GREAT BASIN
E N G I N E E R I N G inc

Terakee Meadow
Approximately 900 S. 4300 W.
West Weber, UT 84404
STORM WATER STUDY
Project No. 16N719
03-12-2019

General Site Information:

The proposed site is located east of 4300 West just south of 900 South. Construction will consist of a new road, sidewalks, curb and gutter, underground utilities, and landscaped areas when completed.

The study area consists of two drainage areas (labeled A-1 and A-2 on the attached figure). Storm water from much of the site (A-1) will be collected in road-side borrow ditches and be directed to inlet boxes where it will continue via storm drain to the west side of the site. Storm water from this area (A-1) will be detained in the four borrow ditches along the proposed road. Storm water from A-2 will be retained on individual lots in retention basins on each lot, excluding lots 2 and 11 The overall site is allowed a unit-release of 0.1 cfs per acre for the 10-yr storm into existing storm drainage facilities in 4300 West. The attached figure shows the project site and location of the storm water outfall. Detention calculations have been provided for the site. (See attached figure and calculations).

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, and other hard surfaced areas. An average runoff coefficient of 0.37 was calculated for A-1 and 0.27 for A-2. The combined average runoff coefficient for A-1 and A-2 is 0.29.

A time of concentration is calculated using the FAA method assuming flow resistance coefficients of K=0.35 for landscape and K=0.91 for hardscape for the drainage area. The times of concentration are about 19 minutes and 11 minutes for A-1 and A-2, respectively. The times are based on the hydraulically longest drainage path inside the drainage area over grass or other vegetation, asphalt, concrete, and/or through a swale or pipeline as applicable. Times calculated to be less than 5 minutes should be rounded to 5 minutes when using this method. Rainfall Intensities were taken from the NOAA website 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 flow, and required detention for the site are also provided and can be found in the attached calculations. Node 5 in this study represents the total discharge from the rears of the lots (A-2) that will be detained in individual retention ponds to be constructed on applicable lots. Outfall 2 represents these ponds.

Pipe Sizes:

Storm water pipes in the project are proposed to be 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 have sufficient capacity to convey the 10-year storm without surcharging.

Orifice Plate:

The orifice plate opening, located on the west side of node 4, will be eccentrically positioned with a diameter of 5.11 inches for the detention facility to utilize its capacity during a 10-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 plate will restrict the flow. The maximum flow through the plate will occur when the detention basin reaches the maximum design depth. A detail of the orifice plate can be found in the construction documents for this project.

Required Detention:

The required detention for the 10-year storm with a release rate of 0.1 cfs/acre is 2,567 cubic feet for A-1. The detention facility has a total capacity of 2,658 cubic feet at a top of water elevation of 4236.85. The required retention for the 10-year 24-hour storm is 13,168 cubic feet for A-2. Each lot, except lots 2 and 11, will be required to retain and percolate or evaporate 1/10 of the total required retention for A-2.

Great Basin Engineering, Inc.

Prepared by Guy Williams, E.I.T.

Reviewed and Signed by Ryan Bingham, P.E.

Terakee Meadow
Approx. 900 S 4500 W West Weber, UT 84404
16N719 - Prelim - 4 SWS.dwg

2 Detained Areas

	Zone 1 (ft^2)
Avg. lot size	42047
Avg. home size	3500
Hardscape C = 0.90 Avg. patio/driveway size	3000
Landscape C = 0.15 C =	0.266

Category Runoff Coefficients		
0.550		0.266

Drainage Areas	Total Area (acres)	60' Road Area (acres)	Zone 1 Area (acres)	C
Σ Det. Areas	12.848	1.268	11.580	0.294
Σ All Areas	12.848	1.268	11.580	0.294
A-1	6.026	1.268	4.757	0.326
A-2	6.823	0.000	6.823	0.266

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	100.00	2.00	10.71	4.00	2.00	0.54	950.00	7.92	19.17
A-2	100.00	2.00	10.71	0.00	2.00	0.00	0.00	0.00	10.71

<p style="text-align: center;"><u>Rainfall Intensities</u></p>
<p style="text-align: center;"><u>Data From NOAA</u></p>

<p style="text-align: center;">**10-Year Storm Intensities**</p>

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

AREA	Tc (minutes)	Storm Intensities I (10-yr.) (in./hr.)
A-1	19.2	1.79
A-2	10.7	2.41

