1st Review

Comments in magenta red provided by Slantern@auroragov.org (Drainage)

LAMP RYNEARSON

Leaving a **Legacy**

4715 Innovation Dr., Ste. 100
Fort Collins, CO 80525
[P] 970.226.0342
[F] 970.226.0879
LampR

Comment acknowledged.

Per the current PDR Pre-Acceptance Checklist and COA Roadway Manual 2.02.4, the PDR review should be completed in 3 reviews, and additional reviews shall incur additional review fees

Subsequent submittals shall be flattened PDFs

PRELIMINARY DRAINAGE REPORT

Comment acknowledged.

QUIKTRIP NO. 4245 SITE PLAN WITH CONDITIONAL USE (DA-2350-00)

LOWRY CREDIT UNION FILING NO.1

CITY OF AURORA, COUNTY OF ARAPAHOE, COLORADO

NOTE: comments shown in green have been addressed by LRA. As needed, additional supporting information is provided her or in the comment response letter.

This should be the top/larger project name

Comment addressed.

Include "Advisory Note that PDR approval is required prior to Civil Plan Approval"

Comment addressed.

PREPARED FOR:

QUIKTRIP CORPORATION
12000 WASHINGTON ST, STE 175
THORNTON, CO 80241
JESSICA GLAVAS, 303.248.0435

PREPARED BY:

LAMP RYNEARSON
4715 INNOVATION DR, STE 100
FORT COLLINS, CO 80525
MICHAEL PALIZZI, 970.226.0342

Comment addressed.

Remove City Engineer signature line. (Per a new City policy effective 03/01/2023, the City Engineer no longer signs Drainage Plans/Reports.)

PROJECT NO. 0222026
DATE: APRIL 24, 2023

Approved For One Year From This Date	
City Engineer	Date
Water Department	Date

Cover page shall be page 1

Per ***2.05.3.01*** of the Roadway Manual, include sequential page numbers starting with the cover page

Comment addressed.

Table of Contents

Provide a variances section in the report

If there are no variances requested, state that no variances are requested under the variance heading

Comment addressed.

Comment addressed.

Cover page shall be page 1

Per ***2.05.3.01*** of the Roadway Manual, include sequential page numbers starting with the cover page

Appendices

Appendix A

1. Vicinity Map
2. Existing Conditions Drainage Plan
3. Developed Conditions Drainage Plans

Comment addressed.

Appendix B

1. Soils Data
2. Floodplain Information
3. Aurora Reference Material

Provide point rainfall date per NOAA Atlas 14 (Provide NOAA Atlas 14 Output in appendix)

Appendix C

1. Rational Method Results
2. Roadway/Inlet Capacity Calculations
3. Storm Sewer Calculations

Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

Comment addressed.

I. Introduction

The purpose of this drainage report is to describe the proposed drainage design of QuikTrip Aurora 4245. This report aims to provide the City with adequate data and descriptions to convey that the proposed development for this project site is in general conformance with City of Aurora drainage criteria as well as the "Final Drainage Report for Aurora Town Center Subdivision Filing No. 1 – Phase 1 A" completed by V3 Consultants January 8, 2002. This master drainage report will be herein referenced as *Master Report*.

A. Location

The proposed development is described as Lot 1, Block 1 of Lowry Credit Union Filing No. 1 and is located at 14305 E Alameda Ave, Aurora, CO 80012.

The project site currently houses a Westerra Credit Union building and is fully developed with utilities, parking facilities and landscaping, making up 1.57 acres of land. The site is located within the City of Aurora and is located at the northeast corner of Alameda Ave and Crystal St. Refer to Appendix A for the vicinity map.

B. Proposed Development

The proposed development will consist of a QuikTrip convenience store and fueling stations. The site will be developed to provide adequate parking and pedestrian movement, as well as serve as a convenient location for patrons to fuel up on gas and treats. The proposed development will generally match current flow patterns and will consist of concrete for the parking lot/drive areas, landscape areas, and roof for the convenience store/fueling canopy structure.

The goal of this development is to completely demolish and remove the existing building and associated infrastructure and replace it with a new Quiktrip gas station. In addition to a new building, the site will also include parking.

According to the NRCS website, the site consists of predominantly Type C (100%) soils. According to the NRCS, the Type C soils are classified as Fondis Silt Loam.

See Appendix B for NRCS soils data.

II. Historic Drainage

A. Overall Basin Description

In assuring that existing drainage patterns will generally be maintained, the "Final Drainage Report for Aurora Town Center Subdivision Filing No. 1 – Phase 1 A" completed by V3 Consultants January 8, 2002 was referenced. See Appendix B for relevant references. This historic basin routes flows to a central detention basin, where both water quality and detention are provided. The proposed site will maintain this drainage pattern.

The proposed development is not affected by any mapped floodplains. The property is in Flood Zone X according to FEMA Flood Insurance Rate Map Number 08001CO331H effective March 5, 2007. Refer to Appendix B for the Flood Insurance Rate Map.

B. Drainage Pattern Through Property

Master Basins:

There is one master basin *(Basin SB 8)* that will be affected with this proposed development. This master basin will be herein referenced in italics.

Comment addressed.

Provide EDN (Engineering Design Number) for Master Report

Basin SB 8 (1.6 Acres) produces 12.1 cfs in the 100-yr storm event and encompasses the vast majority of the existing lot development. The basin was planned for general commercial and was granted an assumed maximum allowable flow of 5.9 cfs (5-yr) and 12.1 cfs (100-yr). Flows are conveyed towards the northeast corner of the lot to a *Type C inlet (Design Point 8)* where they enter the subdivision storm sewer system and are conveyed northeast to the *subdivision detention/water quality pond (Design Point 2)*. The subdivision storm sewer system was sized to accommodate the 5-year flow while flows in excess of the 5-year are expected to make their way to the subdivision detention/water quality pond overland through various, adjacent parking lots and local drainage facilities.

Comm

MASTER BASIN CALCULATIONS (Town Center Phase 1 A Master Report)								
DESIGN POINT	**BASIN**	**AREA**	**Imperviousness %**	**tc**	**C2**	**C100**	**Q5**	**Q100**
SB 8	8	1.60	75.5%				2.60	8.1

C. Outfalls Downstream from Property

Flows are conveyed overland to a concrete valley pan that borders the parking. Once within the pan, flows are carried south to a **Single Type 13 Combination inlet (Design Point A1).** Flows enter the on-site storm sewer system and are conveyed to the on-site flow discharge point (Design Point A2, *Design Point 8*) where they join flows from the subdivision storm sewer system.

C

Do not provide model of inlet at PD stage (this will be determined, reviewed and approved at Civil Plan stage)

Only specify inlets as "grate", "curb opening", etc.

III. Drainage Design Criteria

A. List References

Mile High Flood District's Urban Storm Drainage Criteria Manual (USDCM), and the City of Aurora Storm Drainage Criteria, as well as good engineering practices have been used to calculate the stormwater runoff to design the stormwater facilities for this site.

B. Hydrological Criteria

The 5-year (minor) and 100-year (major) design storms were used for the developed discharge, as indicated in the City of Aurora Storm Drainage Criteria. The City of Aurora's one-hour point rainfall values were used to obtain rainfall data for each storm specified. Refer to Appendix B for these reference values.

As the site basins are relatively small, the Rational Method (MHFD's UD-Rational v.2.00) has been used to calculate developed stormwater runoff for the purpose of sizing inlets, swales and storm pipes.

Impervious values for each basin were calculated from the expected uses and taken from Table 6-3 in Chapter 6 of the UDFCD Volume 1, Management, Hydrology, and Hydraulics. Rational Method "C" values were taken from SDDTC Table 1 for C values.

C. Hydraulic Criteria

Stormwater structures (inlets, swales, storm pipes) have been designed for the proposed site. These have been designed using techniques developed or adopted by the City of Brighton and were sized to capture and convey the major events.

Internal inlets have been sized using MHFD's UD-Inlet v5.02 spreadsheet program.

The storm sewer system will be hydraulically analyzed for the Final Drainage Report using Autodesk Storm and Sanitary Analysis (SSA) software.

IV. Drainage Plan

A. General Concept

The proposed development has been divided into two on-site sub-basins that will be routed to the existing subdivision detention pond and three on-site sub-basins that will discharge off-site without being treated for water quality. Each of the five basins represent a specific discharge point. The on-site sub-basins for the proposed development were determined and routed to establish key stormwater discharge points within the development.

In general, historic flow patterns will be maintained and the existing water quality will be maintained.

Due to site constraints including grade and the fact that the existing site sent runoff off-site without first being treated for water quality, there are three, small sub-basins that will directly discharge developed runoff to adjacent areas. These areas will mostly discharge landscaped areas just as they do today but will also include small, paved areas. Please see below for further discussions regarding this topic.

B. Specific Details

On-Site Basins

There are five proposed basins that were delineated for the proposed development. They are broken into two main categories. A Basins (on-site) and H Basins (off-site / matching historic patterns).

Basins-A

A Basins: (1.30 Acres) produce **9.0 cfs** in the 100-yr storm event.
There are a total of 2 sub-basins that make up the A Basins (A1-A2). Each of these basins delineates on-site development whose storm flow is ultimately conveyed to **Design Point A2** *for the proposed development is the same design point as the master subdivision's Design Point 8.*

Basin A1 (0.19 Acres) produces **1.2 cfs** in the 100-yr storm event. This basin makes up the southwestern portion of the site and includes the landscape area and the westernmost parking/drive aisle. Flows are conveyed overland to a concrete valley pan that borders the parking. Once within the pan, flows are carried south to a **Single Type 13 Combination inlet (Design Point A1).** Flows enter the on-site storm sewer system and are conveyed to the on-site flow discharge point (Design Point A2, *Design Point 8*) where they join flows from the subdivision storm sewer system.

Basin A2 (1.11 Acres) produces **7.8 cfs** in the 100-yr storm event. This basin makes up the majority of the site and includes convenience store, parking, drive aisle, and fueling canopy flows. Convenience store flows are captured exclusively via roof drains which conveys the flows to the on-site storm sewer system. This system ultimately discharges captured flows into the existing ***Type C inlet (*****Design Point A2,** *Design Point 8).* The remaining flows are conveyed overland to the perimeter curb & gutter where they are carried north to and through a 2' curb cut and associated flume to the existing ***Type C inlet (*****Design Point A2,** *Design Point 8).* Flows join flows from the subdivision storm sewer system.

Basins-H (Historic Basins)

There are a total of 3 sub-basins that make up the H Basins (H1-H3). Each of these basins delineates off-site flow that cannot, and is not intended to be conveyed to any of the on-site design points as described above. These basins are discharged to

Master Report design points ***Design Point 2 (Subdivision Detention Pond)*** *or* ***Design Point 7 (Sable Blvd ROW)*** due to existing basin bounds/site grading constraints.

Basin H1 (0.08 Acres) produces **0.3 cfs** in the 100-yr storm event (0.03 cfs in the 5-yr storm). This basin makes up the southern portion of the site and includes a very small portion of landscaping needed to provide a transitional zone for grading as well as the connecting sidewalk from the proposed site to the Alameda Ave. ROW. The negligible flows are conveyed overland to Alameda Ave. ROW **(Design Point H1)** and likely evaporate or infiltrate prior to becoming a nuisance by the neighboring property. It should be noted that the existing credit union use also had a small amount of flows discharging into Alameda Ave. ROW so historic drainage patterns are being maintained. Once within Alameda Ave. ROW flows are conveyed east until they are met by Sable Blvd. ROW ***(Design Point 7).***

Basin H2 (0.14 Acres) produces **0.5 cfs** in the 100-yr storm event (0.08 cfs in the 5-yr storm). This basin makes up the northern portion of the site and includes a small portion of landscaping needed to provide a transitional zone for grading as well as a small portion of the northern access point. Flows are conveyed overland to the northern property line **(Design Point H2),** where the flows are then carried either overland or via the storm drain system to the subdivision detention pond ***(Design Point 2).*** This portion of the site is not conveyed to the on-site system in an effort to maintain the *Master Report* boundary and flow patterns.

Basin H3 (0.07 Acres) produces **0.4 cfs** in the 100-yr storm event (0.13 cfs in the 5-yr storm). This basin makes up the eastern portion of the property and includes a very small portion of landscaping needed to provide a transitional zone for grading as well as a number of the neighboring property's parking stalls. Flows are conveyed overland to the eastern property line **(Design Point H3)** where the flows enter into the neighboring property and are conveyed east eventually being discharged into Sable Blvd ROW ***(Design Point 7),*** matching existing drainage patterns. This portion of the site is not conveyed to the on-site system in an effort to maintain the *Master Report* boundary and flow patterns.

C. Rational Method Results

The runoff from proposed sub-basins was calculated using the rational method to accurately determine sizing of the stormwater infrastructure (inlets, storm pipe, and channels): The 5-year and 100-year criteria were used for the minor and major storm events. The results of the Rational Method analysis for the developed conditions are shown in the table below (see Appendix C for detailed rational method calculations):

DEVELOPED BASIN CALCULATIONS									
DESIGN POINT	**BASIN**	**AREA**	**Imperviousness %**	**tc**	**C5**	**C100**	**Q5**	**Q100**	
A BASINS									
A1	A1	0.19	75%	5.0	0.65	0.79	0.5	1.2	
A2	A2	1.11	90%	5.0	0.77	0.85	3.3	7.8	
Total A	**A2**	1.30	89%				3.8	9.0	
H BASINS									
H1	H1	0.08	13%	10.0	0.14	0.54	0.0	0.3	
H2	H2	0.14	19%	10.0	0.19	0.56	0.1	0.5	
H3	H3	0.08	46%	5.0	0.41	0.67	0.1	0.4	
Total H	-	0.30	16%				0.2	1.2	
ENTIRE SITE									
Total Comp Site		1.52	79%	5.8	0.68	0.81	3.9	9.7	*

*A1, A2, H2, H3 (To match Master Basin SB bounds for proper comparison)

State the name and EDN of the Pond that these flows are being directed to

Provide a summary of the ultimate destination of the flows

Confirm the pond provides both water quality and detention

45

D. Storm Sewer System Design

The storm sewer system consists of one (1) system. Both systems were sized to convey the minor storm (5-year storm) flows without surcharging the inlets and manholes.

Inlets were sized using Mile High Flood District's MHFD-Inlet v5.02.

Autodesk Storm and Sanitary Analysis 2022 software (SSA) will be used for flow routing and storm sewer pipe sizing *at the* time *of the second submittal.* The flows from UD-Rational will be input into SSA as flow hydrographs with peaks occurring at time of concentration (tc) and storm duration of 3*tc. These assumptions are conservative in nature as peak flows for sites like these tend to occur around 30 minutes on a typical storm hydrograph. The average computed tc for the site is *9* minutes thus, 3*tc is relatively close to 30 minutes. The applied storm hydrograph results in higher peak flows and thus add a level of conservativeness to the storm system as a whole.

