GREAT BASIN ENGINEERING INC

WEBER INDUSTRIAL PARK – FLEX BUILDING
2147 RULON WHITE BLVD.
UNINCORPORATED WEBER COUNTY, UTAH 84404
STORM WATER STUDY
Project No. 21N231
9 August 2022

General Site Information:

The proposed Weber Industrial Park – Flex Building site is located at 2147 Rulon White Boulevard along the west side of the road. It is situated near the west side of an island of Unincorporated Weber County, Utah which is bordered on the west by Farr West City, to the north/east by Pleasant View City, and to the south/east by Harrisville City. Construction will consist of a new commercial building to the west of an existing building in the Industrial Park. Also included are parking lots, sidewalks, curb and gutter, underground utilities, and landscaped areas when completed.

Storm water from the site will be collected in inlets and catch basins and will continue via storm drain to the southeast side of the site. Storm water will be detained in a detention facility located mainly above-ground in the parking lot there. Some storage will also be provided in the proposed storm drain piping and inlet boxes throughout the site. The site is allowed a unit-release of 0.1 cfs per acre for the 100-yr storm into an existing storm drainage system in the existing commercial buildings to the east, and ultimately to an existing system in Rulon White Boulevard. The attached figure shows the project site and location of the storm water outfall to the existing system. Detention calculations have been provided for the site. (See attached figure and calculations).

The study area is broken up into 2 drainage areas (labeled A-1 and A-2). A runoff coefficient of 0.15 is used for natural ground and landscaped areas. A runoff coefficient of 0.90 is used for asphalt, concrete, buildings, and other hard surfaced areas. Average runoff coefficients of 0.824 and 0.805, are calculated for areas A-1 and A-2, respectively. This yields a coefficient of 0.81 for the overall study area.

Times of concentration are calculated using the FAA method assuming flow resistance coefficients of K=0.35 for landscape and K=0.91 for hardscape for each of the drainage areas. The times of concentration are about 8 and 9 minutes respectively for areas A-1 and A-2. These times are based on the hydraulically longest drainage path inside each respective drainage area over grass or other vegetation, asphalt, concrete, and/or through a pipeline as applicable. Times calculated to be less than 5 minutes are rounded to 5 minutes (as applicable) when using this method. Rainfall intensities were taken from NOAA Atlas 14 for pipe sizing and detention requirements. The values obtained were interpolated as necessary. A copy of these data is attached.

Data showing area information, runoff coefficient, time of concentration, peak flows, and detention storage requirements for the site are provided in the attached calculations.

Design Requirements:

The design storms and allowable stormwater release rate were found on the weber County Website on 8/9/2022 at https://www.webercountyutah.gov/Engineering/design_standards.php. For storm water conveyance, the requirement is listed as the 10 year event. For major collection of systems (taken to mean detention pond sizing), the requirement listed is the 100 year event with 0.1 cfs/ac release.

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For sites in Utah, the State has been requiring LID Retention of the 80th Percentile Storm when feasible. The Geotechnical Investigation for this site indicates clayey materials were found at depths appropriate for retention under normal circumstances. However, since clays are not efficient at percolation, LID retention is considered infeasible for this site.

Pipe Sizes:

Storm water pipes in the project are proposed to be polyvinylchloride pipes (PVC), concrete pipe (CP), and/or reinforced concrete pipe (RCP). All pipes in the project are sloped to provide the design capacity while maintaining a minimum scour speed of at least 2 feet per second when the pipes are flowing at least half full. The pipes and inlet boxes are designed with enough capacity to convey the 10-year storm without surcharging.

Orifice Plate:

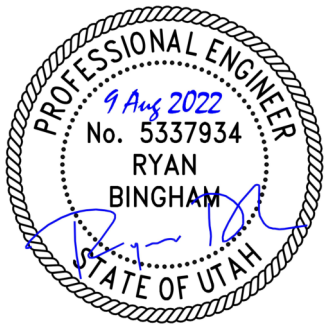
A Stormwater Analysis had been provided by Great Basin Engineering in 1999 for the existing two buildings and site to the east. Coordination for this project must be made with the results of the 1999 Study. A copy of the 1999 Study is attached herewith. Orifice plates have been used at nodes 3 and 10 from this study. The plates themselves are given designations of 101 and 102 for convenience in modeling the flow through these restrictions. The diameters of the openings will need to be adjusted in order to accommodate additional flows.

At node 3, the adjusted orifice must pass the metered release from the previous study (0.097 cfs) in addition to the 100 year total flows from A-1 of this study. The orifice at node 10 will need to pass the previous release from that plate (0.737 cfs) in addition to the allowable release rate from this study (0.1 cfs/ac * 1.52 ac = 0.152 cfs). The orifice plate openings will be 7.2 and 4.0 inches in diameter, respectively for nodes 101 and 102, for the detention facility to utilize its capacity during a 100-yr storm with a release rate of 0.1 cfs/ac. The orifice plate will allow small flows to pass through without detention. As the rate of storm water into the pipes and detention facility increases, the orifice plates will restrict the flow. The maximum flow through the plates will occur when the detention basin from this project and the existing detention facilities from the 1999 project reach their maximum design depths. The adjusted orifices are to be mounted eccentrically, tangent to the bottom of the outflow pipe. A detail of an orifice plate can be found in the construction documents for this project.

Required Detention:

The required detention for the 100-year storm with a release rate of 0.1 cfs/acre is 7,586 cubic feet (cf) for the entire study area. The available volume in the detention facility is 7,640 cf. There is an excess capacity of 54 cf. In the event the facility experiences a storm larger than the design storm water will then spill out onto Rulon White Boulevard and continue downstream in a historical fashion.

Great Basin Engineering, Inc.
Prepared by Ryan Bingham, P.E.



8/9/2022

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

Phase 1 Const. Limits

202.85'

S=0.62%

A-1

A-2

UNIT #1 11,300 SQ.FT.

UNIT #2
5,000
SQ.FT.

UNIT #3
5,000
SQ.FT.

