



**PHASE I DRAINAGE REPORT
FOR
MILLER'S LANDING PDP AMENDMENT #1
Castle Rock, Colorado 80109**

PROJECT NO. PDP20-xxxx

PREPARED FOR:

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PREPARED BY:

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3473 S. Broadway
Englewood, CO 80113
Phone: 303-703-4444
Contact: Elna L. Smith
CORE Project Number: 17-069-005

May 2021



APPROVAL BLOCKS

I. ENGINEER'S STATEMENT:

I affirm that this report and plan for the Phase I Drainage design of the Miller's Landing PDP Amendment #1 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.



Robert D. Hansen, PE, CFM
Colorado Professional Engineer
License #50417

II. TOWN OF CASTLE ROCK APPROVALS:

UTILITIES DEPARTMENT

DATE

DEVELOPMENT SERVICES

DATE



TABLE OF CONTENTS

I.	GENERAL LOCATION AND DESCRIPTION	4
1.1.	Site Location	4
1.2.	Description of Property and Land Use	4
2.	DRAINAGE BASIN AND SUB-BASINS	5
2.1.	Major Drainage Basins	5
2.2.	Minor Drainage Basins	5
3.	EXISTING STORMWATER CONVEYANCE OR STORAGE FACILITIES	5
3.1.	Existing Stormwater Conveyance Facilities	5
3.2.	Existing Stormwater Storage Facilities	6
4.	PROPOSED STORMWATER CONVEYANCE OR STORAGE FACILITIES	6
4.1.	Proposed Stormwater Conveyance Facilities	6
4.2.	Proposed Stormwater Storage Facilities	7
5.	WATER QUALITY ENCHANCEMENT BEST MANAGEMENT PRACTICES	7
5.1.	Non-Structural Best Management Practices	7
5.2.	Structural Best Management Practices	7
6.	FLOODPLAIN MODIFICATIONS	8
6.1.	Major Drainageway – Undesignated Floodplain	8
6.2.	Major Drainageway – Designated Floodplain	8
7.	POTENTIAL PERMITTING REQUIREMENTS	8
8.	REFERENCES	9

APPENDICES

APPENDIX A: DRAINAGE REPORT CHECKLIST

APPENDIX B: FIGURES

APPENDIX C: CALCULATIONS

APPENDIX D: REFERENCE MATERIAL

APPENDIX E: DRAINAGE PLAN



I. GENERAL LOCATION AND DESCRIPTION

I.1. Site Location

The Miller's Landing site is located north of W. Plum Creek Parkway approximately 1,300 feet west of the intersection of Interstate 25 (I-25) and W. Plum Creek Parkway in the Town of Castle Rock, Colorado. The site is primarily within the Northeast Quarter (NE ¼) of Section 10 with a small portion in the Southeast Quarter (SE ¼), Township 8 South, Range 67 West of the 6th P.M. in the Town of Castle Rock, County of Douglas, State of Colorado. The site is bound to the north by an existing drainageway known as the Industrial Tributary, further north by an existing industrial area; to the east by the ACME Brick property and an undeveloped land that is part of the Castle Meadow Planned Development also known as Castle Meadows Northeast Parcel, further east by the railroad and Interstate 25 (I-25); to the south by existing W. Plum Creek Parkway, further south by an undeveloped land that is part of the Castle Meadow Planned Development, and to the southwest by the Philip S. Miller Activity Complex. Roadways near the property that are not served by the proposed drainage improvements are the existing alignment of Prairie Hawk Drive, Topeka Way, and I-25. The proposed realignment of Prairie Hawk Drive will be served by the proposed drainage improvements. A vicinity map is provided in Appendix A.

I.2. Description of Property and Land Use

The Miller's Landing property includes approximately 48.2-acres of undeveloped land. Portions of the site were previously disturbed but have generally been revegetated. The site generally drains to the north and northeast toward the Industrial Tributary. A local storm sewer system collects runoff from a portion of W. Plum Creek Parkway and Castle Meadows and outlets to the project site. The Industrial Tributary is shown on FEMA FIRM Panel 08035C0301G dated March 16, 2016, a portion is identified as Shaded Zone X, refer to Appendix B. The improvements proposed for the Industrial Tributary within the *Public Improvement Construction Plans, Miller's Landing Tributary*, ToCR project number CD19-0029, *Floodplain Modification Study-Industrial Tributary*, ToCR project number FD19-0006, and associated documents are in the final approval process by the Town of Castle Rock to date. These plans and report demonstrate that the Miller's Landing site area will be outside the flood zone.

The soils vary throughout the site and include Newlin gravelly sandy loam (NeE), Fondis clay loam (FoD) and Pits clay (CP). The Newlin gravelly sandy loam is part of the Type B hydrologic soil group, the Fondis clay loam is part of the Type C hydrologic soil group and the Pits clay soil type is assumed to be part of the Type D hydrologic soil group. For the purposes of this Phase I Study we are assuming soils group C as a worst case scenario. A soils map has been provided in Appendix B.

The property is currently zone as IO, Interchange Overlay District, supporting a Mixed Use Development. The specific future uses, and site configuration have not been determined at this time. It is likely the development will include retail stores, food and beverage establishments, entertainment establishments, office space, hotel accommodations and a residential component.

The project will complete the northeast half of W. Plum Creek Parkway along its frontage and extending east to the I-25 southbound off-ramp. The project will also extend Atchison Way from Topeka Way to W. Plum Creek Parkway, a portion of the Atchison Way extension right-of-way near W. Plum Creek Parkway has been platted and is referred to as Prairie Hawk Drive.



2. DRAINAGE BASIN AND SUB-BASINS

2.1. Major Drainage Basins

The Miller's Landing site is in a portion of the Industrial Watershed which outfalls to East Plum Creek. The Industrial Watershed was studied as part of the Omni, Industrial and Westfield Watershed Master Plan report by CH2MHill in January 2011, referred to as the Master Plan hereafter. The Master Plan provided a comprehensive drainage plan and flood plain analysis for the Omni, Industrial and Westfield Watersheds, including providing recommendations for channel improvements. The Master Plan is referenced throughout this report, reference material can be found in Appendix D. The provided reference information has been reviewed and accepted for use in this report. In conjunction with the Master Plan a Flood Hazard Area Delineation study was also completed in April 2013 that mapped the Shaded Zone X area for Industrial Tributary. The Miller's Landing project prepared a Floodplain Modification Study for the reach upstream of the Miller's Landing site in preparation of the channel restoration of that same reach. The Town of Castle Rock has studied the Industrial Tributary reach downstream of the Miller's Landing site and had begun channel restoration construction in the end of 2019 within that area. As previously mentioned, the Floodplain Modification Study-Industrial Tributary, ToCR project number FD19-0006, is in the final approval stage with the Town.

2.2. Minor Drainage Basins

The project is affected by offsite storm flows from a portion of the Castle Meadows property and a portion of W. Plum Creek Parkway. A Final Drainage Report for Miller's Landing Phase I, Castle Rock Project CD19-0019, by CORE Consultants dated April 16, 2020 was used to quantify offsite flows impacting the project site. This study will be referred to as the ML Phase I Study hereafter with reference material found in Appendix D. The provided reference information has been reviewed and accepted for use in this report. The ML Phase I Study master planned the improvements for the full build out of the Miller's Landing project and identified sub-basin groups using lettered/numbered designations. In the existing condition the Miller's Landing site is adjacent to and receiving runoff from the Castle Meadows sub-basin groups OS1 and OS2 and a portion of W. Plum Creek Parkway sub-basin group B1-B7. The referenced sub-basins are shown in the Existing Conditions Exhibit, referenced in Appendix D.

The project site will generally follow the historic drainage patterns with some minor rerouting due to the proposed roadways and development. An onsite storm sewer system will collect and convey developed runoff to proposed detention ponds located as shown on the drainage map, in Appendix E.

3. EXISTING STORMWATER CONVEYANCE OR STORAGE FACILITIES

3.1. Existing Stormwater Conveyance Facilities

An existing 18ftx10ft box culvert conveys flow in the Industrial Tributary under W. Plum Creek Parkway at the west edge of the project site. The Industrial Tributary continues northeast along the northern edge of the project site.

Significant erosion is present along the Industrial Tributary; channel improvements in the Public Improvement Construction Plans – Miller's Landing Tributary, Town project number CD19-0029, to the are in final review and approval at the Town of Castle Rock.

A storm drain system collects flow from the A basins and discharges on the south side of W. Plum Creek Parkway and east of the Industrial Tributary to a water quality basin, discharging into the Industrial Tributary upstream of the W. Plum Creek Parkway box culvert. Off-site basin OS1 currently sheet flows historic flow rates to W. Plum Creek Parkway and is captured by an existing storm system in basin B3. Off-site basin OS2 currently sheet flows historic flow rates to a sump condition on the south side of W. Plum Creek Parkway, entering an existing storm sewer system in basin B6. The existing storm sewer system that collects runoff from the B basins will need to be extended and collect runoff to support the buildout of W. Plum Creek Parkway. This existing storm sewer system currently discharges at grade onto the Miller's Landing property. A portion of the Miller's Landing project area was graded under the Grading, Erosion, & sediment Control Plan for Miller's Landing Phase I Early Grading, ToCR project number GES19-0009. Runoff from the existing pipe discharge is routed through the project site to Pond A, a water quality pond at the north-central area of the project. Within the C sub-basins existing storm drain stubs have been provided to serve the future roadway expansion. The C sub-basin storm sewer system discharges to an existing water quality pond, adjacent to I-25.

An existing earthen channel conveys runoff from an existing culvert crossing Topeka Way at Atchison Way to the Industrial Tributary. With the extension of Atchison Way (Prairie Hawk Drive) from Topeka Way to W. Plum Creek Parkway this runoff will be collected into a storm sewer system. Additionally, there appears to be significant erosion in the existing channel that will be alleviated by the roadway and storm system construction. The discharge from this storm system will be incorporated into the Industrial Tributary mitigation construction.

3.2. Existing Stormwater Storage Facilities

Within the project site there are no existing stormwater storage facilities. Pond A is a temporary water quality treatment facility constructed with the Early Grading mentioned above.

4. PROPOSED STORMWATER CONVEYANCE OR STORAGE FACILITIES

4.1. Proposed Stormwater Conveyance Facilities

The Miller's Landing project will provide storm sewer systems to route runoff to water quality/detention facilities. A culvert crossing will be required to convey flow in the Industrial Tributary under the Atchison Way (Prairie Hawk Drive) roadway extension. Additionally, a grade separated multi-use trail is planned to follow the Industrial Tributary, it is anticipated that the trail will cross over the roadway; therefore, no accommodation within the Tributary is necessary at the crossing.

The existing storm sewer systems in W. Plum Creek Parkway will need to be modified in conjunction with the roadway expansion. The B basin storm drain system will be extended through the project site to a water quality/detention facility, Pond A. The off-site basins



OS1 and OS2 are anticipated to provide water quality/detention on the south side of W. Plum Creek Parkway when those parcels develop. The proposed storm sewer system within Miller's Landing will accommodate historic runoff rates for those basins.

Onsite runoff west of the Atchison Way (Prairie Hawk Drive) extension will be routed through the site via surface flow and onsite storm sewer systems. Runoff will generally be conveyed northeast to the proposed water quality/detention facility, Pond A. The size and location of this storm drain system will be designed during the detailed design phase of the project. Onsite runoff east of the Atchison Way (Prairie Hawk Drive) extension will be routed through the site via surface flow and onsite storm sewer systems, generally conveyed to water quality/detention facility, Pond B. Runoff from a portion of the Atchison Way (Prairie Hawk Drive) extension roadway will be conveyed easterly via surface flow and onsite storm sewer system to a future water quality/detention facility within the Castle Meadows NE parcel, Pond C. An interim water quality/detention facility will be provided.

4.2. Proposed Stormwater Storage Facilities

The proposed water quality/detention facilities, Ponds A, B and C, will be designed as a full-spectrum detention pond (WQCV, EURV, 100-year), and will release at the required flow rates. The water quality/detention pond volume has been calculated using the Urban Drainage spreadsheet for detention ponds. The location and configuration of Ponds are conceptual and subject to change. Refer to Appendix C for calculations. Ponds A and B will release runoff at historic rates into the Industrial Tributary. The runoff collected from the southern portion of the Atchison Way (Prairie Hawk Drive) extension will be collected in a storm sewer system and will discharge into Interim detention facility Pond C, near the NE corner of the Castle Meadows NE parcel. Interim Pond C will discharge to an existing channel on the east side of existing Prairie Hawk Drive at historic rates. When the Castle Meadows NE Parcel develops a permanent water quality/detention facility will incorporate this runoff with the runoff of that parcel.

5. WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES

5.1. Non-Structural Best Management Practices

The project will utilize non-structural best management practices as defined in the future grading, erosion, & sediment control plans for the site during construction. They will include but are not limited to silt fence, inlet protection, diversion ditches, check dams, and sediment basins. Post construction best management practices may include swales and permanent seeding.

5.2. Structural Best Management Practices

Water quality measures will be included in the design of the proposed water quality/detention facilities for the site. The facilities will be designed as extended detention basin which will incorporate structures which will release flows for the excess urban runoff volume (EURV), and the 100-year storm event. Stream stabilization improvements at the outfall of the facilities within Industrial Tributary will also be incorporated.



6. FLOODPLAIN MODIFICATIONS

6.1. Major Drainageway – Undesignated Floodplain

The Industrial Tributary is the only major drainageway impacted by the project and for the purpose of this report will be addressed in Section 6.2.

6.2. Major Drainageway – Designated Floodplain

A portion of the Industrial Tributary directly adjacent to the project is currently mapped as a Zone AE floodway, the portion of the channel to the west of the project is mapped as Shaded Zone X. The Industrial Tributary was studied by the *Omni, Industrial and Westfield Watersheds Flood Hazard Area Delineation* report by CH2MHill in April 2013 in conjunction; and most recently studied by the *Floodplain Modification Study-Industrial Tributary*, ToCR project number FD19-0006 by WaterVation, PLLC, and the *Public Improvement Construction plans-Miller's Landing Tributary*, ToCR project number CD19-0029; currently under final review by the Town of Castle Rock. The afore mention plans remove all developable land withing Miller's Landing from the flood zone.r

7. POTENTIAL PERMITTING REQUIREMENTS

According to the Master Plan, the United States Fish and Wildlife Service (USFWS) have not identified any areas of the Industrial Tributary as “riverine wetlands” or as “emergent wetlands”. The Industrial Tributary has been included in the Department of the Army, Corps of Engineers, Regional General Permit, RGP No. 37 and is valid until October 20, 2022.

CORE Consultants, Inc. completed a Wildlife and Habitat Assessment Report dated July 2019 and determined that no sensitive wildlife species or critical habitats were observed during the field survey; this includes the Preble's Meadows Jumping Mouse.

8. REFERENCES

- CH2MHill. *Omni, Industrial and Westfield Watershed Master Plan: Final Preliminary Design Report*. January 2011. Town of Castle Rock, Colorado
- CORE Consultants, Inc. *Phase III Drainage Report for Miller's Landing Phase I*. December 20, 2019. Town of Castle Rock, Colorado
- CORE Consultants, Inc. *Wildlife and Habitat Assessment Report*. July 2019. Town of Castle Rock, Colorado.
- Town of Castle Rock: Utilities Department. *Storm Drainage Design and Technical Criteria Manual*. Originally published September 2007, Revised October 2012. Town of Castle Rock, Colorado.
- Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual: Volume 1: Management, Hydrology, and Hydraulics*. Originally published September 1969, Updated January 2016, Revised August 2018. Denver, Colorado.
- Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual: Volume 2: Structures, Storage, and Recreation*. Originally published September 1969, Updated January 2016, Revised September 2017. Denver, Colorado.
- Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual: Volume 3: Best Management Practices*. Originally published September 1992, Updated November 2010, Revised April 2018. Denver, Colorado



APPENDICIES

APPENDIX A

Drainage Report Checklist

APPENDIX B

Figures

APPENDIX C

Calculations

APPENDIX D

Reference Material

APPENDIX E

Drainage Plan



3473 South Broadway
Englewood, Colorado 80113
303.703.4444

LIVEYOURCORE.COM

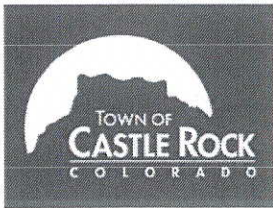
APPENDIX A

Drainage Report Checklist



3473 South Broadway
Englewood, Colorado 80113
303.703.4444

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Utilities Department
 175 Kellogg Court, Castle Rock CO 80109
 720-733-6000

Phase I Drainage Report Checklist

The Phase I 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 I Drainage Report must be signed and sealed by a Professional Engineer licensed in the State of Colorado. The purpose of the Phase I Drainage Report is to describe, at a conceptual level, the feasibility and design characteristics of stormwater management facilities within the proposed development.

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 I 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 I Drainage Report.

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

Included	N/A	
✓		I. COVER SHEET
✓		A. Name of Project, including legal name of development
✓		B. Address
✓		C. Owner
✓		D. Developer
✓		E. Engineer
✓		F. Submittal date and revision dates as applicable
✓		II. GENERAL LOCATION AND DESCRIPTION
✓		A. Site Location
✓		B. Description of Property and Land Use
✓		III. DRAINAGE BASIN AND SUB-BASINS
✓		A. Major Drainage Basins
✓		B. Minor Drainage Basins
✓		IV. EXISTING STORMWATER CONVEYANCE OR STORAGE FACILITIES
✓		A. Existing Stormwater Conveyance Facilities
✓		B. Existing Stormwater Storage Facilities
✓		V. PROPOSED STORMWATER CONVEYANCE OR STORAGE FACILITIES
✓		A. Proposed Stormwater Conveyance Facilities
✓		B. Proposed Stormwater Storage Facilities

Phase I Drainage Report Checklist

Included	N/A	
✓		VI. WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES
✓		A. Non-structural Best Management Practices
✓		B. Structural Best Management Practices
✓		VII. FLOODPLAIN MODIFICATIONS
✓		A. Major Drainageway—Undesignated Floodplain
✓		B. Major Drainageway—Designated Floodplain
✓		VIII. POTENTIAL PERMITTING REQUIREMENTS
✓		IX. REFERENCES
✓		X. APPENDICES
	✓	OVERALL DRAINAGE PLAN (IN POCKET) <i>Referenced</i>
✓		DETAILED DRAINAGE PLANS (IN POCKET)

Notes/Comments:

APPENDIX B

Figures

Vicinity Map

FIRM Maps

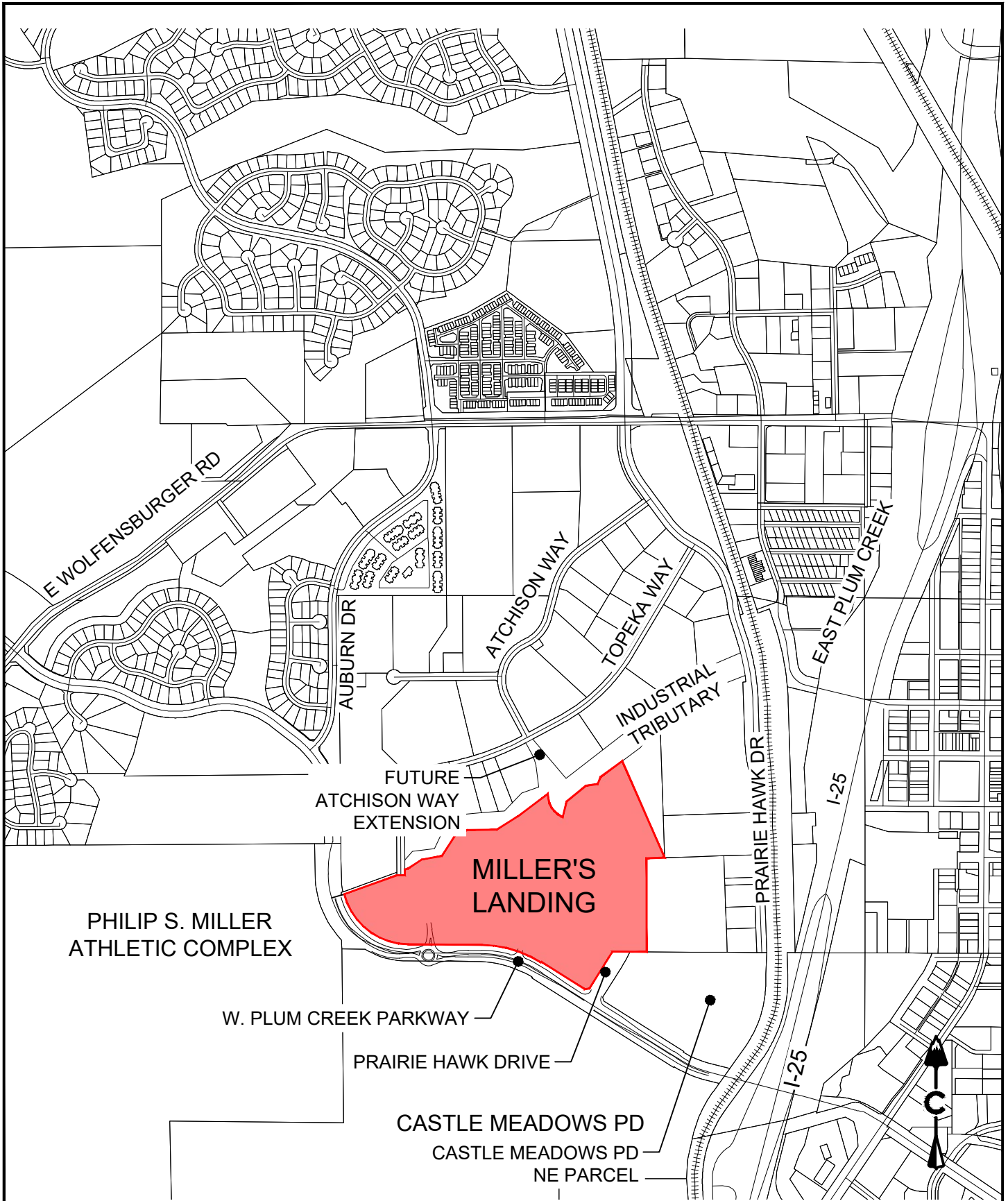
LOMR

Soils Map



3473 South Broadway
Englewood, Colorado 80113
303.703.4444

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S:\17002\17-069 MILLER'S LANDING\CAD\REF\VC MAP\VC MAP-ALL.PDF AMEND 1.DWG

CORE
CORE CONSULTANTS, INC.
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0 1,000'
1 inch = 1,000 ft.

MILLER'S LANDING VICINITY MAP

CREATED BY: MJG

DATE: 05/D17/21

SHEET NUMBER
1
OF 1 SHEETS
JOB NUMBER
17-069

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 1985 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 Geographic Survey website at <http://www.ngs.noaa.gov> or contact the National Geographic Survey at the following address:

NGS Information Services
NOAA, NGS12
National Geodetic Survey
SSMOC-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 the 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.