DETENTION/COMPARISON TO *MASTER REPORT*

It's understood that detention has been fully accounted for for both on and off-site basins. A comparison utilizing the proposed basin flows being conveyed to the pond vs. the *Master Report* shows that the routed flows is lower for the proposed development than what is allowed for the *Master Report.*

The *Master Report* displays a need to be at, or under 5.9 cfs (5-yr) and 12.1 cfs (100-yr). The proposed development plans to only convey 3.9 cfs (5-yr) and 9.7 cfs (100-yr). As is such, flows will be less impactful, which will aid in the detention/water quality pond's ability to safely attenuate flows. See Appendix C for full calculations.

EROSION & SEDIMENT CONTROL

During construction, land grading activates will be minimized and BMP's will be installed to minimize the transport of sediment offsite. Once the site is considered established, then BMP's will be removed and the established vegetation will provide permanent sediment and erosion control.

V. Conclusions

When developed, the site's runoff will be the same as the existing credit union site. The proposed channels, drive lanes, and stormwater system will convey and capture the increased runoff from the site and will route the storm flows to the existing water quality treatment BMP's.

All drainage design considerations contained in this drainage report are in accordance with the City of Aurora Storm Drainage Criteria and the Mile High Flood District's Urban Storm Drainage Criteria Manuals. In general, the design presented in this report serves to provide a ~~safe and adequate~~ drainage system for QuikTrip 4245 Development.

VI. List of References

1. *The Urban Storm Drainage Criteria Manual* (USDCM), Volumes 1, 2, and 3, published by the Mile High Flood District (MHFD), Denver, Colorado, revised April 2018.
2. City of Aurora, Storm Drainage design and Technical Criteria, Revised September, 2010.

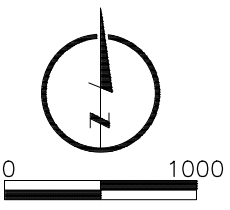
Provide referenced reports in references list, including the master report

Provide EDN (Engineering Design Number) for Master Report

Comment addressed

Appendix A

Maps



LAMP RYNEARSON

LAMPRYNEARSON.COM

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FORT COLLINS, COLORADO
4715 INNOVATION DR., STE. 100 (970)226.0342

KANSAS CITY, MISSOURI
9001 STATE LINE RD., STE. 200 (816)361.0440

DESIGNER / DRAFTER	JUP
REVIEWER	MAP
PROJECT NUMBER	0222026
DATE	04/24/2023
SURFACE LOCATION	
BOOK AND PAGE	

QUIKTRIP 4245
VICINITY MAP

Remove this page from the report, as it is included as a separate document, and not needed in the report

Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

Comment addressed.

Comment addressed.

GENERAL NOTES:

1. CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

2. BEARINGS ARE BASED ON THE STATE PLANE COORDINATE SYSTEM ESTABLISHED FOR THE COLORADO CENTRAL ZONE 0520, NORTH AMERICAN DATUM (NAD) OF 1983. DISTANCE SHOWN HEREON ARE GROUND UNITS. BEING THE NORTH LINE OF LOT, LOWRY CREDIT UNION SUBDIVISION FLING NO. 1, BEARING N89°51'35W, BETWEEN MONUMENTS SHOWN HEREON. VERTICAL RELIF WAS MADE FROM AN ON THE GROUND SURVEY CONTOURS SHOWN HEREON ARE AT 1' INTERVAL USING THE NORTH AMERICAN VERTICAL DATUM OF 1998 (NAVD 88), GEOID 12A. SITE VERTICAL WAS ESTABLISHED BY USING NGS BENCH MARK "B 407 RESEST"

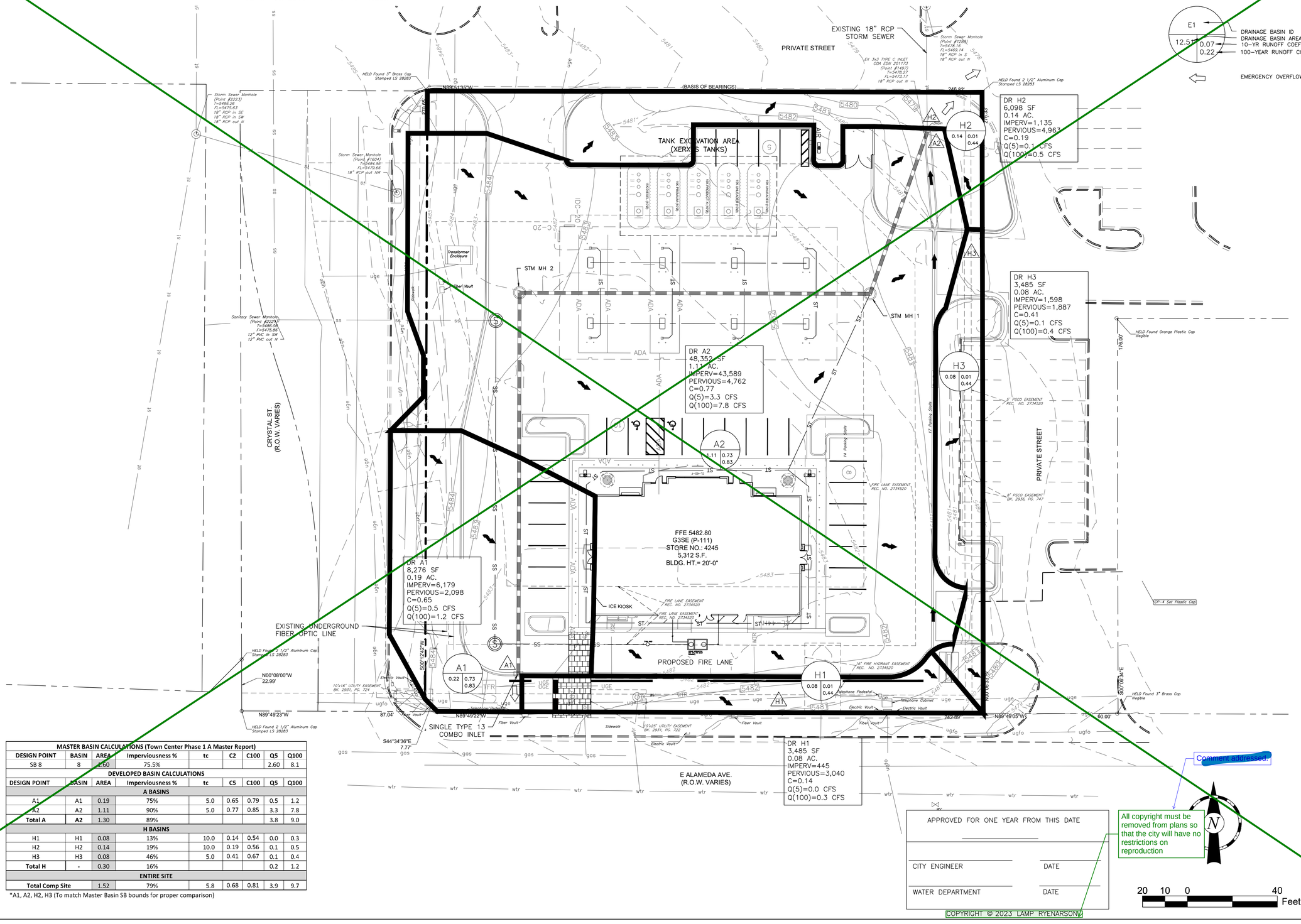
3. ALL PROPOSED STORM SIZED FOR 5-YR EVENT.

4. ALL PROPOSED STORM INFRASTRUCTURE IS PRIVATE.

5. APPLICANT UNDERSTANDS RE-CERTIFICATION MAY BE REQUIRED. IF POND CERTIFICATE, AN EXECUTED I&M PLAN, OR DRAINAGE EASEMENTS DO NOT EXIST, THEY WILL BE REQUIRED PRIOR TO CIVIL PLAN APPROVAL.

811 ALL UTILITIES ARE SHOWN BASED ON THE INFORMATION AVAILABLE TO THE ENGINEER. THERE IS NO GUARANTEE ALL FACILITIES ARE SHOWN OR THAT THE LOCATION, DEPTH, AND SIZE OF EACH FACILITY IS CORRECT. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND SERVICE LINES PRIOR TO CONSTRUCTION.
Know what's **below.** **Call** before you dig.

LEGEND:
- DRAINAGE BASIN BOUNDARY
- PRIVATE STORM SEWER LINE
- CHANNEL FLOW ARROW
- OVERLAND FLOW ARROW
- E1 — DESIGN POINT ID
- E1 / 12.51 / 0.07 / 0.22 — DRAINAGE BASIN ID; DRAINAGE BASIN AREA (AC); 10-YR RUNOFF COEFFICIENT; 100-YEAR RUNOFF COEFFICIENT
- EMERGENCY OVERFLOW ARROW



MASTER BASIN CALCULATIONS (Town Center Phase 1 A Master Report)								
DESIGN POINT	BASIN	AREA	Imperviousness %	tc	C2	C100	Q5	Q100
SB 8	8	1.60	75.5%				2.60	8.1
DEVELOPED BASIN CALCULATIONS								
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Total A	**A2**	1.30	89%				3.8	9.0
H BASINS								
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H2	H2	0.14	19%	10.0	0.19	0.56	0.1	0.5
H3	H3	0.08	46%	5.0	0.41	0.67	0.1	0.4
Total H	-	0.30	16%				0.2	1.2
ENTIRE SITE								
Total Comp Site		1.52	79%	5.8	0.68	0.81	3.9	9.7

*A1, A2, H2, H3 (To match Master Basin SB bounds for proper comparison)

APPROVED FOR ONE YEAR FROM THIS DATE

CITY ENGINEER DATE

WATER DEPARTMENT DATE

Comment addressed.

All copyright must be removed from plans so that the city will have no restrictions on reproduction

20 10 0 40 Feet

FILE LOCATION:L:\Engineering\02222026 Quik Trip Aurora\DRAWINGS\CONSTRUCTION DRAWINGS\83-4245 Civil-SITE.dwg TAB NAME:Post Dev Map USER:JaimeP SAVED:4/24/2023 11:54 AM PLOTTED:4/24/2023 2:38 PM

CHECKED BY: MAP
DRAWN BY: JUP

NORRIS DESIGN
Planning | Landscape Architecture | Branding
1101 Bannock Street
Denver, Colorado 80204
P 303.892.1166
www.norris-design.com

QUIKTRIP NO. 4245 - SITE PLAN

LOWRY CREDIT UNION FILING NO. 1
ALAMEDA AVE & CRYSTAL ST
CITY OF AURORA, ARAPAHOE COUNTY, COLORADO

APPLICANT
QuikTrip Corporation
12000 Washington St, Ste. 175
Thornton, CO 80241
303.248.0435

NOT FOR CONSTRUCTION

DATE:
04/24/2023

SHEET TITLE:
POST-DEVELOPED DRAINAGE MAP

C122

Comment addressed.

Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

201173 1/2

LEGEND:

- EXISTING CONTOURS
- DRAINAGE DIVIDE
- EXISTING OVERLAND FLOW ROUTE
- EXISTING STORM DRAIN
- DESIGN POINT

TOTAL AREA = 81.2 ac

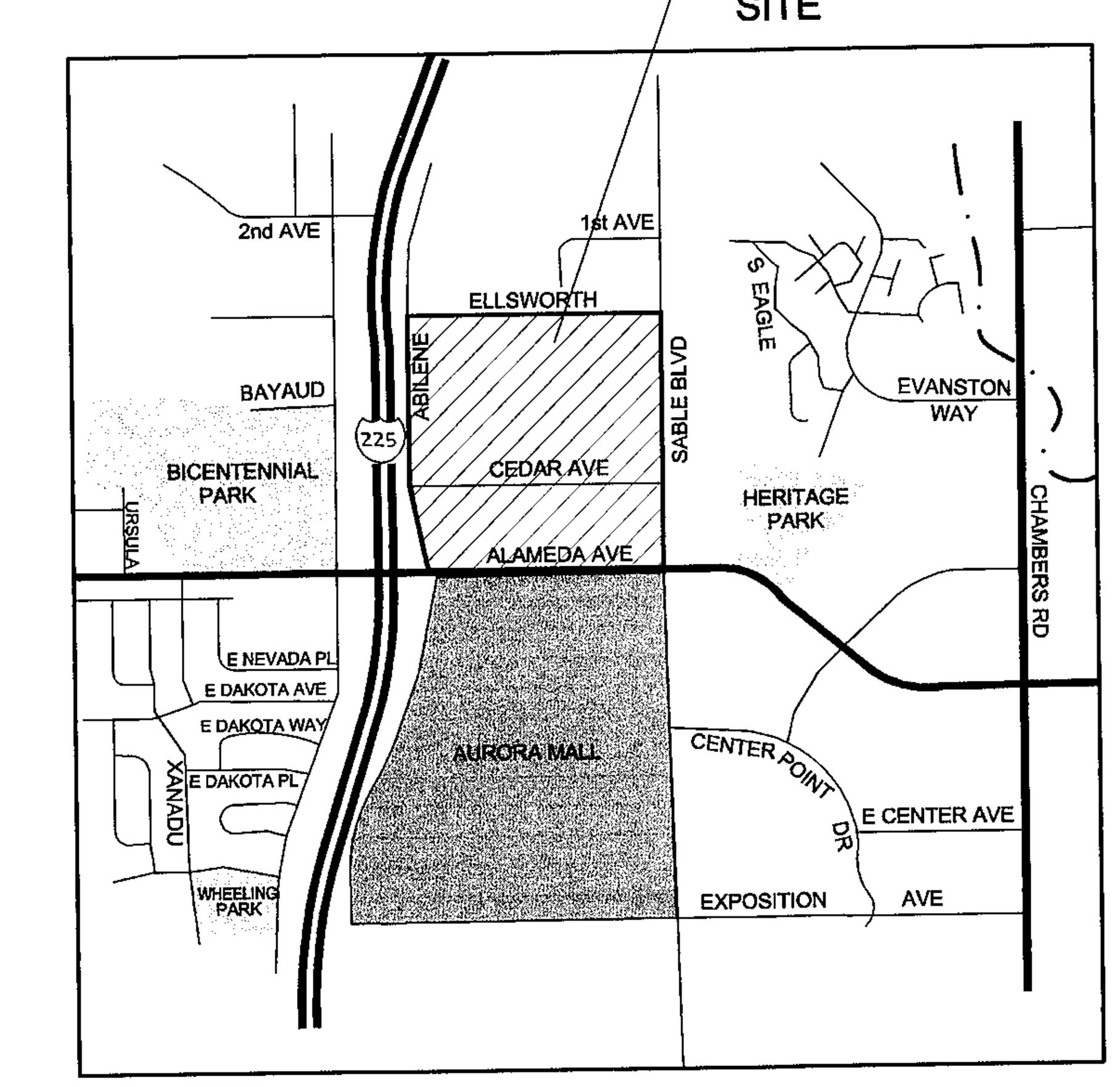
DESIGN POINT	EX. Q 5 YEAR	EX. Q 100 YEAR	100 YEAR ALLOWABLE DISCHARGE
E1	14.7	28.2	32.1 CFS
E2	9.1	17.4	63.0 CFS
E3	5.9	10.6	0.0 CFS
E4	6.4	12.9	12.9 CFS
E5	4.4	11.7	11.7 CFS
E6	5.5	11.3	11.3 CFS
E7	6.1	12.1	12.1 CFS
E8	29.3	58.2	152.0 CFS

-N-

Scale : 1"=100'

0 100 200 FEET

AURORA TOWN CENTER PROJECT SITE



VICINITY MAP

N.T.S.