FF 4286.90

4284.00

4286.00

1

2

3

4

5

6

7

8

9

10

101

102

Storm Water Calculations
Weber Industrial Park - Flex Building
2147 Rulon White Blvd. Unincorporated Weber County, UT 84404
21N231-S7 SWS Exhib.dwg

8/9/2022

2 Detained Areas

Hardscape C =	0.90
Landscape C =	0.15

Drainage Areas	Total Area (ft^2)	Total Area (acres)	Hardscape Area (ft^2)	Hardscape Area (ft^2)	Landscape (ft^2)	Landscape Area (acres)	C
∑ Det. Areas	66205	1.520	58414	1.341	7791	0.179	0.812
∑ All Areas	66205	1.520	58414	1.341	7791	0.179	0.812
A-1	23584	0.541	21201	0.487	2383	0.055	0.824
A-2	42621	0.978	37213	0.854	5408	0.124	0.805

Time of Concentration--use FAA Method

For FAA Method, use K's of..

K =	0.35	for landscape
K =	0.91	for hardscape

$$t_c = \frac{1.8(1.1 - K)\sqrt{L}}{\sqrt[3]{S}}$$

Assume Pipe Flow is at 2 ft/s Scour Speed

**Note: S is in percent, 5 min is smallest allowed Tc

Area	Length on Landscape (ft)	Slope of Landscape (%)	Time on Landscape (min.)	Length on Hardscape (ft)	Slope of Hardscape (%)	Time on Hardscape (min.)	Length in Pipe (ft)	Time in Pipe (min.)	TC for entire Area (min.)
A-1	9.00	2.00	3.21	116.00	2.00	2.92	210.00	1.75	7.89
A-2	9.00	2.00	3.21	121.00	1.50	3.29	305.00	2.54	9.04

Rainfall Intensities
Data From NOAA

10-Year and 100-Year Intensities

The equations used for the 10-Year and 100-Year Intensities were found using the attached Rainfall data as well as Interpolated data where applicable.

Storm Intensities

AREA	Tc (minutes)	I (10-yr.) (in./hr.)	I (100-yr.) (in./hr.)
A-1	7.9	2.93	5.82
A-2	9.0	2.74	5.45

Peak Flow Information
Use Rational Method
10-Year and 100-Year Intensities

Q=CIA

					Peak Flows	
				∑ detained =	3.46	6.89
AREA	C	I10 (in./hr.)	I100 (in./hr.)	A (acres)	Q (10-yr.) (cfs)	Q (100-yr.) (cfs)
A-1	0.824	2.926	5.824	0.54	1.31	2.60
A-2	0.805	2.737	5.450	0.98	2.16	4.29

Node Inlet Requirements

Size pipes for 10 year storm

Area	Node #	% of Total	Q (cfs)
A-1	1	35.0%	0.46
A-1	2	35.0%	0.46
A-1	3	30.0%	0.39
A-1	101	106.5%	1.39
A-2	4	10.0%	0.22
A-2	5	10.0%	0.22
A-2	6	10.0%	0.22
A-2	7	20.0%	0.43
A-2	8	30.0%	0.65
A-2	9	20.0%	0.43
A-2	10	0.0%	0.00
A-2	102	-183.8%	(3.96)

Summary of Node Inlet Requirements

Node	Is required to take (cfs)
1	0.46
2	0.46
3	0.39
4	0.22
5	0.22
6	0.22
7	0.43
8	0.65
9	0.43
10	0.00
101	1.39
102	-3.96

PIPE FLOWS

Upstream Node	Downstream node	Pipe Flow (cfs)
1	2	0.46
2	3	0.91
3	101	1.31
4	5	0.22
5	6	0.43
6	7	0.65
7	8	1.08
8	9	1.72
9	10	2.16
10	102	4.85
101	10	2.70
102	Outfall	0.89

Options for Pipe Sizes Between the Specified Nodes

Up Stream Node	Dn Stream Node	Q (cfs)	Pipe Size (in)	Design Min Slope (%)	Area (ft^2)	Rh (ft)	Manning's n	Scour Min. Slope (%)	First Trial Pipe Size
1	2	0.46	6	0.475%	0.196	0.125	0.011	1.000%	8
		0.46	8	0.102%	0.349	0.167	0.011	0.400%	
		0.46	10	0.031%	0.545	0.208	0.011	0.280%	
2	3	0.91	6	1.900%	0.196	0.125	0.011	1.000%	8
		0.91	8	0.410%	0.349	0.167	0.011	0.400%	
		0.91	10	0.125%	0.545	0.208	0.011	0.280%	
3	101	1.31	6	3.877%	0.196	0.125	0.011	1.000%	10
		1.31	8	0.836%	0.349	0.167	0.011	0.400%	
		1.31	10	0.254%	0.545	0.208	0.011	0.280%	
4	5	0.22	6	0.106%	0.196	0.125	0.011	1.000%	8
		0.22	8	0.023%	0.349	0.167	0.011	0.400%	
		0.22	10	0.007%	0.545	0.208	0.011	0.280%	
5	6	0.43	6	0.423%	0.196	0.125	0.011	1.000%	8
		0.43	8	0.091%	0.349	0.167	0.011	0.400%	
		0.43	10	0.028%	0.545	0.208	0.011	0.280%	
6	7	0.65	6	0.951%	0.196	0.125	0.011	1.000%	8
		0.65	8	0.205%	0.349	0.167	0.011	0.400%	
		0.65	10	0.062%	0.545	0.208	0.011	0.280%	
7	8	1.08	6	2.641%	0.196	0.125	0.011	1.000%	10
		1.08	8	0.569%	0.349	0.167	0.011	0.400%	
		1.08	10	0.173%	0.545	0.208	0.011	0.280%	
8	9	1.72	8	1.458%	0.349	0.167	0.011	0.400%	10
		1.72	10	0.443%	0.545	0.208	0.011	0.280%	
		1.72	12	0.234%	0.785	0.250	0.013	0.200%	
9	10	2.16	8	2.277%	0.349	0.167	0.011	0.400%	12
		2.16	10	0.693%	0.545	0.208	0.011	0.280%	
		2.16	12	0.366%	0.785	0.250	0.013	0.200%	
10	102	4.85	12	1.854%	0.785	0.250	0.013	0.200%	18
		4.85	15	0.564%	1.227	0.313	0.013	0.145%	
		4.85	18	0.213%	1.767	0.375	0.013	0.114%	
101	10	2.70	10	1.084%	0.545	0.208	0.011	0.280%	15
		2.70	12	0.573%	0.785	0.250	0.013	0.200%	
		2.70	15	0.174%	1.227	0.313	0.013	0.145%	
102	Outfall	0.89	6	1.797%	0.196	0.125	0.011	1.000%	8
		0.89	8	0.387%	0.349	0.167	0.011	0.400%	
		0.89	10	0.118%	0.545	0.208	0.011	0.280%	