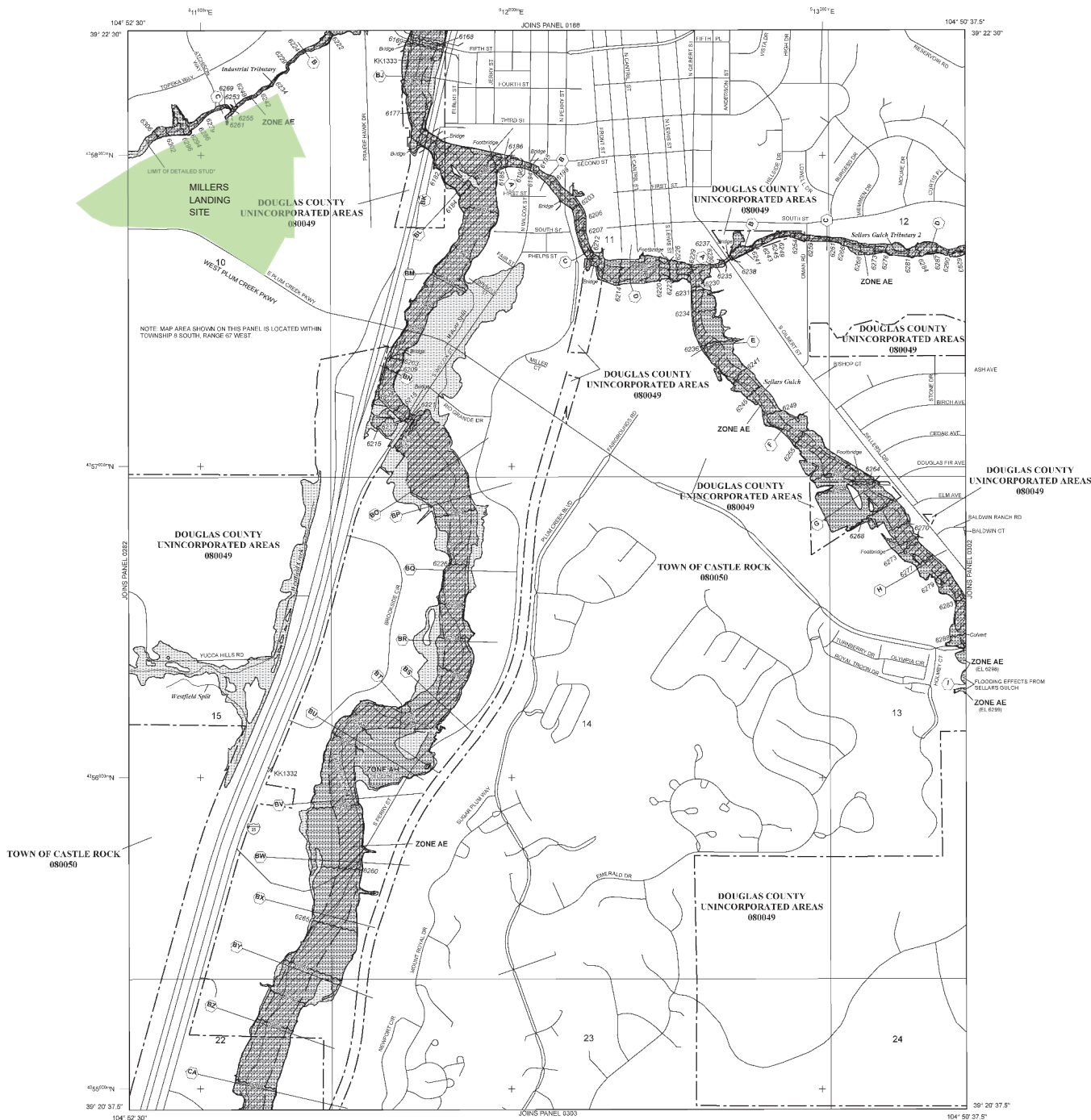
Based on updated topographic information this map reflects more detailed and up-to-date stream channel configurations and floodplain delineations than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance 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 unincorporated 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 details 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://map.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/mip>.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO FLOODING 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 1% annual chance flood is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, AR, AP, 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 AH**
Base Flood Elevations determined.
- ZONE AO**
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average flood depths determined.
- ZONE AR**
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average flood depths determined.
- ZONE AP**
Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently determined. Zone AP indicates that the former flood control system is being retained to provide protection from the 1% annual chance or greater flood.
- ZONE V**
Areas not protected by a Federal Flood Protection System under construction; no Base Flood Elevations determined.
- ZONE VE**
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- 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 average areas less than 1 square mile and areas protected by levees from the 1% annual chance flood.
- OTHER AREAS**
- ZONE D**
Areas determined to be outside the 0.2% annual chance floodplain. 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.
- 0.2% Annual Chance Floodplain Boundary**
- Floodway boundary**
- Zone D boundary**
- CBRS and OPA boundary**
- Boundary dividing Special Flood Hazard Area Zone and boundary dividing Special Flood Hazard Areas of different Base Flood Elevation, flood depths, or flood velocities.**
- Base Flood Elevation line and value; elevation in feet**
- Base Flood Elevation value where uniform within zone; elevation in feet**
- Reference to the North American Vertical Datum of 1988**
- A** **B**
Cross section line
- A** **B**
Transect line
- 41° 02' 00", 89° 02' 00"**
Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 1000-meter Universal Transverse Mercator grid values, zone 13**
- CHS10 X**
Bench mark (see explanation in Notes to Users section of this FISRM panel)
- N.T.S.**
Not To Scale
- MAP REPOSITORIES**
Refer to Map Repository List on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP**
SEPTEMBER 31, 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 map notes and data names, to reflect updated topographic information, to incorporate previously issued letters of map revision.
- For community map version history prior to community 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.**
- MAP SCALE 1" = 500'**
- 250 0 500 1000**
FEET
- 150 0 150 300**
METERS

NFIP **PANEL 0301G**

FIRM
FLOOD INSURANCE RATE MAP
DOUGLAS COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 301 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
	CASTLE ROCK, TOWN OF	080049	0301	G
	DOUGLAS COUNTY	080049	0301	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
080350301G
MAP REVISED
MARCH 16, 2016

Federal Emergency Management Agency

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, NNGS12
National Geodetic Survey
SSMCC-3 #0002
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.

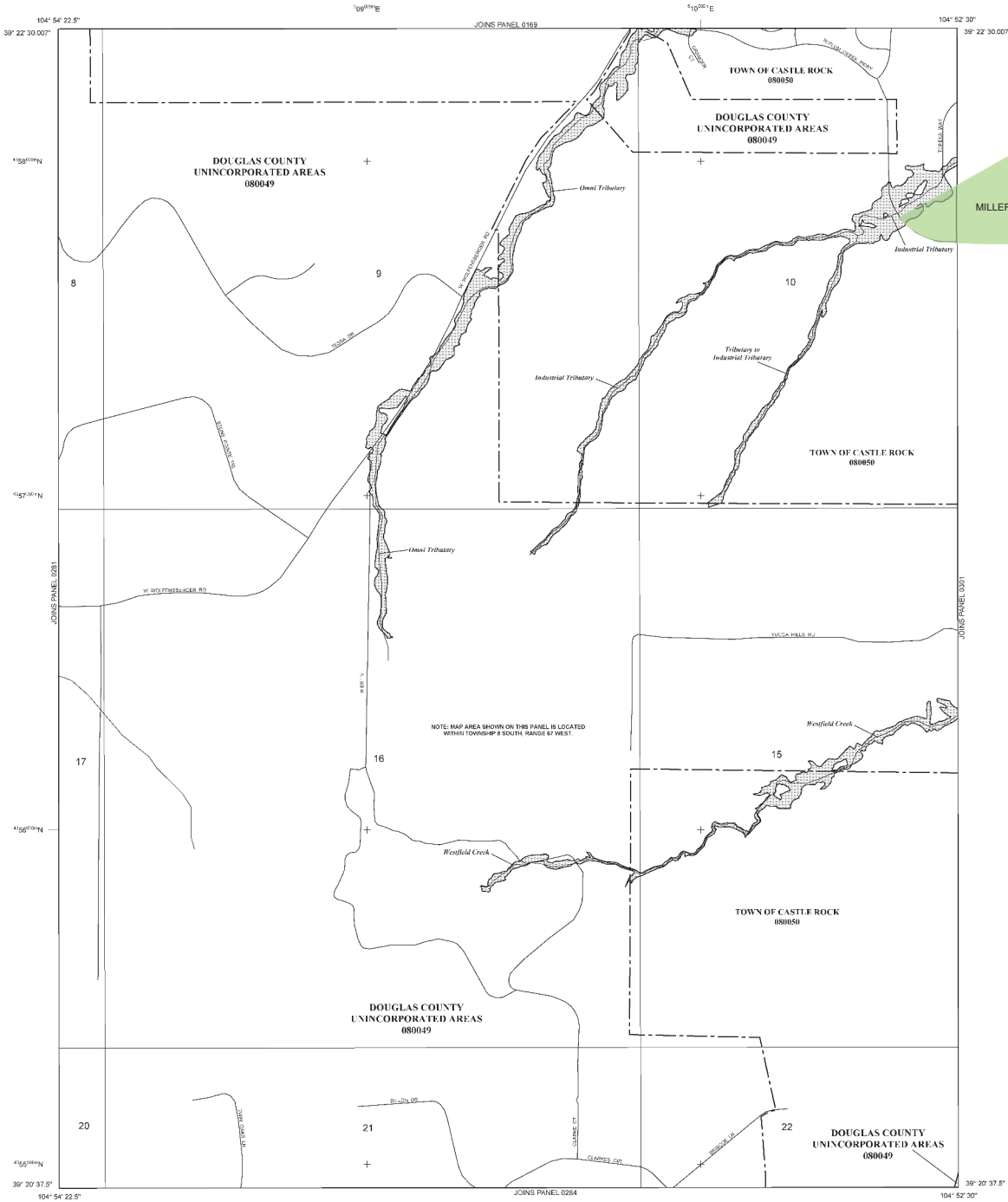
Based on updated topographic information, this map reflects more detailed and up-to-date stream channel configurations and floodplain delineations than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance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



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO FLOODING 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 1% annual chance flood is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, VE, and V. 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 are determined for areas of sheet flow. Base Flood Elevations determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently determined. Zone AR indicates that the former flood control system is being retained to provide protection from the 1% annual chance or greater flood.
- ZONE APF** Areas to be protected from the 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 to allow the 1% annual chance flood to 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 a slope area less than 1 square mile, and areas protected by levees from the 1% annual chance flood.

OTHER AREAS

ZONE D Areas determined to be outside the 0.2% annual chance floodplain. 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

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 (the real value, elevation in feet)

Base Flood Elevation value where uniform within zone; elevation in feet

Referenced to the North American Vertical Datum of 1988

Cross section line

Transect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

1000-meter Universal Transverse Mercator grid values, zone 13

Bench mark (see explanation in Notes to Users section of this FIRM)

Map repository

Refer to Map Repository for 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 map notes, to reflect updated topographic information, to incorporate previously issued letters of map revision.

For community map version history prior to community 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.

MAP REPOSITORIES

Refer to Map Repository for Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

SEPTEMBER 30, 2005

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MAP REPOSITORIES

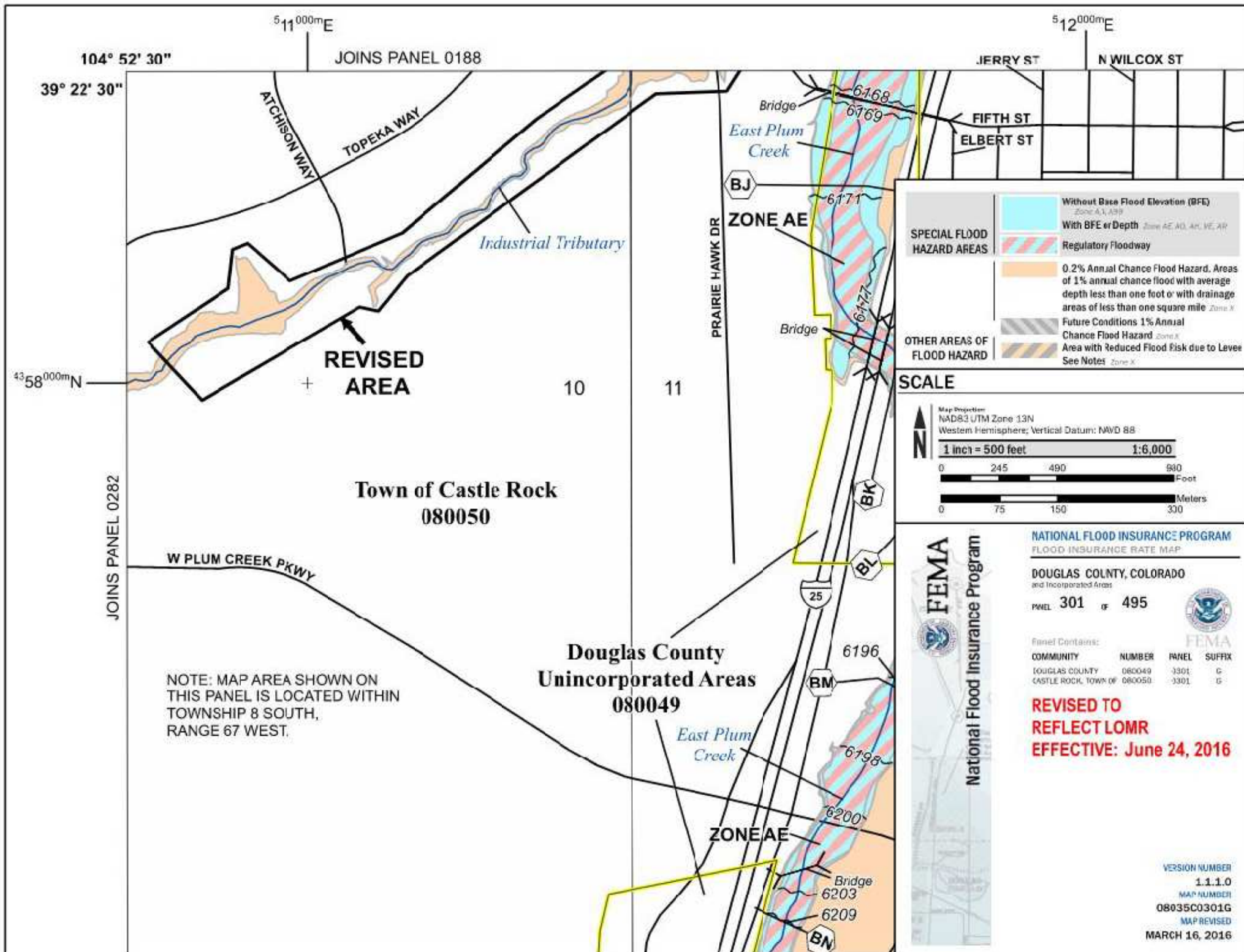
Refer to Map Repository for Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

SEPTEMBER 30, 2005

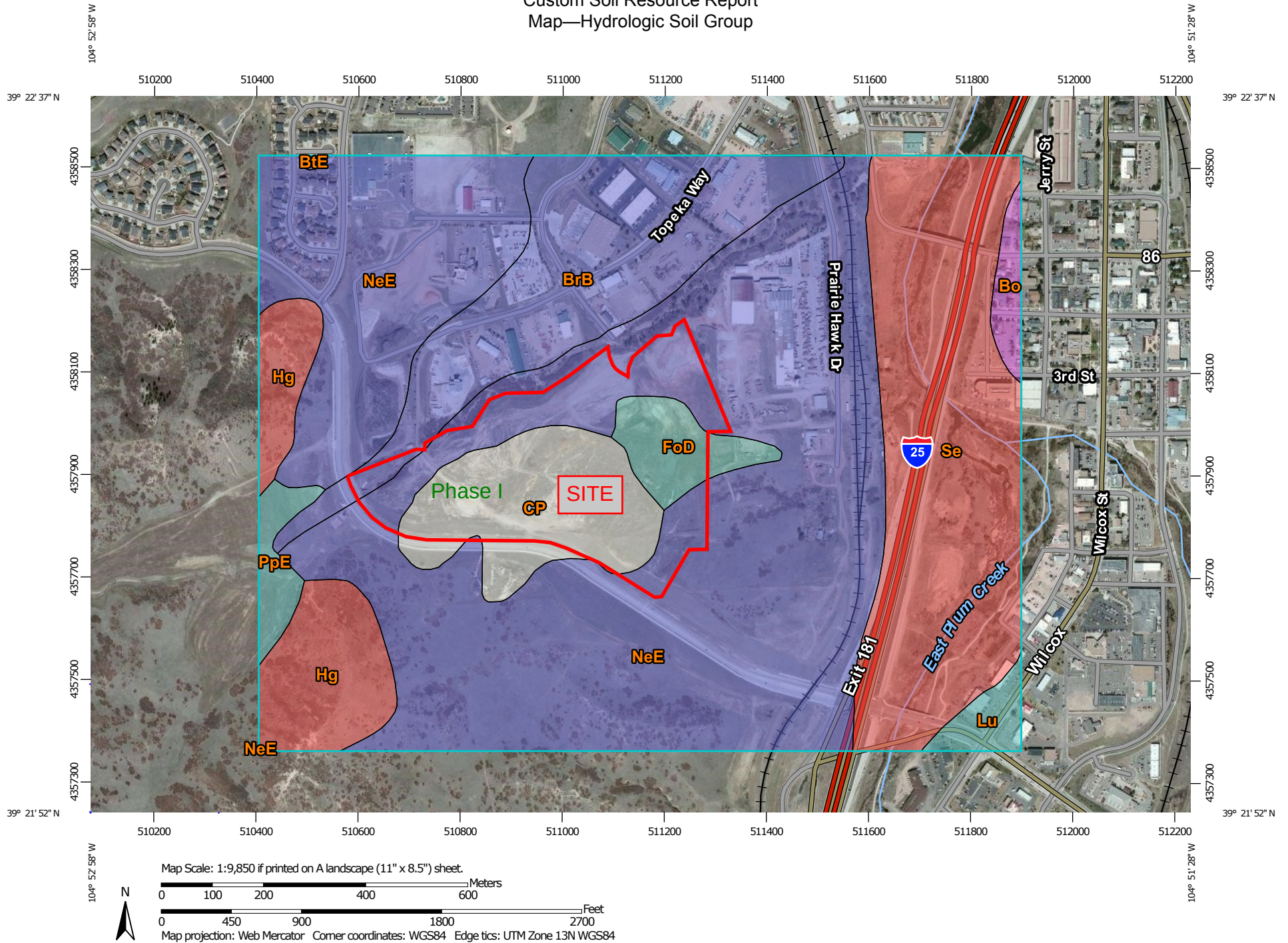
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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 map notes, to reflect updated topographic information, to incorporate previously issued letters of map revision.



Custom Soil Resource Report

Map—Hydrologic Soil Group



Custom Soil Resource Report

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

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: <http://websoilsurvey.nrcs.usda.gov>
 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 8, Sep 23, 2014

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

Date(s) aerial images were photographed: Mar 16, 2012—Apr 13, 2012

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.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Castle Rock Area, Colorado (CO622)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Bo	Blakeland-Orsa association, 1 to 4 percent slopes	A	4.0	0.9%
BrB	Bresser sandy loam, 1 to 3 percent slopes	B	51.6	12.0%
BtE	Bresser-Truckton sandy loams, 5 to 25 percent slopes	B	0.2	0.1%
CP	Pits, clay		28.2	6.5%
FoD	Fondis clay loam, 3 to 9 percent slopes	C	9.2	2.1%
Hg	Hilly gravelly land	D	25.2	5.8%
Lu	Loamy alluvial land, dark surface	C	4.5	1.0%
NeE	Newlin gravelly sandy loam, 8 to 30 percent slopes	B	226.8	52.7%
PpE	Peyton-Pring-Crowfoot sandy loams, 5 to 25 percent slopes	C	5.3	1.2%
Se	Sandy wet alluvial land	D	75.7	17.6%
Totals for Area of Interest			430.8	100.0%

Rating Options—Hydrologic Soil Group*Aggregation Method:* Dominant Condition*Component Percent Cutoff:* None Specified*Tie-break Rule:* Higher

APPENDIX C

Calculations Detention Basin Calculations



3473 South Broadway
Englewood, Colorado 80113
303.703.4444

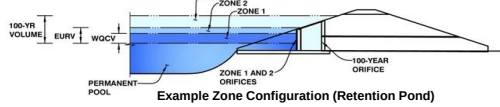
LIVEYOURCORE.COM

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **MILLER'S LANDING CONCEPT PHASE 1 DRAINAGE**

Basin ID: **POND A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB
Watershed Area =	18.75 acres
Watershed Length =	1,675 ft
Watershed Length to Centroid =	900 ft
Watershed Slope =	0.025 ft/ft
Watershed Imperviousness =	80.00% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	0.0% percent
Percentage Hydrologic Soil Groups C/D =	100.0% percent
Target WQCV Drain Time =	40.0 hours
Location for 1-hr Rainfall Depths =	User Input

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

Water Quality Capture Volume (WQCV) =	0.513 acre-feet
Excess Urban Runoff Volume (EURV) =	1.473 acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	1.323 acre-feet
5-yr Runoff Volume (P1 = 1.43 in.) =	1.912 acre-feet
10-yr Runoff Volume (P1 = 1.66 in.) =	2.288 acre-feet
25-yr Runoff Volume (P1 = 1.69 in.) =	2.356 acre-feet
50-yr Runoff Volume (P1 = 2.26 in.) =	3.304 acre-feet
100-yr Runoff Volume (P1 = 2.6 in.) =	3.892 acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	4.797 acre-feet
Approximate 2-yr Detention Volume =	1.188 acre-feet
Approximate 5-yr Detention Volume =	1.732 acre-feet
Approximate 10-yr Detention Volume =	1.985 acre-feet
Approximate 25-yr Detention Volume =	1.874 acre-feet
Approximate 50-yr Detention Volume =	2.281 acre-feet
Approximate 100-yr Detention Volume =	2.476 acre-feet

Optional User Overrides

	acre-feet
	acre-feet
1.06	inches
1.43	inches
1.66	inches
	inches
2.26	inches
2.60	inches
	inches

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.513 acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.960 acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	1.259 acre-feet
Total Detention Basin Volume =	2.733 acre-feet
Initial Surcharge Volume (ISV) =	67 ft ³
Initial Surcharge Depth (ISD) =	0.33 ft
Total Available Detention Depth (H _{total}) =	9.90 ft
Depth of Trickle Channel (H _{TC}) =	0.50 ft
Slope of Trickle Channel (S _{TC}) =	0.005 ft/ft
Slopes of Main Basin Sides (S _{main}) =	4 H:V
Basin Length-to-Width Ratio (R _{L/W}) =	2
Initial Surcharge Area (A _{ISV}) =	203 ft ²
Surcharge Volume Length (L _{ISV}) =	14.3 ft
Surcharge Volume Width (W _{ISV}) =	14.3 ft
Depth of Basin Floor (H _{FLOOR}) =	0.45 ft
Length of Basin Floor (L _{FLOOR}) =	106.1 ft
Width of Basin Floor (W _{FLOOR}) =	59.3 ft
Area of Basin Floor (A _{FLOOR}) =	6,284 ft ²
Volume of Basin Floor (V _{FLOOR}) =	1,143 ft ³
Depth of Main Basin (H _{MAIN}) =	8.62 ft
Length of Main Basin (L _{MAIN}) =	175.0 ft
Width of Main Basin (W _{MAIN}) =	128.2 ft
Area of Main Basin (A _{MAIN}) =	22,439 ft ²
Volume of Main Basin (V _{MAIN}) =	116,650 ft ³
Calculated Total Basin Volume (V _{total}) =	2.708 acre-feet

Depth Increment = 0.50 ft

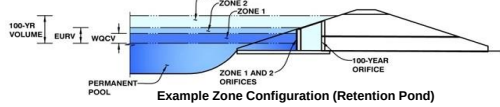
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
Top of Micropool	0.00		14.3	14.3	203		0.005		
ISV	0.33		14.3	14.3	203		0.005	67	0.002
	0.50		14.3	14.3	203		0.005	102	0.002
Floor	1.00		48.9	31.3	1,529		0.035	299	0.007
	1.28		106.1	59.3	6,284		0.144	1,318	0.030
	1.50		107.8	61.0	6,578		0.151	2,733	0.063
	2.00		111.8	65.0	7,269		0.167	6,194	0.142
	2.50		115.8	69.0	7,993		0.183	10,008	0.230
	3.00		119.8	73.0	8,748		0.201	14,192	0.326
	3.50		123.8	77.0	9,535		0.219	18,761	0.431
Zone 1 (WQCV)	3.87		126.8	80.0	10,138		0.233	22,400	0.514
	4.00		127.8	81.0	10,355		0.238	23,732	0.545
	4.50		131.8	85.0	11,206		0.257	29,121	0.669
	5.00		135.8	89.0	12,089		0.278	34,943	0.802
	5.50		139.8	93.0	13,004		0.299	41,215	0.946
	6.00		143.8	97.0	13,952		0.320	47,953	1.101
	6.50		147.8	101.0	14,931		0.343	55,172	1.267
	7.00		151.8	105.0	15,942		0.366	62,889	1.444
Zone 2 (EURV)	7.09		152.5	105.7	16,128		0.370	64,332	1.477
	7.50		155.8	109.0	16,986		0.390	71,120	1.633
	8.00		159.8	113.0	18,061		0.415	79,880	1.834
	8.50		163.8	117.0	19,168		0.440	89,186	2.047
	9.00		167.8	121.0	20,308		0.466	99,054	2.274
	9.50		171.8	125.0	21,479		0.493	109,499	2.514
Z3 (100+1/2WQCV)	9.94		175.3	128.5	22,536		0.517	119,182	2.736
	10.00		175.8	129.0	22,682		0.521	120,538	2.767
	10.50		179.8	133.0	23,917		0.549	132,187	3.035
	11.00		183.8	137.0	25,185		0.578	144,461	3.316
	11.50		187.8	141.0	26,484		0.608	157,377	3.613
	12.00		191.8	145.0	27,815		0.639	170,950	3.924
	12.50		195.8	149.0	29,179		0.670	185,197	4.252
	13.00		199.8	153.0	30,574		0.702	200,134	4.594
	13.50		203.8	157.0	32,001		0.735	215,777	4.954
	14.00		207.8	161.0	33,461		0.768	232,141	5.329
	14.50		211.8	165.0	34,952		0.802	249,243	5.722
	15.00		215.8	169.0	36,475		0.837	267,098	6.132
	15.50		219.8	173.0	38,031		0.873	285,723	6.559
	16.00		223.8	177.0	39,618		0.909	305,134	7.005
	16.50		227.8	181.0	41,237		0.947	325,346	7.469
	17.00		231.8	185.0	42,888		0.985	346,376	7.952
	17.50		235.8	189.0	44,572		1.023	368,240	8.454
	18.00		239.8	193.0	46,287		1.063	390,954	8.975
	18.50		243.8	197.0	48,034		1.103	414,533	9.516
	19.00		247.8	201.0	49,814		1.144	438,993	10.078
	19.50		251.8	205.0	51,625		1.185	464,351	10.660
	20.00		255.8	209.0	53,468		1.227	490,623	11.263
	20.50		259.8	213.0	55,344		1.271	517,825	11.888
	21.00		263.8	217.0	57,251		1.314	545,972	12.534
	21.50		267.8	221.0	59,190		1.359	575,081	13.202
	22.00		271.8	225.0	61,161		1.404	605,168	13.893
	22.50		275.8	229.0	63,165		1.450	636,248	14.606
	23.00		279.8	233.0	65,200		1.497	668,338	15.343
	23.50		283.8	237.0	67,267		1.544	701,453	16.103
	24.00		287.8	241.0	69,367		1.592	735,611	16.887
	24.50		291.8	245.0	71,498		1.641	770,825	17.696
	25.00		295.8	249.0	73,661		1.691	807,114	18.529
	25.50		299.8	253.0	75,857		1.741	844,492	19.387
	26.00		303.8	257.0	78,084		1.793	882,976	20.270
	26.50		307.8	261.0	80,343		1.844	922,581	21.180
	27.00		311.8	265.0	82,634		1.897	963,324	22.115
	27.50		315.8	269.0	84,958		1.950	1,005,221	23.077
	28.00		319.8	273.0	87,313		2.004	1,048,288	24.065
	28.50		323.8	277.0	89,700		2.059	1,092,540	25.081
	29.00		327.8	281.0	92,120		2.115	1,137,993	26.125
	29.50		331.8	285.0	94,571		2.171	1,184,665	27.196
	30.00		335.8	289.0	97,054		2.228	1,232,570	28.296

