FINAL DRAINAGE REPORT

BOULDER COUNTY
CORONER FACILITY
5600 Flatiron Parkway
Boulder, Colorado

July 15, 2013
(Revised October 7, 2013)

Prepared for:

Boulder County
Building Services Department
2020 13th Street
Boulder, CO 80302

Prepared by:

SCOTT, COX & ASSOCIATES, INC.
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Project No. 12506B

ENGINEER'S STATEMENT

I hereby certify that this report for the final drainage design of the Boulder County Coroner Facility Technical Document Review was prepared under my direct supervision in accordance with the provisions of the City of Boulder Design and Construction Standards for the owners thereof.

_____

Donald P. Ash, P.E.
Registered Professional Engineer
State of Colorado No. 36045

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INTRODUCTION

This report is submitted as the Final Drainage Report of the existing and proposed conditions for the project located at 5600 Flatiron Parkway in the City of Boulder. The site is located in the Southwest ¼ of Section 27, Township 1N, Range 70W of the 6th Principal Meridian in the City of Boulder, Boulder County, State of Colorado. The site is bounded by Flatiron Parkway to the north and existing commercial/industrial developments to the east, south and west. A vicinity map is included with this report.

This report is being prepared to accompany the Technical Document Review application for the project. The purpose of this Final Drainage Report and Plan is to address specific drainage issues related to the proposed site changes. This study meets the requirements set forth in the City of Boulder Design and Construction Standards.

EXISTING ON-SITE DRAINAGE

The 6.95 acre site is currently developed with a two-story commercial/industrial building and associated parking and drives. The majority of the site is rooftop and asphalt and generally slopes from the west to the east at a slope of 2.0%.

Existing drainage patterns are shown on the Grading and Drainage Plan that is included with this report. For the purposes of this report, we have broken the existing site into one (1) historic drainage basin, Basin H. Basin H is comprised of the portion of the lot that is being developed.

Existing runoff calculations for Basin H has been included in Appendix A in the back of this report. The runoff from the existing site is also shown in Table 1.

OFF-SITE DRAINAGE

The offsite drainage has been broken out into one (1) offsite basin, Basin OS1. The offsite basin is comprised of developed runoff from the commercial/industrial development to the west. Runoff from this basin has been accommodated for in the proposed drainage design.

PROPOSED ON-SITE DRAINAGE

The Grading and Drainage Plan shows the proposed site plan, on-site grading and overland flow directions. Basin A consists of the portion of the 6.95 acre lot that is being developed. Under proposed conditions, Basin A will be broken into four (4) sub-basins, Basins A1 – A4.

Basin A1 is located along the west side of the site and consists of a portion of the parking lot and landscape areas. Runoff within this basin is conveyed via overland and channel flow to Design Point 1, at the existing storm sewer inlet that is located northwest of the proposed Coroner Facility. Ultimately runoff within this basin is conveyed east through the existing storm sewer, through the Water Quality Stormceptor and into Dry Creek No. 2.

Basin A2 is located along the east side of the site and consists of a portion of the access drive, parking lot and landscape areas. Runoff within this basin is conveyed via overland and channel flow to Design Point 2, at the existing storm sewer inlet that is located northeast of the proposed Coroner Facility. Ultimately runoff within this basin is conveyed east through the existing storm sewer, through the Water Quality Stormceptor and into Dry Creek No. 2.

Basin A3 is located along the south side of the site and consists of roof, parking lot and landscape areas. Runoff within this basin is conveyed via overland and channel flow to Design Point 3, located at the proposed porous landscape detention (PLD). Ultimately runoff within this basin is conveyed east through the existing storm sewer and into Dry Creek No. 2.

Basin A4 is located along the north side of the site and consists of a portion of the roof from the existing Sherriff's Building. Runoff within this basin is conveyed via storm sewer flow to Design Point 4, at the existing storm sewer outfall that is located east of the existing Sherriff's Building. Ultimately runoff within this basin is conveyed east through the existing storm sewer, through the Water Quality Stormceptor and into Dry Creek No. 2.

Proposed drainage patterns are shown on the Grading and Drainage Plan that is included with this report.

Proposed runoff calculations for all of the proposed basins have been enclosed in Appendix A. The runoff from the proposed site is also shown in Table 1.

DRAINAGE DESIGN CRITERIA

As required in City of Boulder Design and Construction Standards for Drainage Improvements (DCS) for all non-single family residential uses, hydrologic information was developed for an initial storm return period of 5-years and major storm return period of 100-years. The criteria and methodology used in determining the storm runoff peaks and volumes were those outlined in the DCS.

The design rainfall data used in this study was taken from the time-intensity-frequency curve for the City of Boulder (Figure 7-1 DCS) as developed by Urban Drainage and Flood Control District (UD&FCD). Runoff calculations were obtained using the Rational Method as outlined in the DCS for basins having less than 160 acres.

The Rational Formula is:

$$Q = CIA$$

Where:
- Q = Peak Discharge (cfs)
- C = Runoff Coefficient (Table 7-2 DCS)
- I = Rainfall Intensity (in / hr) (Figure 7-1 DCS)
- A = Drainage Basin Tributary Area (acres)

The existing and proposed conditions for the entire site were analyzed for the 5 and 100-year storm events. The results are shown in the following Table 1 and the relevant calculation sheets are provided in Appendix A.

TABLE 1
RUNOFF CALCULATIONS SUMMARY

Drainage Basin	Design Point	Area (AC)	t_c (min)	C_5	I_5 (in/hr)	Q_5 (cfs)	C_{100}	I_{100} (in/hr)	Q_{100} (cfs)
HISTORIC BASINS									
H	- -	3.34	13.08	0.53	3.65	6.43	0.76	7.25	18.27
DEVELOPED BASINS									
A		3.34	11.88	0.67	3.90	8.68	0.82	7.70	21.10
A1	1	1.08	13.08	0.56	3.90	2.35	0.77	7.70	6.39
A2	2	1.06	6.66	0.77	5.10	4.19	0.87	9.90	9.19
A3	3	0.73	7.09	0.55	4.85	1.97	0.77	9.70	5.45
A4	4	0.47	5.21	0.85	5.70	2.27	0.90	10.60	4.46
OFFSITE BASINS									
OS1	- -	2.10	7.99	0.80	3.75	6.30	0.85	7.40	13.21

DETENTION STORAGE

The site was previously developed with large amounts of parking and roof runoff. Storm runoff due to the proposed improvements is slightly increased during the 5-year and 100-year storm events. This is due to the slight increase of the overall imperviousness of the site. With this minor increase in storm water runoff, it is our conclusion that the peak runoff for the initial and major storm events from the tributary basin can be conveyed directly to the major drainage system without adverse impact upstream, surrounding, or downstream properties and facilities, per Section 7.12 of the City of Boulder Design and Construction Standards. Therefore, no storm water detention facilities are proposed for the site.

STORM WATER QUALITY

The principal forms of storm water quality runoff enhancement is the use of a Rain Garden/Bioretention Water Quality Facility and the Water Quality Stormceptor. Where possible, grass buffers will be used in drainage routes to help slow runoff, minimize directly connected impervious areas and promote infiltration, thus reducing peak volumes.

The Rain Garden/Bioretention Water Quality Facility has been designed to provide the required water quality capture volume (WQCV) for the developed areas of the site included in Basin A3. The calculations for the facility sizing and orifice release are enclosed in Appendix C.

The Bioretention Facility designed for this site utilizes partial infiltration of the WQCV within the designated 12-hour drain time. Underdrains will be provided within the sub-soils of the water quality facility with an orifice plate installed where the under drains tie into the proposed release structure. This partial infiltration option meets the requirements for Bioretention and the 12-hour drain time as specified in the Urban Drainage and Flood Control District (UDFCD) Drainage Criteria Manual.

In the event the individual pond was to overflow, the flow will be directed to the emergency spillways and spill directly to the drainage system and into Dry Creek No. 2. The spillway has been sized to convey two times (2X) the runoff from the developed conditions during the 100 year storm.

The application of the Rain Garden/Bioretention Water Quality facility, providing water quality capture volume in the pond, and the use of grass buffers as structural BMPs are consistent with the requirements for redeveloping urban areas outlined in the UD&FCD, Urban Storm Drainage Criteria Manual, Volume 3, Best Management Practices.

The Water Quality Stormceptor has been designed to provide the required water quality for the developed areas of the site included in Basins A1 and A2. Due to the location of the Stormceptor, basins A4 and OS1 will also be treated prior to being released into Dry Creek No. 2.

The Stormceptor for this site is the STC 900 Precast Concrete Stormceptor. The Stormceptor is an oil and sediment separator, and was sized to treat storm water runoff by removing pollutants through gravity separation and floatation. The system was designed to achieve water quality through the removal of 85% of total suspended solids (TSS). The proposed Stormceptor will be installed along the existing 24" storm sewer pipe that runs from the 5' Type R inlet into Dry Creek No. 2.