Weber Industrial Park - Flex Building

Combined Detention Facility

C = 0.81

Area = 1.52 acres

Remaining Unit Discharge = 0.10 cfs/acre

Release through Restriction = 0.152 cfs

Detention Pond Sized For The 100 Year Storm

Time	Rainfall Intensity	Accumulated Volume	Allowable Release	Needed Detention	
min	in./hr.	(CF)	(CF)	(CF)	
5	6.76	2502	46	2456	
10	5.14	3805	91	3714	
15	4.24	4708	137	4571	
20	3.61	5341	182	5158	
25	3.18	5883	228	5655	
30	2.86	6351	274	6078	
35	2.62	6792	319	6473	
40	2.39	7066	365	6701	
45	2.19	7299	410	6888	
50	2.02	7488	456	7032	
55	1.88	7665	502	7164	
60	1.77	7861	547	7314	
90	1.26	8407	821	7586	<- Det
120	0.98	8679	1094	7584	
180	0.67	8887	1641	7246	
360	0.37	9913	3283	6630	
720	0.23	12152	6566	5586	
1440	0.13	13431	13132	299	

Required Storage Volume = **7586** ft^3

Total Required Capacity = **7586** cf

Provided Capacities:

Above-ground = 7144 cf

Pipes = 365 cf

Boxes = 130 cf

Total Provided Capacity = **7640** cf

Excess Capacity = **54** cf

Node 101 Calcs

Previous Discharge (1999) = 0.097 cfs

Additional Discharge (2022) = 2.599 cfs

New Total Discharge Through Restriction = 2.696 cfs

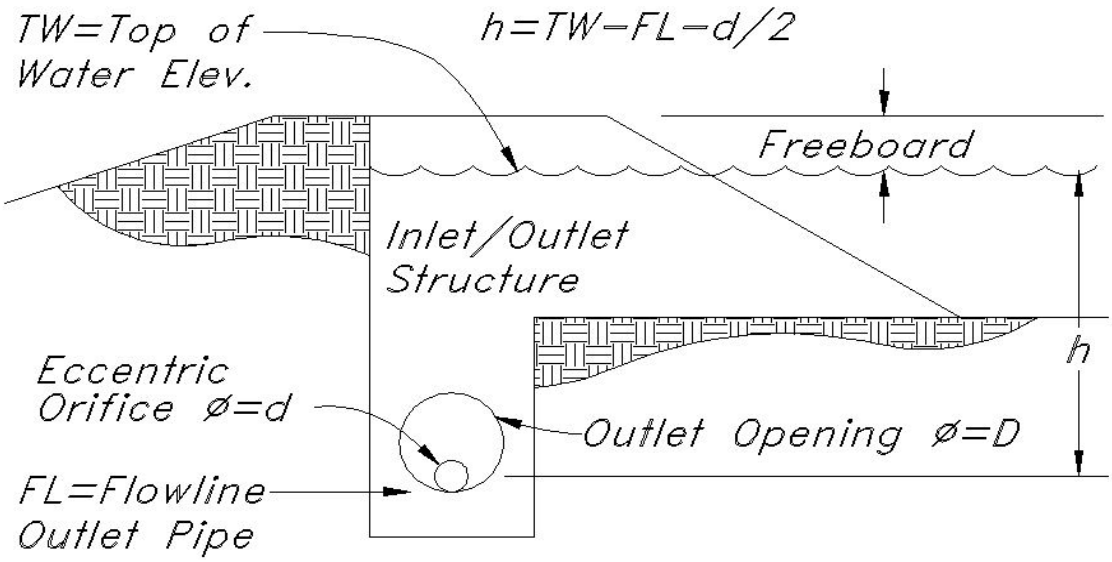
Node 102 Calcs

Previous Discharge (1999) = 0.737 cfs

Additional Discharge (2022) = 0.152 cfs

New Total Discharge Through Restriction = 0.889 cfs

ORIFICE PLATE CALCULATIONS



$$Q_{orif} = 0.62 \cdot A_o \cdot \sqrt{64.4 \cdot h}$$

$$A_o = \frac{\pi \cdot d^2}{4}$$

$$h = TW - FL - {}^{d}/_{2}$$

$$Q_{req} = Q_{orif}$$

Let $\Delta = Q_{req} - Q_{orif}$, and Goal Seek Δ to zero by changing "trial d".

	Node 101	Node 102	
TW =	4286.10	4285.90	
FL =	4282.08	4281.38	
Q_{req} =	2.696	0.889	cfs
trial d=	0.5980	0.3302	ft
Δ =	0.000	0.000	ft
d =	7.2	4.0	inches