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **MILLER'S LANDING CONCEPT PHASE 1 DRAINAGE**

Basin ID: **POND B**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	26.88	acres
Watershed Length =	1,200	ft
Watershed Length to Centroid =	560	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	90.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Water Quality Capture Volume (WQCV) =	0.899	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.399	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	2.056	acre-feet	1.06	inches
5-yr Runoff Volume (P1 = 1.43 in.) =	2.902	acre-feet	1.43	inches
10-yr Runoff Volume (P1 = 1.66 in.) =	3.435	acre-feet	1.66	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	3.515	acre-feet		inches
50-yr Runoff Volume (P1 = 2.26 in.) =	4.843	acre-feet	2.26	inches
100-yr Runoff Volume (P1 = 2.6 in.) =	5.650	acre-feet	2.60	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	6.912	acre-feet		inches
Approximate 2-yr Detention Volume =	1.947	acre-feet		
Approximate 5-yr Detention Volume =	2.779	acre-feet		
Approximate 10-yr Detention Volume =	3.205	acre-feet		
Approximate 25-yr Detention Volume =	3.020	acre-feet		
Approximate 50-yr Detention Volume =	3.665	acre-feet		
Approximate 100-yr Detention Volume =	3.904	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.899	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.500	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	1.955	acre-feet
Total Detention Basin Volume =	4.354	acre-feet
Initial Surcharge Volume (ISV) =	118	ft ³
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H _{total}) =	9.90	ft
Depth of Trickle Channel (H _{TC}) =	0.50	ft
Slope of Trickle Channel (S _{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S _{main}) =	4	H:V
Basin Length-to-Width Ratio (L _W) =	2	
Initial Surcharge Area (A _{ISV}) =	356	ft ²
Surcharge Volume Length (L _{ISV}) =	18.9	ft
Surcharge Volume Width (W _{ISV}) =	18.9	ft
Depth of Basin Floor (H _{FLOOR}) =	0.65	ft
Length of Basin Floor (L _{FLOOR}) =	151.5	ft
Width of Basin Floor (W _{FLOOR}) =	83.9	ft
Area of Basin Floor (A _{FLOOR}) =	12,704	ft ²
Volume of Basin Floor (V _{FLOOR}) =	3,291	ft ³
Depth of Main Basin (H _{MAIN}) =	8.42	ft
Length of Main Basin (L _{MAIN}) =	218.8	ft
Width of Main Basin (W _{MAIN}) =	151.2	ft
Area of Main Basin (A _{MAIN}) =	33,094	ft ²
Volume of Main Basin (V _{MAIN}) =	186,090	ft ³
Calculated Total Basin Volume (V _{total}) =	4.354	acre-feet

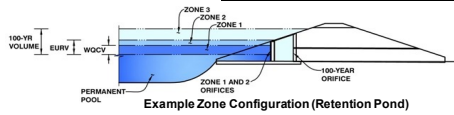
Depth Increment =	0.50	ft							
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
Top of Micropool	0.00		18.9	18.9	356		0.008		
ISV	0.33		18.9	18.9	356		0.008	118	0.003
	0.50		18.9	18.9	356		0.008	178	0.004
	1.00		53.6	35.9	1,921		0.044	472	0.011
Floor	1.48		151.5	83.9	12,704		0.292	3,606	0.083
	1.50		151.6	84.0	12,742		0.293	3,861	0.089
	2.00		155.6	88.0	13,701		0.315	10,470	0.240
	2.50		159.6	92.0	14,691		0.337	17,567	0.403
	3.00		163.6	96.0	15,714		0.361	25,167	0.578
	3.50		167.6	100.0	16,768		0.385	33,286	0.764
Zone 1 (WQCV)	3.85		170.4	102.8	17,526		0.402	39,287	0.902
	4.00		171.6	104.0	17,855		0.410	41,940	0.963
	4.50		175.6	108.0	18,974		0.436	51,146	1.174
	5.00		179.6	112.0	20,124		0.462	60,920	1.399
	5.50		183.6	116.0	21,307		0.489	71,276	1.636
	6.00		187.6	120.0	22,522		0.517	82,232	1.888
	6.50		191.6	124.0	23,768		0.546	93,803	2.153
Zone 2 (EURV)	6.94		195.2	127.6	24,892		0.571	104,508	2.399
	7.00		195.6	128.0	25,047		0.575	106,006	2.434
	7.50		199.6	132.0	26,358		0.605	118,856	2.729
	8.00		203.6	136.0	27,700		0.636	132,369	3.039
	8.50		207.6	140.0	29,075		0.667	146,561	3.365
	9.00		211.6	144.0	30,482		0.700	161,449	3.706
	9.50		215.6	148.0	31,920		0.733	177,048	4.064
Z3 (100+1/2WQCV)	9.89		218.8	151.2	33,065		0.759	189,720	4.355
	10.00		219.6	152.0	33,391		0.767	193,375	4.439
	10.50		223.6	156.0	34,894		0.801	210,444	4.831
	11.00		227.6	160.0	36,428		0.836	228,274	5.240
	11.50		231.6	164.0	37,995		0.872	246,878	5.668
	12.00		235.6	168.0	39,594		0.909	266,274	6.113
	12.50		239.6	172.0	41,224		0.946	286,477	6.577
	13.00		243.6	176.0	42,887		0.985	307,503	7.059
	13.50		247.6	180.0	44,582		1.023	329,369	7.561
	14.00		251.6	184.0	46,308		1.063	352,090	8.083
	14.50		255.6	188.0	48,067		1.103	375,683	8.624
	15.00		259.6	192.0	49,857		1.145	400,162	9.186
	15.50		263.6	196.0	51,680		1.186	425,545	9.769
	16.00		267.6	200.0	53,535		1.229	451,848	10.373
	16.50		271.6	204.0	55,421		1.272	479,086	10.998
	17.00		275.6	208.0	57,340		1.316	507,275	11.645
	17.50		279.6	212.0	59,291		1.361	536,431	12.315
	18.00		283.6	216.0	61,273		1.407	566,571	13.007
	18.50		287.6	220.0	63,288		1.453	597,710	13.722
	19.00		291.6	224.0	65,335		1.500	629,864	14.460
	19.50		295.6	228.0	67,413		1.548	663,050	15.222
	20.00		299.6	232.0	69,524		1.596	697,283	16.007
	20.50		303.6	236.0	71,667		1.645	732,579	16.818
	21.00		307.6	240.0	73,841		1.695	768,955	17.653
	21.50		311.6	244.0	76,048		1.746	806,426	18.513
	22.00		315.6	248.0	78,287		1.797	845,008	19.399
	22.50		319.6	252.0	80,557		1.849	884,718	20.310
	23.00		323.6	256.0	82,860		1.902	925,571	21.248
	23.50		327.6	260.0	85,195		1.956	967,583	22.213
	24.00		331.6	264.0	87,561		2.010	1,010,771	23.204
	24.50		335.6	268.0	89,960		2.065	1,055,149	24.223
	25.00		339.6	272.0	92,391		2.121	1,100,736	25.269
	25.50		343.6	276.0	94,853		2.178	1,147,545	26.344
	26.00		347.6	280.0	97,348		2.235	1,195,594	27.447
	26.50		351.6	284.0	99,874		2.293	1,244,899	28.579
	27.00		355.6	288.0	102,433		2.352	1,295,474	29.740
	27.50		359.6	292.0	105,024		2.411	1,347,337	30.931
	28.00		363.6	296.0	107,646		2.471	1,400,503	32.151
	28.50		367.6	300.0	110,301		2.532	1,454,989	33.402
	29.00		371.6	304.0	112,988		2.594	1,510,810	34.683
	29.50		375.6	308.0	115,706		2.656	1,567,982	35.996
	30.00		379.6	312.0	118,457		2.719	1,626,521	37.340
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: MILLER'S LANDING CONCEPT PHASE 1 DRAINAGE

Basin ID: POND C - INTERIM



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	4.48	acres
Watershed Length =	860	ft
Watershed Length to Centroid =	430	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	80.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Water Quality Capture Volume (WQCV) =	0.123	acre-feet
Excess Urban Runoff Volume (EURV) =	0.352	acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.307	acre-feet
5-yr Runoff Volume (P1 = 1.43 in.) =	0.444	acre-feet
10-yr Runoff Volume (P1 = 1.66 in.) =	0.531	acre-feet
25-yr Runoff Volume (P1 = 1.69 in.) =	0.547	acre-feet
50-yr Runoff Volume (P1 = 2.26 in.) =	0.766	acre-feet
100-yr Runoff Volume (P1 = 2.6 in.) =	0.903	acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	1.113	acre-feet
Approximate 2-yr Detention Volume =	0.284	acre-feet
Approximate 5-yr Detention Volume =	0.414	acre-feet
Approximate 10-yr Detention Volume =	0.474	acre-feet
Approximate 25-yr Detention Volume =	0.448	acre-feet
Approximate 50-yr Detention Volume =	0.545	acre-feet
Approximate 100-yr Detention Volume =	0.592	acre-feet

Optional User Overrides

	acre-feet
	acre-feet
1.06	inches
1.43	inches
1.66	inches
	inches
2.26	inches
2.60	inches
	inches

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.123	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.229	acre-feet
Zone 3 Volume (User Defined - Zones 1 & 2) =	0.363	acre-feet
Total Detention Basin Volume =	0.715	acre-feet
Initial Surge Volume (ISV) =	16	ft ³
Initial Surge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H _{total}) =	9.90	ft
Depth of Trickle Channel (H _{TC}) =	0.50	ft
Slope of Trickle Channel (S _{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S _{main}) =	4	H:V
Basin Length-to-Width Ratio (R _{L/W}) =	2	
Initial Surge Area (A _{ISV}) =	49	ft ²
Surcharge Volume Length (L _{SV}) =	7.0	ft
Surcharge Volume Width (W _{SV}) =	7.0	ft
Depth of Basin Floor (H _{FLOOR}) =	0.08	ft
Length of Basin Floor (L _{FLOOR}) =	23.3	ft
Width of Basin Floor (W _{FLOOR}) =	15.0	ft
Area of Basin Floor (A _{FLOOR}) =	349	ft ²
Volume of Basin Floor (V _{FLOOR}) =	14	ft ³
Depth of Main Basin (H _{MAIN}) =	8.99	ft
Length of Main Basin (L _{MAIN}) =	95.2	ft
Width of Main Basin (W _{MAIN}) =	86.9	ft
Area of Main Basin (A _{MAIN}) =	8,272	ft ²
Volume of Main Basin (V _{MAIN}) =	30,922	ft ³
Calculated Total Basin Volume (V _{total}) =	0.711	acre-feet

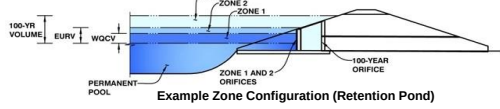
Depth Increment =	0.50	ft							
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
Top of Micropool	0.00		7.0	7.0	49		0.001		
ISV	0.33		7.0	7.0	49		0.001	16	0.000
	0.50		7.0	7.0	49		0.001	24	0.001
Floor	0.91		23.3	15.0	349		0.008	54	0.001
	1.00		24.0	15.7	377		0.009	87	0.002
	1.50		28.0	19.7	551		0.013	318	0.007
	2.00		32.0	23.7	758		0.017	644	0.015
	2.50		36.0	27.7	997		0.023	1,081	0.025
	3.00		40.0	31.7	1,268		0.029	1,646	0.038
	3.50		44.0	35.7	1,570		0.036	2,354	0.054
	4.00		48.0	39.7	1,905		0.044	3,222	0.074
	4.50		52.0	43.7	2,272		0.052	4,265	0.098
Zone 1 (WQCV)	4.94		55.5	47.2	2,621		0.060	5,340	0.123
	5.00		56.0	47.7	2,671		0.061	5,499	0.126
	5.50		60.0	51.7	3,102		0.071	6,941	0.159
	6.00		64.0	55.7	3,564		0.082	8,606	0.198
	6.50		68.0	59.7	4,059		0.093	10,511	0.241
	7.00		72.0	63.7	4,586		0.105	12,671	0.291
	7.50		76.0	67.7	5,145		0.118	15,102	0.347
Zone 2 (EURV)	7.55		76.4	68.1	5,202		0.119	15,361	0.353
	8.00		80.0	71.7	5,735		0.132	17,821	0.409
	8.50		84.0	75.7	6,358		0.146	20,843	0.478
	9.00		88.0	79.7	7,013		0.161	24,184	0.555
	9.50		92.0	83.7	7,700		0.177	27,861	0.640
Zone 3 (User)	9.92		95.4	87.0	8,301		0.191	31,220	0.717
	10.00		96.0	87.7	8,419		0.193	31,889	0.732
	10.50		100.0	91.7	9,169		0.210	36,285	0.833
	11.00		104.0	95.7	9,952		0.228	41,064	0.943
	11.50		108.0	99.7	10,767		0.247	46,242	1.062
	12.00		112.0	103.7	11,614		0.267	51,836	1.190
	12.50		116.0	107.7	12,492		0.287	57,861	1.328
	13.00		120.0	111.7	13,403		0.308	64,334	1.477
	13.50		124.0	115.7	14,346		0.329	71,270	1.636
	14.00		128.0	119.7	15,321		0.352	78,685	1.806
	14.50		132.0	123.7	16,328		0.375	86,596	1.988
	15.00		136.0	127.7	17,366		0.399	95,018	2.181
	15.50		140.0	131.7	18,437		0.423	103,968	2.387
	16.00		144.0	135.7	19,540		0.449	113,461	2.605
	16.50		148.0	139.7	20,675		0.475	123,513	2.835
	17.00		152.0	143.7	21,841		0.501	134,141	3.079
	17.50		156.0	147.7	23,040		0.529	145,360	3.337
	18.00		160.0	151.7	24,271		0.557	157,186	3.608
	18.50		164.0	155.7	25,534		0.586	169,636	3.894
	19.00		168.0	159.7	26,829		0.616	182,725	4.195
	19.50		172.0	163.7	28,155		0.646	196,470	4.510
	20.00		176.0	167.7	29,514		0.678	210,886	4.841
	20.50		180.0	171.7	30,905		0.709	225,989	5.188
	21.00		184.0	175.7	32,328		0.742	241,796	5.551
	21.50		188.0	179.7	33,782		0.776	258,322	5.930
	22.00		192.0	183.7	35,269		0.810	275,584	6.327
	22.50		196.0	187.7	36,788		0.845	293,597	6.740
	23.00		200.0	191.7	38,339		0.880	312,377	7.171
	23.50		204.0	195.7	39,922		0.916	331,941	7.620
	24.00		208.0	199.7	41,536		0.954	352,304	8.088
	24.50		212.0	203.7	43,183		0.991	373,482	8.574
	25.00		216.0	207.7	44,862		1.030	395,492	9.079
	25.50		220.0	211.7	46,573		1.069	418,350	9.604
	26.00		224.0	215.7	48,315		1.109	442,070	10.149
	26.50		228.0	219.7	50,090		1.150	466,670	10.713
	27.00		232.0	223.7	51,897		1.191	492,166	11.299
	27.50		236.0	227.7	53,736		1.234	518,573	11.905
	28.00		240.0	231.7	55,606		1.277	545,907	12.532
	28.50		244.0	235.7	57,509		1.320	574,184	13.181
	29.00		248.0	239.7	59,444		1.365	603,421	13.853
	29.50		252.0	243.7	61,411		1.410	633,634	14.546
	30.00		256.0	247.7	63,410		1.456	664,838	15.263
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **MILLER'S LANDING CONCEPT PHASE 1 DRAINAGE**

Basin ID: **POND C**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB
Watershed Area =	18.88 acres
Watershed Length =	1,100 ft
Watershed Length to Centroid =	800 ft
Watershed Slope =	0.025 ft/ft
Watershed Imperviousness =	90.00% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	0.0% percent
Percentage Hydrologic Soil Groups C/D =	100.0% percent
Target WQCV Drain Time =	40.0 hours
Location for 1-hr Rainfall Depths =	User Input

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

Water Quality Capture Volume (WQCV) =	0.632 acre-feet
Excess Urban Runoff Volume (EURV) =	1.685 acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	1.452 acre-feet
5-yr Runoff Volume (P1 = 1.43 in.) =	2.050 acre-feet
10-yr Runoff Volume (P1 = 1.66 in.) =	2.426 acre-feet
25-yr Runoff Volume (P1 = 1.69 in.) =	2.483 acre-feet
50-yr Runoff Volume (P1 = 2.26 in.) =	3.421 acre-feet
100-yr Runoff Volume (P1 = 2.6 in.) =	3.991 acre-feet
500-yr Runoff Volume (P1 = 3.14 in.) =	4.882 acre-feet
Approximate 2-yr Detention Volume =	1.367 acre-feet
Approximate 5-yr Detention Volume =	1.952 acre-feet
Approximate 10-yr Detention Volume =	2.251 acre-feet
Approximate 25-yr Detention Volume =	2.121 acre-feet
Approximate 50-yr Detention Volume =	2.574 acre-feet
Approximate 100-yr Detention Volume =	2.742 acre-feet

Optional User Overrides

	acre-feet
	acre-feet
1.06	inches
1.43	inches
1.66	inches
	inches
2.26	inches
2.60	inches
	inches

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.632 acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.053 acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	1.373 acre-feet
Total Detention Basin Volume =	3.058 acre-feet
Initial Surcharge Volume (ISV) =	83 ft ³
Initial Surcharge Depth (ISD) =	0.33 ft
Total Available Detention Depth (H _{total}) =	9.90 ft
Depth of Trickle Channel (H _{TC}) =	0.50 ft
Slope of Trickle Channel (S _{TC}) =	0.005 ft/ft
Slopes of Main Basin Sides (S _{main}) =	4 H:V
Basin Length-to-Width Ratio (R _{L/W}) =	2

Initial Surcharge Area (A _{ISV}) =	250 ft ²
Surcharge Volume Length (L _{ISV}) =	15.8 ft
Surcharge Volume Width (W _{ISV}) =	15.8 ft
Depth of Basin Floor (H _{FLOOR}) =	0.49 ft
Length of Basin Floor (L _{FLOOR}) =	115.8 ft
Width of Basin Floor (W _{FLOOR}) =	64.8 ft
Area of Basin Floor (A _{FLOOR}) =	7,504 ft ²
Volume of Basin Floor (V _{FLOOR}) =	1,490 ft ³
Depth of Main Basin (H _{MAIN}) =	8.58 ft
Length of Main Basin (L _{MAIN}) =	184.4 ft
Width of Main Basin (W _{MAIN}) =	133.5 ft
Area of Main Basin (A _{MAIN}) =	24,611 ft ²
Volume of Main Basin (V _{MAIN}) =	130,718 ft ³
Calculated Total Basin Volume (V _{total}) =	3.040 acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
Top of Micropool	0.00		15.8	15.8	250		0.006		
ISV	0.33		15.8	15.8	250		0.006	83	0.002
	0.50		15.8	15.8	250		0.006	125	0.003
Floor	1.00		50.5	32.8	1,657		0.038	353	0.008
	1.32		115.8	64.8	7,504		0.172	1,707	0.039
	1.50		117.2	66.3	7,766		0.178	3,082	0.071
	2.00		121.2	70.3	8,516		0.196	7,151	0.164
	2.50		125.2	74.3	9,298		0.213	11,603	0.266
	3.00		129.2	78.3	10,112		0.232	16,454	0.378
	3.50		133.2	82.3	10,958		0.252	21,720	0.499
	4.00		137.2	86.3	11,836		0.272	27,417	0.629
Zone 1 (WQCV)	4.01		137.3	86.3	11,854		0.272	27,536	0.632
	4.50		141.2	90.3	12,746		0.293	33,561	0.770
	5.00		145.2	94.3	13,687		0.314	40,168	0.922
	5.50		149.2	98.3	14,661		0.337	47,254	1.085
	6.00		153.2	102.3	15,667		0.360	54,835	1.259
	6.50		157.2	106.3	16,705		0.383	62,927	1.445
Zone 2 (EURV)	7.00		161.2	110.3	17,775		0.408	71,546	1.642
	7.11		162.1	111.1	18,015		0.414	73,514	1.688
	7.50		165.2	114.3	18,877		0.433	80,707	1.853
	8.00		169.2	118.3	20,011		0.459	90,428	2.076
	8.50		173.2	122.3	21,177		0.486	100,723	2.312
	9.00		177.2	126.3	22,375		0.514	111,610	2.562
	9.50		181.2	130.3	23,604		0.542	123,103	2.826
Z3 (100+1/2WQCV)	9.92		184.6	133.6	24,662		0.566	133,238	3.059
	10.00		185.2	134.3	24,866		0.571	135,220	3.104
	10.50		189.2	138.3	26,160		0.601	147,975	3.397
	11.00		193.2	142.3	27,486		0.631	161,385	3.705
	11.50		197.2	146.3	28,844		0.662	175,466	4.028
	12.00		201.2	150.3	30,234		0.694	190,234	4.367
	12.50		205.2	154.3	31,656		0.727	205,706	4.722
	13.00		209.2	158.3	33,110		0.760	221,896	5.094
	13.50		213.2	162.3	34,596		0.794	238,821	5.483
	14.00		217.2	166.3	36,113		0.829	256,496	5.888
	14.50		221.2	170.3	37,663		0.865	274,939	6.312
	15.00		225.2	174.3	39,245		0.901	294,165	6.753
	15.50		229.2	178.3	40,859		0.938	314,190	7.213
	16.00		233.2	182.3	42,505		0.976	335,030	7.691
	16.50		237.2	186.3	44,183		1.014	356,700	8.189
	17.00		241.2	190.3	45,893		1.054	379,218	8.706
	17.50		245.2	194.3	47,635		1.094	402,598	9.242
	18.00		249.2	198.3	49,409		1.134	426,858	9.799
	18.50		253.2	202.3	51,214		1.176	452,012	10.377
	19.00		257.2	206.3	53,052		1.218	478,078	10.975
	19.50		261.2	210.3	54,922		1.261	505,070	11.595
	20.00		265.2	214.3	56,824		1.305	533,005	12.236
	20.50		269.2	218.3	58,758		1.349	561,899	12.899
	21.00		273.2	222.3	60,724		1.394	591,768	13.585
	21.50		277.2	226.3	62,722		1.440	622,628	14.294
	22.00		281.2	230.3	64,752		1.486	654,495	15.025
	22.50		285.2	234.3	66,814		1.534	687,385	15.780
	23.00		289.2	238.3	68,907		1.582	721,314	16.559
	23.50		293.2	242.3	71,033		1.631	756,298	17.362
	24.00		297.2	246.3	73,191		1.680	792,353	18.190
	24.50		301.2	250.3	75,381		1.731	829,495	19.043
	25.00		305.2	254.3	77,603		1.782	867,739	19.921
	25.50		309.2	258.3	79,857		1.833	907,103	20.824
	26.00		313.2	262.3	82,143		1.886	947,602	21.754
	26.50		317.2	266.3	84,461		1.939	989,251	22.710
	27.00		321.2	270.3	86,811		1.993	1,032,068	23.693
	27.50		325.2	274.3	89,192		2.048	1,076,067	24.703
	28.00		329.2	278.3	91,606		2.103	1,121,265	25.741
	28.50		333.2	282.3	94,052		2.159	1,167,679	26.806
	29.00		337.2	286.3	96,530		2.216	1,215,323	27.900
	29.50		341.2	290.3	99,040		2.274	1,264,214	29.022
	30.00		345.2	294.3	101,582		2.332	1,314,368	30.174

APPENDIX D

Reference Material

Omni, Industrial and Westfield Watershed Master Plan



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reconstruction are necessary to address channel flow splits or lateral erosion. Finally, improved crossings are also proposed to address specific problem areas where overtopping occurs in violation of Town criteria. Table i-3 presents a tabular summary of the elements of the selected plan. The elements of the plan are also shown on **Figure i-3 through Figure i-6**.