APPROVED FOR ONE YEAR FROM THIS DATE

10-31-2001

CITY ENGINEER — DATE 10-22-01

DIRECTOR OF UTILITIES — DATE 10/25/01

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987

303-534-6700 METRO DENVER AREA UTILITY NOTIFICATION CENTER OF COLORADO

DATE	11 July 2001	11 July 2001	ISSUED FOR REVIEW
H. SCALE	1"=100'	6 Aug 2001	REVISED PER COA COMMENTS
V. SCALE		17 Oct 2001	REVISED PER COA COMMENTS
DESIGNER	PM		
DRAFTER	rh		
CHECKED BY	MC		

V3 CONSULTANTS

200 Union Boulevard Suite 200 Lakewood, Colorado 80228 303.989.8588 303.989.9932 fax

PRELIMINARY DRAINAGE STUDY
AURORA TOWN CENTER, SUBDIVISION FILING NO. 1
EXISTING CONDITIONS DRAINAGE MAP
AURORA, COLORADO

V3 PROJECT NUMBER: 01007

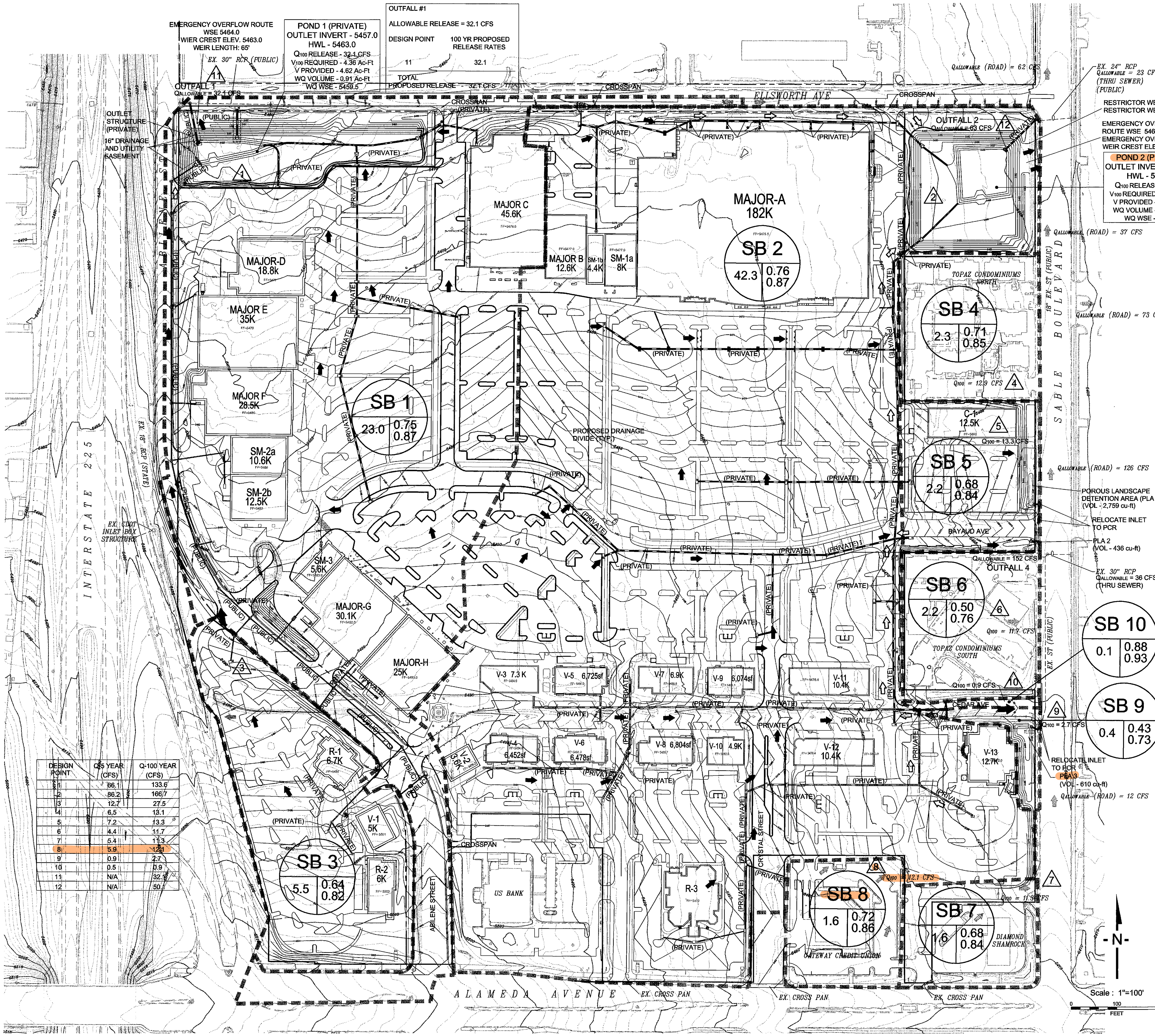
D1.0

201173 1/2

Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

Comment addressed.

201173 v2


EMERGENCY OVERFLOW ROUTE
WSE 5464.0
WIER CREST ELEV. 5463.0
WEIR LENGTH: 65'
POND 1 (PRIVATE)
OUTLET INVERT - 5457.0
HWL - 5463.0
Q100 RELEASE - 32.1 CFS
V100 REQUIRED - 4.36 Ac-Ft
V PROVIDED - 4.62 Ac-Ft
WQ VOLUME - 0.91 Ac-Ft
WQ WSE - 5459.5
OUTFALL #1
ALLOWABLE RELEASE = 32.1 CFS
DESIGN POINT
100 YR PROPOSED RELEASE RATES
11
32.1
TOTAL PROPOSED RELEASE - 32.1 CFS
OUTFALL 1
ELLSWORTH AVE
CROSSPAN
OUTFALL 2
EX. 24" RCP
QALLOWABLE = 23 CFS
(THRU SEWER)
(PUBLIC)
RESTRICTOR WEIR CREST ELEV. 5462.5
RESTRICTOR WEIR WSE 6463.0
EMERGENCY OVERFLOW ROUTE WSE 5464.0
EMERGENCY OVERFLOW WEIR CREST ELEV. 6463.0
POND 2 (PRIVATE)
OUTLET INVERT - 5456.0
HWL - 5463.0
Q100 RELEASE - 63 CFS
V100 REQUIRED - 5.05 Ac-Ft
V PROVIDED - 5.15 Ac-Ft
WQ VOLUME - 1.45 Ac-Ft
WQ WSE - 5459.7
MAJOR-A
182K
MAJOR C
45.6K
MAJOR B
12.6K
MAJOR-D
18.8K
MAJOR E
35K
MAJOR F
28.5K
SM-2a
10.6K
SM-2b
12.5K
SM-3
5.6K
MAJOR-G
30.1K
MAJOR-H
25K
SB 1
23.0
0.75
0.87
SB 2
42.3
0.76
0.87
SB 3
5.5
0.64
0.82
SB 4
2.3
0.71
0.85
SB 5
2.2
0.68
0.84
SB 6
2.2
0.50
0.76
SB 7
1.6
0.68
0.84
SB 8
1.6
0.72
0.86
SB 9
0.4
0.43
0.73
SB 10
0.1
0.88
0.93
TOPAZ CONDOMINIUMS NORTH
TOPAZ CONDOMINIUMS SOUTH
SABLE BOULEVARD
INTERSTATE 225
ALAMEDA AVENUE
ABILENE STREET
CRYSTAL STREET
BAYAUD AVE
CEDAR AVE
US BANK
GATEWAY CREDIT UNION
DIAMOND SHAMROCK
PROPOSED DRAINAGE DIVIDE (TYP.)
POROUS LANDSCAPE DETENTION AREA (PLA 1)
(VOL - 2,759 cu-ft)
RELOCATE INLET TO PCR
PLA 2
(VOL - 436 cu-ft)
EX. 30" RCP
QALLOWABLE = 36 CFS
(THRU SEWER)
OUTFALL 4
RELOCATE INLET TO PCR
PLA 3
(VOL - 610 cu-ft)
QALLOWABLE (ROAD) = 62 CFS
QALLOWABLE (ROAD) = 37 CFS
QALLOWABLE (ROAD) = 73 CFS
QALLOWABLE (ROAD) = 126 CFS
QALLOWABLE (ROAD) = 12 CFS
QALLOWABLE = 152 CFS
OUTLET STRUCTURE (PRIVATE)
16" DRAINAGE AND UTILITY EASEMENT
EX. CDOT INLET BOX STRUCTURE
EX. CROSS PAN
Scale : 1"=100'
0
100
200
FEET
- N -

LEGEND:

	EXISTING CONTOURS
89	PROPOSED CONTOURS
	SUBBASIN DELINEATION
BASIN 1	DRAINAGE BASIN IDENTIFICATION
AREA (Ac.) 0.00	RUNOFF COEFFICIENT: 0.00 5 YEAR, 0.00 100 YEAR
	EXISTING OVERLAND FLOW ROUTE
	PROPOSED 100-YR FLOW CONVEYED THROUGH PIPE
	PROPOSED 100-YR OVERLAND FLOW ROUTE
	PROPOSED STORM DRAIN
	EXISTING STORM DRAIN
#	DESIGN POINT

TOTAL AREA = 73.5 ac

NOTES:

1. ALL HISTORIC OUTFALL DESIGN FLOWS PERTAINING TO SOUTH SABLE BOULEVARD WERE OBTAINED FROM AURORA CENTER SUBDIVISION, FILING NO. 1 PLANS PREPARED BY STITES & ASSOCIATES, INC. DATED MAY 1977.

2. CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH THE CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

OUTFALL #2

ALLOWABLE RELEASE = 63 CFS

DESIGN POINT	100 YR PROPOSED RELEASE RATES
12	50.1
4	12.9

TOTAL PROPOSED RELEASE - 63.0 CFS

OUTFALL #4

ALLOWABLE RELEASE = 152 CFS

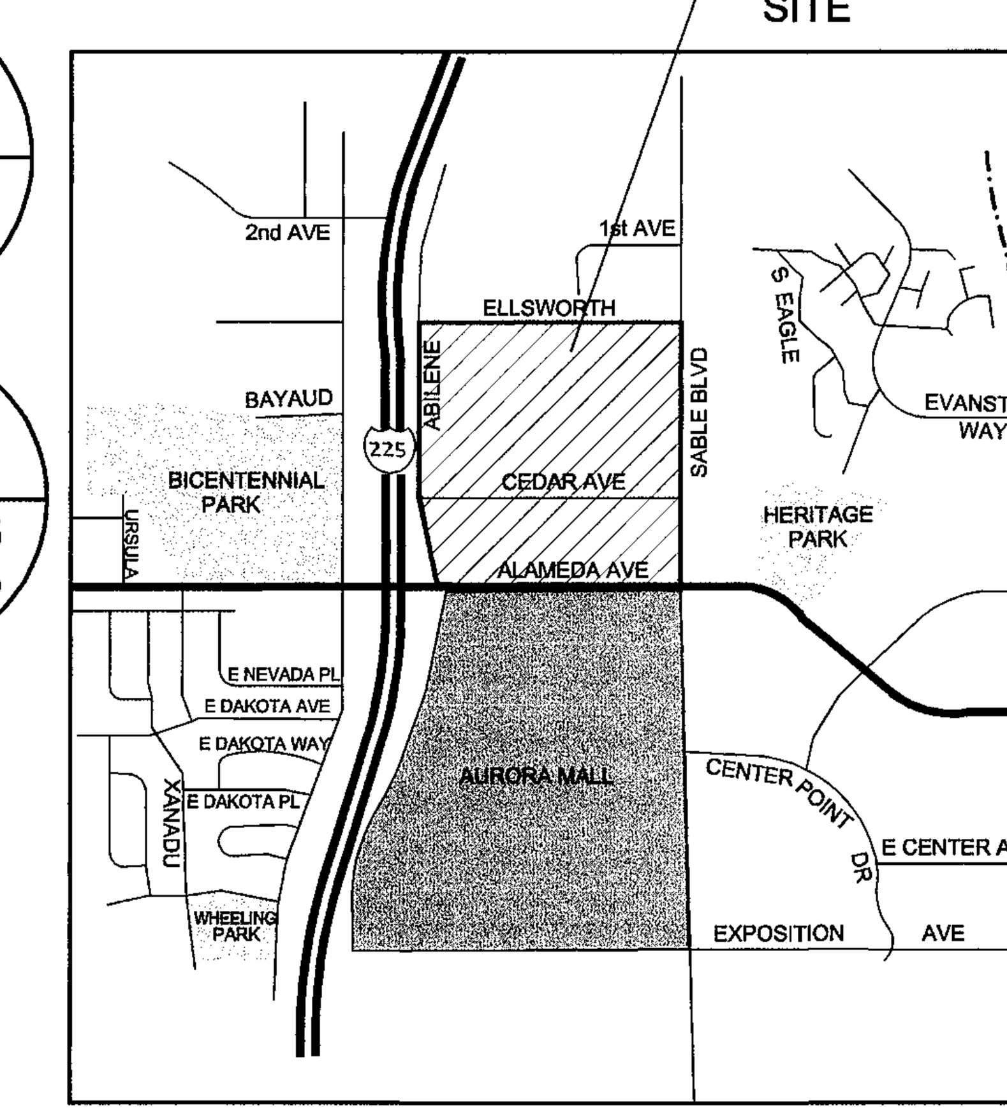
DESIGN POINT	100 YR PROPOSED RELEASE RATES
5	13.3
6	11.7
7	11.3
9	0.9
10	2.7

TOTAL PROPOSED RELEASE - 39.9 CFS

DESIGN POINT	Q-5 YEAR (CFS)	Q-100 YEAR (CFS)
1	66.1	133.6
2	86.2	166.7
3	12.7	27.5
4	6.5	13.1
5	7.2	13.3
6	4.4	11.7
7	5.4	11.3
8	5.9	12.1
9	0.9	2.7
10	0.5	0.9
11	N/A	32.1
12	N/A	50.1

BENCHMARK:

C.O.A. BENCHMARK # 07.1 045A WITH UNMARKED 2" BRASS CAP SET IN S END OF E CONCRETE HEADWALL OF HIGHLINE CANAL BRIDGE IN ABILENE ST @ 350'± S OF E 2nd AVE. CHANGED LINE NO. FROM 07 & REV. ELEV. ON 4-06-93 DUE TO UPDATED INFO. OLD ELEV. 5458.438' - NEW ELEV. 5458.439



VICINITY MAP

N.T.S.

