GREAT BASIN ENGINEERING INC

THE CHALETS PHASE 5
OSPREY POINT AND QUAIL LANE
HUNTSVILLE, UTAH
STORM WATER STUDY
Project No. 11N222
12-14-2011
Revised 12-29-11
Revised 12-12-12

General Site Information:

The proposed Phase 5 of the Chalets Subdivision is located at the intersection of the proposed Osprey Point and existing Quail Lane in Huntsville, Utah. Construction will consist of an addition to Quail Lane as well as a new cul-de-sac called Osprey Point, sidewalks, curb and gutter, underground utilities, and eight lots prepared for development when completed. Storm water from the site will be detained at a detention pond located at the intersection of Quail Lane and Snow Basin Road which will be re-shaped to provide the required volume. The portion of the Chalets Subdivision that will contribute flows to this detention facility has an area of about 26.63 acres. Storm water from site will be collected in inlet boxes or swales and continue via storm drain to the detention pond and be released at 0.1 cfs per acre for the 10-year storm into an existing storm drain system already in place to serve much of the development. Storm water will then continue to the north in this system in a historical fashion to Pine View Reservoir. The attached figure shows the project site and location of storm water outfall. Detention calculations have been provided for the site. (See attached figure and calculations).

The proposed site is broken into three drainage areas. (labeled A-1, A-2, and A-3). A runoff coefficient of 0.15 was used for natural ground and common areas. A runoff coefficient of 0.90 was used for asphalt, concrete, buildings, and other hard surfaced areas. An average runoff coefficient of 0.38 was calculated for the area contributing to the detention pond.

A time of concentration for the 100-year design storm was calculated using the FAA method and rational coefficients of 0.35 for landscape and 0.91 for hardscape. The time of concentration ranged from 19 to 23 minutes. This time is based on the longest path inside the detention area over grass, asphalt, concrete, or through a pipeline as applicable. Five minutes is the shortest time allowed using this method. Rainfall intensities were found on the NOAA website. The values obtained were interpolated as necessary. A copy of this data is attached. As mentioned previously, the allowable release rate from the site is 0.1 cubic feet per second per acre.

Data showing area information, runoff coefficient, time of concentration, peak flow, and required detention for the site is also provided and can be found in the attached calculations.

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 velocity of 2 feet per second when the pipes are flowing full. The pipes and inlet boxes have sufficient capacity to convey the 10-year storm without surcharging. The 100 year storm will be conveyed with minimal surcharging in the inlet boxes and catch basins.

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Orifice Plate:

An orifice plate has been used historically for this site. It needs to be resized based on the re-shaped detention pond. It will be used to control the rate that storm water flows from the project. It will be located at the detention pond (See attached figure). The orifice plate will be 7.19 inches in diameter for the pond to fill completely during a 10-yr storm. The orifice plate will allow small flows to pass through without detention. As the rate of storm water into the pipes and above ground detention basins increases, the orifice plate will restrict the flow. The maximum flow through the plate will come when the detention basin reaches the maximum design depth. A detail of the orifice plate is attached.

Required Detention:

The available detention pond is 28,925 cubic feet with a top of water at 4993.10. A berm set at 4994.10 provides 1 foot of freeboard. The required detention for the 10-year storm with a release rate of 0.1 cfs/acre is also 28,925 cubic feet for the pond. In the event the pond experiences a storm larger than the design storm water will then spill out into Snow Basin Road and continue to the north in a historical fashion.

Great Basin Engineering, Inc.

Prepared by Ryan Bingham, P.E.

Reviewed by Mark Babbitt, P.E.

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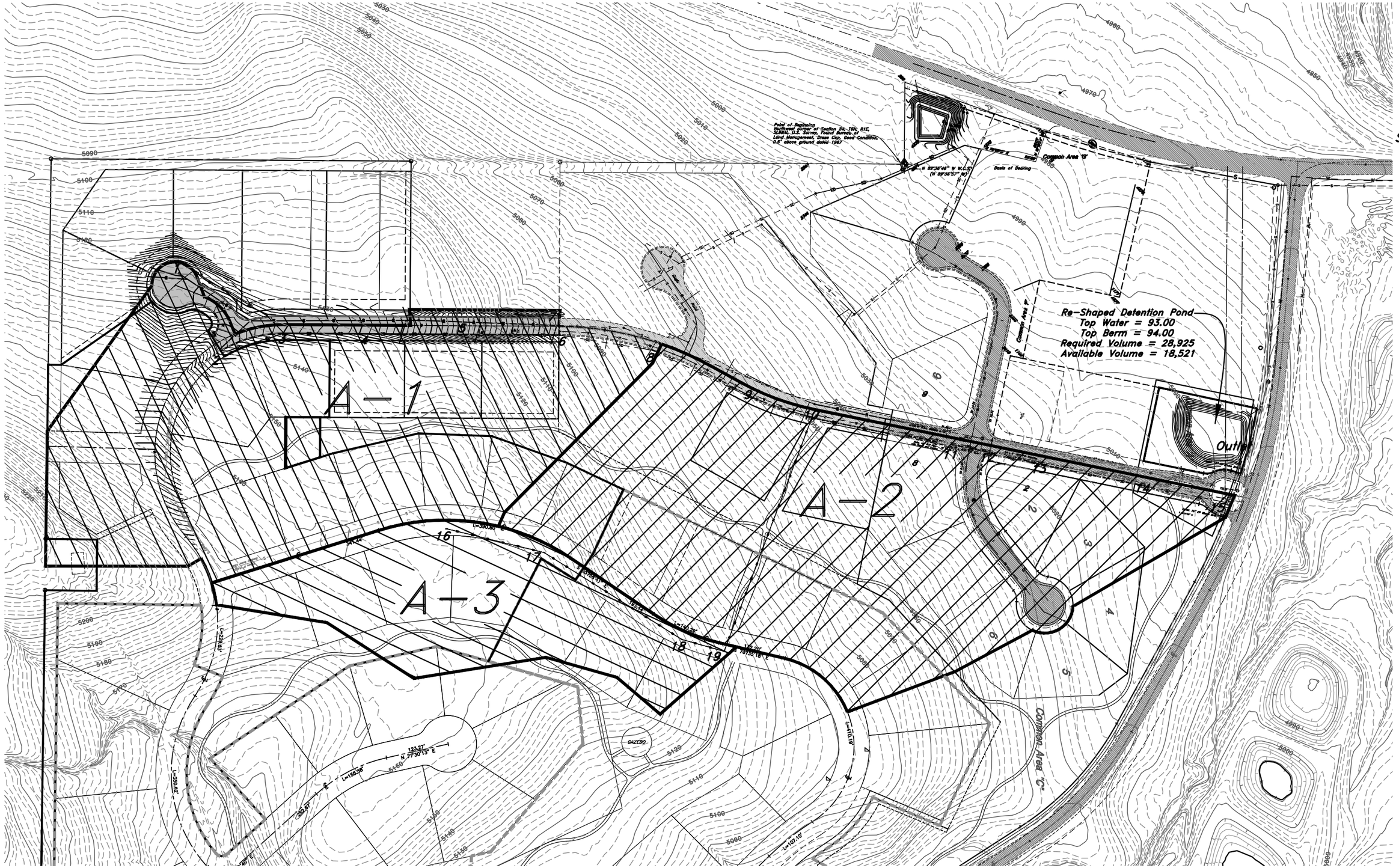


Scale: NTS

W:\96n120 - Chalets\dwg\Phase 5 - 2009\96n120 ph 5 S1 horiz-SWS 3.dwg, 12/11/2012 1:44:28 PM, ryanb,
1:1.7735

Storm Water Study
Chalets Phase 5
Osprey Point and Quail Road Huntsville, UT
96n120 ph 5 S1 horiz-SWS.dwg
12/11/2012

Street and Residential Hardscape Cd =	0.90
Street and Residential Landscape Cd =	0.15
Common Areas Cd =	0.15
Calculated Cd for (60') R.O.W. Sections =	0.600

3 Detained Areas

RESIDENTIAL INFO

Average lot size is	21000	sq. ft.
an average home size c	4000	sq. ft.
an avg. patio/driveway size c	2500	sq. ft.
Resulting in a total landscape o	14500	sq. ft.
Resulting in a total hardscape o	6500	sq. ft.
Resulting in a Residential Cd of	0.382	

Drainage Areas	Total Area (acres)	60' Road Area (acres)	Common Area (acres)	Residential Area (acres)	C
∑ Det. Areas	26.633	4.162	4.514	17.957	0.377
∑ All Areas	26.633	4.162	4.514	17.957	0.377
A-1	10.580	1.975	1.494	7.111	0.390
A-2	11.780	1.426	2.540	7.813	0.358
A-3	4.273	0.761	0.480	3.032	0.395

Time of Concentration--use FAA Method

For FAA Method, use C's of..

C = 0.35 for landscape

C = 0.91 for hardscape

For Concrete, use an average CL street slope

Assume Pipe Flow is at 2 ft/s

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

**Note: S is in percent

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	164.00	20.00	6.37	684.00	10.00	4.15	972.00	8.10	18.62
A-2	422.00	10.00	12.87	84.00	5.00	1.83	970.00	8.08	22.79
A-3	147.00	2.00	12.99	237.00	2.55	3.85	610.00	5.08	21.93

Rainfall Intensities
Data From NOAA

10-Year Storm Intensities

The equations used for the 10-Year Storm Intensities were found using the attached Rainfall data as well as Interpolated data from the produced graphs. The equations developed are 6th order polynomials, which give very high "R^2" values.

The equations used are: $$I = At^6 + Bt^5 + Ct^4 + Dt^3 + Et^2 + Ft + G$$

where……

	10-Yr. Coeff.
A =	3.450E-11
B =	-1.465E-08
C =	2.489E-06
D =	-2.178E-04
E =	1.059E-02
F =	-2.941E-01
G =	5.118E+00

		Storm Intensities
AREA	Tc (minutes)	I (10-yr.) (in./hr.)
A-1	18.6	2.18
A-2	22.8	1.92
A-3	21.9	1.97

Peak Flow Information

Use Rational Method

10-Year Storm Intensities

Q=CIA

AREA	C	I10 (in./hr.)
A-1	0.390	2.175
A-2	0.358	1.924
A-3	0.395	1.970

Peak Flows

∑ detained =	20.42
A (acres)	Q (10-yr.) (cfs)
10.58	8.98
11.78	8.12
4.27	3.32

Node Inlet Requirements

Size pipes for 10 year storm

Area	Node #	% of Total	Q (cfs)
A-1	1	15.0%	1.35
A-1	2	15.0%	1.35
A-1	3	15.0%	1.35
A-1	4	15.0%	1.35
A-1	5	15.0%	1.35
A-1	6	15.0%	1.35
A-1	7	5.0%	0.45
A-1	8	5.0%	0.45
A-2	9	20.0%	1.62
A-2	10	15.0%	1.22
A-2	11	35.0%	2.84
A-2	12	5.0%	0.41
A-2	13	12.0%	0.97
A-2	14	8.0%	0.65
A-2	15	5.0%	0.41
A-3	16	35.0%	1.16
A-3	17	25.0%	0.83
A-3	18	30.0%	1.00
A-3	19	10.0%	0.33

PIPE FLOWS

Upstream Node	Downstream node	Pipe Flow (cfs)
1	3	1.35
2	3	1.35
3	4	4.04
4	5	5.39
5	6	6.73
6	8	8.53
7	6	0.45
8	9	8.98
9	10	10.60
10	11	15.14
11	12	17.99
12	13	18.39
13	14	19.37
14	15	20.02
15	Outlet	20.42
16	17	1.16
17	18	1.99
18	19	2.99
19	10	3.32

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	3	1.35	15	0.043%	1.227	0.313	0.013	0.150%	15
		1.35	18	0.016%	1.767	0.375	0.013	0.120%	
		1.35	21	0.007%	2.405	0.438	0.013	0.100%	
2	3	1.35	15	0.043%	1.227	0.313	0.013	0.150%	15
		1.35	18	0.016%	1.767	0.375	0.013	0.120%	
		1.35	21	0.007%	2.405	0.438	0.013	0.100%	
3	4	4.04	15	0.391%	1.227	0.313	0.013	0.150%	15
		4.04	18	0.148%	1.767	0.375	0.013	0.120%	
		4.04	21	0.065%	2.405	0.438	0.013	0.100%	
4	5	5.39	15	0.695%	1.227	0.313	0.013	0.150%	15
		5.39	18	0.263%	1.767	0.375	0.013	0.120%	
		5.39	21	0.116%	2.405	0.438	0.013	0.100%	
5	6	6.73	15	1.086%	1.227	0.313	0.013	0.150%	15
		6.73	18	0.411%	1.767	0.375	0.013	0.120%	
		6.73	21	0.180%	2.405	0.438	0.013	0.100%	
6	8	8.53	15	1.742%	1.227	0.313	0.013	0.150%	15
		8.53	18	0.659%	1.767	0.375	0.013	0.120%	
		8.53	21	0.290%	2.405	0.438	0.013	0.100%	
7	6	0.45	15	0.005%	1.227	0.313	0.013	0.150%	15
		0.45	18	0.002%	1.767	0.375	0.013	0.120%	
		0.45	21	0.001%	2.405	0.438	0.013	0.100%	
8	9	8.98	15	1.931%	1.227	0.313	0.013	0.150%	15
		8.98	18	0.730%	1.767	0.375	0.013	0.120%	
		8.98	21	0.321%	2.405	0.438	0.013	0.100%	
9	10	10.60	18	1.018%	1.767	0.375	0.013	0.120%	18
		10.60	21	0.448%	2.405	0.438	0.013	0.100%	
		10.60	24	0.220%	3.142	0.500	0.013	0.080%	
10	11	15.14	21	0.913%	2.405	0.438	0.013	0.100%	21
		15.14	24	0.448%	3.142	0.500	0.013	0.080%	
		15.14	27	0.239%	3.976	0.563	0.013	0.067%	
11	12	17.99	21	1.288%	2.405	0.438	0.013	0.100%	21
		17.99	24	0.632%	3.142	0.500	0.013	0.080%	
		17.99	27	0.337%	3.976	0.563	0.013	0.067%	

12	13	18.39	21	1.347%	2.405	0.438	0.013	0.100%	**21**
		18.39	24	0.661%	3.142	0.500	0.013	0.080%	
		18.39	27	0.353%	3.976	0.563	0.013	0.067%	
13	14	19.37	21	1.494%	2.405	0.438	0.013	0.100%	**21**
		19.37	24	0.733%	3.142	0.500	0.013	0.080%	
		19.37	27	0.391%	3.976	0.563	0.013	0.067%	
14	15	20.02	24	0.783%	3.142	0.500	0.013	0.080%	**24**
		20.02	27	0.418%	3.976	0.563	0.013	0.067%	
		20.02	30	0.238%	4.909	0.625	0.013	0.058%	
15	Outlet	20.42	24	0.815%	3.142	0.500	0.013	0.080%	**24**
		20.42	27	0.435%	3.976	0.563	0.013	0.067%	
		20.42	30	0.248%	4.909	0.625	0.013	0.058%	
16	17	1.16	15	0.032%	1.227	0.313	0.013	0.150%	**15**
		1.16	18	0.012%	1.767	0.375	0.013	0.120%	
		1.16	21	0.005%	2.405	0.438	0.013	0.100%	
17	18	1.99	15	0.095%	1.227	0.313	0.013	0.150%	**15**
		1.99	18	0.036%	1.767	0.375	0.013	0.120%	
		1.99	21	0.016%	2.405	0.438	0.013	0.100%	
18	19	2.99	15	0.214%	1.227	0.313	0.013	0.150%	**15**
		2.99	18	0.081%	1.767	0.375	0.013	0.120%	
		2.99	21	0.036%	2.405	0.438	0.013	0.100%	
19	10	3.32	15	0.265%	1.227	0.313	0.013	0.150%	**15**
		3.32	18	0.100%	1.767	0.375	0.013	0.120%	
		3.32	21	0.044%	2.405	0.438	0.013	0.100%	

Combined Detention Pond

C = 0.38

Area = 26.63 acres

Allowable Discharge Rate = 0.100 cfs/acre

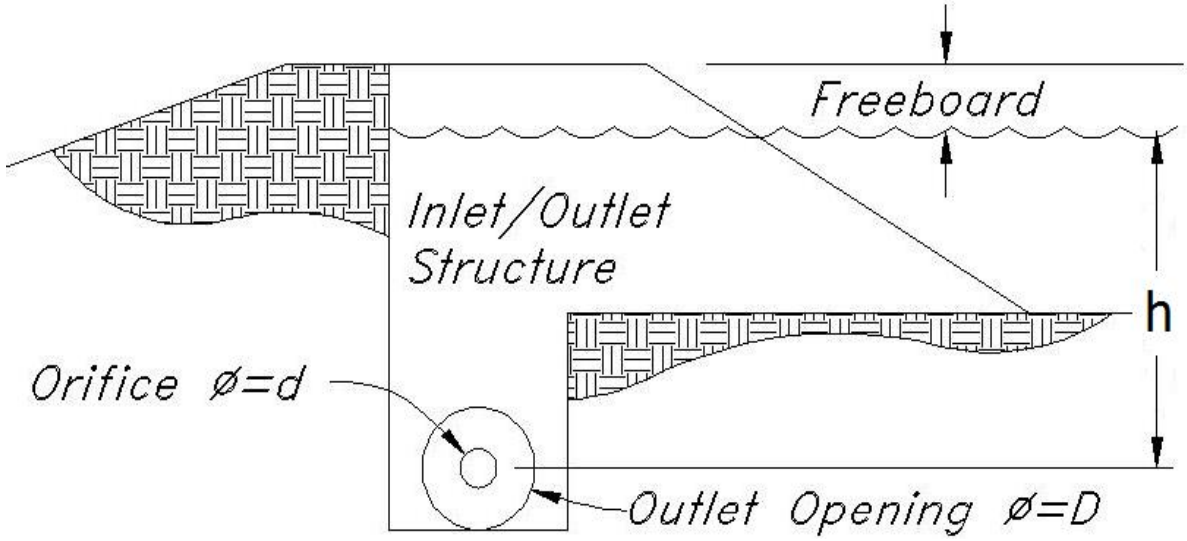
Total Release Rate = 2.663 cfs

Detention Pond Sized For The 10 Year Storm

Time	Rainfall Intensity	Accumulated Volume	OR Allowable Release	Needed Detention	Needed Detention	
min	in./hr.	(CF)	(CF)	(CF)	(acre-ft)	
5	3.89	11702	799	10903	0.250	
10	3.04	18316	1598	16718	0.384	
15	2.47	22306	2397	19909	0.457	
20	2.08	25088	3196	21892	0.503	
25	1.82	27379	3995	23384	0.537	
30	1.63	29457	4794	24663	0.566	
35	1.49	31362	5593	25769	0.592	
40	1.37	33042	6392	26650	0.612	
45	1.27	34440	7191	27249	0.626	
50	1.18	35547	7990	27557	0.633	
55	1.10	36413	8789	27624	0.634	
60	1.03	37144	9588	27556	0.633	
90	0.80	43307	14382	28925	0.664	<-Peak Detent
120	0.63	45472	19176	26296	0.604	
180	0.44	48019	28764	19255	0.442	
360	0.28	61351	57528	3823	0.088	
720	0.18	78911	115055	-36144	-0.830	
1440	0.11	97988	230111	-132122	-3.033	

So, our detention pond needs to hold 28925 ft^3 of water

ORIFICE PLATE CALCULATIONS



$$Q = 0.62 \cdot A_o \cdot \sqrt{2 \cdot g \cdot h}$$

Q = Total Discharge Rate

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

$$g = 32.2$$

h= 3.6047

Q = 2.663

Solving for d, we have…..

$$d = \sqrt{\frac{4 \cdot Q}{0.62 \cdot \pi \cdot \sqrt{2 \cdot g \cdot h}}}$$

Substituting Q, G, and H, we have…..

d = 0.599 feet

OR

d = 7.190 inches

NOAA Atlas 14, Volume 1, Version 5
Location name: Huntsville, Utah, US*
Coordinates: 41.2460, -111.7989
Elevation: 5120ft*
* source: Google Maps

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	**1.84** (1.61–2.12)	**2.33** (2.05–2.69)	**3.17** (2.76–3.65)	**3.92** (3.40–4.52)	**5.12** (4.34–5.96)	**6.24** (5.14–7.33)	**7.55** (6.02–8.99)	**9.11** (7.01–11.1)	**11.7** (8.46–14.6)	**14.1** (9.71–18.1)
10-min	**1.40** (1.22–1.62)	**1.78** (1.57–2.05)	**2.41** (2.11–2.77)	**2.98** (2.59–3.44)	**3.90** (3.31–4.54)	**4.75** (3.91–5.58)	**5.75** (4.59–6.83)	**6.94** (5.33–8.42)	**8.87** (6.44–11.1)	**10.7** (7.39–13.7)
15-min	**1.16** (1.01–1.34)	**1.46** (1.29–1.70)	**1.99** (1.74–2.29)	**2.46** (2.14–2.85)	**3.22** (2.73–3.75)	**3.92** (3.23–4.61)	**4.75** (3.79–5.65)	**5.73** (4.41–6.96)	**7.33** (5.32–9.18)	**8.84** (6.10–11.4)
30-min	**0.780** (0.682–0.900)	**0.988** (0.870–1.14)	**1.34** (1.17–1.54)	**1.66** (1.44–1.92)	**2.17** (1.84–2.53)	**2.64** (2.18–3.10)	**3.20** (2.55–3.80)	**3.86** (2.97–4.69)	**4.94** (3.58–6.18)	**5.95** (4.11–7.65)
60-min	**0.483** (0.422–0.557)	**0.611** (0.539–0.706)	**0.829** (0.725–0.955)	**1.03** (0.891–1.19)	**1.34** (1.14–1.56)	**1.64** (1.35–1.92)	**1.98** (1.58–2.35)	**2.39** (1.84–2.90)	**3.06** (2.22–3.83)	**3.68** (2.54–4.73)
2-hr	**0.314** (0.280–0.357)	**0.392** (0.350–0.447)	**0.507** (0.448–0.576)	**0.615** (0.538–0.702)	**0.791** (0.678–0.910)	**0.952** (0.798–1.11)	**1.14** (0.928–1.35)	**1.37** (1.07–1.65)	**1.74** (1.28–2.15)	**2.08** (1.46–2.64)
3-hr	**0.241** (0.217–0.270)	**0.299** (0.269–0.335)	**0.373** (0.333–0.418)	**0.443** (0.393–0.498)	**0.556** (0.484–0.629)	**0.661** (0.563–0.755)	**0.787** (0.654–0.913)	**0.936** (0.753–1.11)	**1.18** (0.902–1.44)	**1.40** (1.03–1.78)
6-hr	**0.166** (0.152–0.182)	**0.203** (0.186–0.223)	**0.245** (0.223–0.270)	**0.283** (0.256–0.313)	**0.340** (0.304–0.379)	**0.388** (0.342–0.435)	**0.443** (0.384–0.504)	**0.506** (0.429–0.582)	**0.630** (0.516–0.740)	**0.742** (0.591–0.895)
12-hr	**0.107** (0.098–0.118)	**0.131** (0.120–0.145)	**0.158** (0.144–0.175)	**0.182** (0.165–0.201)	**0.218** (0.195–0.243)	**0.248** (0.218–0.278)	**0.280** (0.242–0.318)	**0.314** (0.266–0.362)	**0.367** (0.302–0.433)	**0.411** (0.330–0.494)
24-hr	**0.068** (0.063–0.075)	**0.084** (0.077–0.091)	**0.100** (0.092–0.109)	**0.113** (0.104–0.124)	**0.132** (0.121–0.144)	**0.146** (0.133–0.160)	**0.161** (0.146–0.176)	**0.176** (0.159–0.193)	**0.196** (0.176–0.220)	**0.212** (0.188–0.250)
2-day	**0.041** (0.038–0.044)	**0.050** (0.046–0.055)	**0.060** (0.055–0.065)	**0.067** (0.062–0.074)	**0.078** (0.072–0.085)	**0.087** (0.079–0.094)	**0.095** (0.087–0.104)	**0.103** (0.094–0.113)	**0.115** (0.103–0.126)	**0.123** (0.110–0.136)
3-day	**0.030** (0.028–0.033)	**0.037** (0.034–0.040)	**0.044** (0.041–0.048)	**0.050** (0.046–0.055)	**0.059** (0.054–0.064)	**0.065** (0.059–0.071)	**0.072** (0.065–0.078)	**0.078** (0.071–0.085)	**0.087** (0.078–0.096)	**0.094** (0.084–0.103)
4-day	**0.025** (0.023–0.027)	**0.031** (0.028–0.033)	**0.037** (0.034–0.040)	**0.042** (0.038–0.045)	**0.049** (0.045–0.053)	**0.054** (0.049–0.059)	**0.060** (0.054–0.065)	**0.066** (0.059–0.072)	**0.073** (0.066–0.080)	**0.079** (0.070–0.087)
7-day	**0.018** (0.016–0.019)	**0.021** (0.020–0.024)	**0.026** (0.024–0.028)	**0.029** (0.027–0.032)	**0.034** (0.031–0.037)	**0.038** (0.034–0.041)	**0.042** (0.038–0.046)	**0.045** (0.041–0.050)	**0.051** (0.045–0.056)	**0.055** (0.048–0.061)
10-day	**0.014** (0.013–0.015)	**0.017** (0.016–0.019)	**0.021** (0.019–0.022)	**0.023** (0.021–0.025)	**0.027** (0.024–0.029)	**0.029** (0.027–0.032)	**0.032** (0.029–0.035)	**0.034** (0.031–0.038)	**0.038** (0.034–0.041)	**0.040** (0.036–0.044)
20-day	**0.009** (0.009–0.010)	**0.011** (0.011–0.012)	**0.014** (0.012–0.015)	**0.015** (0.014–0.016)	**0.017** (0.016–0.019)	**0.019** (0.017–0.020)	**0.020** (0.018–0.022)	**0.021** (0.020–0.023)	**0.023** (0.021–0.025)	**0.024** (0.022–0.027)
30-day	**0.008** (0.007–0.008)	**0.009** (0.009–0.010)	**0.011** (0.010–0.012)	**0.012** (0.011–0.013)	**0.014** (0.013–0.015)	**0.015** (0.014–0.016)	**0.016** (0.015–0.018)	**0.017** (0.016–0.019)	**0.019** (0.017–0.020)	**0.020** (0.018–0.021)
45-day	**0.006** (0.006–0.007)	**0.008** (0.007–0.009)	**0.009** (0.009–0.010)	**0.010** (0.009–0.011)	**0.012** (0.011–0.013)	**0.013** (0.012–0.014)	**0.014** (0.012–0.015)	**0.015** (0.013–0.016)	**0.016** (0.014–0.017)	**0.016** (0.015–0.018)
60-day	**0.006** (0.005–0.006)	**0.007** (0.006–0.008)	**0.008** (0.008–0.009)	**0.009** (0.008–0.010)	**0.010** (0.010–0.011)	**0.011** (0.010–0.012)	**0.012** (0.011–0.013)	**0.013** (0.012–0.014)	**0.014** (0.013–0.015)	**0.014** (0.013–0.016)

[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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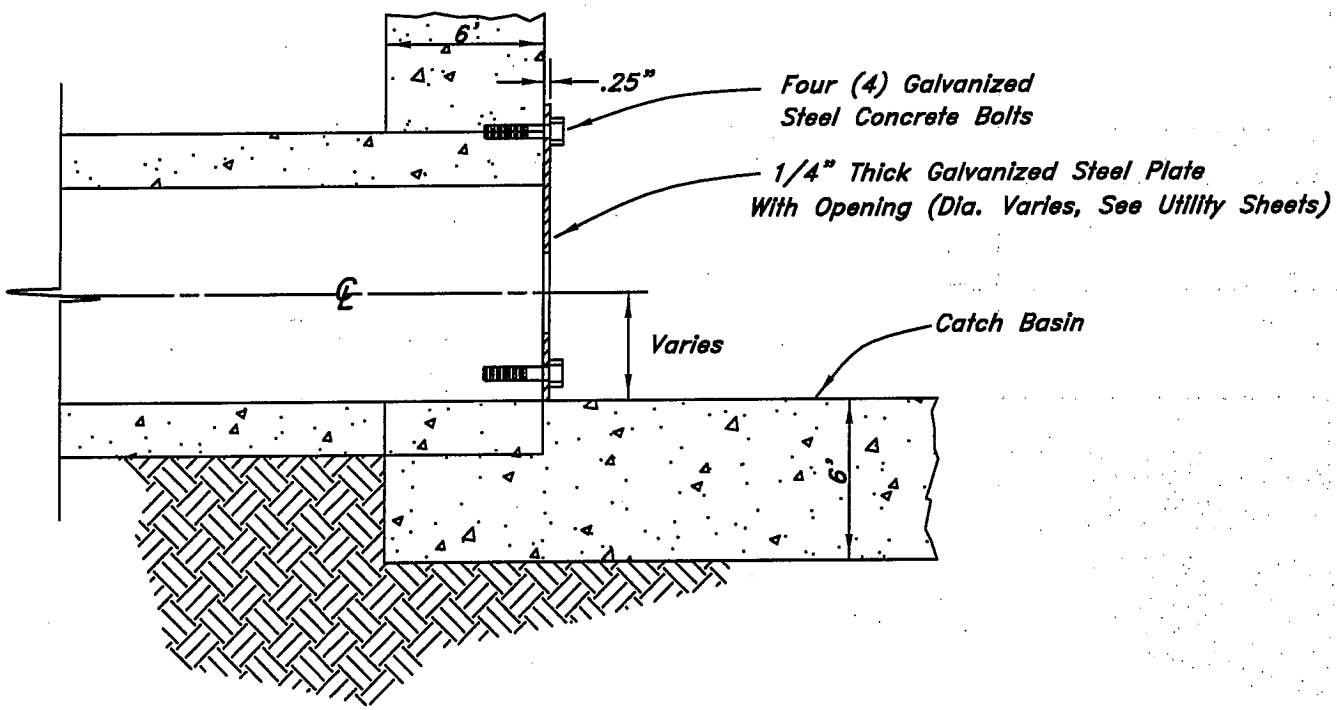
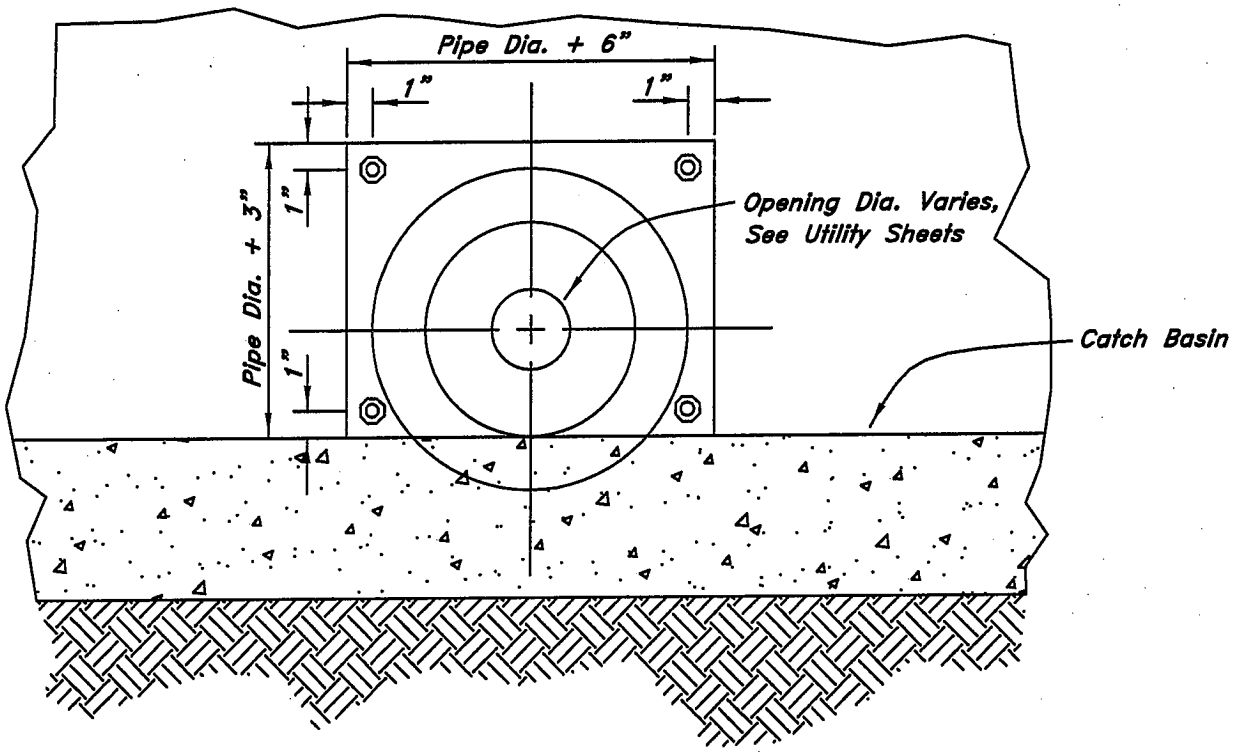
PF graphical





Orifice Plate Detail