Table i-3
Combined Alternative

Tributary	Problem ID	Proposed Solution or Improvement	Total Cost
Omni	Stream Stability	Construct 28- 4' drop structures	\$ 2,100,000
Omni	Stream Stability	Construct 36- 4' drop structures	\$ 682,700
Omni	Bank Protection	Provide Bank Protection up to the 10-Year Water Surface Elevation	\$ 63,600
Omni	Undersized Infrastructure	Replace existing 2 – 48" RCPs at Wolfensberger Road with 3 – 7' x '4' CBC to convey the 100-year peak flow	\$ 336,000
Omni	Undersized Infrastructure	Add an additional 66" RCP to the existing 2 – 66" RCPs at Red Hawk Drive	\$ 64,000
Omni	Detention Pond	Reduce the peak flow through Prairie Hawk Drive with 6.2 acre-ft of additional storage	\$ 95,800
Omni	New Infrastructure	Install 3 – 36" RCP equalizer culverts for additional storage at Prairie Hawk Drive	\$ 33,800
Omni	New Infrastructure	Install 1 cross culvert at the intersection of Wolfensberger Road and Heir Lane to Prevent Roadway Flooding	\$ 10,500
Omni	New Infrastructure	Install 2 – 54" cross culverts on Wolfensberger Road 750 feet east of Heir Lane to Prevent Roadway Flooding	\$ 17,400
Omni	New Infrastructure	Install 2 – 54" cross culverts on Wolfensberger Road 2,500' east of Heir Lane to Prevent Roadway Flooding	\$ 17,400
Omni Tributary	New Infrastructure	Construct 2- 4' drop structures at the exposed utility crossing and at the bike trail crossing	\$ 150,000
Omni Tributary	New Infrastructure	Provide Bank Protection up to the 10-Year Water Surface Elevation	\$ 18,100
Industrial	Stream Stability	Construct 32 - 4' - 6' drop structures	\$ 2,325,000
Industrial	Stream Stability	Construct 1 – concrete check structure	\$ 12,300
Industrial	Poorly Defined Channel	Channelize the flow from below the existing stock pond	\$ 18,000.00
Industrial	Stream Stability	Construct 12" Grouted Boulder Rundown	\$ 150,000
Industrial	Undersized Infrastructure	Replace existing culvert at Prairie Hawk Drive with 12' x 10' CBC to pass the 100-year existing peak flows	\$ 157,500
Industrial	Undersized Infrastructure	Raise Channel Invert from Prairie Hawk Drive to 1,200 feet upstream of the crossing	\$ 23,100

Table i-3

Combined Alternative

Tributary	Problem ID	Proposed Solution or Improvement	Total Cost
Industrial Tributary	Stream Stability	Construct 11- 4' - 6' drop structures	\$ 825,000
Westfield	Stream Stability	Construct 7 - 4' drop structures	\$ 525,000
Westfield	Stream Stability	Construct 23 – concrete check structures	\$ 471,500
Westfield	Poorly Defined Channel	Channelize the flow to the BNSF culvert and from the culvert outfall to East Plum Creek	\$ 39,000
Westfield	Detention Pond	Reduce the peak flows through existing infrastructure through a series of 2 - 10-acre-foot detention ponds	\$ 419,9000
Westfield	Undersized Infrastructure	Increase the capacity of existing driveway culverts to pass the 10-year existing peak flows at 2 driveways	\$ 36,000
Westfield	Undersized Infrastructure	Increase the capacity of the existing culvert to pass the 100-year existing peak flows at I-25, BNSF Railway and the East Frontage Road	\$ 1,161,200
Total			\$9,287,230

The selected plan addresses all conveyance, detention, and stream stability issues for the Omni, Industrial and Westfield Tributaries. The following is a general description of the selected improvements (refer to **Appendix D** for conceptual drawings):

Omni Channel

Priority 1

- All drop structures providing grade control to existing head cuts and culvert crossings including structures at Stations 10+99, 34+54, 42+68, 53+60, 82+68, 112+63, 119+08, 129+80, and 142+98.
- Installation of 3 – 7' x 4' CBC at Wolfensberger Road near Red Hawk Drive
- Installation of an additional 66" RCP at Red Hawk Drive
- Addition of 6.2 acre-ft detention at existing detention pond at Prairie Hawk Drive
- 3 – 36" RCP Equalizer Culverts for additional detention at Prairie Hawk Drive
- Installation of 1 – 48" RCP pipe at Wolfensberger Road and Heir Lane
- Installation of 2 – 54" RCP pipes at Wolfensberger Road 500-feet east of Heir Lane
- Installation of 2 – 54" RCP pipes at Wolfensberger Road 2,500-feet east of Heir Lane
- Bank stabilization at three locations stations 52+50 to 45+00, station 45+00 to 42+94, and station 42+94 to 39+50
- Repair grouted riprap rundown downstream of Red Hawk Drive.
- Raise the Channel Invert Downstream of the Castel Highlands Detention Pond and Upstream of Wolfensberger Road

II. Study Area Description

Project Area

The Omni, Industrial and Westfield Watersheds lie on the southwest side of the Town, west of I-25, and drain water to East Plum Creek. The Omni Watershed runoff is accumulated from 1.69 sq mi (1080 acre) of watershed also outfalls to East Plum Creek. The Industrial Watershed runoff is accumulated from 0.79 sq mi (507 acre) of watershed area and outfalls to East Plum Creek. The Westfield basin runoff is accumulated from 0.75 square miles (sq mi) (480 acre) and outfalls to East Plum Creek. All three basins convey water under the Burlington Northern and Santa Fe Railroad (BNSF) before reaching East Plum Creek. The Westfield tributary also conveys flows under I-25 before reaching East Plum Creek. A large percentage of the Study Area is located within the Town. The upper portions of each of the watershed are located outside of the Town in Douglas County. A plan view of the study area and the reach identifications for the Omni, Industrial and Westfield is presented in **Figure II-1**.

Land Use

Land use, both proposed and existing, within the 3.23 sq-mile Study Area consists of developed land, undeveloped land, and land committed to open space. In its current state, 18 percent of the Study Area is impervious while 32 percent of the Study Area is anticipated to become impervious in the future. Portions of the lower Westfield Watershed are planned for general commercial and light industrial use. Future plans in the Omni Watershed include low-density multi-family and single-family development as well as land designated as open space. Future plans in the Industrial Watershed include light industrial and single-family development as well as land designated as open space and parks.

The Study Area is comprised of three separate watersheds, 1) Omni (Omni Study Area), 2) Industrial (Industrial Study Area) 3) the Westfield (Westfield Study Area). Existing land uses for the three watersheds are depicted in **Figure II-2** and future land uses in **Figure II-3**.

Omni Study Area

The Omni Study Area is currently a partially developed basin with the lower portions of the basin being developed and the upper reaches of the basin being mostly undeveloped. For the purposes of this study, the basin was subdivided into 15 sub-watersheds.

In the existing conditions, the majority of the lower Omni Study Area is designated as single family, commercial, golf course, and open space land uses. The majority of the upper Omni Study Area is designated as agricultural land. In the future conditions, an increase in single family with dedicated open space land use occurs in the middle portions of the Study Area. The future percent impervious value increases from 24 percent to 27 percent.

Industrial Study Area

The Industrial Study Area is currently developed in the lower reaches and undeveloped in the upper reaches of the basin. The watershed was broken into nine sub-watersheds for analysis.

Future land use conditions show much of the upper reaches of the Industrial basin becoming open space and a large regional park. An approximately 100-acre regional park will be placed directly west of the proposed Coachline Road extension. The upper reaches of the Industrial Study Area change from agricultural land use to parks and open space so an increase in percent imperviousness is expected due to

trails, fields, and infrastructure. In the lower portion of the basin, land use changes from open space in the existing condition to commercial and industrial land uses in the future. The future land use percent impervious increases from 18 percent to 44 percent for the entire basin.

Westfield Study Area

The Westfield Study Area is a mostly undeveloped basin comprised of sandy loam soil. The basin is steeper in the upper reaches before flattening near I-25. The watershed was sub-divided into 6 sub-watersheds for analysis.

In its current condition, the entire portion of the basin west of I-25 is agricultural land and low density residential. The existing conditions percent impervious for the Westfield Study Area is 6 percent. Future conditions show some of the land on the lower portion of the basin being zoned for open space, single family, and general commercial land uses. On the eastern side of I-25, the land is zoned for general commercial and open space land uses. The future conditions percent impervious increases from 6 percent to approximately 31 percent.

Selection of percent impervious values for given land use data was done using tables RO-3 and RO-5 from the *Urban Storm Drainage Criteria Manual (USDCM)*, Volume 1 (2004). **Table II-1** shows the selected percent impervious values for the land use descriptions provided by the Town of Castle Rock that are within the Study Area.

TABLE II-1
Land Use Percent Impervious Value Summary

LAND USE DESCRIPTION	PERCENT IMPERVIOUS VALUE
Agricultural	2%
General Commercial	95%
General Industrial	85%
Golf Course	10%
Light Industrial	80%
Multiple Family	75%
Road/Highway	95%
Open Space	5%
Public Land	5%
Restricted Commercial	80%
Schools	50%
Single Family*	36%
Low Density Multi-Family	65%
Park	50%

*Estimated density of 4 units/acre of 2,000 sq. ft single family two story homes

Soil types within the Westfield Watershed are mainly a mixture of Type B and Type C Soils. Soil types within the upper reaches of the Omni and Industrial Watershed are a mixture of Type B, Type C, and Type D soil, and soil types within the lower portions of the Omni and Industrial Watersheds are mostly Type B soil. Hydrologic soil classifications within the three watersheds are summarized on Figure II-4.

Outfall Description

Omni Study Area

In the upper reaches of the Omni Study Area, a number of private driveways create informal detention ponds as water flows along Wolfensberger Road. Downstream channel improvements and detention ponds control the flow all the way to a detention pond at Prairie Hawk Drive. Here flow passes under the roadway, before crossing under the BNSF and eventually reaching East Plum Creek.

A large tributary converges with the Omni Tributary at the lower detention pond. This tributary originates northwest of the mainstem near the Red Hawk Ridge Golf Course.

Reach 1 – Outfall into East Plum Creek to Prairie Hawk Drive

There is a large drop structure downstream of the culverts near Park Street and there are a series of check structures upstream of the culverts. Between the BNSF Railroad Bridge and the culverts near Park Street, riprap has been placed sporadically along the channel banks and channel bottom.

Reach 2 – Prairie Hawk Drive to Wolfensberger Road

From Prairie Hawk Drive to the detention pond a few hundred feet upstream that includes a concrete lined low flow channel. From the detention pond to Red Hawk Drive, the channel is incised by between 1 foot and over 6 foot. Further upstream are a series of small head cuts and channel incision less than 2’.

Reach 3 – Wolfensberger Road to Detention Pond 2000’ D/S of Coachline Road

Directly upstream of Wolfensberger Road the channel is slightly incised. Further, upstream, near the top of this reach, the channel becomes deeply incised, greater than 6 feet in some locations.

Reach 4 – Detention Pond 2000’ D/S of Coachline Road to Coachline Road

This reach is characterized by a concrete lined channel bottom and a series of drop structures leading to the detention pond.

Reach 5 – Coachline Road to Town/County Boundary

Upstream of Coachline Road, flow is in a heavily vegetated channel with only a few small head cuts and some private drives.

Reach 6 – Town/County Boundary to Upstream Study Limit

The upstream reach of the Omni Tributary a series of private drives with no outlets and a few small head cuts. When the channel becomes defined, there are v-ditches running on both sides of Wolfensberger Road with flow overtopping the roadway and crossing back and forth between the north and south side of the road.

Un-named Tributary to Omni

Reach 1 – Prairie Hawk Drive to 1000’ D/S of Red Hawk Drive

The lower reach of the un-named tributary to Omni is incised nearly the entire length of the reach, ranging from 1 foot at the downstream end to as much as 15 foot vertical banks in some locations.

Reach 2 – 1000’ D/S of Red Hawk Drive to Red Hawk Drive

This reach incised between 1 and 10 feet in this heavily vegetated reach through the golf course.

Industrial Study Area

The Industrial Study Area is currently developed in the lower reaches and undeveloped in the upper reaches of the basin. In the upper reaches, the mainstem of the Industrial Tributary and a tributary to the mainstem of the Industrial Tributary, that is nearly as long and as defined as the mainstem, confluence at a large stock pond. Above the stock pond, the basin is mostly comprised of sandy loam soil and hilly gravelly land. The spillway from the large stock pond outfalls north of the historic channel and rejoins the historic channel approximately 1,000 feet downstream of the pond. The historic channel just downstream of the stock pond does not convey the flow from upstream. The new flow path and the historic channel join a few hundred yards downstream of the spillway. Near the confluence of the new flow path with the historic channel, the basin becomes developed to the north of the Industrial Tributary.

Reach 1 – Outfall into East Plum Creek to Atchison Way (Extended)

Near the outfall to East Plum Creek, the flow crosses under a 48” CMP stacked above an 84” CMP under Prairie Hawk Drive before crossing a 9’ arch under the railroad then flowing to East Plum Creek. Upstream of Prairie Hawk Drive and extending to the top of this reach; the channel is incised between 2 and 10 feet and has very little vegetation. At the top of this reach is a large head cut at the confluence with an un-named tributary coming from Topeka Way and Atchison Way (Extended). The combined flow of the mainstem of the Industrial with the tributary flow has caused a 15 to 20 foot drop to occur. The tributary is deeply incised v-ditch.

Reach 2 – Atchison Way (Extended) to approximately 1500’ U/S of Atchison Way (Extended)

Throughout this reach, the channel is heavily vegetated and there are a series of small head cuts. The channel through this section is generally a deeply incised v-ditch running parallel to the commercial properties north of the channel.

Reach 3 – 1500’ U/S of Atchison Way (Extended) to Confluence with Tributary

Reach 3 of the Industrial Tributary extends from where the flow becomes channelized, to just downstream of the large stock pond. Throughout this reach, the channel is poorly defined and shallow overland flow occurs. Drop structures within this reach will be determined by the Redeker Property development plan and the regional park development plan.

Reach 4 – Confluence with Tributary to approximately 2500’ U/S of Confluence with Tributary

Throughout Reach 4, beginning downstream at the large stock pond, the channel is well defined with occasional steep slopes. This reach includes a number of 1-foot head cuts and a few larger head cuts greater than 6 feet. Low flow channel incision is also seen at various locations throughout the reach. The lower 2000’ of channel will have drop structures at locations determined from the regional park development plan.

Reach 5 – 2000’ U/S of Confluence with Tributary to Upstream Study Limit

Throughout reach 5, the channel is poorly defined. At various locations throughout this reach are a few small 2-foot head cuts showing some instability in the stream.

Un-named tributary to the Industrial Tributary

Reach 1 – Confluence with mainstem of Industrial Tributary to Upstream Study Limit

The un-named tributary is very similar to the upper two reaches of the Industrial tributary in that the channel is well-defined becoming less defined moving upstream. There are some head cuts ranging from large to a series of small head cuts spanning the distance of the reach.

Westfield Study Area

The basin is steeper in the upper reaches before flattening near I-25. In the upper reaches of the Westfield Study Area, there are many tributaries. Most of the tributaries originate north of the mainstem of the Westfield Tributary to East Plum Creek. As the watershed nears the outfall, a flow split occurs with some of the water flowing north and some of the water flowing south in the railroad ditch.

Reach 1 – Outfall to East Plum Creek to Downstream Most Private Driveway

The lower reach of the Westfield Tributary is a poorly defined channel with overland flow occurring in high flow events. This reach crosses two private drives with 2-foot culverts.

Reach 2 – Downstream Most Private Driveway to Upstream Most Private Driveway

The channel is well defined throughout this reach of the Westfield Tributary. In the lower portion of the reach, several culverts are partially or completely blocked with sediment. The channel upstream of the culverts is severely degraded by development and multiple private driveways with no culvert outlets. The entrance to this reach is large head cut.

Reach 3 – Upstream Most to Upstream of Town/County Line

This reach shows less instability than the two reaches downstream. The only instabilities seen in this reach are steep and erodible banks at some locations and a few small head cuts.

Reach 4 – Upstream of Town/County Line to Upstream Study Limit

Similar to Reach 3, this reach shows very little instability in the channel with only a few small head cuts. Throughout this reach, the channel is poorly defined.

Flood history

The most significant recorded flood in the area was in June 14 – June 16, 1965. Most of the reported impacts were along East Plum Creek but there is anecdotal evidence of extremely high flows along each of the tributaries, most commonly seen as headcuts or areas of severe channel incision. The rains from the 1965 flood also caused overland flooding. Southwest of Castle Rock immense orographic precipitation fell directly on top of Dawson Butte. The destructive overland flow that occurred in the immediate area of Dawson Butte caused the small natural channels on the steep slopes in this area to over top and form new channels following the line of least resistance.



Flood scars from 1965 on Dawson Butte as seen from South Dawson Tributary
(Courtesy of the Douglas County Library)

Sensitive Environmental and Habitat Areas

The lower reaches of all the tributaries are close to being completely developed with few native areas remaining. Farther up in the watersheds, the minor development that has occurred is very low density and the channels are largely undisturbed, with the exception of stock ponds. Much of the channel area remains covered with coniferous trees, deciduous shrubs and open grassy meadows. No sensitive environmental or habitat areas were identified along the waterways of the upper watershed. As the streams make their way into the overbanks of the East Plum Creek channel, areas of Preble's Meadow Jumping Mouse habitat have been identified.

Existing Wetland Conditions

The United States Fish and Wildlife Service (USFWS) have not identified any areas of the Omni, Industrial or Westfield tributaries as "riverine wetlands" or as "emergent wetlands." The field observations of these ephemeral streams generally reflect the analysis completed by the USFWS, however small pockets of ephemeral wetlands were found along the stream and a detailed inventory should be completed prior to the construction of any improvements

In 2005 Douglas County and the Towns of Castle Rock and Parker created the Douglas County Habitat Conservation Plan (DCHCP) to gain compliance with the Endangered Species Act (ESA) because of the USFWS listing the Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*) (PMJM) as a threatened subspecies in 1998. The DCHCP delineates riparian areas and adjacent upland habitats on nonfederal lands with a high likelihood of supporting PMJM within the three major watersheds in the County (Plum Creek, Cherry Creek, and South Platte River upstream of Chatfield Reservoir). These delineations cover the confluence area of the Omni, Industrial and Westfield tributaries with East Plum Creek. The delineated PMJM habitat depicted in the DCHCP is referred to as the Riparian Conservation Zone (RCZ) and was developed to:

- Be biologically defensible by using the best scientific and commercial data available
- Delineate potential habitat to include areas needed for all aspects of Preble's life cycle (e.g., water, cover, nesting, breeding, foraging, movement, and hibernation)
- Be reproducible and capable of being accurately located on the County's existing aerial photography and GIS data base In order to include all components of potential Preble's habitat within reaches

The DCHCP is the governing document for the Town of Castle Rock incidental takes permit for the PMJM within the designated RCZ and covers identified activities that the Town needs to conduct within the RCZ, and that may have temporary and permanent impacts on the RCZ. The activities covered by the DCHCP include construction, use, maintenance, and closure of roads, bridges, trails and recreational facilities; maintenance and repair of existing structures and facilities; emergency activities; habitat improvements that benefit the RCZ; and other necessary County or Town public improvements provided the impacts to the RCZ do not exceed the impact threshold described in the DCHCP

TABLE III-3
SWMM5 Summary

Link ID	Length (ft)	Manning's N	Shape	Allowable Depth (feet)	Base Width (ft)	Side Slope (ft/ft)	# Barrels
16-2	30	0.013	CIRCULAR	6	0	0	3
16-3	30	0.025	TRAPEZOIDAL	10	10	10	1
16-4	400	0.04	TRAPEZOIDAL	10	15	3	1
16-5	100	0.04	DUMMY	5	0	0	1
17-2	100	0.04	DUMMY	0	0	0	1
17-4	60	0.013	CIRCULAR	5	0	0	2
17-5	60	0.025	TRAPEZOIDAL	10	10	10	1
17-6	250	0.04	TRAPEZOIDAL	5	15	3	1
20-2	80	0.025	TRAPEZOIDAL	5	10	10	1
20-3	400	0.04	TRAPEZOIDAL	10	15	3	1
21b	50	0.024	CIRCULAR	4	0	0	2
21b-2	50	0.025	TRAPEZOIDAL	5	10	10	1
21b-3	290	0.04	TRAPEZOIDAL	5	15	3	1
22-3	1500	0.04	TRAPEZOIDAL	10	10	3	1
23-2	100	0.013	CIRCULAR	6	0	0	2
23-3	100	0.025	TRAPEZOIDAL	5	10	10	1
23-4	450	0.04	TRAPEZOIDAL	10	10	3	1
23-5	1150	0.04	TRAPEZOIDAL	10	10	3	1
24-2	200	0.013	CIRCULAR	4	0	0	1
2b	400	0.04	TRAPEZOIDAL	5	15	3	1

TABLE III-4

Summary of Peak Flow Rates at Key Locations

SWMM5 Design Point	5-yr Existing (cfs)	5 - yr Future (cfs)	10-yr Existing (cfs)	10 - yr Future (cfs)	100-yr Existing (cfs)	100 - yr Future (cfs)
2b (Culverts on Westfield)	100	140	170	220	560	650
J-6 (Tributary to Industrial)	130	310	200	380	610	850
J-7 (Industrial Pond)	80	130	120	180	400	490
J-10 (Lower Omni Pond)	170	170	290	320	1200	1250
22 (Upper Omni Pond)	150	170	250	270	820	860
O-1 (Westfield Outfall)	140	360	230	450	740	1020
O-2 (Industrial Outfall)	210	480	270	590	800	1220
O-3 (Omni Outfall)	310	310	370	370	920	930

*Flow rates are rounded to the nearest 10 cfs

Previous Studies

Previous studies have been limited to small sections of the Omni, Industrial, or Westfield watersheds. There are no available previous studies of an entire watershed for comparison. In 2007, a baseline hydrology report was prepared for the Town for the entire East Plum Creek watershed (CH2M HILL 2007). Although the Study Area is within the East Plum Creek watershed, the flow rates cannot be compared due to the resolution differences between each study. When East Plum Creek was delineated, an average basin area of 7 square miles (4,480 acres) was used compared to the 71 acres used in this Study.

Since particular design points are not available for comparison, other hydrologic studies performed within the Town are used to compare unit flow rates. The Baseline Hydrology Report for Sellars Gulch (PBS&J, 2008) and the Baseline Hydrology Report for Mitchell Gulch (CH2M HILL 2006) are used to compare unit flow rates for applied percent impervious values. **Table III-5** below presents this comparison.

Results of Analysis

Results from the hydrologic analysis for both the existing and future condition are summarized in **Table III-4**. Peak flows for all design points and inflow hydrographs are provided in Appendix B. A more detailed presentation of the results of the study can be found in the Baseline Hydrology Report.



Exposed Utility Crossing in Reach 1 of the Omni Tributary

Within reach 1 of the un-named tributary to Omni there are few flood hazards. No private properties are impacted by the floodplain, but the two bike crossings are overtopped.

Reach 2 – 1000' D/S of Red Hawk Drive to Red Hawk Drive

Upstream of Prairie Hawk Drive, sediment has been deposited in the 3-foot concrete lined channel. From the concrete lined channel to the Emergency Easement, the channel appears stable. Between the Emergency Easement and Red Hawk Drive, the sandy channel is incised by between 1 foot and over 6 foot. Just downstream of Red Hawk Drive is a drop structure with approximately 12-inch riprap that is failing. Directly upstream of Red Hawk Drive is a bike trail in the channel with heavy sediment deposition. Further upstream are a series of small head cuts and channel incision less than 2'.

There are no infrastructure related problems within this reach.

There are no flooding related issues within this reach and the 100-year floodplain is completely contained within the channel banks.

Industrial Study Area

Reach 1 – Outfall into East Plum Creek to Atchison Way (Extended)

Beginning upstream of Prairie Hawk Drive and extending to the top of this reach; the channel is incised between 2 and 10 feet. Throughout the reach, the banks are vertical with very little vegetation. A culvert outfall approximately half way up the reach is undercut by approximately 15 to 20 feet. At the top of this reach is a large head cut at the confluence with an un-named tributary coming from Topeka Way. The combined flow of the mainstem of the Industrial with the tributary flow has caused a 15 to 20 foot drop to occur. The tributary is deeply incised v-ditch. No private properties are threatened in this reach, however continued bank instability will continue to impact storm utility infrastructure through this area.

