Design Criteria:

Commercial Areas 1, 2, & 3 and VHD #1 & VHD #2 are to detain and release at a rate of 0.2 cubic feet per second per acre (cfs/ac) per Lehi City's storm drain design requirements. A 100 year 24 hour storm is to be to be used for sizing detention areas and a 10 year 24 hour storm is to be used for pipe sizing. The rational method will be used. Refer to Appendix A for rainfall intensity duration frequency curves used for this study.

No sumps to be used.

Minimum pipe size: 12"

Pipe Type: ADS for pipes less than 36" and two feet or more of cover.
RCP for pipes less than 36" and less than two feet of cover
RCP for pipes 36" and larger (refer to Lehi City Design Standards Section 9.07)

Summary of Results:

Onsite detention will be utilized on Commercial Areas #1, #2, #3, VHD #1, and VHD #2. The calculations for these detention areas will be provided with final site design. The remainder of the undetained storm water will be conveyed to three detention ponds (Detention Pond #1, Detention Pond #2, and Detention Pond #3) that will discharge to the Jordan River at a rate of 0.2 cfs/ac. Refer to sheets SD-2 through SD-4 for sizing calculations for Detention Ponds #1, #2, and #3 and SD-5 for a summary of pipe sizing calculations. SD-6 is an exhibit showing the location of all pipes and ponds in Cold Spring Ranch.

Consulting Engineers and Surveyors, Inc.
3302 N. Main, Spanish Fork, UT 84660 (801)798-0555

Storm Drainage Calculations

Detention Pond #1

Detention Pond Calculations

Date: December 5, 2016
Project #:
Prepared By: BT
Revisions: 1/26/2017

Design Criteria

Intensity Table:	NOAA	
Return Period:	100	year
Allowable Discharge:	0.20	cfs/Ac

Allowable Discharges

Storm Drain Discharge:	1.14	cfs
Sump Infiltration:	0.00	cfs
Total Discharge:	*1.14*	*cfs*

Weighted "C" Value

Surface Type	*Area (ac)*	*"C" Value*	*C*A*
High Density #4	5.72	0.65	3.72
Other	0	0.00	0.00
Totals	5.72		3.72
Weighted "C" Value		***0.65***	

Drainage Calculations

Duration	Intensity	Depth	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*	*in*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	6.22	0.52	0.65	5.72	23.14	6,942	1.14	343	6,599
10.0	4.73	0.79	0.65	5.72	17.60	10,559	1.14	687	9,872
15.0	3.90	0.98	0.65	5.72	14.51	13,059	1.14	1,030	12,029
30.0	2.63	1.32	0.65	5.72	9.78	17,613	1.14	2,061	15,552
60.0	1.63	1.63	0.65	5.72	6.06	21,832	1.14	4,121	17,711
120.0	0.88	1.76	0.65	5.72	3.28	23,600	1.14	8,242	15,358
180.0	0.59	1.78	0.65	5.72	2.20	23,787	1.14	12,364	11,424
360.0	0.32	1.89	0.65	5.72	1.17	25,314	1.14	24,727	587
720.0	0.18	2.12	0.65	5.72	0.66	28,448	1.14	49,454	-21,006
1440.0	0.09	2.16	0.65	5.72	0.33	28,931	1.14	98,908	-69,978

Maximum Storage Requirement: ***17,711 cf***

Detention Basin Design

Total Storage Requirement: **17,711 cf**

Notes / Details

Consulting Engineers and Surveyors, Inc.
3302 N. Main, Spanish Fork, UT 84660 (801)798-0555

Storm Drainage Calculations

Detention Pond #2

Detention Pond Calculations

Date: December 5, 2016
Project #:
Prepared By: BT
Revisions: 1/25/2017

Design Criteria

Intensity Table:	NOAA	
Return Period:	100	year
Allowable Discharge:	0.20	cfs/Ac

Allowable Discharges

Storm Drain Discharge:	32.31	cfs
Sump Infiltration:	0.00	cfs
Total Discharge:	*32.31*	*cfs*

Weighted "C" Value

Surface Type	*Area (ac)*	*"C" Value*	*C*A*
HD #1 & HD #5	22.07	0.65	14.35
Medium Density (Excludes MD #2)	50.54	0.55	27.80
Low Density	22.85	0.40	9.14
Open Space	56.72	0.20	11.34
ROW	9.39	0.72	6.76
Totals	161.57		69.39
Weighted "C" Value		***0.43***	

Drainage Calculations

Duration	Intensity	Depth	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*	*in*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	6.22	0.52	0.43	161.57	431.58	129,474	32.31	9,694	119,780
10.0	4.73	0.79	0.43	161.57	328.20	196,918	32.31	19,389	177,529
15.0	3.90	0.98	0.43	161.57	270.61	243,545	32.31	29,083	214,462
30.0	2.63	1.32	0.43	161.57	182.49	328,473	32.31	58,166	270,308
60.0	1.63	1.63	0.43	161.57	113.10	407,157	32.31	116,331	290,826
120.0	0.88	1.76	0.43	161.57	61.13	440,129	32.31	232,663	207,467
180.0	0.59	1.78	0.43	161.57	41.08	443,626	32.31	348,994	94,632
360.0	0.32	1.89	0.43	161.57	21.86	472,102	32.31	697,988	-225,886
720.0	0.18	2.12	0.43	161.57	12.28	530,553	32.31	1,395,976	-865,423
1440.0	0.09	2.16	0.43	161.57	6.24	539,546	32.31	2,791,953	-2,252,407