EROSION CONTROL

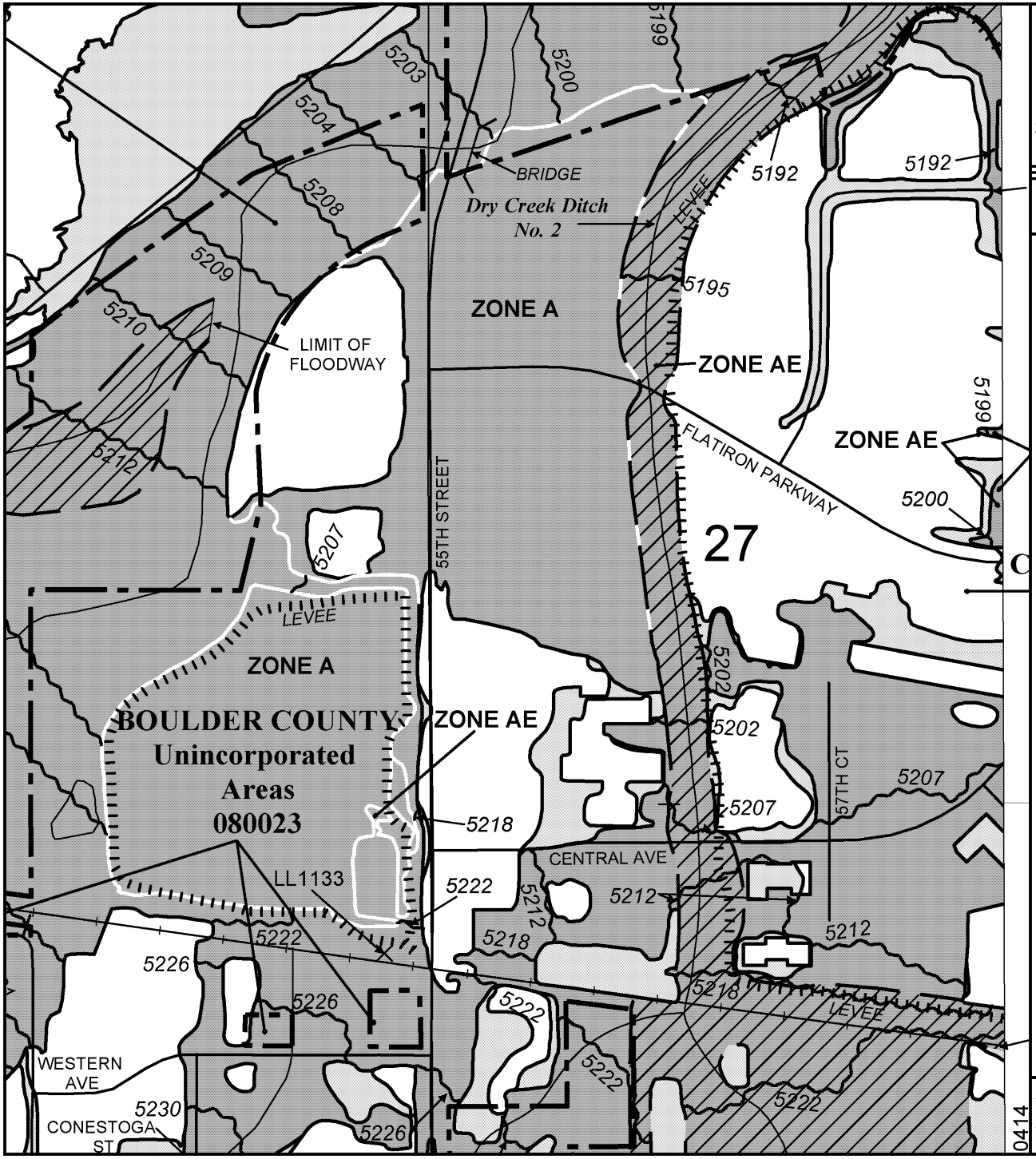
Erosion control measures should be implemented prior to demolition or construction, and shall be maintained during all phases of construction project. Erosion control measures will consist of silt fencing along the property being developed, tracking control measures at the access points to the site, hay bales at grass swales and re-vegetation with appropriate plant species.

FLOOD STATEMENT

Based on the National Flood Insurance Program Flood Insurance Rate Map, FIRM Panel 08013C0413J F dated December 18, 2012, the site is located within Zone A, an area determined to be inside the 100-yr floodplain.

CONCLUSION

The primary consideration for this project was to design a drainage plan for the site to accommodate the proposed development plan without having an adverse impact on the surrounding properties. The drainage plan handles runoff from 5-year and 100-year storm events. All analyses were performed in accordance with the City of Boulder Design and Construction Standard and Urban Drainage & Flood Control District (UDFCD) Criteria Manual.



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0413J

FIRM

FLOOD INSURANCE RATE MAP

BOULDER COUNTY, COLORADO

AND INCORPORATED AREAS

PANEL 413 OF 615

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BOULDER , CITY OF	080024	0413	J
BOULDER COUNTY	080023	0413	J

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

MAP NUMBER
08013C0413J

MAP REVISED
DECEMBER 18, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX A

DRAINAGE CALCULATIONS

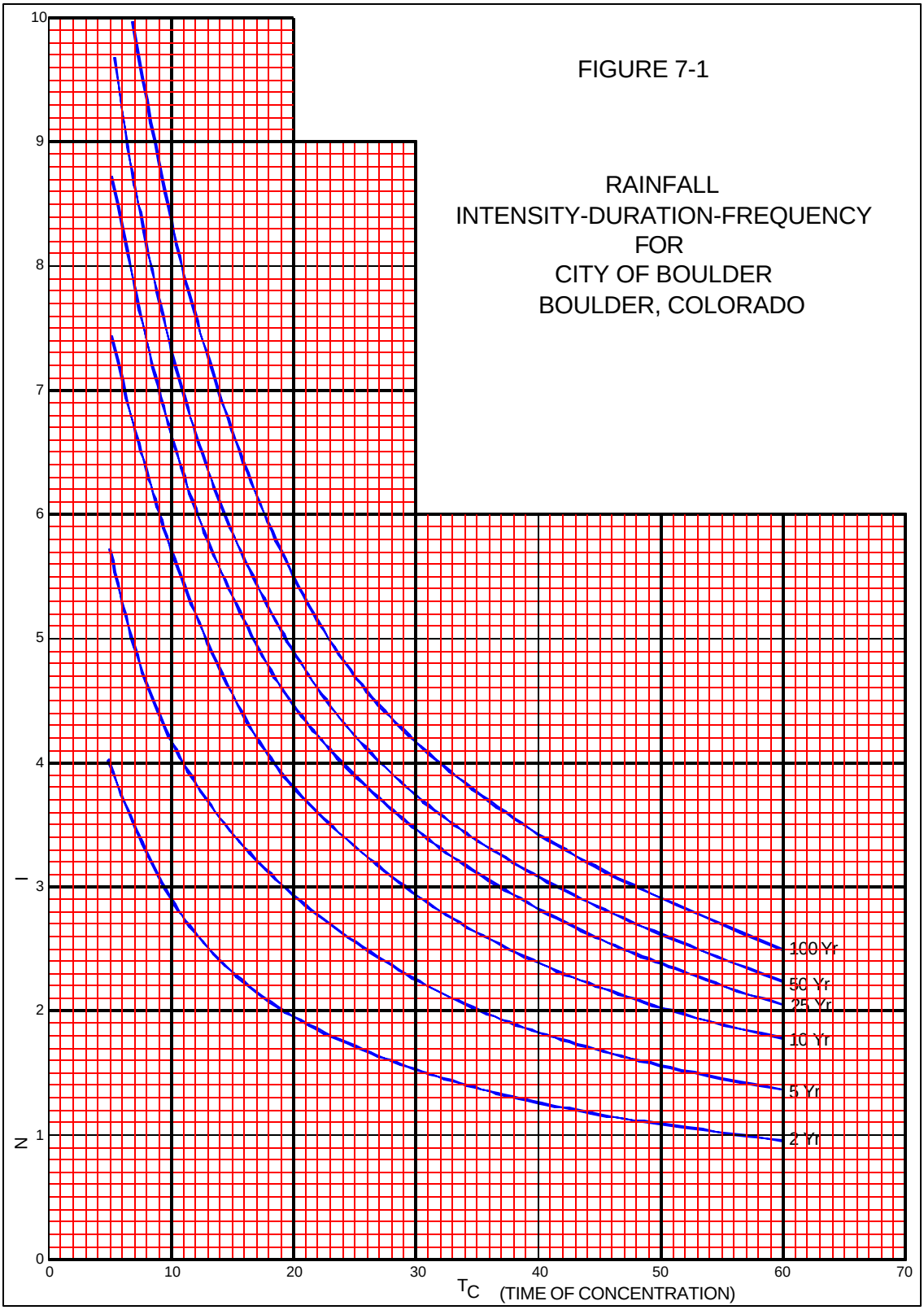


FIGURE 7-1
RAINFALL
INTENSITY-DURATION-FREQUENCY
FOR
CITY OF BOULDER
BOULDER, COLORADO
100 Yr
50 Yr
25 Yr
10 Yr
5 Yr
2 Yr
I
N
T
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
TC (TIME OF CONCENTRATION)

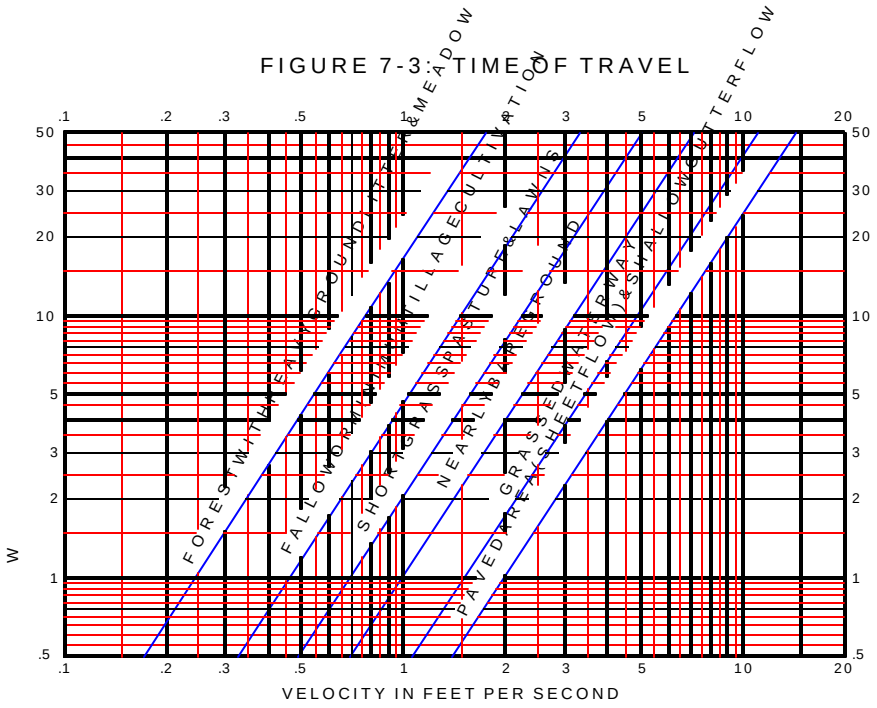
Table 7-2: Runoff Coefficients for the Rational Method

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	STORM FREQUENCY			
		2-Yr	5-Yr	10-Yr	100-Yr
Business:					
Commercial Areas	95	0.87	0.88	0.90	0.93
Neighborhood Areas	65	0.60	0.65	0.70	0.80
Residential:					
Single-Family	40	0.40	0.45	0.50	0.70
Multi-Unit (detached)	50	0.50	0.55	0.60	0.75
Multi-Unit (attached)	70	0.65	0.70	0.70	0.80
½ Acre Lot	30	0.30	0.40	0.45	0.65
Apartments	70	0.65	0.70	0.70	0.80
Industrial:					
Light Areas	80	0.75	0.80	0.80	0.85
Heavy Areas	90	0.80	0.80	0.85	0.90
Parks, Cemeteries:	7	0.15	0.25	0.35	0.60
Playgrounds:	13	0.20	0.30	0.40	0.70
Schools:	50	0.50	0.55	0.60	0.75
Railroad Yard Areas:	40	0.40	0.45	0.50	0.70
Undeveloped Areas:					
Historic Flow Analysis	2	0.10	0.20	0.30	0.60
Greenbelts, Agricultural	-	-	-	-	-
Offsite Flow Analysis (when offsite land use is not defined)	45	0.45	0.50	0.55	0.72
Streets:					
Paved	100	0.87	0.88	0.90	0.93
Gravel	7	0.15	0.25	0.35	0.65
Drives and Walks:	96	0.85	.087	0.90	0.92
Roofs:	90	0.80	0.85	0.90	0.90
Lawns:					
Sandy Soil	0	0.00	0.10	0.20	0.50
Clayey Soil	0	0.10	0.20	0.30	0.60

NOTE: These rational formula coefficients do not apply for larger basins where the time-of-concentration exceeds 60 minutes.

(Source: Urban Drainage and Flood Control District)

FIGURE 7-3: TIME OF TRAVEL



ESTIMATE OF AVERAGE FLOW VELOCITY FOR USE WITH THE RATIONAL METHOD

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

HISTORIC

BASIN H 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	1.69	0.10	
ROOF	0.47	0.80	
DRIVES AND WALKS	1.18	0.85	
TOTAL AREA	3.34	**0.46**	= WEIGHTED C

BASIN H 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	1.69	0.20	
ROOF	0.47	0.85	
DRIVES AND WALKS	1.18	0.87	
TOTAL AREA	3.34	**0.53**	= WEIGHTED C

BASIN H 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	1.69	0.30	
ROOF	0.47	0.90	
DRIVES AND WALKS	1.18	0.90	
TOTAL AREA	3.34	**0.60**	= WEIGHTED C

BASIN H 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	1.69	0.60	
ROOF	0.47	0.90	
DRIVES AND WALKS	1.18	0.92	
TOTAL AREA	3.34	**0.76**	= WEIGHTED C

BASIN H % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	1.69	0.00	
ROOF	0.47	90.00	
DRIVES AND WALKS	1.18	96.00	
TOTAL AREA	3.34	**46.58**	= % IMPERVIOUS

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consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Historic
Land Use: Undeveloped
Basin Area (A) = 3.34 acres

Basin Identification: H
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.46	0.53	0.60	0.76

GIVEN

Overland flow length (Lo)	280	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	275	feet
Channel velocity (V)	2	feet/second
Total Travel Length (L=Lo+Lc)	555	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 13.7 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 2.3 min.

Time of Concentration Tc = Ti + Tt Tc = 16.0 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 13.1 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 13.1 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
2.50	3.65	4.95	7.25

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
3.87	6.43	9.85	18.27

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consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

PROPOSED

BASIN A 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.99	0.10	
ROOF	0.69	0.80	
DRIVES AND WALKS	1.66	0.85	
TOTAL AREA	3.34	**0.62**	= WEIGHTED C

BASIN A 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.99	0.20	
ROOF	0.69	0.85	
DRIVES AND WALKS	1.66	0.87	
TOTAL AREA	3.34	**0.67**	= WEIGHTED C

BASIN A 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.99	0.30	
ROOF	0.69	0.90	
DRIVES AND WALKS	1.66	0.90	
TOTAL AREA	3.34	**0.72**	= WEIGHTED C

BASIN A 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.99	0.60	
ROOF	0.69	0.90	
DRIVES AND WALKS	1.66	0.92	
TOTAL AREA	3.34	**0.82**	= WEIGHTED C

BASIN A % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	0.99	0.00	
ROOF	0.69	90.00	
DRIVES AND WALKS	1.66	96.00	
TOTAL AREA	3.34	**66.26**	= % IMPERVIOUS

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Proposed
Land Use: Commercial
Basin Area (A) = 3.34 acres

Basin Identification: A
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.62	0.67	0.72	0.82

GIVEN

Overland flow length (Lo)	280	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	275	feet
Channel velocity (V)	3	feet/second
Total Travel Length (L=Lo+Lc)	555	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 10.4 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 1.5 min.

Time of Concentration Tc = Ti + Tt Tc = 11.9 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 13.1 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 11.9 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
2.68	3.90	5.30	7.70

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
5.52	8.68	12.77	21.10

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PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

PROPOSED

BASIN A1 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.50	0.10	
ROOF	0.00	0.80	
DRIVES AND WALKS	0.58	0.85	
TOTAL AREA	1.08	**0.50**	= WEIGHTED C

BASIN A1 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.50	0.20	
ROOF	0.00	0.85	
DRIVES AND WALKS	0.58	0.87	
TOTAL AREA	1.08	**0.56**	= WEIGHTED C

BASIN A1 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.50	0.30	
ROOF	0.00	0.90	
DRIVES AND WALKS	0.58	0.90	
TOTAL AREA	1.08	**0.62**	= WEIGHTED C

BASIN A1 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.50	0.60	
ROOF	0.00	0.90	
DRIVES AND WALKS	0.58	0.92	
TOTAL AREA	1.08	**0.77**	= WEIGHTED C

BASIN A1 % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	0.50	0.00	
ROOF	0.00	90.00	
DRIVES AND WALKS	0.58	96.00	
TOTAL AREA	1.08	**51.49**	= % IMPERVIOUS

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Proposed
Land Use: Commercial
Basin Area (A) = 1.08 acres

Basin Identification: A1
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.50	0.56	0.62	0.77

GIVEN

Overland flow length (Lo)	280	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	275	feet
Channel velocity (V)	3	feet/second
Total Travel Length (L=Lo+Lc)	555	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 12.9 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 1.5 min.