The three hydraulic structures within this reach are the 8-foot RCP outfall Stormsewer structure, constructed by CDOT that discharges directly to East Plum Creek from just upstream of Park Street, the 7-

foot CMP stacked below a 4-foot CMP and a 9-foot Rhyolite arch. The stacked 7-foot CMP below a 4 foot CMP beneath Prairie Hawk Drive has a capacity of 1130 cfs but is undersized for the 100-year future flows. The 9-foot Rhyolite arch under the Burlington Northern Railroad has a capacity of 1170 cfs and passes both the existing and future flows. The CDOT 8' RCP Stormsewer outfall for the Industrial Tributary is designed for a 100-year flow rate of 850 cfs. The calculated existing flow rate for the system is 796 cfs. This system passes existing flows but will be pressurized under future flow conditions with an outlet velocity of 24.3 ft/sec.

Within reach 1, the floodplain exhibits backwater effects directly upstream of Prairie Hawk Drive but does not affect any private property. The flow throughout the remainder of this reach is contained within the channel banks.



Undercut Culvert on Industrial Reach 1

Reach 2 – Atchison Way (Extended) to approximately 1500' U/S of Atchison Way (Extended)

Near the downstream portion of this reach is a temporary dirt road crossing the flow with no outlet. Throughout this reach, the channel is heavily vegetated and there are a series of small head cuts. The channel through this section is generally a deeply incised v-ditch running parallel to the commercial properties north of the channel. No private properties are threatened in this reach, however continued bank instability will continue to impact storm utility infrastructure through this area.

There are no infrastructure related problems within this reach.

The floodplain extends outside of the channel banks and enters private industrial property. The floodplain for the remainder of this reach is contained within the channel banks.



Eroded Channel in Reach 2 of the Industrial Channel

Reach 3 – 1500' U/S of Atchison Way (Extended) to Confluence with Tributary

Reach 3 of the Industrial Tributary extends from where the flow becomes channelized to just downstream of the large stock pond. Throughout this reach, the channel is poorly defined and shallow overland flow occurs.

There are no infrastructure related problems within this reach. The stock pond at the top of this reach does not release flows to the historic channel.

Within this reach, shallow overland flow occurs with multiple split flow conditions. The stock pond marking the top of this reach releases flows through this spillway to the spillway channel while flows overtopping the pond enter the historic channel. Flows in the spillway channel that do not split to join the historic channel enter private industrial property.

Reach 4 – Confluence with Tributary to approximately 2500' U/S of Confluence with Tributary

Throughout Reach 4, beginning downstream at the large stock pond, the channel is well defined with occasional steep slopes. This reach includes a number of 1-foot head cuts and a few larger head cuts greater than 6 feet. Low flow channel incision is also seen at various locations throughout the reach.

There are no infrastructure related problems within this reach.

There are no flooding related issues within this reach as no properties are impacted by the 100-year floodplain.

Reach 5 – 2000' U/S of Confluence with Tributary to Upstream Study Limit

Throughout reach 5, the channel is poorly defined. At various locations throughout this reach are a few small 2-foot head cuts showing some instability in the stream.

There are no infrastructure related problems within this reach.

There are no flooding related issues within this reach as no properties are impacted by the 100-year floodplain.

Un-named tributary to the Industrial Tributary

Reach 1 – Confluence with mainstem of Industrial Tributary to Upstream Study Limit

The un-named tributary is very similar to the upper two reaches of the Industrial tributary in that the channel is well defined near the stock becoming less defined moving upstream. There is a large, 6-foot head cut a series of small head cuts spanning the distance of the reach.

There are no infrastructure related problems within this reach.

There are no flooding related issues within this reach as no properties are impacted by the 100-year floodplain.

Westfield Study Area

Reach 1 – Outfall to East Plum Creek to Downstream Most Private Driveway

The lower reach of the Westfield Tributary is a poorly defined channel with overland flow occurring in high flow events. This reach crosses two private drives with 2-foot culverts that have a capacity of approximately 22 cfs and that are partially blocked with sediment. These culverts do not pass the 100-year future or 100-year existing flow rates, however being driveways the two culverts are only required to pass the 10-year flow rate. The 2 - 24-inch RCP undersized driveway culverts cause a backwater effect in the floodplain. Also within this reach are two properties impacted by the 100-year floodplain.

In the downstream most reach of the Westfield Tributary, a split flow condition exists with a portion of the flow running north along the railroad ditch to a 72-inch CMP under the Burlington Northern Railroad and a portion of the flow running south along the railroad ditch to a 36-inch CMP outfall under the Burlington Northern Railroad. Neither one of these outfalls are size for the full 100-year future flows. Each culvert pipes has a capacity of 331 cfs and 98 cfs respectively. The predicted North discharge, accounting for the split flow, for the future developed condition is 742 cfs while the south future developed conditions split flow is 317 cfs. This indicates that both culverts that drain the Westfield system are undersized

Reach 2 – Downstream Most Private Driveway to Upstream Most Private Driveway

The channel is well defined throughout reach 2 of the Westfield Tributary. In the lower portion of the reach are 4 - 52-inch by 36-inch elliptical RCPs that are each partially or completely blocked with sediment. The channel upstream of the culverts is severely degraded by development and multiple private driveways with no culvert outlets. At one location of a driveway with no outlet has eroded into a "hole" upstream of the driveway and has collected a substantial amount of debris. The entrance to this reach is large head cut. Continued erosion could affect private structures and property.

Within reach 2 are undersized culverts located at private driveways.

Within this reach, upstream of the undersized culverts, bulges in the floodplain occur. Although this reach is severely degraded and the floodplain is not entirely contained within the channel banks, no properties are at risk from flooding.

Reach 5– Station 77+35 to Station 104+97

The recommended plan for Reach 5 of the Omni Channel includes one Priority 1 drop structures, seven Priority 2 check structures, and two Priority 3 drop structures to stabilize the channel grade. Priority 1 structures are recommended to stabilize existing head cuts and to stabilize where tributaries confluence with the Omni main channel.

Reach 6 – Station 104+97 to Station 149+98

The recommended plan for Reach 6 of the Omni Channel includes four Priority 1 drop structures, twenty-two Priority 2 check structures, and six Priority 3 drop structures to stabilize the channel grade. Priority 1 structures are recommended to stabilize existing head cuts and to stabilize where tributaries confluence with the Omni main channel.

Additional improvements within this reach include several infrastructure improvements. The channel currently overtops Wolfensberger Road near Heir Lane twice. Currently no infrastructure is present to cross the flows 1 – 48” RCP is recommended at Heir Lane and 2 – 54” RCPs are recommended 500’ east of the intersection to cross flows and prevent street flooding. In addition existing infrastructure 2,500’ east of the intersection is undersized and 2 – 54” RCPs are recommended as replacements.

Omni Tributary

Reach 1 – Station 0+00 to Station 18+41

The recommended plan for Reach 1 of the Omni Tributary includes two Priority 1 drop Structures downstream of the bike trails and the exposed utility crossing, Bank stabilization is also recommended through this reach downstream of the existing bike trail crossing.

Reach 2 – Station 18+41 to Station 27+74

No improvements are recommended at this time. However, the stream channel will need to be monitored for erosion and additional stabilization may be needed in the future if infrastructure is threatened.

Industrial Drainage Channel

Reach 1 – Station 0+00 to Station 25+22

The recommended plan for Reach 1 of the Industrial Channel includes three Priority 1 drops Structures, and five Priority 2 Drop structures to stabilize the channel grade. In addition, the channel thalweg will be raised from station 25+00 to station 13+00 upstream of Prairie Hawk Drive to restore the channel to near historic conditions. Bank stabilization is also recommended through this reach. Finally, the culvert under Prairie Hawk Drive should be replaced with a 12’ x 10’ CBC to improve conveyance and to accommodate a potential future bike trail. The CDOT 8’ RCP with drop manholes becomes pressurized during the 100-year future peak flows with outlet velocities exceeding 20 feet per second. In future conditions, upstream detention can be formalized and recognized to reduce the future velocity to the existing and design velocity.

Reach 2 – Station 25+22 to Station 40+76

The recommended plan for Reach 2 of the Industrial Channel includes no Priority 1 drop structures, and eleven Priority 2 check structures to stabilize the channel grade as well as several drop structures proposed on the Redeker Property. Priority 1 drop structures are recommended to stabilize existing head cuts and downstream of existing infrastructure that may be in danger if channel erosion continues. Priority 3 drop structures should be constructed if Priority 1 and Priority 2 drop structures do not stabilize the channel.

Other recommended improvements within this reach include a 12’ sloping grouted boulder run down near the Topeka way tributary confluence (station 26+64) and channelization from station 40+76+ to station 38+50.

Reach 3 – Station 40+76 to Station 50+71

Channelization is recommended from station 50+50 to station 40+76. No other improvements are recommended for the reach.

Reach 4 – Station 50+71 to Station 75+42

This reach is primarily within the proposed Town of Castle Rock Regional Park. Seven Priority 1 drop structures are recommended for the regional park as well as one Priority 3 drop structure to stabilize the channel. Priority 1 drop structures are recommended to stabilize existing head cuts and downstream of existing infrastructure that may be in danger if channel erosion continues. Priority 3 drop structures should be constructed if Priority 1 and Priority 2 drop structures do not stabilize the channel

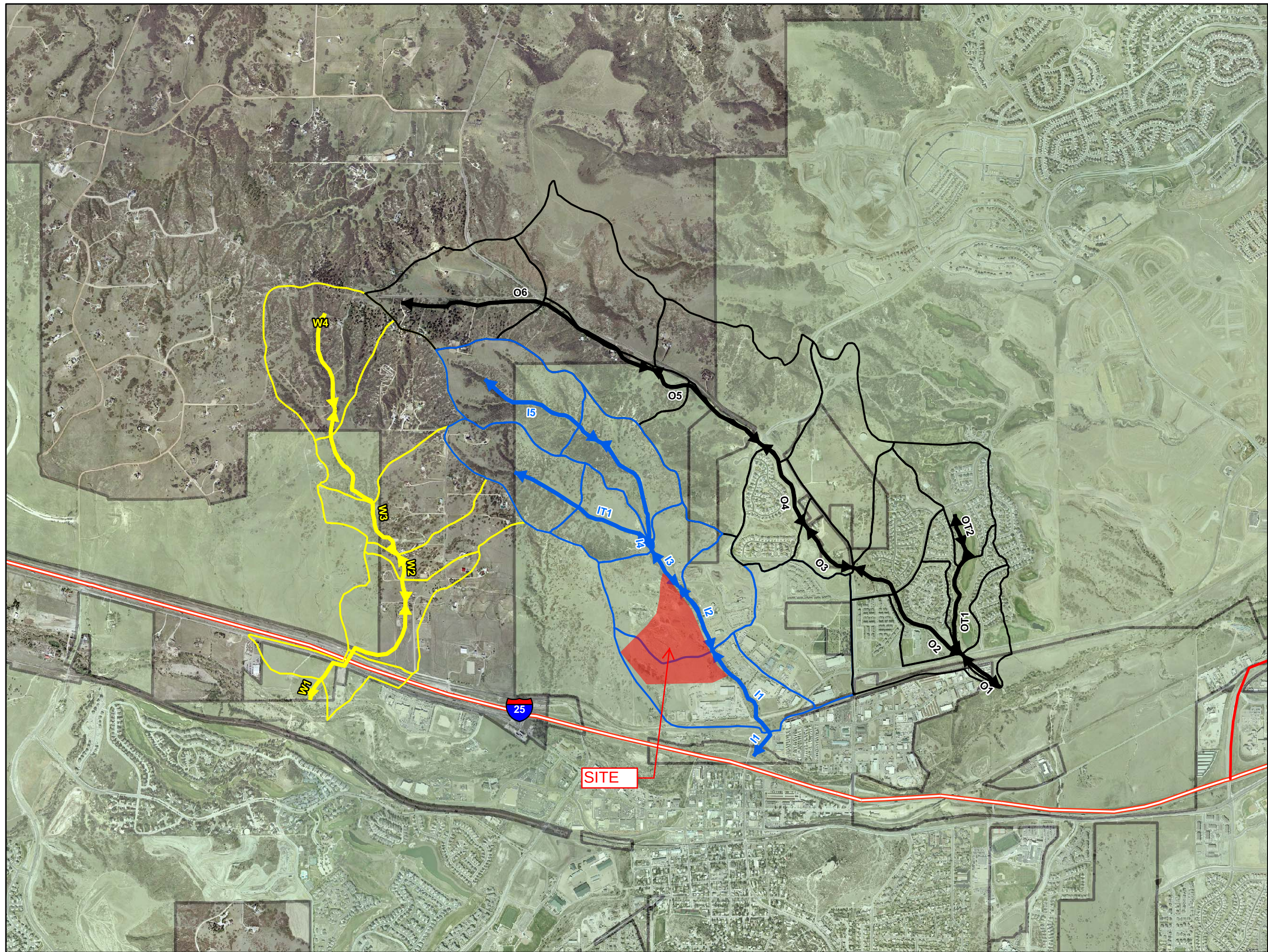
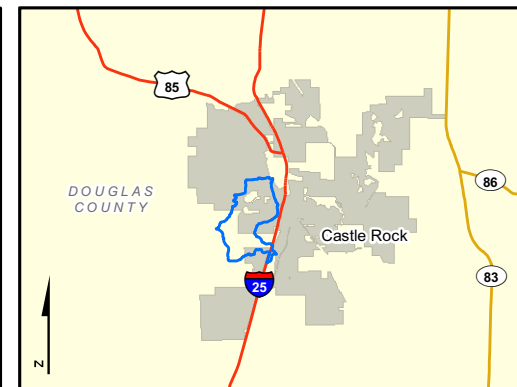
Reach 5– Station 75+42 to Station 103+65

The recommended plan for Reach 5 of the Industrial Channel includes one Priority 2 check structure, and five Priority 3 drop structures to stabilize the channel grade. . Priority 1 drop structures are recommended to stabilize existing head cuts and downstream of existing infrastructure that may be in danger if channel erosion continues. Priority 3 drop structures should be constructed if Priority 1 and Priority 2 drop structures do not stabilize the channel

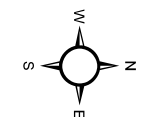
Industrial Tributary

Reach 1 – Station 0+00 to Station 29+47

The recommended plan for Reach 1 of the Industrial Tributary includes three Priority 1 drop Structures within the Town of Castle Rock Regional Park, and eight Priority 3 drop structures to stabilize the channel grade. The Priority 3 structure should be constructed if the Priority 1 and Priority 2 structures do not stabilize the channel. No other improvements are recommended for this reach.

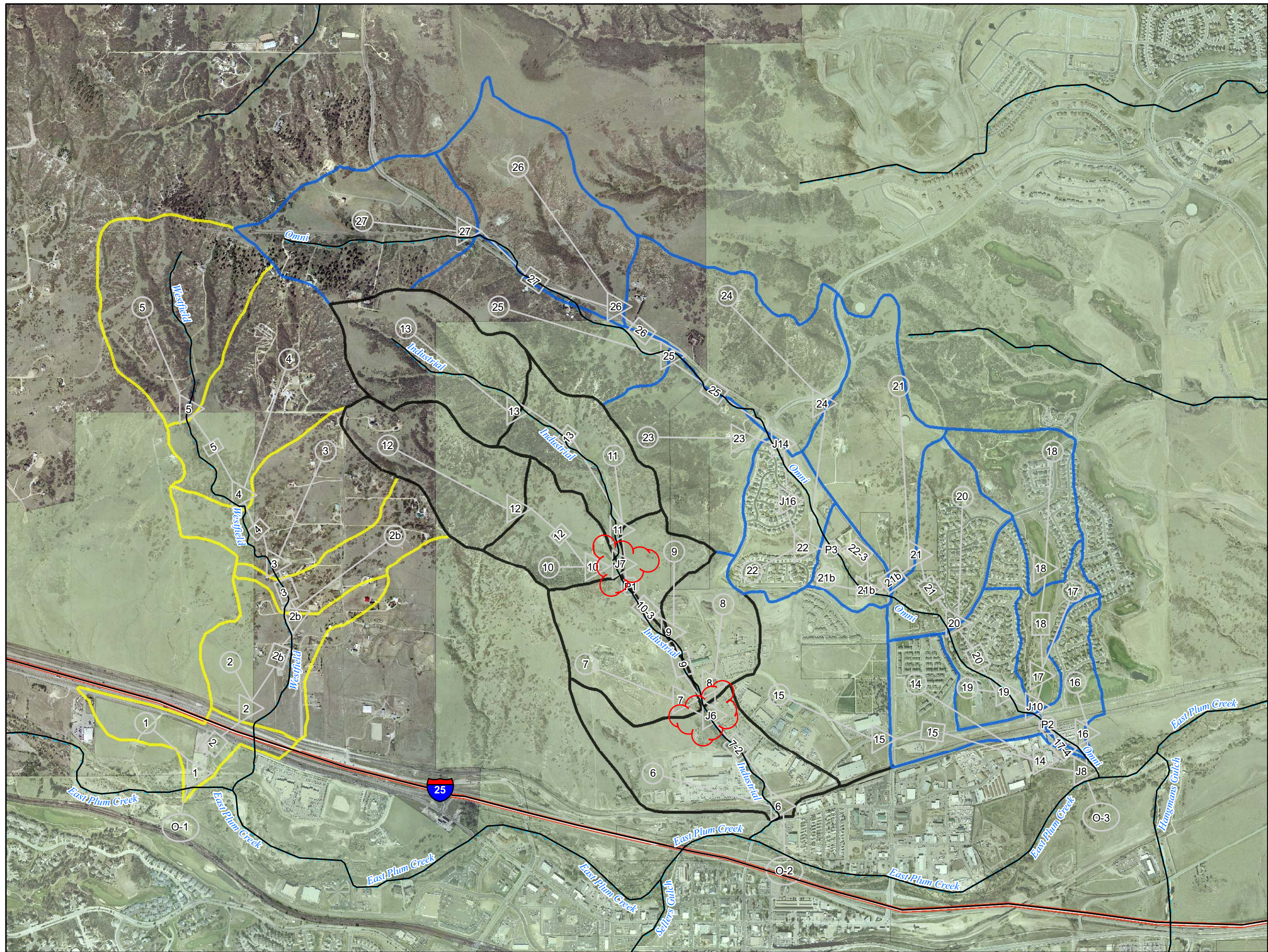
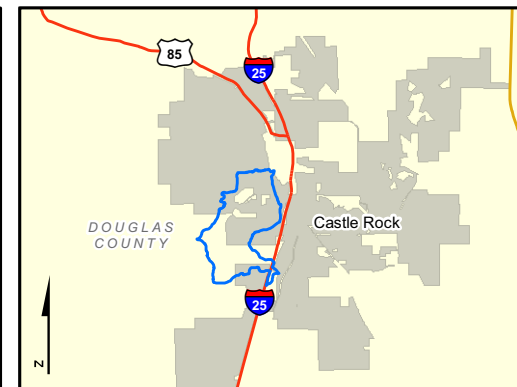


- Legend**
- Omni Reaches
 - Industrial Reaches
 - Westfield Reaches
 - Industrial
 - Omni
 - Westfield
 - Castle Rock Town Boundary



0 600 1,200
Feet

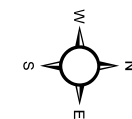
Figure II-1
Omni/Industrial/Westfield
Watershed Master Plan
Reach Layout



Watershed Location

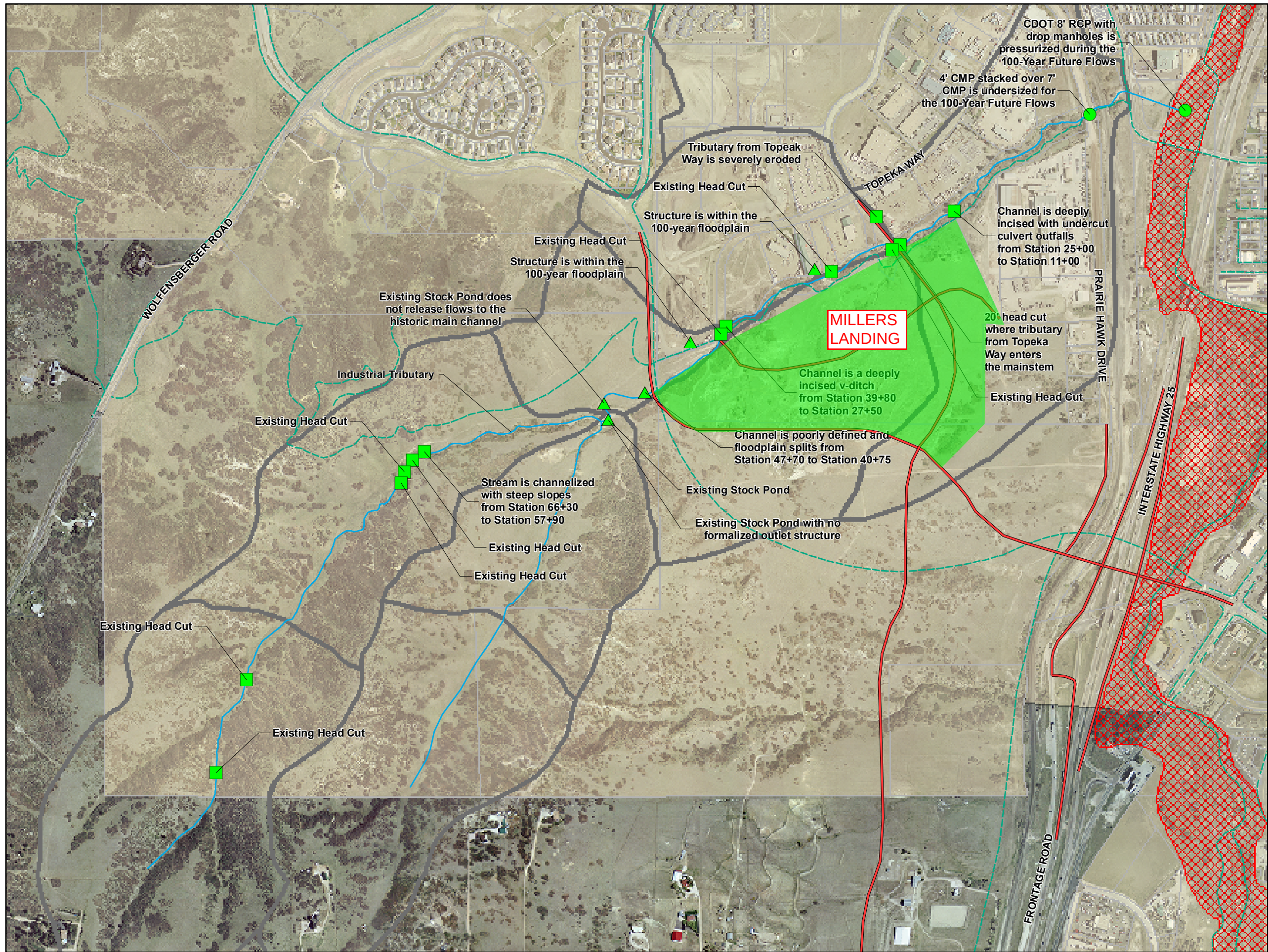
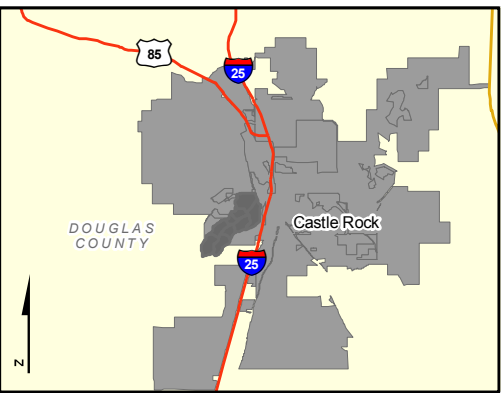
Legend

- Perennial Streams and Creeks
- Industrial
- Omni
- Westfield
- Castle Rock Town Boundary
- Outfall Identification
- Conveyance Element
- Sub Basin Identification
- Storage Element
- Design Point or Junction



0 600 1,200
Feet

FIGURE III-1
Omni/Industrial/Westfield
Watershed Master Plan
Watershed Connectivity



Watershed Location

Legend

- ▲ Flooding
- Infrastructure
- Stream Stability
- Proposed Road Centerline
- Trail
- Industrial Centerline
- Industrial 100-YR Floodplain
- Industrial 500-YR Floodplain
- PMJM Habitat
- Industrial
- Parcel Boundary
- Town of Castle Rock Boundary