Peak Flow Information
Use Rational Method
10-Year Storm Intensities

Q=CIA

AREA	C	I10 (in./hr.)
A-1	0.326	1.786
A-2	0.266	2.409

	Peak Flows
Σ detained =	7.87
A (acres)	Q (10-yr.) (cfs)
6.03	3.50
6.82	4.37

Node Inlet Requirements

		Size pipes for	10	year storm	

Area	Node #	% of Total	Q (cfs)
A-1	1	35.0%	1.23
A-1	2	35.0%	1.23
A-1	3	15.0%	0.53
A-1	4	15.0%	0.53
A-2	5	100.0%	4.37

Summary of Node Inlet Requirements

Node	Is required to take (cfs)
1	1.23
2	1.23
3	0.53
4	0.53
5	4.37

PIPE FLOWS

Upstream Node	Downstream node	Pipe Flow (cfs)
1	2	1.23
2	3	2.45
3	4	2.98
4	Outfall 1	1.29
5	Outfall 2	4.37

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	1.23	15	0.036%	1.227	0.313	0.013	0.150%	
		1.23	18	0.014%	1.767	0.375	0.013	0.120%	15
		1.23	24	0.003%	3.142	0.500	0.013	0.080%	
2	3	2.45	15	0.144%	1.227	0.313	0.013	0.150%	
		2.45	18	0.055%	1.767	0.375	0.013	0.120%	15
		2.45	24	0.012%	3.142	0.500	0.013	0.080%	
3	4	2.98	15	0.213%	1.227	0.313	0.013	0.150%	
		2.98	18	0.080%	1.767	0.375	0.013	0.120%	15
		2.98	24	0.017%	3.142	0.500	0.013	0.080%	
4	Outfall 1	1.29	15	0.040%	1.227	0.313	0.013	0.150%	
		1.29	18	0.015%	1.767	0.375	0.013	0.120%	15
		1.29	24	0.003%	3.142	0.500	0.013	0.080%	

Terakee Meadow

Borrow Ditch Facility

C = 0.33

Area = 6.03 acres

Release through Restriction = 1.285 cfs

Detention Pond Sized For The 10 Year Storm

Time	Rainfall Intensity	Accumulated Volume	Allowable Release	Needed Detention	
min	in./hr.	(CF)	(CF)	(CF)	
5	3.24	1908	386	1522	
10	2.47	2909	771	2138	
15	2.04	3604	1157	2447	
20	1.74	4087	1542	2545	
25	1.53	4494	1928	2567	<- Req. Det.
30	1.37	4840	2313	2527	
35	1.26	5174	2699	2476	
40	1.14	5381	3084	2297	
45	1.05	5557	3470	2088	
50	0.97	5703	3855	1848	
55	0.90	5843	4241	1602	
60	0.85	5999	4626	1373	
90	0.61	6515	6939	-424	
120	0.49	6896	9252	-2356	
180	0.35	7483	13878	-6395	
360	0.22	9496	27756	-18260	
720	0.14	11955	55512	-43557	
1440	0.08	14245	111024	-96779	

Required Storage Volume = **2567** ft^3

Terakee Meadow

**Lot Detention Facilities**
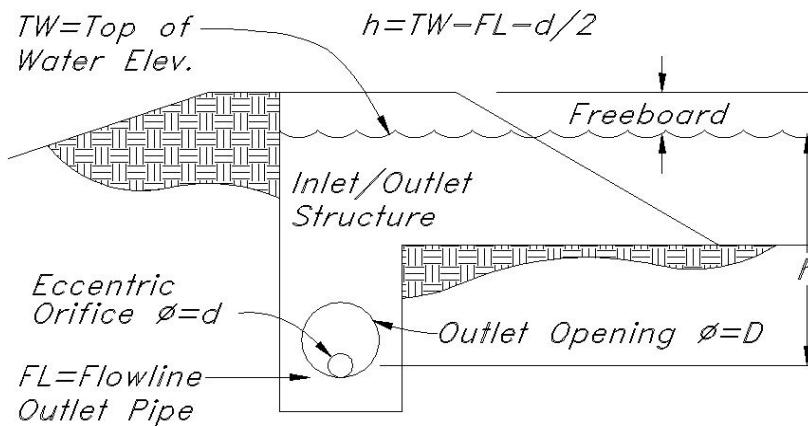
C = 0.27   Remaining Unit Discharge = 0.000 cfs/acre

Area = 6.82 acres

Release through Restriction = 0.000 cfs

Detention Pond Sized For The   10   Year Storm

Time	Rainfall Intensity	Accumulated Volume	Allowable Release	Needed Detention
min	in./hr.	(CF)	(CF)	(CF)
5	3.24	1764	0	1764
10	2.47	2689	0	2689
15	2.04	3331	0	3331
20	1.74	3778	0	3778
25	1.53	4155	0	4155
30	1.37	4474	0	4474
35	1.26	4783	0	4783
40	1.14	4974	0	4974
45	1.05	5137	0	5137
50	0.97	5272	0	5272
55	0.90	5401	0	5401
60	0.85	5546	0	5546
90	0.61	6022	0	6022
120	0.49	6375	0	6375
180	0.35	6917	0	6917
360	0.22	8779	0	8779
720	0.14	11052	0	11052
1440	0.08	13168	0	13168

Required Storage Volume = **13168** ft^3

ORIFICE PLATE CALCULATIONS

TW=Top of Water Elev.

$h=TW-FL-d/2$

Freeboard

Inlet/Outlet Structure

Eccentric Orifice ∅=d

Outlet Opening ∅=D

FL=Flowline Outlet Pipe

h

Q = Total Discharge Rate

$$Q = 0.62 \cdot A_o \cdot \sqrt{64.4 \cdot h}$$

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

Solving for d, we have.....

$$d = \sqrt{\frac{4 \cdot Q}{0.62 \cdot \pi \cdot \sqrt{64.4 \cdot \left(TW - FL - \frac{d}{2}\right)}}}$$

Let

$$\Delta = d - \sqrt{\frac{4 \cdot Q}{0.62 \cdot \pi \cdot \sqrt{64.4 \cdot \left(TW - FL - \frac{d}{2}\right)}}}$$

Goal-seek Δ to zero by changing "trial d"

TW =	4236.85	
FL =	4233.34	
Q =	1.285	cfs
trial d=	0.4255	ft
Δ =	0.000	ft
d =	5.11	inches

NOAA Atlas 14, Volume 1, Version 5
Location name: Ogden, Utah, USA*
Latitude: 41.249°, Longitude: -112.0878°
Elevation: 4237.79 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	1.50 (1.31-1.74)	1.88 (1.67-2.20)	2.58 (2.27-3.00)	3.24 (2.81-3.77)	4.31 (3.65-5.04)	5.30 (4.36-6.28)	6.49 (5.15-7.78)	7.91 (6.04-9.66)	10.2 (7.34-12.8)	12.3 (8.45-15.9)
10-min	1.15 (0.996-1.32)	1.44 (1.27-1.67)	1.97 (1.72-2.28)	2.46 (2.14-2.87)	3.28 (2.78-3.83)	4.03 (3.31-4.78)	4.94 (3.92-5.92)	6.02 (4.60-7.35)	7.76 (5.59-9.77)	9.37 (6.43-12.1)
15-min	0.944 (0.824-1.09)	1.19 (1.05-1.38)	1.62 (1.42-1.89)	2.04 (1.77-2.37)	2.71 (2.30-3.17)	3.33 (2.74-3.95)	4.08 (3.24-4.89)	4.97 (3.80-6.08)	6.41 (4.62-8.07)	7.75 (5.31-9.97)
30-min	0.636 (0.554-0.736)	0.800 (0.706-0.930)	1.09 (0.958-1.27)	1.37 (1.19-1.59)	1.82 (1.55-2.13)	2.24 (1.84-2.66)	2.75 (2.18-3.29)	3.35 (2.56-4.09)	4.32 (3.11-5.44)	5.22 (3.58-6.72)
60-min	0.394 (0.343-0.455)	0.495 (0.437-0.575)	0.677 (0.593-0.786)	0.848 (0.737-0.987)	1.13 (0.957-1.32)	1.39 (1.14-1.65)	1.70 (1.35-2.04)	2.07 (1.58-2.53)	2.67 (1.93-3.36)	3.23 (2.21-4.16)
2-hr	0.248 (0.219-0.282)	0.309 (0.274-0.354)	0.400 (0.352-0.458)	0.488 (0.424-0.560)	0.634 (0.540-0.734)	0.767 (0.638-0.899)	0.926 (0.744-1.10)	1.12 (0.863-1.36)	1.42 (1.04-1.79)	1.70 (1.18-2.19)
3-hr	0.192 (0.173-0.216)	0.237 (0.213-0.267)	0.297 (0.266-0.335)	0.353 (0.313-0.399)	0.443 (0.386-0.505)	0.527 (0.450-0.608)	0.633 (0.524-0.741)	0.757 (0.607-0.907)	0.961 (0.732-1.20)	1.15 (0.839-1.47)
6-hr	0.130 (0.120-0.143)	0.159 (0.145-0.176)	0.193 (0.175-0.213)	0.223 (0.201-0.247)	0.270 (0.240-0.301)	0.308 (0.271-0.347)	0.352 (0.305-0.403)	0.402 (0.340-0.467)	0.505 (0.411-0.608)	0.597 (0.472-0.745)
12-hr	0.083 (0.076-0.090)	0.101 (0.093-0.110)	0.122 (0.112-0.133)	0.140 (0.128-0.153)	0.168 (0.151-0.185)	0.190 (0.169-0.212)	0.214 (0.187-0.242)	0.241 (0.206-0.276)	0.281 (0.233-0.330)	0.315 (0.254-0.377)
24-hr	0.050 (0.046-0.055)	0.061 (0.057-0.067)	0.073 (0.068-0.080)	0.083 (0.077-0.091)	0.097 (0.089-0.105)	0.108 (0.099-0.117)	0.118 (0.108-0.129)	0.129 (0.117-0.141)	0.144 (0.129-0.167)	0.160 (0.139-0.191)
2-day	0.029 (0.027-0.031)	0.035 (0.033-0.039)	0.042 (0.039-0.046)	0.048 (0.044-0.051)	0.055 (0.051-0.059)	0.061 (0.056-0.065)	0.066 (0.061-0.072)	0.072 (0.066-0.078)	0.079 (0.072-0.086)	0.084 (0.076-0.096)
3-day	0.021 (0.019-0.023)	0.026 (0.024-0.028)	0.031 (0.028-0.033)	0.035 (0.032-0.037)	0.040 (0.037-0.043)	0.044 (0.041-0.048)	0.048 (0.044-0.052)	0.053 (0.048-0.057)	0.058 (0.053-0.063)	0.062 (0.056-0.070)
4-day	0.017 (0.016-0.018)	0.021 (0.019-0.022)	0.025 (0.023-0.027)	0.028 (0.026-0.030)	0.032 (0.030-0.035)	0.036 (0.033-0.039)	0.039 (0.036-0.043)	0.043 (0.039-0.047)	0.048 (0.043-0.052)	0.051 (0.046-0.056)
7-day	0.011 (0.011-0.012)	0.014 (0.013-0.015)	0.017 (0.015-0.018)	0.019 (0.017-0.020)	0.022 (0.020-0.023)	0.024 (0.022-0.026)	0.026 (0.024-0.028)	0.028 (0.026-0.031)	0.031 (0.028-0.034)	0.033 (0.030-0.036)
10-day	0.009 (0.008-0.010)	0.011 (0.010-0.012)	0.013 (0.012-0.014)	0.015 (0.014-0.016)	0.017 (0.016-0.018)	0.018 (0.017-0.020)	0.020 (0.018-0.021)	0.021 (0.020-0.023)	0.023 (0.021-0.025)	0.024 (0.022-0.027)
20-day	0.006 (0.005-0.006)	0.007 (0.007-0.008)	0.008 (0.008-0.009)	0.009 (0.009-0.010)	0.011 (0.010-0.011)	0.011 (0.011-0.012)	0.012 (0.011-0.013)	0.013 (0.012-0.014)	0.014 (0.013-0.015)	0.015 (0.013-0.016)
30-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)
45-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)
60-day	0.003 (0.003-0.004)	0.004 (0.004-0.004)	0.005 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.006-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.007)	0.007 (0.007-0.008)	0.008 (0.007-0.008)	0.008 (0.007-0.008)

[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.
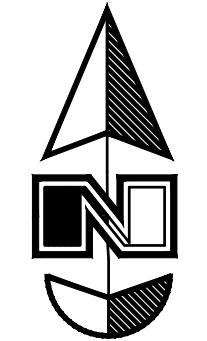
Please refer to NOAA Atlas 14 document for more information.

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Storm Water Study Exhibit
Terakee Meadow Subdivision
A part of the Northwest Quarter of Section 21, T6N, R2W, SLB&M, U.S. Survey
Weber County, Utah
March 2019

Scale: 1" = 60'

Graphic Scale

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