PRELIMINARY DRAINAGE REPORT

88th & Rosemary

(Lot 1, Palombo and Agazio Subdivision)
8705 Rosemary Street
Commerce City, Colorado

Prepared for:

Evergreen Devco, Inc.

1873 South Bellaire Street, Suite 1200

Denver, Colorado 80222

Prepared by:

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4582 South Ulster Street, Suite 1500

Denver, Colorado 80237

Kimley»Horn

Project #: 096266043

Prepared: July 2022

Revised: January 2023

CERTIFICATIONS

"I hereby certify that this preliminary drainage study for 88th & Rosemary (Lot 1, Palombo and Agazio Subdivision) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Commerce City's *Storm Drainage Design and Technical Criteria Manual* for the owners thereof."

____

Shannon Petersen, P.E.

Registered Professional Engineer

State of Colorado No. 59369

Evergreen Devco, Inc. hereby certifies that the drainage facilities for 88th & Rosemary (Lot 1, Palombo and Agazio Subdivision) shall be constructed according to the design presented in this report. I understand that Commerce City does not and will not assume liability for the drainage facilities designed and/or certified by my engineer, and that Commerce City reviews drainage plans pursuant to Colorado Revised Statutes Title 30, Article 28; but cannot, on behalf of 88th & Rosemary (Lot 1, Palombo and Agazio Subdivision), guarantee that final drainage design review will absolve Evergreen Devco, Inc. and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Development Plan does not imply approval of my engineer's drainage design.

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Evergreen Devco, Inc.

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Authorized Signature

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GENERAL LOCATION AND DESCRIPTION

SITE LOCATION

88th & Rosemary (the "Site"), also known as Lot 1 of the Palombo and Agazio Subdivision, is located in a portion of the southwest quarter of Section 14, Township 2 South, Range 67 West of the Sixth Principal Meridian, City of Commerce City, County of Adams, State of Colorado. The Site is bounded by Union Pacific Railroad property to the northwest, E 88th Avenue to the north, Rosemary Street to the east, and adjacent private properties to the south, as shown in the Vicinity Map (**Appendix A**).

DESCRIPTION OF PROPERTY

The 6.70± acre Site is currently vacant land and currently zoned I-1, Light Intensity Industrial District. The Site generally slopes from the southeast to the northwest from an elevation of ±5121 feet to an elevation of ±5114 feet with an average slope of 2%.

According to the Natural Resources Conservation Service (NRCS), the Site consists of Ascalon sandy loam (AsC), Nunn loam (NIA/NIB), and Vona sandy loam (VoC). Nunn loam makes up the majority of the site as a Type C soil, and Vona sandy loam and Ascalon sandy loam make up the remainder of the site as a Type A and Type B soil, respectively. A Custom Soil Resource Report from the NRCS Web Soil Survey website for the Site is included as **Appendix B**.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel 607 of 1150 for Adams County and incorporated areas (eff. 03/05/2007), the Site is located within Zone X, which is classified as an area of minimal flood hazard, outside of the regulatory floodplain. The FIRMette for the Site is included as **Appendix C**.

The O'Brien Canal is an irrigation canal located west of the Site. The canal is located on the west side of the adjacent Union Pacific Railroad and is not anticipated to negatively impact the development of the Site.

There are no significant geologic features located within the Site.

DESCRIPTION OF PROJECT

The Project consists of a 54,600 SF building, a gravel staging area, surface parking, and storm sewer infrastructure to convey flows for the proposed development, and landscaping along the perimeter and within open space areas.

Water quality and detention for the Project will be provided in one private, full spectrum extended detention basin (EDB), designed per the Mile High Flood District (MHFD) and City of Commerce City (City) criteria. The control release from the EDB outlet structure will discharge into the existing storm sewer system on 88th Avenue.

DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTION

The Site is part of the Irondale Gulch Watershed and generally flows from the southeast to the northwest toward a low area east of the Union Pacific Railroad (UPRR) tracks. According to the Irondale Gulch Outfall Systems Plan (OSP) and the Commerce City Irondale Plan, the Site is located within Reach 2, which is described as having no defined flow path. Runoff through the Site is conveyed downstream via sheet flow, collected in the existing storm sewer system on 88th Avenue, conveyed through storm sewers under the UPRR and O'Brien Canal, and is eventually tributary to the South Platte River. Excerpts from the Irondale Gulch OSP and Irondale Plans are included in **Appendix H**.

SUB-BASIN DESCRIPTIONS

EXISTING SUB-BASIN DESCRIPTIONS

The existing tributary area to the Project has been divided into three (3) on-site sub-basins and four (4) offsite areas. The existing conditions sub-basin locations are shown on the Existing Drainage Map included in **Appendix E**.

Hydrology calculations for the minor and major storm events for the existing conditions sub-basins are included in **Appendix D**. The existing sub-basins with their respective summaries are provided below:

Subbasin EX1

Subbasin EX1 consists of the majority of the Site. Runoff from the 5.85-acre basin flows overland from southeast to northwest to design point EX1. Offsite basins OS1, OS2, and OS4 are tributary to on-site Subbasin EX1.

Subbasin EX2

Subbasin EX2 is located in the southwest corner of the Site. Runoff from the 0.49-acre basin flows overland from east to west to design point EX2. There is no offsite area tributary to on-site Subbasin EX2.

Subbasin EX3

Subbasin EX3 is located along the southern boundary of the Site. Runoff from the 0.36-acre basin flows overland from north to southwest to design point EX3. Offsite basin OS3 is tributary to on-site Subbasin EX3.

Subbasin OS1

Subbasin OS1 is located to the north of the Site, along 88th Avenue. Runoff from the 0.22-acre basin flows overland from north to southwest to design point OS1 and is tributary to on-site basin EX1 and design point EX1.

Subbasin OS2

Subbasin OS2 is located to the east of the Site, along Rosemary Street. Runoff from the 0.61-acre basin flows overland from east to west to design point OS2 and is tributary to on-site basin EX1 and design point EX1.

Subbasin OS3

Subbasin OS3 is located along the southeastern boundary of Site, west of Rosemary Street. Runoff from the 0.15-acre basin flows overland from south to north to design point OS3 and is tributary to on-site basin EX3 and design point EX3.

Subbasin OS4

Subbasin OS4 is located southeast of the Site, along and adjacent to Rosemary Street. Runoff from the 10.28-acre basin generally flows overland from south to north to design point OS4 and is tributary to offsite basin OS2, and eventually on-site basin EX1 and design point EX1.

PROPOSED SUB-BASIN DESCRIPTIONS

The proposed tributary area to the Project has been divided into twelve (12) on-site sub-basins and six (6) offsite areas. The proposed conditions sub-basin locations are shown on the Proposed Drainage Map included in **Appendix E**.

Hydrology calculations for the minor and major storm events for the proposed conditions sub-basins are included in **Appendix D**. The proposed sub-basins are summarized in **Table 1** and described in the following sections.

Table 1: Summary of Proposed Sub-basins

Sub-Basin	Tributary Area (ac.)	Impervious Percentage	Peak Runoff (cfs)	
			Q5	Q100
A1	0.42	69%	0.89	2.13
A2	0.83	85%	2.57	5.54
A3	1.23	48%	1.45	4.07
A4	0.38	76%	0.77	1.67
A5	0.57	81%	1.66	3.45
A6	0.46	76%	1.25	2.64
A7	0.46	49%	0.53	1.49
A8	0.05	100%	0.21	0.42
A9	0.60	0%	0.03	1.01
A10	0.28	0%	0.01	0.49
A11	0.08	0%	0.00	0.13
R1	1.25	90%	4.92	9.81
OS1	0.24	79%	0.79	1.65
OS2A	0.21	90%	0.78	1.59
OS2B	0.30	90%	1.54	3.12
OS2C	0.16	100%	0.91	1.81
OS3	0.15	0%	0.01	0.24
OS4	10.28	30%	6.04	17.19

Subbasin A1

Sub-basin A1 is located along the north side of the proposed building (0.42 acres) and consists of parking and drive aisles. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site.

Subbasin A2

Sub-basin A2 is located along the west side of the proposed building (0.83 acres) and consists of drive aisles and loading area. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site.

Subbasin A3

Sub-basin A3 is located along the west side of the proposed building (1.23 acres) and consists of drive aisles, loading area, and storage area. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site.

Subbasin A4

Sub-basin A4 is located along the north side of the proposed building (0.38 acres) and consists of parking, drive aisles, and landscaping. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. Offsite basin OS2A is tributary to Subbasin A4.

Subbasin A5

Sub-basin A5 is located along the east side of the proposed building (0.57 acres) and consists of parking, drive aisles, and landscaping. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. Offsite basin OS2B is tributary to Subbasin A5.

Subbasin A6

Sub-basin A6 is located along the east side of the proposed building (0.46 acres) and consists of parking, drive aisles, and landscaping. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. Offsite basins OS2C and OS4 are tributary to Subbasin A6.

Subbasin A7

Sub-basin A7 is located along the south side of the proposed building (0.46 acres) and consists of parking, drive aisles, and landscaping. Runoff will sheet flow toward a Type R inlet at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. Offsite basin OS3 is tributary to Subbasin A7.

Subbasin A8

Sub-basin A8 is located along the west side of the proposed building (0.05 acres) and consists of a reverse slope loading area. Runoff will sheet flow toward a trench drain at the low point of the basin and will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site.

Subbasin A9

Sub-basin A9 (0.60 acres) consists of the EDB and associated landscaping. Runoff will sheet flow toward the pond bottom, through the proposed trickle channel, and into the pond outlet structure. The controlled release from the outlet structure will discharge to the existing 60-in storm sewer on 88th Avenue to the north.

Subbasin A10

Sub-basin A10 is located along the western property boundary (0.28 acres) and consists of landscaping. Runoff will sheet flow offsite to the west to match existing flow patterns.

Subbasin A11

Sub-basin A11 is located along the northern property boundary (0.08 acres) and consists of landscaping. Runoff will sheet flow offsite to the west to match existing flow patterns.

Subbasin R1

Sub-basin R1 (1.25 acres) consists of the roofing of the proposed building. Runoff will be conveyed through the roof drain system to the downspout location along the east side of the building and is ultimately conveyed to the EDB in the southwest corner of the Site.

Subbasin OS1

Subbasin OS1 is located to the north of the Site, along 88th Avenue. Runoff from the 0.24-acre basin flows overland from north to southwest to design point OS1 and is not tributary to the proposed Site.

Subbasin OS2A

Subbasin OS2A is located to the west of the Site, along Rosemary Street. Runoff from the 0.21-acre basin flows overland from east to west to design point OS2A and is tributary to on-site basin A4 and design point A4. Runoff will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. The EDB will not be sized to accommodate runoff from this area. Runoff from the basin will flow through the proposed EDB.

Subbasin OS2B

Subbasin OS2B is located to the west of the Site, along Rosemary Street. Runoff from the 0.30-acre basin flows overland from east to west to design point OS2B and is tributary to on-site basin A5 and design point A5. Runoff will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. The EDB will not be sized to accommodate runoff from this area. Runoff from the basin will flow through the proposed EDB.

Subbasin OS2C

Subbasin OS2C is located to the west of the Site, along Rosemary Street. Runoff from the 0.16-acre basin flows overland from east to west to design point OS2C and is tributary to on-site basin A6 and design point A6. Runoff will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. The EDB will not be sized to accommodate runoff from this area. Runoff from the basin will flow through the proposed EDB.

Subbasin OS3

Subbasin OS3 is located along the southeastern boundary of Site, west of Rosemary Street. Runoff from the 0.15-acre basin flows overland from south to north to design point OS3 and is tributary to on-site basin A7 and design point A7. Runoff will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. The EDB will not be sized to accommodate runoff from this area. Runoff from the basin will flow through the proposed EDB.

Subbasin OS4

Subbasin OS4 is located southeast of the Site, along and adjacent to Rosemary Street. Runoff from the 10.28-acre basin generally flows overland from south to north to design point OS4 and is tributary to offsite basin OS2C, and eventually on-site basin A6 and design point A6. Runoff will be conveyed through the proposed storm sewer system to the EDB located in the southwest corner of the Site. The EDB will not be sized to accommodate runoff from this area. Runoff from the basin will flow through the proposed EDB.

DRAINAGE DESIGN CRITERIA

REGULATIONS

The Commerce City Storm Drainage Design and Technical Criteria Manual (the “City Criteria”) and the MHFD Urban Storm Drainage Criteria Manual, Volumes 1-3 (the “USDCM”) were used to develop the proposed drainage design for the Project.

PREVIOUS DRAINAGE STUDIES

According to the Irondale Gulch OSP and the Commerce City Irondale Plan, the Site is located within Reach 2, which is described as having no defined flow path. Runoff through the Site is conveyed downstream via sheet flow and is collected in the existing storm sewer system on 88th Avenue, conveyed through storm sewers under the UPRR and O’Brien Canal and is eventually tributary to the South Platte River. Excerpts from the Irondale Gulch OSP and Irondale Plan is included in **Appendix H**.

The proposed drainage for the Site will follow the existing drainage patterns as described in the Irondale Gulch OSP and Irondale Plan.

The City’s Irondale Plan includes reference to a preferred approach of regional detention for the watershed. According to the conceptual stormwater infrastructure map and future buildout map within the plan, a portion of the Site had been identified as a location for a future regional detention basin. A meeting was held with the City on April 13, 2022, to discuss the regional detention basin as identified in the Irondale Plan. After discussing Project needs with the regional detention needs of the City, it was determined that the City will not pursue the regional detention on the Site.

HYDROLOGIC CRITERIA

The Rational Method was used to calculate peak runoff from the existing and proposed drainage basins for the minor (5-Year) and major (100-Year) storm events, in accordance with MHFD and City requirements. Runoff coefficients from Table 501 of the City Criteria were used to calculate the composite coefficients for each drainage sub-basin. The time of concentration for each sub-basin was also calculated in accordance with the USDCM. Rainfall depths from Section 4.3 of the City Criteria were utilized in the Rational Method calculation. Detailed hydrologic calculations are included as **Appendix D**.

HYDRAULIC CRITERIA

The hydraulic calculations to size the proposed drainage system components will be completed in accordance with the City of Commerce City and MHFD criteria. The hydraulic software that will be used to size each drainage component is summarized in **Table 2**. Detailed hydraulic calculations will be submitted with the Final Drainage Report.

Table 2: Hydraulic Software Utilized

Proposed Storm Improvement	Hydraulic Software Utilized
Curb and Area Inlets	MHFD-Inlet v5.01 Bentley FlowMaster v10.03
Storm Sewers	Bentley StormCAD v10.03
Full Spectrum Detention Basin	MHFD-Detention v4.05 and

VARIANCES

No known variances are being requested as part of the Project.

STORMWATER QUALITY

Runoff from the proposed impervious area will be treated for water quality in the proposed Full Spectrum EDB. The preliminary EDB design is included in **Appendix F**.

The Site will utilize Post-Construction Source Control Best Management Practices including routine landscape maintenance such as routine mowing and bagging grass clippings, fertilization of the Site (by manufacturer's recommendations), weed removal, snow and ice management, spill response and containment, and street and parking lot sweeping and maintenance. An Operation and Maintenance (O&M) manual will be prepared (at the time of final design) to provide guidance for routine inspection and long-term maintenance of the permanent water quality BMPs, which consists of the proposed EDB. The responsibility of maintenance for each will be included in the O&M Manual.

GROUNDWATER INVESTIGATION

A geotechnical report for the Site was completed by CTL Thompson, Inc. in June 2022 (included as **Appendix G**). According to the geotechnical report, five (5) widely spaced exploratory borings were drilled and sampled to a maximum of 35-feet. Groundwater was not encountered during drilling and the test holes were dry when checked after drilling. Therefore, groundwater is not expected to influence Site development.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

The developed drainage system for the Site consists of a proposed storm sewer system that will route flow through the Site and into the full spectrum EDB, which will discharge to the existing 60-inch storm sewer on 88th Avenue to the north.

STORM SEWER CAPACITY

Runoff developed from the Site will be conveyed via overland flow, roof drains, curb and gutters, and storm inlets into the proposed storm sewer system. The proposed storm sewer directs flow to the proposed EDB, located in the southwest corner of the site. The EDB will provide a controlled release to the existing storm sewer on 88th Avenue to the north. The proposed layout of the storm sewer is shown on the Proposed Drainage Map included in **Appendix E**.

The proposed inlets will be sized in utilizing the latest version of the MHFD Street Capacity and Inlet Sizing Spreadsheet. Curb inlet capacities will be calculated assuming a maximum of 6-inches of gutter flow in the minor storm event and a maximum of 8-inches of gutter flow in the major storm event per MHFD requirements. Inlet capacity calculations will be included in the Final Drainage Report.

The proposed private storm sewer system will be analyzed utilizing StormCAD to demonstrate that the system is adequately sized to meet MHFD and City Criteria. The StormCAD hydraulic output will be included in the Final Drainage Report.

DETENTION AND WATER QUALITY

Water Quality and Detention for the Project will be provided in a proposed Full Spectrum EDB, designed per the USDCM and City Criteria. The allowable release rate for the proposed detention pond is defined in Section 12.3 of the City Criteria. Since the majority of the Site consists of Type C soils, the allowable release rate for the minor and major storm events are 0.17 cfs/acre and 1.00 cfs/acre, respectively.

The EDB will be private and maintained by the Owner. The pond volumes, outlet structures, and emergency spillways will be sized using MHFD's UD-Detention Version 4.05 spreadsheet. The EDB has been sized to provide sufficient Water Quality Capture Volume (WQCV), Excess Urban Runoff Volume (EURV), and storage for the 100-year storm event of the on-site tributary area in accordance with the USDCM and City Criteria.

The EDB was also analyzed to include all offsite area being routed through the pond. A summary of the pond sizing parameters is included as **Table 3**. The preliminary sizing for the proposed EDB is included in **Appendix F**. Detailed calculations and output for the proposed EDB will be included in the Final Drainage Report.

Table 3: Summary of Tributary Area

Drainage Facility	Tributary Drainage Basins	Tributary Area (ac).	Overall Impervious Percentage	Allowable Release Rate	
				5-Year (cfs)	100-Year (cfs)
EDB	A1-A9, R1, OS1-OS4	17.35	44.85%	2.95	17.35

CONCLUSIONS

COMPLIANCE WITH STANDARDS

The proposed drainage design associated with the Project is in accordance with the Commerce City Storm Drainage Design and Technical Criteria Manual and the MHFD Urban Drainage and Flood Control District Manual.

DRAINAGE CONCEPT

Project topography and drainage conveyance facilities will follow existing drainage patterns. Developed runoff from the Site will be conveyed via a proposed storm sewer system to the full spectrum EDB, which will discharge to the existing 60-inch storm sewer on 88th Avenue to the north.

DOWNSTREAM SYSTEM

The Project will provide an EDB that have been designed per MHFD and City requirements to provide water quality, detention, and a controlled release of the developed runoff from the Site. It is assumed that the receiving 60-in storm sewer on 88th Avenue has sufficient capacity given that the developed flow from the Site will be less than the total existing peak runoff. With the decrease in overall runoff from the Site, the Project is not anticipated to adversely affect downstream drainage facilities.

REFERENCES

1. Custom Soil Resource Report, Natural Resources Conservation Service, Web Soil Survey, retrieved January 2021.
2. Flood Insurance Rate Map, Panel Number 08001C0607H, Federal Emergency Management Agency, effective March 5, 2007.
3. Irondale Gulch Outfall Systems Plan, Moser & Associates Engineering, dated September 2011.
4. Irondale Neighborhood & Infrastructure Plan, City of Commerce City, dated 2018.
5. Preliminary Geotechnical Investigation, CTL Thompson, Inc., dated June 9,2022.
6. Storm Drainage Design and Technical Criteria Manual, City of Commerce City, dated December 2021.
7. Urban Storm Drainage Criteria Manual, Volumes 1-3, Mile High Flood District, latest edition.

APPENDIX A – VICINITY MAP


E 96th Ave
E 96th Ave
E 96th Ave
Monaco St
South Platte River
76
E 92nd
Project Site
E 88th Ave
E 88th Ave
E 88th Ave
2
Brighton Rd
Rosemary St
76
IRONDALE
2
N
4000 ft
Google Earth

APPENDIX B - NRCS SOILS REPORT

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

88th & Rosemary
Commerce City, Adams County, CO

January 26, 2022

Soil Map


104° 54' 13" W
104° 53' 55" W
39° 51' 23" N
39° 51' 14" N
508250
508290
508330
508370
508410
508450
508490
508530
508570
508610
508650
4411820
4411780
4411740
4411700
4411660
4411620
4411580
SITE
NIA
88th
E 88th Ave
NIB
AsC
Rosemary St
NIA
VoC
NIA
Soil Map may not be valid at this scale.
Map Scale: 1:1,980 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 25 50 100 150
Feet
0 50 100 200 300
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Adams County Area, Parts of Adams and Denver Counties, Colorado
Survey Area Data: Version 18, Aug 31, 2021

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

Date(s) aerial images were photographed: Oct 3, 2018—Dec 4, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AsC	Ascalon sandy loam, 3 to 5 percent slopes	7.9	38.6%
NlA	Nunn loam, 0 to 1 percent slopes	3.7	18.2%
NlB	Nunn loam, 1 to 3 percent slopes	6.9	33.8%
VoC	Vona sandy loam, 3 to 5 percent slopes	1.9	9.4%
Totals for Area of Interest		**20.5**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

AsC—Ascalon sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlnt
Elevation: 3,550 to 5,970 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Ascalon and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 6 inches: sandy loam
Bt1 - 6 to 12 inches: sandy clay loam
Bt2 - 12 to 19 inches: sandy clay loam
Bk - 19 to 35 inches: sandy clay loam
C - 35 to 80 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.1 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Moderate (about 6.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains, R072XY111KS - Sandy Plains

Hydric soil rating: No

Minor Components

Stoneham

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains, R072XY100KS - Loamy Tableland
Hydric soil rating: No

Vona

Percent of map unit: 8 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder, backslope, footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains, R072XY111KS - Sandy Plains
Hydric soil rating: No

Platner

Percent of map unit: 2 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains, R072XY100KS - Loamy Tableland
Hydric soil rating: No

NlA—Nunn loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2tln3
Elevation: 3,900 to 6,250 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Nunn and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile

Ap - 0 to 6 inches: loam
Bt1 - 6 to 10 inches: clay loam
Bt2 - 10 to 26 inches: clay loam
Btk - 26 to 31 inches: clay loam
Bk1 - 31 to 47 inches: loam
Bk2 - 47 to 80 inches: loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 7 percent
Maximum salinity: Nonsaline (0.1 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum: 0.5
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Haverson, rarely flooded

Percent of map unit: 10 percent
Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R067BY036CO - Overflow
Hydric soil rating: No

Heldt

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY042CO - Clayey Plains

Hydric soil rating: No

NlB—Nunn loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tln2
Elevation: 3,900 to 6,250 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Nunn and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile

Ap - 0 to 6 inches: loam
Bt1 - 6 to 10 inches: clay loam
Bt2 - 10 to 26 inches: clay loam
Btk - 26 to 31 inches: clay loam
Bk1 - 31 to 47 inches: loam
Bk2 - 47 to 80 inches: loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 7 percent
Maximum salinity: Nonsaline (0.1 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum: 0.5
Available water supply, 0 to 60 inches: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Wages

Percent of map unit: 8 percent
Landform: Alluvial fans, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Fort collins

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Haverson, very rarely flooded

Percent of map unit: 2 percent
Landform: Alluvial fans, drainageways, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear, concave
Ecological site: R067BY036CO - Overflow
Hydric soil rating: No

VoC—Vona sandy loam, 3 to 5 percent slopes

Map Unit Setting

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

Map Unit Composition

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

Description of Vona

Setting

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

Typical profile

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

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.3 inches)

Interpretive groups

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

Minor Components

Truckton

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

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Hydrologic Soil Group and Surface Runoff

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–Adams County Area, Parts of Adams and Denver Counties, Colorado			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
AsC—Ascalon sandy loam, 3 to 5 percent slopes			
Ascalon	80	Low	B
NlA—Nunn loam, 0 to 1 percent slopes			
Nunn	85	Medium	C
NlB—Nunn loam, 1 to 3 percent slopes			
Nunn	85	Medium	C
VoC—Vona sandy loam, 3 to 5 percent slopes			
Vona	90	Very low	A

APPENDIX C - FEMA FIRMETTE

National Flood Hazard Layer FIRMette

FEMA

104°54'20"W 39°51'30"N

104°53'43"W 39°51'3"N

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

1:6,000

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

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/13/2022 at 12:42 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX D - HYDROLOGIC CALCULATIONS

Kimley»Horn

STANDARD FORM SF-1
RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

DATE: 7/7/2021

SOIL: C

LAND USE:	PAVEMENT AREA	OPEN SPACE AREA	ROOF AREA	CONCRETE AREA
2-YEAR COEFF.	0.87	0.00	0.80	0.87
5-YEAR COEFF.	0.88	0.01	0.85	0.87
10-YEAR COEFF.	0.90	0.05	0.90	0.88
100-YEAR COEFF.	0.93	0.20	0.90	0.89
IMPERVIOUS %	100%	0%	90%	96%

DESIGN BASIN	DESIGN POINT	PAVEMENT AREA (AC)	OPEN SPACE AREA (AC)	ROOF AREA (AC)	CONCRETE AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
On-Site Basins											
EX1	EX1	0.04	5.52	0.17	0.11	**5.85**	0.05	0.06	0.10	0.24	5%
EX2	EX2	0.00	0.49	0.00	0.00	**0.49**	0.00	0.01	0.05	0.20	0%
EX3	EX3	0.00	0.36	0.00	0.00	**0.36**	0.00	0.01	0.05	0.20	0%
		0.04	**6.37**	**0.17**	**0.11**	**6.70**	**0.04**	**0.05**	**0.09**	**0.23**	**5%**
BASIN SUBTOTAL		**1%**	**95%**	**3%**	**2%**	**100%**					
Off-Site Basins											
OS1	OS1	0.16	0.06	0.00	0.00	**0.22**	0.63	0.64	0.66	0.73	72%
OS2	OS2	0.24	0.37	0.00	0.00	**0.61**	0.34	0.35	0.38	0.49	39%
OS3	OS3	0.00	0.15	0.00	0.00	**0.15**	0.00	0.01	0.05	0.20	0%
OS4	OS4	1.07	7.07	0.76	1.38	**10.28**	0.27	0.28	0.31	0.42	30%
		1.47	**7.65**	**0.76**	**1.38**	**11.26**	0.27	0.29	0.32	0.43	31%
BASIN SUBTOTAL		**13%**	**68%**	**7%**	**12%**	**100%**					

Kimley»Horn

STANDARD FORM SF-2
Time of Concentration

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

DATE: 7/7/2021

SUB-BASIN DATA			INITIAL TIME (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)					FINAL Tc
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T_i Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C_v (9)	VEL fps (11)	T_t Min. (12)	COMP. tc (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	Tc Min. (17)	Min.
On-Site Basins																
EX1	5.85	0.06	300	1.0%	32.6	285	1.4%	7.0	0.8	5.7	38.3	585	1.2%	5%	34.2	34.2
EX2	0.49	0.01	253	1.2%	29.7						29.7	253	1.2%		30.2	29.7
EX3	0.36	0.01	109	1.5%	18.1						18.1	109	1.5%		27.6	18.1
Off-Site Basins																
OS1	0.22	0.64	51	2.4%	4.6						4.6	51	2.4%	72%	14.0	5.0
OS2	0.61	0.35	176	1.1%	17.9						17.9	176	1.1%	39%	21.3	17.9
OS3	0.15	0.01	45	6.8%	7.1						7.1	45	6.8%		26.3	7.1
OS4	10.28	0.28	300	2.1%	20.4	1,358	1.2%	20.0	2.2	10.5	30.9	1658	1.3%	30%	39.1	30.9

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

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

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

P_1 (1-Hour Rainfall) = **1.37**

DATE: 7/7/2021

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
STORM LINE	DESIGN POINT	DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site Basins																					
	EX1	EX1	5.85	0.06	34.2	0.34	1.99	0.67													
	EX2	EX2	0.49	0.01	29.7	0.00	2.16	0.01													
	EX3	EX3	0.36	0.01	18.1	0.00	2.84	0.01													
Off-Site Basins																					
	OS1	OS1	0.22	0.64	5.0	0.14	4.65	0.64													
	OS2	OS2	0.61	0.35	17.9	0.21	2.85	0.61													
	OS3	OS3	0.15	0.01	7.1	0.00	4.19	0.01													
	OS4	OS4	10.28	0.28	30.9	2.86	2.11	6.04													

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

P_1 (1-Hour Rainfall) = **2.58**

DATE: 7/7/2021

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
STORM LINE	DESIGN POINT	DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site Basins																					
	EX1	EX1	5.85	0.24	34.19	1.40	3.74	5.24													
	EX2	EX2	0.49	0.20	29.72	0.10	4.07	0.40													
	EX3	EX3	0.36	0.20	18.11	0.07	5.34	0.38													
Off-Site Basins																					
	OS1	OS1	0.22	0.73	5.00	0.16	8.75	1.37													
	OS2	OS2	0.61	0.49	17.88	0.30	5.38	1.60													
	OS3	OS3	0.15	0.20	7.10	0.03	7.89	0.24													
	OS4	OS4	10.28	0.42	30.88	4.32	3.98	17.19													

Kimley»Horn

PROJECT NAME: 88th & Rosemary DATE: 7/7/2021
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS)	
				Q5	Q100
On-Site Basins					
EX1	EX1	5.85	5%	0.67	5.24
EX2	EX2	0.49	0%	0.01	0.40
EX3	EX3	0.36	0%	0.01	0.38
TOTAL		**6.70**	**5%**	**0.69**	**6.02**
Off-Site Basins					
OS1	OS1	0.22	72%	0.64	1.37
OS2	OS2	0.61	39%	0.61	1.60
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.26**	**31%**	**7.29**	**20.39**

Kimley»Horn

STANDARD FORM SF-1
RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

DATE: 7/7/2021

SOIL: C

LAND USE:	PAVEMET AREA	LANDSCAPE AREA	ROOF AREA	GRAVEL AREA	CONCRETE AREA
2-YEAR COEFF.	0.87	0.00	0.80	0.30	0.87
5-YEAR COEFF.	0.88	0.01	0.85	0.36	0.87
10-YEAR COEFF.	0.90	0.05	0.90	0.43	0.88
100-YEAR COEFF.	0.93	0.20	0.90	0.65	0.89
IMPERVIOUS %	100%	0%	90%	40%	96%

DESIGN BASIN	DESIGN POINT	PAVEMET AREA (AC)	LANDSCAPE AREA (AC)	ROOF AREA (AC)	GRAVEL AREA (AC)	CONCRETE AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
On-Site Basins												
A1	A1	0.20	0.01	0.00	0.20	0.01	**0.42**	0.58	0.61	0.66	0.78	69%
A2	A2	0.63	0.00	0.00	0.20	0.00	**0.83**	0.73	0.75	0.79	0.86	85%
A3	A3	0.31	0.22	0.00	0.70	0.00	**1.23**	0.39	0.43	0.48	0.64	48%
A4	A4	0.26	0.06	0.00	0.06	0.01	**0.38**	0.65	0.67	0.70	0.78	76%
A5	A5	0.43	0.11	0.00	0.00	0.03	**0.57**	0.71	0.72	0.74	0.79	81%
A6	A6	0.33	0.11	0.00	0.00	0.02	**0.46**	0.66	0.67	0.70	0.75	76%
A7	A7	0.12	0.08	0.00	0.26	0.00	**0.46**	0.40	0.44	0.49	0.65	49%
A8	A8	0.05	0.00	0.00	0.00	0.00	**0.05**	0.87	0.88	0.90	0.93	100%
A9	A9	0.00	0.60	0.00	0.00	0.00	**0.60**	0.00	0.01	0.05	0.20	0%
A10	A10	0.00	0.28	0.00	0.00	0.00	**0.28**	0.00	0.01	0.05	0.20	0%
A11	A11	0.00	0.08	0.00	0.00	0.00	**0.08**	0.00	0.01	0.05	0.20	0%
R1	R1	0.00	0.00	1.25	0.00	0.00	**1.25**	0.80	0.85	0.90	0.90	90%
		2.32	**1.54**	**1.25**	**1.42**	**0.08**	**6.61**	**0.53**	**0.56**	**0.60**	**0.69**	**62%**
BASIN SUBTOTAL		**35%**	**23%**	**19%**	**21%**	**1%**	**100%**					
Off-Site Basins												
OS1	OS1	0.15	0.05	0.00	0.00	0.04	**0.24**	0.69	0.70	0.73	0.78	79%
OS2A	OS2A	0.17	0.02	0.00	0.00	0.02	**0.21**	0.78	0.79	0.81	0.85	90%
OS2B	OS2B	0.25	0.03	0.00	0.00	0.03	**0.30**	0.79	0.80	0.82	0.86	90%
OS2C	OS2C	0.15	0.00	0.00	0.00	0.01	**0.16**	0.87	0.88	0.90	0.93	100%
OS3	OS3	0.00	0.15	0.00	0.00	0.00	**0.15**	0.00	0.01	0.05	0.20	0%
OS4	OS4	1.07	7.07	0.76	0.00	1.38	**10.28**	0.27	0.28	0.31	0.42	30%
		1.79	**7.32**	**0.76**	**0.00**	**1.48**	**11.35**	**0.30**	**0.32**	**0.35**	**0.45**	**34%**
BASIN SUBTOTAL		**16%**	**65%**	**7%**	**0%**	**13%**	**100%**					

Kimley»Horn

STANDARD FORM SF-2
Time of Concentration

PROJECT NAME: **88th & Rosemary**
PROJECT NUMBER: **96266043**
CALCULATED BY: **SWH**
CHECKED BY: **SLP**

DATE: 7/7/2021

SUB-BASIN DATA			INITIAL TIME (T_i)			TRAVEL TIME (T_t)					Tc CHECK (URBANIZED BASINS)					FINAL Tc
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T_i Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C_v (9)	VEL fps (11)	T_t Min. (12)	COMP. tc (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	Tc Min. (17)	Min.
On-Site Basins																
A1	0.42	0.61	75	0.5%	9.8	163	0.5%	20.0	1.4	1.9	11.7	238	0.5%	69%	17.3	11.7
A2	0.83	0.75	75	1.7%	4.6	262	0.6%	20.0	1.5	2.8	7.5	337	0.8%	85%	14.4	7.5
A3	1.23	0.43	209	1.3%	16.4	233	0.5%	20.0	1.4	2.7	19.2	442	0.9%	48%	22.9	19.2
A4	0.38	0.67	85	0.2%	13.5	215	0.5%	20.0	1.4	2.6	16.2	300	0.4%	76%	17.2	16.2
A5	0.57	0.72	72	1.3%	5.4	212	0.5%	20.0	1.4	2.5	7.9	284	0.7%	81%	15.0	7.9
A6	0.46	0.67	78	1.4%	6.2	131	0.5%	20.0	1.4	1.5	7.7	209	0.8%	76%	15.0	7.7
A7	0.46	0.44	106	0.3%	19.5	153	1.0%	20.0	2.0	1.3	20.7	258	0.7%	49%	21.0	20.7
A8	0.05	0.88	75	4.8%	2.1						2.1	75	4.8%	100%	9.2	5.0
A9	0.60	0.01	56	15.4%	6.0						6.0	56	15.4%		26.3	6.0
A10	0.28	0.01	28	12.6%	4.5						4.5	28	12.6%		26.1	5.0
A11	0.08	0.01	18	10.1%	3.9						3.9	18	10.1%		26.1	5.0
R1	1.25	0.85	75	2.0%	3.2						3.2	75	2.0%		27.0	5.0
Off-Site Basins																
OS1	0.24	0.70	51	2.4%	3.9						3.9	51	2.4%	79%	12.8	5.0
OS2A	0.21	0.79	72	2.4%	3.6						3.6	72	2.4%	90%	11.1	5.0
OS2B	0.30	0.80	38	4.4%								38				
OS2C	0.16	0.88	48	7.3%								48				
OS3	0.15	0.01	45	6.8%	7.1						7.1	45	6.8%		26.3	7.1
OS4	10.28	0.28	300	2.1%	20.4	1,358	1.2%	20.0	2.2	10.5	30.9	1658	1.3%	30%	39.1	30.9

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

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

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

P_1 (1-Hour Rainfall) = 1.37

DATE: 7/7/2021

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
STORM LINE	DESIGN POINT	DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCIT Y	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site Basins																					
	A1	A1	0.42	0.61	11.7	0.26	3.48	0.89													
	A2	A2	0.83	0.75	7.5	0.62	4.12	2.57													
	A3	A3	1.23	0.43	19.2	0.53	2.76	1.45													
	A4	A4	0.38	0.67	16.2	0.26	3.00	0.77													
	A5	A5	0.57	0.72	7.9	0.41	4.04	1.66													
	A6	A6	0.46	0.67	7.7	0.31	4.08	1.25													
	A7	A7	0.46	0.44	20.7	0.20	2.64	0.53													
	A8	A8	0.05	0.88	5.0	0.05	4.65	0.21													
	A9	A9	0.60	0.01	6.0	0.01	4.42	0.03													
	A10	A10	0.28	0.01	5.0	0.00	4.65	0.01													
	A11	A11	0.08	0.01	5.0	0.00	4.65	0.00													
	R1	R1	1.25	0.85	5.0	1.06	4.65	4.92													
Off-Site Basins																					
	OS1	OS1	0.24	0.70	5.0	0.17	4.65	0.79													
	OS2A	OS2A	0.21	0.79	5.0	0.17	4.65	0.78													
	OS2B	OS2B	0.30	0.80	0.0	0.24	6.39	1.54													
	OS2C	OS2C	0.16	0.88	0.0	0.14	6.39	0.91													
	OS3	OS3	0.15	0.01	7.1	0.00	4.19	0.01													
	OS4	OS4	10.28	0.28	30.9	2.86	2.11	6.04													

Kimley»Horn

STANDARD FORM SF-3
STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

P_1 **(1-Hour Rainfall) =** **2.58**

DATE: 7/7/2021

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
STORM LINE	DESIGN POINT	DESIGN BASIN	AREA (AC)	RUNOFF COEFF	tc (min)	C*A(ac)	I (in/hr)	Q (cfs)	tc(max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
On-Site Basins																					
	A1	A1	0.42	0.78	11.69	0.32	6.55	2.13													
	A2	A2	0.83	0.86	7.47	0.71	7.76	5.54													
	A3	A3	1.23	0.64	19.17	0.78	5.19	4.07													
	A4	A4	0.38	0.78	16.18	0.30	5.65	1.67													
	A5	A5	0.57	0.79	7.94	0.45	7.60	3.45													
	A6	A6	0.46	0.75	7.72	0.34	7.68	2.64													
	A7	A7	0.46	0.65	20.74	0.30	4.98	1.49													
	A8	A8	0.05	0.93	5.00	0.05	8.75	0.42													
	A9	A9	0.60	0.20	5.99	0.12	8.32	1.01													
	A10	A10	0.28	0.20	5.00	0.06	8.75	0.49													
	A11	A11	0.08	0.20	5.00	0.02	8.75	0.13													
	R1	R1	1.25	0.90	5.00	1.12	8.75	9.81													
Off-Site Basins																					
	OS1	OS1	0.24	0.78	5.00	0.19	8.75	1.65													
	OS2A	OS2A	0.21	0.85	5.00	0.18	8.75	1.59													
	OS2B	OS2B	0.30	0.86	0.00	0.26	12.04	3.12													
	OS2C	OS2C	0.16	0.93	0.00	0.15	12.04	1.81													
	OS3	OS3	0.15	0.20	7.10	0.03	7.89	0.24													
	OS4	OS4	10.28	0.42	30.88	4.32	3.98	17.19													

Kimley»Horn

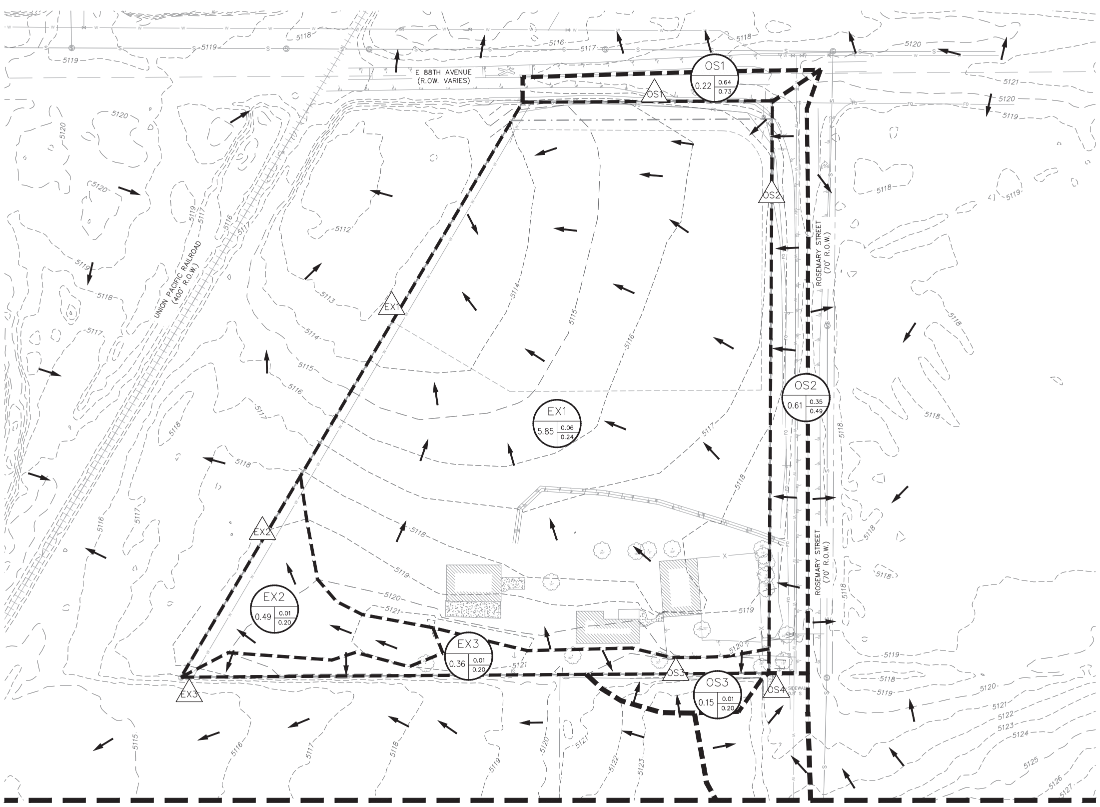
PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

DATE: 7/7/2021

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS)	
				Q5	Q100
On-Site Basins					
A1	A1	0.42	69%	0.89	2.13
A2	A2	0.83	85%	2.57	5.54
A3	A3	1.23	48%	1.45	4.07
A4	A4	0.38	76%	0.77	1.67
A5	A5	0.57	81%	1.66	3.45
A6	A6	0.46	76%	1.25	2.64
A7	A7	0.46	49%	0.53	1.49
A8	A8	0.05	100%	0.21	0.42
A9	A9	0.60	0%	0.03	1.01
A10	A10	0.28	0%	0.01	0.49
A11	A11	0.08	0%	0.00	0.13
R1	R1	1.25	90%	4.92	9.81
TOTAL		**6.61**	**62%**	**14.29**	**32.86**
Off-Site Basins					
OS1	OS1	0.24	79%	0.79	1.65
OS2A	OS2A	0.21	90%	0.78	1.59
OS2B	OS2B	0.30	90%	1.54	3.12
OS2C	OS2C	0.16	100%	0.91	1.81
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.35**	**34%**	**10.07**	**25.59**

APPENDIX E - DRAINAGE MAPS



MATCHLINE – SEE SHEET 2

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- ONSITE BASIN BOUNDARY
- OFFSITE BASIN BOUNDARY
- EX. CONTOUR
- EX. ASPHALT
- EX. WATER LINE
- EX. GAS LINE
- EX. FIBER LINE
- EX. FENCE
- EX. FIRE HYDRANT
- EXISTING CONCRETE
- EXISTING ROOF
- EXISTING FLOW ARROW
- A – DRAINAGE BASIN
- B – BASIN ACREAGE
- C – 5–YEAR RUNOFF COEFFICIENT
- D – 100–YEAR RUNOFF COEFFICIENT
- A1 DESIGN POINT

Kimley»Horn

PROJECT NAME: 88th & Rosemary DATE: 7/7/2021
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS)	
				Q5	Q100
On-Site Basins					
EX1	EX1	5.85	5%	0.67	5.24
EX2	EX2	0.49	0%	0.01	0.40
EX3	EX3	0.36	0%	0.01	0.38
TOTAL		**6.70**	**5%**	**0.69**	**6.02**
Off-Site Basins					
OS1	OS1	0.22	72%	0.64	1.37
OS2	OS2	0.61	39%	0.61	1.60
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.26**	**31%**	**7.29**	**20.39**

NORTH

GRAPHIC SCALE IN FEET
0 25 50 100
1" = 50'

CITY STAFF CERTIFICATE:
APPROVED BY THE DEPARTMENT OF COMMUNITY DEVELOPMENT OF THE CITY OF COMMERCE CITY, THIS DAY OF , 20 .

DEPARTMENT OF COMMUNITY DEVELOPMENT

ASSESSORS PARCEL ID: 0172128202002

811 Know what's below. Call before you dig.

NO.	REVISION	BY	DATE	APPR.

Kimley»Horn
© 2021 KIMLEY–HORN AND ASSOCIATES, INC.
4852 South Ulster Street, Suite 1500
Denver, Colorado 80237 (303) 228–2300 services@kimley–horn.com

DESIGNED BY: SLP
DRAWN BY: JAQ
CHECKED BY: SLP
DATE: 08/25/2022

E. 88TH AVE. & ROSEMARY ST.
COMMERCE CITY, CO
SITE DEVELOPMENT PLAN
EXISTING DRAINAGE MAP

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

PROJECT NO. 096266043
DRAWING NAME 096266043_EX_DRN

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- ONSITE BASIN BOUNDARY
- OFFSITE BASIN BOUNDARY
- EX. CONTOUR
- EX. ASPHALT
- EX. WATER LINE
- EX. GAS LINE
- EX. FIBER LINE
- EX. FENCE
- EX. FIRE HYDRANT
- EXISTING CONCRETE
- EXISTING ROOF
- EXISTING FLOW ARROW
- A – DRAINAGE BASIN
- B – BASIN ACREAGE
- C – 5–YEAR RUNOFF COEFFICIENT
- D – 100–YEAR RUNOFF COEFFICIENT
- DESIGN POINT

Kimley»Horn

PROJECT NAME: 88th & Rosemary DATE: 7/7/2021
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS) Q5	PEAK FLOWS (CFS) Q100
On-Site Basins					
EX1	EX1	5.85	5%	0.67	5.24
EX2	EX2	0.49	0%	0.01	0.40
EX3	EX3	0.36	0%	0.01	0.38
TOTAL		**6.70**	**5%**	**0.69**	**6.02**
Off-Site Basins					
OS1	OS1	0.22	72%	0.64	1.37
OS2	OS2	0.61	39%	0.61	1.60
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.26**	**31%**	**7.29**	**20.39**

NORTH

GRAPHIC SCALE IN FEET
0 37.5 75 150
1" = 75'

CITY STAFF CERTIFICATE:
APPROVED BY THE DEPARTMENT OF COMMUNITY DEVELOPMENT OF THE CITY OF COMMERCE CITY, THIS DAY OF , 20 .

DEPARTMENT OF COMMUNITY DEVELOPMENT

ASSESSORS PARCEL ID: 0172128202002

811 Know what's below. Call before you dig.

NO.	REVISION	BY	DATE	APPR.

Kimley»Horn
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4852 South Ulster Street, Suite 1500
Denver, Colorado 80237 (303) 228-2300 services@kimley-horn.com

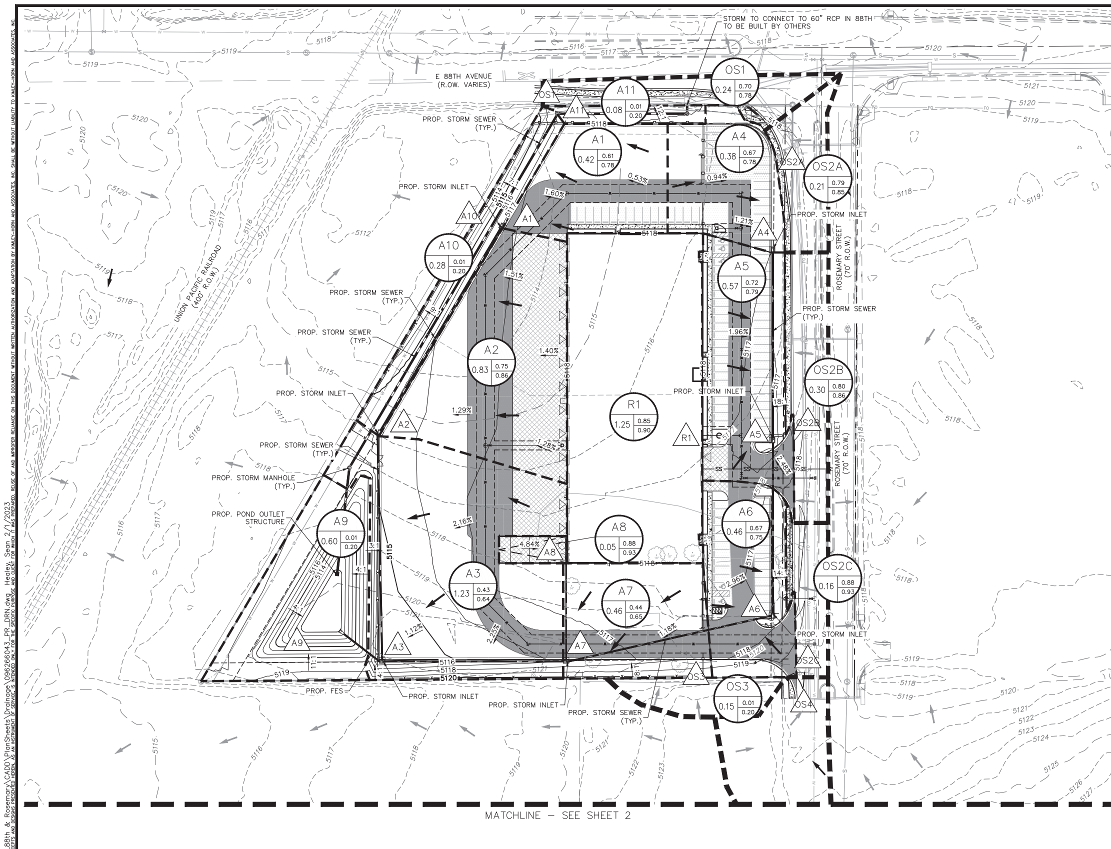
DESIGNED BY: SLP
DRAWN BY: JAQ
CHECKED BY: SLP
DATE: 08/25/2022

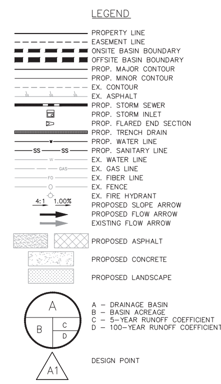
E. 88TH AVE. & ROSEMARY ST.
COMMERCE CITY, CO
SITE DEVELOPMENT PLAN
EXISTING DRAINAGE MAP

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

PROJECT NO.
096266043

DRAWING NAME
096266043_EX_DRN





Kimley»Horn

PROJECT NAME: 88th & Rosemary
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP
DATE: 7/7/2021

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS)	
				Q5	Q100
On-Site Basins					
A1	A1	0.42	69%	0.89	2.13
A2	A2	0.83	85%	2.57	5.54
A3	A3	1.23	48%	1.45	4.07
A4	A4	0.38	76%	0.77	1.67
A5	A5	0.57	81%	1.66	3.45
A6	A6	0.46	76%	1.25	2.64
A7	A7	0.46	49%	0.53	1.49
A8	A8	0.05	100%	0.21	0.42
A9	A9	0.60	0%	0.03	1.01
A10	A10	0.28	0%	0.01	0.49
A11	A11	0.08	0%	0.00	0.13
R1	R1	1.25	90%	4.92	9.81
TOTAL		**6.61**	**62%**	**14.29**	**32.86**
Off-Site Basins					
OS1	OS1	0.24	79%	0.79	1.65
OS2A	OS2A	0.21	90%	0.78	1.59
OS2B	OS2B	0.30	90%	1.54	3.12
OS2C	OS2C	0.16	100%	0.91	1.81
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.35**	**34%**	**10.07**	**25.59**

NORTH

GRAPHIC SCALE IN FEET
0 25 50 100
1" = 50'

CITY STAFF CERTIFICATE:
APPROVED BY THE DEPARTMENT OF COMMUNITY DEVELOPMENT OF THE CITY OF COMMERCE CITY, THIS ____ DAY OF ________, 20__.

DEPARTMENT OF COMMUNITY DEVELOPMENT

ASSESSORS PARCEL ID: 0172128202002

811 Know what's **below.** **Call** before you dig.

NO.	REVISION	BY	DATE	APPR.

Kimley»Horn
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4852 South Ulster Street, Suite 1500
Denver, Colorado 80237 (303) 228-2300 services@kimley-horn.com

DESIGNED BY: SLP
DRAWN BY: JAQ
CHECKED BY: SLP
DATE: 01/27/2023

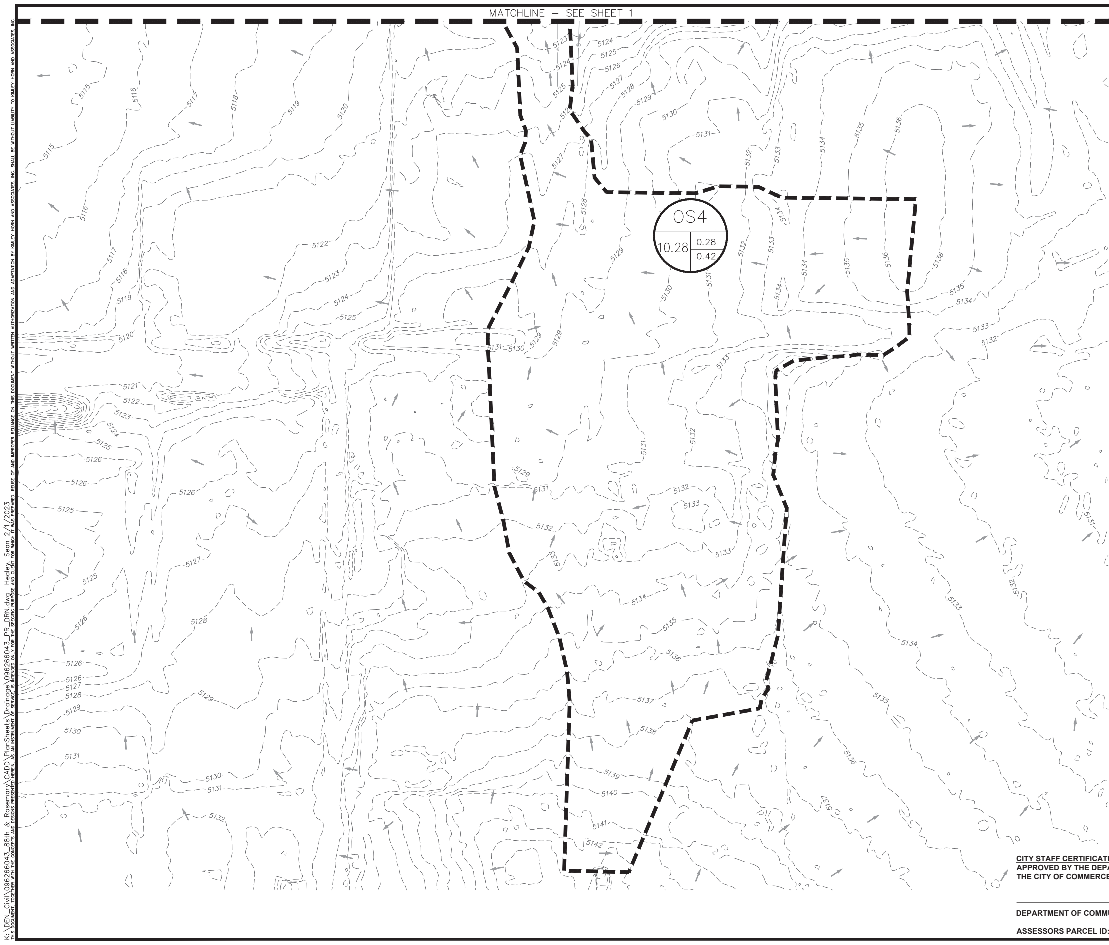
E. 88TH AVE. & ROSEMARY ST.
COMMERCE CITY, CO
SITE DEVELOPMENT PLAN
PROPOSED DRAINAGE MAP

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

PROJECT NO.
096266043

DRAWING NAME
096266043_PR_DRN

1



LEGEND

- PROPERTY LINE
- EASEMENT LINE
- ONSITE BASIN BOUNDARY
- OFFSITE BASIN BOUNDARY
- PROP. MAJOR CONTOUR
- PROP. MINOR CONTOUR
- EX. CONTOUR
- EX. ASPHALT
- PROP. STORM SEWER
- PROP. STORM INLET
- PROP. FLARED END SECTION
- PROP. TRENCH DRAIN
- PROP. WATER LINE
- PROP. SANITARY LINE
- EX. WATER LINE
- EX. GAS LINE
- EX. FIBER LINE
- EX. FENCE
- EX. FIRE HYDRANT
- 4:1 1.00% PROPOSED SLOPE ARROW
- PROPOSED FLOW ARROW
- EXISTING FLOW ARROW
- PROPOSED ASPHALT
- PROPOSED CONCRETE
- PROPOSED LANDSCAPE

A – DRAINAGE BASIN
B – BASIN ACREAGE
C – 5–YEAR RUNOFF COEFFICIENT
D – 100–YEAR RUNOFF COEFFICIENT

A1 DESIGN POINT

Kimley»Horn

PROJECT NAME: 88th & Rosemary DATE: 7/7/2021
PROJECT NUMBER: 96266043
CALCULATED BY: SWH
CHECKED BY: SLP

RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	IMPERVIOUS %	PEAK FLOWS (CFS)	
				Q5	Q100
On-Site Basins					
A1	A1	0.42	69%	0.89	2.13
A2	A2	0.83	85%	2.57	5.54
A3	A3	1.23	48%	1.45	4.07
A4	A4	0.38	76%	0.77	1.67
A5	A5	0.57	81%	1.66	3.45
A6	A6	0.46	76%	1.25	2.64
A7	A7	0.46	49%	0.53	1.49
A8	A8	0.05	100%	0.21	0.42
A9	A9	0.60	0%	0.03	1.01
A10	A10	0.28	0%	0.01	0.49
A11	A11	0.08	0%	0.00	0.13
R1	R1	1.25	90%	4.92	9.81
TOTAL		**6.61**	**62%**	**14.29**	**32.86**
Off-Site Basins					
OS1	OS1	0.24	79%	0.79	1.65
OS2A	OS2A	0.21	90%	0.78	1.59
OS2B	OS2B	0.30	90%	1.54	3.12
OS2C	OS2C	0.16	100%	0.91	1.81
OS3	OS3	0.15	0%	0.01	0.24
OS4	OS4	10.28	30%	6.04	17.19
TOTAL		**11.35**	**34%**	**10.07**	**25.59**

NORTH

GRAPHIC SCALE IN FEET
0 35 70 140
1" = 70'

DEPARTMENT OF COMMUNITY DEVELOPMENT

ASSESSORS PARCEL ID: 0172128202002

811 Know what's below. Call before you dig.

Kimley»Horn
© 2021 KIMLEY-HORN AND ASSOCIATES, INC.
4582 South Ulster Street, Suite 1500
Denver, Colorado 80237 (303) 228-2300 services@kimley-horn.com

DESIGNED BY: SLP
DRAWN BY: JAQ
CHECKED BY: SLP
DATE: 01/27/2023

E. 88TH AVE. & ROSEMARY ST.
COMMERCE CITY, CO
SITE DEVELOPMENT PLAN
PROPOSED DRAINAGE MAP

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

PROJECT NO. 096266043
DRAWING NAME 096266043_PR_DRN

2

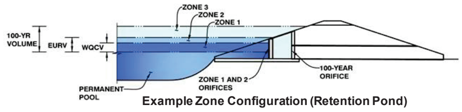
APPENDIX F - DETENTION FACILITY DESIGN

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **88th & Rosemary**

Basin ID: **Detention Pond - Onsite Tributary Area**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	6.25	acres		
Watershed Length =	1,216	ft		
Watershed Length to Centroid =	608	ft		
Watershed Slope =	0.005	ft/ft		
Watershed Imperviousness =	62.00%	percent		
Percentage Hydrologic Soil Group A =	9.4%	percent		
Percentage Hydrologic Soil Group B =	38.6%	percent		
Percentage Hydrologic Soil Groups C/D =	52.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center			

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.127	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.401	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.249	acre-feet	0.84	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.355	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.37 in.) =	0.473	acre-feet	1.37	inches
25-yr Runoff Volume (P1 = 1.75 in.) =	0.691	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	0.866	acre-feet	2.08	inches
100-yr Runoff Volume (P1 = 2.43 in.) =	1.071	acre-feet	2.43	inches
500-yr Runoff Volume (P1 = 3.35 in.) =	1.578	acre-feet	3.35	inches
Approximate 2-yr Detention Volume =	0.231	acre-feet		
Approximate 5-yr Detention Volume =	0.339	acre-feet		
Approximate 10-yr Detention Volume =	0.427	acre-feet		
Approximate 25-yr Detention Volume =	0.517	acre-feet		
Approximate 50-yr Detention Volume =	0.569	acre-feet		
Approximate 100-yr Detention Volume =	0.651	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.127	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.275	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.249	acre-feet
Total Detention Basin Volume =	0.651	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1.00 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	--	--	--	1,885	0.043		
	--	1.00	--	--	--	2,894	0.066	2,389	0.055
	--	2.00	--	--	--	4,110	0.094	5,891	0.135
	--	3.00	--	--	--	5,533	0.127	10,713	0.246
	--	4.00	--	--	--	7,165	0.164	17,062	0.392
	--	5.00	--	--	--	9,004	0.207	25,146	0.577
	--	6.00	--	--	--	11,051	0.254	35,174	0.807
	--	7.00	--	--	--	13,306	0.305	47,352	1.087
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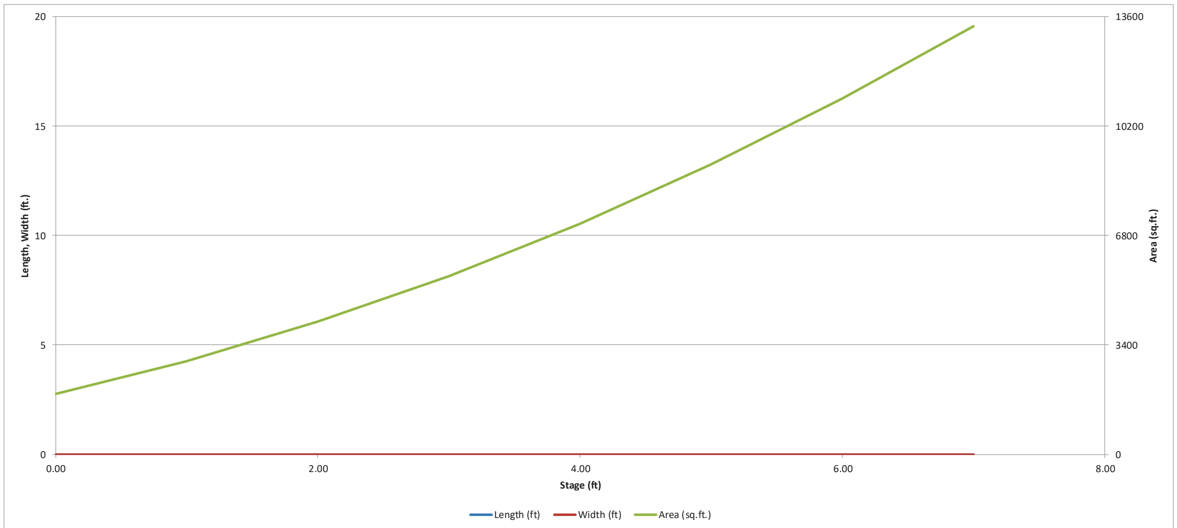
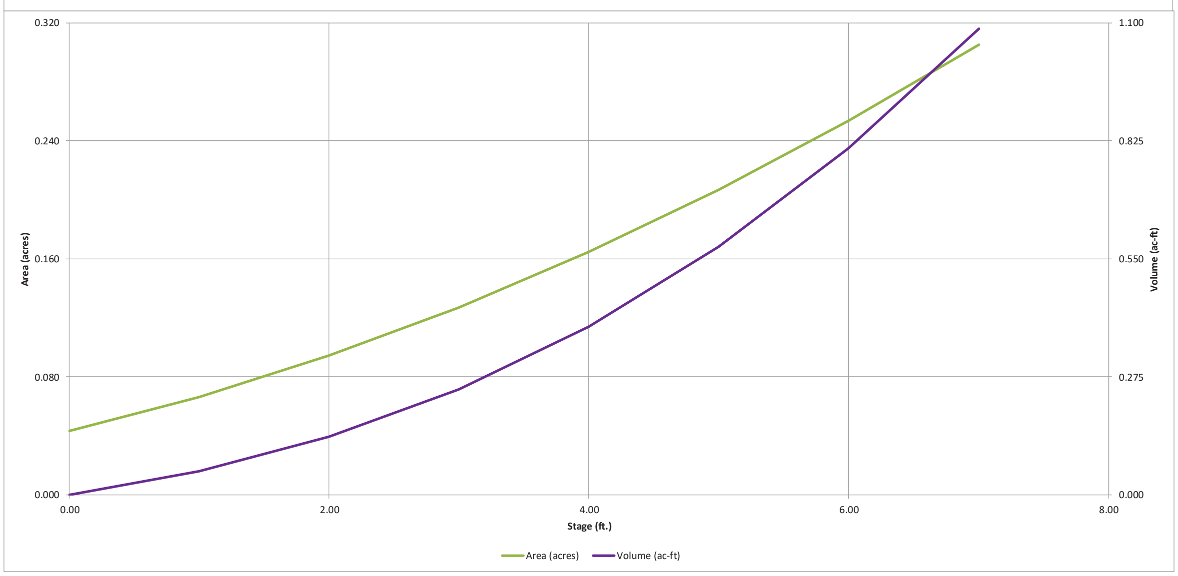
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



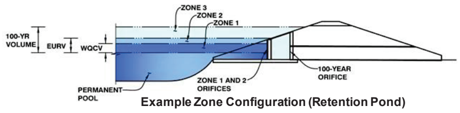


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **88th & Rosemary**

Basin ID: **Detention Pond - Onsite & Offsite Tributary Area**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	17.35	acres		
Watershed Length =	1,946	ft		
Watershed Length to Centroid =	973	ft		
Watershed Slope =	0.014	ft/ft		
Watershed Imperviousness =	44.85%	percent		
Percentage Hydrologic Soil Group A =	56.3%	percent		
Percentage Hydrologic Soil Group B =	17.2%	percent		
Percentage Hydrologic Soil Groups C/D =	26.5%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Commerce City - Civic Center			

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

WQCV and EURV from onsite tributary area sizing

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.127	acre-feet	0.127	acre-feet
Excess Urban Runoff Volume (EURV) =	0.401	acre-feet	0.401	acre-feet
2-yr Runoff Volume (P1 = 0.84 in.) =	0.444	acre-feet	0.84	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.647	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.37 in.) =	0.832	acre-feet	1.37	inches
25-yr Runoff Volume (P1 = 1.75 in.) =	1.362	acre-feet		inches
50-yr Runoff Volume (P1 = 2.08 in.) =	1.791	acre-feet	2.08	inches
100-yr Runoff Volume (P1 = 2.43 in.) =	2.362	acre-feet	2.43	inches
500-yr Runoff Volume (P1 = 3.35 in.) =	3.685	acre-feet	3.35	inches
Approximate 2-yr Detention Volume =	0.416	acre-feet		
Approximate 5-yr Detention Volume =	0.612	acre-feet		
Approximate 10-yr Detention Volume =	0.783	acre-feet		
Approximate 25-yr Detention Volume =	1.020	acre-feet		
Approximate 50-yr Detention Volume =	1.169	acre-feet		
Approximate 100-yr Detention Volume =	1.396	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.127	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.274	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.995	acre-feet
Total Detention Basin Volume =	1.396	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1.00 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	--	--	--	1,885	0.043		
	--	1.00	--	--	--	2,894	0.066	2,389	0.055
	--	2.00	--	--	--	4,110	0.094	5,891	0.135
	--	3.00	--	--	--	5,533	0.127	10,713	0.246
	--	4.00	--	--	--	7,165	0.164	17,062	0.392
	--	5.00	--	--	--	9,004	0.207	25,146	0.577
	--	6.00	--	--	--	11,051	0.254	35,174	0.807
	--	7.00	--	--	--	13,306	0.305	47,352	1.087
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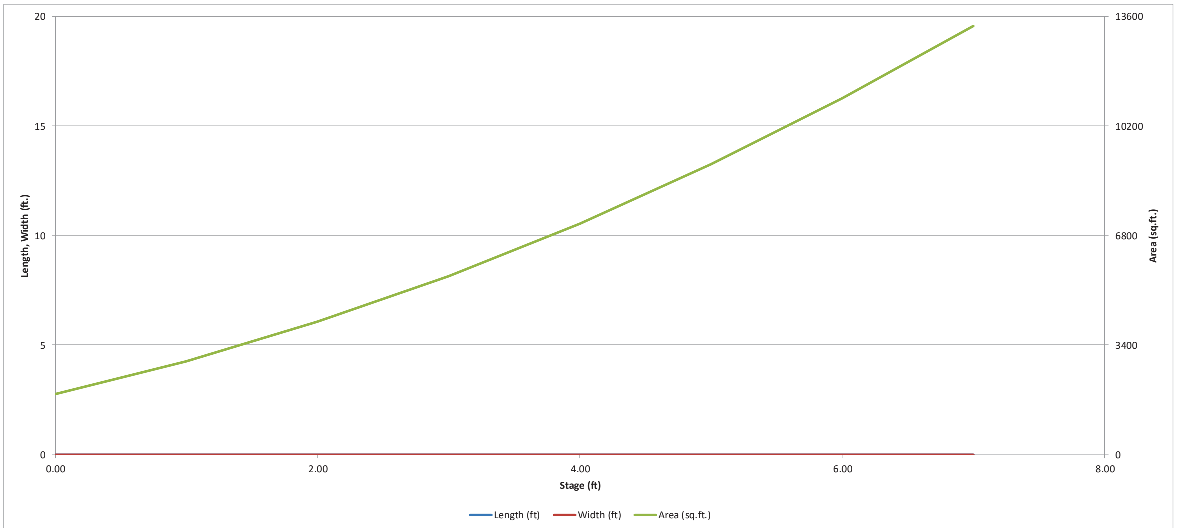
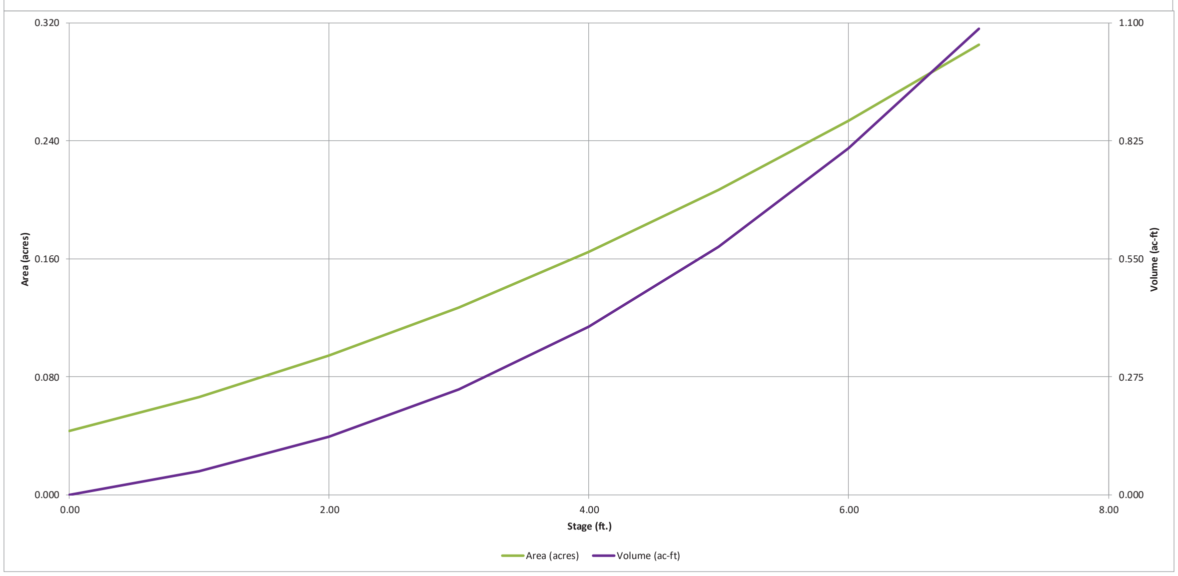
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)





APPENDIX G – GEOTECHNICAL REPORT

PRELIMINARY GEOTECHNICAL INVESTIGATION

INDUSTRIAL PARCEL – 88TH AVENUE & ROSEMARY STREET
SOUTHWEST CORNER OF 88TH AVENUE
AND ROSEMARY STREET
COMMERCE CITY, COLORADO

Prepared for:

EVERGREEN DEVCO, INC.
1873 South Bellaire Street, Suite 1200
Denver, Colorado 80222

Attention:
Jazzmine Clifton

Project No. DN51,543-115-R1

June 9, 2022

Table of Contents

Table of Contents, Continued

SCOPE

This report presents the results of our Preliminary Geotechnical Investigation for the proposed industrial development planned southwest of 88th Avenue and Rosemary Street in Commerce City, Colorado (Fig. 1). We understand you are contemplating the site for construction of an industrial use building served by buried utilities, and paved access drives and surface parking. The purpose of this investigation was to evaluate the subsurface conditions to assist in planning of site development and construction. The report contains descriptions of the subsurface conditions found in our exploratory borings and discussions of site development and construction as influenced by geotechnical considerations. The scope was described in our Proposal (DN 22-0079) dated March 1, 2022.

This report is based on our understanding of the planned construction, subsurface conditions found in our exploratory borings, site reconnaissance, results of field and laboratory tests, engineering analysis, and our experience. The preliminary discussions presented in the report are intended for evaluation and planning purposes only. An additional, site-specific investigation will be necessary to design structures and pavements. A summary of our conclusions and recommendations follows, with more detailed discussion in the report.

SUMMARY OF CONCLUSIONS

1. The site is judged suitable for the proposed development. The primary geotechnical concern is the presence of expansive soils. We believe this concern can be mitigated with proper planning, engineering, design and construction. We believe there are no geotechnical constraints that would preclude development.

2. Strata found in our borings consisted of about 17 to 23 feet of primarily sandy to very sandy clay with lesser amounts of clayey sand underlain by clean to silty sand and gravel to the maximum depth explored of 35 feet. Bedrock was not encountered. Testing indicates the clay is variably expansive. The sand and gravel are judged to be non-expansive.

3. Groundwater was not encountered during drilling and the holes were dry when checked after drilling. Groundwater is not expected to influence site development or building construction. Groundwater will likely fluctuate seasonally and may rise in response to development, precipitation, landscape irrigation, and flow in Big Burlington Ditch.

4. Our investigation indicates expansive clay and non-expansive clayey sand are present at depths likely to influence performance of shallow foundations. We estimate total potential heave at the ground surface could range from about ½-inch to 8 inches. Shallow foundations such as footings can likely be suitable provided sub-excavation is performed to a depth of 10 feet below foundation level. We judge potential movements should be reduced to about 1 to 2 inches after sub-excavation.

5. Slab-on-grade floors appear suitable at this site provided sub-excavation is performed and risk of potential movement is acceptable. The choice of floor support methods should depend on the tolerance for movement. Structurally supported floors can be used for areas where movement is not tolerable.

6. Pavement subgrade soils are likely to be derived of expansive clay, which are considered poor subgrade material. Sub-excavation of at least 3 feet below pavements should be planned. For preliminary purposes, we anticipate a minimum full-depth asphalt section of at least 5 inches for parking lots and at least 6 inches for access drives. An additional 1 to 2 inches of asphalt may be necessary. A pavement design should be performed during the design-level investigation.

7. Control of surface drainage will be critical to the performance of foundations, slabs-on-grade and pavements. Overall surface drainage should be designed to provide rapid run-off of surface water away from the structure and off pavements and flatwork. Water should not be allowed to pond near the crests of slopes, near structures or on pavements and flatwork. Conservative irrigation practices should be employed to reduce the risk of subsurface wetting.

SITE CONDITIONS AND PROPOSED DEVELOPMENT

The site contains approximately 6.5 acres and is located southwest of 88th Avenue and Rosemary Street in Commerce, Colorado (Fig. 1 and Photo 1). The site is bordered by 88th Avenue to the north, Rosemary Street to the east, commercial and industrial developments to the south, and the Union Pacific Railroad and Big Burlington Ditch to the west. A majority of the site is vacant, with a single-family residence and several outbuildings present in the southeast corner. Ground cover consists of primarily grass and weeds, with some scattered trees surrounding the residence and outbuildings in the southern portion. The site generally slopes to the northwest, with overall topographic relief of approximately 5 feet. According to the Adams County Assessor, the existing residence is a single-story structure built in 1901 with a detached garage. The adjacent farm utility building was built in 2011. Available Google Earth aerial imagery of the site (dating back to 1985) indicates the site has remained largely unchanged, with the exception of the farm utility building construction in 2011.

Photo 1 – Google Earth© Aerial Site Photo – June 2021

We understand the site is being considered for construction of an approximately 41,000 square foot industrial use building with surface parking and access drives. Plans also indicate a detention pond is planned in the southwest corner of the site. We assume the building will likely have light to moderate foundation loads and no below-grade areas. Based on existing grades, we anticipate relatively minor (5 feet or less) cut and fill grading will be necessary to achieve construction grades.

INVESTIGATION

We investigated subsurface conditions on April 29, 2022 by drilling and sampling five widely-spaced exploratory borings at the approximate locations shown on Fig. 1. Approximate boring locations and elevations were determined by our representative using a Leica GS18 GPS unit referencing the North American Datum of 1983 (NAD83). Prior to drilling, we contacted the Utility Notification Center of Colorado and local sewer and water districts to identify locations of buried utilities. The borings were drilled to depths of 25 to 35 feet below existing grades using 4-inch diameter, continuous-flight solid-stem auger and a truck-mounted CME-45 drill rig.

Samples were obtained at approximate 5-foot intervals using a 2.5-inch diameter (O.D.) modified California barrel sampler driven by blows of an automatic 140-pound hammer falling 30 inches. Bulk samples were also obtained from auger cuttings within the upper 5 feet in TH-1 and TH-4. Our field representative was present to observe drilling operations, log the strata encountered, and obtain samples. Graphical logs of the exploratory borings are presented on Fig. 2.

The samples were returned to our laboratory where they were examined by our engineers and testing was assigned. Laboratory tests included dry density, moisture content, particle-size analysis (gradation and percent silt and clay-sized particles passing the No. 200 sieve), Atterberg limits, swell-consolidation, and water-soluble sulfate concentration. Swell-consolidation tests were performed by wetting the samples under approximate overburden pressures (i.e. the pressure exerted by the overlying soil). Results of laboratory tests are presented in Appendix A and summarized in Table A-I.

SUBSURFACE CONDITIONS

Strata found in our borings consisted of about 17 to 23 feet of primarily sandy to very sandy clay with lesser amounts of clayey sand underlain by clean to silty sand and gravel to the maximum depth explored of 35 feet. Bedrock was not encountered. Some pertinent engineering characteristics of the soils are described in the following paragraphs.

Sandy Clay and Clayey Sand

At least 17 feet of sandy to very sandy clay was encountered in each boring. Clayey sand was found within the clay in TH-1 and TH-5. The clay was medium stiff to very stiff and the clayey sand was medium dense based on the results of field penetration resistance tests. Three clay samples compressed 0.3 to 2.9 percent and seven swelled 0.1 to 7.9 percent when wetted, with an average swell of 2.3 percent. Three clay samples developed load-back swelling pressures of approximately 2,700 to 7,600 pounds per square foot (psf). Three samples of sandy clay contained 50 to 72 percent silt and clay-sized particles with two exhibiting moderate plasticity. One sample of clayey sand compressed 4.3 percent when wetted and another contained 43 percent silt and clay-sized particles. Testing indicates the clay is variably expansive and we judge the clayey sand is non-expansive.

Clean to Silty Sand and Gravel

Clean to silty sand and gravel was found beneath the sandy clay and clayey sand at depths of about 17 to 23 feet. The sand and gravel was dense to very dense. Two samples contained 3 and 14 percent fines. The same samples contained 17 and 52 percent gravel-sized material (retained on the No. 4 sieve) respectively. We judge the sand/gravel is non-expansive.

Groundwater

Groundwater was not encountered during drilling. When checked after drilling on June 2, 2022, the holes were dry. Groundwater is not expected to influence site development or building construction. Groundwater will likely fluctuate seasonally and may rise in response to development, precipitation, landscape irrigation, and flow in Big Burlington Ditch.

GEOLOGIC HAZARDS

Geologic hazards were evaluated through review of geologic maps, exploratory borings, site reconnaissance, and local experience. Primary geologic hazards include expansive soils, and the regional issue of seismicity. We believe potential impacts of these hazards can be reduced with proper engineering, design, and construction practices. We identified no geologic hazard which would preclude development. These hazards and conceptual mitigation methods are discussed in the following sections.

Site Geology

According to the Geologic Map of the Commerce City Quadrangle, Adams and Denver Counties, Colorado (Lindvall, R.M., U.S. Geological Survey, Geological Quadrangle Map GQ-1541, 1980), the site soils consist of windblown (Eolian) deposits of fine sand, sandy silt, and clay underlain by the Broadway Alluvium. The mapping is generally consistent with the conditions found in our borings.

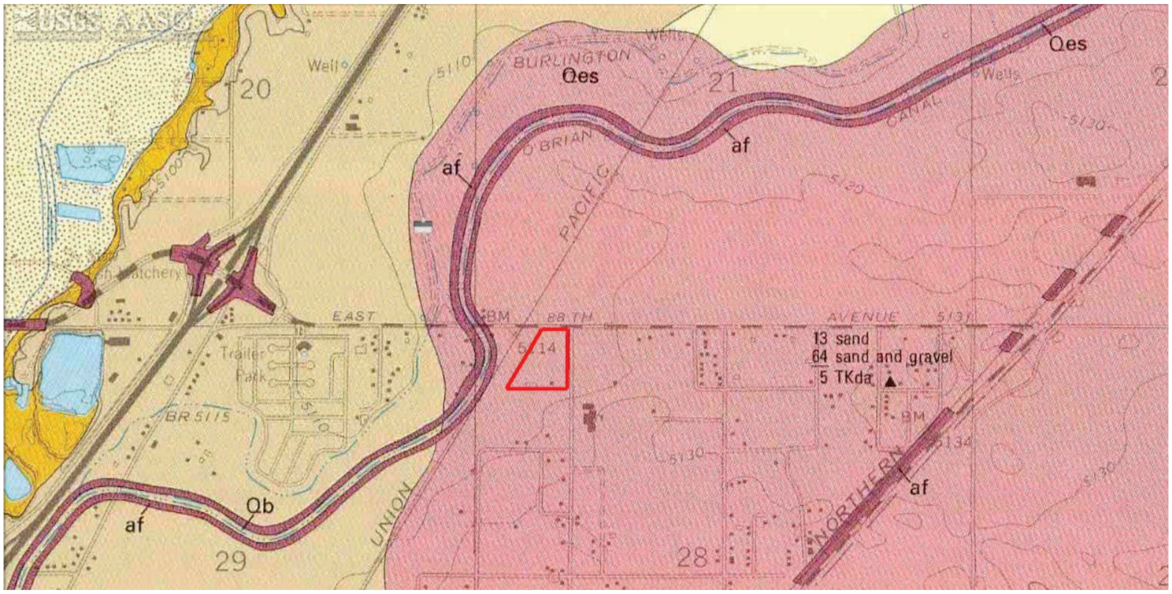


Photo 2 – Lindvall, R.M., 1980, Geologic Map of the Commerce City Quadrangle, Adams and Denver Counties, Colorado

Expansive Soils

Colorado is a challenging location to practice geotechnical engineering. The climate is relatively dry and the near-surface soils are typically dry and comparatively stiff. These soils and related sedimentary bedrock formations react to changes in moisture conditions. Some of the soils swell as they increase in moisture and are referred to as expansive soils. Other soils can compress significantly upon wetting and are identified as compressible soils. Much of the land available for development east of the Front Range is underlain by expansive clay or claystone bedrock near the surface. The soils that exhibit compressible behavior are more likely west of the Continental Divide; however, both types of soils occur throughout the state.

Covering the ground with buildings, pavements, flatwork, etc., coupled with landscape irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement due to heave or settlement is inevitable. Expansive soils are present at this site, which constitutes a geologic hazard. It is critical that precautions are taken to increase the chances that the foundations and slabs-on-grade will perform satisfactorily. Engineered design of grading, pavements, foundations, slabs-on-grade, and drainage can mitigate, but not eliminate, the effects of expansive and compressible soils. Sub-excavation is a ground improvement method that can be used to reduce the impacts of swelling and compressive soils, as discussed in the report.

Seismicity

According to the USGS, Colorado's Front Range and eastern plains are considered low seismic hazard zones. The earthquake hazard exhibits higher risk in western Colorado compared to other parts of the state. The Denver Metropolitan area has experienced earthquakes within the past 100 years, shown to be related to deep drilling, liquid injection, and oil/gas extraction. Naturally occurring earthquakes along faults due to tectonic shifts are rare in this area.

The soil and bedrock at this site are not expected to respond unusually to seismic activity. The 2021 International Building Code (Section 16.13.2.2) defers the estimation of Seismic Site Classification to ASCE7-22, a structural engineering publication. Updates from the previous versions of ASCE7 include (1) incorporation of additional Site Classifications BC, CD, and DE, (2) removal of tabulated blow-count and shear-strength correlations to shear wave velocity, and (3) requires the engineer to reduce shear wave velocity values by a factor of 1.3 when empirically estimated or not directly measured. The table below summarizes ASCE7-22 Site Classification Criteria.

ASCE7-22 SITE CLASSFICIATION CRITERIA

Seismic Site Class	$\bar{v}_s$, Calculated Using Measured or Estimated Shear Wave Velocity Profile (ft/s)
A. Hard Rock	>5,000
B. Medium Hard Rock	>3,000 to 5,000
BC. Soft Rock	>2,100 to 3,000
C. Very Dense Sand or Hard Clay	>1,450 to 2,100
CD. Dense Sand or Very Stiff Clay	>1,000 to 1,450
D. Medium Dense Sand or Stiff Clay	>700 to 1,000
DE. Loose Sand or Medium Stiff Clay	>500 to 700
E. Very Loose Sand or Soft Clay	≥500
F. Soils requiring Site Response Analysis	See Section 20.2.1

Based on the results of our investigation, the reduced, empirically estimated average shear wave velocity values for the upper 100 feet range between 629 and 1008 feet per second, with an average value of 863 feet per second. We judge the subsurface likely ranges between Seismic Site Classification CD and DE. The field penetration test results along with the empirical estimates imply that shear-wave velocity seismic tests to directly measure $\bar{v}_s$ could result in a better Seismic Site Classification. The subsurface conditions indicate low susceptibility to liquefaction from a materials and groundwater perspective.

Other Considerations

We observed no evidence of unstable slopes. Erosion potential on this site is considered to be low due to gentle slopes. Erosion can be expected to increase during construction but should return to preconstruction rates or less if proper grading practices, surface drainage design, and revegetation efforts are implemented. Construction sites within the Denver Metropolitan area are subject to U.S. Environmental Protection Agency (EPA) regulations regarding control of storm water discharge and soil erosion.

We did not identify significant economically recoverable, high quality aggregate in our borings. In most of the Denver area, oil and gas is present in deep formations, particularly shales that until recently were uneconomic for production.

ESTIMATED POTENTIAL HEAVE

Based on the subsurface profiles, swell consolidation test results and our experience, we calculated total potential heave at the existing ground surface for each test hole. The analysis involves dividing the soil profile into layers and modeling the heave of each layer from representative swell tests. We estimate about ½-inch to 8 inches of potential ground heave based on 20-feet depth of wetting below existing grade. Due to widely spaced borings, variations from our estimates should be anticipated. It is not certain these movements will occur.

ESTIMATED POTENTIAL GROUND HEAVE BASED ON 20- FEET DEPTH OF WETTING

Boring	Estimated Potential Heave at Existing Ground Surface (inches)
TH-1	3 ½
TH-2	8
TH-3	2 ½
TH-4	2 ½
TH-5	½

SITE DEVELOPMENT

The primary geotechnical concern that we believe will influence development on this site is the presence of expansive soils. This concern can be mitigated with proper planning, engineering, design and construction. We believe there are no geologic or geotechnical constraints at this site that would preclude development. The following sections provide discussion of site development recommendations. These recommendations should be reviewed once development/grading plans are developed.

Existing Fill and Demolition

Although existing fill was not encountered in our borings, it is likely present around the existing residence and outbuildings in the southeast corner of the site. Existing fill (where present) is considered to be unsuitable as-is to support structures on shallow foundations and should be completely removed and replaced as moisture-conditioned, compacted fill. The existing be reused if it is substantially free of organics, trash, and other deleterious materials. Utilities, structural elements, slabs, and other debris below proposed improvements should be removed and replaced with moisture-conditioned, compacted fill. Prior to obtaining a demolition permit, we recommend testing the existing structures for asbestos or other environmental hazards. Our firm can perform environmental services upon request. Environmental considerations can significantly impact the project cost and should be evaluated early in the planning process.

Excavation

We believe the soils penetrated by our exploratory borings can be excavated with typical heavy-duty equipment. We recommend the owner and the contractor become familiar with applicable local, state and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Based on our investigation and OSHA, we anticipate the clay will classify as Type B soil and the sand/gravel will classify as Type C soil, which require maximum side slope inclinations of 1:1 and 1½:1 (horizontal:vertical), respectively, for temporary excavations in dry conditions. Flatter slopes will likely be necessary where seepage is present (if any).

Excavation side slopes specified by OSHA are dependent upon soil types and groundwater or seepage conditions encountered. The contractor's "competent person" is required to identify the soils encountered in the excavations and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation. A professional engineer should design excavations deeper than 20 feet, if any.

Site Grading

The ground surface in areas to be filled should be stripped of debris, vegetation/organics and other deleterious materials, scarified and moisture conditioned to between 1 percent and 4 percent above optimum for clay or within 2 percent of optimum for sand, and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). If imported fill is necessary, potential fill materials should be submitted to our office for approval prior to importing to the site.

The properties of fill will affect the performance of foundations, slabs-on-grade, utilities, pavements, flatwork and other improvements. The on-site soils are suitable for use as new fill from a geotechnical standpoint provided they are substantially free of debris, vegetation/organics and other deleterious materials. Fill should be placed in thin loose lifts, moisture-conditioned and compacted prior to placement of the next lift. Clay fill should be moisture-conditioned between 1 and 4 percent above optimum moisture content and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). Sand fill should be moisture conditioned to within 2 percent of optimum moisture content and compacted similarly. The placement and compaction of new fill should be observed and density tested by our representative during construction.

Our experience indicates fill will settle under its own weight. We estimate potential settlement of about 1 to 2 percent of the fill thickness even if the fill is compacted to the specified criteria. Most of this settlement usually occurs during and soon after construction; for clayey fill, it may continue for a longer period of time.

Sub-Excavation

Our investigation indicates variably expansive clay and non-expansive clayey sand are present at depths likely to influence the performance of shallow foundations, slabs-on-grade, flatwork, and pavements. Sub-excavation is a ground improvement method that can be used to mitigate impacts of swelling soils, and reduce potential heave. To facilitate use of footing foundations, sub-excavation to 10 feet below foundation level will be necessary. Sub-excavation should also extend at least 5 feet laterally outside foundations. A conceptual sub-excavation profile is shown on Fig. 3. We judge potential movements should be reduced to about 1 to 2 inches. Sub-excavation of at least 3 feet should be considered below pavements and exterior flatwork to improve performance.

Sub-excavation has been used in the Denver area with satisfactory performance for most of the sites where this ground modification method has been completed. We have seen isolated instances where settlement of sub-excavation fill has led to damage to buildings supported on footings. In most cases, the settlement was caused by wetting associated with poor surface drainage or seepage, and/or poorly compacted fill placed at the horizontal limits of excavation. Wetting of the fill may cause softening and settlement.

The excavation contractor should be chosen carefully to assure they have experience with fill placement at over-optimum moisture and have the necessary compaction equipment. The contractor should provide a construction disc to break down fill materials and anticipate use of push-pull scraper operations and dozer assistance. The operation will be relatively slow. In order for the procedure to be performed properly, close contractor control of fill placement to specifications is required. Sub-excavation fill should be moisture-conditioned between 1 percent and 4 percent above optimum moisture content with an average test moisture content each day of at least 1 percent above optimum. Fill should be compacted as recommended in Site Grading.

Special precautions should be taken for compaction fill at corners, access ramps, and along the perimeters of the sub-excavation as large compaction equipment cannot easily reach these areas. Our representative should observe placement procedures and test compaction of the fill on a nearly full-time basis. The swell of moisture-conditioned fill should be tested during fill placement.

Slopes

We recommend permanent cut and fill slopes be designed with a maximum grade of 3:1 (horizontal to vertical). If site constraints (property boundaries and streets) do not permit construction with recommended slopes, we should be contacted. Surface drainage should not be allowed to sheet flow across slopes or pond near the crest of slopes. All cut and fill slopes should be re-vegetated as soon as possible after grading to reduce potential for erosion problems.

Utilities

Water and sewer lines are usually constructed beneath pavements. Compaction of trench backfill can have a significant effect on the life and serviceability of pavements. Trench backfill should be placed in thin (8 inches or less) loose lifts and moisture-conditioned and compacted as discussed in Site Grading. The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction. For utility installation, our experience indicates use of a self-propelled compactor results in more reliable performance compared to backfill “compacted” by a sheepsfoot wheel attachment on a backhoe or trackhoe. The upper portion of the trenches should be widened to allow the use of a self-propelled compactor. Special attention should be paid to backfill placed adjacent to valves and penetrations in the pavements as we have seen instances where settlement in excess of 2 percent has occurred.

Pavements

The soil properties of the pavement subgrade will affect pavement thickness design and expansive subgrade mitigation. Subgrade will likely consist of primarily expansive native clay, or fill derived thereof. Clay soils are considered to possess relatively poor pavement support characteristics. Expansive soil mitigation beyond moisture-conditioning and compaction may be needed. Sub-excavation of at least 3 feet below pavements should be planned. Additional measures may be needed to supplement subgrade sub-excavation. Placement of extra base course is one alternative. Use of chemical stabilization is another. Commerce City’s minimum sections are presented in the table below. An additional 1 to 2 inches of asphalt and/or base should be planned and budgeted for above City minimums due to the expansive, clayey composition of the subgrade. A pavement design should be performed during the design-level investigation.

CITY OF COMMERCE CITY MINIMUM PAVEMENT SECTIONS

Roadway Classification	Full Depth Asphalt (inches)	Asphalt + Base (inches)	Portland Cement Concrete (inches)
Parking Lots	5.0	3.0 + 6.0	4.5
Local Streets, Alleys and Private Streets	6.0	Allowed*	5.5
Minor Collectors (Residential)	6.5	Allowed*	6.0
Minor Collectors (Commercial)	7.0	Allowed*	6.5
Major Collectors	7.0	Allowed*	6.5
Minor Arterials	7.5	Allowed*	7.0
Major Arterials	8.0	Allowed*	7.5

*Per approved pavement design report

BUILDING CONSTRUCTION CONSIDERATIONS

The following discussions are preliminary and are not intended for design or construction. The discussions are based on widely-spaced borings. Proposed grading may affect our recommendations. A design-level investigation should be performed once plans are more developed.

Foundations

Our investigation indicates expansive clay and non-expansive clayey sand are present at depths likely to influence performance of shallow foundations. We anticipate light to moderate foundation loads for the building. Shallow foundations such as footings will likely be suitable provided sub-excavation is performed to a depth of 10 feet below foundation level. Additional borings will be necessary to provide foundation design parameters.

Floor Construction and Slabs-On-Grade

The use of conventional slab-on-grade floors should be limited to areas where risk of potential movement is tolerable. We judge potential slab movement of about 2 inches or less after sub-excavation is performed as discussed previously. The performance of pavements, side-walks, and other surface flatwork installed outside sub-excavated areas will likely be erratic at this site. Shallower excavation of 3 to 5 feet can be considered in these areas to enhance per-formance.

The following precautions will be required to reduce the potential for damage due to movement of slabs-on-grade placed at this site:

1. Isolation of the slabs from foundation walls, columns or other slab penetrations;
2. Voiding of interior partition walls to allow for slab movement without transferring movement to the structure;
3. Use of flexible water and gas connections to allow for slab movement; and
4. Proper surface grading and drainage practices to reduce water availability to sub-slab and foundation soils.

Structurally supported floors should be used where movement and damage cannot be tolerated, or where sensitive finishes are planned. Design and construction issues associated with structural floors include ventilation and lateral loads.

Concrete

Concrete in contact with soils can be subject to sulfate attack. We measured a water-soluble sulfate concentration of 0.05 percent in one sample from this site. Sulfate concentrations less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to the American Concrete Institute (ACI) Guide To Durable Concrete (ACI 201.2R-01). For this level of sulfate concentration, ACI indicates any type of cement can be used for concrete in contact with the subsoils. Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist. Concrete should have a total air content of 6 percent ±1.5 percent. All below-grade walls in contact with the sub-soils should be damp-proofed. Additional testing should be performed during the design-level investigation.

Surface Drainage

The performance of foundations, floors, pavements, and other improvements will be influenced by surface drainage. It will be necessary to design and construct surface grades, landscaping, and roof drains to avoid excessive wetting near foundations. Pavement grading and drainage should also be planned to remove water efficiently and avoid excessive wetting of subgrade soils

RECOMMENDED FUTURE INVESTIGATIONS

We recommend the following investigations and services:

1. Design-level investigation for the building;
2. Construction testing and observation during site development, and building and pavement construction; including compaction testing of grading fill, utility trench backfill and pavements; and
3. Foundation installation observations.

CONSTRUCTION OBSERVATIONS

This report has been prepared for the exclusive use of Evergreen Devco, Inc. and your team to provide geotechnical design and construction criteria for development planning. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structure proposed, the geologic setting, and the subsurface conditions encountered.

We recommend that CTL | Thompson, Inc. provide construction observation services to allow us the opportunity to verify whether soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation, primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the development will perform satisfactorily. It is critical that all recommendations in this and future reports are followed during construction.

LIMITATIONS

Our exploratory borings were widely-spaced to provide a general picture of subsurface conditions for due diligence assessment and preliminary planning of development. Variations in the subsoil conditions not indicated by our borings are likely. We believe this investigation was conducted in a manner consistent with the level of care and skill ordinarily used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

If we can be of further service in discussing either the contents of this report or the analysis of the influence of subsurface conditions on the project, please call.

CTL | THOMPSON, INC.

Javier Avitia-Herrera, E.I.T.
Staff Engineer

Reviewed by:

COLORADO LICENSED PROFESSIONAL ENGINEER CHRISTOPHER L. FITZSIMMONS 0059336

Chris Fitzsimmons, P.E.
Project Manager

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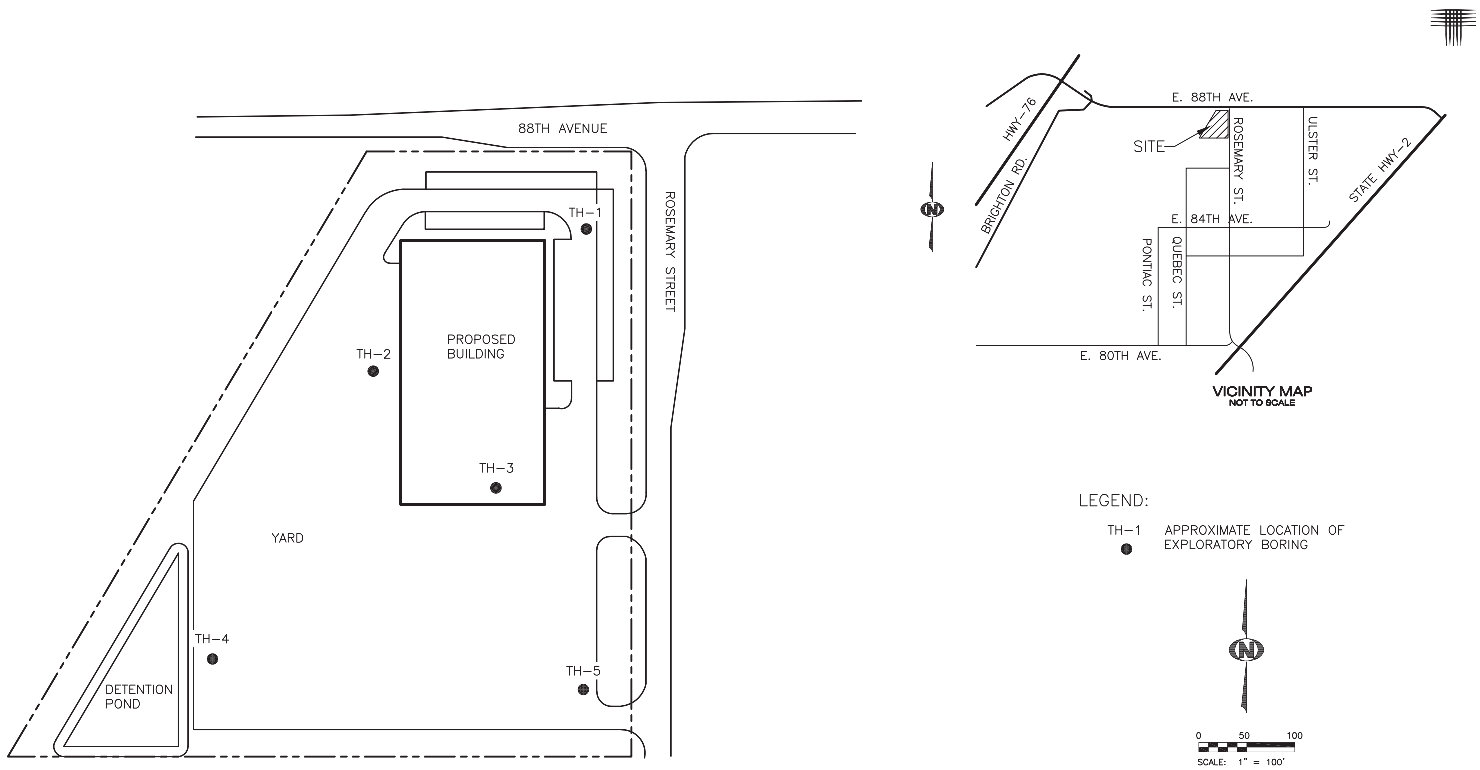
Jun 9 2022 10:43 AM

Shawn Fitzhugh, P.E.
Chief Operating Officer

Via e-mail: jclifton@evgre.com



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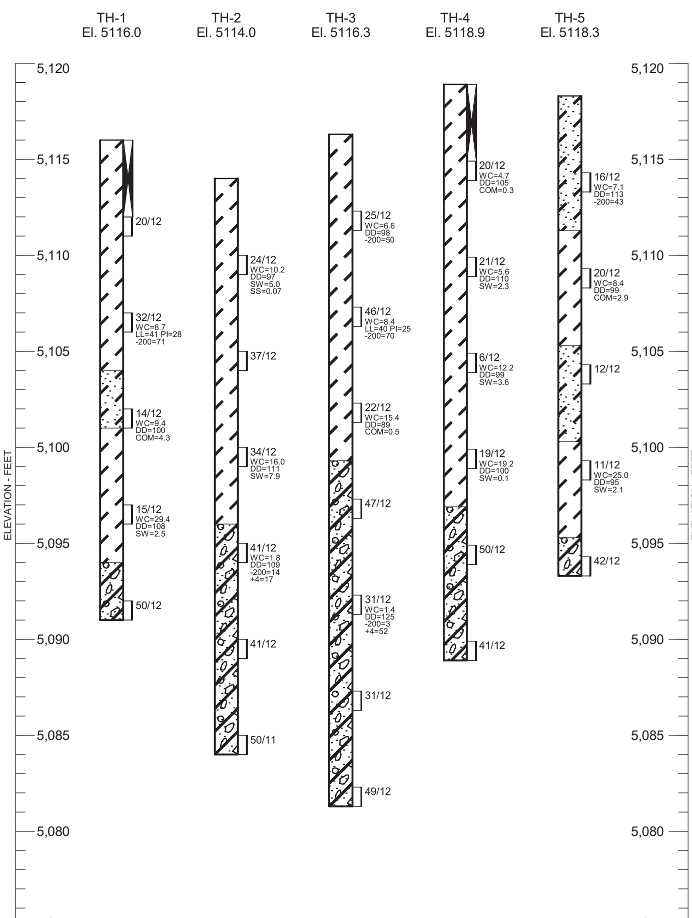
CTL|T Project No. DN51,543-115-R1

Locations of Exploratory Borings

Fig. 1



SUMMARY LOGS OF EXPLORATORY BORINGS

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LEGEND:

CLAY, SANDY TO VERY SANDY, MEDIUM STIFF TO VERY STIFF, SLIGHTLY MOIST, BROWN, WHITE, TAN, GRAY, RUST (CL).

SAND, CLAYEY, MEDIUM DENSE, SLIGHTLY MOIST, BROWN, TAN (SC).

SAND AND GRAVEL, CLEAN TO SILTY, MEDIUM DENSE TO VERY DENSE, SLIGHTLY MOIST, BROWN, TAN, GRAY, WHITE (GP, GP-GM, SP, SP-SM).

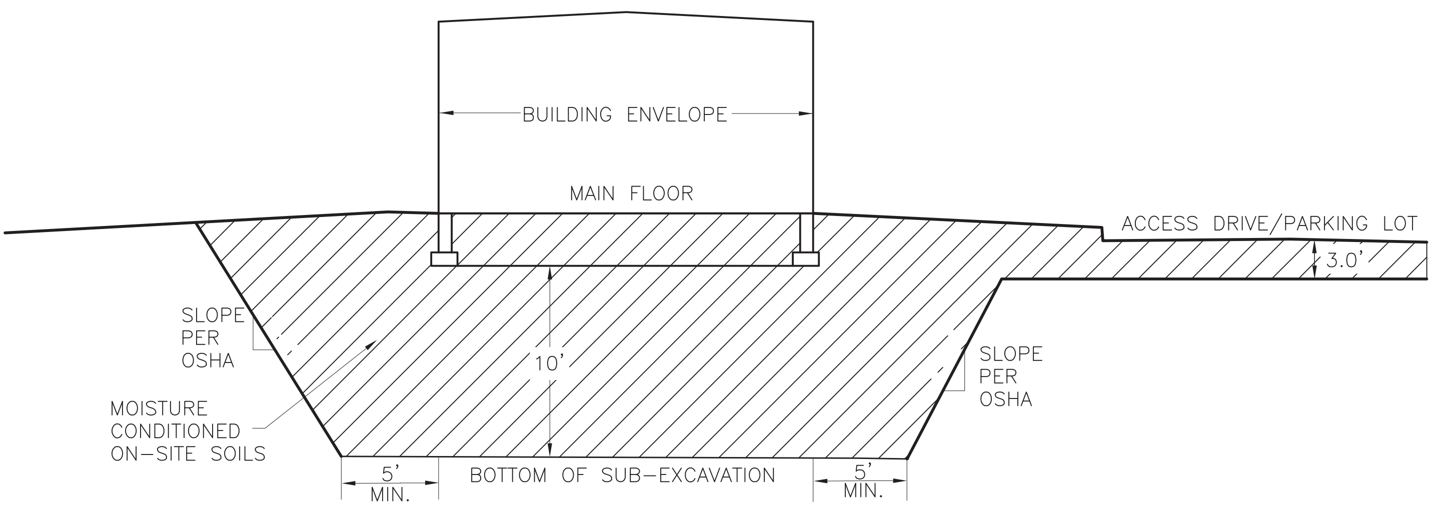
DRIVE SAMPLE. THE SYMBOL 20/12 INDICATES 20 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

BULK SAMPLE COLLECTED FROM AUGER CUTTINGS.

NOTES:

1. THE BORINGS WERE DRILLED ON APRIL 29, 2022 USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND TRUCK-MOUNTED CME-45 DRILL RIG.
2. BORING LOCATIONS AND ELEVATIONS ARE APPROXIMATE AND WERE DETERMINED BY A REPRESENTATIVE OF OUR FIRM USING A LEICA GS18 GPS UNIT REFERENCING THE NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. GROUNDWATER WAS NOT ENCOUNTERED DURING THIS INVESTIGATION.
4. WC - INDICATES MOISTURE CONTENT (%).
   DD - INDICATES DRY DENSITY (PCF).
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).
   COM - INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).
   LL - INDICATES LIQUID LIMIT.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).
5. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

FIG. 2



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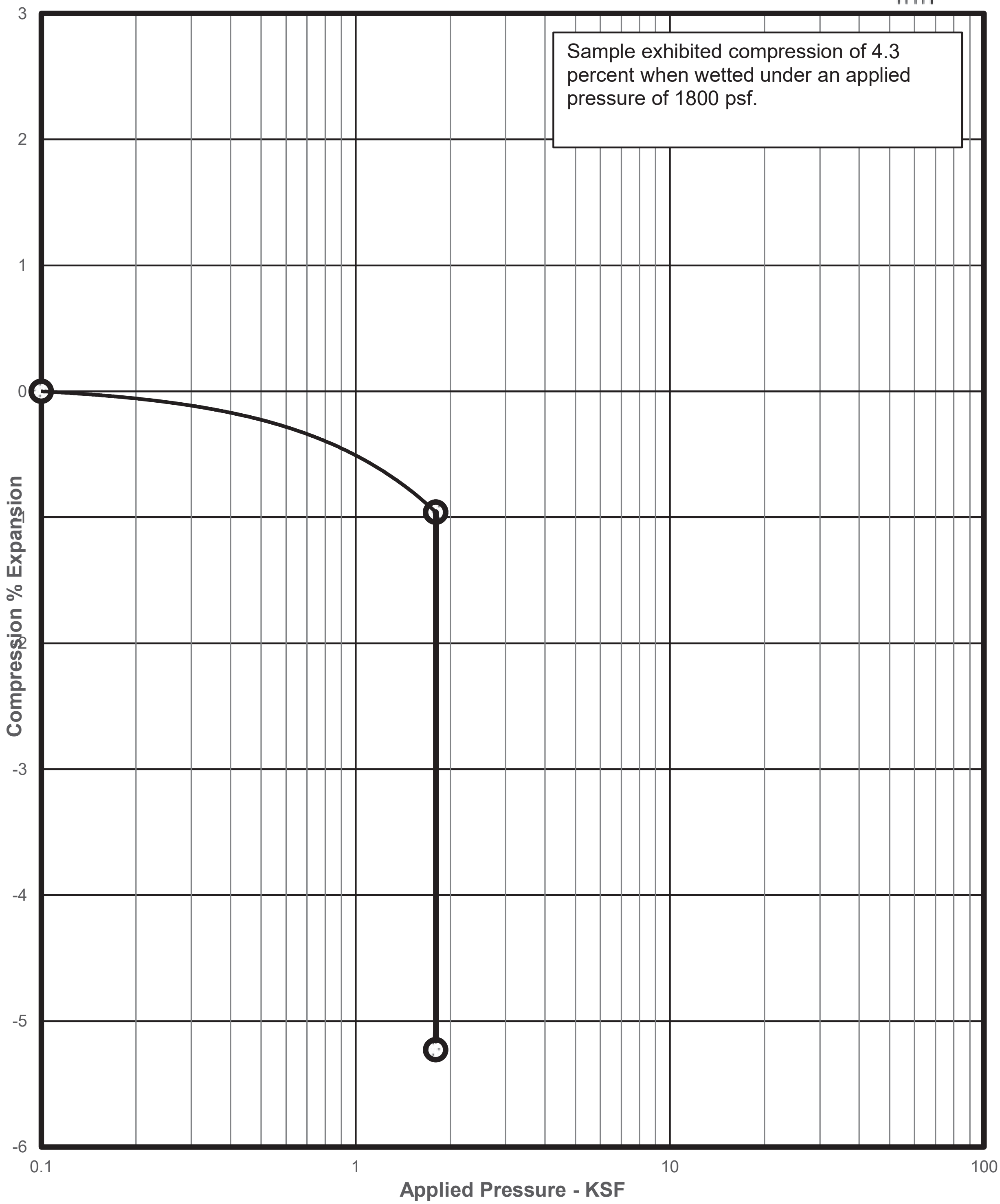
Conceptual Sub-Excavation Profile

Fig. 3

APPENDIX A

LABORATORY TEST RESULTS AND TABLE A-I



SAMPLE OF:	SAND, CLAYEY (SC)	DRY UNIT WEIGHT:	100	pcf
FROM:	TH-1 AT 14 FEET	MOISTURE CONTENT:	9.4	%

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INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET

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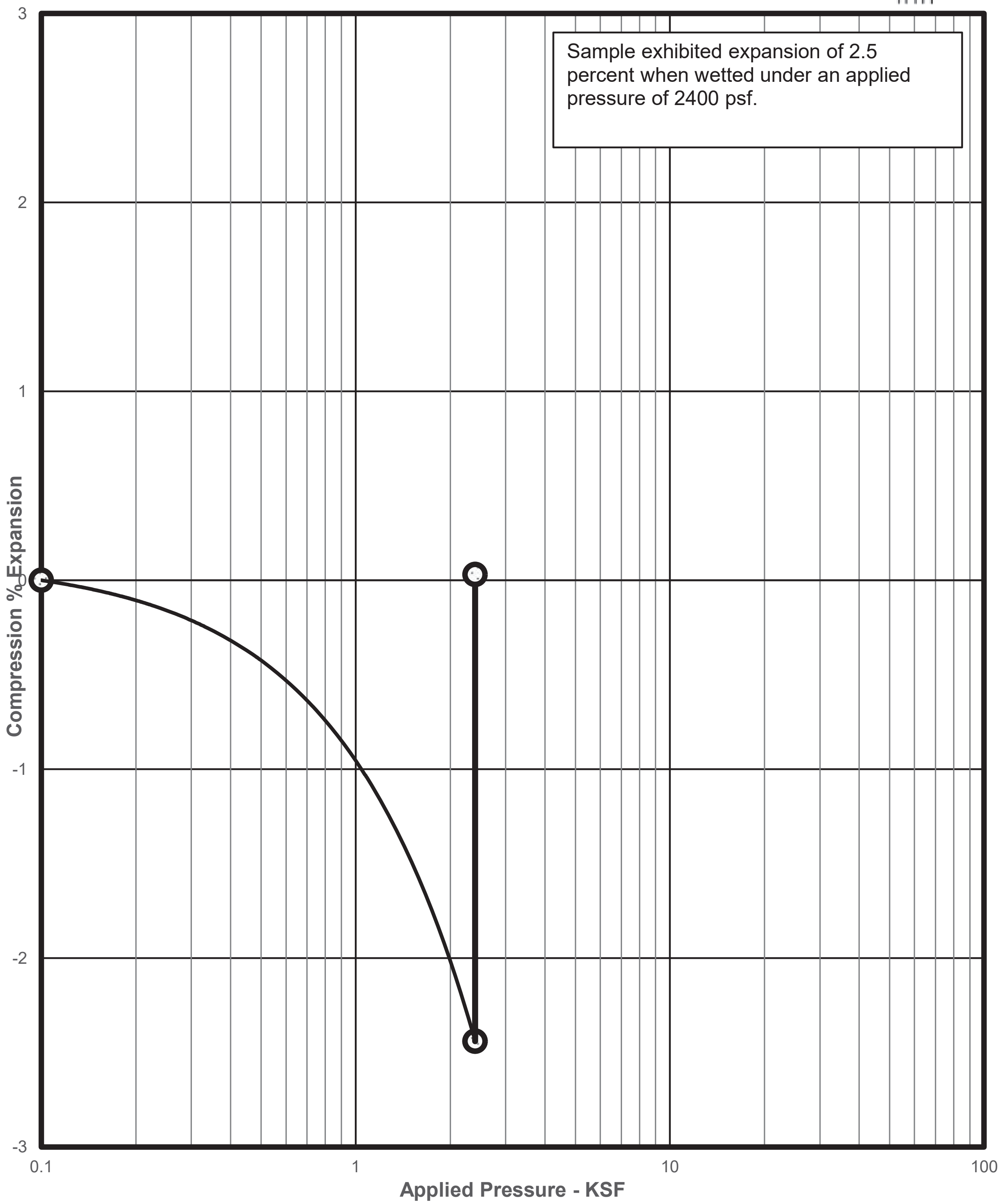
Swell Consolidation Test Results FIG. A- 1



SAMPLE OF:	CLAY, SANDY (CL)	DRY UNIT WEIGHT:	108	pcf
FROM:	TH-1 AT 19 FEET	MOISTURE CONTENT:	29.4	%

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INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET

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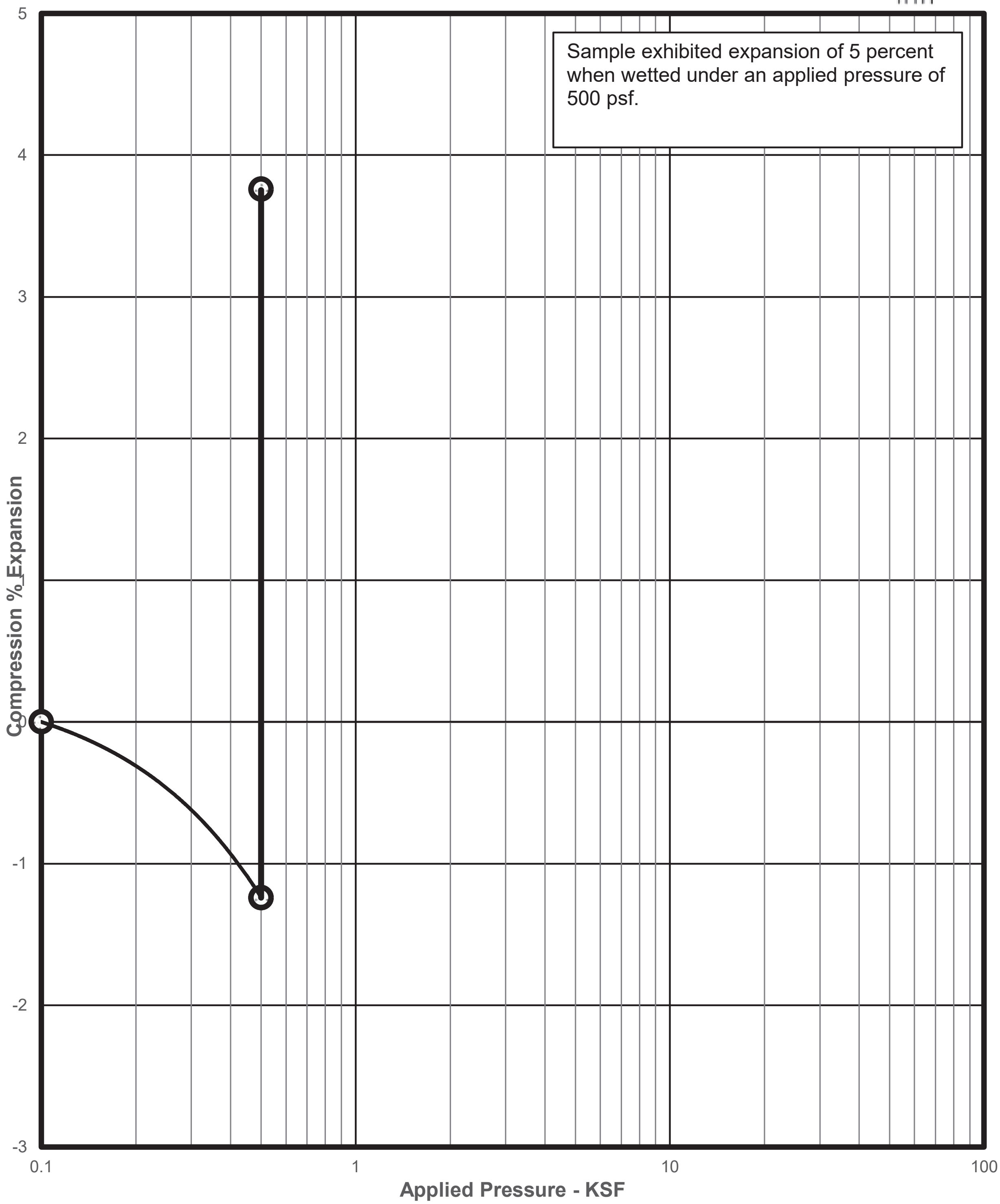
Swell Consolidation Test Results FIG. A- 2



SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-2 AT 4 FEET

DRY UNIT WEIGHT: 97 pcf
MOISTURE CONTENT: 10.2 %

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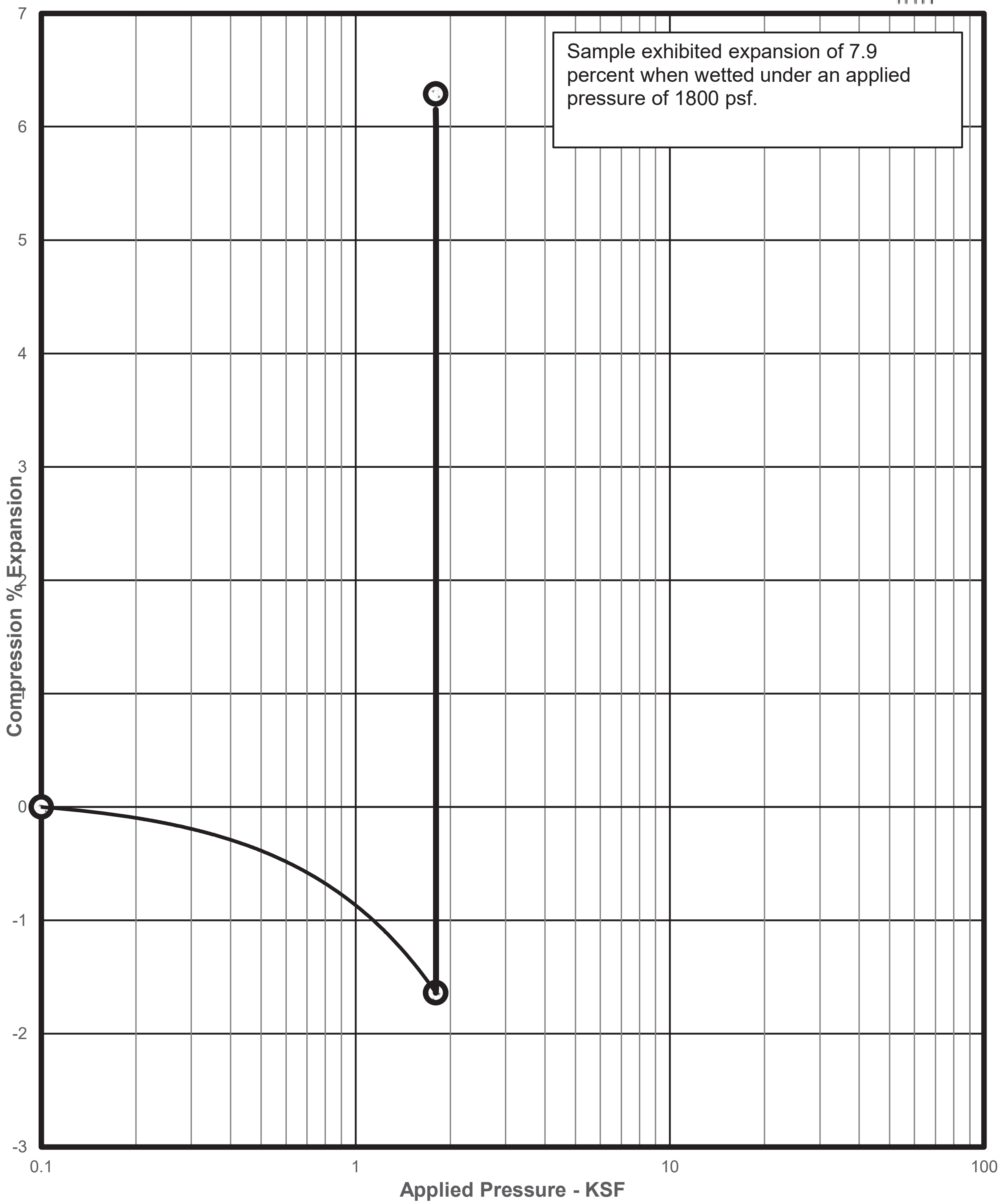
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 3

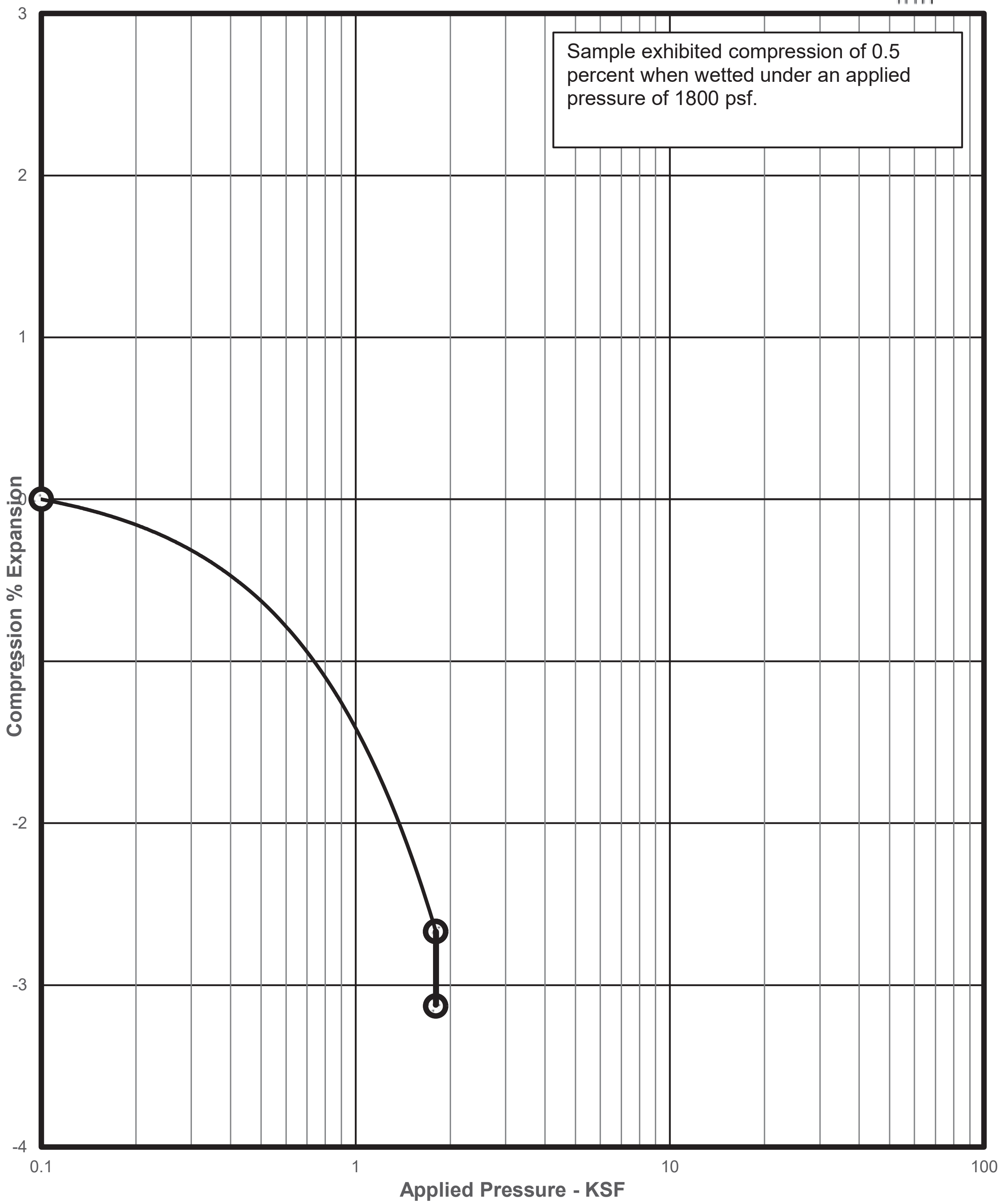


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-2 AT 14 FEET

DRY UNIT WEIGHT: 111 pcf
MOISTURE CONTENT: 16.0 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 4

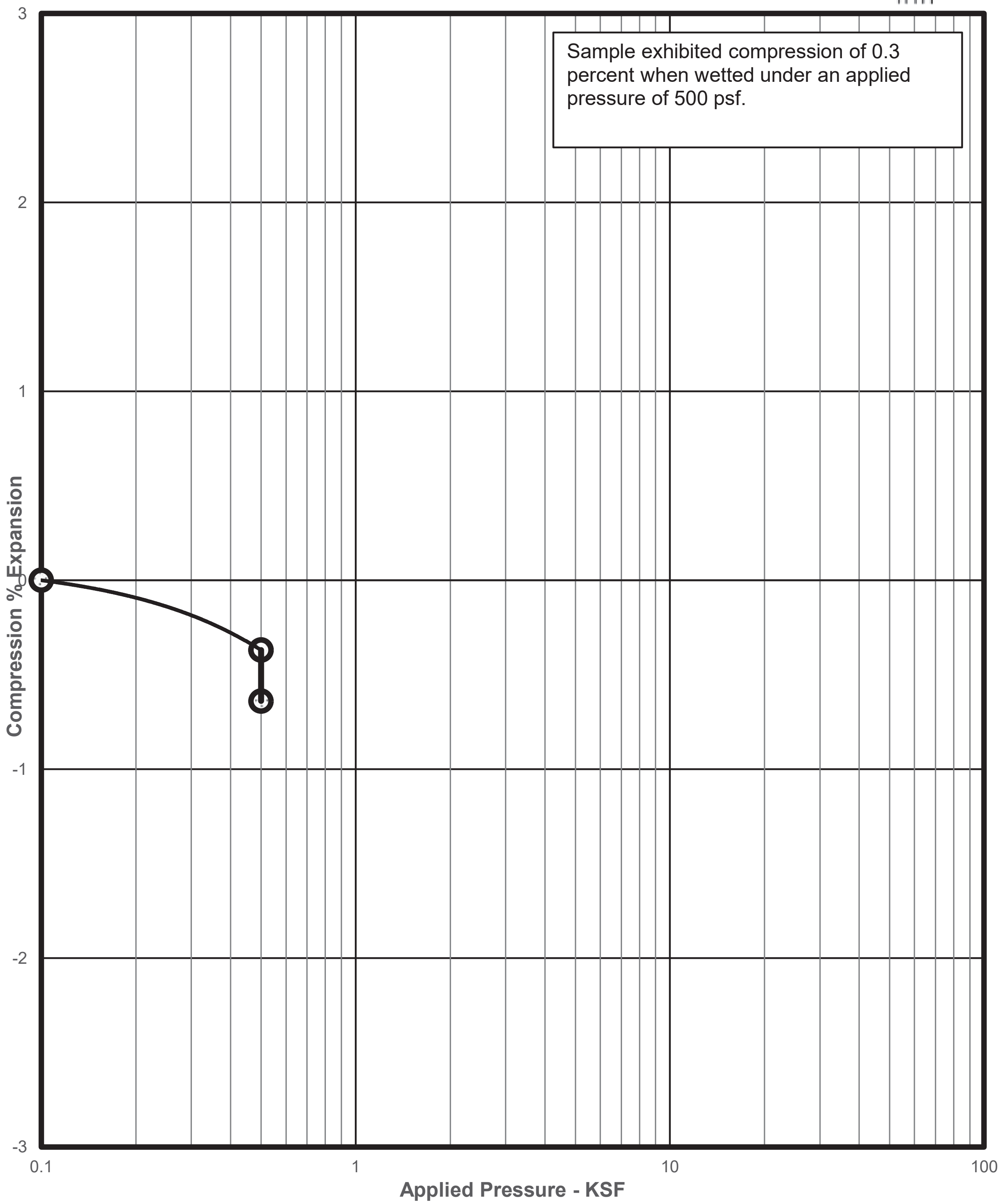


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-3 AT 14 FEET

DRY UNIT WEIGHT: 89 pcf
MOISTURE CONTENT: 15.4 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 5

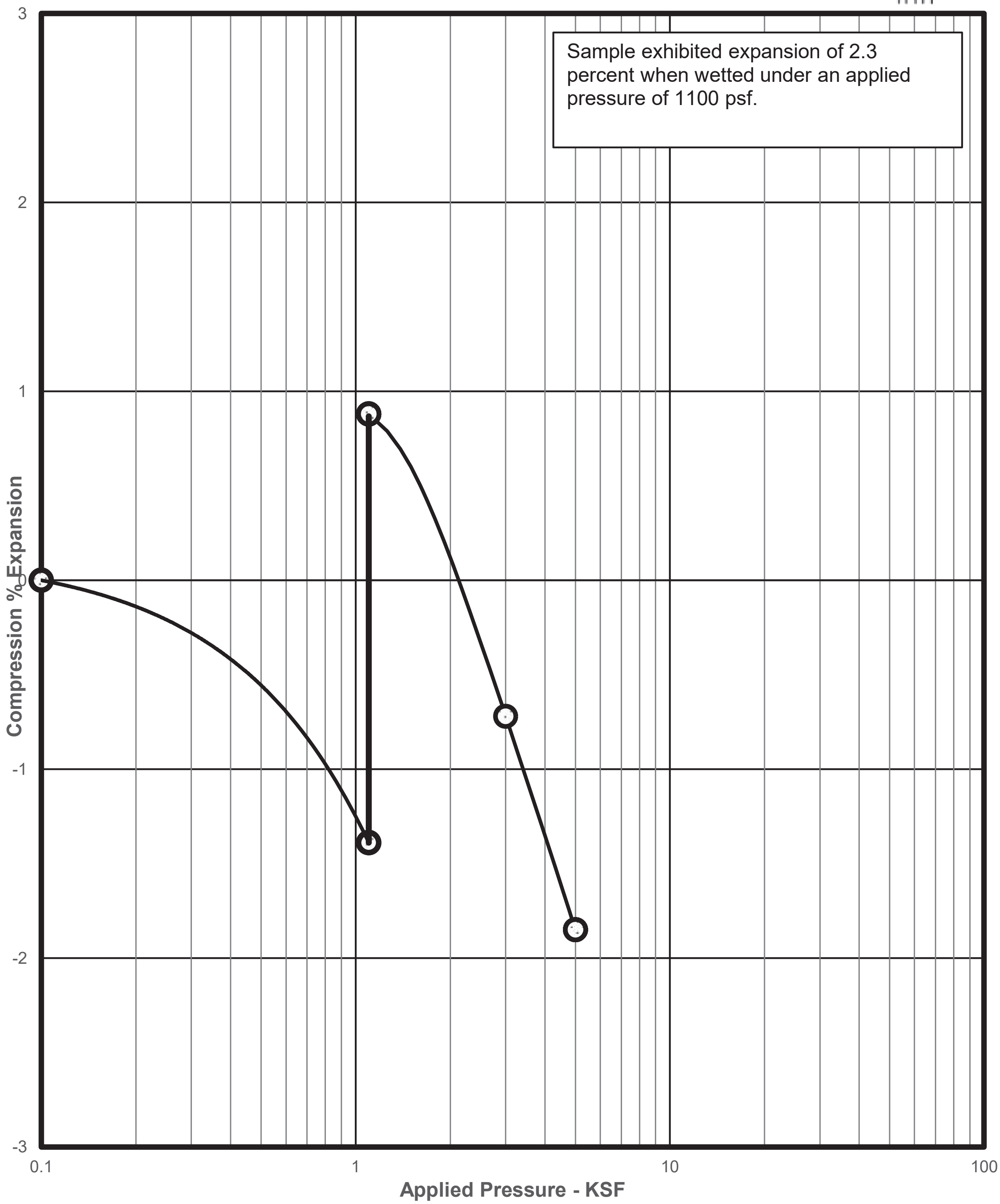


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-4 AT 4 FEET

DRY UNIT WEIGHT: 105 pcf
MOISTURE CONTENT: 4.7 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 6

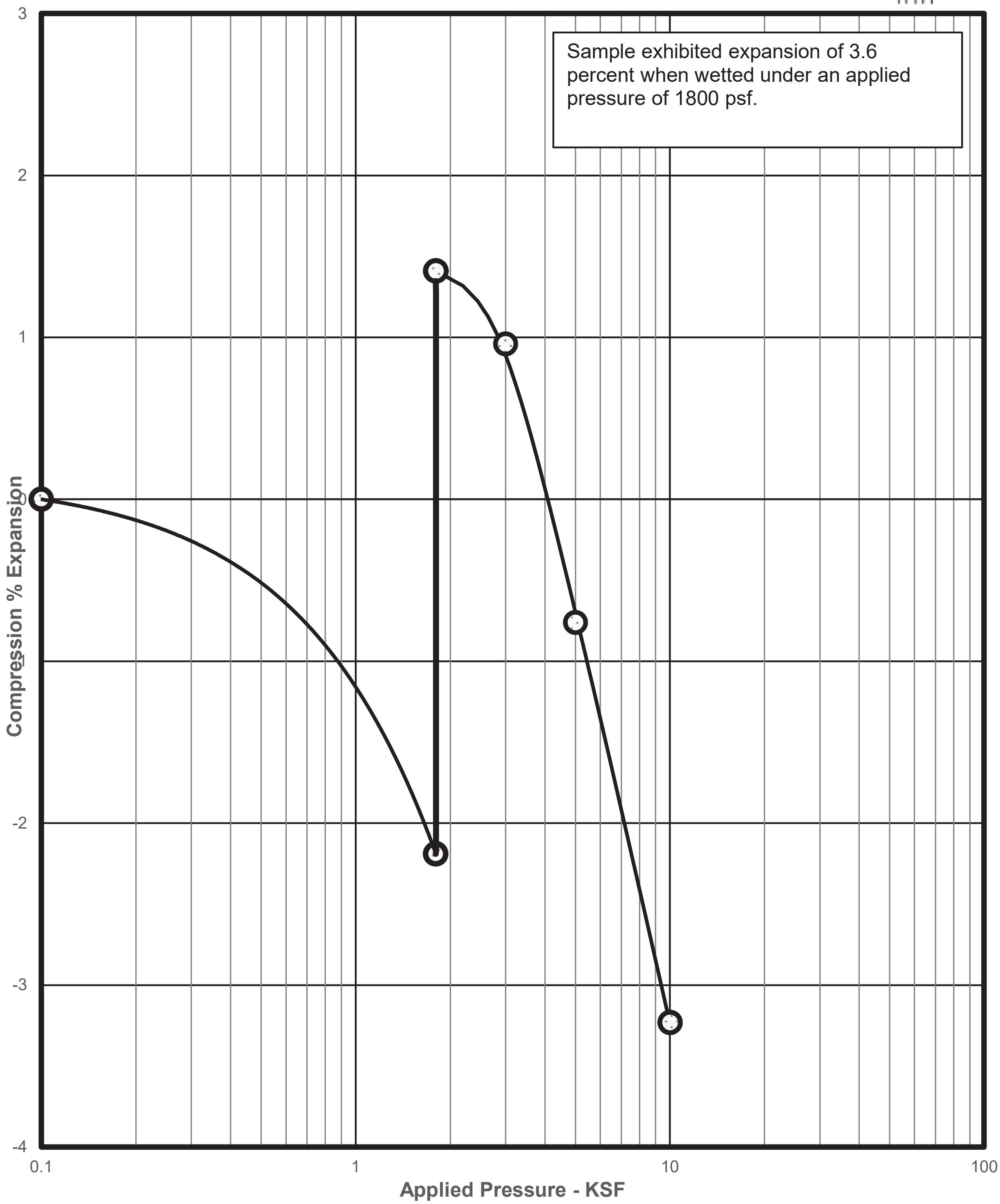


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-4 AT 9 FEET

DRY UNIT WEIGHT: 110 pcf
MOISTURE CONTENT: 5.6 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 7

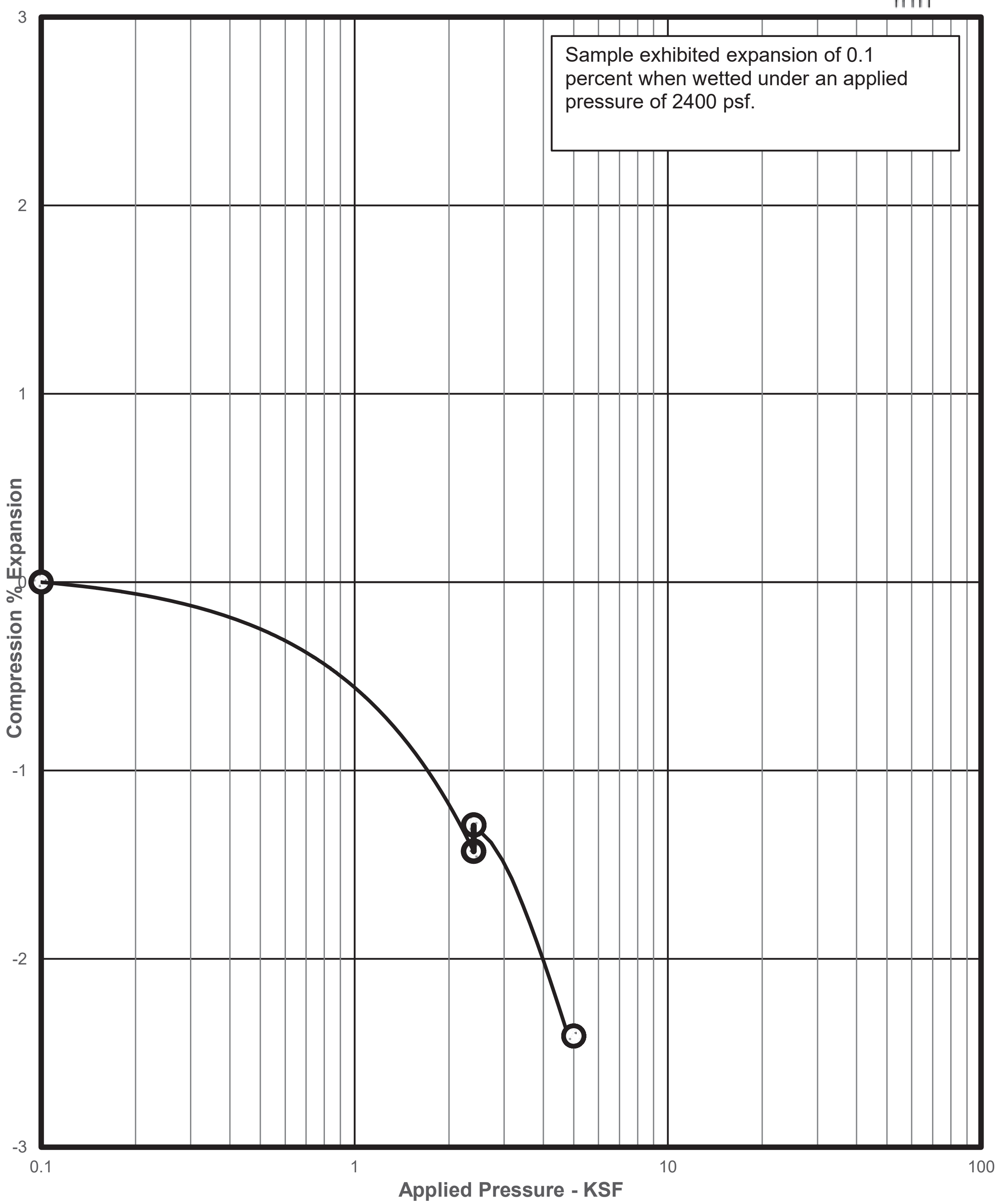


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-4 AT 14 FEET

DRY UNIT WEIGHT: 99 pcf
MOISTURE CONTENT: 12.2 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 8

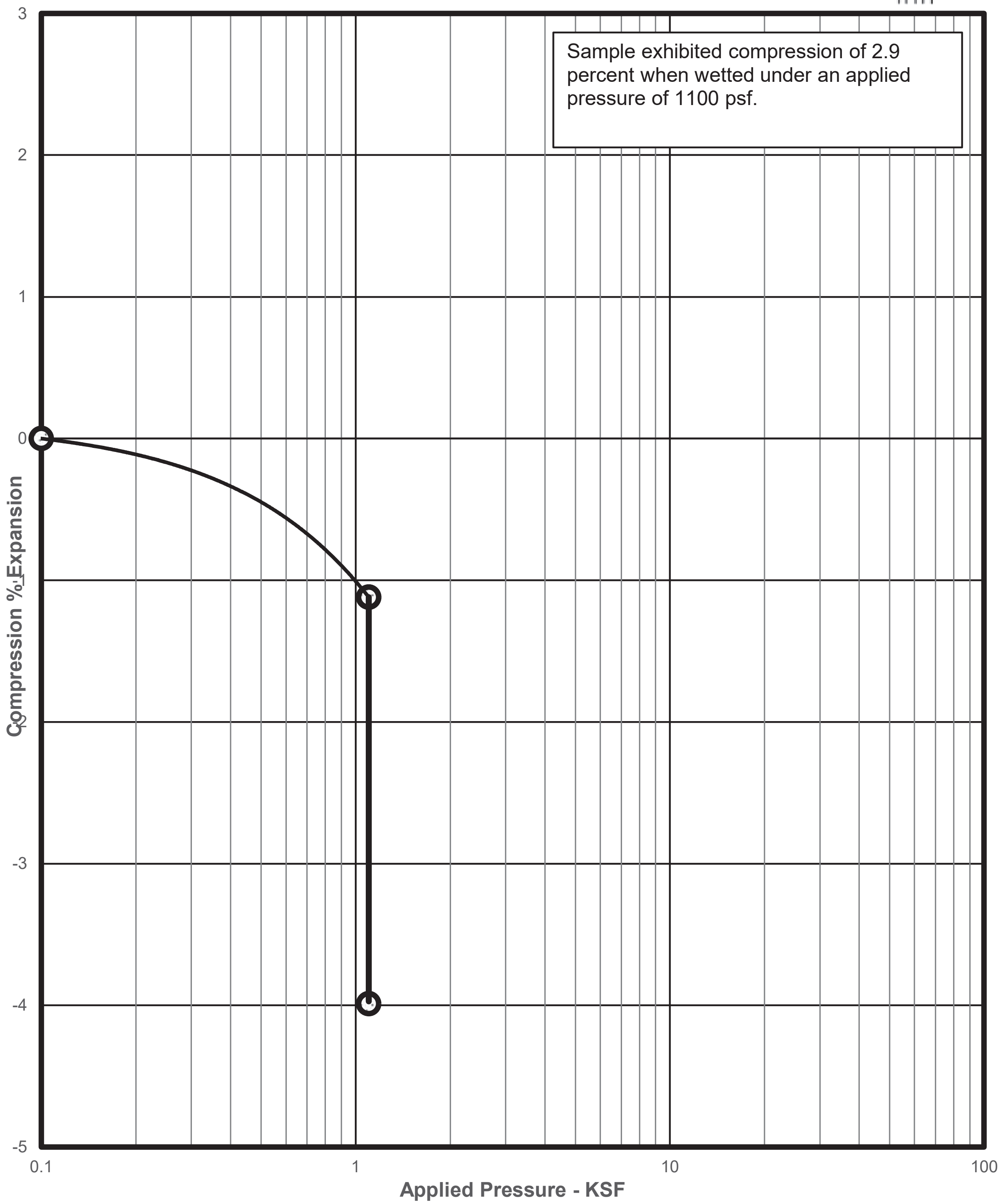


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-4 AT 19 FEET

DRY UNIT WEIGHT: 100 pcf
MOISTURE CONTENT: 19.2 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 9



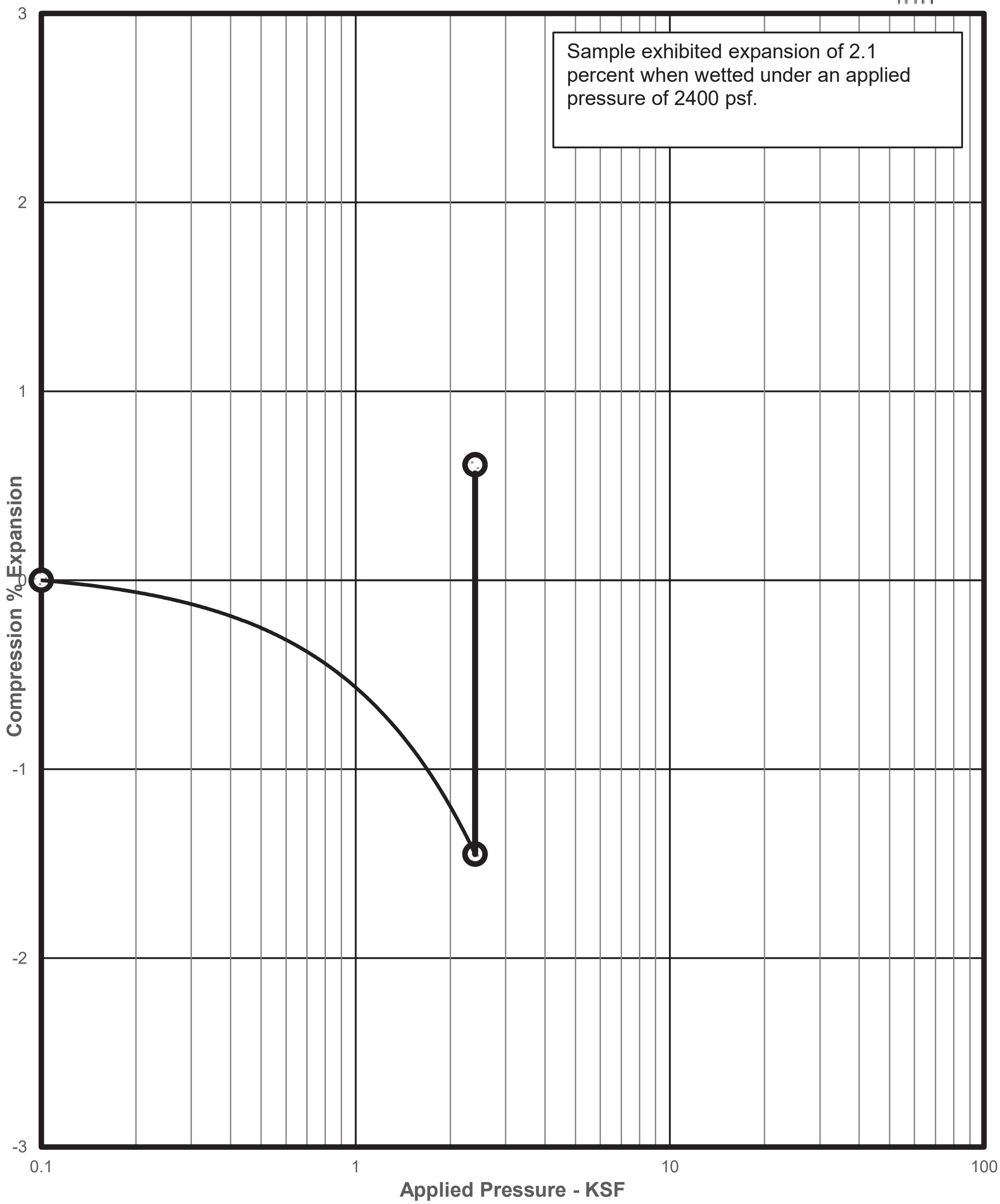
SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-5 AT 9 FEET

DRY UNIT WEIGHT: 99 pcf
MOISTURE CONTENT: 8.4 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results

FIG. A- 10

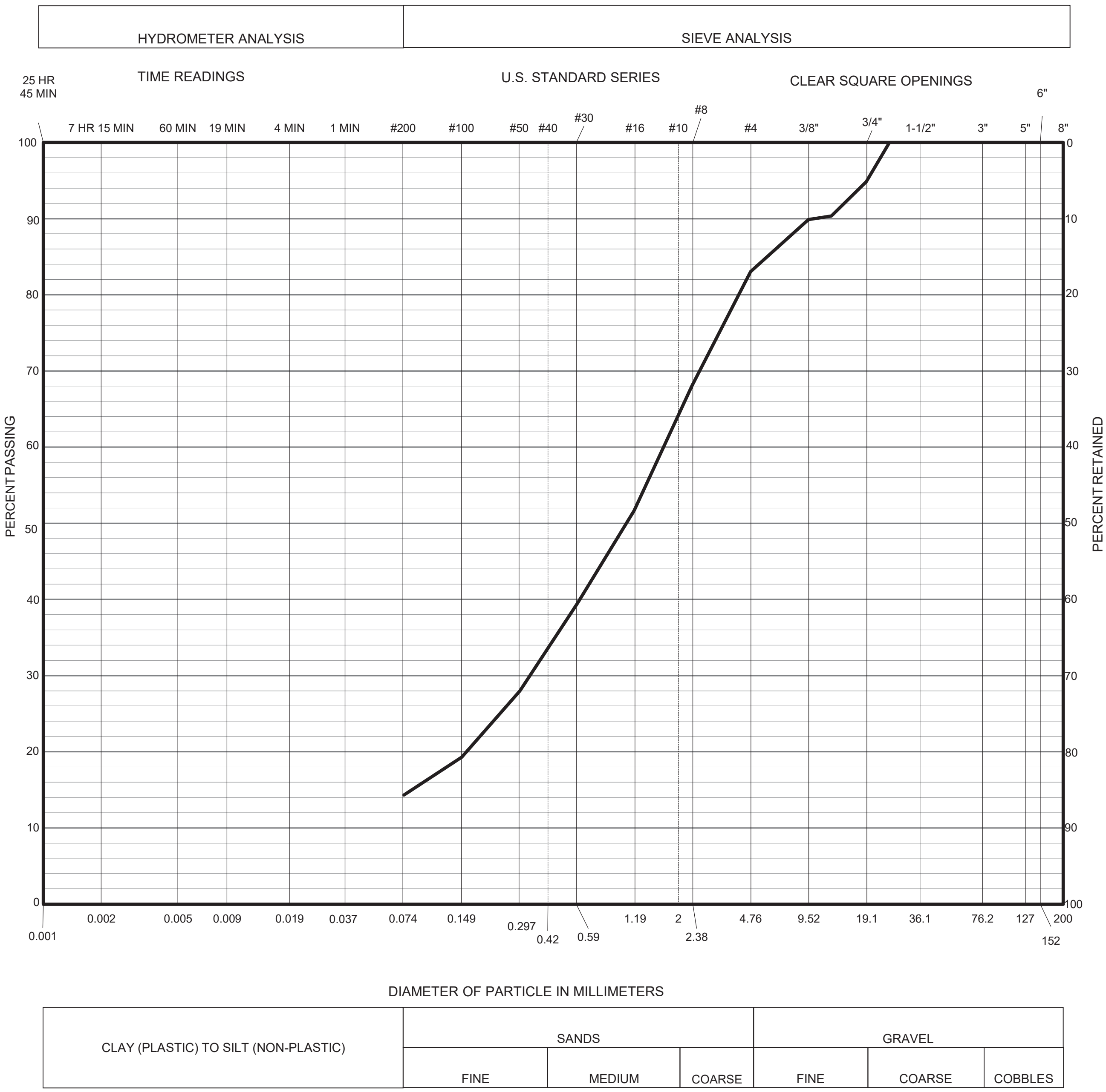


SAMPLE OF: CLAY, SANDY (CL)
FROM: TH-5 AT 19 FEET

DRY UNIT WEIGHT: 95 pcf
MOISTURE CONTENT: 25.0 %

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Swell Consolidation Test Results FIG. A- 11



SAMPLE OF: GRAVEL, SILTY (GW)

FROM: TH-2 AT 19 FEET

GRAVEL: 17.0%

SAND: 68.7%

SILT & CLAY: 14.4%

LIQUID LIMIT: -

PLASTIC INDEX: -

D10 -- D30 0.352 D60: 1.781 CU: -- CC: --

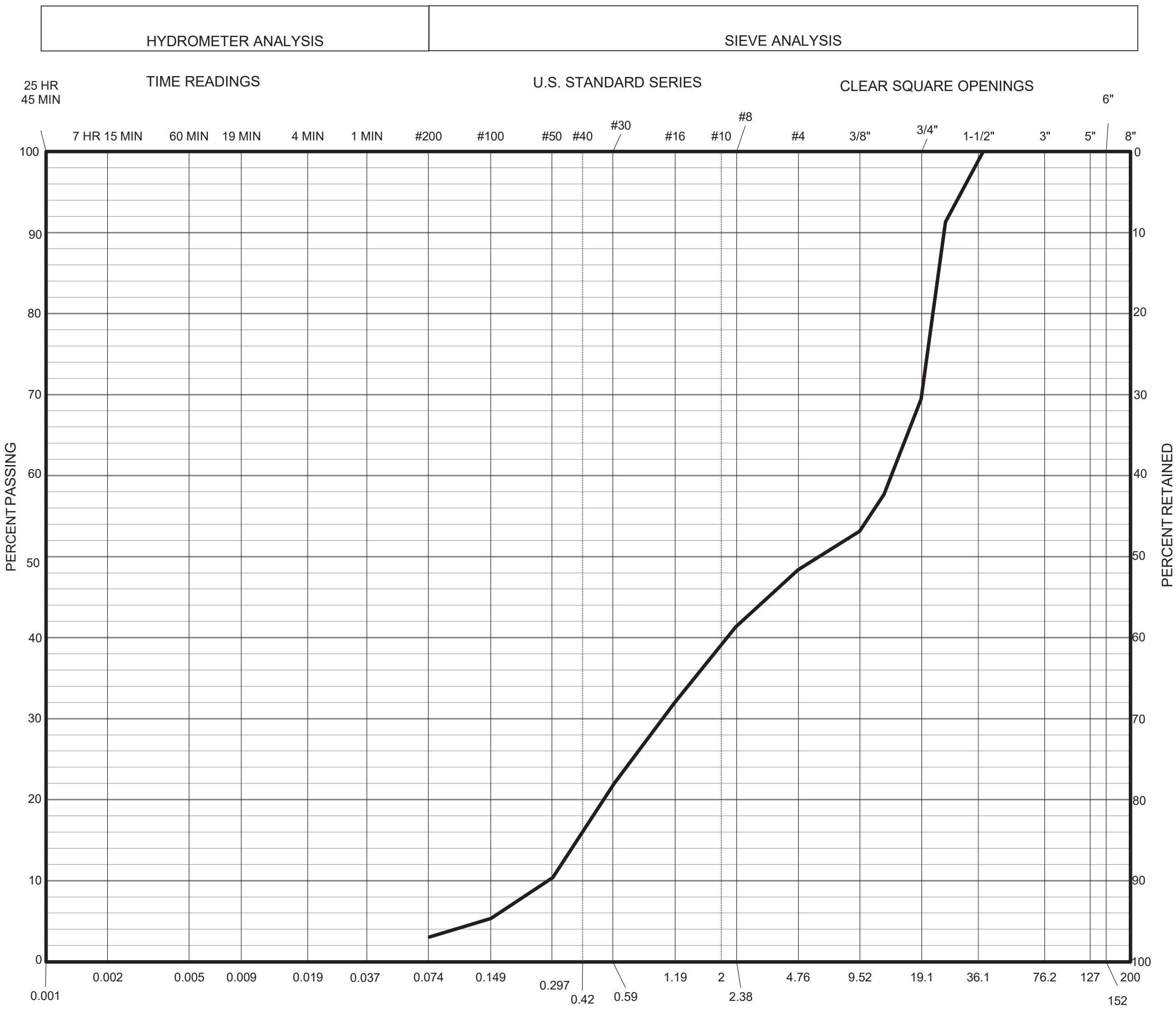
Size (mm)	-	-	25.0	19.0	12.5	9.5	4.8	2.4	1.2	0.6	0.3	0.2	0.1	-	-	-	-	-	-
% Passing	-	-	100.0	94.9	90.3	89.9	83.0	68.0	51.7	39.5	28.0	19.3	14.4	-	-	-	-	-	-

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Gradation Test Results

FIG. A- 12

-



DIAMETER OF PARTICLE IN MILLIMETERS

CLAY (PLASTIC) TO SILT (NON-PLASTIC)	SANDS			GRAVEL		
	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLES

SAMPLE OF: GRAVEL, SILTY (GW)
FROM: TH-3 AT 24 FEET

GRAVEL: 51.6%
SILT & CLAY: 3.1%
PLASTIC INDEX: -

SAND: 45.3%
LIQUID LIMIT: -

D1(0.289 D30 1.067 D60: 13.777 CU: 47.7 CC: 0.3

Size (mm)	-	38.1	25.0	19.0	12.5	9.5	4.8	2.4	1.2	0.6	0.3	0.2	0.1	-	-	-	-	-	-
% Passing	-	####	91.3	69.4	57.7	53.2	48.4	41.3	31.9	22.0	10.4	5.4	3.1	-	-	-	-	-	-

EVERGREEN DEVCO, INC.
INDUSTRIAL PARCEL - 88TH AVENUE AND ROSEMARY STREET
CTL|T PROJECT NO. DN51,543-115-R1

Gradation Test Results

FIG. A- 13

TABLE A - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA: SWELL (%)	SWELL TEST DATA: COMPRESSION (%)	SWELL TEST DATA: APPLIED PRESSURE (psf)	SWELL TEST DATA: SWELL PRESSURE (psf)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	SOLUBLE SULFATE CONTENT (%)	RETAINED NO. 4 SIEVE (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
TH-1	9	8.7						41	28			71	CLAY, SANDY (CL)
TH-1	14	9.4	100		4.3	1,800							SAND, CLAYEY (SC)
TH-1	19	29.4	108	2.5		2,400							CLAY, SANDY (CL)
TH-2	4	10.2	97	5.0		500				0.07			CLAY, SANDY (CL)
TH-2	14	16.0	111	7.9		1,800							CLAY, SANDY (CL)
TH-2	19	1.8	109								17	14	GRAVEL, SILTY (GW)
TH-3	4	6.6	98									50	CLAY, SANDY (CL)
TH-3	9	8.4						40	25			70	CLAY, SANDY (CL)
TH-3	14	15.4	89		0.5	1,800							CLAY, SANDY (CL)
TH-3	24	1.4	125								52	3	GRAVEL, SILTY (GW)
TH-4	4	4.7	105		0.3	500							CLAY, SANDY (CL)
TH-4	9	5.6	110	2.3		1,100	4,000						CLAY, SANDY (CL)
TH-4	14	12.2	99	3.6		1,800	7,600						CLAY, SANDY (CL)
TH-4	19	19.2	100	0.1		2,400	2,700						CLAY, SANDY (CL)
TH-5	4	7.1	113									43	SAND, CLAYEY (SC)
TH-5	9	8.4	99		2.9	1,100							CLAY, SANDY (CL)
TH-5	19	25.0	95	2.1		2,400							CLAY, SANDY (CL)

APPENDIX H – EXCERPTS FROM PREVIOUS DRAINAGE PLANS

IRONDALE NEIGHBORHOOD & INFRASTRUCTURE PLAN

Commerce CITY

Snapshot Report: Drainage

Waterways and waterbodies

The Irondale neighborhood is located near the downstream end of the Irondale Gulch Watershed. This watershed encompasses 23.4 square miles (14,979 acres) in total, compared to 556 acres for the Irondale neighborhood. The watershed begins upstream in the City of Aurora, near I-70, where it drains northwesterly through the City of Denver, Rocky Mountain Arsenal National Wildlife Refuge (RMANWR), and Commerce City before ultimately discharging into the South Platte River near 88th Avenue.

The Snapshot Report

The snapshot report is designed to provide an overview of the current conditions within the neighborhood. The snapshot is not exhaustive, but rather a foundation to engage in conversation about the existing and future plans to be developed.

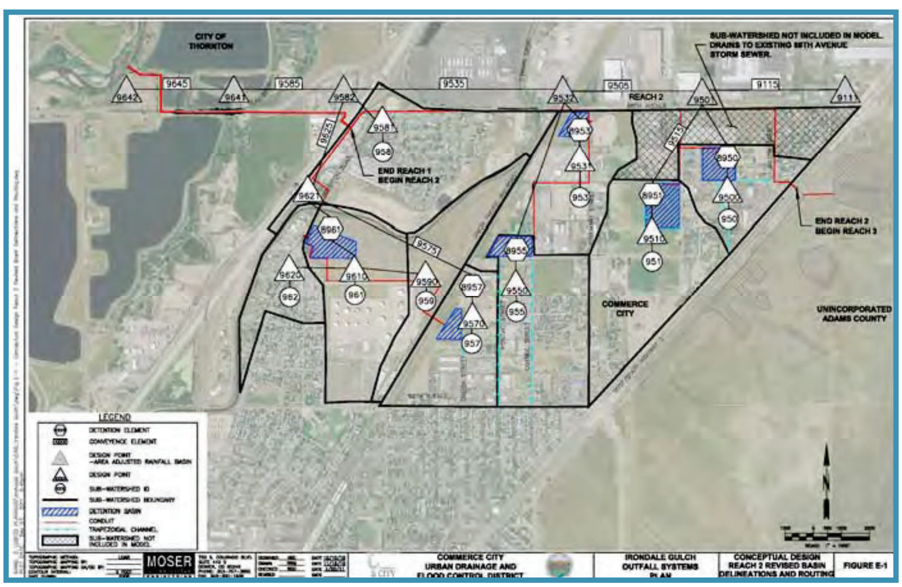
Drainage from the upper watershed comes from three different tributaries – named Irondale Gulch, Tributary A, and Tributary B. These flows cross northwesterly into Irondale by crossing over State Highway 2 and ponding behind the BNSF Railroad embankment. If a storm event is large enough, these flows could overtop the railroad tracks and flood into the Irondale neighborhood.

Between Irondale and the South Platte River, the overall flow pattern is northwest towards 88th Avenue and the Union Pacific Railroad crossing, then directly west towards the river. In general, there are no defined flow paths here; flows from upstream and runoff generated in the Irondale area move toward the river as shallow flooding and sheet flow. In the current condition, these flows are prevented from reaching the South Platte by the UPRR embankment, the O'Brian Canal, and Interstate 76.

Existing Network

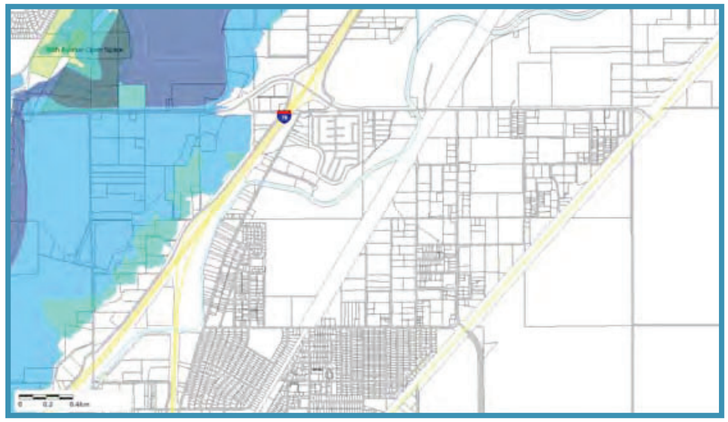
The 2011 Irondale Gulch Outfall Systems Plan by Moser & Associates Engineering (Irondale OSP) explained that "the main flood hazard in the study area is the absence of conveyance in Commerce City west of State Highway 2." There are no culverts under major roadways or railroads with significant embankments and there are no storm water detention or retention facilities within Commerce City. Additionally, the upper watershed and Irondale neighborhood area do not have a formal or informal outfall to the South Platte River.

Below: UDFCD Conceptual Design Drainage Infrastructure



There is an existing 48-inch drainage pipe on the north side of 88th Avenue and an existing 18-inch drainage pipe along Ulster Street. However, this storm system empties into a retention basin at the northeast corner of 88th Avenue and the UPRR and does not have a direct connection to the river. This retention basin has a capacity of 15.3 acre-feet.

Floodplains



Above map image from Adams County GIS interactive flood-plain viewer available at: https://gisapp.adcogov.org/Html5Viewer/index.html?viewer=FEMA.FEMA

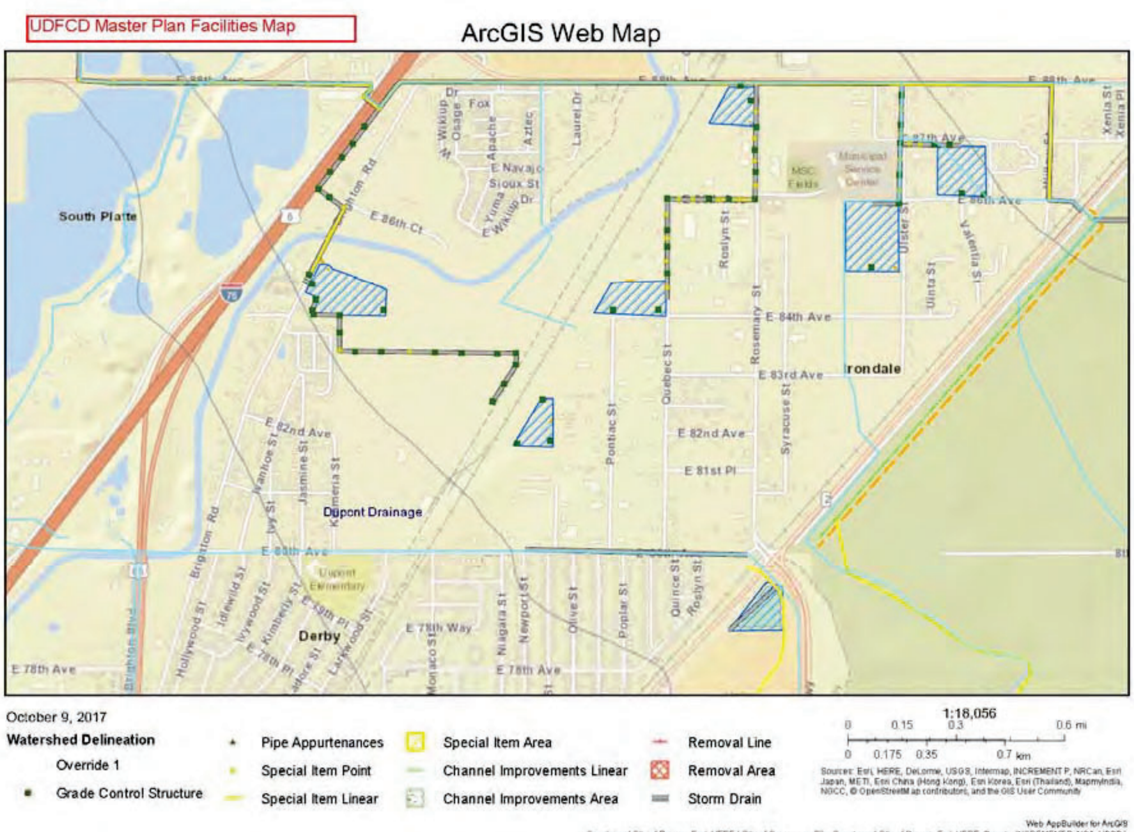
The Irondale neighborhood is not located inside of a FEMA designated regulatory Special Flood Hazard Area (SFHA) or a Flood Hazard Area Delineation (FHAD) by Denver UDFCD. The Irondale area can be found on four (4) FEMA Flood Insurance Rate Map (FIRM) panels 08001C 0606H - 0609H.

Planned Upgrades & Extensions

The 2011 Irondale OSP and Conceptual Design Report evaluated existing and proposed drainage conditions throughout the Irondale Gulch watershed – of which the Irondale neighborhood is a smaller portion closer to the outlet of the watershed, through which the upstream flows would naturally pass to reach the South Platte River.

The OSP divided the watershed into three geographic groups of similar nature:

1) The area from I-76 to the South Platte River (Reach 1);
2) The area from SH 2 to I-76, including the Irondale neighborhood (Reach 2); and
3) The upper portions of the watershed east of SH 2, including the Rocky Mountain Arsenal National Wildlife Refuge (RMA).



For each of the three geographic areas, the OSP evaluated 8 categories of alternatives – or different combinations of detention and conveyance. This resulted in a selected plan, with conceptual design, for a 100-year conveyance system to reconnect the watershed with the South Platte River. Since there is no existing outfall path to the South Platte River, and since the lower areas of the watershed are mostly developed, the OSP selected plan relied heavily on detention/ retention in the Rocky Mountain Arsenal (RMA) to lower peak flow rates and the size of the needed downstream conveyance system. However, even with significant amounts of detention, the selected plan proposed a large diameter concrete pipe/ concrete box culvert outfall system for approximately 1,200-feet along 88th Avenue, beginning just west of SH2 and proceeding west to the South Platte River.

Details of the OSP Selected and Conceptual Improvement Plans are summarized in the following list:

Reach 1 – South Platte River to I-76 at 88th Avenue:
- Three (3) 48-inch reinforced concrete pipes (RCP) jacked under I-76;
- One (1) 10'x3' reinforced concrete box culvert (approximately 4,600 feet);
- Grading required along 88th Avenue, near the Bull Seep, to raise the roadway;
- OSP Conceptual Design Improvement Cost of $9.1 million (2011).

(Commerce City, City of Thornton and Unincorporated Adams County)

Reach 2 – 88th Avenue between I-76 and State Highway 2 (Including Irondale neighborhood):
- 76- x 48-inch HERCP jacked under the O'Brian Canal
- 60-inch RCP jacked under the UPRR
- 60-inch RCP along Willow Street, 88th Avenue, Brighton Road and I-76 ROW;
- 60-inch RCP jacked under SH 2 and the BNSF to convey flows from the RMA;
- Six (6) Regional Detention/ Retention Basins (5 inside of Irondale neighborhood);
- Engineered channels and smaller drainage pipes along minor roadways to convey runoff to the detention basins;
- OSP Conceptual Design Improvement Cost of $31.9 million (2011).

(Commerce City and Unincorporated Adams County)

Reach 3 – State Highway 2 between 88th Avenue and 80th Avenue:
- An engineered channel along the east side of SH2 to convey 100-year storm runoff to a proposed crossing under SH 2 and the BNSF Railroad.
- OSP Conceptual Design Improvement Cost of $620,000 (2011).

(Rocky Mountain Arsenal and Unincorporated Adams County)

Reach 4/ Tributary A/ Tributary B:
- Irondale Gulch – Reach 4: Construct Detention Basin 209 ("Railroad Detention");
- Tributary A - formally recognizing the five (5) natural depressions as regional retention basins for flood control and constructing Detention Basin 8911;
- Tributary B - formally recognizing the two (2) natural depressions as regional retention basins for flood control and constructing one spillway from a natural depression;
- OSP Conceptual Design Improvement Cost of $5.1 million (2011).

(Rocky Mountain Arsenal and Unincorporated Adams County)

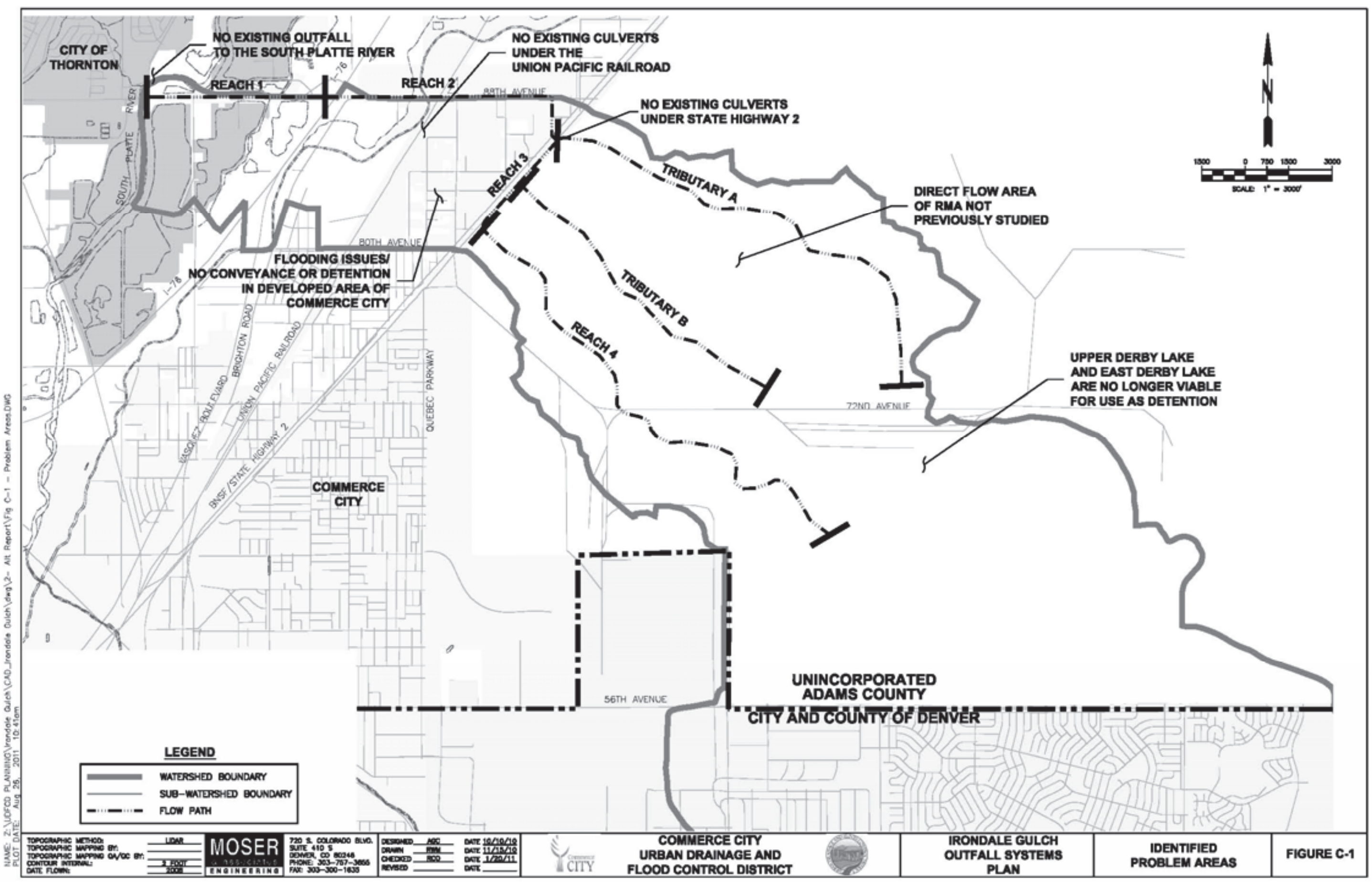
To reduce flows in major and minor storm events, the OSP report says that all future detention basins should incorporate "full spectrum detention" as requested by the Urban Drainage and Flood Control District (UDFCD).

Previous & Related Plans

In 2011 Commerce City and the Denver Urban Drainage and Flood Control District (UDFCD) completed a hydrology and master plan study for the Irondale watershed. This jointly funded study was entitled Irondale Gulch Outfall Systems Plan (OSP) and was performed by Moser & Associates Engineering. This study reviewed the hydrology and drainage patterns of the watershed and proposed solutions to improve existing drainage problems.

Special Considerations

The OSP report recommends that the selected plan improvements may be constructed in two phases, Phase 1: Detention and Phase 2: Outfall System. These phases may overlap with each other, but the biggest impact to minimizing flooding would be to construct the detention and retention basins in Reach 4, Tributary A, and Tributary B first. Then followed by the six (6) full spectrum detention ponds in Reach 2, of which five (5) are within the Irondale neighborhood. The OSP report also explains that the Reach 2 ponds (Irondale) may be constructed as retention ponds as areas redevelop and later converted to detention ponds when the 88th Avenue outfall system is built.



[The information presented and summarized here was obtained from the 2011 Irondale Gulch Outfall Systems Plan Conceptual Design Report by Moser & Associates Engineering. Referred to as the 2011 Irondale OSP]

Perspectives

The comments heard from public meetings reflect differing concerns and opinions about the future of the neighborhood. These comments are illustrative of the four main perspectives and comments regarding Irondale.

Business

On-site Detention is working for some businesses in the neighborhood. Smaller lots are hard to develop because the area needed for detention can be considerable and leave little for the desired use.

Resident

- Runoff drains to the back of properties and ponds there.
- Low spots along streets created ponding and traffic problems
- Property flooding occurs frequently, creating access problems
- Some residents saw benefit in a regional detention approach and were supportive of the idea. Others saw it as a negative impact to their property value.
- Local drainage issues persist throughout the neighborhood

Official

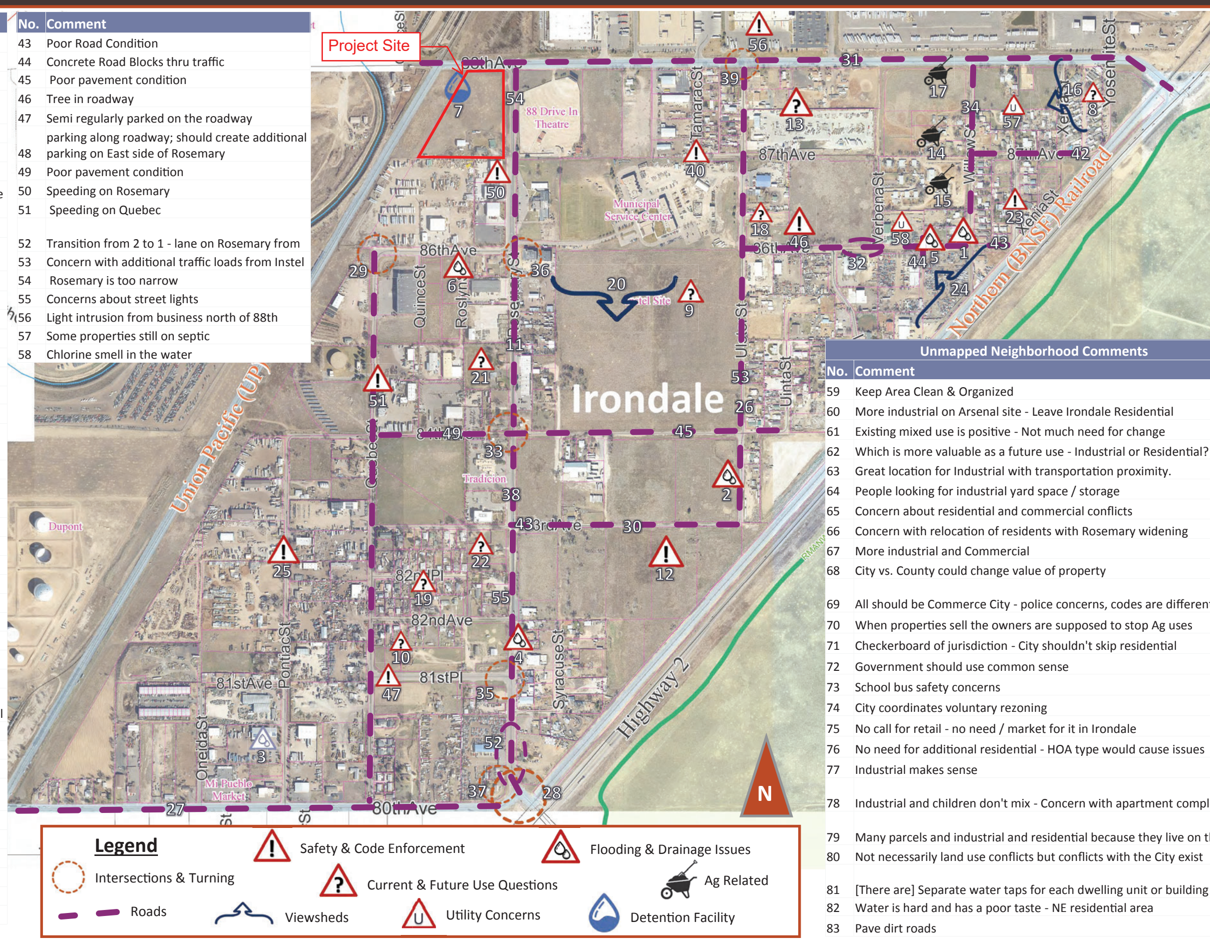
Drainage in Irondale needs improvement. The regional system makes sense in terms of efficiency but is cost-prohibitive without outside assistance.

Visitor

Excess stormwater runoff ponds along streets, limiting access and causing trucks to drive down the center of the paved road.

No.	Comment
1	Draining and ponding toward back of property
2	Standing water on Ulster
3	No concerns at this location
4	Drainage to east from Rosemary to back of property at
5	Concrete barriers cause flooding problems
6	Roselyn flooding on street
7	Future Detention location; owner may want higher use
8	Concern with mobile homes and rezoning to get rid of the use. consider changing back to residential
9	concern with Instel noise, traffic & parking
10	Conflict with Residential & Commercial Uses, some own-
11	Wayfinding Needed on Rosemary
12	Trash dumping location
13	Interested in I2 or higher use zoning
14	Small properties sold as "horse properties"
15	Dust issues from riding & flies
16	Concern with lowered property values
17	manure issues
18	May be interested in industrial
19	Concern with unknown future uses & investment into property that can't be recouped
20	New development looking nice
21	Interested in Ag or Industrial zoning
22	Higher uses for site possible; commercial expansion
23	Possible squatter
24	Poor image of the area
25	Code enforcement on property and in the street
26	Traffic on Ulster
27	High commuter traffic on 80th
28	Train blocks turning traffic on Highway 2
29	Curve at 86th & Ulster Unsafe
30	Poor road condition
31	Width & thru lanes length not adequate for traffic
32	Unpaved section causes issues with high speed and gravel
33	Cannot turn left at 3:30pm
34	Poor Road Quality
35	Cannot turn left
36	Fire station left turn egress nearly impossible at 3:30pm -
37	No left turn permitted at intersection
38	Heavy Traffic backing up on Rosemary
39	Narrow intersection concern with trucks and car conflicts
40	Parking occurring in the street blocking roadway
41	High traffic related to Irondale neighborhood
42	Poor asphalt & patching

No.	Comment
43	Poor Road Condition
44	Concrete Road Blocks thru traffic
45	Poor pavement condition
46	Tree in roadway
47	Semi regularly parked on the roadway
48	parking along roadway; should create additional parking on East side of Rosemary
49	Poor pavement condition
50	Speeding on Rosemary
51	Speeding on Quebec
52	Transition from 2 to 1 - lane on Rosemary from
53	Concern with additional traffic loads from Instel
54	Rosemary is too narrow
55	Concerns about street lights
56	Light intrusion from business north of 88th
57	Some properties still on septic
58	Chlorine smell in the water



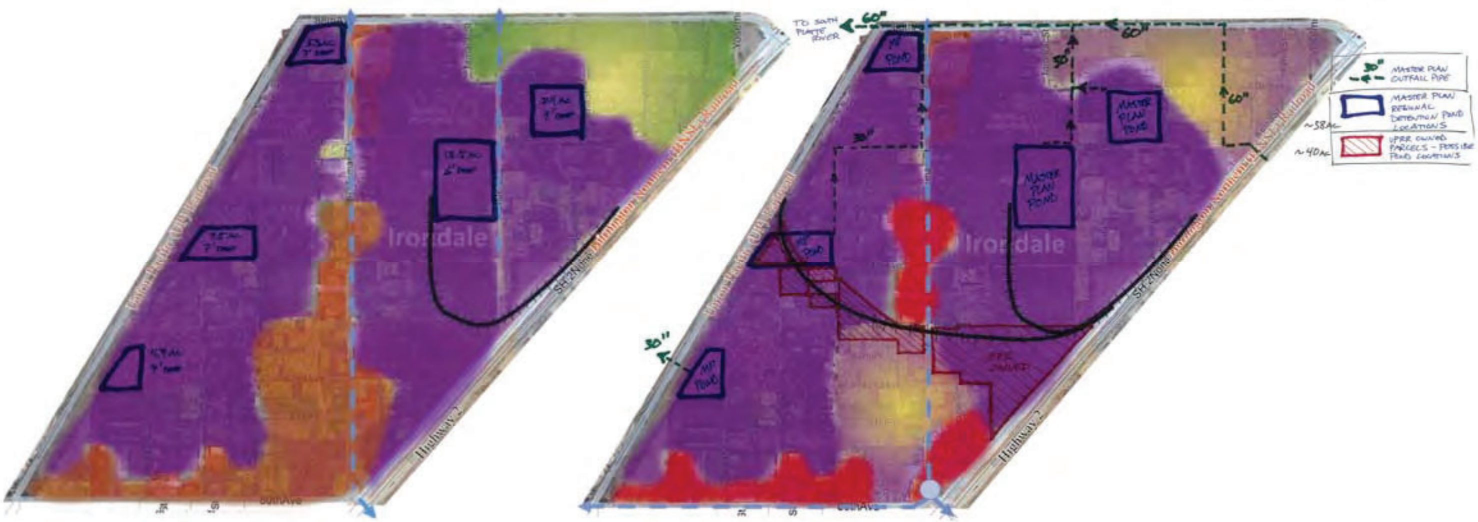
Unmapped Neighborhood Comments

No.	Comment
59	Keep Area Clean & Organized
60	More industrial on Arsenal site - Leave Irondale Residential
61	Existing mixed use is positive - Not much need for change
62	Which is more valuable as a future use - Industrial or Residential?
63	Great location for Industrial with transportation proximity.
64	People looking for industrial yard space / storage
65	Concern about residential and commercial conflicts
66	Concern with relocation of residents with Rosemary widening
67	More industrial and Commercial
68	City vs. County could change value of property
69	All should be Commerce City - police concerns, codes are different,
70	When properties sell the owners are supposed to stop Ag uses
71	Checkerboard of jurisdiction - City shouldn't skip residential
72	Government should use common sense
73	School bus safety concerns
74	City coordinates voluntary rezoning
75	No call for retail - no need / market for it in Irondale
76	No need for additional residential - HOA type would cause issues
77	Industrial makes sense
78	Industrial and children don't mix - Concern with apartment complexes
79	Many parcels and industrial and residential because they live on the
80	Not necessarily land use conflicts but conflicts with the City exist
81	[There are] Separate water taps for each dwelling unit or building even
82	Water is hard and has a poor taste - NE residential area
83	Pave dirt roads

Drainage Networks Development

Consideration was also given to drainage as part of the scenario planning. Drainage plans were developed for both the current vision and industrial transition scenarios. The only master drainage plan for Irondale comes from Urban Drainage and Flood Control District, which prepared an *Outfall Systems Plan Conceptual Design Report for Irondale Gulch* in September 2011. This master drainage plan recommends constructing five regional detention ponds within the Irondale neighborhood. The locations for these regional detention ponds were selected by Urban Drainage on parcels of land that were undeveloped at the time of the September 2011 plan. As the plan was just that – a planning document— the pond locations are conceptual and not currently owned by the City for development as regional detention ponds. The exact locations would be determined in coordination with property owners at the time of acquisition and development. Other possible locations for regional detention ponds are the parcels of land owned by Union Pacific Railroad (UPRR). While the UPRR may be constructing a cross-connect railroad track through these parcels, there is a potential to collaborate with the UPRR to utilize a portion of these parcels as regional detention provided that it does not interfere with the tracks themselves.

Option 1: Current Vision | Option 2: Industrial Transition



See Drainage Network Maps on Pages #

Regional Versus On-Site Detention

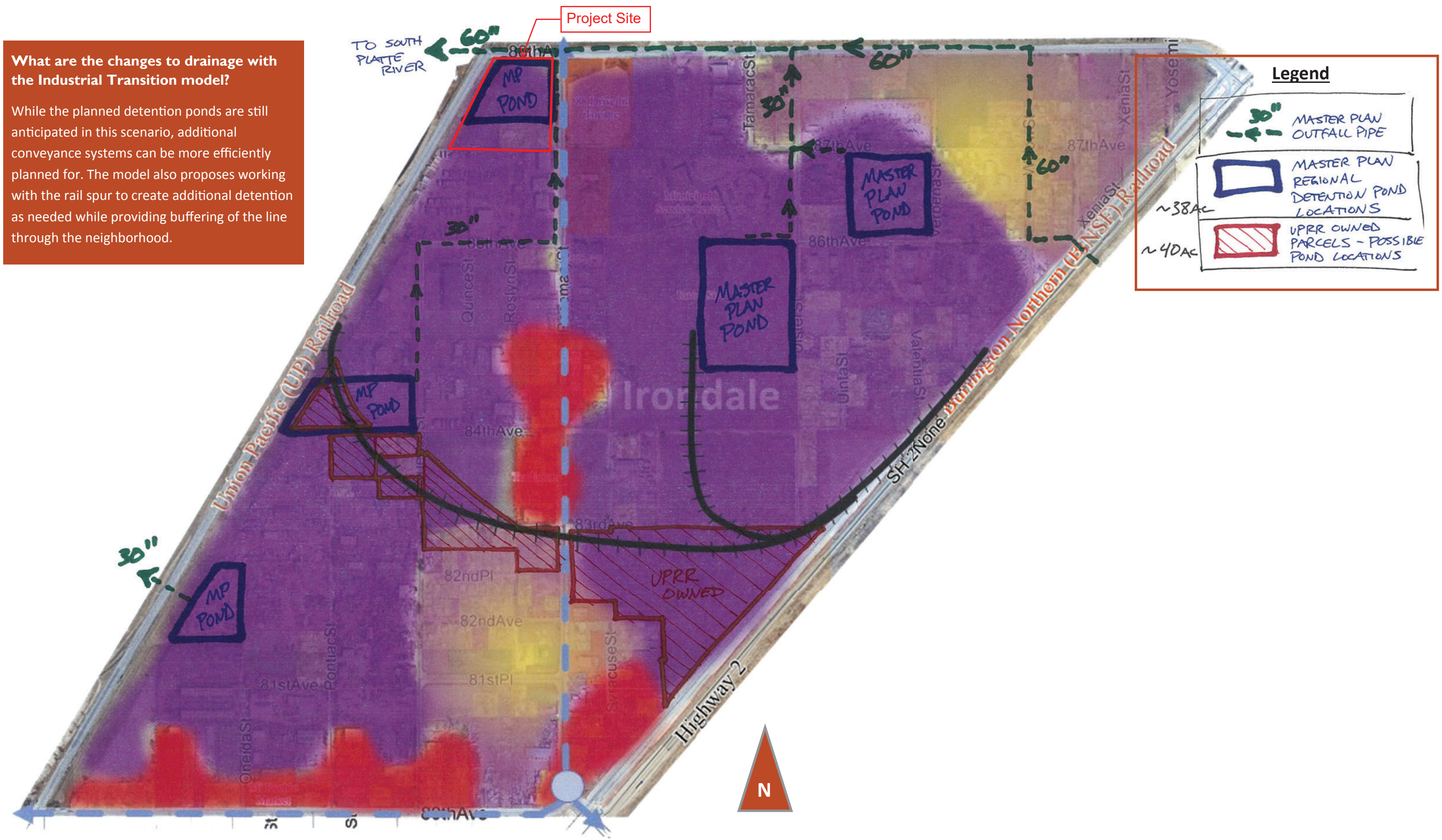
Developing the plan for how to handle regional versus on-site detention plans for the neighborhood was also a major consideration in this chapter for drainage. While a regional approach is highly favorable from an efficiency and long-term maintenance standpoint, the system can be very expensive to develop. An on-site approach, as is currently being used, can take up more land and put a high burden on smaller new development in the neighborhood. Weighing these options included development of pros and cons, consultation with staff, technical committee, the public opinion, and City Council recommendations.

What are the changes to Drainage with the Current Vision?

The existing drainage network includes planned detention areas within the neighborhood. At present, most of these areas have not been constructed. The current vision allocates large detention areas throughout the neighborhood to accommodate most of the industrial uses without a significant amount of attention to the residential areas.

What are the changes to drainage with the Industrial Transition model?

While the planned detention ponds are still anticipated in this scenario, additional conveyance systems can be more efficiently planned for. The model also proposes working with the rail spur to create additional detention as needed while providing buffering of the line through the neighborhood.



Note: Recommendations for drainage alternatives are detailed in the Drainage section in the Implementation chapter of this plan.

Below: Stormwater Detention Pros and Cons

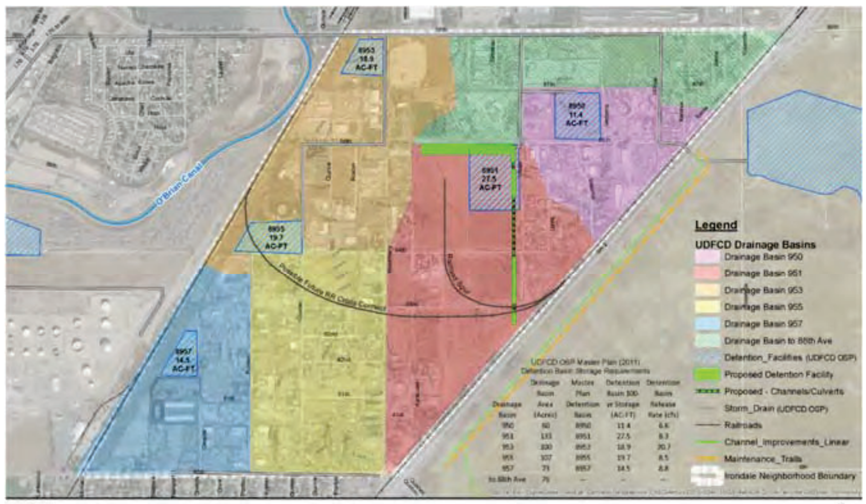
	Regional Detention	Sub-Regional Detention	On-Site Detention
Advantages	Most efficient use of space for detention Captures runoff from both new development and historic areas. Maintenance and inspection needs are focused on larger facility. Frees up space on individual sites for development uses. City has more control over design aspects. Final design and construction may be delegated to developer. Full implementation of regional detention and neighborhood drainage system would lessen off-site work for developers and may make sites more attractive for business owners.	Allows flexibility for larger developers.	Easiest to implement. Little to no offsite improvements required for developers. This may be a benefit for small business owners. The developer's drainage study is limited to the site and contributing offsite flow areas. Drainage basin level drainage study is not necessary.
Disadvantages	Requires municipality or large developer to plan, design and construct the pond and drainage system. The City would need to take the lead on planning and design. Requires up-front capital investment. Conveyance of un-detained flows from sites to regional pond may require larger storm drain and/ or open channels. Timing is important - If neighborhood drainage and detention system is not constructed in advance, new developments would need to provide on-site detention and offsite drainage improvements.	May not work in all circumstances Requires large developer to plan, design and construct the pond and drainage system.	Does not address neighborhood level drainage issues. Stormwater detention is distributed at many locations. Land area on individual sites is lost for detention. Neighborhood level drainage system may never be constructed. Connection of future drainage system to existing ponds may be challenging. Needs resources to inspect and enforce maintenance. No assurances that detention areas will remain functional. City has less control over shape, depth, slope of detention pond and related safety hazards. Need clear City standards and guidance.
	Regional Detention Option (City Lead)	Modified Regional Detention Option (Developer Lead)	On-site Detention Option (Current Criteria)

Drainage Recommendations

Drainage Alternatives Overview

The stormwater drainage system is one of the more complex infrastructure issues facing the future of Irondale. In considering the regional watershed, and both upstream and downstream impacts, this system faces extensive external influences - some even extending beyond the boundaries of Commerce City.

Because this system is so expansive in its needs to address improvements beyond the boundaries of the Irondale Neighborhood, a flexible approach in needed to provide guidance for both short-term decision-making as well as options to consider long-term solutions.

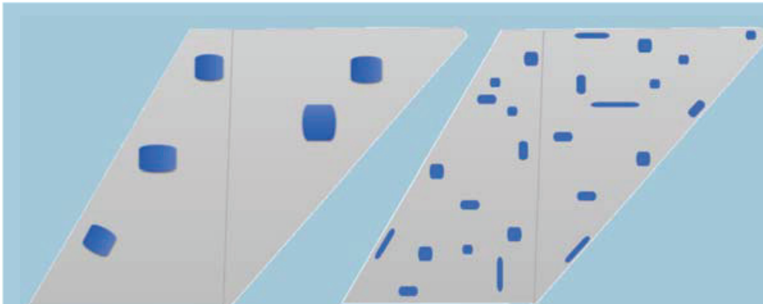


AYRES ASSOCIATES Irondale: Conceptual Stormwater Infrastructure

This plan recommends that a Regional Detention approach be considered moving forward, but that interim improvements may utilize a system of Individual On-Site detention until such time as funding is identified. The Regional approach would consolidate detention in larger, more centrally located ponds throughout the neighborhood. This regional approach is complicated by the high upfront cost and minimal opportunities to phase the system into place. It does provide a superior solution by reducing the overall amount of land in the neighborhood dedicated to detention, thus increasing total economic viability.

Conceptual Stormwater Infrastructure Map

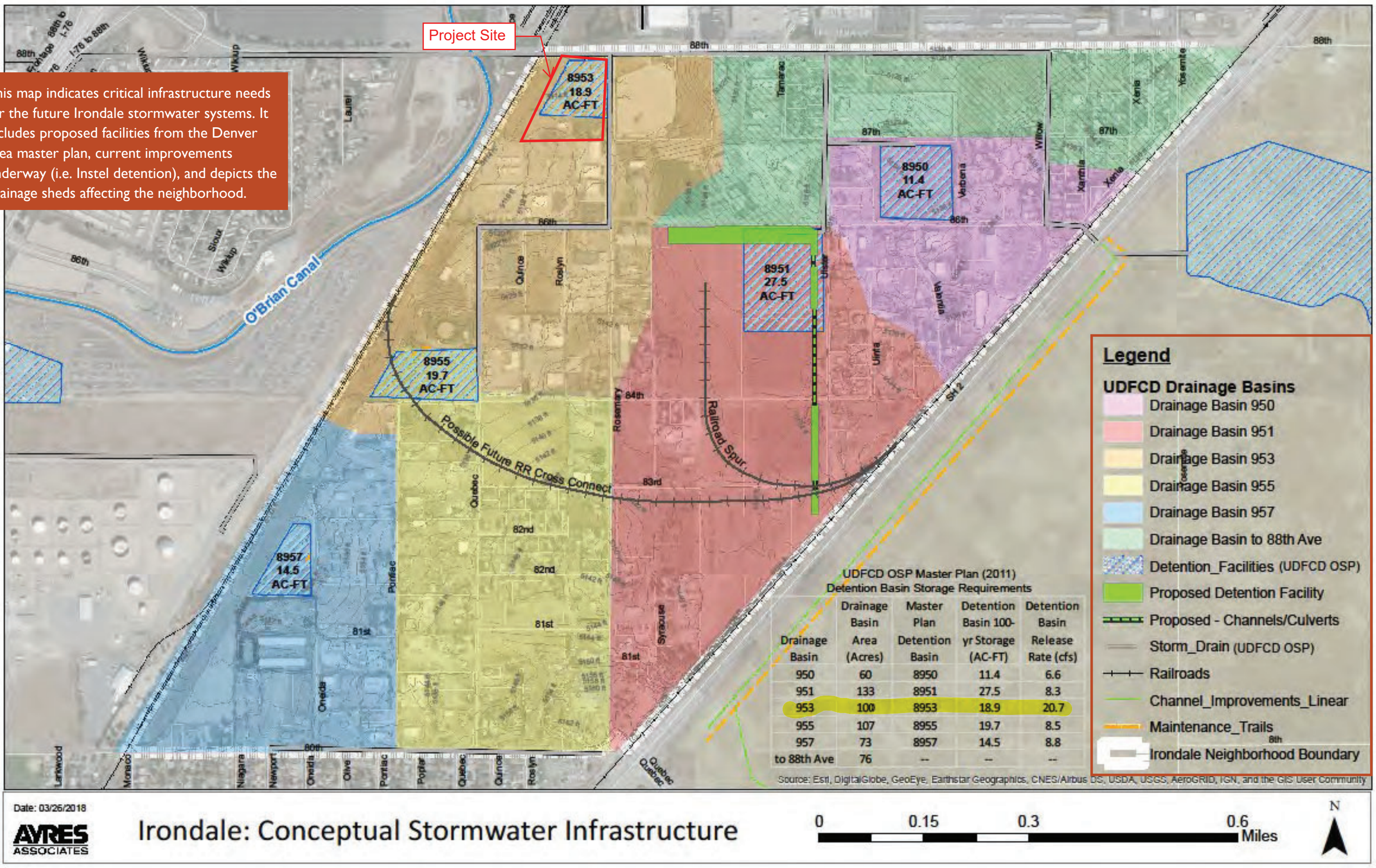
Until such time as funding can be secured, Individual On-Site detention may be used to address drainage issues for development projects. Due to this interim approach, properties that may have the potential to site a regional pond as depicted in the Denver Urban Drainage Map will *not* be precluded from developing the site based on preservation of the regional drainage potential, causing issues later on should these sites not be purchased (by the City) before development occurs. It is important to note that larger individual basins may be required due to the efficiency of this incremental approach.



Preferred Approach: Regional Detention

Interim Incremental Approach: Individual On-Site Detention

In the meantime, the City will continue working to find opportunities to implement Regional Detention considering the sub-basins that exist in the Irondale Neighborhood. Larger developments which consolidate property may benefit from this coordinated approach. It is important to note that as on-site detention is developed within a drainage basin, the effectiveness of a regional detention basin decreases.



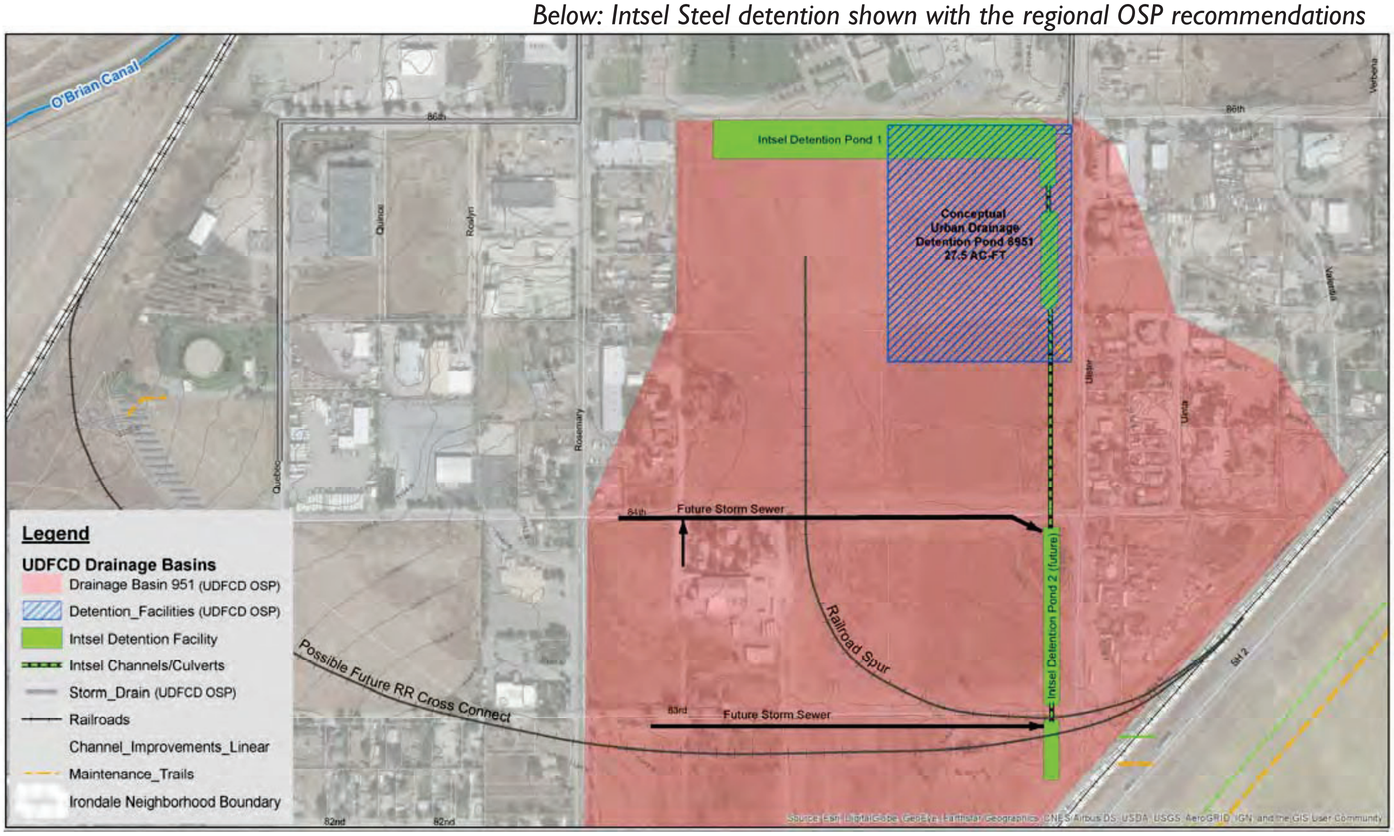
UDFCD OSP Master Plan (2011) Detention Basin Storage Requirements

Drainage Basin	Drainage Basin Area (Acres)	Master Plan Detention Basin	Detention Basin 100-yr Storage (AC-FT)	Detention Basin Release Rate (cfs)
950	60	8950	11.4	6.6
951	133	8951	27.5	8.3
953	100	8953	18.9	20.7
955	107	8955	19.7	8.5
957	73	8957	14.5	8.8
to 88th Ave	76	--	--	--

It is recommended that new development follow the current Commerce City Storm Drainage Design and Technical Criteria Manual, the Urban Storm Drainage Design and Technical Criteria Manual (USDCM) by the Urban Drainage and Flood Control District (UDFCD), and conform to existing drainage masterplans and studies. For this neighborhood, UDFCD has prepared the Irondale Gulch Outfall Systems Plan (OSP) that provides guidance and requirements for development within the Irondale neighborhood. The Irondale Gulch watershed currently does not have a drainage outfall to the South Platte River – the natural drainage has been cut-off by roads, railroads, and irrigation canals, leaving no path for stormwater to drain to the river. The OSP identifies 1) an outfall system to convey flows to the South Platte River, 2) regional detention ponds within Irondale, and 3) additional conveyance, detention, and retention improvements upstream of the neighborhood in the Rocky Mountain Arsenal National Wildlife Refuge (RMA).

The OSP divides Irondale into six drainage basins. Five of the basins include a conceptual regional detention pond while the sixth does not; it drains directly to the existing 88th Avenue storm sewer and roadside ditch drainage facilities. The 88th Avenue storm sewer infrastructure drains to a retention pond (no outlet) on the north side of 88th Ave, east of the Union Pacific railroad tracks. Because Irondale does not have a drainage outfall to the South Platte River, the OSP recommends regional retention ponds to be constructed initially, ultimately to be converted to detention ponds once the downstream conveyance system is constructed. The retention volume requirement is the total drainage basin runoff from a 100 -year, 24-hour storm with no credit for infiltration. A recent development project (Intsel) within one of the drainage basins has amended the regional detention concept proposed in the OSP with a sub-regional retention/detention system to fit their site. Amending the regional detention concept in this way is not preferred by City staff for the neighborhood moving forward, and is therefore not recommended with this study. A discussion about the sub -regional concept is included for completeness.

Below: Intsel Steel detention shown with the regional OSP recommendations



The sub-regional concept adheres to the overall release rate outlined in the OSP for each drainage basin at a designated location, but provides the required retention/detention storage at multiple in -line ponds. This concept relieves the burden of providing regional detention from one downstream property. For this concept to work properly, the entire drainage basin area needs to be master planned so that flows from all contributing areas are evaluated. Additional retention/detention volume may need to be provided by future upstream ponds as development occurs within the drainage basin. Hydrologic routing between ponds also needs to be evaluated as development occurs.

While the OSP regional detention approach is supported in concept by the City, it requires significant upfront funding and investment that is currently unavailable. Therefore, this plan recommends on-site, local detention basins for each development as it occurs, following the Commerce City Storm Drainage Design and Technical Criteria Manual. Advantages and disadvantages of regional and on-site detention are listed on a table following this section.

If funding were to become available for regional detention, the following further describes the regional detention concept. It is important to note, as local on-site detention is developed within a drainage basin, the feasibility and effectiveness of a regional detention pond decreases.

The regional detention pond system as proposed in the OSP, provides the retention/detention capacity required for runoff from the entire drainage basin. A regional detention basin may relieve each upstream developer from having to dedicate space on his or her lot for detention/retention – leaving more land for the development. Each development would, however, need to provide conveyance from their property to the regional pond.

Additionally, a regional detention pond places the responsibility for the maintenance of the pond on the City; helping to ensure that it is maintained and continues to function as designed. Detention basins on private land where maintenance is performed privately would rely on City code enforcement.

Five sites were identified in the OSP as potential locations for regional detention ponds. The OSP selected these sites because they were vacant at the time of the OSP and were located at or near the lowest point of each drainage basin. Consideration was not given in the OSP to current land ownership or development potential of the selected sites. This plan does not include a regional detention pond site analysis; these sites are shown in the plan exhibits because they were shown in the OSP. Any adequately sized parcel or group of parcels of land near the low point within each of the five basins, can be used for regional detention, given that the resulting pond can provide adequate storage capacity and meet the outfall criteria in the OSP.

This study also explored the possibility of placing regional detention ponds along the railroad cross - connect corridor. This option is attractive in that it provides the possibility of placing some regional ponds in land adjacent to the railroad – land that may be unattractive to prospective developers. This option may be viable for the drainage basins in the southern portion of the Irondale neighborhood, specifically drainage basins 955 and 951. However, in the event that the Union Pacific Railroad is amenable to this concept, it is likely they will not allow these ponds to be constructed until after the railroad cross-connect is constructed and the available excess land has been clearly identified.

Drainage Recommendations

The first priority in pursuing a regional detention pond system needs to be identifying and purchasing the land where each of the regional detention ponds will be constructed. Prior to development occurring, the pond must be built to the size required for the drainage basin. When development occurs, each developer would pay a development fee that would go to the City to recoup the cost of the regional pond. Due to the potential for varying sizes of development within Irondale, it is recommended that this fee be based on the developed lot size, relative to the drainage basin acreage, and may also use stormwater runoff contributions as an incentive to minimize imperviousness and promote infiltration. During the development review process, project runoff conveyance from the site to the regional detention basin needs to be considered. In many locations throughout Irondale there is no curb and gutter nor roadside ditches to adequately convey the runoff to the pond. It is critical to identify a conveyance path to the pond without impacting adjacent or downstream properties. Conveyance infrastructure would be the responsibility of the developer, but may be master planned in advance by the City.

The map depicts the drainage basins, conceptual detention basins, and the associated storage requirements as specified in the OSP for the Irondale neighborhood.

Until an outfall is constructed to the South Platte River, detention ponds will need to be constructed as retention ponds. During this interim period, retention ponds must be designed to provide infiltration to fully drain within the time frames mandated by Colorado Revised Statue 37 -92-602 (8). Infiltration cannot be considered in pond retention volume calculations, but must be considered to comply with State requirements. As mentioned above, retention basins should be designed contain the total basin runoff from a 100-year, 24-hour storm with no credit for infiltration. Ultimately, when the downstream outfall system is in place, water quality treatment must be provided by detention basins prior to discharge into the conveyance storm system to the river.

Below: Stormwater Detention Implementation

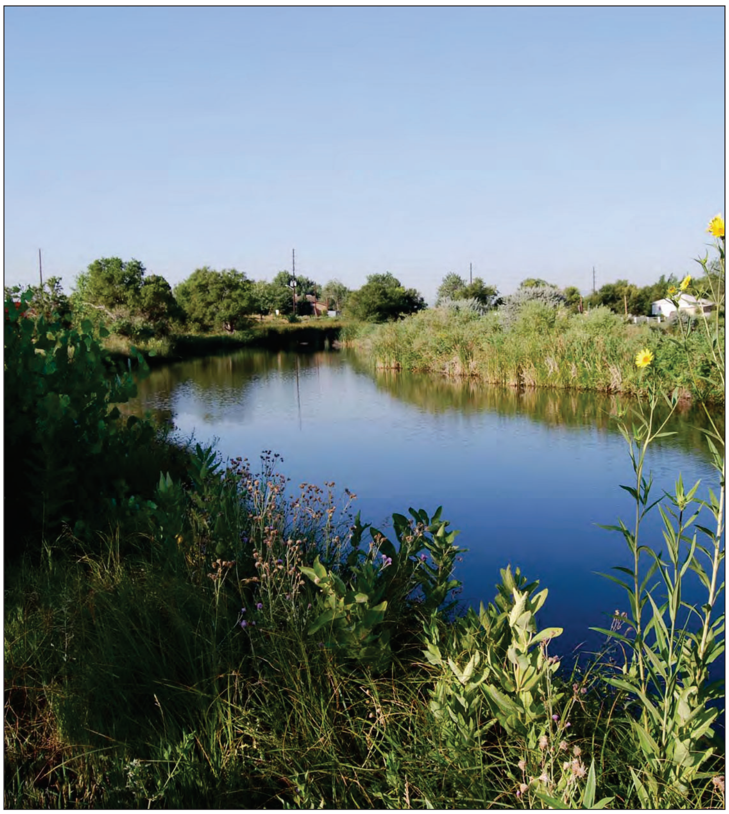
	Regional Detention	Sub-Regional Detention	On-Site Detention
Description	Larger detention facility serving multiple developments and sites. Typically located near an outfall to a major drainage system. Often owned and maintained by a municipality, but may also be held by an HOA, business owner's association, or metro district.	Medium sized detention facility serving one large development or a portion of a drainage basin. Ownership would likely be held by developer, business owner's association, or metro district.	Smaller detention facilities located within new development sites. Detention pond would serve one site or lot only. Required on each new or redeveloped site. Owned and maintained by site owner.
Implementation	Recommend a neighborhood level comprehensive drainage and planning study to determine location and size of detention pond and upstream neighborhood drainage system. Regional detention would ideally be constructed before future development can proceed. Neighborhood drainage system should be built from downstream up. Sites that develop before regional detention would require on-site detention. Implementation process includes: study/planning, design, property acquisition, and construction. Portions of implementation may be done by the City or given to developers. 'Fee-in-lieu' may be an option to recover costs. A City policy would need to be developed.	A comprehensive drainage and planning study at the drainage basin level would need to be performed. Design and constructed by developer	Designed and constructed with site development by business owner or developer Needs to meet current City criteria and policy for this neighborhood.

Full Infrastructure Buildout

If the items in the CIP and the drainage network are implemented the neighborhood may look significantly different. A map of these options is on the next page.

Future Buildout Map

This map shows the future buildout of infrastructure in Irondale should all the proposed improvements occur.



IRONDALE GULCH
OUTFALL SYSTEMS PLAN
CONCEPTUAL DESIGN REPORT

Project Sponsors

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

COMMERCE CITY

Prepared by:

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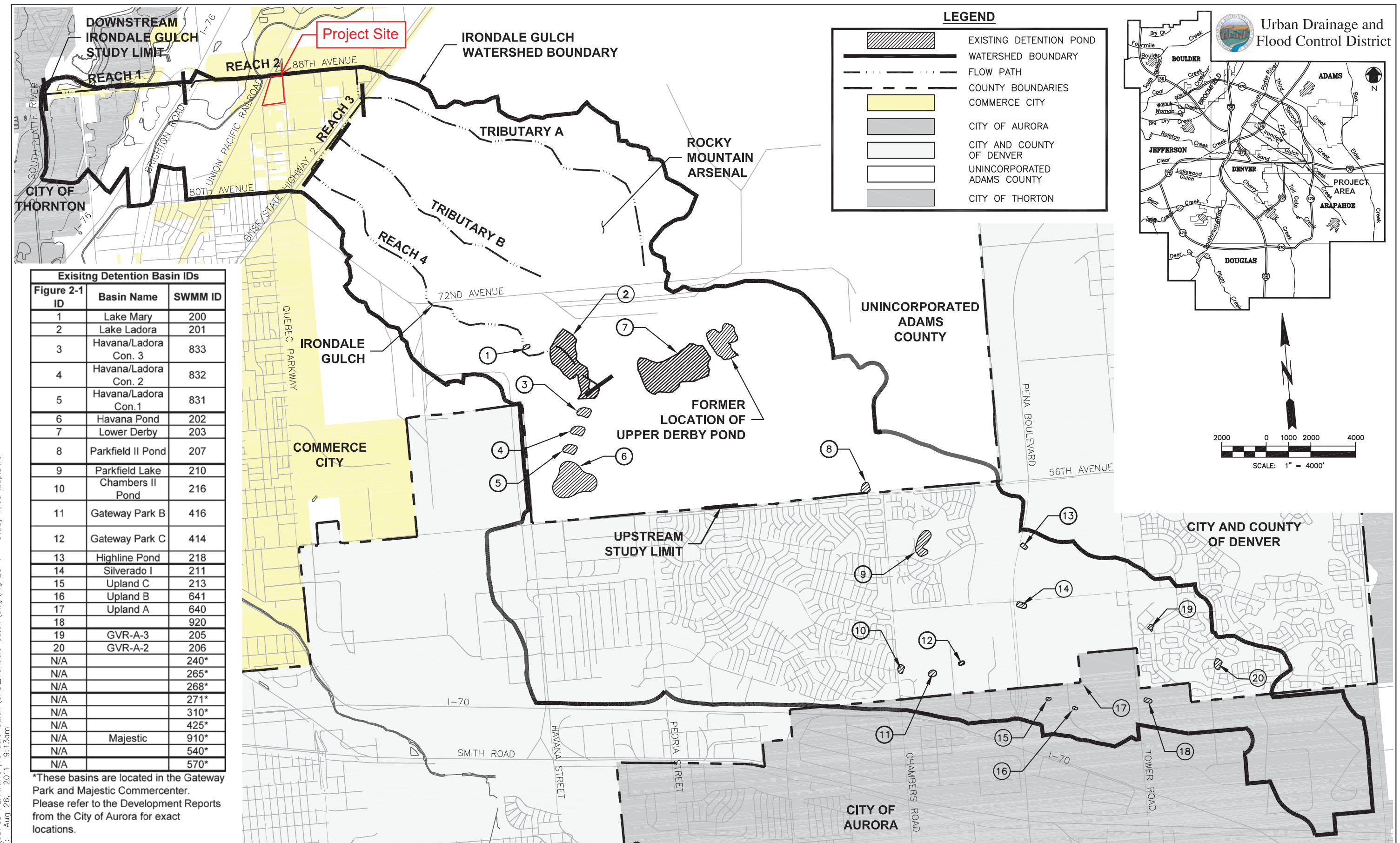
September 2011



Exisitng Detention Basin IDs		
Figure 2-1 ID	Basin Name	SWMM ID
1	Lake Mary	200
2	Lake Ladora	201
3	Havana/Ladora Con. 3	833
4	Havana/Ladora Con. 2	832
5	Havana/Ladora Con.1	831
6	Havana Pond	202
7	Lower Derby	203
8	Parkfield II Pond	207
9	Parkfield Lake	210
10	Chambers II Pond	216
11	Gateway Park B	416
12	Gateway Park C	414
13	Highline Pond	218
14	Silverado I	211
15	Upland C	213
16	Upland B	641
17	Upland A	640
18		920
19	GVR-A-3	205
20	GVR-A-2	206
N/A		240*
N/A		265*
N/A		268*
N/A		271*
N/A		310*
N/A		425*
N/A	Majestic	910*
N/A		540*
N/A		570*

*These basins are located in the Gateway Park and Majestic Commercenter. Please refer to the Development Reports from the City of Aurora for exact locations.

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PLOT DATE: Aug 26, 2011 9:13am

TOPOGRAPHIC METHOD:	LIDAR
TOPOGRAPHIC MAPPING BY:	
TOPOGRAPHIC MAPPING QA/QC BY:	
CONTOUR INTERVAL:	2 FOOT
DATE FLOWN:	2008

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DESIGNED	AGC	DATE 10/10/10
DRAWN	RWM	DATE 11/15/10
CHECKED	RCO	DATE 1/20/11
REVISED		DATE

COMMERCE CITY
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

IRONDALE GULCH OUTFALL SYSTEMS PLAN

STUDY AREA

FIGURE ES-1

Reach 2: Reach 2 spans from the I-76 at 88th Avenue to SH2 at 88th Avenue and is located within Commerce City. This reach contains the highest density of development within the Study Area and consists of both residential and industrial development. The area contains some undeveloped land and is zoned for further development. There is no defined flowpath therefore runoff moves downstream as sheet flow or infiltrates. There are problems here with flooding and ponding.

Reach 3: Reach 3 spans from SH 2 at 88th Avenue to SH 2 at 80th Avenue. Reach 3 is located within the RMA. There is no existing conveyance under SH 2 or the BNSF which will cause overtopping in this location.

Reach 4: Reach 4 spans from SH 2 at 80th Avenue upstream to the confluence with the Montbello Tributary. The entirety of this reach is located within the RMA which consists of undeveloped open space land. Flow within Reach 4 is conveyed via drainage infrastructure consisting of natural and engineered channels. The reach also contains several existing detention facilities.

Tributary A: Tributary A flows through the open space land of the RMA. This reach is part of the DFA that has been added to the Irondale Gulch Watershed in the current study. Flow within Tributary A is conveyed via natural channels and as sheet flow through the RMA to SH 2. The topography within this reach includes numerous natural depressions.

Tributary B: Tributary B also flows through the open space land of the RMA. This reach is part of the DFA that has been added to the Irondale Gulch Watershed in the current study. Flow within Tributary B is conveyed via natural channels and as sheet flow through the RMA to SH 2. The topography within this reach includes numerous natural depressions.

2.4 FLOOD HISTORY

There is no known flood history for the study area. This is due in part to the fact that until recently, the land was either unused or agricultural and consisted of almost all pervious areas. Additionally, little to no base flows have been recorded at SH 2 for the Irondale Gulch Mainstem. However, due to the lack of a defined outfall downstream of SH 2 there are several locations where potential flooding and existing ponding is problematic.

2.5 WETLANDS AND RIPARIAN ZONES

For the area along Irondale Gulch, there is an almost continuous zone of riparian species intermixed with wetlands in undeveloped areas, primarily in the RMA and adjacent to the SPR. The RMA zone contains 5 different types of wetland communities (ESCO 1999 as cited in the 2002 Environmental Assessment). The wetlands are generally located in the low-flow channel section and around permanent lakes. In currently developed areas, especially where an engineered channel exists, there are no clearly established riparian zones or wetlands.

2.6 ENVIRONMENTAL ASSESSMENT

The RMA is the largest uninterrupted mass of undeveloped land located within Adams County and it supports an abundance of flora and fauna. According to the 2002 Environmental Assessment (EA) (ERO), the Colorado Butterfly plant is one threatened species supported by the habitat of the RMA:
At the time of the 2002 EA there were other candidate species pending threatened classification as well.

A thorough investigation should be performed prior to any construction and precautionary actions shall be taken to ensure these species, and any other sensitive species, and their supporting habitat is undisturbed.