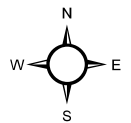
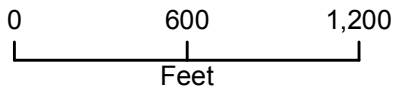
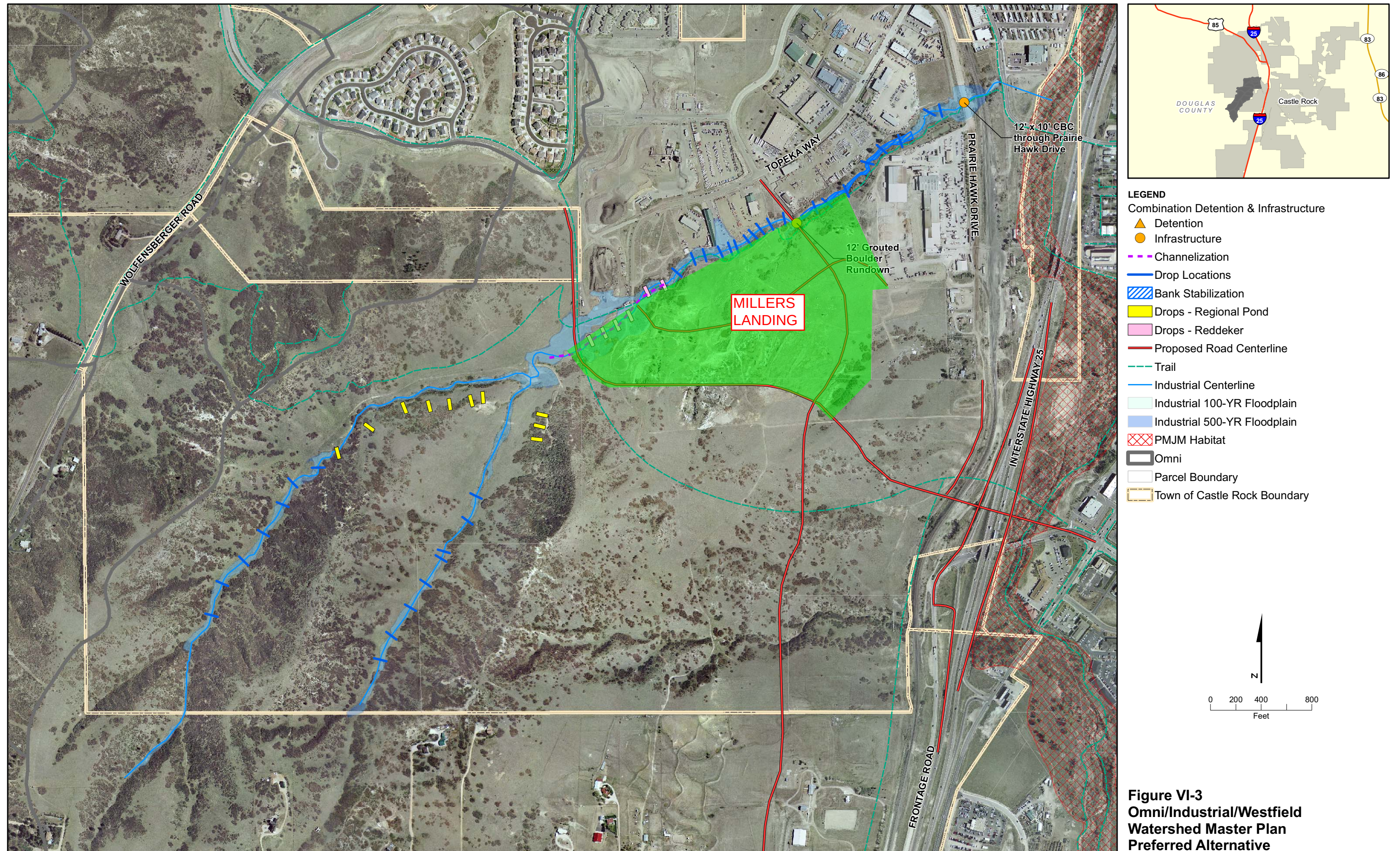
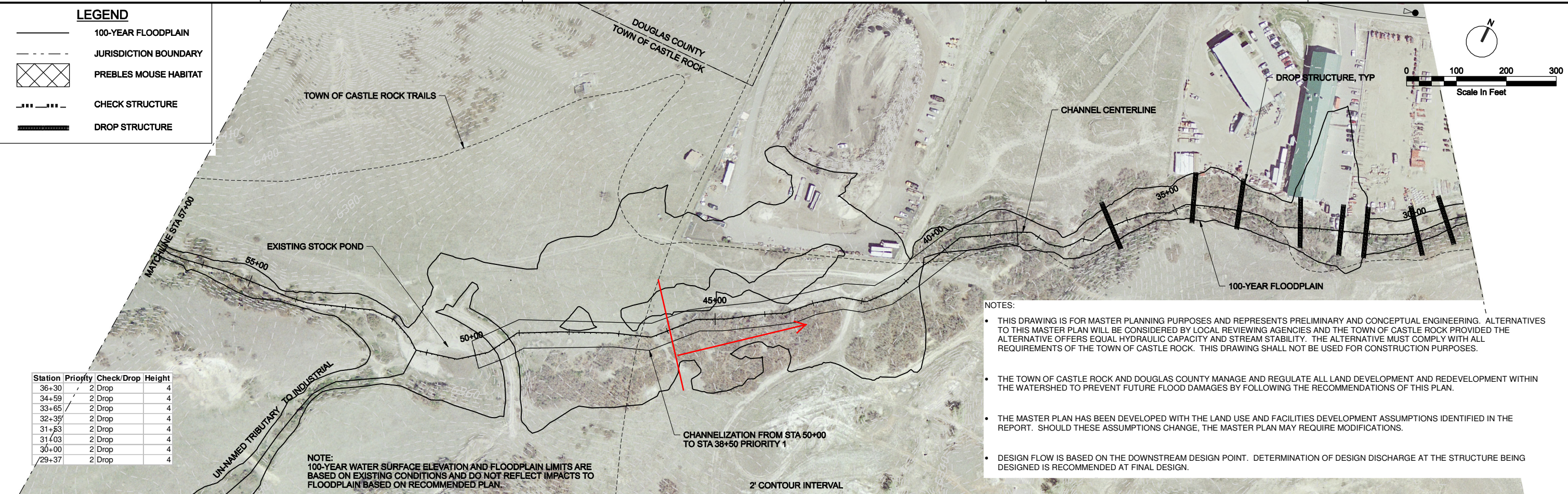
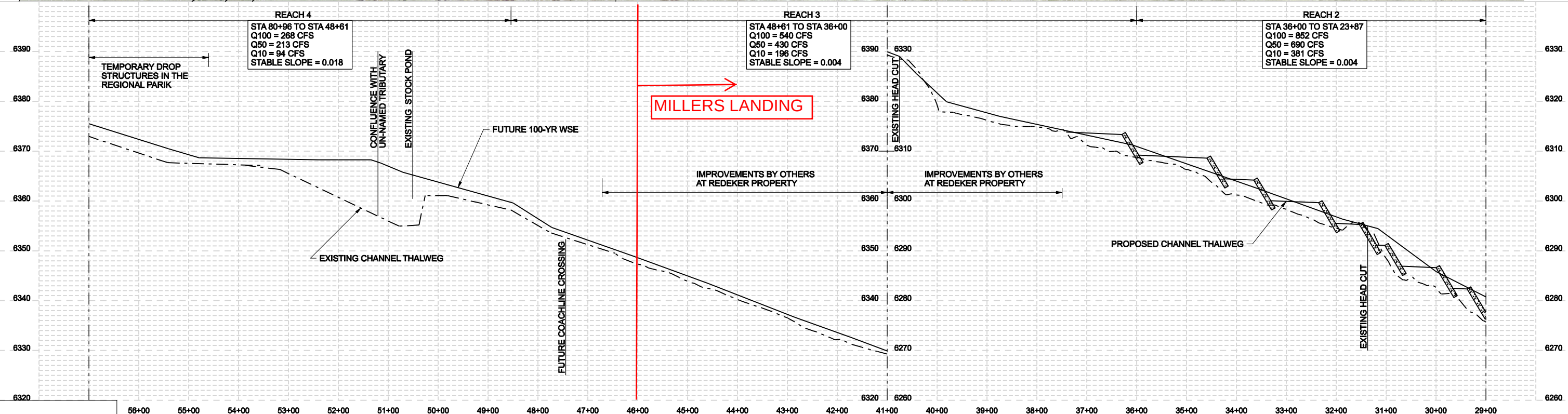


Figure IV-3
Omni/Industrial/Westfield
Watershed Master Plan
Identified Problem Areas





PRELIMINARY

NOT FOR CONSTRUCTION

NOTE:
TOPOGRAPHY FROM TOWN OF CASTLE ROCK (2006), NAVD 88 VERTICAL DATUM,
NAD 83 STATE PLANE COLORADO CONTROL HORIZONTAL DATUM
AERIAL MAPPING FROM TOWN OF CASTLE ROCK (2006)

DSGN	A COOK	NO	DATE	DESCRIPTION	APVR	N	BY	APVD	VERIFICATION
DR	C SCHNEE								
CHK	A TURNER								
APVD	M GLIDDEN								
		NO.	DATE	REVISION					

VERIFY SCALE
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0" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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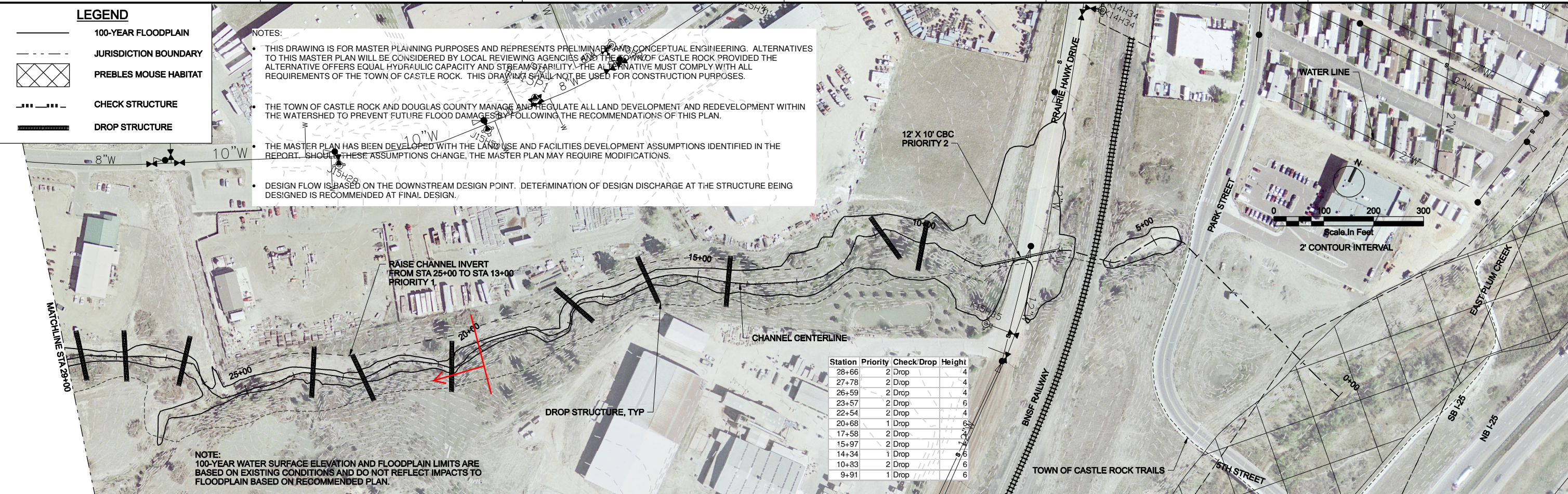
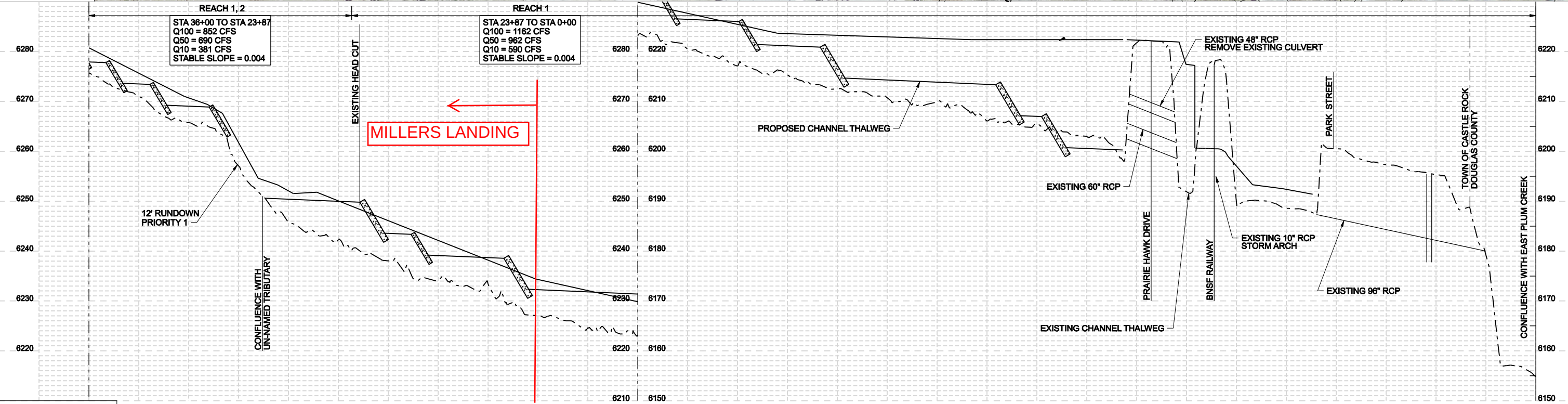
TOWN OF CASTLE ROCK
COLORADO

INDUSTRIAL
PLAN AND PROFILE
STA 57+00 TO STA 29+00

SHEET	10
DWG	PP-3
DATE	JULY 2010
PROJ	381198

FILENAME: MP_Industrial_PP03.dgn PLOT DATE: 11/8/2010 PLOT TIME: 3:06:33 PM

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PRELIMINARY

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NOTE:
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NAD 83 STATE PLANE COLORADO CONTROL HORIZONTAL DATUM
AERIAL MAPPING FROM TOWN OF CASTLE ROCK (2006)

DSGN	A COOK	NO	DATE	DESCRIPTION	REVISION	APVR	N	BY	APVD	SCALES ACCORDINGLY
DR	C SCHNEE									
CHK	A TURNER									
APVD	M GLIDDEN									

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0" 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL

TOWN OF CASTLE ROCK COLORADO

INDUSTRIAL PLAN AND PROFILE STA 29+00 TO STA 0+00

SHEET	11
DWG	PP-4
DATE	JULY 2010
PROJ	381198

FILENAME: MP_Industrial_PP04.dgn PLOT DATE: 11/8/2010 PLOT TIME: 3:27:01 PM

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**PHASE III DRAINAGE REPORT FOR
COACHLINE ROAD AND PLUM CREEK BOULEVARD AT I-25
CASTLE ROCK, COLORADO**

A Part of Sections 10 and 11,
Township 8 South, Range 67 West
Of the 6th P.M., Douglas County, Colorado

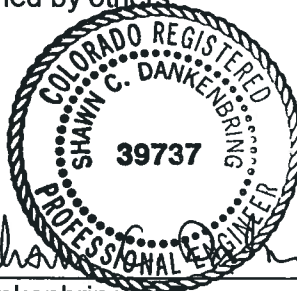
January 26, 2007
Revised March 18, 2009

Prepared by:
Felsburg Holt & Ullevig
6300 S. Syracuse Way, Suite 600
Centennial, CO 80111
(303) 721-1440
FAX (303) 721-0832
fhu@fhueng.com

FHU Reference No. 02-241

CERTIFICATION STATEMENT

I affirm that this report and plan for the Phase III drainage design for the Coachline Road and Plum Creek Boulevard at I-25 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.



Signature: Shawn C. Dankenbring 3-18-09
Shawn C. Dankenbring, P.E.
Registered Professional Engineer of Colorado No. 39737

Town of Castle Rock Approvals:

<u>DKL</u> Approved Utilities Department Development Services	<u>9/01/09</u> Date
<u>SEP 01 2009</u> Development Services Town of Castle Rock	<u> </u> Date

II. DRAINAGE BASINS AND SUB-BASINS

A. MAJOR BASIN DESCRIPTION

The project area is within the East Plum Creek Major Drainage Basin. This major basin has an area of about 85 square miles that lies above (south) of the project area. The areas of this basin include open range and large lot subdivisions. A small percentage of the upstream basin consists of multi and single family residential subdivisions and commercial and business areas.

The project area adjacent to East Plum Creek is within the Federal Emergency Management Agency's (FEMA) Zone AE (See Figure 3). Zone "AE" is part of the FEMA 100-year flood hazard area where base flood elevations have been determined. East Plum Creek also has a floodway. The floodway is the area of the floodplain that should be reserved (kept free of obstructions) to allow floodwaters to move downstream. The hydraulic analysis for this bridge is located in a separate document from this report. It should be referenced in order to get details for peak design flows, bridge hydraulics, freeboard, scour, and countermeasures. This separate report is in a format for the FEMA Conditional Letter of Map (CLOMR). A CLOMR is required by FEMA to get a determination that this project conforms to their criteria.

Other project areas are within Zone X which includes areas determined by FEMA to be outside the 500-year floodplain (FEMA, 2006).

Industrial Tributary will maintain historic patterns except right under Coachline Road where it will be conveyed in a 10 foot tall and 18 feet wide box culvert used to convey stormwater as well as pedestrians. The 5-year flow will be conveyed in a low flow channel adjacent to the trail. The 100-year flow will inundate the trail less than 4 feet of depth.

B. MINOR BASINS DESCRIPTIONS

East of I-25, Coachline Road's offsite drainage will be conveyed under the roadway at locations that approximate the historic drainage pattern. Stormwater from both sides of Coachline Drive will be intercepted in a series of Type R inlets and passed eastward to a series of water quality ponds. Interceptor ditches will be placed along the top of cut areas to direct storm water to controlled riprap swales down the embankment or cross culvert.

West of I-25, Plum Creek Boulevard's drainage will pass to Type R inlets at its intersection with Wilcox Street. This will include minor offsite drainage and drainage from Wilcox Street that has historically passed towards Plum Creek Boulevard. Stormwater from both sides of the re-aligned Plum Creek Boulevard will also be intercepted in a series of Type R inlets and passed westward to the sump of Plum Creek which is right under I-25.

C. IRRIGATION

No irrigation facilities are known to exist and none are evident in the field.

IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. STORMWATER CONVEYANCE FACILITIES

Coachline Road and Plum Creek Parkway will ultimately be major arterials with 2 lanes in each direction. There will be no inundation of buildings during the major 100-year storm. The roadway cross culverts will pass the 100-year storm flows. Storm sewers will be able to intercept the 5 year storm. In places where there is not an emergency outfall, the 100-year storm event will be passed. Proposed drainage patterns will remain as close to the historic patterns as possible.

Table 2 lists the flows for which pipes will be sized. Additional details for storm sewers with inlets are located in Appendices A and B. The modified extended detention basins for water quality will be sized to treat the roadway flows plus minor offsite areas from the cut condition. The offsite flows from Basins OS1, OS2 and OS6 will be routed through the site and will not pass directly into a water quality pond. See Meadows South Regional Park Report (FHU, 2008) for details on offsite Basin OS1.

A Basins are collected in a storm sewer and discharged into a concrete forebay in the pond by the box culvert and then discharge into the Industrial Tributary. The outflow from B Basins is discharge from a 36-inch reinforced concrete pipe with riprap. In the future the developer will connect this onto a system that will flow through the downstream site and discharge into a pond that is proposed by the developer. C Basins are collected in storm sewer and discharged into concrete forebay at the pond located at the interchange prior to being discharged into Plum Creek. D Basins are collected in a storm sewer and will be treated in an underground system prior to being discharged into Plum Creek. Basins E are collected in a storm sewer and discharged in Plum Creek, the original plan for this was to be treated in a pond before being discharged but utility conflicts did not allow this.

Table 2-Summary Runoff Table

Contributing Basin	Area in Acres	Peak Discharge (cfs)		Remarks
		5-Yr.	100-Yr.	
OS1 Ex	304		423	(2% Impervious Area)
OS1 Dev	304		569	(20% Impervious Area)
OS2	10.4	2.1	23.1	
OS3	1.66	0.3	3.3	
OS6	14.3	2.8	30.9	
A	5.93	7.8	21.4	
B	3.77	8.9	39.2	
C	18.63	15.8	56.7	
D	2.38	9.4	18.6	
E	2.97	6.9	15.6	

Table 3-Summary Modified Extended Detention Basin Table

Pond No.	Contributing Basins	Paved area (Acres)	Water Quality Capture Volume*
1	All of Basin A	2.94	0.15 acre feet
3	All of Basin C	7.64	0.39 acre feet

*NOTE: Water Quality Capture Volume (WQCV) is equal to one-half inch of rainfall over the impervious paved surface or 0.0417 acre feet per acre, plus an additional 20% for sediment.

B. STORMWATER STORAGE FACILITIES

Half of the roadway impervious surfaces such pavement and walks will be placed as a part of this project. The first phase of Coachline is installing water quality ponds to treat the impervious area that is draining to the ponds. The developer is responsible for building the other half of Coachline Road. In the future, full spectrum detention will probably be required for the site that includes, 1) Water Quality Capture Volume (WQCV), 2) Excess Urban Runoff Volume (EURV), and 3) 100-year detention. The pond on the park could be modified to incorporate the future paving and achieve WQCV, EURV and detention for the roadway but the park site might utilize this pond as well, so modification will need to occur when the future development is done. The existing pond at the interchange was constructed with the CDOT project and only provides water quality for Coachline, including the future paving on the additional lanes.

Pond 1 (Basins A) is located at the box culvert and will be reconfigured in the future when the road is widened and development occurs within the park. The ultimate outflow for the pond at that time will be 2.9 cfs for the 100-year and 0.9 cfs for the 10-year flow. The 10-year water surface elevation is 6348.2 and the 100-year water surface elevation is a little less than 6350. This pond has a maintenance trail that is 10 feet wide and has less than 10 percent grade. A curb cut at the top will allow access from Coachline Road.

Pond 2 (Basins C) is located at the interchange and will be maintained by the Town, even though the pond is within CDOT's ROW. The outflow for the pond at that time will be 56.7 cfs for the 100-year and 8.0 cfs for the 10-year flow. The 10-year water surface elevation will be 6210 and the 100-year water surface elevation is a little less than 6212. This pond provides water quality and detains the minor storm. A 10 foot wide and 10 percent grade access trail off of CDOT's south bound on ramp from Plum Creek to I-25 will provide access.

C. WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES

Permanent structural water quality will be provided during this paving project at the park site and interchange site. The facilities have been addressed in the section above. Temporary ponding facilities will be incorporated into the rough grading plan. The location of the temporary pond is shown in the Coachline Grading Plans. This temporary pond will drain to the south and under the railroad in an existing pipe until the paving project starts and grades under the new railroad bridge.

The project will disturb approximately 29 acres; therefore a Colorado Discharge Permit System permit (CDPS) will be required. The Town of Castle Rock will apply for this permit and will transfer it to the contractor. Basic storm water management practices will be required for the project.

First, the site perimeter will be stabilized with silt fence, or reinforced rock berms. Areas to be protected will be delineated with plastic (construction) fence. Initial construction activities will include placing the embankment material and drainage structures. Contour furrowing, seeding and mulching of all disturbed embankment areas will occur as soon as the embankment and topsoil has been placed.

The total area anticipated to be disturbed is approximately 29 acres. Of the 29 acres to be disturbed, the roadway and sidewalks on the south side will be the impervious surfaces.

The construction plans show the locations of the proposed roadway culverts and channels that convey storm waters. The historic flows pass via these channels to the Industrial Tributary that eventually terminates at East Plum Creek (the ultimate receiving waters). No changes in these historic paths will be made.