APPROVED FOR ONE YEAR FROM THIS DATE

10-31-2001

CITY ENGINEER — DATE 10-23-01

DIRECTOR OF UTILITIES — DATE 10/25/01

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987

303-534-6700 METRO DENVER AREA UTILITY NOTIFICATION CENTER OF COLORADO

DATE	11 July 2001	11 July 2001	ISSUED FOR REVEIW
H. SCALE	1"=100'	6 August 2001	REVISED PER COA COMMENT
DESIGNER	PM	17 Oct 2001	REVISED PER COA COMMENT
DRAFTER	dh		
CHECKED BY	MC		

V3 CONSULTANTS

200 Union Boulevard
Suite 200
Lakewood, Colorado 80228
303.989.8588 303.989.9932 fax

PRELIMINARY DRAINAGE STUDY
AURORA TOWN CENTER, SUBDIVISION FILING NO. 1
PROPOSED CONDITIONS DRAINAGE MAP
AURORA, COLORADO

V3 PROJECT NUMBER: 01007

D1.1

Appendix B

Reference Material

Provide point rainfall data per NOAA Atlas 14 (Provide NOAA Atlas 14 Output in appendix)

Comments addressed.


104° 49' 18" W
104° 49' 11" W
515270
515280
515290
515300
515310
515320
515330
515340
515350
515360
515370
515380
515390
515400
515410
515420
515430
39° 42' 43" N
39° 42' 40" N
4395820
4395810
4395800
4395790
4395780
4395770
4395760
4395750
4395740
4395730
4395720
FdC
FdB
Crystal St
Alameda
Soil Map may not be valid at this scale.
Map Scale: 1:794 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 10 20 40 60
Feet
0 35 70 140 210
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 Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Arapahoe County, Colorado
Survey Area Data: Version 18, Sep 1, 2022

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
FdB	Fondis silt loam, 1 to 3 percent slopes	C	2.3	100.0%
FdC	Fondis silt loam, 3 to 5 percent slopes	C	0.0	0.0%
Totals for Area of Interest			**2.3**	**100.0%**

Description

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 soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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. Only the soils that in their natural condition are in group D are assigned to dual classes.

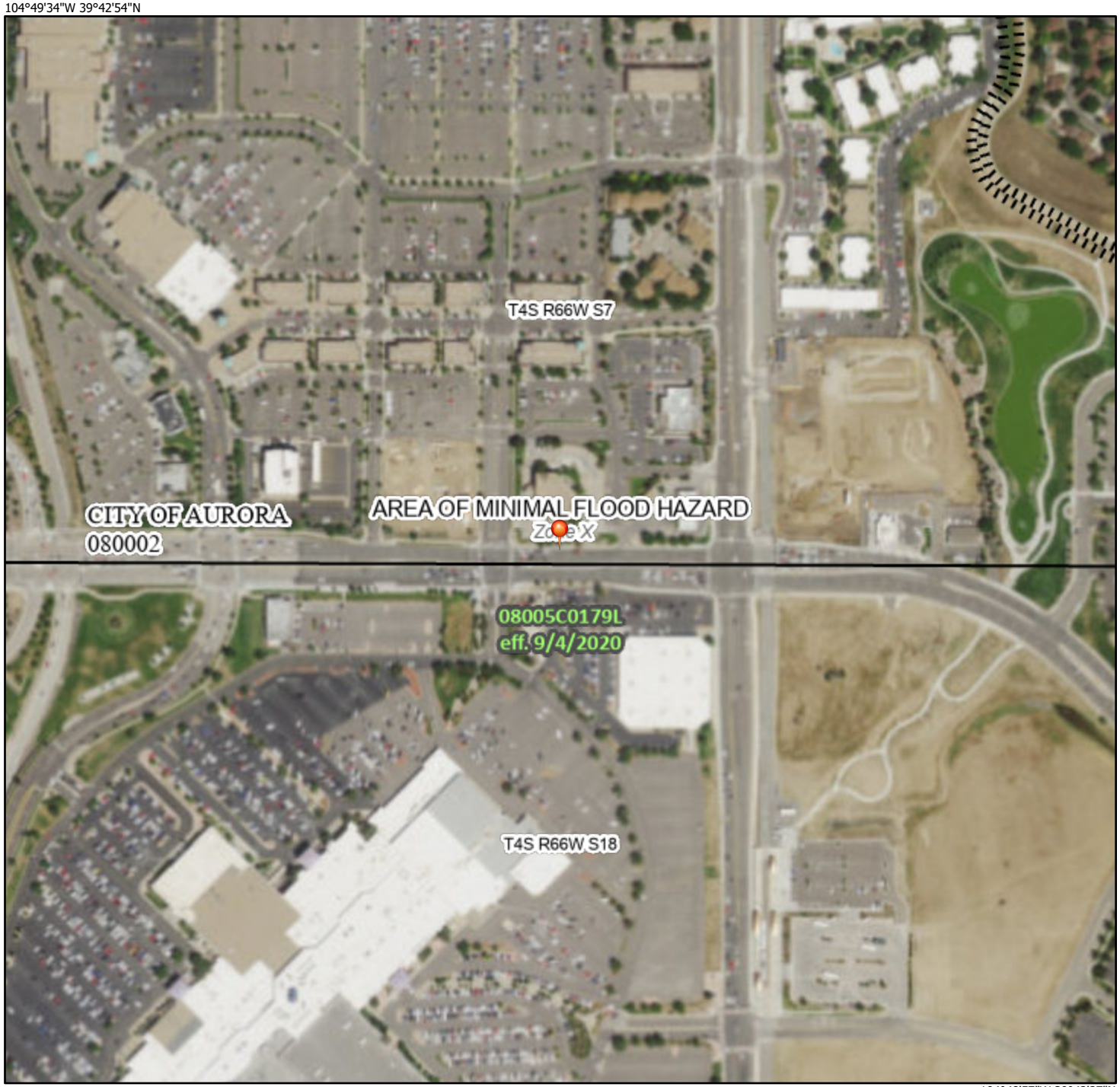
Rating Options

Aggregation Method: Dominant Condition

National Flood Hazard Layer FIRMette

FEMA

104°49'34"W 39°42'54"N



104°48'57"W 39°42'27"N

Feet 1:6,000

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

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

Legend

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

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

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

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

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

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- 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 3/13/2023 at 4:30 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.

CITY OF AURORA
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

Table of Contents

DESIGN STORM FREQUENCIES

Land Uses or Type of Facility	Minor Storm	Major Storm
Residential, Business, and Industrial	2-year[(1)]	100-year
City Center Zone	5-year[(1)]	100-year
Transit Oriented Developments, Urban Centers	N/A	100-year
Open Channels, Culverts, Bridges	See USDCM	100-year
Detention Ponds	(2)	100-year[(2)]

(1) Frequency for sizing of storm sewers (most cases). Storm sewer flows originating from a location with a larger design storm frequency shall continue with that frequency to a logical point of outfall.

(2) Detention ponds shall be evaluated for multiple discharges (10-year and 100-year storms). Single stage discharges (100-year) will only be allowed with prior approval by the City.

3.32 Street Flow Capacities

The primary purpose of streets is for traffic. However, streets are also an integral part of the storm drainage system and can be used for storm runoff within reasonable limits. The allowable street flows shall be calculated by multiplying the theoretical capacity by the reduction factor from Figure ST-2 of the USDCM. Figures 4A and 4B present the allowable 2-year and 100-year street flow capacities for different street classifications.

CHAPTER 5.00 HYDROLOGIC CRITERIA

5.10 INTRODUCTION

Basic information for calculating peak flows and runoff volumes is presented in this chapter. The Rational Method shall be used for small basins and the Colorado Urban Hydrograph Procedure for large basins. Consideration will be given to other methodologies on a case-by-case basis. Particular attention should be given to accurate computation of time-of-concentration.

5.20 RATIONAL METHOD

The Rational Method is applied for small drainage areas when peak runoff is needed for the sizing of storm sewer systems. See USDCM Volume I, Runoff Section, Table RO-1. The method is based on the following formula:

$$Q = CIA \qquad (5.1)$$

where Q = Peak discharge (cfs)
C = Runoff coefficient from Table 1
I = Rainfall intensity (inches/hour)
A = Drainage area (acres)

Form SF-1 presents the standard form to be used for computing the time of concentration.

5.21 Time of Concentration (Tc)

For urban areas, the time of concentration consists of an inlet time or overland flow time (t_i) plus the time of travel (t_t) in a storm sewer, paved gutter, roadside drainage ditch, drainage channel, or other drainage facilities. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel (t_t) in a combined form, such as a small swale, channel, or drainageway. The latter portion (t_t) of the time of concentration is estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Inlet time, on the other hand, will vary with surface slope, depression storage, surface coefficient, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow.

The time of concentration (t_c) shall be calculated using the following equation for both urban and non-urban areas:

$$t_c = t_i + t_t \qquad (5.2)$$

where t_c = time of concentration (minutes)
t_i = initial, inlet, or overland flow time (minutes)
t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

A. Non-Urbanized Basins

The initial or overland flow time (t_i) is calculated using the following equation:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{\sqrt[3]{S}} \qquad (5.3)$$

where t_i = initial or overland flow time (minutes)
C_5 = runoff coefficient for 5-year frequency
L = length of overland flow, (ft., 500 ft. max.)
S = average basin slope (ft/ft)

The equation shall be used for distances not more than 500 feet. For longer basin lengths, the runoff will be considered in a combined form and the travel time (t_t) shall be calculated using the hydraulic properties of the swale, ditch, or channel, or estimated using Figure 1. The time of concentration is then the sum of the initial flow time (t_i) and the travel time (t_t) in accordance with equation 5.2. **The minimum t_c shall be ten minutes under non-urbanized conditions**.

B. Urbanized Basins

The time of concentration (t_c) to the first design point after urbanization shall be the lesser value calculated using the equation in A. above (substituting appropriate values for the urbanized conditions, with a maximum length of overland flow of 300 feet) or the following:

$$t_c = \frac{L'}{180} + 10 \qquad (5.4)$$

Where t_c = time of concentration (minutes)

L' = length of flow to first design point from the most remote point (feet)

Normally the above equation will govern the time of concentration in urbanized basins.

The travel time (t_t) portion of the time of concentration shall be computed using the hydraulic properties of the ditch, channel, curb and gutter, storm sewer, or calculated using Figure 1. **The minimum t_c under urbanized conditions shall be five minutes**.

5.22 Rainfall Intensity

The intensity, I, is the average rainfall rate in inches per hour for a duration equal to the time-of-concentration. An approximation for the rainfall intensity can be determined using the following equation:

In the City of Aurora, the only accepted storm inlet in the public right-of-way or for public ownership is the Type R modified curb-opening inlet. Grated and combination inlets may be used in private areas, or only with the written approval of the City Engineer. Grated inlets located in areas where bicycle or pedestrian traffic is expected shall have bicycle/pedestrian-safe grates.

6.52 Inlet Design

The length of opening required for curb-opening inlets shall be based on UDFCD's UD-INLET spreadsheets or the inlet capacity charts and design procedures included at the end of this manual (Figures 2 and 3).

The minimum length for a single curb-opening inlet is 5 feet and the maximum length is 15 feet. If the required length exceeds 15 feet, multiple inlets shall be used, or a structural design (with calculations submitted for approval) of the inlet, stamped and signed by a Professional Engineer, is required. These calculations and details shall be included with the first review of the civil submittal for the project. The maximum length of an inlet shall be 30-feet.

Inlets greater than ten feet in depth require structural design and details be submitted for review and approval. The calculations and details shall be included with the first review of the civil submittal for the project.

Design procedures for private grated and private combination inlets can be found in the USDCM chapter on "Street/Inlets/Storm Sewers."

To compensate for effects which decrease the capacity of the inlets such as debris plugging, pavement overlaying, and variations in design assumptions, the theoretical capacity calculated for the inlets designed using Figures 2 and 3 (UD-INLET has its own clogging factors) shall be reduced by the following reduction factors to determine the allowable capacity of the inlet:

Inlet Type	Percentage of Theoretical Capacity Allowed
Curb Opening	80%
Grated	50%
Combination	65%

The size of outlet pipes from storm water inlets shall be based upon the design flow rate at the inlet, but shall not be less than 18 inches in diameter.

All inlets in sump condition must provide an emergency overflow. All emergency overflows shall be designed for a 100-year storm, assuming the storm sewer pipes are plugged.

Inlets shall be sized with the appropriate design storm for the system. If an inlet is designed for the 2-year design storm, then, it must be considered plugged during the 100-year storm.

CHAPTER 7.00 COMPUTER PROGRAMS

There are many computer programs on the market for the analysis and design of storm water facilities. However, to assist in the review of design computations and to promote uniformity of results, the designer should use the following computer software which have been developed under the support of several Denver Metropolitan Cities and Counties and the Urban Drainage and Flood Control District:

CUHP-2005, latest edition: Colorado Urban Hydrograph Procedure computer model, developed for urban runoff prediction. Submit paper and electronic copies with each submittal.

EPA SWMM 5.0, latest edition: Modified EPA runoff block of the SWMM package, used with CUHP-2005 as a watershed modeling and flow routing for urban areas. EPA SWMM 5.0 is the only routing program acceptable to the City, except where older versions of UDSWMM will continue to be used in certain drainage basins. Submit paper and electronic copies with each submittal.

UD-RATIONAL, latest edition: When dealing with a drainage network, RATIONAL can accumulate flow times and peak runoff rates with detailed tabulations of computations.

NEO-UDSEWER, latest edition: Storm Sewer Design and Flow Analysis

UD-INLET, latest edition: Street Hydraulics and Inlet Sizing

UD-CHANNELS, latest edition: Design of Open Channels – This spread sheet is good for preliminary design of open channels. More detailed analysis will be required for final approval of channel design.

UD-CULVERT, latest edition: Design of Culverts

Other computer software widely used in the design of stormwater facilities may be approved by the City on a case-by-case basis.

To compute water surface profiles in open channels and drainageways, the designer shall use the computer programs HEC-2 or HEC-RAS developed by the Army Corps of Engineers. Submit paper and electronic copies with each submittal.

Computer spreadsheets may be used if they conform to the City of Aurora standard forms.

TABLE 1
RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	85	.60	.65	.70	.80
Residential:					
Single-Family (**)	(*)	.40	.45	.50	.60
Multi-Unit (detached)	60	.45	.50	.60	.70
Multi-Unit (attached)	75	.60	.65	.70	.80
1/2 Acre Lot or Larger	(*)	.30	.35	.40	.60
Apartments	80	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Areas	90	.80	.80	.85	.90
Parks, Cemeteries	5	.10	.10	.35	.60
Playgrounds	10	.15	.25	.35	.65
Schools	50	.45	.50	.60	.70
Railroad Yard Areas	15	.40	.45	.50	.60
Undeveloped Areas:					
Historic Flow Analysis, Greenbelts, Agricultural	2	(See "Lawns")			
Off-Site Flow Analysis (when land use not defined)	45	.43	.47	.55	.65

TABLE 1 (continued)

RUNOFF COEFFICIENTS AND PERCENTS IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY			
		2	5	10	100
Streets:					
Paved	100	.87	.88	.90	.93
Gravel	40	.15	.25	.35	.65
Concrete Drive and Walks	96	.87	.87	.88	.89
Roofs	90	.80	.85	.90	.90
Lawns, Sandy Soil (A and B Soils):	2				
2% Slope		.05	.06	.08	.10
2-7% Slope		.10	.11	.13	.15
>7% Slope		.15	.16	.18	.20
Lawns, Clay Soil (C and D Soils):	5				
2% Slope		.13	.14	.15	.17
2-7% Slope		.18	.19	.20	.22
>7% Slope		.25	.27	.30	.35

NOTE: These Rational Formula coefficients may not be valid for large basins

(*)See Figures *RO-3 through RO-5* of USDCM Volume 1 for percent impervious.

(**)Up to 5 units per acre. Single-family with more than 5 units per acre, use values for multi-unit/detached

.

TABLE 2

Roughness Coefficients ("*n*") for Channel Design

(after Chow 1959)

Channel Type	Roughness Coefficient (*n*)		
	Minimum	Typical	Maximum
I. Excavated or Dredged			
1. Earth, straight and uniform			
a. Gravel, uniform section, clean	0.022	0.025	0.030
b. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. Grass, some weeds	0.025	0.030	0.033
b. Dense weeds or aquatic plants	0.030	0.035	0.040
c. Earthy bottom and rubble/riprap sides	0.028	0.030	0.035
3. Channels not maintained, weeds and brush uncut			
a. Dense weeds, high as flow depth	0.050	0.080	0.120
b. Clean bottom, brush on sides	0.040	0.050	0.080
II. Natural streams (top width at flood stage 100 ft)			
1. Streams on plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Clean, winding, some pools and shoals, some weeds and stones	0.035	0.045	0.050
c. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
III. Lined or Built-Up Channels			
1. Concrete			
a. Towel/float finish	0.011	0.015	0.016
b. Shotcrete	0.016	0.020	0.025
2. Gravel bottom with sides of:			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
3. Wetland Bottom Channels	See Figure 6		
4. Grass-Lined Channels and Swales	See Figure 7		

(Source: USDCM, Volume 1, Major Drainage, 04/2008)

TABLE 2 (continued)

Large Conduits:	
Concrete:	Manning's n
Precast concrete pipe, ordinary joint alignment	0.013
Poured in place, steel forms, projections 1/8" or less	0.013
Poured in place, smooth wood forms, projections 1/8" or less	0.013
Poured in place, ordinary work with steel forms	0.014
Poured in place, ordinary work with wood forms	0.015
Steel:	
Structural plate corrugated, 2"x6" corrugations, 5' to 20' diameter	$\frac{0.0377}{D^{0.078}}$
Corrugated pipe, 1"x3" corrugations, 3' to 8' diameter	$\frac{0.0306}{D^{0.075}}$
Plastic/HDPE:	
Pipe with smooth interior wall	0.012

Table 6-3. Recommended percentage imperviousness values

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

Table 6-5. Runoff coefficients, *c*

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

201171
8G

2001-3030

CONSULTANTS

FINAL DRAINAGE REPORT
for
Aurora Town Center
Subdivision Filing No. 1 - Phase 1A
Aurora, Colorado

January 8, 2002

Prepared for:

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APPROVED FOR ONE YEAR FROM THIS DATE
1/23/2002
WEW 1/11/02 — 1-11-02
DIRECTOR OF PUBLIC WORKS
JAW 1-16-02 — 1/16/02
DIRECTOR OF UTILITIES

AURORA TOWN CENTER
Subdivision Filing No. 1 - Phase 1A
FINAL DRAINAGE REPORT

1.0 INTRODUCTION

Aurora Town Center – Phase 1A is a commercial/retail shopping center located in the southwest corner of Section 7, Township 4 South, Range 66 West of the Sixth Principal Meridian in the City of Aurora, Arapahoe County, Colorado. Aurora Town Center is located on approximately 73.5 acres of land with sparse residential and commercial development within the area. Fully or partially improved roadways are located adjacent to the site. South Sable Boulevard (an existing 90-foot right-of-way) and East Alameda Avenue (an existing 110-foot right-of-way) are fully improved roadways with curb, gutter and sidewalk. South Abilene Street (the northern portion is lying currently within the existing CDOT Interstate Highway - 225 right-of-way) and East Ellsworth Avenue (an existing 60-foot right-of-way) are improved roadways with no curb, gutter or sidewalk **(See Figure 1).**

Phase 1A consists of the construction of a Super Target Store, two detention ponds and adjacent surface parking lots which encompass approximately 26 acres. The existing developments that border Phase 1A consists of two single-family residential housing units within Tract 48 north and adjacent to East Cedar Avenue. Also adjacent to Phase 1A is Tract 49 which has previously been subdivided into two separate plats. The northern portion was platted as Topaz Townhomes Subdivision Filing No. 2, and the southern portion has been platted as Cedar Square Subdivision Filing No. 2. The Topaz Townhomes project was never completed, although utility improvements and internal access roadways have been constructed. This parcel will be replatted as a portion of the Aurora Town Center development. The Cedar Square Subdivision, Filing No. 2 is a multi-family development. Cedar Square Subdivision Filing No. 1 is also an existing multi-family development located just north of the Topaz Townhomes Subdivision Filing No. 2, on the south half of Tract 34. There are also some single-family units within the Sable Ridge Subdivision, Filing No. 4, located south and adjacent to East Ellsworth Avenue within the Phase 1A development area.

The majority of Phase 1A is currently undeveloped vacant land covered with sparse native vegetation with exception to some single-family units within Sable Ridge Subdivision mentioned above. The entire subject property is proposed to be overlot graded. Refer to the Erosion and Sediment Control Report and Plan prepared by V3 Consultants dated July 13, 2001 for more information regarding the overlot grading design.

1.1 Proposed Conditions

As stated above, the proposed development for phase 1A will consist of a 182,000 square foot Super Target Store with internal parking areas, landscaped islands and landscaped areas around the building. This development will also include the construction of two detention ponds.

3.2 Hydrologic Criteria

As referenced in the Preliminary Drainage Study, the Rational Method analysis utilizing the Intensity-Duration-Frequency curves established for the City of Aurora for the area north of Alameda Avenue were used in the determination of on-site runoff for the 5-year and 100-year storm events **(See Exhibit 2)**. The 5-year and 100-year runoff coefficients were based on the type of proposed development and were weighted according to the existing and proposed land uses in each subbasin. The time of concentration values have been calculated for each of the subbasins per the City of Aurora's Criteria.

Detention Pond 1 was sized according to criteria established in the City of Aurora's "Storm Drainage Design and Technical Criteria" manual, along with the UDFCD's, "Urban Drainage Criteria Manual, Volume 3 Best Management Practices." Detention Pond 2 at the northeast corner of the site was sized according to the volume required to discharge the preapproved allowable flow rate at this location. A version of the rational method (FAA Method) was used which assumes a constant runoff coefficient and uses the area of the drainage basin and the allowable release rate for the basin to determine a storage volume. The method calculates a volume based on the stormwater runoff coming into the pond minus the stormwater runoff leaving the pond (the allowable release rate) multiplied by the time duration corresponding to the stormwater runoff coming into the pond. The intensity is varied depending on time using the intensity curves for the City of Aurora (north of Alameda Avenue). The maximum stored volume over a duration of time is the required detention volume for the pond.

4.0 DRAINAGE FACILITY DESIGN

4.1 General Concept

The proposed Phase 1A site has been divided into two distinct subbasins (SB1 and SB2). The proposed 100 - year storm event release rates, in both cases, have been either matched or reduced from the allowable release rates. The calculations for the release rates for both Ponds 1 and 2 have been included in the Preliminary Drainage Study. Both of the two detention ponds are proposed in Phase 1a. Pond 1 located at the northwest corner of the site will detain stormwater runoff from SB 1, restrict the release rate from the ponds to the allowable release rates and provide sufficient stormwater detention volume as set forth in the City of Aurora's Storm Drainage Design and Technical Manual. Pond 2, which is located at the northeast corner of the site, will detain stormwater runoff from SB 2 and restrict the release from the pond to the approved maximum release rate stated in the Preliminary Drainage Study and will provide sufficient stormwater detention volume according to the FAA Method.

Per the Preliminary Drainage Study, the allowable release rate from Pond 1 is 32.1 cfs. The allowable release rates for the eastern drainage area is also set forth in the Preliminary Drainage Study. The study allows for a release rate of 63 cfs at Outfall 2 which is located at the Ellsworth Avenue and Sable Boulevard intersection. The 100-year unrestricted release from the Topaz Townhomes North site of 12.9 cfs is also tributary to Outfall 2 therefore the allowable release rate needs to be reduced accordingly. The allowable release rate from Pond 2 is

63.0 cfs-12.9 cfs or 50.1 cfs. The storm sewer system at Outfall 2 is an existing 30" RCP which crosses under Sable Boulevard at this point.

4.1.1 Subbasin 1

Subbasin 1 (SB 1), consists of 23 acres within the western portion of the site and is tributary to Pond 1 and Outfall 1. Included in the area tributary to Pond 1 are Subbasin 1 and Subbasin 3 which total 28.5 acres (See PDSE 1 for Overall Areas). An internal ridgeline separates SB 1 from SB 2. The percent imperviousness of the totally developed SB 1 and SB 3 is 76.5. As stated in the Preliminary Drainage Study, the calculated volume for the 100-year storm event is 3.45 ac-ft. An additional 0.88 ac-ft of volume is required for Water Quality to bring the total required volume of Pond 1 to 4.36 ac-ft. Three (3) walls with a maximum height of 3.5' will be constructed on the south and east sides of Pond 1 to obtain the required volume. The actual volume provided at a high water level of 5463.0 in Pond 1 is 4.62 ac-ft. The water surface elevation at the required water quality volume is 5459.82. The historic flow rate of 32.1 cfs will be maintained through the use of a 23" restrictor orifice that restricts the runoff into the existing storm sewer system located within Ellsworth Avenue at Outfall 1. Also as part of the outlet structure is a 40-hr drain time orifice plate designed per Urban Storm Drainage Criteria Manual Volume 3. On the upstream side of the orifice plate is a trash rack to capture debris before it can clog the orifice. A 2.33' deep micro pool will be constructed at the bottom of Pond 1, below the invert of the outlet, to capture additional sedimentation before the stormwater is released into the existing storm sewer. Pond 1 has been located a distance of 40' (from the back of curb to the high water level of the pond) south of Ellsworth Avenue in anticipation of a future RTD light rail track along Ellsworth Avenue.

Stormwater runoff from SB 1 during the 5-year storm event will be collected in an onsite storm sewer system and conveyed to Pond 1. The onsite storm sewer system is designed to convey the 5-year storm event without surcharging the pipes. Stormwater runoff from SB 1 during the 100-year storm event will be conveyed to Pond 1 via overland flow with a maximum ponding depth of 1-½' within the drive aisles and 1 foot within parking areas. The emergency overflow from Pond 1 is an earth weir located at the northwest corner of the pond. The weir, with a crest length of 41', has been sized to discharge the 100-year developed peak inflow to the pond.

4.1.2 Subbasin 2

Subbasin 2 (SB 2) consisting of 42.3 acres within the northeast portion of the site is tributary to Pond 2 and Outfall 2, located at the northeast corner of the site. Included in the area tributary to Pond 2 are Subbasin 2 and Subbasin 8 which total 43.9 acres (See PDSE 1 for Overall Areas). The percent imperviousness of SB 2 and SB 8 is 80.2. The allowable release rate, per the Preliminary Drainage Study for Outfall 2, from Pond 1 is 50.1 cfs of which 10.0 cfs will be discharged into the storm sewer and the remaining 40.1 cfs will be discharged directly onto Sable Boulevard

via an overland restrictor weir with a length of 34.8'. The 10.0 cfs will be discharged from SB 2 into the storm sewer via a 12.1" restrictor orifice. With an allowable release rate of 50.1 cfs and using the FAA Method for calculating stormwater detention volume, the total stormwater detention volume required for Pond 2, including a 1.45 ac-ft increase for water quality volume, is 5.05 ac-ft while the actual volume provided is 5.16 ac-ft. The water surface elevations for the required water quality volume and the 100-year storm event are 5459.5 and 5463.0, respectively. Also as part of the outlet structure is a 40-hr drain time orifice plate designed per Urban Storm Drainage Criteria Manual Volume 3. On the upstream side of the orifice plate is a trash rack to capture debris before it can clog the orifice. A 2.33' deep micro pool will be constructed at the bottom of Pond 2, below the invert of the outlet, to capture additional sedimentation before the stormwater is released into the existing storm sewer.

WQCV taken care of

Pond 2 has been offset from Ellsworth Avenue and Sable Boulevard to a distance of 40' and 40' respectively (from the back of curb to the high water level of the pond) in anticipation of a future RTD light rail tracks planned along those streets. One (1) wall with a maximum height of 3.5' will be constructed along the north, west, and south sides of Pond 2 in order to obtain the required detention volume.

Stormwater runoff from the 5-year storm event will be conveyed via storm sewers to Pond 2. The storm sewer system has been designed to convey the 5-year storm event without surcharging the pipes. For the most part, the 100-year storm event will be conveyed to the Pond via overland flow with a maximum ponding depth of 1-½' within the drive aisles and 1 foot within parking areas. There are a few areas, such as the area just south of Cedar Avenue where runoff from the 100-year storm event will need to be conveyed via storm sewers to Pond 2 due to grading restrictions which make it impossible to provide an overland flow route to the pond.

5.0 CONCLUSION

5.1 Compliance with Standards

This drainage report was prepared in accordance to current engineering standards and applicable criteria as practiced in the Denver Metropolitan area and the City of Aurora Storm Drainage Design and Technical Criteria Manual.

5.2 Summary

The proposed Aurora Town Center, Phase 1A will consist of approximately 26 acres and is located within the City of Aurora. Two proposed detention ponds will be required to attenuate the peak flow generated from the site to levels at or below the accepted flow rate for the existing storm drain systems within Ellsworth Avenue and Sable Boulevard. There are two points of outfall where stormwater runoff is discharged from the site. Outfalls 1 and 2 will release stormwater runoff at the allowable release rates through the use of restrictor plates and overland weirs at the outlet locations.

AURORA TOWN CENTER
WATER QUALITY AND
100 REQUIRED DETENTION VOLUME CALCULATIONS

WATER QUALITY VOLUME

WATER QUALITY VOLUME= (WQCV/12)*A*1.2(
where, WQCV is equal to the 40-hr Drain Time Water Quality Control Volume (inches) from Figure EDB-2, from the Manual and

A is equal to the Subbasin Area

SUBBASIN	TOTAL AREA	PERCENT IMPERVIOUS	WQCV (inches)	WQ VOLUME	WQ VOL*20%	TOTAL VOLUME(100)
SB 1 (POND 1)	28.5	76.5	0.32	0.76	0.15	0.91
SB 2 (POND 2)	43.9	80.2	0.33	1.21	0.24	1.45

100-YR STORMWATER DETENTION VOLUME

VOLUME =$K_{(100)}$*A

where A is equal to the Subbasin Area and

$K_{(100)}=(1.78I-0.002I^2-3.56)/1000$

where I is equal to the percent impervious area

SUBBASIN	TOTAL AREA	PERCENT IMPERVIOUS	K(100)	VOLUME(100)	WQ VOL	TOTAL VOLUME(100)
SB 1 (POND 1)	28.5	76.5	0.12	3.45	0.91	4.36
SB 2 (POND 2)*						

* SEE ATTACHED RATIONAL METHOD CALCULATIONS FOR STORMWATER DETENTION VOLUME FOR POND 2

Aurora Town Center-Pond 2
Detention Pond Volume Calculations

Elevation	Area	Avg. Area	Incremental Depth	Incremental Volume (cf)	Cum. Volume (cf)	Cum Vol (Ac-ft)	
							2.33' DEEP
							MICROPOOL
5456.0	11,591						
		12,504	1.0	12,492	0	0.00	
5457.0	13,416						
		14,667	1.0	14,667	14,667	0.34	
5458.0	15,918						
		22,654	1.0	22,654	37,321	0.86	
5459.0	29,390						
		37,099	1.0	37,099	74,420	1.71	**WQ WSE-5459.7**
5460.0	44,807						
		46,578	1.0	46,578	120,998	2.78	
5461.0	48,349						
		50,149	1.0	50,149	171,146	3.93	
5462.0	51,948						
		53,811	1.0	53,811	224,957	5.16	
5463.0	55,674						**100-YR WSE-5463.0**

TOTAL VOLUME PROVIDED **5.16 AC-FT**

NOTE: MICROPOOL VOLUME IS NOT INCLUDED IN TOTAL STORMWATER DETENTION VOLUME CALCULATIONS

AURORA TOWN CENTER
5-YEAR WEIGHTED RUNOFF COEFFICENTS AND PERCENT IMPERVIOUS CALCULATION

TYPE OF AREA	5-YR "C" FACTOR	PERCENT IMPERVIOUS
PAVEMENT	0.88	100
ROOF	0.85	90
LANDSCAPE	0.25	7

We must remain at or under this imperviousness.

SUBBASIN	TOTAL AREA	PAVEMENT AREA	ROOF AREA	LANDSCAPE AREA	5-YR RUNOFF COEFFICIENT	PERCENT IMPERVIOUS
SB 1	23.0	14.0	4.4	4.6	0.75	79.5
SB 2	42.3	24.9	9.5	7.9	0.76	80.4
SB 3	5.5	3.0	0.4	2.1	0.64	63.8
SB 8	1.6	1.0	0.2	0.4	0.72	75.5
SB 2&8 COMB.	43.9	25.9	9.7	8.3	0.75	80.2
SB 1&3 COMB.	28.5	17.0	4.8	6.7	0.73	76.5

Subbasin Designations refer to Preliminary Drainage Study

AURORA TOWN CENTER
100 YEAR WEIGHTED RUNOFF COEFFICENTS AND PERCENT IMPERVIOUS CALCULATION

TYPE OF AREA	100-YR "C" FACTOR	PERCENT IMPERVIOUS
PAVEMENT	0.93	100
ROOF	0.90	90
LANDSCAPE	0.65	7

SUBBASIN	TOTAL AREA	PAVEMENT AREA	ROOF AREA	LANDSCAPE AREA	100-YR RUNOFF COEFFICIENT	PERCENT IMPERVIOUS
SB 1	23.0	14.0	4.4	4.6	0.87	79.5
SB 2	42.3	24.9	9.5	7.9	0.87	80.4
SB 3	5.5	3.0	0.4	2.1	0.82	63.8
SB 8	1.6	1.0	0.2	0.4	0.86	75.5
SB 2&8 COMB.	43.9	25.9	9.7	8.3	0.87	80.2
SB 1&3 COMB.	28.5	17.0	4.8	6.7	0.86	76.5

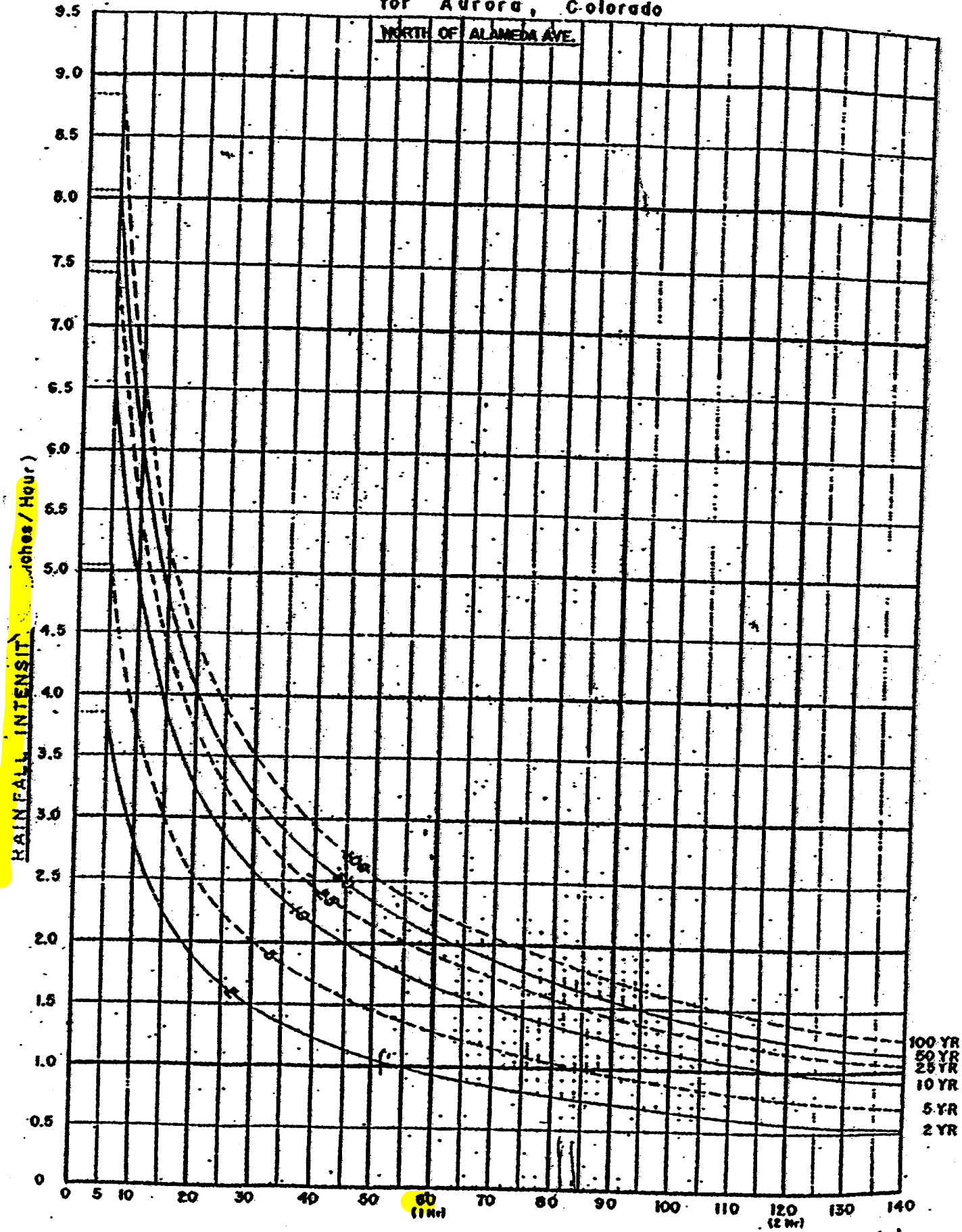
Subbasin Designations refer to Preliminary Drainage Study

STORM DRAINAGE SPECIFICATIONS

INTENSITY-DURATION-FREQUENCY CURVES

for Aurora, Colorado

NORTH OF ALAMEDA AVE.

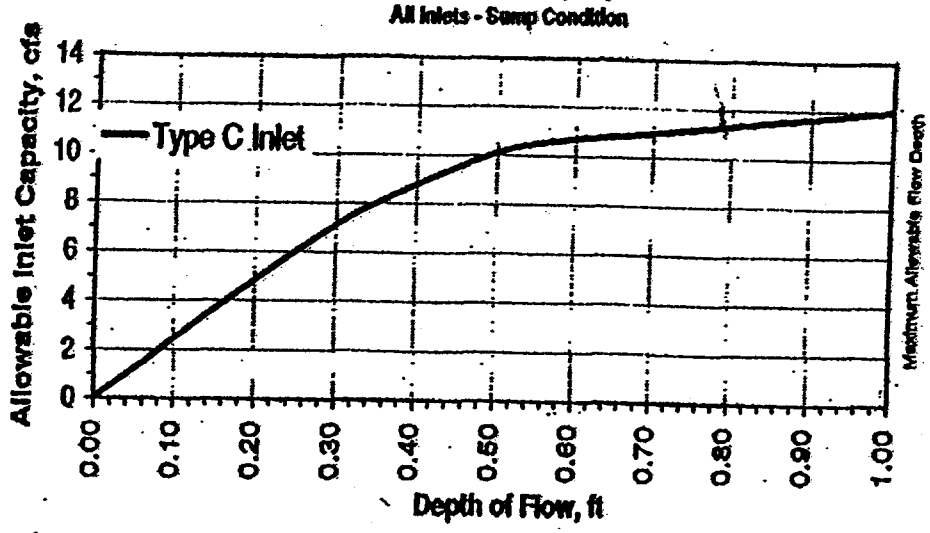


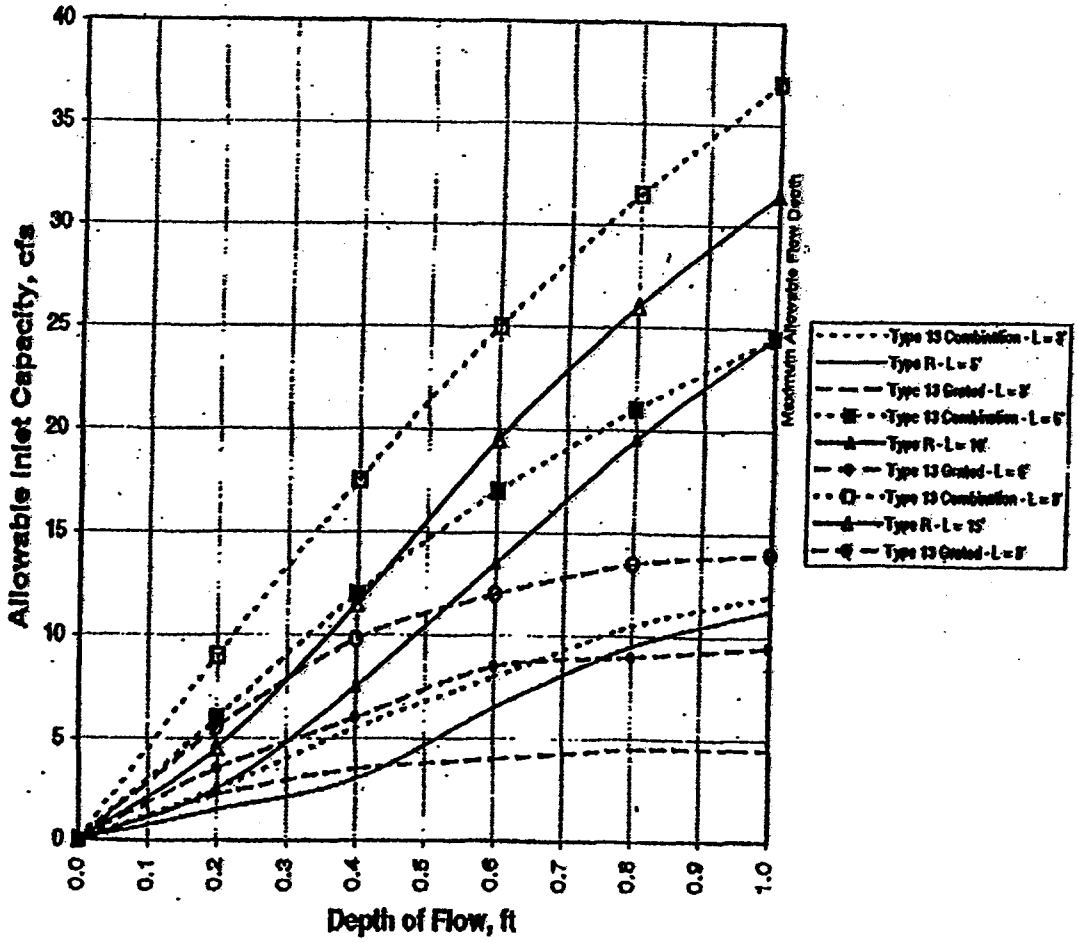
August, 1969

CHART I-I
(0 to 140 Min)

FIGURE 3

Figure 904
Allowable Inlet Capacity
All Inlets - Sump Condition





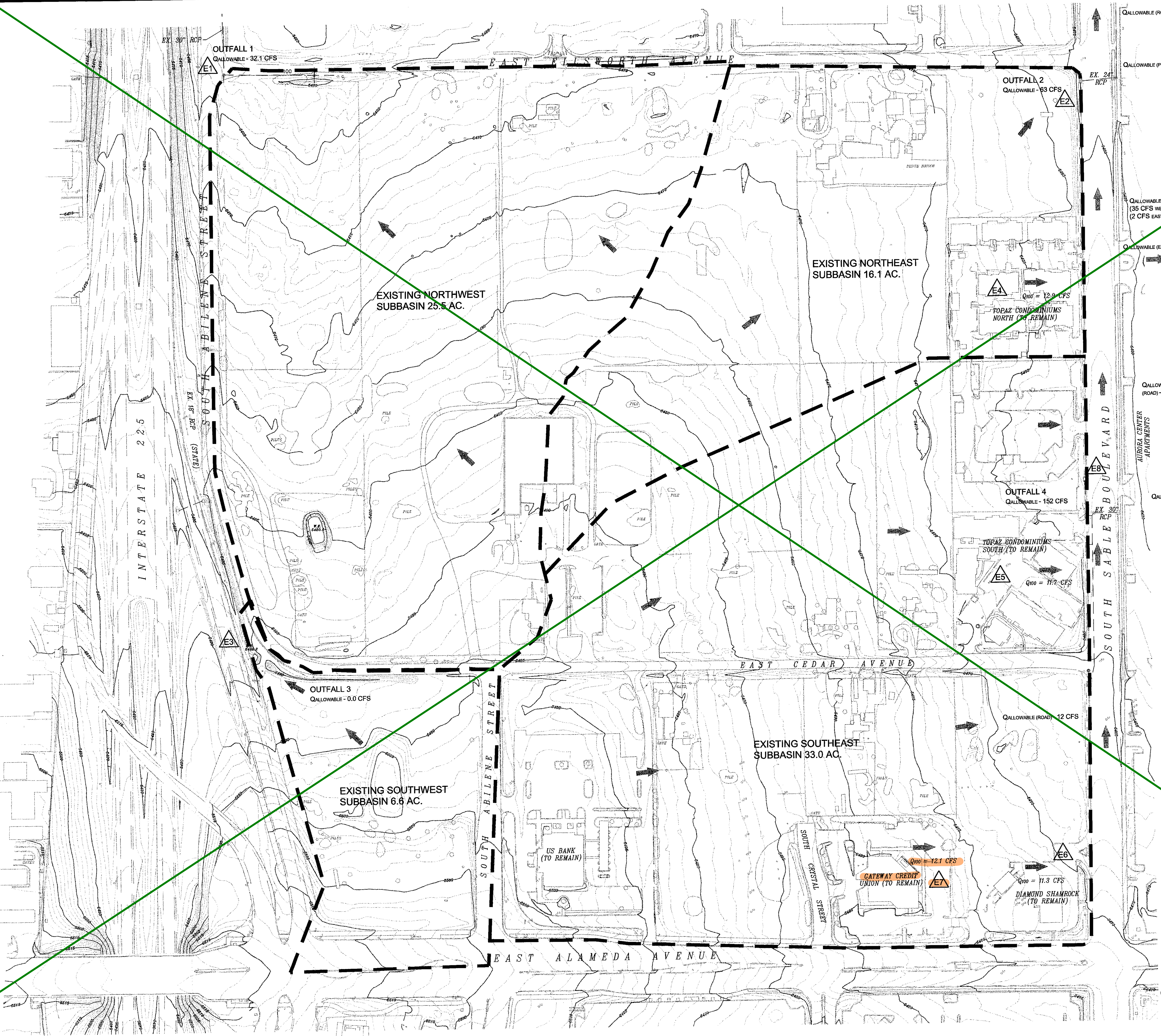
Reference: WRC Engineering, Inc., TM-1, February 1989

Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

This page is already included in the report

Remove redundant pages

201173 ½



LEGEND:

EXISTING CONTOURS

DRAINAGE DIVIDE

EXISTING OVERLAND FLOW ROUTE

EXISTING STORM DRAIN

DESIGN POINT

TOTAL AREA = 81.2 ac

DESIGN POINT	EX. Q 5 YEAR	EX. Q 100 YEAR	100 YEAR ALLOWABLE DISCHARGE
E1	14.7	28.2	32.1 CFS
E2	9.1	17.4	63.0 CFS
E3	5.9	10.6	0.0 CFS
E4	6.4	12.9	12.9 CFS
E5	4.4	11.7	11.7 CFS
E6	5.5	11.3	11.3 CFS
E7	6.1	12.1	12.1 CFS
E8	29.3	58.2	152.0 CFS

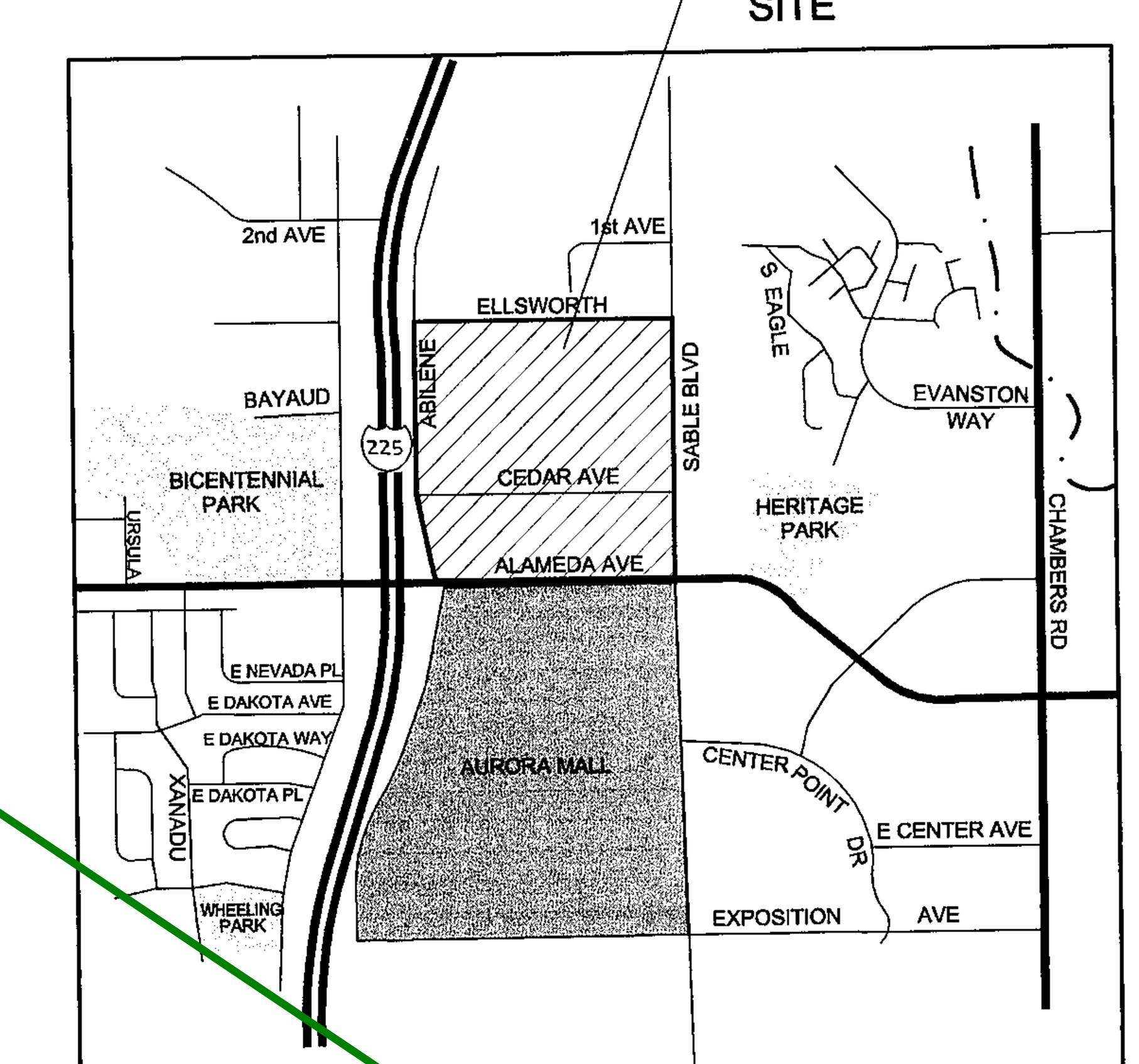
- N -

Scale : 1"=100'

0 100 200

FEET

AURORA TOWN CENTER PROJECT SITE



VICINITY MAP

N.T.S.

APPROVED FOR ONE YEAR FROM THIS DATE

10-31-2001

CITY ENGINEER — DATE 10-23-01

DIRECTOR OF UTILITIES — DATE 10/25/01

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987

303-534-6700 METRO DENVER AREA UTILITY NOTIFICATION CENTER OF COLORADO

COLORADO REGISTERED PROFESSIONAL ENGINEER MARK DENNIS C... 33123

DATE	11 July 2001	11 July 2001	ISSUED FOR REVIEW
H. SCALE	1"=100'	6 Aug 2001	REVISED PER COA COMMENTS
V. SCALE		17 Oct 2001	REVISED PER COA COMMENTS
DESIGNER	PM		
DRAFTER	dh		
CHECKED BY	MC		

V3 CONSULTANTS

200 Union Boulevard
Suite 200
Lakewood, Colorado 80228
303.989.8588 303.989.9932 fax

PRELIMINARY DRAINAGE STUDY
AURORA TOWN CENTER, SUBDIVISION FILING NO. 1
EXISTING CONDITIONS DRAINAGE MAP
AURORA, COLORADO

V3 PROJECT NUMBER: 01007

D1.0

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Plan Sheets included within reports are to be formatted to 8.5x11 or 11x17 size

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Remove redundant pages

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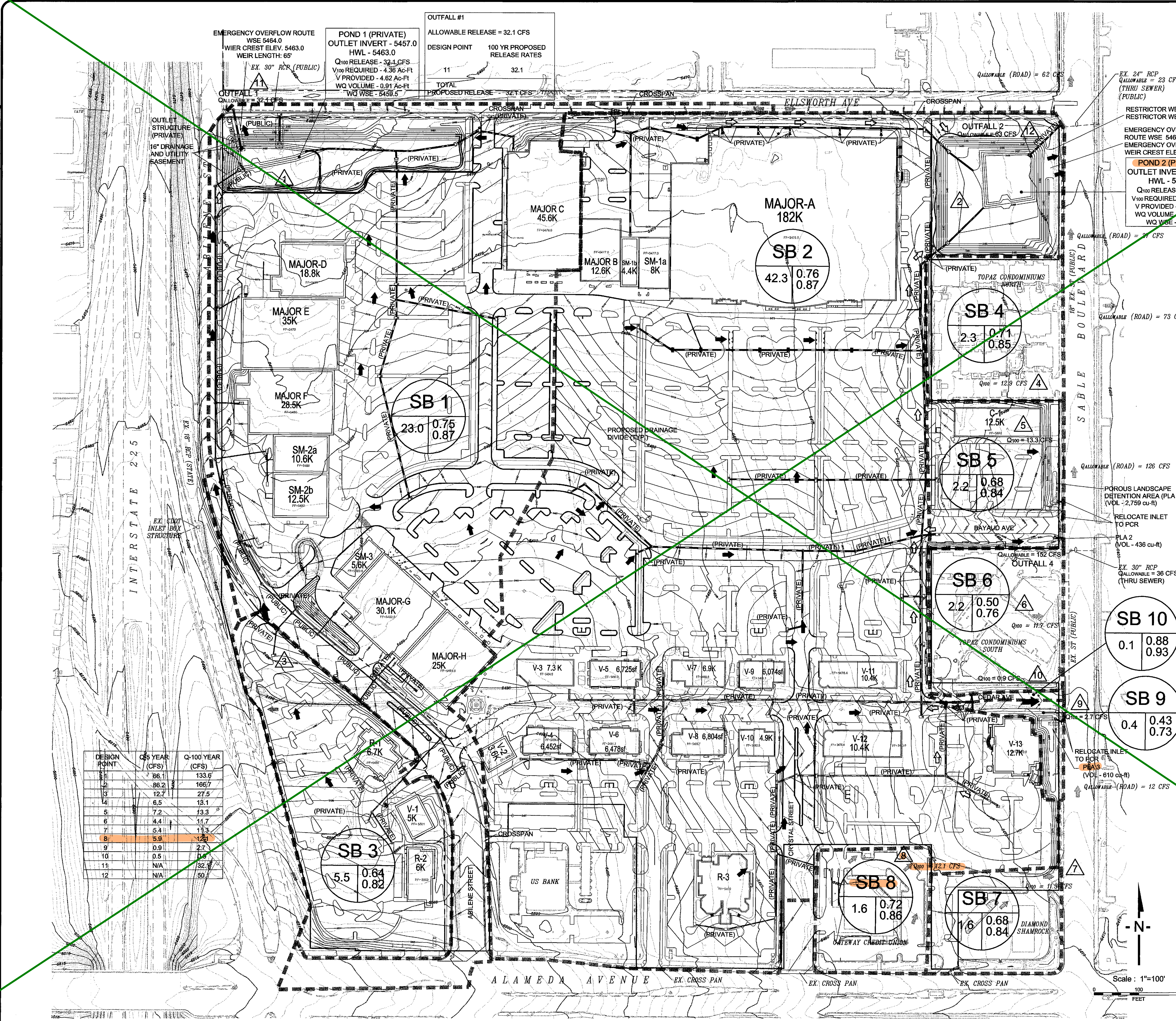


EMERGENCY OVERFLOW ROUTE
WSE 5464.0
WIER CREST ELEV. 5463.0
WEIR LENGTH: 65'
POND 1 (PRIVATE)
OUTLET INVERT - 5457.0
HWL - 5463.0
Q_{100} RELEASE - 32.1 CFS
V_{100} REQUIRED - 4.36 Ac-Ft
V PROVIDED - 4.62 Ac-Ft
WQ VOLUME - 0.91 Ac-Ft
WQ WSE - 5459.5
OUTFALL 1
OUTLET STRUCTURE (PRIVATE)
16" DRAINAGE AND UTILITY EASEMENT
ELLSWORTH AVE
CROSSPAN
OUTFALL 2
EX. 24" RCP
(THRU SEWER)
(PUBLIC)
RESTRICTOR WEIR CREST ELEV. 5462.5
RESTRICTOR WEIR WSE 6463.0
EMERGENCY OVERFLOW ROUTE WSE 5464.0
EMERGENCY OVERFLOW WEIR CREST ELEV. 6463.0
POND 2 (PRIVATE)
OUTLET INVERT - 5456.0
HWL - 5463.0
Q_{100} RELEASE - 63 CFS
V_{100} REQUIRED - 5.05 Ac-Ft
V PROVIDED - 5.15 Ac-Ft
WQ VOLUME - 1.45 Ac-Ft
WQ WSE - 5459.7
MAJOR-A 182K
MAJOR C 45.6K
MAJOR B 12.6K
SM-1b 4.4K
SM-1a 8K
MAJOR-D 18.8K
MAJOR E 35K
MAJOR F 28.5K
SM-2a 10.6K
SM-2b 12.5K
SB 1 23.0 0.75 0.87
SB 2 42.3 0.76 0.87
SB 4 2.3 0.71 0.85
SB 5 2.2 0.68 0.84
SB 6 2.2 0.50 0.76
SB 3 5.5 0.64 0.82
SB 8 1.6 0.72 0.86
SB 7 1.6 0.68 0.84
SB 10 0.1 0.88 0.93
SB 9 0.4 0.43 0.73
TOPAZ CONDOMINIUMS NORTH
TOPAZ CONDOMINIUMS SOUTH
SABLE BOULEVARD
INTERSTATE 225
PROPOSED DRAINAGE DIVIDE (TYP)
POROUS LANDSCAPE DETENTION AREA (PLA 1) (VOL - 2,759 cu-ft)
RELOCATE INLET TO PCR
PLA 2 (VOL - 436 cu-ft)
EX. 30" RCP
(THRU SEWER)
BAYAUD AVE
OUTFALL 4
CEDAR AVE
RELOCATE INLET TO PCR
PLA 3 (VOL - 610 cu-ft)
MAJOR-G 30.1K
MAJOR-H 25K
SM-3 5.6K
R-1 6.7K
V-1 5K
R-2 6K
R-3
US BANK
GATEWAY CREDIT UNION
DIAMOND SHAMROCK
CRYSTAL STREET
ABILENE STREET
ALAMEDA AVENUE
EX. CROSS PAN
EX. CDOT INLET BOX STRUCTURE
V-3 7.3K
V-5 6,725sf
V-7 6.9K
V-9 6,074sf
V-11 10.4K
V-4 6,452sf
V-6 6,478sf
V-8 6,804sf
V-10 4.9K
V-12 10.4K
V-13 12.7K
V-2 3.6K
Scale: 1"=100'
-N-

DESIGN POINT	Q-5 YEAR (CFS)	Q-100 YEAR (CFS)
1	66.1	133.6
2	86.2	166.7
3	12.7	27.5
4	6.5	13.1
5	7.2	13.3
6	4.4	11.7
7	5.4	11.3
8	5.9	12.1
9	0.9	2.7
10	0.5	0.9
11	N/A	32.1
12	N/A	50.1

OUTFALL #1

ALLOWABLE RELEASE = 32.1 CFS

DESIGN POINT	100 YR PROPOSED RELEASE RATES
11	32.1

TOTAL PROPOSED RELEASE - 32.1 CFS

LEGEND:

- EXISTING CONTOURS
- PROPOSED CONTOURS
- SUBBASIN DELINEATION
- DRAINAGE BASIN IDENTIFICATION
- AREA (Ac.)
- RUNOFF COEFFICIENT: 5 YEAR, 100 YEAR
- EXISTING OVERLAND FLOW ROUTE
- PROPOSED 100-YR FLOW CONVEYED THROUGH PIPE
- PROPOSED 100-YR OVERLAND FLOW ROUTE
- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- DESIGN POINT

TOTAL AREA = 73.5 ac

NOTES:

1. ALL HISTORIC OUTFALL DESIGN FLOWS PERTAINING TO SOUTH SABLE BOULEVARD WERE OBTAINED FROM AURORA CENTER SUBDIVISION, FILING NO. 1 PLANS PREPARED BY STITES & ASSOCIATES, INC. DATED MAY 1977.

2. CITY OF AURORA PLAN REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH THE CITY OF AURORA DESIGN CRITERIA AND THE CITY CODE. THE CITY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, OF DIMENSIONS AND ELEVATIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE. THE CITY OF AURORA, THROUGH THE APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

OUTFALL #2

ALLOWABLE RELEASE = 63 CFS

DESIGN POINT	100 YR PROPOSED RELEASE RATES
12	50.1
4	12.9

TOTAL PROPOSED RELEASE - 63.0 CFS

OUTFALL #4

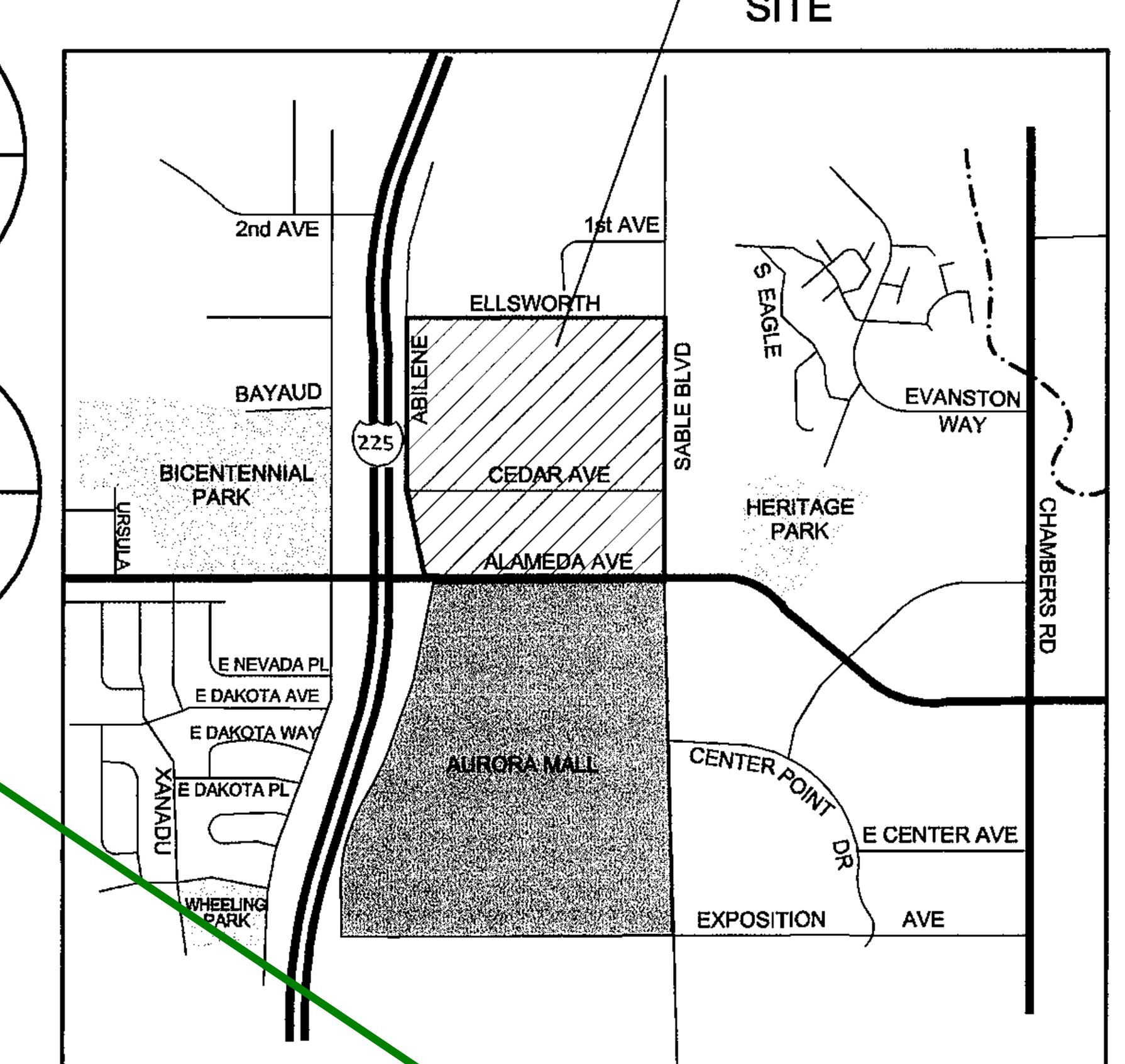
ALLOWABLE RELEASE = 152 CFS

DESIGN POINT	100 YR PROPOSED RELEASE RATES
5	13.3
6	11.7
7	11.3
9	0.9
10	2.7

TOTAL PROPOSED RELEASE - 39.9 CFS

BENCHMARK:

C.O.A. BENCHMARK # 07.1 045A WITH UNMARKED 2" BRASS CAP SET IN S END OF E CONCRETE HEADWALL OF HIGHLINE CANAL BRIDGE IN ABILENE ST @ 350'± S OF E 2nd AVE. CHANGED LINE NO. FROM 07 & REV. ELEV. ON 4-06-93 DUE TO UPDATED INFO. OLD ELEV. 5458.438' - NEW ELEV. 5458.439



VICINITY MAP

N.T.S.

APPROVED FOR ONE YEAR FROM THIS DATE

10-31-2001

CITY ENGINEER — DATE 10-29-01

DIRECTOR OF UTILITIES — DATE 10/25/01

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987

303-534-6700 METRO DENVER AREA UTILITY NOTIFICATION CENTER OF COLORADO

DATE	11 July 2001	11 July 2001	ISSUED FOR REVEIW
H. SCALE	1"=100'	6 August 2001	REVISED PER COA COMMENT
DESIGNER	PM	17 Oct 2001	REVISED PER COA COMMENT
DRAFTER	dh		
CHECKED BY	MC		

V3 CONSULTANTS
200 Union Boulevard
Suite 200
Lakewood, Colorado 80228
303.989.8588 303.989.9932 fax

PRELIMINARY DRAINAGE STUDY
AURORA TOWN CENTER, SUBDIVISION FILING NO. 1
PROPOSED CONDITIONS DRAINAGE MAP
AURORA, COLORADO

V3 PROJECT NUMBER: 01007

D1.1

Leaving a Legacy

Appendix C

Hydrologic & Hydraulic Calculations

LAMP RYNEARSON

Imperviousness

QT - AURORA

Input Parameters

Basin(s)	Design Point	Pavement (i=100)	Roof (i=90)	Landscape (i= 2)	Total Area (Acres)	Calculated Percent Impervious (%)
Existing (Town Center Phase 1 A Master Plan)						
SB 8	8	Values Obtained from Master Plan			1.60	75.5%
Developed						
A BASINS						
A1	A1	0.14	0.00	0.05	0.19	75%
A2	A2	0.89	0.12	0.10	1.11	90%
Total A		**1.03**	**0.12**	**0.15**	**1.30**	**88%**
H BASINS						
H1	H1	0.01		0.07	0.08	13%
H2	H2	0.02		0.12	0.14	19%
H3	H3	0.04		0.04	0.08	46%
Total H		**0.03**	**0.00**	**0.19**	**0.22**	**16%**
Entire Site						
Total Comp Site		**1.09**	**0.12**	**0.31**	**1.52**	**79%** *

*A1, A2, H2, H3 (To match Master Basin SB bounds for proper comparison)

Table 6-3. Recommended percentage imperviousness values

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

Calculation of Peak Runoff using Rational Method

Designer: GLF
Company: LAMP RYNEARSON
Date: 3/15/2023
Project: QT - AURORA
Location: AURORA, CO

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

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

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

Computed $t_c = t_i + t_t$

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

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.87	1.14	1.39	1.76	2.08	2.42	3.30
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
A1	0.19	C	75.0	0.60	0.65	0.68	0.74	0.76	0.79	0.82	63.00			0.040	4.12	87.00			0.010	20	2.00	0.73	4.84	13.99	5.00	2.93	3.87	4.71	5.97	7.06	8.21	11.19	0.34	0.47	0.61	0.84	1.02	1.23	1.75
A2	1.11	C	90.0	0.74	0.77	0.79	0.82	0.84	0.85	0.87	31.00			0.016	2.85	369.00			0.020	20	2.83	2.17	5.03	12.71	5.03	2.93	3.86	4.71	5.96	7.04	8.20	11.18	2.41	3.29	4.15	5.45	6.55	7.75	10.81
H1	0.08	C	13.0	0.08	0.14	0.23	0.39	0.46	0.54	0.63	35.00			0.067	5.47	0.00			0.000	20	0.01	0.00	5.47	23.79	10.00	2.34	3.08	3.76	4.76	5.63	6.55	8.93	0.02	0.03	0.07	0.15	0.21	0.28	0.45
H2	0.14	C	19.0	0.13	0.19	0.27	0.43	0.49	0.56	0.65	54.00			0.045	7.35	0.00			0.000	20	0.02	0.00	7.35	22.77	10.00	2.34	3.08	3.76	4.76	5.63	6.55	8.93	0.04	0.08	0.14	0.28	0.38	0.51	0.81
H3	0.08	C	46.0	0.35	0.41	0.47	0.58	0.62	0.67	0.73	20.00			0.020	4.43	0.00			0.000	20	0.06	0.00	4.43	18.18	5.00	2.93	3.87	4.71	5.97	7.06	8.21	11.19	0.08	0.13	0.18	0.28	0.35	0.44	0.66
For Comparison																																							
Total Comp. Site	1.52	C	79.3	0.64	0.68	0.71	0.76	0.78	0.81	0.84	31.00			0.016	3.60	369.00			0.020	20	2.83	2.17	5.78	14.68	5.78	2.82	3.72	4.53	5.74	6.78	7.89	10.76	2.76	3.85	4.92	6.65	8.09	9.69	13.70

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	A1	A2
Site Type (Urban or Rural)	URBAN	URBAN
Inlet Application (Street or Area)	STREET	AREA
Hydraulic Condition	In Sump	Swale
Inlet Type	CDOT/Denver 13 Combination	CDOT Type C

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.5	3.3
Major Q_{Known} (cfs)	1.2	7.8

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypa

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)		
Percent Impervious		
NRCS Soil Type		

Watershed Profile

Overland Slope (ft/ft)		
Overland Length (ft)		
Channel Slope (ft/ft)		
Channel Length (ft)		

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)		
One-Hour Precipitation, P_1 (inches)		

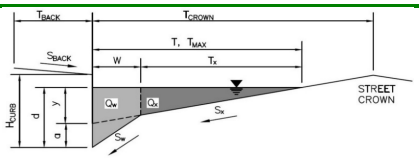
CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.5**	**3.3**
Major Total Design Peak Flow, Q (cfs)	**1.2**	**7.8**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	0.0

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

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

Project: **QT AURORA**
Inlet ID: **A1**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.000	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	50.0	ft
Gutter Width	W =	1.73	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

1'

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	50.0	50.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches

Check boxes are not applicable in SUMP conditions

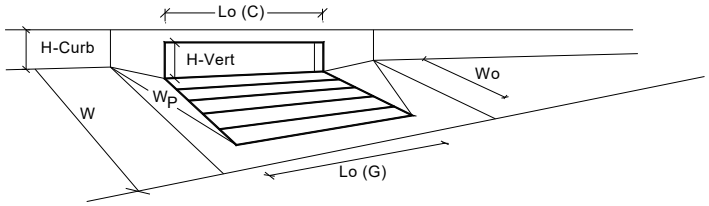
MINOR STORM Allowable Capacity is not applicable to Sump Condition
MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

Add Note in large font: "For reference only.
See the Civil Plans for Design Information."

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



CDOT/Denver 13 Combination

Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT/Denver 13 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	☐ Override Depths
Grate Information		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.73	1.73	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.51	0.51	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.36	0.36	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.1**	**5.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.5	1.2	cfs

Per ***6.52*** of the Criteria, Clogging Factor is 0.20 (Review all inlet calculations versus the Criteria)

Comments addressed.

Add Note in large font: "For reference only. See the Civil Plans for Design Information."

Comment acknowledged. This particular calculation has been removed.

VERIFY

MHFD-Inlet, Version 5.02 (Augu

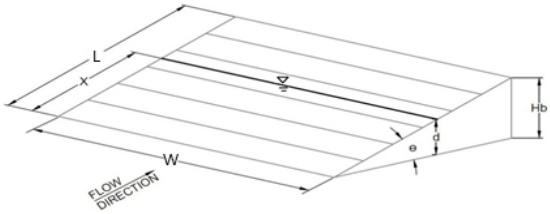
AREA INLET IN A SWALE

QT AURORA

A2

Inlet Design Information (Input)

Type of Inlet: CDOT Type C — Inlet Type = CDOT Type C



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	3.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	ft
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.96	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.45	0.62	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.5**	**8.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Call out the location of this item in the plans

Provide a cross section of this in the plans

2' CONCRETE CURB CUT / FLUME

Rectangular

Bottom Width (ft)	= 2.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 2.00
N-Value	= 0.013

Calculations

Compute by:	Known Depth
Known Depth (ft)	= 0.50

Highlighted

Depth (ft)	= 0.50
Q (cfs)	= 7.769
Area (sqft)	= 1.00
Velocity (ft/s)	= 7.77
Wetted Perim (ft)	= 3.00
Crit Depth, Yc (ft)	= 0.50
Top Width (ft)	= 2.00
EGL (ft)	= 1.44