Time of Concentration Tc = Ti + Tt Tc = 14.5 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 13.1 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 13.1 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
2.68	3.90	5.30	7.70

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
1.45	2.35	3.54	6.39

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

PROPOSED

BASIN A2 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.15	0.10	
ROOF	0.00	0.80	
DRIVES AND WALKS	0.91	0.85	
TOTAL AREA	1.06	**0.74**	= WEIGHTED C

BASIN A2 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.15	0.20	
ROOF	0.00	0.85	
DRIVES AND WALKS	0.91	0.87	
TOTAL AREA	1.06	**0.77**	= WEIGHTED C

BASIN A2 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.15	0.30	
ROOF	0.00	0.90	
DRIVES AND WALKS	0.91	0.90	
TOTAL AREA	1.06	**0.81**	= WEIGHTED C

BASIN A2 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.15	0.60	
ROOF	0.00	0.90	
DRIVES AND WALKS	0.91	0.92	
TOTAL AREA	1.06	**0.87**	= WEIGHTED C

BASIN A2 % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	0.15	0.00	
ROOF	0.00	90.00	
DRIVES AND WALKS	0.91	96.00	
TOTAL AREA	1.06	**82.30**	= % IMPERVIOUS

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Proposed
Land Use: Commercial
Basin Area (A) = 1.06 acres

Basin Identification: A2
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.74	0.77	0.81	0.87

GIVEN

Overland flow length (Lo)	160	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	140	feet
Channel velocity (V)	3	feet/second
Total Travel Length (L=Lo+Lc)	300	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 5.9 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 0.8 min.

Time of Concentration Tc = Ti + Tt Tc = 6.7 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 11.7 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 6.7 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
3.60	5.10	6.80	9.90

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
2.84	4.19	5.88	9.19

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

PROPOSED

BASIN A3 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.34	0.10	
ROOF	0.22	0.80	
DRIVES AND WALKS	0.18	0.85	
TOTAL AREA	0.73	**0.49**	= WEIGHTED C

BASIN A3 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.34	0.20	
ROOF	0.22	0.85	
DRIVES AND WALKS	0.18	0.87	
TOTAL AREA	0.73	**0.55**	= WEIGHTED C

BASIN A3 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.34	0.30	
ROOF	0.22	0.90	
DRIVES AND WALKS	0.18	0.90	
TOTAL AREA	0.73	**0.62**	= WEIGHTED C

BASIN A3 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.34	0.60	
ROOF	0.22	0.90	
DRIVES AND WALKS	0.18	0.92	
TOTAL AREA	0.73	**0.77**	= WEIGHTED C

BASIN A3 % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	0.34	0.00	
ROOF	0.22	90.00	
DRIVES AND WALKS	0.18	96.00	
TOTAL AREA	0.73	**49.53**	= % IMPERVIOUS

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Proposed
Land Use: Commercial
Basin Area (A) = 0.73 acres

Basin Identification: A3
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.49	0.55	0.62	0.77

GIVEN

Overland flow length (Lo)	65	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	140	feet
Channel velocity (V)	3	feet/second
Total Travel Length (L=Lo+Lc)	205	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 6.3 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 0.8 min.

Time of Concentration Tc = Ti + Tt Tc = 7.1 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 11.1 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 7.1 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
3.45	4.85	6.60	9.70

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
1.23	1.97	3.01	5.45

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

PROPOSED

BASIN A4 2 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.00	0.10	
ROOF	0.47	0.80	
DRIVES AND WALKS	0.00	0.85	
TOTAL AREA	0.47	**0.80**	= WEIGHTED C

BASIN A4 5 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.00	0.20	
ROOF	0.47	0.85	
DRIVES AND WALKS	0.00	0.87	
TOTAL AREA	0.47	**0.85**	= WEIGHTED C

BASIN A4 10 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.00	0.30	
ROOF	0.47	0.90	
DRIVES AND WALKS	0.00	0.90	
TOTAL AREA	0.47	**0.90**	= WEIGHTED C

BASIN A4 100 YEAR WEIGHTED RUNOFF COEFFICIENT

SURFACE	AREA	C	
LANDSCAPE	0.00	0.60	
ROOF	0.47	0.90	
DRIVES AND WALKS	0.00	0.92	
TOTAL AREA	0.47	**0.90**	= WEIGHTED C

BASIN A4 % IMPERVIOUS

SURFACE	AREA	C	
LANDSCAPE	0.00	0.00	
ROOF	0.47	90.00	
DRIVES AND WALKS	0.00	96.00	
TOTAL AREA	0.47	**90.00**	= % IMPERVIOUS

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Proposed
Land Use: Commercial
Basin Area (A) = 0.47 acres

Basin Identification: A4
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.80	0.85	0.90	0.90

GIVEN

Overland flow length (Lo)	170	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	100	feet
Channel velocity (V)	3	feet/second
Total Travel Length (L=Lo+Lc)	270	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 4.7 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 0.6 min.

Time of Concentration Tc = Ti + Tt Tc = 5.2 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 11.5 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 5.2 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
3.90	5.70	7.40	10.60

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
1.46	2.27	3.12	4.46

SCOTT, COX & ASSOCIATES INC.
consulting engineers - surveyors

PROJECT # 12506B
DATE 10/7/2013
BY DPA

STORM RUNOFF HYDROLOGY
Rational Method

Condition: Offsite
Land Use: Industrial - Light Areas
Basin Area (A) = 2.10 acres

Basin Identification: OS1
Design Frequencies: 2 yr. , 5yr, 10yr & 100 yr.
Comments:

Runoff Coefficients (C) =

2 year	5 year	10 year	100 year
0.75	0.80	0.80	0.85

GIVEN

Overland flow length (Lo)	140	feet (500 feet maximum)
Overland flow slope (S)	2	%
Channel travel length (Lc)	350	feet
Channel velocity (V)	2	feet/second
Total Travel Length (L=Lo+Lc)	490	feet

Method 1

Ti = 1.8*(1.1-C5)*(Lo^0.5)/(S^0.333) Ti = 5.1 min.
(intial design pt.)
Travel time Tt = Lc/V(fps)*60 sec./min. Tt = 2.9 min.

Time of Concentration Tc = Ti + Tt Tc = 8.0 min.

Tc CHECK (Required for Urban Basins)

TC = (L/180) + 10 min. (initial design pt.) Tc = 12.7 min.

Tc min for Urban Basins = 5 min.
Tc min for Non Urban Basins = 10 min.

Tc Summary 8.0 min. (Lessor of Method 1 or Tc check)

Intensity (I) From Intensity - Duration - Frequency Curve
City of Boulder Design and Construction Standards, Figure 7-1

2 year	5 year	10 year	100 year
2.55	3.75	5.05	7.40

Peak Flow (Q) = C*I*A (cfs)

2 year	5 year	10 year	100 year
4.02	6.30	8.48	13.21

APPENDIX B

HYDRAULIC CALCULATIONS

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

Project No.: 12506B
Date: 7/15/2013
By: DPA

GRATE FLOW CALCULATIONS

2' by 2' Inlet - Basins A1 & OS1
Neenan Type R-3402-E

Q=Cd*A*(2gH)**0.5	**10.70**	**CFS**	**Q= CALCULATED FLOW**
	0.60		Cd= ORIFICE COEF.
	2.1	Sq. Ft.	A= OPEN AREA
	3.11	FT	H=HEAD IN FEET
	32.20	FT/s^2	g=gravitation force 32.2 ft/sec2
	60%		Percentage of Capacity Allowed
			(Per CDOT and DCS 7.09 Table 7-5)

10.70 CFS >> 8.55 CFS (5-yr Design Flow)

∴ O.K.

W.S.E.	5200.00
RIM	5196.89
H=HEIGHT FROM BOTTOM OF THE OPENING	3.11

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

Project No.: 12506B
Date: 7/15/2013
By: DPA

WEIR FLOW CALCULATIONS 2' by 2' Inlet - Basins A1 & OS1
Neenan Type R-3402-E

Enter starting C, L, d to calculate Q.

Q=Cw*Lw*(d**1.5)

Q=Flow=	**131.63**	CFS	
C=Weir Coef.=	3		
L=Weir Length=	8	FT	
d =Depth	3.110	FT	(37.32 IN.)

Max Water Surface Elevation=	5200.00
Grate Elevation=	5196.89

Cw = Weir Coefficient
Lw = Weir Length =2L+2W
d = depth

131.63 CFS >> 8.55 CFS (5-yr Design Flow)

∴ O.K.

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

Project No.:	12506B
Date:	9/9/2013
By:	DPA

GRATE FLOW CALCULATIONS

2' by 2' Inlet - Basin A3
Neenan Type R-3402-E

Q=Cd*A*(2gH)**0.5	**7.43**	**CFS**	**Q= CALCULATED FLOW**
	0.60		Cd= ORIFICE COEF.
	2.1	Sq. Ft.	A= OPEN AREA
	1.50	FT	H=HEAD IN FEET
	32.20	FT/s^2	g=gravitation force 32.2 ft/sec2
	60%		Percentage of Capacity Allowed
			(Per CDOT and DCS 7.09 Table 7-5)

7.43 CFS >> 5.45 CFS (100-yr Design Flow)

∴ O.K.

W.S.E.	5203.00
RIM	5201.50
H=HEIGHT FROM BOTTOM OF THE OPENING	1.50

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

Project No.: 12506B
Date: 7/15/2013
By: DPA

WEIR FLOW CALCULATIONS 2' by 2' Inlet - Basin A3
Neenan Type R-3402-E

Enter starting C, L, d to calculate Q.

Q=Cw*Lw*(d**1.5)

Q=Flow=	**24.00**	CFS	
C=Weir Coef.=	3		
L=Weir Length=	8	FT	
d =Depth	1.000	FT	(12.00 IN.)

Max Water Surface Elevation=	5202.50
Grate Elevation=	5201.50

Cw = Weir Coefficient
Lw = Weir Length =2L+2W
d = depth

24.00 CFS >> 5.34 CFS (100-yr Design Flow)

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

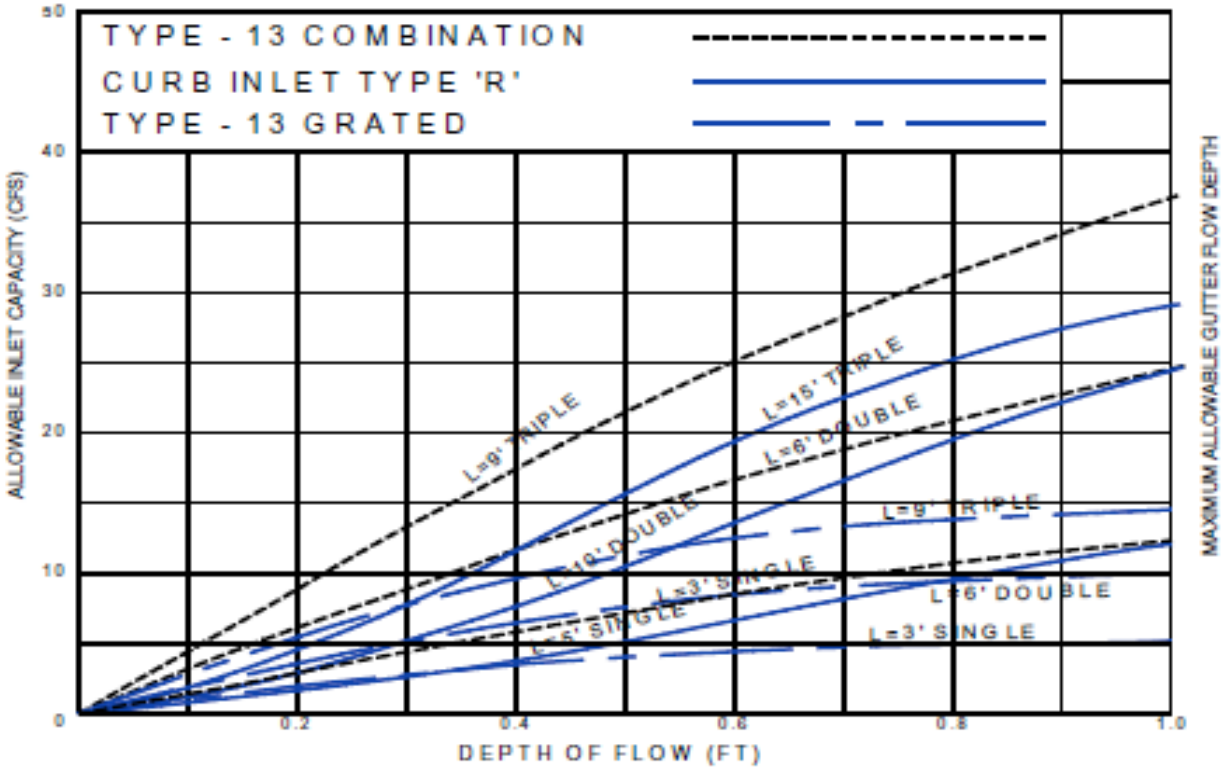
Project No.: 12506B
Date: 7/15/2013
By: DPA

INLET FLOW CALCULATIONS

5' CDOT Type R Inlet - Basin A2
Per COB DCS Chapter 7.09(B)(1)

Minor Storm		8 IN.	D = Allowable depth in cross pan
		7.75 CFS	**Q = Theoretical Flow**
		80%	Percentage of Capacity Allowed
			(Per CDOT and DCS 7.09 Table 7-5)
		6.20 CFS	**Q = Allowbale Flow**
	∴ **O.K. >>**	4.07 CFS	**Q = 5-yr Design Flow**
Major Storm		12 IN.	D = Allowable depth above flowline
		12.00 CFS	**Q = Theoretical Flow**
		80%	Percentage of Capacity Allowed
			(Per CDOT and DCS 7.09 Table 7-5)
		9.60 CFS	**Q = Allowbale Flow**
	∴ **O.K. >>**	9.14 CFS	**Q = 100-yr Design Flow**

Figure 7-7: Allowable Inlet Capacity
Sump Conditions - All Inlets



SCOTT, COX & ASSOCIATES,INC.

consulting engineers - surveyors

PROJECT #: 12506B

DATE: 10/7/2013

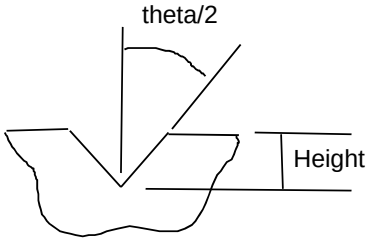
BY: DPA

V-Notch Weir Flow Calculations

Enter starting Theta and H,

Q=C*(H**(5/2))*tan(theta/2)

Q=Flow=	**22.96**	CFS			
C=Weir Coef.=	2.50				
Theta(**Total Angle**)=	146.6	Degrees			
H=Height=	1.50	Feet	(	18	Inches)
Width at top of Weir=	10.00	Feet	(	120	Inches)



22.96 CFS >> 10.68 CFS (2x100-yr Design Flow - Basin A3)

∴ O.K.

APPENDIX C

WATER QUALITY POND CALCULATIONS

WATER QUALITY STORMCEPTOR CALCULATIONS

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

PROJECT #: 12506B
DATE: 10/7/2013
BY: DPA

Calculate Water Quality Capture Volume - Porous Landscape Detention
Reference UDFCD Manual - Volume 3 - 12 hour drain time

1. Basin Storage Volume

A. Imperviousness Ratio ($I = I_a / 100$) I_A = 50.00%
i = 0.500

B. Contributing Watershed A = 0.73 Acres

C. Water Quality Capture Volume (WQCV)
$WQCV = 0.8 \times (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$
WQCV = 0.165 in / acre

D. Design Volume
Volume = (WQCV / 12) * Area Volume = 0.0100 acre - feet
For Porous Landscape Detention 437 cubic feet

WATER QUALITY CAPTURE VOLUME (WQCV) = 437 cubic feet

VOLUME PROVIDED = 872 cubic feet

∴ O.K.

SCOTT, COX & ASSOCIATES, INC.
consulting engineers - surveyors

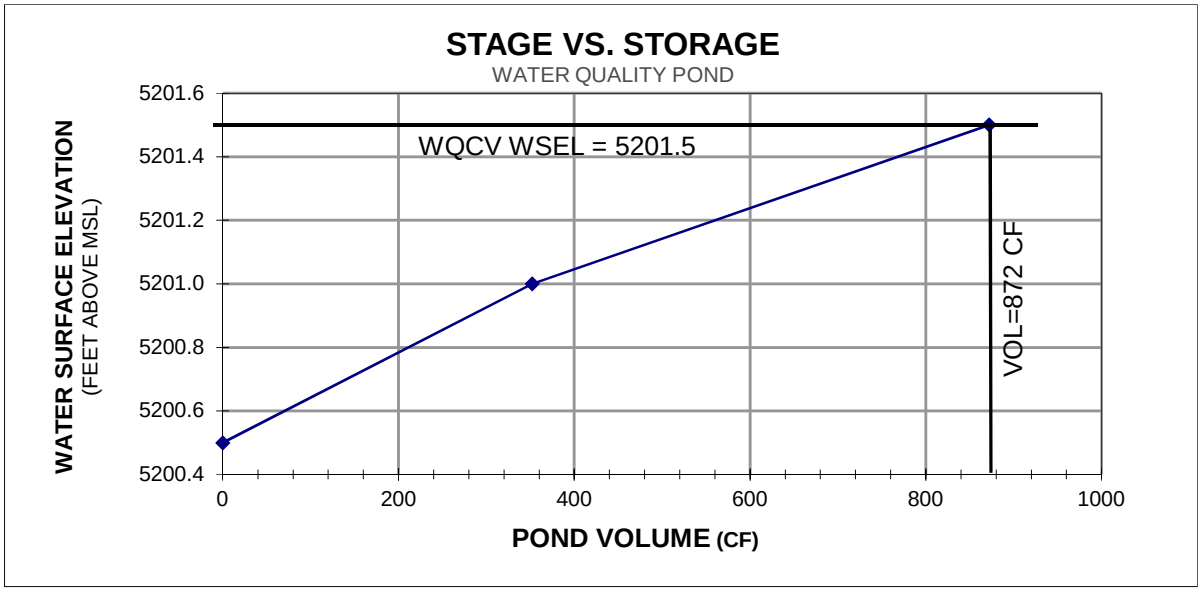
PROJECT #: 12506B
DATE: 10/7/2013
DATE: DPA

PROPOSED W.S.E.: 5201.50

POND VOLUME CALCULATION - BASIN A3

ELEVATION	DEPTH	AREA S.F.	WEIGHTED AVG AREA S.F.	INCREMENTAL VOLUME C.F.	CUMMULATIVE VOLUME C.F.
5200.5		582			
	0.5		705	352	352
5201.0		827			
	0.5		1,040	520	872
5201.5		1,252			
	TOTAL (CUBIC FEET)			**872**	

STAGE/STORAGE		
STAGE(SF)	VOL(CF)±	CUM VOL(CF)
5200.5	0	0
5201.0	352	352
5201.5	520	872



Design Procedure Form: Rain Garden (RG)

Designer:	**Dana Smyly**
Company:	**Scott, Cox & Associates, Inc.**
Date:	**October 7, 2013**
Project:	**12506C - Coroner's Bldg**
Location:	**Boulder, CO**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 50.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.500
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time ($WQCV = 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$)	WQCV = 0.17 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 32,000 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 440 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = _____ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = _____ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = _____ cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 3.00 ft / ft **Z < 4:1**
C) Mimimum Flat Surface Area	A_{Min} = 293 sq ft
D) Actual Flat Surface Area	A_{Actual} = 582 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 1252 sq ft
F) Rain Garden Total Volume ($V_T = ((A_{Top} + A_{Actual}) / 2) * Depth$)	V_T= 917 cu ft
3. Growing Media	Choose One (●) 18" Rain Garden Growing Media ( ) Other (Explain):
4. Underdrain System	Choose One
A) Are underdrains provided?	(●) YES ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 0.2 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 440 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 0.80 in

Design Procedure Form: Rain Garden (RG)

Designer: Dana Smyly
Company: Scott, Cox & Associates, Inc.
Date: October 7, 2013
Project: 12506C - Coroner's Bldg
Location: Boulder, CO

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ○ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ○ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ◉ NO

Notes:

Appendix 1
Stormceptor Design Summary

Project Information

Date	9/9/2013
Project Name	Boulder County Coroner's Office
Project Number	N/A
Location	Boulder, CO

Designer Information

Company	Scott Cox & Associates
Contact	Dana Smyly

Notes

N/A

Drainage Area

Total Area (ac)	4.71
Imperviousness (%)	77.6

The Stormceptor System model STC 900 achieves the water quality objective removing 85% TSS for a Fine (organics, silts and sand) particle size distribution.

Rainfall

Name	BOULDER 2
State	CO
ID	843
Years of Records	1948 to 2005
Latitude	40°2'2"N
Longitude	105°16'52"W

Water Quality Objective

TSS Removal (%)	80

Upstream Storage

Storage (ac-ft)	Discharge (cfs)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 450i	77
STC 900	**85**
STC 1200	85
STC 1800	86
STC 2400	89
STC 3600	90
STC 4800	92
STC 6000	92
STC 7200	94
STC 11000	95
STC 13000	96
STC 16000	96

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in.	1 in.	3 in.
Multiple inlet pipes	3 in.	3 in.	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Rinker Materials 1 (800) 909-7763 www.rinkerstormceptor.com

Stormceptor®

Appendix 2
Summary of Design Assumptions

SITE DETAILS

Site Drainage Area

Total Area (ac)	4.71	Imperviousness (%)	77.6

Surface Characteristics

Width (ft)	906
Slope (%)	2
Impervious Depression Storage (in.)	0.5
Pervious Depression Storage (in.)	0.2
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Maintenance Frequency

Sediment build-up reduces the storage volume for sedimentation. Frequency of maintenance is assumed for TSS removal calculations.	
Maintenance Frequency (months)	12

Infiltration Parameters

Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (in/hr)	2.44
Min. Infiltration Rate (in/hr)	0.4
Decay Rate (s^{-1})	0.00055
Regeneration Rate (s^{-1})	0.01

Evaporation

Daily Evaporation Rate (inches/day)	0.1

Dry Weather Flow

Dry Weather Flow (cfs)	No

Winter Months

Winter Infiltration	False

Upstream Attenuation

Stage-storage and stage-discharge relationship used to model attenuation upstream of the Stormceptor System is identified in the table below.

Storage ac-ft	Discharge cfs
0	0

Rinker MATERIALS™

PARTICLE SIZE DISTRIBUTION

Particle Size Distribution

Removing fine particles from runoff ensures the majority of pollutants, such as heavy metals, hydrocarbons, free oils and nutrients are not discharged into natural water resources. The table below identifies the particle size distribution selected to define TSS removal for the design of the Stormceptor System.

Fine (organics, silts and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity ft/s
20	20	1.3	0.0013					
60	20	1.8	0.0051					
150	20	2.2	0.0354					
400	20	2.65	0.2123					
2000	20	2.65	0.9417					

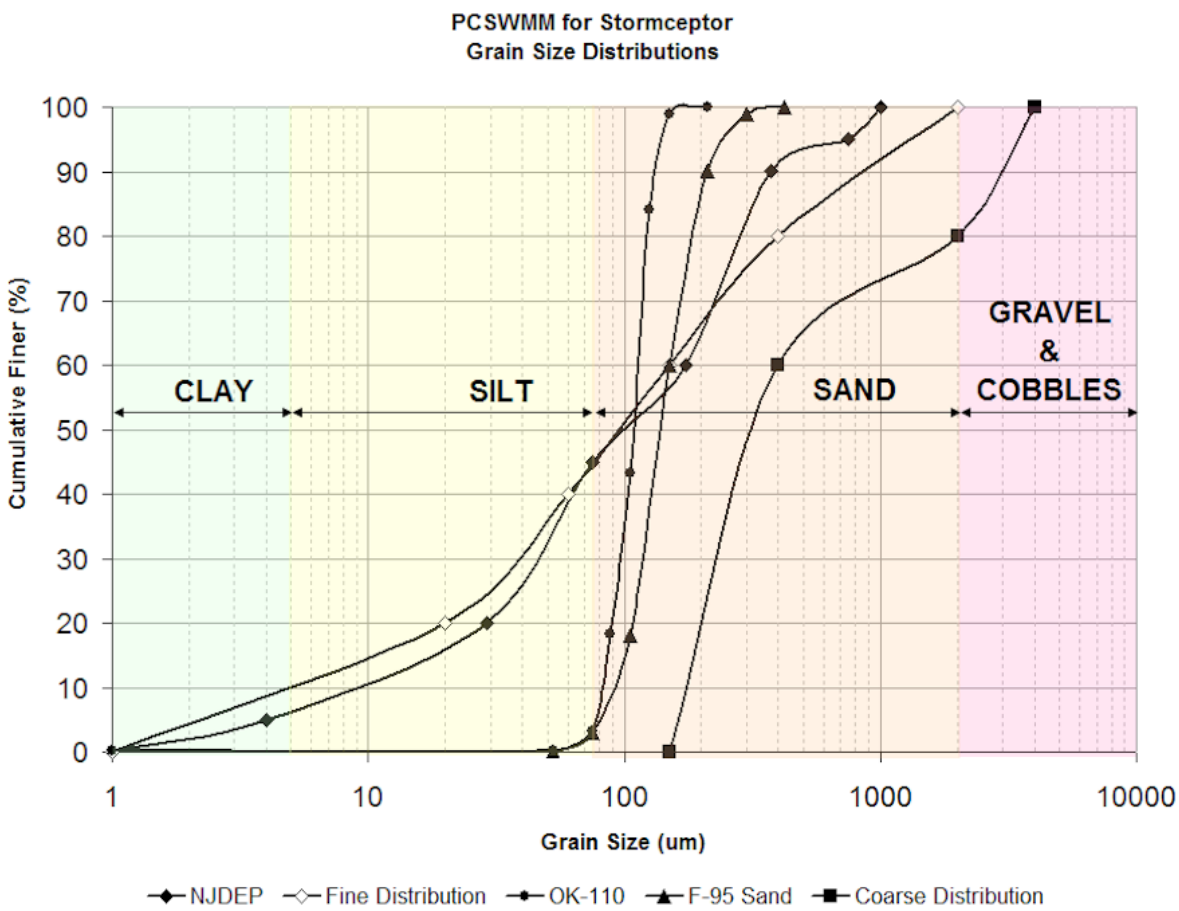


Figure 1. PCSWMM for Stormceptor standard design grain size distributions.

TSS LOADING

TSS Loading Parameters

TSS Loading Function	Buildup / Washoff

Buildup/Washoff Parameters

Target Event Mean Concentration (EMC) (mg/L)	125
Exponential Buildup Power	0.4
Exponential Washoff Exponential	0.2

TSS Availability Parameters

Availability = A + Bi^C	
Availability Constant A	0.057
Availability Factor B	0.04
Availability Exponent C	1.1
Min. Particle Size Affected by Availability (µm)	400

HYDROLOGY ANALYSIS

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of the Stormceptor System are based on the average annual removal of TSS for the selected site parameters. The Stormceptor System is engineered to capture fine particles (silts and sands) by focusing on average annual runoff volume ensuring positive removal efficiency is maintained during all rainfall events, while preventing the opportunity for negative removal efficiency (scour).

