subdivision routed through pond but not detained.

The Meadows Filing 20

REGIONAL DETENTION POND VOLUME CALCULATIONS

SUBDIVISION The Meadows - Filing 20

CALCULATED BY VJV

DATE 10/14/04

POND DESIG	ELEV	AREA (ft ²)	VOLUME (ft ³)	VOLUME _{sum} (ft ³)	METHOD
PROPOSED REGIONAL DETENTION POND	6071.3	0	0	0	prismoidal
	6072	61452	14,338.80	14,338.80	
	6074	147114	202,431.52	216,770.32	
	6076	179373	325,954.46	542,724.78	
	6078	190356	369,674.61	912,399.40	
	6080	206164	396,414.92	1,308,814.32	
	6082	217326	423,440.96	1,732,255.28	
	6084	257236	474,001.61	2,206,256.89	
	6086	265447	522,661.50	2,728,918.39	
	6087	283905	274,624.30	3,003,542.69	

8.58 acre-feet = 373,744.80 ft³
 38.68 acre-feet = 1,684,900.80 ft³
 48.50 acre-feet = 2,112,660.00 ft³

By Interpolation
 Elev_{wq}(ft)= 6076.48
 Elev₁₀(ft)= 6081.89
 Elev₁₀₀(ft)= 6083.80

The Meadows Filing 20

DETENTION POND WEIR AND ORIFICE SIZING CALCULATIONS

SUBDIVISION The Meadows - Filing 20

CALCULATED BY VJV

DATE 10/14/04

REGIONAL DETENTION POND

WATER SURFACE	INVERT ELEV	PONDING ELEV	Qr (cfs)	HEAD at Qr (ft)	WEIR LENGTH (ft)	AREA (ft2)	ORIFICE DIAMETER (in)	
							Calculated	***Actual
*10yr	6076.48	6081.89	203.00	5.41	5.97			
**100yr	6081.89	6083.80	330.33	1.91	37.79			
***100yr	6071.30	6083.80	330.33	10.00		20.02	60.60	60 1/2

Detention pond outlet structure consists of three outlet boxes, each with a 72" outlet pipe. Center box contains water quality release, 10-year release rate and one-third of the total 100-year release rate. Side outlet boxes release one-third of the total 100-year release rate per box.

*10-year weir opening in center outlet box is contracted weir; $L = (Q_r / (3.3h^{1.5})) + 0.2h$

**2-100-year side boxes-flow is controlled by standard weir, length of walls; $L = Q_r / (3.3h^{1.5})$

***Center outlet box 100-year flow is controlled by orifice plate over outlet pipe; $Area = Q_r / (.65(2gh)^{1/2})$

The Meadows Filing 20

WEIR DESIGN

Pond: WATER QUALITY/DETENTION POND

DESIGNED BY: VJV

JOB NAME

The Meadows - Filing 20

DATE:

14-Oct-04

EMERGENCY OVERFLOW WEIR DESIGN

Determine min. weir length to assure control of the pipe inlet:

Release Rate (Q_{weir})= 1982.00 cfs = 2 x 100 yr. release

$$L = Q_{\text{weir}} / (C(H)^{3/2})$$

Where:

Q_{weir}= 1982.00 cfs

C= 3.4

from Table 1301

H= 3.20 ft

Weir Height

L= 101.8 ft

Length of Weir

WATER QUALITY OUTLET SIZING (DRY POND)

SUBDIVISION The Meadows - Filing 20CALCULATED BY VJV DATE 10/14/04

WATER QUALITY CONTROL DESIGN

Water Quality Volume:373,745 ft³

8.58 acre-ft

*Required Area Per Row:6.31 in² $a = WQCV/K_{40}$ $K_{40} = 0.013D_{WQ}^2 + 0.22D_{WQ} - 0.10$ Number/Size of Holes per Row:

8 Columns of 1" Diameter Holes

Depth at Outlet:

5.1 ft

# Columns	Area per diameter of hole and number of columns												
	1/4	3/8	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/8	1 1/4
1	0.049	0.110	0.196	0.249	0.307	0.371	0.442	0.518	0.601	0.690	0.785	0.994	1.227
2	0.098	0.221	0.393	0.497	0.614	0.742	0.884	1.037	1.203	1.381	1.571	1.988	2.454
3	0.147	0.331	0.589	0.746	0.920	1.114	1.325	1.555	1.804	2.071	2.356	2.982	3.682
4	0.196	0.442	0.785	0.994	1.227	1.485	1.767	2.074	2.405	2.761	3.142	3.976	4.909
5	0.245	0.552	0.982	1.243	1.534	1.856	2.209	2.592	3.007	3.451	3.927	4.970	6.136
6	0.295	0.663	1.178	1.491	1.841	2.227	2.651	3.111	3.608	4.142	4.712	5.964	7.363
7	0.344	0.773	1.374	1.740	2.148	2.599	3.093	3.629	4.209	4.832	5.498	6.958	8.590
8	0.393	0.884	1.571	1.988	2.454	2.970	3.534	4.148	4.811	5.522	6.283	7.952	9.817



Phase III Drainage Report Checklist

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

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

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

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

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

Phase III Drainage Report Checklist

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

Notes/Comments: