GREAT BASIN ENGINEERING

NORTH VIEW HOLDINGS LLC
2700 NORTH HIGHWAY 89
WEBER COUNTY, UTAH
STORM WATER STUDY
Project No. 08N222
2-8-2013
Revised 2-26-13

General Site Information:

A proposed medical building is located immediately north of the front runner station at 2700 North and Highway 89 in Weber County, Utah. Construction will include parking lots in the front and rear of the building, sidewalk, curb and gutter, and other surface improvements including landscaping. Also included are underground utilities such as sewer, water, and storm drain. The site has an area of about 1.48 acres within the limits of this study. Storm water from site will be collected in inlet boxes in the parking areas and drive aisles throughout the site and continue via storm drain to a proposed retention facility located above ground in the west parking area, and be released into an existing storm drain pipe at the southwest corner of the site. The attached figure shows the project site and location of detention facility. Detention calculations have been provided for the site. (See attached figure and calculations).

The proposed site is broken into two drainage areas (labeled A-1 and A-2). 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, buildings, and other hard surfaced areas. An average runoff coefficient of 0.74 was calculated for the site in the proposed conditions which is equivalent to about 78% of hardscape.

A time of concentration for the 100-year design storm was calculated using the FAA method and rational coefficients of 0.35 for grass and 0.91 for concrete for each of the areas. The time of concentration is 9 minutes for A-1 and 11 minutes for A-2. 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.

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 PVC (polyvinyl chloride) and/or CP (concrete pipe). 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 are designed to convey the 10-year storm without surcharging. The pipes also have additional capacity to allow for pass-through flow from the area to the east of Highway 89 which flows under the through the system of the North View Holdings Property. Since the area that contributes to this is 11 acres (see the attached figure), an additional conservative value of 0.2 cfs/acre or 2.2 cfs has been added to the required pipe flow for sizing. If the property to the east of Highway 89 is developed, it should be restricted to no more than this release rate.

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Orifice Plate:

An orifice plate will be used to control the rate that storm water flows from the project. It is located at the downstream side of the western-most catch basin in the west parking lot. It is labeled as catch basin #1 on the attached figure. The orifice is calculated to be 6.5 inches. This included the pass through flow of 2.2 cfs mentioned previously.

Required Detention:

The available detention volume in the ponding area is 7,230 cubic feet. The required detention for the 100-year storm with a release rate of 0.1 cfs/acre is 7,160 cubic feet. In the event the pond experiences a storm larger than the design storm water will then spill out of the pond, flow to the west toward an existing detention pond on the east side of the railroad tracks in a historical fashion.

Great Basin Engineering, Inc.

Prepared by Ryan Bingham, P.E.

Reviewed by Mark Babbitt, P.E.

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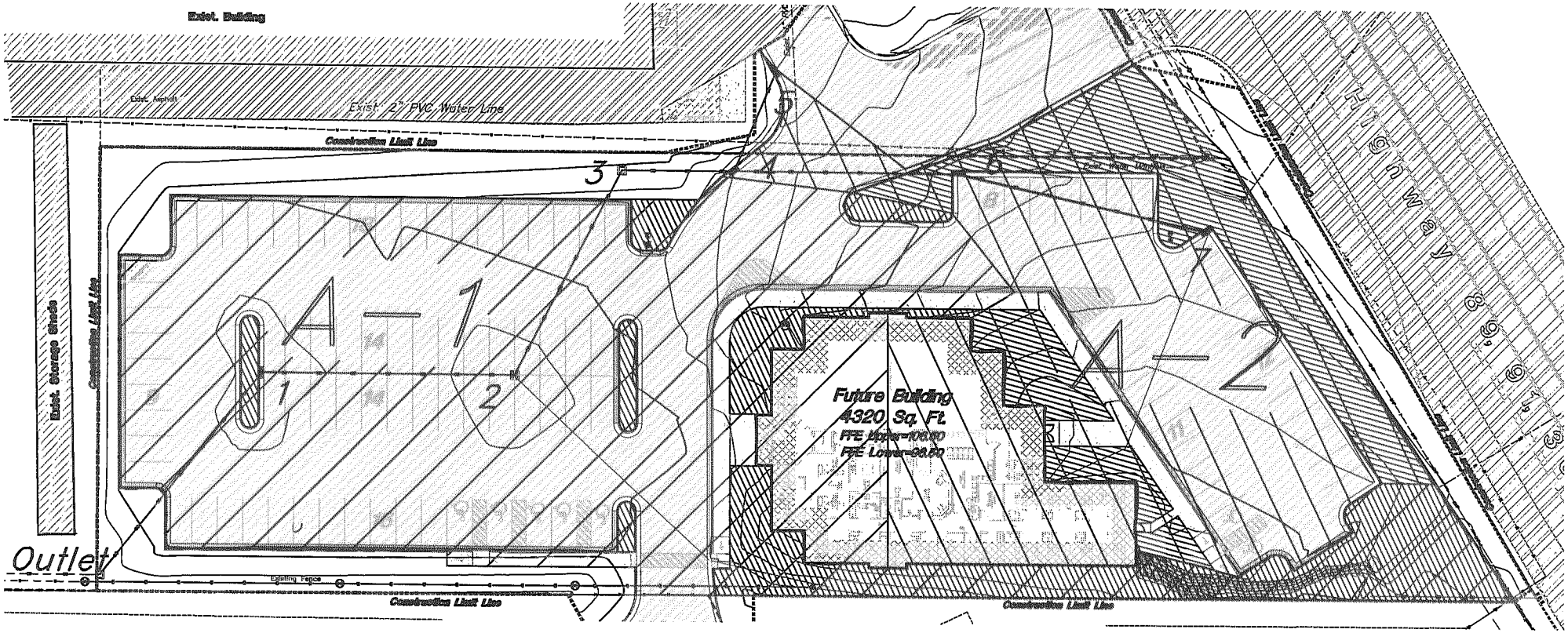

Exist. Building
Exist. Asphalt
Exist. 2" PVC Water Line
Construction Limit Line
Exist. Storage Shed
Construction Limit Line
A-1
1
2
3
A-2
Future Building
4320 Sq. Ft.
FFE Upper=100.00
FFE Lower=88.00
Outlet
Existing Fence
Construction Limit Line
Construction Limit Line

Storm Water Study
North View Holdings
2700 North Highway 89, Weber County, Utah
08N222_S-4.dwg
2/8/2013

2 Detained Areas

Hardscape Cd =	0.90
Landscape Cd =	0.15

Drainage Areas	Total Area (ft^2)	Total Area (acres)	Hardscape Area (ft^2)	Hardscape Area (acres)	Landscape Area (ft^2)	Landscape Area (acres)	C
Σ Det. Areas	64661	1.484	50729	1.165	13932	0.320	0.738
Σ All Areas	64661	1.484	50729	1.165	13932	0.320	0.738
A-1	40361	0.927	33216	0.763	7145	0.164	0.767
A-2	24300	0.558	17513	0.402	6787	0.156	0.691

Time of Concentration--use FAA Method

For FAA Method, use C's of..

C =	0.35	for landscape
C =	0.91	for hardscape

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

Assume Pipe Flow is at 2 ft/s

**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	28.00	2.00	5.67	80.00	3.67	1.98	170.00	1.42	9.07
A-2	43.00	2.00	7.03	94.00	2.65	2.40	145.00	1.21	10.63

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 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.	100-Yr. Coeff.
A =	2.832E-11	5.818E-11
B =	-1.207E-08	-2.480E-08
C =	2.064E-06	4.235E-06
D =	-1.822E-04	-3.727E-04
E =	8.963E-03	1.823E-02
F =	-2.529E-01	-5.095E-01
G =	4.475E+00	8.919E+00

Storm Intensities

AREA	Tc (minutes)	I (10-yr.) (in./hr.)	I (100-yr.) (in./hr.)
A-1	9.1	2.80	5.55
A-2	10.6	2.61	5.17

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

Q=CIA

					Peak Flows	
				Σ detained =	2.99	5.93
AREA	C	I10 (in./hr.)	I100 (in./hr.)	A (acres)	Q (10-yr.) (cfs)	Q (100-yr.) (cfs)
A-1	0.767	2.796	5.547	0.93	1.99	3.94
A-2	0.691	2.605	5.166	0.56	1.00	1.99

Node Inlet Requirements

Size pipes for 10 year storm

Area	Node #	% of Total	Q (cfs)
A-1	1	30.0%	0.60
A-1	2	70.0%	1.39
A-1	3	0.0%	0.00
A-2	4	5.0%	0.05
A-2	5	5.0%	0.05
A-2	6	30.0%	0.30
A-2	7	279.0%	2.80

PIPE FLOWS

Upstream Node	Downstream node	Pipe Flow (cfs)
1	Outlet	5.19
2	1	4.59
3	2	3.20
4	3	3.20
5	4	0.05
6	4	3.10
7	6	2.80

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	Outlet	5.19	12	2.121%	0.785	0.250	0.013	0.200%	18
		5.19	15	0.645%	1.227	0.313	0.013	0.150%	
		5.19	18	0.244%	1.767	0.375	0.013	0.120%	
2	1	4.59	12	1.661%	0.785	0.250	0.013	0.200%	18
		4.59	15	0.505%	1.227	0.313	0.013	0.150%	
		4.59	18	0.191%	1.767	0.375	0.013	0.120%	
3	2	3.20	10	2.135%	0.545	0.208	0.013	0.280%	15
		3.20	12	0.807%	0.785	0.250	0.013	0.200%	
		3.20	15	0.246%	1.227	0.313	0.013	0.150%	
4	3	3.20	10	2.135%	0.545	0.208	0.013	0.280%	15
		3.20	12	0.807%	0.785	0.250	0.013	0.200%	
		3.20	15	0.246%	1.227	0.313	0.013	0.150%	
5	4	0.05	8	0.002%	0.349	0.167	0.013	0.400%	8
		0.05	10	0.001%	0.545	0.208	0.013	0.280%	
		0.05	12	0.000%	0.785	0.250	0.013	0.200%	
6	4	3.10	10	2.003%	0.545	0.208	0.013	0.280%	15
		3.10	12	0.757%	0.785	0.250	0.013	0.200%	
		3.10	15	0.230%	1.227	0.313	0.013	0.150%	
7	6	2.80	10	1.633%	0.545	0.208	0.013	0.280%	15
		2.80	12	0.618%	0.785	0.250	0.013	0.200%	
		2.80	15	0.188%	1.227	0.313	0.013	0.150%	

North View Holdings

Combined Detention Pond

C = 0.74

Area = 1.48 acres

Allowable Discharge Rate = 0.100 cfs/acre

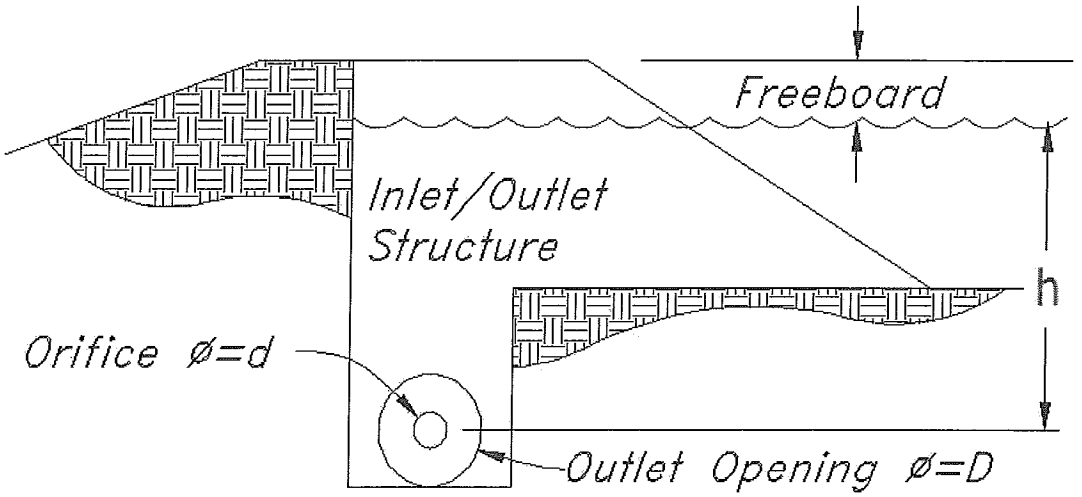
Total Release Rate = 0.148 cfs

Detention Pond Sized For The 100 Year Storm

Time	Rainfall Intensity	Accumulated Volume	OR Allowable Release	Needed Detention	Needed Detention	
min	in./hr.	(CF)	(CF)	(CF)	(acre-ft)	
5	6.78	2230	45	2186	0.050	
10	5.31	3495	89	3406	0.078	
15	4.32	4259	134	4125	0.095	
20	3.64	4790	178	4612	0.106	
25	3.18	5226	223	5003	0.115	
30	2.85	5620	267	5353	0.123	
35	2.60	5981	312	5669	0.130	
40	2.39	6299	356	5942	0.136	
45	2.22	6561	401	6160	0.141	
50	2.06	6766	445	6320	0.145	
55	1.91	6920	490	6430	0.148	
60	1.78	7043	534	6509	0.149	
90	1.35	7961	802	7160	0.164	<- Max Detention
120	1.02	8048	1069	6980	0.160	
180	0.68	8062	1603	6458	0.148	

So, our detention pond needs to hold 7160 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= 4.275

Q = 2.348 <- Includes pass-through flow from east of Hwy. 89
pass-through = 2.2 cfs

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 = 0.539 feet

OR

d = 6.470 inches

11 ac @ 0.2 cfs/ac = 2.2 cfs

NOAA Atlas 14, Volume 1, Version 5
Location name: Ogden, Utah, US*
Coordinates: 41.3090, -112.0090
Elevation: 4294ft*
* 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	1.61 (1.40–1.86)	2.03 (1.79–2.34)	2.76 (2.42–3.18)	3.44 (3.00–3.98)	4.57 (3.88–5.32)	5.60 (4.61–6.59)	6.84 (5.45–8.15)	8.30 (6.37–10.1)	10.7 (7.74–13.4)	12.9 (8.89–16.6)
10-min	1.22 (1.07–1.41)	1.54 (1.36–1.78)	2.10 (1.84–2.42)	2.63 (2.29–3.04)	3.48 (2.95–4.04)	4.27 (3.51–5.02)	5.21 (4.15–6.20)	6.32 (4.85–7.68)	8.14 (5.89–10.2)	9.82 (6.76–12.6)
15-min	1.01 (0.884–1.17)	1.27 (1.12–1.47)	1.74 (1.52–2.00)	2.17 (1.89–2.51)	2.87 (2.44–3.34)	3.52 (2.90–4.14)	4.30 (3.42–5.12)	5.22 (4.01–6.35)	6.72 (4.86–8.42)	8.12 (5.59–10.4)
30-min	0.680 (0.594–0.786)	0.858 (0.758–0.990)	1.17 (1.03–1.35)	1.46 (1.27–1.69)	1.93 (1.64–2.25)	2.37 (1.95–2.79)	2.90 (2.31–3.45)	3.52 (2.70–4.27)	4.53 (3.28–5.67)	5.47 (3.76–7.01)
60-min	0.421 (0.368–0.486)	0.531 (0.469–0.613)	0.724 (0.635–0.834)	0.904 (0.787–1.05)	1.20 (1.02–1.39)	1.47 (1.21–1.73)	1.79 (1.43–2.13)	2.18 (1.67–2.65)	2.80 (2.03–3.51)	3.38 (2.33–4.34)
2-hr	0.269 (0.239–0.306)	0.336 (0.298–0.383)	0.434 (0.384–0.494)	0.528 (0.461–0.602)	0.684 (0.584–0.787)	0.826 (0.690–0.961)	0.996 (0.804–1.18)	1.20 (0.932–1.45)	1.52 (1.11–1.90)	1.82 (1.27–2.33)
3-hr	0.208 (0.187–0.233)	0.256 (0.231–0.289)	0.321 (0.287–0.360)	0.381 (0.339–0.429)	0.478 (0.417–0.543)	0.569 (0.487–0.653)	0.681 (0.567–0.794)	0.813 (0.655–0.968)	1.03 (0.789–1.28)	1.23 (0.903–1.56)
6-hr	0.141 (0.130–0.155)	0.173 (0.158–0.191)	0.209 (0.190–0.230)	0.241 (0.218–0.268)	0.291 (0.260–0.325)	0.333 (0.293–0.375)	0.380 (0.329–0.434)	0.434 (0.366–0.502)	0.542 (0.443–0.641)	0.641 (0.508–0.792)
12-hr	0.090 (0.083–0.099)	0.110 (0.101–0.121)	0.133 (0.121–0.146)	0.153 (0.139–0.168)	0.183 (0.164–0.203)	0.207 (0.184–0.232)	0.234 (0.204–0.265)	0.263 (0.224–0.302)	0.306 (0.254–0.360)	0.342 (0.276–0.411)
24-hr	0.056 (0.051–0.061)	0.068 (0.062–0.075)	0.082 (0.075–0.090)	0.093 (0.085–0.102)	0.108 (0.098–0.118)	0.120 (0.108–0.131)	0.132 (0.119–0.144)	0.143 (0.129–0.157)	0.160 (0.142–0.183)	0.174 (0.152–0.208)
2-day	0.033 (0.030–0.036)	0.040 (0.037–0.044)	0.048 (0.044–0.052)	0.054 (0.049–0.059)	0.062 (0.057–0.068)	0.068 (0.062–0.075)	0.075 (0.068–0.082)	0.081 (0.073–0.089)	0.089 (0.080–0.098)	0.095 (0.085–0.106)
3-day	0.024 (0.022–0.026)	0.029 (0.027–0.032)	0.035 (0.032–0.038)	0.039 (0.036–0.043)	0.046 (0.042–0.050)	0.050 (0.046–0.055)	0.055 (0.050–0.060)	0.060 (0.054–0.066)	0.066 (0.060–0.073)	0.071 (0.063–0.079)
4-day	0.020 (0.018–0.021)	0.024 (0.022–0.026)	0.028 (0.026–0.031)	0.032 (0.030–0.035)	0.037 (0.034–0.041)	0.041 (0.038–0.045)	0.045 (0.041–0.050)	0.050 (0.045–0.054)	0.055 (0.049–0.060)	0.059 (0.052–0.065)
7-day	0.013 (0.012–0.015)	0.016 (0.015–0.018)	0.019 (0.018–0.021)	0.022 (0.020–0.024)	0.025 (0.023–0.028)	0.028 (0.026–0.031)	0.031 (0.028–0.034)	0.033 (0.030–0.037)	0.037 (0.033–0.040)	0.039 (0.035–0.043)
10-day	0.011 (0.010–0.012)	0.013 (0.012–0.014)	0.015 (0.014–0.017)	0.017 (0.016–0.019)	0.020 (0.018–0.022)	0.022 (0.020–0.024)	0.023 (0.021–0.026)	0.025 (0.023–0.028)	0.027 (0.025–0.030)	0.029 (0.026–0.032)
20-day	0.007 (0.006–0.008)	0.008 (0.008–0.009)	0.010 (0.009–0.011)	0.011 (0.010–0.012)	0.013 (0.012–0.014)	0.014 (0.013–0.015)	0.015 (0.013–0.016)	0.016 (0.014–0.017)	0.017 (0.015–0.018)	0.018 (0.016–0.019)
30-day	0.006 (0.005–0.006)	0.007 (0.006–0.007)	0.008 (0.007–0.009)	0.009 (0.008–0.010)	0.010 (0.009–0.011)	0.011 (0.010–0.012)	0.012 (0.011–0.013)	0.012 (0.011–0.013)	0.013 (0.012–0.014)	0.014 (0.013–0.015)
45-day	0.005 (0.004–0.005)	0.006 (0.005–0.006)	0.007 (0.006–0.007)	0.007 (0.007–0.008)	0.008 (0.008–0.009)	0.009 (0.008–0.010)	0.010 (0.009–0.010)	0.010 (0.009–0.011)	0.011 (0.010–0.012)	0.011 (0.010–0.012)
60-day	0.004 (0.004–0.004)	0.005 (0.005–0.005)	0.006 (0.005–0.006)	0.006 (0.006–0.007)	0.007 (0.007–0.008)	0.008 (0.007–0.008)	0.008 (0.008–0.009)	0.009 (0.008–0.010)	0.009 (0.009–0.010)	0.010 (0.009–0.011)

[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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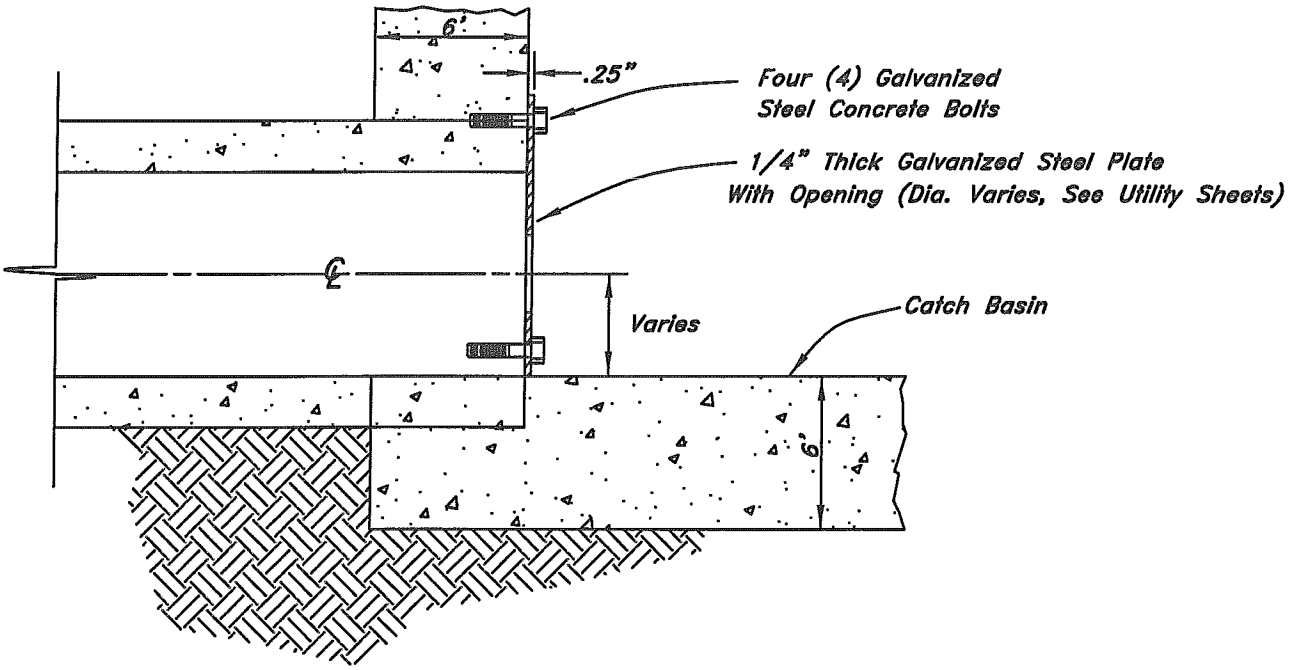
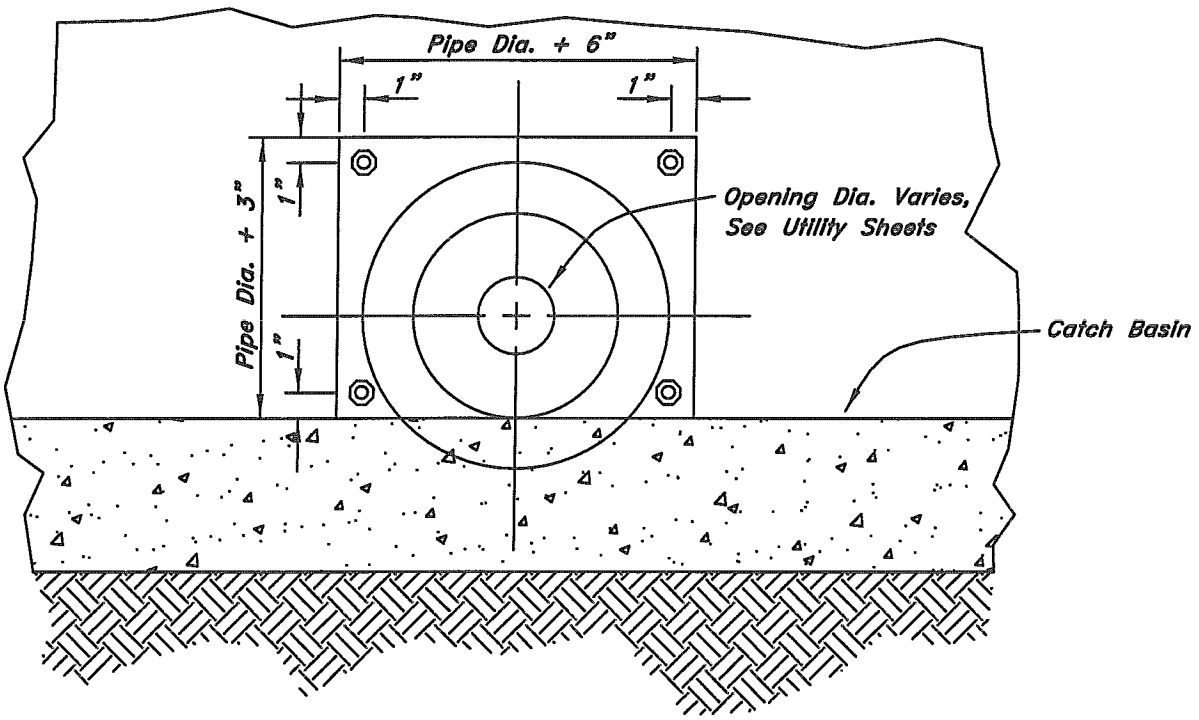
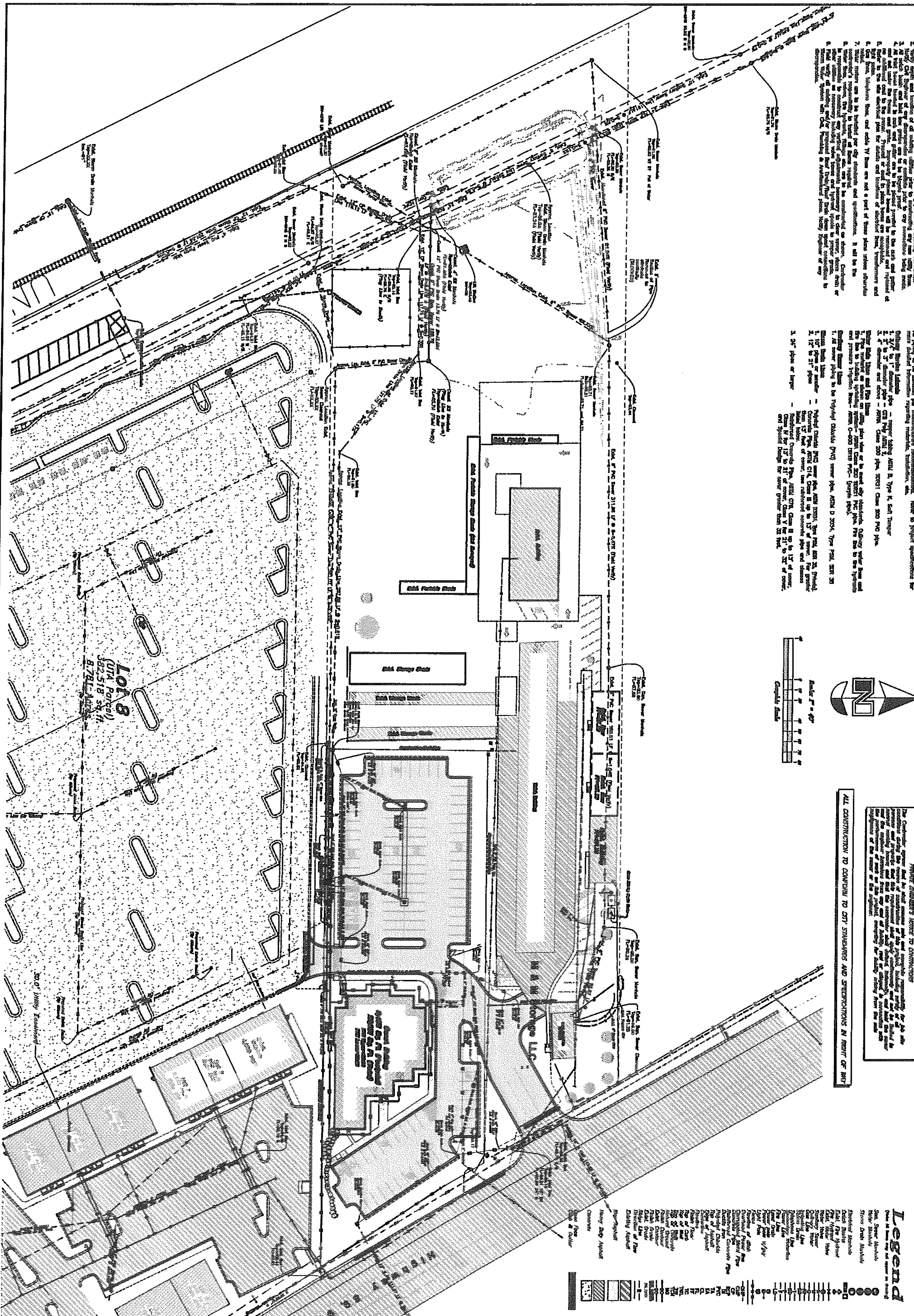
PF graphical





Orifice Plate Detail



Overall Utility Plan

North View Holdings LLC

2700 North Highway 89
Weber County, Utah

01 May 2013

UHI Overall

GREAT BASIN ENGINEERING NORTH
CONSULTING ENGINEERS AND SURVEYORS
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Ogden, Utah 84403
P.O. Box 150048, Ogden, Utah 84415

REV	DATE	DESCRIPTION