D. FLOODPLAIN MODIFICATION

None of the Coachline project area is within a FEMA designated floodplain. The cumulative basin area of the 174 and 130 acre basins that concentrates at Coachline Road is 304 acres. No floodplain mapping is planned within the park area. FEMA mapping for the Industrial tributary ends about 1000 feet north of Coachline Road (see Figure 3). Refer to the CLOMR (FHU, 2007) for

COEFFICIENTS OF DEVELOPMENT

Project: Coachline, Douglas County, CO

Project #: 02-241

Date: 05-Feb-09

File: CoachHydro.xls

BASIN	AREA ACRES	IMPERVIOUSNESS				SOIL TYPE			RUNOFF COEFF.			
		Open % Imp. 0 Acres	Future % Imp. 40 Acres	Paved % Imp. 100 Acres	Comp. % Imp.	A Percent of Total Area	B Percent of Total Area	C/D Percent of Total Area	2 YEAR	5 YEAR	10 YEAR	100 YEAR
OS2	10.20	10.20	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
OS3	1.66	1.66	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
OS4	1.90	1.90	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
OS5	1.12	1.12	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
OS6	13.80	13.80	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
A1	2.48	1.97	0.00	0.51	20.42	0.0	0.0	100.0	0.173	0.262	0.346	0.553
A2	0.86	0.16	0.00	0.70	81.53	0.0	0.0	100.0	0.614	0.642	0.677	0.756
A3	1.00	0.52	0.00	0.48	47.57	0.0	0.0	100.0	0.323	0.385	0.447	0.597
A4	0.60	0.12	0.00	0.47	79.51	0.0	0.0	100.0	0.590	0.620	0.657	0.740
A5	0.47	0.11	0.00	0.36	75.88	0.0	0.0	100.0	0.550	0.584	0.623	0.714
A6	0.52	0.10	0.00	0.43	81.73	0.0	0.0	100.0	0.616	0.644	0.679	0.757
B1	0.49	0.12	0.00	0.36	74.84	0.0	0.0	100.0	0.539	0.574	0.614	0.707
B2	0.55	0.10	0.00	0.45	81.53	0.0	0.0	100.0	0.614	0.642	0.677	0.756
B3	0.45	0.19	0.00	0.26	57.39	0.0	0.0	100.0	0.387	0.440	0.494	0.624
B4	0.40	0.08	0.00	0.32	80.38	0.0	0.0	100.0	0.600	0.629	0.665	0.746
B5	0.13	0.03	0.00	0.10	76.82	0.0	0.0	100.0	0.560	0.593	0.631	0.720
B6	1.17	0.55	0.00	0.62	52.68	0.0	0.0	100.0	0.355	0.412	0.470	0.610
B7	0.58	0.14	0.00	0.44	75.83	0.0	0.0	100.0	0.549	0.583	0.623	0.713
C1	0.81	0.41	0.00	0.39	48.62	0.0	0.0	100.0	0.329	0.391	0.452	0.600
C2	0.41	0.12	0.00	0.29	71.38	0.0	0.0	100.0	0.504	0.543	0.586	0.686
C3	0.81	0.53	0.00	0.28	34.78	0.0	0.0	100.0	0.250	0.325	0.398	0.575
C4	0.52	0.30	0.00	0.21	41.34	0.0	0.0	100.0	0.286	0.355	0.422	0.585
C5	2.37	1.86	0.00	0.50	21.29	0.0	0.0	100.0	0.177	0.266	0.349	0.554
C6	1.96	1.47	0.00	0.49	25.06	0.0	0.0	100.0	0.198	0.283	0.363	0.560
C7	2.12	1.23	0.00	0.89	42.09	0.0	0.0	100.0	0.291	0.358	0.425	0.586
C8	1.63	0.83	0.00	0.80	48.98	0.0	0.0	100.0	0.331	0.392	0.453	0.600
C9	1.50	1.07	0.00	0.43	28.52	0.0	0.0	100.0	0.217	0.298	0.375	0.565
C10	1.57	1.06	0.00	0.51	32.61	0.0	0.0	100.0	0.239	0.316	0.390	0.571
C11	1.33	0.82	0.00	0.50	38.06	0.0	0.0	100.0	0.268	0.340	0.410	0.580
C12	1.45	1.03	0.00	0.42	28.78	0.0	0.0	100.0	0.218	0.299	0.376	0.566
C13	0.75	0.30	0.00	0.45	60.04	0.0	0.0	100.0	0.407	0.457	0.509	0.633
C14	1.40	1.01	0.00	0.39	28.05	0.0	0.0	100.0	0.214	0.296	0.374	0.565
Pond A	5.93	2.99	0.00	2.94	49.62	0.0	0.0	100.0	0.335	0.396	0.456	0.602
Post	28.30	16.24	0.00	12.05	42.60	0.0	100.0	0.0	0.248	0.310	0.370	0.502
Pre	28.30	28.30	0.00	0.00	0.00	0.0	100.0	0.0	0.000	0.060	0.150	0.350
Pond C	0.86	0.16	0.00	0.70	81.53	0.0	0.0	100.0	0.614	0.642	0.677	0.756
Pond C/CDC	0.86	0.16	0.00	0.70	81.53	0.0	0.0	100.0	0.614	0.642	0.677	0.756

TIME OF CONCENTRATION

Project: Coachline, Douglas County, CO
 Project #: 02-241
 Date: 05-Feb-09
 File: CoachHydro.xls

Equation:
 $t_t = 0.395(1.1 - C_s)L^{0.5}/S^{0.33}$
 $V = C_v S_w^{0.5}$
 $t_r = L_w/(60V)$

SUB-BASIN DATA		INITIAL/OVERLAND TIME (t_i)				TRAVEL TIME (t_r)					T_c	T_c Check (urban)**		FINAL
DESIG.	C5	AREA (AC)	LENGTH, L (FT)	SLOPE, S (%)	t_i (MIN)	LENGTH, L_w (FT)	SLOPE, S_w (%)	SURF. TYPE	VEL. (F/S)	t_r (MIN)	t_i+t_r (MIN)	$L_T=L+L_w$ (FT)	$L_T/180+10$ (MIN)	T_c (MIN)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	OS2	0.06	10.20	303	36.0	10.0	1133	13.2	E	5.4	3.5	13.5	Non Urban since C<0.3	13.5
2	OS3	0.06	1.66	356	10.7	16.2	216	8.3	E	4.3	0.8	17.0	Non Urban since C<0.3	17.0
3	OS4	0.06	1.90	370	11.6	16.1	194	7.0	E	4.0	0.8	16.9	Non Urban since C<0.3	16.9
4	OS5	0.06	1.12	440	10.9	17.9	339	9.4	E	4.6	1.2	19.1	Non Urban since C<0.4	19.1
5	OS6	0.06	13.80	107	11.2	8.7	1607	10.1	E	4.8	5.6	14.4	Non Urban since C<0.3	14.4
6														
7	A1	0.26	2.48	99	26.4	5.1	516	9.9	F	6.3	1.4	6.5	Non Urban since C<0.3	6.5
8	A2	0.64	0.86	97	4.1	5.1	560	1.8	F	2.7	3.5	8.6	657.2	8.6
9	A3	0.39	1.00	215	20.5	7.0	400	0.5	F	1.4	4.7	11.7	614.8	11.7
10	A4	0.62	0.60	41	2.0	4.4	410	0.5	F	1.4	4.8	9.3	451	9.3
11	A5	0.58	0.47	57	2.0	5.6	340	0.5	F	1.4	4.0	9.6	397	9.6
12	A6	0.64	0.52	41	2.0	4.2	322	0.5	F	1.4	3.8	8.0	363	8.0
13	B1	0.57	0.49	59	2.0	5.8	355	0.5	F	1.4	4.2	10.0	413.5	10.0
14	B2	0.64	0.55	49	2.0	4.6	325	0.5	F	1.4	3.8	8.4	374.1	8.4
15	B3	0.44	0.45	61	2.0	7.4	277	1.4	F	2.4	1.9	9.3	337.2	9.3
16	B4	0.63	0.40	49	2.0	4.7	256	1.8	F	2.7	1.6	6.3	305.4	6.3
17	B5	0.59	0.13	62	3.0	5.0	92	2.8	F	3.4	0.5	5.5	154.6	5.5
18	B6	0.41	1.17	310	6.1	12.0	307	4.2	F	4.1	1.2	13.3	617.8	13.3
19	B7	0.58	0.58	64	3.9	4.7	363	4.1	F	4.1	1.5	6.2	426.7	6.2
20	C1	0.39	0.81	120	5.4	8.1	302	6.3	F	5.0	1.0	9.1	421.9	9.1

SURFACE TYPES

A=Forest with ground litter & meadow
 B=Fallow or minimum tillage cultivation
 C= Short grass pasture & lawns

D=Nearly bare ground
 E=Grassed waterway
 F=Paved area (sheet flow) & shallow gutter flow

TIME OF CONCENTRATION

Project: Coachline, Douglas County, CO
 Project #: 02-241
 Date: 05-Feb-09
 File: CoachHydro.xls

Equation:
 $t_t = 0.395(1.1 - C_s)L^{0.5}/S^{0.33}$
 $V = C_v S_w^{0.5}$
 $t_r = L_w/(60V)$

SUB-BASIN DATA		INITIAL/OVERLAND TIME (t _i)					TRAVEL TIME (t _r)					T _c	T _c Check (urban)**		FINAL
DESIG.	C5	AREA (AC)	LENGTH (FT)	SLOPE (%)	t _i (MIN)	LENGTH (FT)	SLOPE (%)	SURF. TYPE	VEL. (F/S)	t _r (MIN)	t _i +t _r (MIN)	TOTAL (FT)	L/180+10 (MIN)	T _c (MIN)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
21	C2	0.54	0.41	226	5.3	8.7	203	5.9	F	4.9	0.7	9.4	428.3	12.4	9.4
22	C3	0.33	0.81	164	21.3	6.5	204	5.9	F	4.9	0.7	7.2	367.5	12.0	7.2
23	C4	0.35	0.52	200	9.5	9.1	207	5.8	F	4.8	0.7	9.8	407.3	12.3	9.8
24	C5	0.27	2.37	216	24.6	7.7	361	4.2	F	4.1	1.5	9.2	576.5	13.2	9.2
25	C6	0.28	1.96	400	11.0	13.4	220	3.6	F	3.8	1.0	14.3	620.2	13.4	13.4
26	C7	0.36	2.12	230	27.8	6.8	377	3.3	F	3.6	1.7	8.5	607	13.4	8.5
27	C8	0.39	1.63	163	25.5	5.6	377	3.3	F	3.6	1.7	7.3	540	13.0	7.3
28	C9	0.30	1.50	205	26.3	7.0	382	5.6	F	4.7	1.3	8.4	587	13.3	8.4
29	C10	0.32	1.57	191	25.7	6.7	382	6.7	F	5.2	1.2	7.9	573	13.2	7.9
30	C11	0.34	1.33	175	21.7	6.6	383	5.7	F	4.8	1.3	7.9	558	13.1	7.9
31	C12	0.30	1.45	182	22.0	7.0	356	6.2	F	5.0	1.2	8.2	538	13.0	8.2
32	C13	0.46	0.75	84	22.6	3.8	312	5.9	F	4.9	1.1	4.9	396	12.2	4.9
33	C14	0.30	1.40	212	26.4	7.2	330	6.4	F	5.0	1.1	8.3	542	13.0	8.3
34			0			0									
35			0			0									
36			0			0									
37			0			0									
38			0			0									
39			0			0									
			0			0									

SURFACE TYPES

A=Forest with ground litter & meadow
 B=Fallow or minimum tillage cultivation
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 D=Nearly bare ground
 E=Grassed waterway
 F=Paved area (sheet flow) & shallow gutter flow

Project: Coachline, Douglas County, CO
Project 02-241
Date: 05-Feb-08
File: CoachHydro.xls

1-Hour Intensity
5-Year
1.43

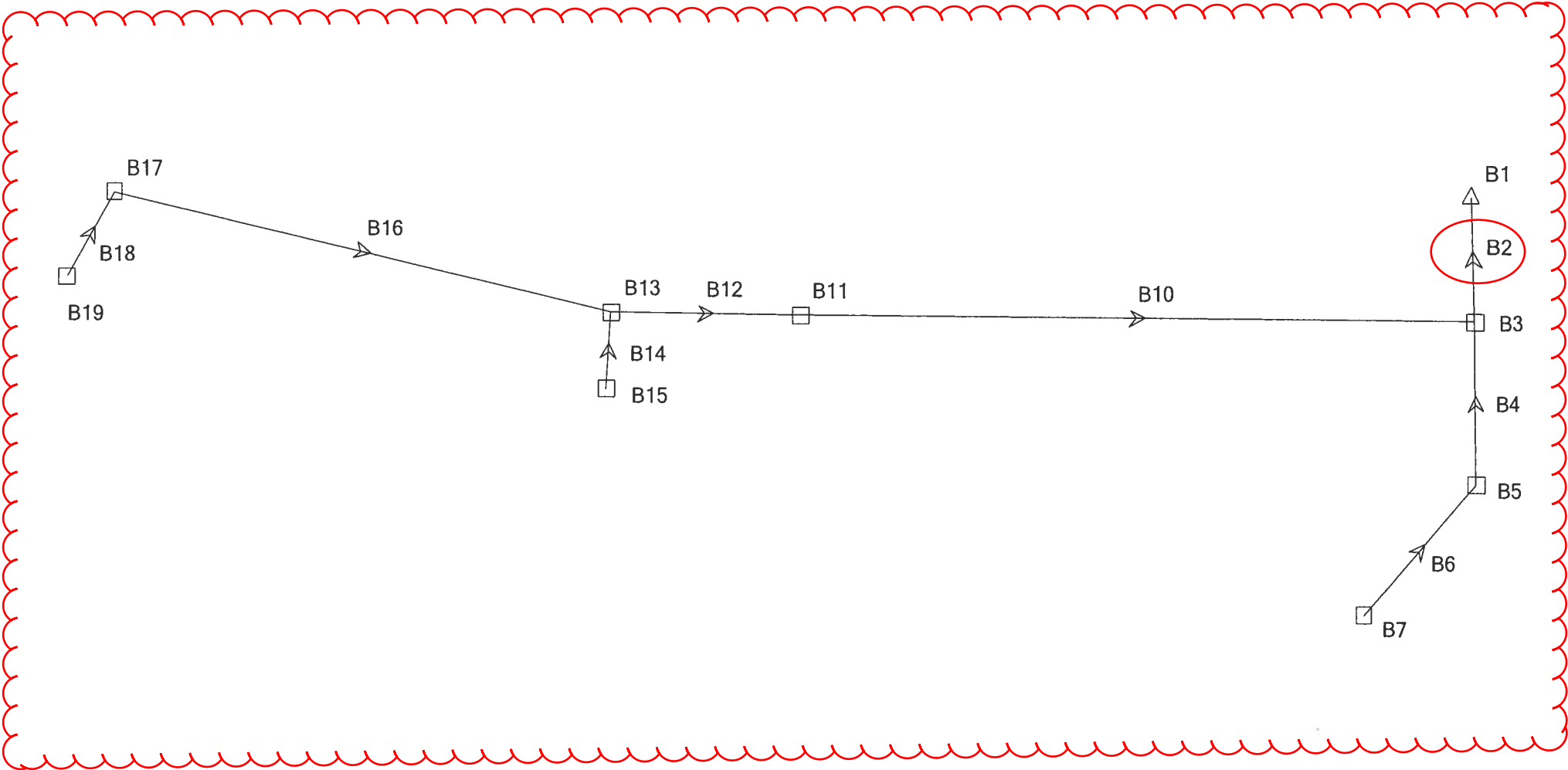
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Project: Coachline, Douglas County, CO
Project #: 02-241
Date: 05-Feb-09
File: CoachHydro.xls

1-Hour Intensity
100-Year
2.66

$$I = (28.5 P_1) / (10 + T_C)^{0.88}$$
[illegible]

Scenario: Base



Scenario: Base

Pipe Report

Label	Up. Inlet Area (acres)	Up. Inlet Rat. Coef.	Up. Inlet Area (acres)	Up. Calc. Sys. CA (acres)	I (in/hr)	System Q (cfs)	L (ft)	S (ft/ft)	Size	Mannings n	Q Full (cfs)	Up. Invert (ft)	Dn. Invert (ft)	Up. Gr Elev. (ft)	Dn. Gr. Elev. (ft)	HGL In (ft)	HGL Out (ft)	v Out (ft/s)
B4	1.17	0.41	0.48	1.09	3.40	3.74	82.00	0.004878	30 inch	0.013	28.65	6,332.00	6,331.60	6,337.43	6,337.44	6,332.64	6,332.57	2.12
B18	0.49	0.57	0.28	0.28	3.86	1.09	45.00	0.026667	18 inch	0.013	17.15	6,354.50	6,353.30	6,358.73	6,357.58	6,354.89	6,353.91	1.60
B16	0.55	0.64	0.35	0.63	3.84	2.45	243.00	0.020165	18 inch	0.013	14.92	6,353.10	6,348.20	6,357.58	6,353.49	6,353.69	6,348.96	2.72
B14	0.45	0.44	0.20	0.20	4.02	0.80	35.00	0.051429	18 inch	0.013	23.82	6,350.00	6,348.20	6,354.46	6,353.49	6,350.33	6,348.96	0.89
B12	0.40	0.63	0.25	1.08	3.77	4.10	83.00	0.045783	18 inch	0.013	22.47	6,348.00	6,344.20	6,353.49	6,351.42	6,348.78	6,344.63	9.68
B10	0.13	0.59	0.08	1.16	3.75	4.38	322.00	0.037267	18 inch	0.013	20.28	6,344.00	6,332.00	6,351.42	6,337.44	6,344.80	6,332.47	9.15
B2	0.58	0.58	0.34	2.59	3.36	8.76	37.00	0.004324	36 inch	0.013	43.86	6,331.40	6,331.24	6,337.44	6,334.20	6,332.33	6,332.15	4.84
B6	10.20	0.06	0.61	0.61	3.44	2.12	69.00	0.005217	30 inch	0.013	29.63	6,332.56	6,332.20	6,335.10	6,337.43	6,333.04	6,332.75	2.66

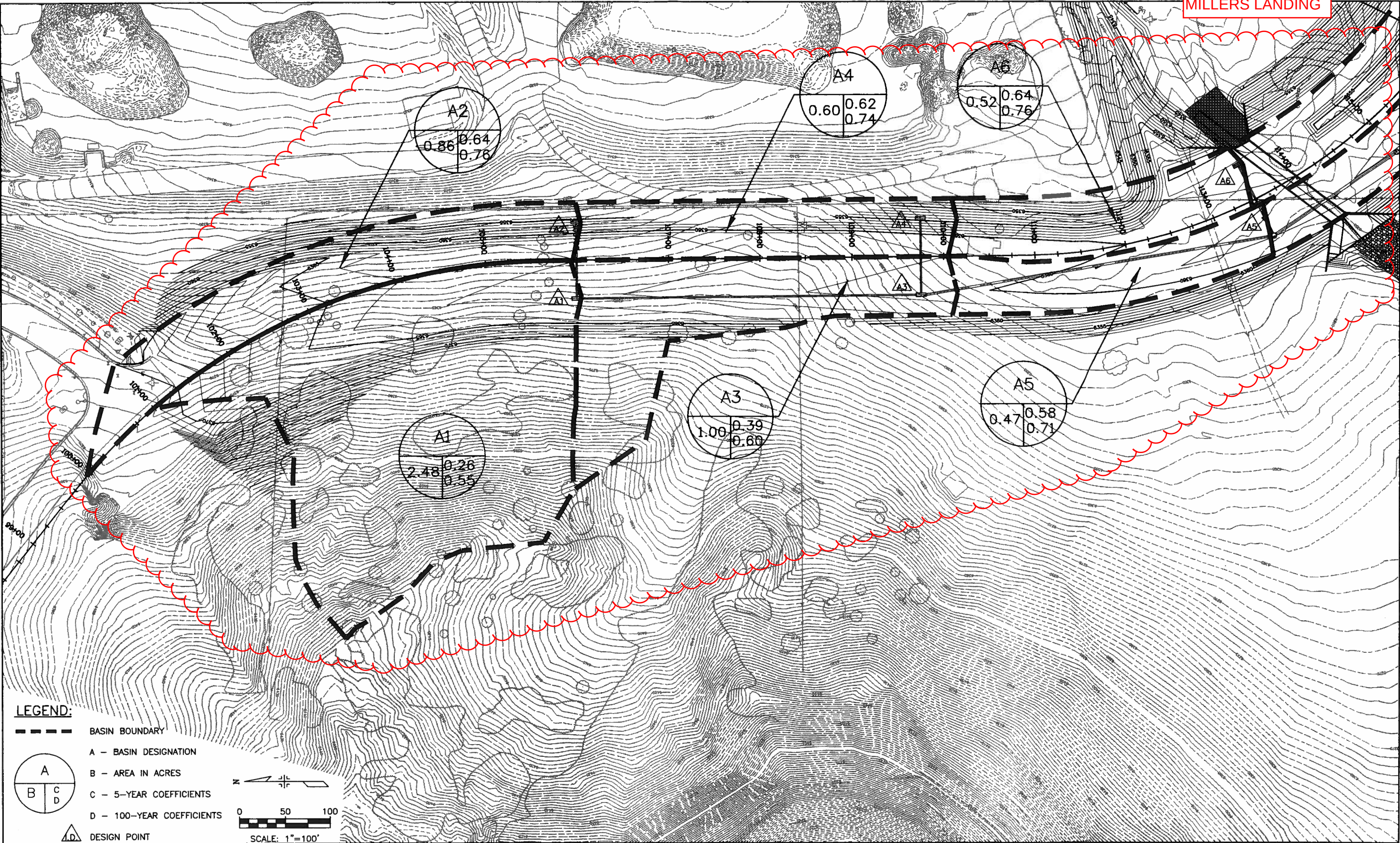
5 YR OUTLET
FLOW FROM B
STORM DRAIN
SYSTEM

Scenario: Base

Pipe Report

Label	Up. Inlet Area (acres)	Up. Inlet Rat. Coef.	Up. Inlet Area (acres)	Up. Calc. Sys. CA (acres)	I (in/hr)	System Q (cfs)	L (ft)	S (ft/ft)	Size	Mannings n	Q Full (cfs)	Up. Invert (ft)	Dn. Invert (ft)	Up. Gr Elev. (ft)	Dn. Gr. Elev. (ft)	HGL In (ft)	HGL Out (ft)	v Out (ft/s)
B4	1.17	0.61	0.71	4.28	6.22	26.85	82.00	0.004878	30 inch	0.013	28.65	6,332.00	6,331.60	6,337.43	6,337.44	6,334.38	6,334.08	5.48
B18	0.49	0.71	0.35	0.35	7.02	2.46	45.00	0.026667	18 inch	0.013	17.15	6,354.50	6,353.30	6,358.73	6,357.58	6,355.09	6,354.37	1.83
B16	0.55	0.76	0.42	0.77	7.00	5.40	243.00	0.020165	18 inch	0.013	14.92	6,353.10	6,348.20	6,357.58	6,353.49	6,354.00	6,349.55	3.23
B14	0.45	0.62	0.28	0.28	7.30	2.05	35.00	0.051429	18 inch	0.013	23.82	6,350.00	6,348.20	6,354.46	6,353.49	6,350.54	6,349.55	1.23
B12	0.40	0.75	0.30	1.34	6.88	9.33	83.00	0.045783	18 inch	0.013	22.47	6,348.00	6,344.20	6,353.49	6,351.42	6,349.18	6,345.54	5.59
B10	0.13	0.72	0.09	1.44	6.86	9.94	322.00	0.037267	18 inch	0.013	20.28	6,344.00	6,332.00	6,351.42	6,337.44	6,345.22	6,334.08	5.63
B2	0.58	0.71	0.41	6.13	6.17	38.18	37.00	0.004324	36 inch	0.013	43.86	6,331.40	6,331.24	6,337.44	6,334.20	6,333.53	6,333.25	7.58
B6	10.20	0.35	3.57	3.57	6.26	22.52	69.00	0.005217	30 inch	0.013	29.63	6,332.56	6,332.20	6,335.10	6,337.43	6,334.76	6,334.62	4.63