NOAA Atlas 14, Volume 1, Version 5
Location name: Ogden, Utah, USA*
Latitude: 41.2966°, Longitude: -112.014°
Elevation: 4286.24 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.58** (1.38-1.82)	**1.98** (1.75-2.29)	**2.71** (2.38-3.13)	**3.40** (2.95-3.92)	**4.50** (3.82-5.23)	**5.52** (4.55-6.50)	**6.76** (5.38-8.04)	**8.21** (6.29-9.97)	**10.6** (7.63-13.2)	**12.8** (8.77-16.4)
10-min	**1.20** (1.05-1.39)	**1.51** (1.34-1.75)	**2.06** (1.81-2.38)	**2.58** (2.24-2.98)	**3.42** (2.90-3.98)	**4.20** (3.46-4.94)	**5.14** (4.09-6.11)	**6.24** (4.78-7.59)	**8.04** (5.81-10.1)	**9.71** (6.68-12.5)
15-min	**0.992** (0.868-1.14)	**1.25** (1.10-1.44)	**1.70** (1.50-1.97)	**2.14** (1.86-2.47)	**2.83** (2.40-3.29)	**3.47** (2.86-4.09)	**4.24** (3.38-5.05)	**5.16** (3.95-6.27)	**6.64** (4.80-8.32)	**8.02** (5.52-10.3)
30-min	**0.670** (0.584-0.772)	**0.840** (0.744-0.972)	**1.15** (1.01-1.33)	**1.44** (1.25-1.66)	**1.90** (1.62-2.22)	**2.34** (1.92-2.75)	**2.86** (2.27-3.40)	**3.47** (2.66-4.22)	**4.47** (3.23-5.61)	**5.40** (3.72-6.93)
60-min	**0.414** (0.361-0.477)	**0.520** (0.460-0.602)	**0.710** (0.623-0.820)	**0.889** (0.773-1.03)	**1.18** (1.00-1.37)	**1.45** (1.19-1.70)	**1.77** (1.41-2.11)	**2.15** (1.65-2.61)	**2.77** (2.00-3.47)	**3.34** (2.30-4.29)
2-hr	**0.263** (0.234-0.300)	**0.329** (0.292-0.376)	**0.426** (0.376-0.484)	**0.518** (0.452-0.590)	**0.670** (0.572-0.772)	**0.810** (0.676-0.944)	**0.977** (0.788-1.16)	**1.18** (0.914-1.42)	**1.49** (1.09-1.86)	**1.79** (1.25-2.29)
3-hr	**0.204** (0.183-0.228)	**0.251** (0.226-0.283)	**0.314** (0.281-0.353)	**0.373** (0.332-0.420)	**0.467** (0.409-0.532)	**0.557** (0.477-0.640)	**0.667** (0.556-0.779)	**0.797** (0.643-0.951)	**1.01** (0.774-1.25)	**1.21** (0.886-1.54)
6-hr	**0.138** (0.127-0.152)	**0.169** (0.154-0.186)	**0.204** (0.186-0.225)	**0.236** (0.213-0.262)	**0.285** (0.254-0.318)	**0.326** (0.286-0.366)	**0.372** (0.321-0.424)	**0.424** (0.358-0.491)	**0.531** (0.433-0.634)	**0.627** (0.497-0.779)
12-hr	**0.088** (0.081-0.096)	**0.107** (0.099-0.118)	**0.129** (0.119-0.142)	**0.149** (0.135-0.163)	**0.178** (0.160-0.197)	**0.202** (0.179-0.226)	**0.228** (0.199-0.258)	**0.256** (0.218-0.293)	**0.298** (0.247-0.350)	**0.333** (0.269-0.399)
24-hr	**0.054** (0.049-0.059)	**0.066** (0.060-0.072)	**0.078** (0.072-0.086)	**0.089** (0.082-0.097)	**0.103** (0.094-0.113)	**0.115** (0.104-0.125)	**0.126** (0.114-0.138)	**0.137** (0.124-0.150)	**0.153** (0.137-0.178)	**0.169** (0.146-0.203)
2-day	**0.031** (0.029-0.034)	**0.038** (0.035-0.042)	**0.045** (0.042-0.050)	**0.051** (0.047-0.056)	**0.059** (0.054-0.064)	**0.065** (0.060-0.071)	**0.071** (0.065-0.077)	**0.077** (0.070-0.084)	**0.085** (0.077-0.092)	**0.090** (0.081-0.102)
3-day	**0.023** (0.021-0.025)	**0.028** (0.026-0.030)	**0.033** (0.031-0.036)	**0.037** (0.034-0.041)	**0.043** (0.040-0.047)	**0.048** (0.044-0.052)	**0.052** (0.048-0.057)	**0.057** (0.051-0.062)	**0.063** (0.056-0.069)	**0.067** (0.060-0.075)
4-day	**0.019** (0.017-0.020)	**0.023** (0.021-0.025)	**0.027** (0.025-0.029)	**0.030** (0.028-0.033)	**0.035** (0.032-0.038)	**0.039** (0.036-0.042)	**0.043** (0.039-0.047)	**0.047** (0.042-0.051)	**0.052** (0.046-0.057)	**0.055** (0.049-0.061)
7-day	**0.013** (0.012-0.014)	**0.015** (0.014-0.017)	**0.018** (0.017-0.020)	**0.021** (0.019-0.023)	**0.024** (0.022-0.026)	**0.026** (0.024-0.029)	**0.029** (0.026-0.031)	**0.031** (0.028-0.034)	**0.034** (0.031-0.037)	**0.036** (0.033-0.040)
10-day	**0.010** (0.009-0.011)	**0.012** (0.011-0.013)	**0.014** (0.013-0.016)	**0.016** (0.015-0.018)	**0.019** (0.017-0.020)	**0.020** (0.019-0.022)	**0.022** (0.020-0.024)	**0.024** (0.021-0.026)	**0.025** (0.023-0.028)	**0.027** (0.024-0.029)
20-day	**0.006** (0.006-0.007)	**0.008** (0.007-0.009)	**0.009** (0.009-0.010)	**0.010** (0.010-0.011)	**0.012** (0.011-0.013)	**0.013** (0.012-0.014)	**0.014** (0.013-0.015)	**0.015** (0.013-0.016)	**0.016** (0.014-0.017)	**0.016** (0.015-0.018)
30-day	**0.005** (0.005-0.006)	**0.006** (0.006-0.007)	**0.007** (0.007-0.008)	**0.008** (0.008-0.009)	**0.009** (0.009-0.010)	**0.010** (0.009-0.011)	**0.011** (0.010-0.012)	**0.011** (0.011-0.012)	**0.012** (0.011-0.013)	**0.013** (0.012-0.014)
45-day	**0.004** (0.004-0.005)	**0.005** (0.005-0.006)	**0.006** (0.006-0.007)	**0.007** (0.006-0.007)	**0.008** (0.007-0.008)	**0.008** (0.008-0.009)	**0.009** (0.008-0.009)	**0.009** (0.009-0.010)	**0.010** (0.009-0.011)	**0.010** (0.009-0.011)
60-day	**0.004** (0.004-0.004)	**0.005** (0.004-0.005)	**0.005** (0.005-0.006)	**0.006** (0.006-0.006)	**0.007** (0.006-0.007)	**0.007** (0.007-0.008)	**0.008** (0.007-0.008)	**0.008** (0.008-0.009)	**0.009** (0.008-0.009)	**0.009** (0.008-0.010)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

CONSULTING ENGINEERS
AND LAND SURVEYORS

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FOREFRONT @ WEBER INDUSTRIAL PARK
STORM WATER STUDY

Project No. 98N226A
March 19, 1999

General Site Information:

The proposed project is located just north of 2150 North Street on Rulon White Boulevard in the Weber Industrial Park. The site is broken into 3 areas. Most of the project is located in Area 2 which includes the buildings , parking and the future development area.

The site consists of about 7.2 acres. About 2.8 acres is for the future development. Most of the site landscaping is located adjacent to Rulon White Boulevard. Storm water from most of the landscaping area and a section of roadway to the south is undetained. The total release rate for the site will be limited to 0.20 cubic feet per second per acre. The storm water discharge from the undetained areas is deducted from the total allowable release rate. Attached is a copy of the storm water calculations for the project.

A runoff coefficient of 0.15 was used for natural ground and landscaped areas. A runoff coefficient of 0.90 was used for asphalt, concrete, and other hard surfaced areas.

A time of concentration for each detention area was calculated. The time of concentration was calculated using the method outlined by Seelye in "Design" page 18-01. The time of concentration ranged from 7 to 10 minutes. This time is based on the longest path inside the detention area over grass, asphalt, concrete, or through a pipeline as applicable. Rainfall intensities for a 10-year and 100-year storm event were taken from Technical Paper Number 28 from the Weather Bureau. A copy of this data is also attached.

In the event that one of the storm water pipes becomes plugged, storm water will run overland through the parking lot to an adjacent catch basin located in the site or to the overflow points indicated on the attached figure. The maximum depth in any of the parking lots before water flows overland to an overflow point is 12-inches.

Storm water flows through the 10-year flood will be routed through the proposed catch basins and storm water pipelines. Orifice plates will be used to restrict the discharge from each detention area to an executable release rate. These restrictions will cause the storm water to be detained primarily in the parking and other asphalt areas.

A 24-inch reinforced concrete pipe will be placed in the existing drainage ditch along the south side of the property. It will be connected via a junction box to an existing 24-inch pipe running to the storm sewer system.

Detention Pond Sizes:

Grading requirements were used to size the size of each detention area. A 10-year storm event was used to verify if each detention area had sufficient detention volume. It was found that each drainage area has sufficient volume for the 10-year storm. Some additional volume is available for the 100-year storm in each detention area. The available and required detention for the 10-year and 100-year storm is shown in the attached calculations.

Pipe Sizes:

Storm water pipes in the project are proposed to be PVC and reinforced concrete (RCP) . Pipe sizes will vary from 8-inches to 24-inches. Pipes up to 12-inches will be C-900 PVC. Pipes 12-inches and larger will be RCP. All pipes will be sloped so that a minimum scour velocity of 2-feet per second is maintained.

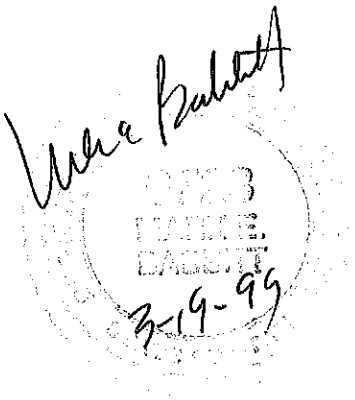
Orifice Plates:

Three orifice plates will be used to restrict the release rate of storm water from the project site. An orifice plate will be placed in each inlet box indicated on the attached figure. The orifice plates have a diameter of 1.37, 3.7, and 3.8-inches for Areas 1 through 3, respectively. The orifice plate in Area 1 is sized to restrict the flows from Area 1 only. The plate in Area 2 is designed to restrict the flows from Area 2 and pass through the detained flows from Area 1. This orifice plate is also sized to limit discharge from the future development area to 0.109 cubic feet per second per acre. This is the same discharge rate applied to the remainder of Area 2. The orifice plate in Area 3 is sized to pass through flows from Areas 1 and 2 but detain flows from Area 3

100-Year Storm Flow Routing:

As indicated above, the 10-year storm will be routed through the catch basins and storm drain pipelines to the detention ponds. The 100-year storm will fill the detention ponds. Once the detention ponds reach maximum capacity, the storm water will spill out at the overflow points shown on the attached figure. The maximum depth before overflowing will be 12-inches.

Great Basin Engineering, Inc.



Mark E. Babbitt, P. E.

Forefront @ Weber Industrial Park
98N226B
19-Mar-99
Storm Water Study

3 Drainage Areas, 1 Undetained Area

Area	Area Total (sf)	Area Hard Surface (sf)	Area Landscaping (sf)	Area Total (acres)	Area Hard Surface (acres)	Area Landscaping (acres)	Runoff Coefficient
Area 1	21092	18298	2794	0.484	0.420	0.064	0.801
Area 2	256569	125690	130879	5.890	2.885	3.005	0.517
Area 3	13392	12006	1386	0.307	0.276	0.032	0.822
Undetained	24542	9100	15442	0.563	0.209	0.354	0.428
Totals	315595	165094	150501	7.245	3.790	3.455	0.542

Area 2 includes the area for future development west of the current development site.

Runoff Coefficient
C=0.15 for natural ground and landscaping
C=0.90 for hard surfaces i.e. roof, asphalt, concrete, etc.

Time of Concentration use "Design" by Seelye

Area 1	
33' over Asphalt @ 2.1%	1 min.
124' over Curb & Gutter @ 0.5%	6 min.
433' through pipe	3 min.
	10 min.
Area 2	
87' Over asphalt @ 1.4%	4 min.
400' through pipe	3 min.
	7 min.
Area 3	
33' over Asphalt @ 1.6%	1 min.
287' over Curb & Gutter @ 0.5%	8 min.
	9 min.
Undetained area	
75' over grass @ 2.75%	15 min.

Rainfall Intensities
Use data from Weather Bureau Technical Paper No. 28
10 Year Storm

Area 1	@ tc=10 min., Intensity =	3.20 inches per hour
Area 2	@ tc=7 min., Intensity =	3.8 inches per hour
Area 3	@ tc=9 min., Intensity =	3.40 inches per hour
Undet. area	@ tc=14 min., Intensity =	2.76 inches per hour

35

36

37

1.37"ø Orifice Plate

3.74"ø Orifice Plate

3.80"ø Orifice Plate

Overflow Point

Overflow Point

Overflow Point

Vol = 1311

8" PVC

8" PVC

Area 1

Area 2

Proposed Building

12" RCP

12" RCP

Vol = 14108

Area 2

Vol = 14108

8" PVC

8" PVC

Vol = 14108

Vol = 14108

Area 2

Proposed Building

15" RCP

15" RCP

Vol = 1326

Area 3

24" RCP

24" RCP

Undetained Area

24" RCP

Exist. Ditch

Future Development Area

Exist. 24" RCP

Boulevard

White

Rulon

2150 North Street

Peak Flow
Use "Rational Method"
Q=CiA

Area	C	I (in/hr)	Area (acres)	Q (cfs)
Area 1	0.801	3.20	0.484	1.24
Area 2	0.517	3.8	5.890	11.58
Area 3	0.822	3.40	0.307	0.86
Undetained	0.428	2.76	0.563	0.67

Allowable Release Rate	0.200	cfs/ac
Total Allowable Release Rate	1.449	cfs
Undetained Release Rate	0.666	cfs
Net Allowable Release Rate	0.78	cfs

Area 1 10 Year Storm

C= 0.801
Area = 0.484
Allowable outflow rate = 0.200 cfs/ac Effluent = 0.097

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	4.50	523.37	29.05	494.31	
10	3.20	744.34	58.10	686.24	
15	2.65	924.61	87.16	837.46	
20	2.22	1032.78	116.21	916.57	
30	1.70	1186.30	174.31	1011.98	
40	1.40	1302.60	232.42	1070.18	
50	1.20	1395.64	290.52	1105.12	
60	1.05	1465.43	348.63	1116.80	Required Detention
90	0.76	1591.03	522.94	1068.09	
120	0.60	1674.77	697.26	977.52	
180	0.43	1800.38	1045.88	754.50	
240	0.35	1953.90	1394.51	559.39	
300	0.29	2023.68	1743.14	280.54	

Area 2 10 Year Storm

C= 0.517

Area = 5.890

Allowable outflow rate = 0.109 cfs/ac Effluent = 0.640

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	4.50	4114.24	192.11	3922.13	
10	3.20	5851.37	384.22	5467.14	
15	2.65	7268.49	576.33	6692.16	
20	2.22	8118.77	768.44	7350.33	
30	1.70	9325.61	1152.66	8172.95	
40	1.40	10239.89	1536.88	8703.01	
50	1.20	10971.31	1921.10	9050.21	
60	1.05	11519.88	2305.32	9214.55	Required Detention
90	0.76	12507.29	3457.98	9049.31	
120	0.60	13165.57	4610.65	8554.93	
180	0.43	14152.99	6915.97	7237.02	
240	0.35	15359.83	9221.29	6138.54	
300	0.29	15908.40	11526.62	4381.78	

Area 3 10 Year Storm

C= 0.822

Area = 0.307

Allowable outflow rate = 0.150 cfs/ac Effluent = 0.046

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	4.50	341.32	13.83	327.49	
10	3.20	485.43	27.67	457.77	
15	2.65	603.00	41.50	561.50	
20	2.22	673.54	55.34	618.20	
30	1.70	773.66	83.01	690.65	
40	1.40	849.51	110.68	738.83	
50	1.20	910.19	138.35	771.84	
60	1.05	955.70	166.02	789.68	Required Detention
90	0.76	1037.62	249.02	788.59	
120	0.60	1092.23	332.03	760.20	
180	0.43	1174.15	498.05	676.10	
240	0.35	1274.27	664.07	610.20	
300	0.29	1319.78	830.08	489.69	

Area 1 100 Year Storm

C= 0.801

Area = 0.484

Allowable outflow rate = 0.200 cfs/ac Effluent = 0.097

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	6.50	755.97	29.05	726.92	
10	4.95	1151.41	58.10	1093.30	
15	4.00	1395.64	87.16	1308.49	
20	3.47	1614.30	116.21	1498.09	
30	2.65	1849.23	174.31	1674.92	
40	2.20	2046.95	232.42	1814.53	
50	1.82	2116.73	290.52	1826.20	
60	1.62	2260.94	348.63	1912.32	Required Detention
90	1.25	2616.83	522.94	2093.89	
120	0.90	2512.16	697.26	1814.90	
180	0.65	2721.51	1045.88	1675.62	
240	0.51	2847.12	1394.51	1452.60	
300	0.45	3140.20	1743.14	1397.06	

Area 2 100 Year Storm

C= 0.517

Area = 5.890

Allowable outflow rate = 0.109 cfs/ac Effluent = 0.640

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	6.50	5942.79	192.11	5750.68	
10	4.95	9051.33	384.22	8667.11	
15	4.00	10971.31	576.33	10394.98	
20	3.47	12690.15	768.44	11921.71	
30	2.65	14536.99	1152.66	13384.32	
40	2.20	16091.25	1536.88	14554.37	
50	1.82	16639.82	1921.10	14718.72	
60	1.62	17773.52	2305.32	15468.20	
90	1.25	20571.21	3457.98	17113.22	Required Detention
120	0.90	19748.36	4610.65	15137.71	
180	0.65	21394.05	6915.97	14478.08	
240	0.51	22381.47	9221.29	13160.18	
300	0.45	24685.45	11526.62	13158.83	

Area 3 100 Year Storm

C= 0.822

Area = 0.307

Allowable outflow rate = 0.150 cfs/ac Effluent = 0.046

Time (min.)	Rainfall Intensity (in/hr)	Accumulated Volume (CF)	Allowable Discharge (CF)	Needed Detention (CF)	
5	6.50	493.02	13.83	479.18	
10	4.95	750.91	27.67	723.24	
15	4.00	910.19	41.50	868.69	
20	3.47	1052.79	55.34	997.45	
30	2.65	1206.00	83.01	1122.99	
40	2.20	1334.95	110.68	1224.27	
50	1.82	1380.45	138.35	1242.11	
60	1.62	1474.51	166.02	1308.49	Required Detention
90	1.25	1706.61	249.02	1457.58	
120	0.90	1638.34	332.03	1306.31	
180	0.65	1774.87	498.05	1276.82	
240	0.51	1856.79	664.07	1192.72	
300	0.45	2047.93	830.08	1217.85	

Available Detention

Pond	Area (sf)	Avg Depth (in)	Volume (cf)	Required 10-year	Required 100-year
Area 1	6344	7.44	1311	1117	2094
Area 2	42324	12.00	14108	9215	17113
Area 3	3977	12.00	1326	790	1458

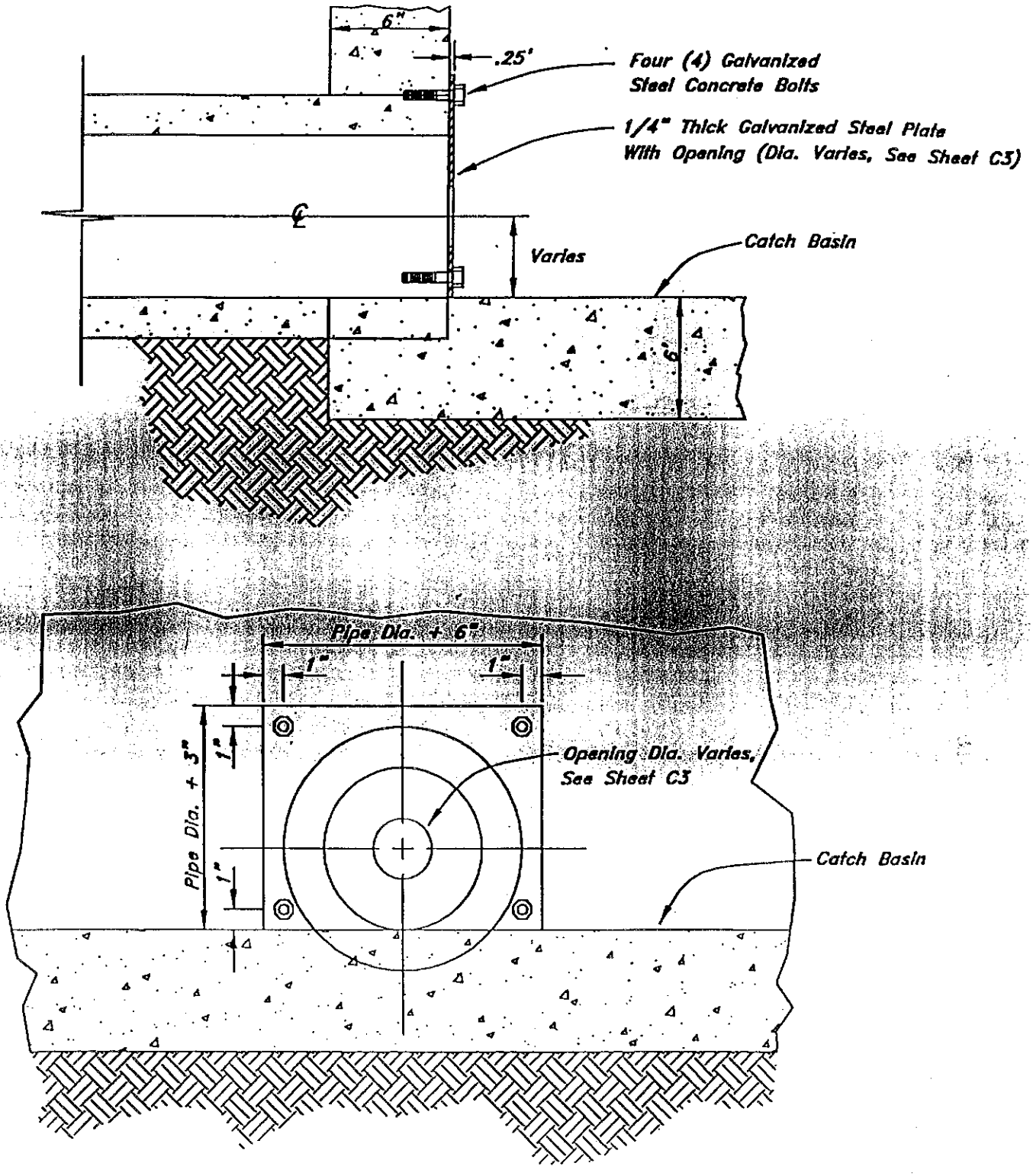
Orifice Plates

Use Orifice Equation $Q=CdA(2gh)^{.50}$

cd= 0.62 Area = $(Pi\ d^2)/4$

Area	Top water Elevation (ft)	Flow line Pipe (ft)	Pipe Size (in)	Calculated Head (ft)	Effluent Rate (cfs)	Area Orifice (sf)	Diameter Orifice (ft)	Diameter Orifice (in)
Area 1	83.20	79.04	12	3.660	0.097	0.010	0.114	1.368
Area 2	83.00	78.60	15	3.775	0.737	0.076	0.312	3.744
Area 3	83.04	78.41	15	4.005	0.783	0.079	0.317	3.803

Mount the orifice plates in the outlet catch basin concentric to the outlet pipe.
Storm water flows from Area 1 to Area 2 to Area 3

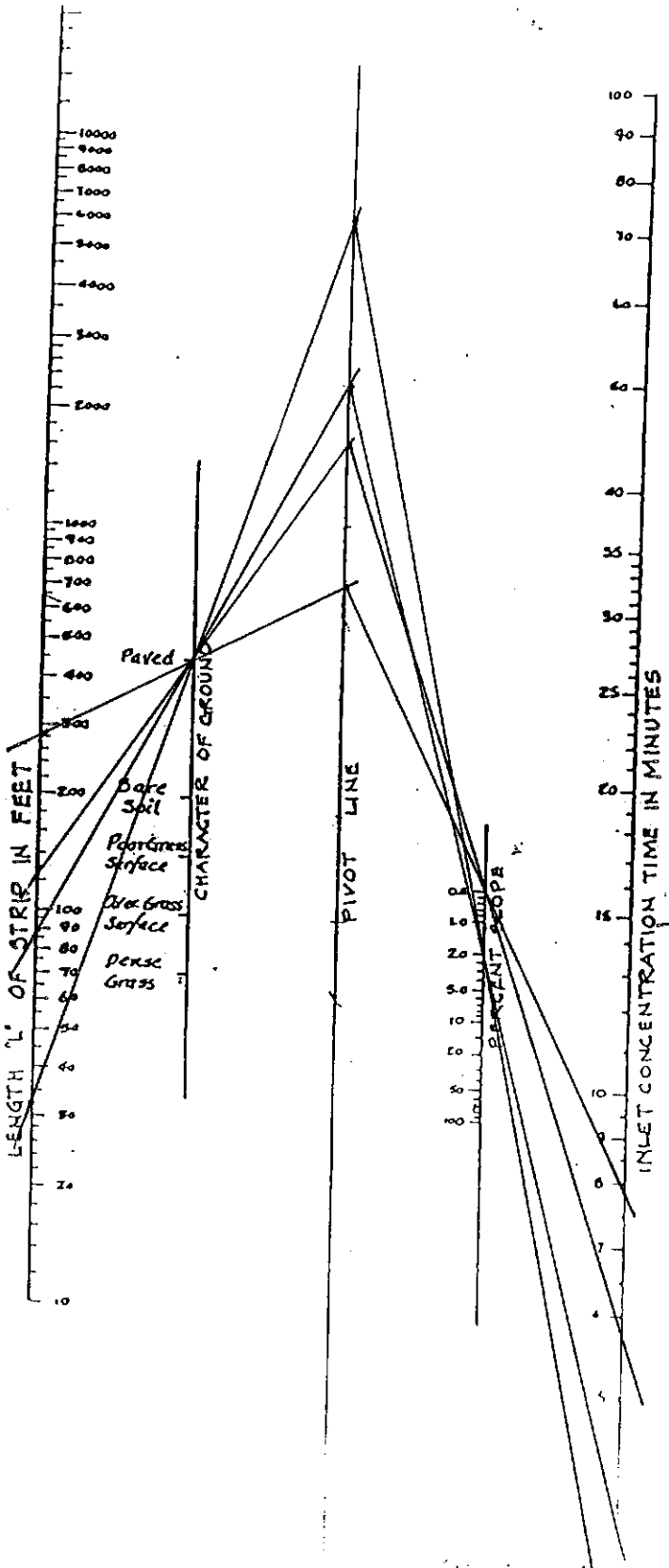


Restriction Plate Detail

OPLATE

FOREFRONT @ WILBUR INDUSTRIAL PARK

9 & N 226 A



AREA 1

33' OVER ASPHALT @ 2.1%
= 1 min ±

124' OVER CURB + GUTTER @ 0.5%
= 6 min ±

433' THROUGH PIPE @ 2 FPS
≈ 3 min

t_c tot ≈ 10 min

AREA 2

87' OVER ASPHALT @ 1.4%
= ≈ 4 min

400' THROUGH PIPE @ 2 FPS
≈ 3 min

t_c tot ≈ 7 min

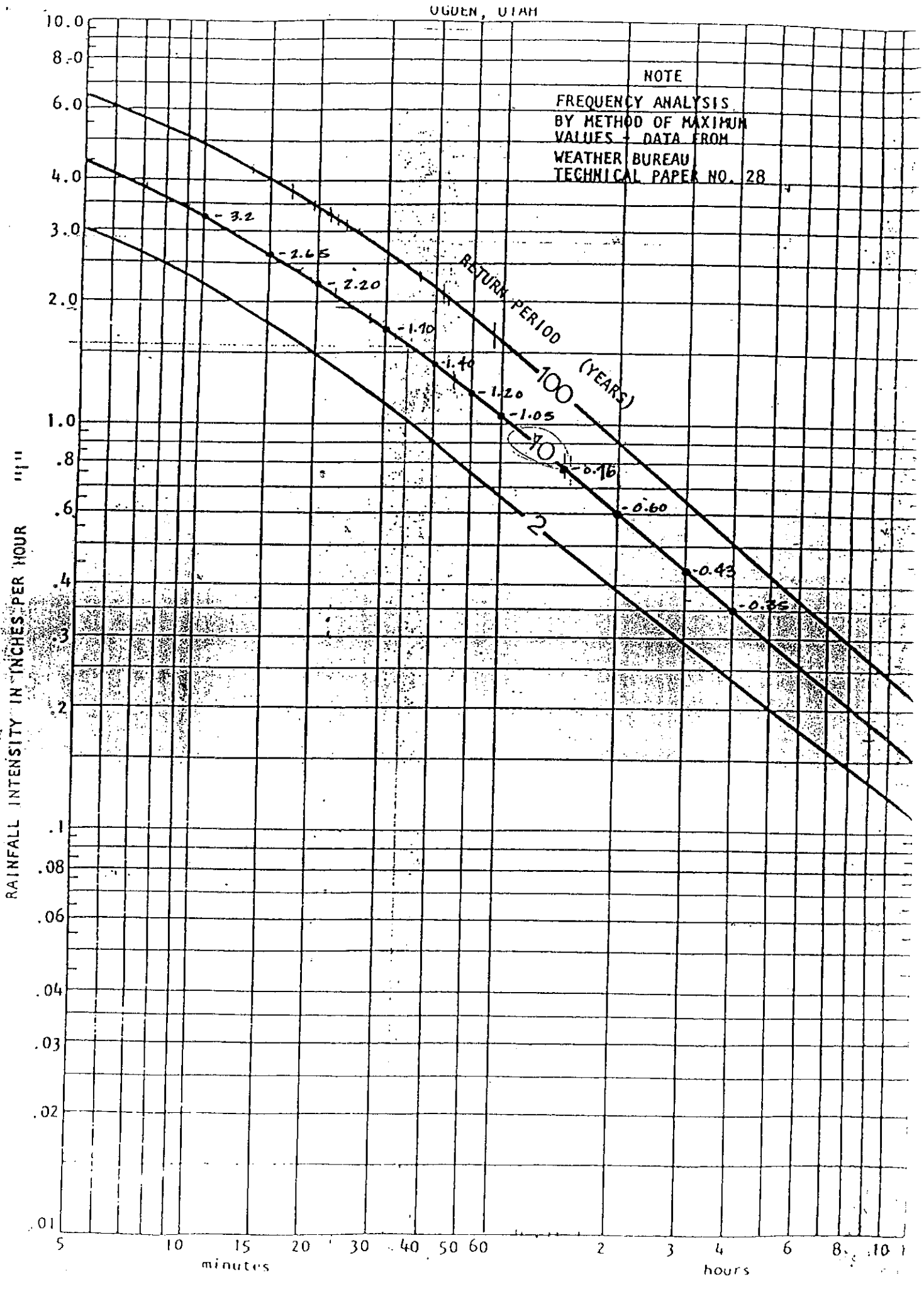
AREA 3

33' OVER ASPHALT @ 1.6%
= 1 min ±

287' OVER CURB & GUTTER @ 0.5%
= 8 min

t_c tot ≈ 9 min

OVERLAND FLOW TIME


OGDEN, UTAH
NOTE
FREQUENCY ANALYSIS BY METHOD OF MAXIMUM VALUES - DATA FROM WEATHER BUREAU TECHNICAL PAPER NO. 28
RETURN PERIOD (YEARS)
100
10
2
-3.2
-2.65
-2.20
-1.10
-1.40
-1.20
-1.05
-0.16
-0.60
-0.43
-0.35
RAINFALL INTENSITY IN INCHES PER HOUR
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.8
.6
.4
.3
.2
.1
.08
.06
.04
.03
.02
.01
5
10
15
20
30
40
50
60
2
3
4
6
8
10
minutes
hours