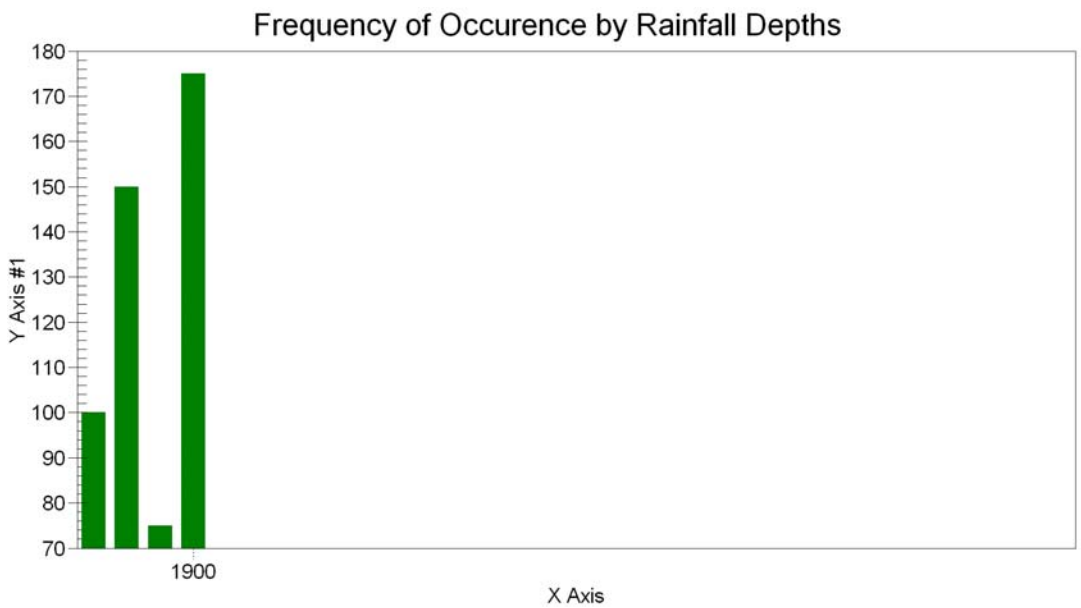
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

Rainfall Station	BOULDER 2		
Rainfall File Name	CO843.NDC	Total Number of Events	5249
Latitude	40°2'2"N	Total Rainfall (in.)	932.0
Longitude	105°16'52"W	Average Annual Rainfall (in.)	16.1
Elevation (ft)	5415	Total Evaporation (in.)	389.6
Rainfall Period of Record (y)	58	Total Infiltration (in.)	207.3
Total Rainfall Period (y)	58	Percentage of Rainfall that is Runoff (%)	37.4

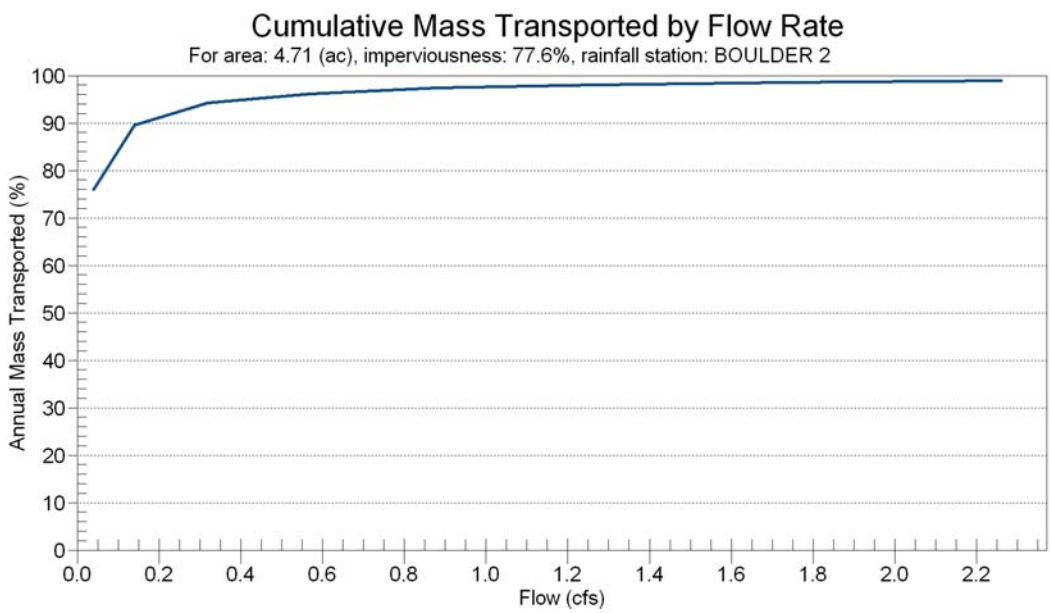
Rainfall Event Analysis

Rainfall Depth in.	No. of Events	Percentage of Total Events %	Total Volume in.	Percentage of Annual Volume %
0.25	4390	83.6	442	47.5
0.50	573	10.9	207	22.3
0.75	124	2.4	79	8.5
1.00	82	1.6	72	7.8
1.25	25	0.5	28	3.0
1.50	26	0.5	36	3.8
1.75	10	0.2	16	1.8
2.00	3	0.1	6	0.6
2.25	4	0.1	9	0.9
2.50	4	0.1	9	1.0
2.75	4	0.1	10	1.1
3.00	2	0.0	6	0.6
3.25	1	0.0	3	0.3
3.50	0	0.0	0	0.0
3.75	0	0.0	0	0.0
4.00	0	0.0	0	0.0
4.25	0	0.0	0	0.0
4.50	0	0.0	0	0.0
4.75	0	0.0	0	0.0
5.00	0	0.0	0	0.0
5.25	0	0.0	0	0.0
5.50	0	0.0	0	0.0
5.75	0	0.0	0	0.0
6.00	0	0.0	0	0.0
6.25	0	0.0	0	0.0
6.50	0	0.0	0	0.0
6.75	0	0.0	0	0.0
7.00	0	0.0	0	0.0
7.25	0	0.0	0	0.0
7.50	1	0.0	7	0.8
7.75	0	0.0	0	0.0
8.00	0	0.0	0	0.0
8.25	0	0.0	0	0.0
>8.25	0	0.0	0	0.0



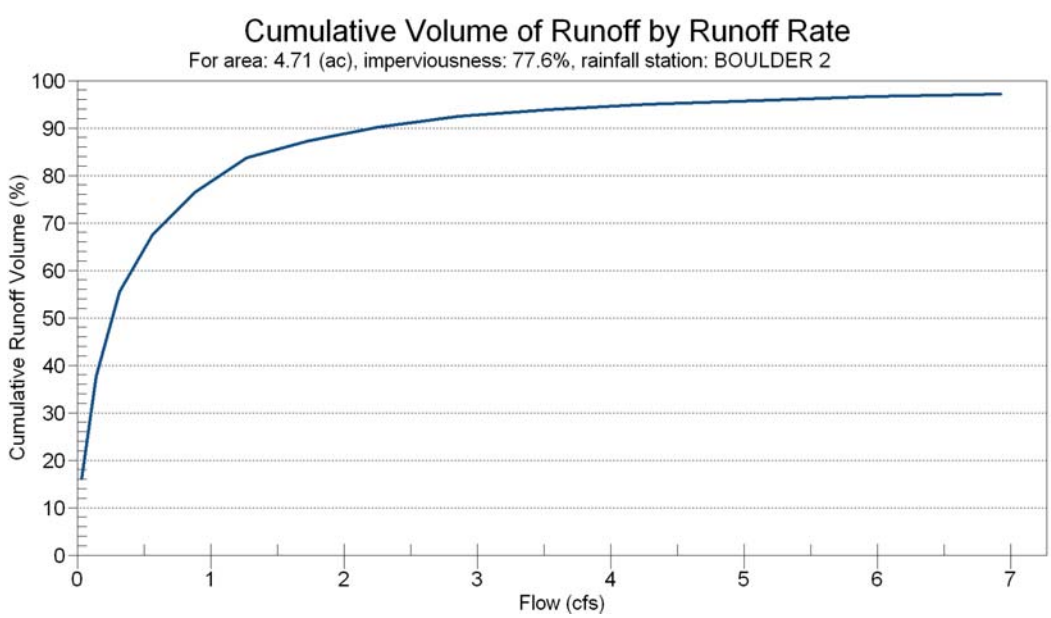
Pollutograph

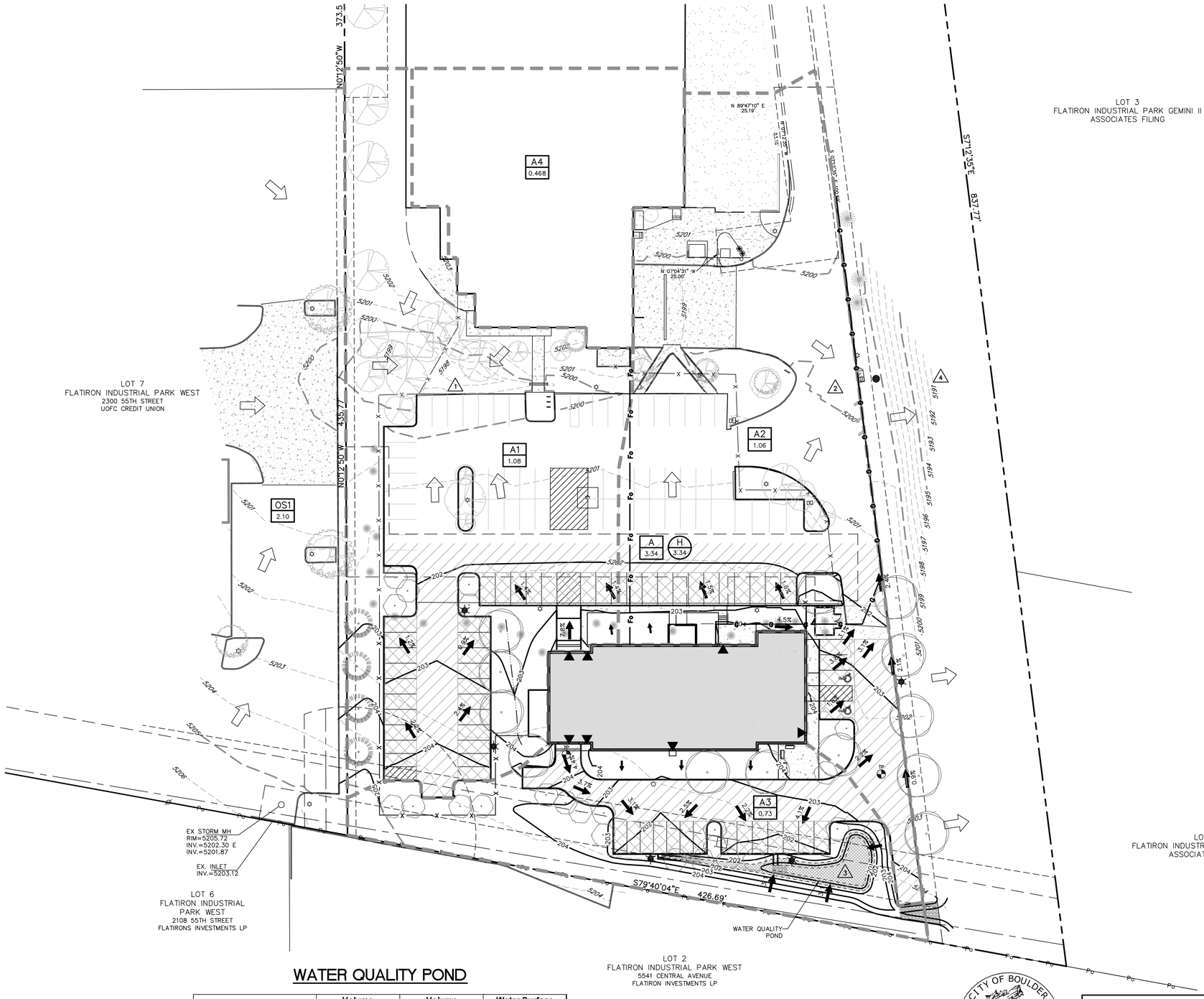
Flow Rate cfs	Influent Mass ton	Effluent Mass ton	Total Mass ton	Cumulative Mass %
0.035	45.8832	14.4485	60.3361	76.0
0.141	53.9792	6.3789	60.3361	89.5
0.318	56.8821	3.4661	60.3361	94.3
0.565	58.0437	2.3001	60.3361	96.2
0.883	58.7785	1.5642	60.3361	97.4
1.271	59.2174	1.1253	60.3361	98.1
1.73	59.4583	0.8822	60.3361	98.5
2.26	59.6552	0.6842	60.3361	98.9
2.86	59.807	0.5324	60.3361	99.1
3.531	59.9181	0.4213	60.3361	99.3
4.273	59.9929	0.3476	60.3361	99.4
5.085	60.0534	0.286	60.3361	99.5
5.968	60.1106	0.2288	60.3361	99.6
6.922	60.1645	0.1749	60.3361	99.7
7.946	60.2151	0.1232	60.3361	99.8
9.041	60.2558	0.0836	60.3361	99.9
10.206	60.2888	0.0495	60.3361	99.9
11.442	60.3086	0.0286	60.3361	100.0
12.749	60.3207	0.0165	60.3361	100.0
14.126	60.3262	0.0099	60.3361	100.0
15.574	60.3306	0.0055	60.3361	100.0
17.092	60.3339	0.0033	60.3361	100.0
18.681	60.3361	0.0011	60.3361	100.0
20.341	60.3361	0	60.3361	100.0
22.072	60.3361	0	60.3361	100.0
23.873	60.3361	0	60.3361	100.0
25.744	60.3361	0	60.3361	100.0
27.687	60.3361	0	60.3361	100.0
29.7	60.3361	0	60.3361	100.0
31.783	60.3361	0	60.3361	100.0



Cumulative Runoff Volume by Runoff Rate

Runoff Rate cfs	Runoff Volume ft³	Volume Overflowed ft³	Cumulative Runoff Volume %
0.035	960817	5002907	16.1
0.141	2247089	3716193	37.7
0.318	3311216	2652618	55.5
0.565	4024082	1939405	67.5
0.883	4564183	1399518	76.5
1.271	4992948	970637	83.7
1.73	5204002	759667	87.3
2.26	5377650	585986	90.2
2.86	5517292	446376	92.5
3.531	5597358	366309	93.9
4.273	5664598	299096	95.0
5.085	5713887	249796	95.8
5.968	5758172	205530	96.6
6.922	5797104	166602	97.2
7.946	5830050	133666	97.8
9.041	5858557	105158	98.2
10.206	5882288	81449	98.6
11.442	5901968	61772	99.0
12.749	5917814	45931	99.2
14.126	5929982	33756	99.4
15.574	5938901	24844	99.6
17.092	5946323	17422	99.7
18.681	5952195	11551	99.8
20.341	5956090	7656	99.9
22.072	5958338	5409	99.9
23.873	5960300	3445	99.9
25.744	5961420	2322	100.0
27.687	5962584	1156	100.0
29.7	5963537	204	100.0
31.783	5963741	0	100.0





RUNOFF TABLE

Drainage Basin	Design Point	Area (AC)	t_c (min)	C_5	I_5 (in/hr)	Q_5 (cfs)	C_{100}	I_{100} (in/hr)	Q_{100} (cfs)
HISTORIC BASINS									
H	- -	3.34	13.08	0.53	3.65	6.43	0.76	7.25	18.27
DEVELOPED BASINS									
A		3.34	11.88	0.67	3.90	8.68	0.82	7.70	21.10
A1	1	1.08	13.08	0.56	3.90	2.35	0.77	7.70	6.39
A2	2	1.06	6.66	0.77	5.10	4.19	0.87	9.90	9.19
A3	3	0.73	7.09	0.55	4.85	1.97	0.77	9.70	5.45
A4	4	0.47	5.21	0.85	5.70	2.27	0.90	10.60	4.46
OFFSITE BASINS									
OS1	- -	2.10	7.99	0.80	3.75	6.30	0.85	7.40	13.21

WATER QUALITY POND

Stage	Volume Required (CF)	Volume Provided (CF)	Water Surface Elevation (FT)
WQCV	440	838	5201.5

CITY OF BOULDER
DEPARTMENT OF PUBLIC WORKS
APPROVED
ENGINEERING CONSTRUCTION DRAWING
ENGINEERING REVIEW MANAGER DATE
APPROVAL EXPIRES ONE YEAR AFTER DATE ABOVE

CITY OF BOULDER
PUBLIC WORKS DEPARTMENT
RECOMMENDATION FOR APPROVAL
WATER/SEWER
TRANSPORTATION
DRAINAGE

COLORADO REGISTERED PROFESSIONAL ENGINEER
DONALD P. ASH
10/07/13
36045

DRAWN BY: JAS CHECKED BY: DPA

Boulder County Administrative Services
Building Services Division - Architects
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REVISION	DATE
Tec Doc Review	07/15/2013
Tec Doc Resubmittal	10/07/2013

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1530 55th Street • Boulder, Colorado 80303
(303) 444 – 3051

JOB NO. 12506B DWG. NO. 12506B–1

Applicant Information
Boulder County Administrative Services
Building Services Division - Architects
P.O. Box 471
Boulder, Colorado 80306
Application Type: TEC DOC REVIEW
Case No.: ---

BOULDER COUNTY CORONER FACILITY

5600 Flatiron Parkway
Boulder, Colorado 80301

Project No: 12506B

OVERALL DRAINAGE PLAN

D1.01