100-YR OUTLET
FLOW FROM B
STORM DRAIN
SYSTEM

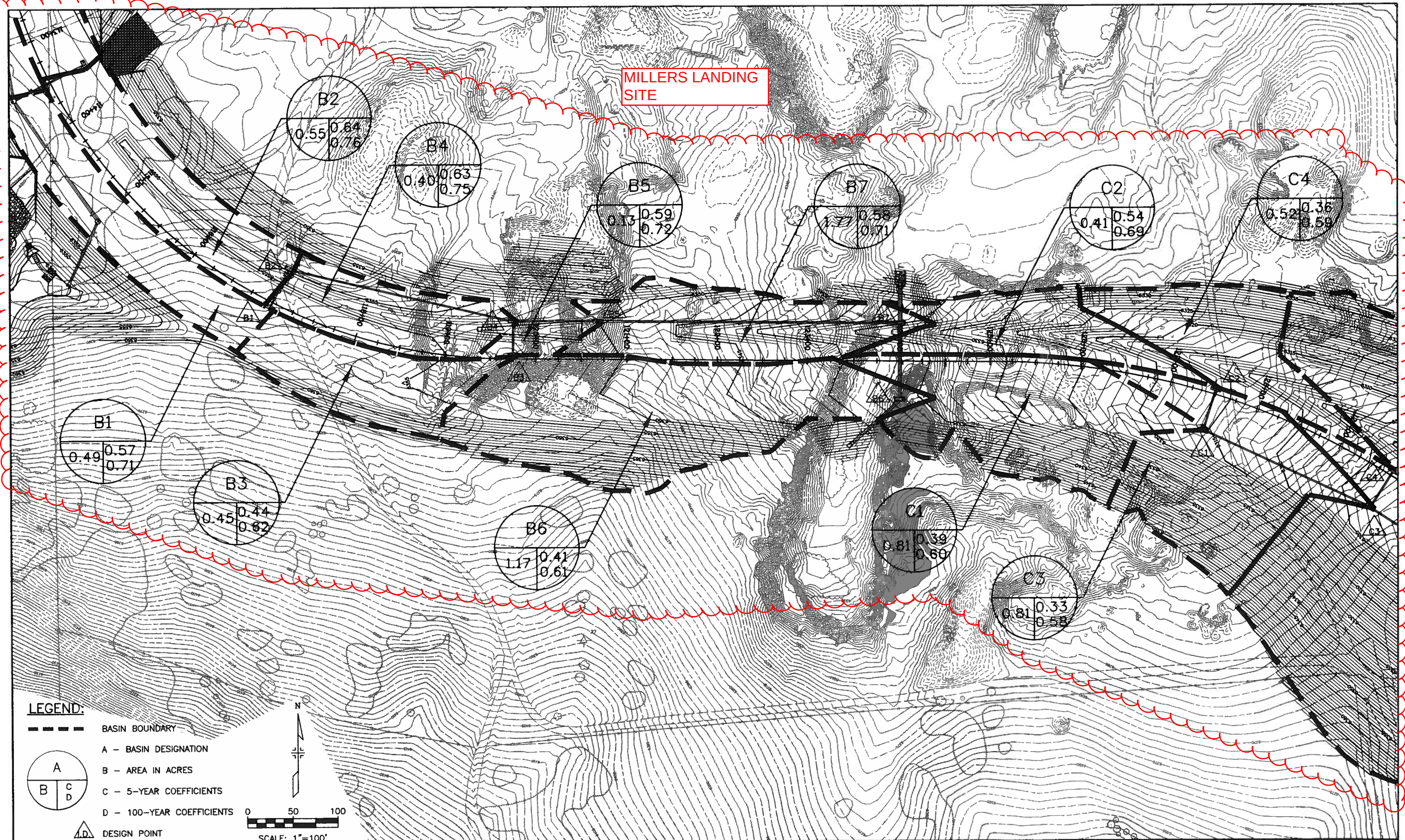


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Index of Revisions			

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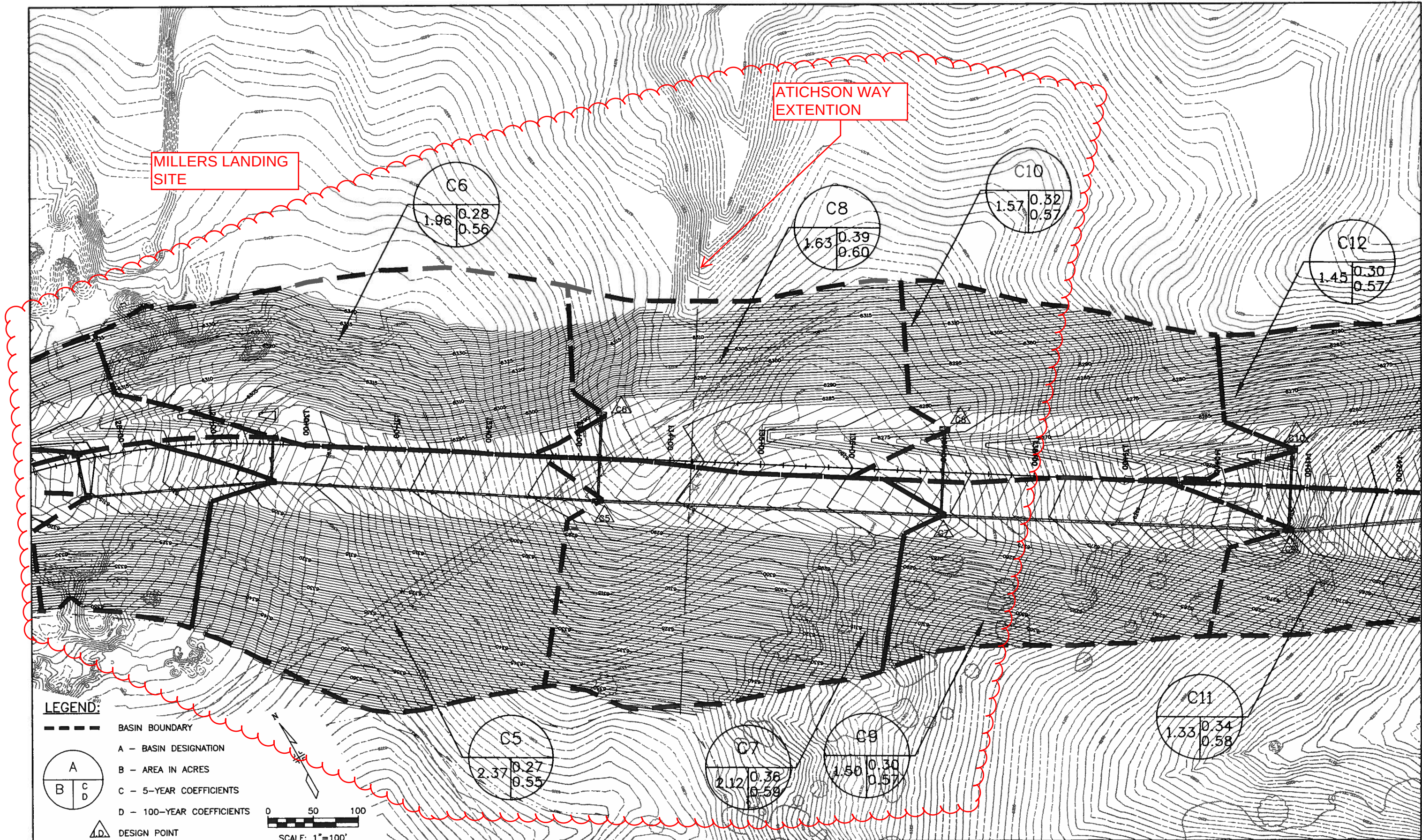
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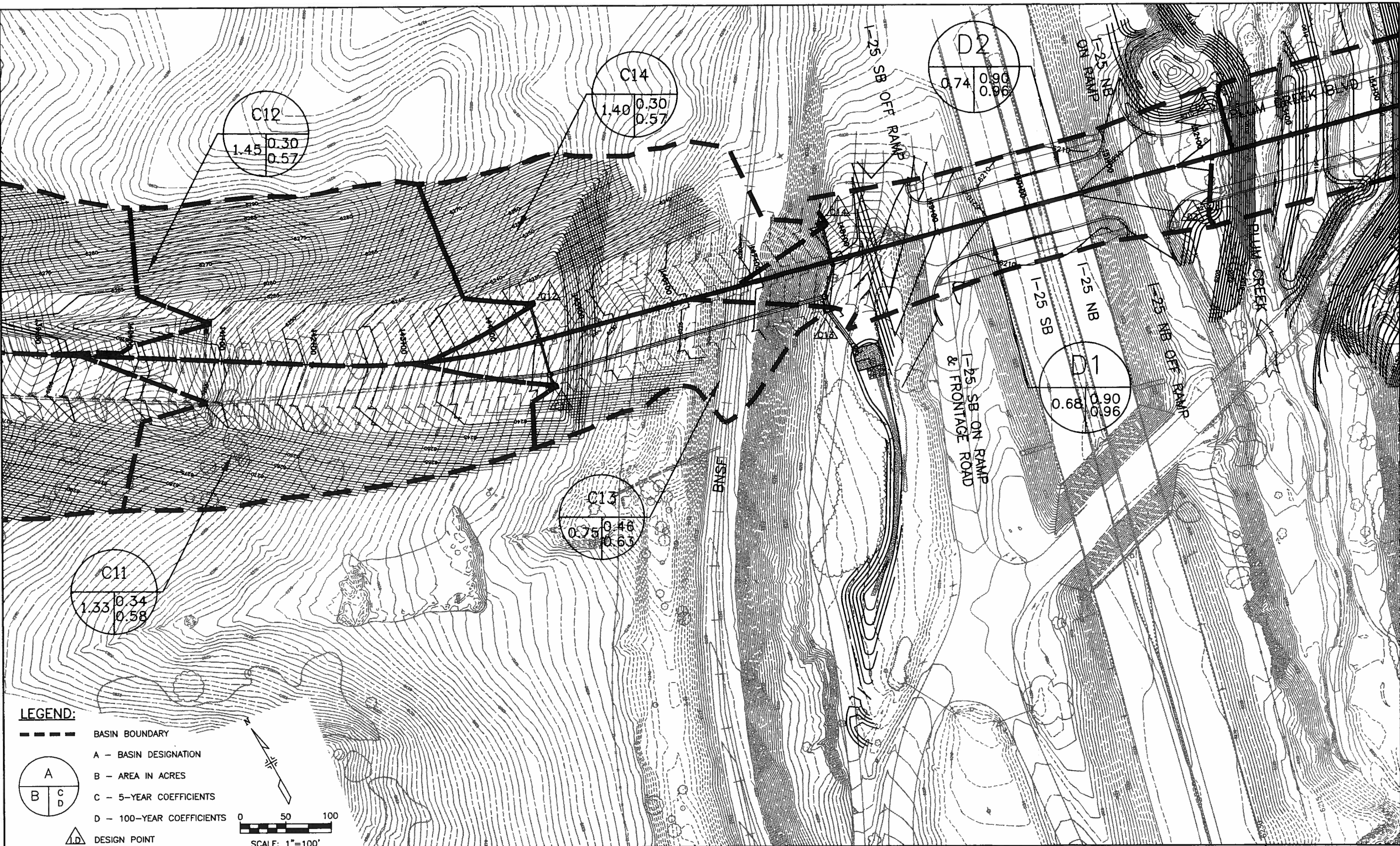


FELSBURG
HOLT &
ULLEVIG



TOWN OF
CASTLE ROCK
COLORADO

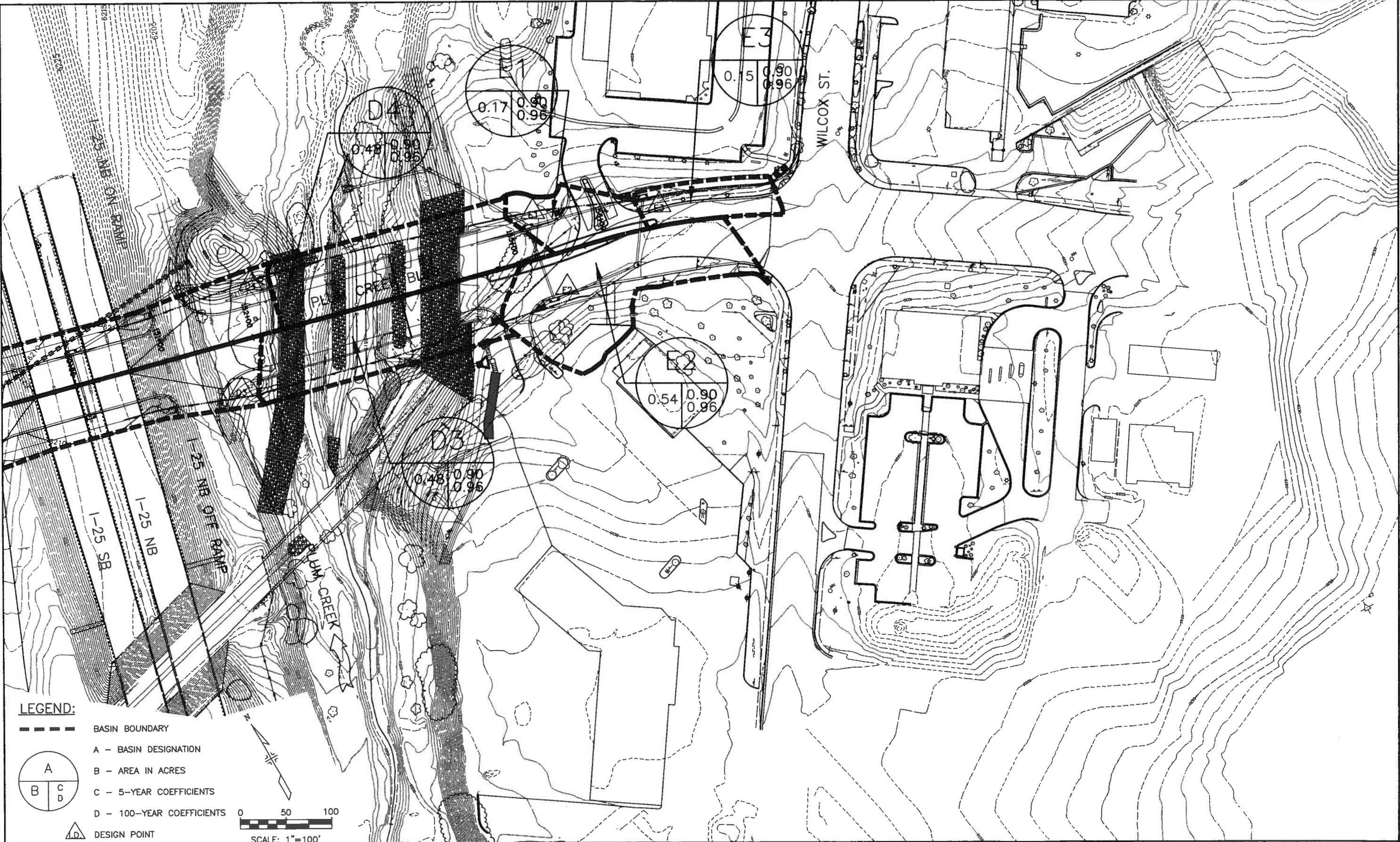
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Citadel Development, LLC

WILDLIFE AND HABITAT SURVEY REPORT

Citadel Station

Castle Rock, CO 80109

June 2016

A large, solid orange geometric shape, resembling a stylized triangle or a section of a larger triangle, is positioned in the bottom right corner of the page. It is composed of two overlapping triangles, creating a complex, angular form that extends from the bottom edge towards the top right corner.

WILDLIFE AND HABITAT SURVEY REPORT

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Castle Rock, CO 80109

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CONTENTS

1	Introduction	3
1.1	Project Description	3
1.2	Regulatory Background	3
2	Methods	5
2.1	Desktop Review	5
2.2	Field Survey	5
3	Results	6
3.1	Desktop Review	6
3.1.1	Landscape and Habitat Conditions	6
3.1.2	Federally Protected Species	6
3.1.2.1	Threatened, Endangered, Proposed, and Candidate Species	6
3.1.2.2	Migratory Birds	8
3.1.2.3	Eagles	8
3.1.3	State Protected Species	9
3.2	Field Survey	10
3.2.1	Verification of Landscape and Habitat Conditions	10
3.2.2	Wildlife Observations	11
4	Conclusions and Recommendations	12
5	References	14

TABLES

Table 1. Federal Threatened, Endangered, Proposed, and Candidate Species Listed for Douglas County, Colorado and their Potential to Occur at the Project	6
Table 2. State Protected Species and their Potential to Occur at the Project	9
Table 3. Wildlife Species Observed during the Field Survey on June 9, 2016	11

FIGURES

Figure 1 Project Boundary and Field Survey Observations

3 RESULTS

3.1 Desktop Review

3.1.1 Landscape and Habitat Conditions

Review of topographic maps indicated that the Project sits at an elevation of approximately 6,200 feet above mean sea level (AMSL). Review of aerial imagery indicated that the landscape ranges from flat to hilly and is dominated by short vegetation, with some individual trees and groups of trees/shrubs interspersed throughout. Trees and shrubs are generally associated with an unnamed drainage (a tributary to East Plum Creek). A small portion of this drainage intersects the western portion of the Project (**Figure 1**), where it is culverted, and then continues to parallel (outside) the northern boundary of the Project. Review of aerial imagery also indicated the presence of a wetland feature in the central portion of the Project and a depression feature in the northeastern portion (**Figure 1**). The Project is bordered to the north and east by industrial facilities, to the west and south by West Plum Creek Parkway, and also to the west by Philip S. Miller Park and associated walking trails.

3.1.2 Federally Protected Species

3.1.2.1 Threatened, Endangered, Proposed, and Candidate Species

Table 1, below, summarizes federally listed threatened, endangered, proposed, and/or candidate species listed for Douglas County, Colorado (USFWS 2016a). The table also summarizes what potential, if any, these species have to occur within the Project boundary based on home ranges and habitat preferences. Note that no federally designated critical habitats for the species listed below overlap the Project.

Table 1. Federal Threatened, Endangered, Proposed, and Candidate Species Listed for Douglas County, Colorado and their Potential to Occur at the Project

Species and Listing Status	Home Range and Habitat Preferences	Potential to Occur at Project Site (Not Likely to Occur, May Occur, or Known to Occur)
<i>Mammals</i>		
Preble's meadow jumping mouse (<i>Zapus hudsonius preblei</i>), Federally Threatened	In Colorado, the mouse is known to occupy the Front Range from the Wyoming border to El Paso County, Colorado. The mouse occupies riparian areas and adjacent wet meadows where it prefers dense shrub, grass, and forb ground cover (CPW 2016b).	<u>Not likely to occur</u> : suitable habitat for this species is limited within the Project boundary to the wetland feature and a small stand of Gambel's oak in the central and western portions of the Project, respectively. No jumping mice or small mammal holes were identified during the field survey. Habitat is more suitable for this species outside the Project and to the north along the wooded unnamed tributary

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of East Plum Creek.

Birds

Least tern (<i>Stern antillarum</i>), Federally Endangered	Species nests on sandbars of major rivers in Colorado. During migration, the bird occasionally occurs in the Lower South Platte River Basin. They forage in streams, reservoirs, marshes, gravel pits, and other impounded wetlands (CPW 2016c).	<u>Not likely to occur</u> : suitable foraging habitat may exist along the unnamed drainage that parallels the outer edge of the northern Project boundary, but habitat for this species within the Project itself is lacklustre. The species may pass through the area or temporarily use the central wetland feature during migration, but it is not expected to nest in the area.
Mexican spotted owl (<i>Strix occidentalis lucida</i>), Federally Threatened	This species resides in southern Colorado and uses steep canyons with dense stands of large ponderosa pines (<i>Pinus ponderosa</i>) and old-growth mixed-conifer forests (CPIF 2000).	<u>Not likely to occur</u> : aerial imagery and field survey observations indicate that suitable habitat for this species is lacking within and near the Project.
Piping plover (<i>Charadrius melodus</i>), Federally Threatened	Although USFWS lists the bird for Douglas County, CPW information indicates that the bird tends to occur in eastern Colorado. The bird prefers sparsely-vegetated sandy shorts of reservoirs and gravel pits (CPW 2016d).	<u>Not likely to occur</u> : home range and suitable habitat for this species do not overlap the Project area.
Whooping crane (<i>Grus americana</i>), Federally Endangered	According to CPW's online species profile for the Whooping Crane (CPW 2016e), the bird has not been observed in Colorado since 2010. Whooping cranes tend to utilize mudflats around reservoirs and in agricultural areas (CPW 2016e).	<u>Not likely to occur</u> : there have been recent sightings of the bird in Colorado, their central migration corridor does not overlap the Project, and suitable habitat is lacking therein.

Fish

Greenback cutthroat trout (<i>Oncorhynchus clarki stomias</i>), Federally Threatened	The only population of true greenback cutthroat trout is known to occur in Bear Creek, a small tributary of the Arkansas River west of Colorado Springs (USFWS 2012).	<u>Not likely to occur</u> : the current range of this species does not overlap the Project.
Pallid sturgeon (<i>Scaphirhynchus albus</i>), Federally Endangered	This species is not found in Colorado; however, water depletion from the Platte River drainage in Colorado and other states could contribute to its decline in rivers downstream. The fish generally	<u>Not likely to occur</u> : neither range nor suitable habitat overlaps the Project area.

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	prefers large, free-flowing, warm-water, and turbid rivers (USFWS 2014).	
<i>Flowering Plants</i>		
Colorado butterfly plant (<i>Gaura neomexiana</i> var. <i>coloradensis</i>), Federally Threatened	Occurs primarily in northcentral Colorado. The plant is typically found in wetland habitats along meandering stream channels in undisturbed areas (USFWS 2011).	<u>Not likely to occur</u> : the Project is disturbed and suitable stream riparian habitat tends to occur outside and to the north of the northern boundary line.
Ute Ladies'-tresses (<i>Spiranthes diluvialis</i>), Federally Threatened	Known to occur from central to north-central and north-western Colorado. The plant tends to occur along streams and open seepage areas in cottonwoods as well as moist meadows at moderate elevations where soils are both sandy and stony (CNHP 2014).	<u>Not likely to occur</u> : the only habitat potentially suitable for this species in the Project boundary would be associated with the centrally located wetland feature. However, the land near this feature is disturbed and invasive species compose the majority of plants in the area. No Ute Ladies'-tresses were observed during the field survey.
Western prairie fringed orchid (<i>Platanthera praeclara</i>), Federally Threatened	Although listed by USFWS IPaC for Douglas County (USFWS 2016a), this species is not known to currently occur in Colorado. The plant prefers mesic to wet tallgrass prairies and meadows.	<u>Not likely to occur</u> : neither range nor habitat for this species overlap the Project site.

3.1.2.2 Migratory Birds

There are a number of birds protected under the MBTA which could use habitats within the Project area. Because the Project is dominated by short, upland vegetation, birds that utilize these habitats are expected to use the Project (as verified by the field survey; more information presented in **Section 3.2**). Species may include but would not be limited to, sparrows, wrens, crows, pigeons, and starlings. Water bird species, such as ducks, herons, blackbirds, and shorebirds also likely use the surface water features and riparian habitat in and near the Project. These habitats are limited (i.e., the centrally located wetland and the unnamed tributary to East Plum Creek); therefore, water bird use of the Project would be confined to these features. Trees and shrubs are limited in the Project area; therefore, nesting, if any, is expected to primarily be associated with ground-nesting species. For this reason, raptor nesting is not expected to occur in the Project boundary.

3.1.2.3 Eagles

Both golden eagles (*Aquila chrysaetos*) and bald eagles (*Haliaeetus leucocephalus*) are known to occur in Douglas County. Golden eagles most frequently nest on cliffs and in large trees and generally hunt

APPENDIX E

Drainage Plan

EXISTING CONDITIONS DRAINAGE PLAN

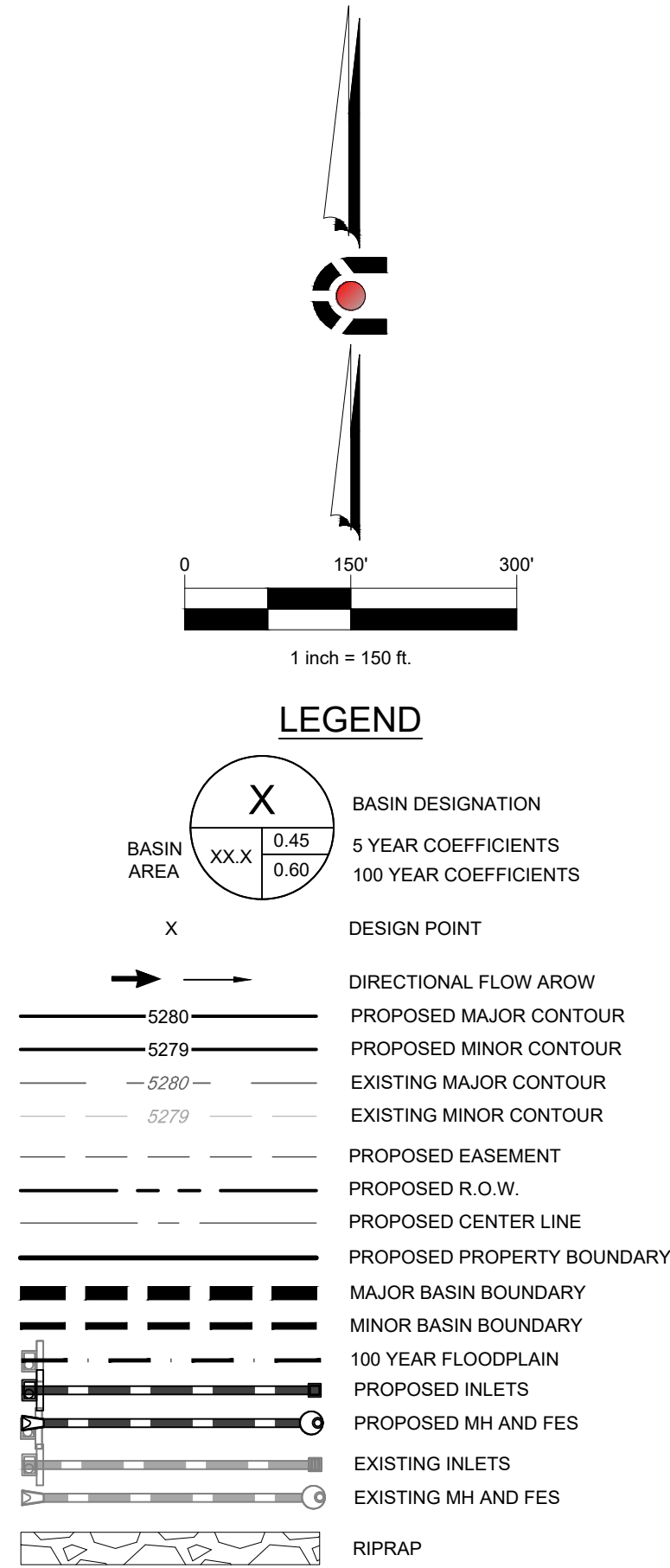
PROPOSED DRAINAGE PLAN



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