Maximum Storage Requirement: ***290,826 cf***

Detention Basin Design

Total Storage Requirement: **290,826 cf**

Notes / Details

Consulting Engineers and Surveyors, Inc.
3302 N. Main, Spanish Fork, UT 84660 (801)798-0555

Storm Drainage Calculations

Detention Pond #3

Detention Pond Calculations

Date: January 25, 2017
Project #:
Prepared By: BT
Revisions:

Design Criteria

Intensity Table:	NOAA	
Return Period:	100	year
Allowable Discharge:	0.20	cfs/Ac

Allowable Discharges

Storm Drain Discharge:	8.31	cfs
Sump Infiltration:	0.00	cfs
Total Discharge:	*8.31*	*cfs*

Weighted "C" Value

Surface Type	*Area (ac)*	*"C" Value*	*C*A*
HD #2 & HD #3 and a Portion of HD #4	18.28	0.65	11.88
MD #2	20.43	0.55	11.24
Open Space	2.83	0.20	0.57
ROW	1.71	0.72	1.23
Totals	41.53		23.68
Weighted "C" Value		***0.57***	

Drainage Calculations

Duration	Intensity	Depth	Runoff C	Area	Rainfall	Accumulated Flow	Allowable Discharge	Discharge	Required Storage
min	*in/hr*	*in*		*Ac*	*cfs*	*cf*	*cfs*	*cf*	*cf*
5.0	6.22	0.52	0.57	41.53	147.30	44,189	8.31	2,492	41,697
10.0	4.73	0.79	0.57	41.53	112.01	67,207	8.31	4,984	62,223
15.0	3.90	0.98	0.57	41.53	92.36	83,121	8.31	7,476	75,645
30.0	2.63	1.32	0.57	41.53	62.28	112,106	8.31	14,951	97,155
60.0	1.63	1.63	0.57	41.53	38.60	138,961	8.31	29,903	109,058
120.0	0.88	1.76	0.57	41.53	20.86	150,214	8.31	59,806	90,408
180.0	0.59	1.78	0.57	41.53	14.02	151,408	8.31	89,709	61,699
360.0	0.32	1.89	0.57	41.53	7.46	161,126	8.31	179,417	-18,291
720.0	0.18	2.12	0.57	41.53	4.19	181,075	8.31	358,835	-177,759
1440.0	0.09	2.16	0.57	41.53	2.13	184,144	8.31	717,670	-533,525

Maximum Storage Requirement: ***109,058 cf***

Detention Basin Design

Total Storage Requirement: **109,058 cf**

Notes / Details

Pipe Sizing Calculations

Pipe Number	Overland Time (min)	Upstream Pipe Distance (ft)	Average Pipe Speed (ft/s)	Pipe Time (min)	Total Time of Concentration (min)	10-year Rainfall Intensity (in/hr)	Contributing Area (ac)	Weighted C-Value	Peak Flow (cfs)	Additional flow (cfs)	Total Peak Flow (cfs)	Pipe Diameter (in)	Minimum/Existing Slope (%)	Pipe Velocity (ft/s)	Pipe Capacity (cfs)	
13	15	0	3.0	0	15	2.00	1.80	0.57	2.07	5.88	7.95	18	0.60%	4.62	8.16	Okay
12	15	736	3.0	4	19	1.82	15.10	0.57	15.80	5.88	21.67	24	0.95%	7.04	22.11	Okay
11	25	0	3.0	0	25	1.56	20.43	0.57	18.32	0.00	18.32	24	0.70%	6.04	18.98	Okay
10	25	1848	3.0	10	35	1.26	35.53	0.57	25.73	5.88	31.61	30	0.60%	6.49	31.86	Okay
9	15	0	3.0	0	15	2.00	1.88	0.43	1.62	3.97	5.59	12	2.50%	7.19	5.65	Okay
8	15	882	3.0	5	20	1.78	3.84	0.43	2.96	7.46	10.42	18	1.00%	5.96	10.53	Okay
7	15	1544	3.0	9	24	1.60	11.33	0.43	7.84	7.46	15.31	24	0.50%	5.11	16.04	Okay
6	15	2447	3.0	14	29	1.38	16.38	0.43	9.78	7.46	17.25	24	0.60%	5.59	17.57	Okay
5	20	0	3.0	0	20	1.78	12.21	0.43	9.41	0.00	9.41	18	0.80%	5.33	9.42	Okay
4	20	2716	3.0	15	35	1.26	28.59	0.43	15.59	7.46	23.06	30	0.35%	4.96	24.33	Okay
3	25	3758	3.0	21	46	1.07	54.96	0.43	25.45	7.46	32.92	30	0.65%	6.75	33.16	Okay
2	25	0	3.0	0	25	1.56	21.49	0.43	14.51	0.00	14.51	24	0.45%	4.84	15.22	Okay
1	30	4881	3.0	27	57	0.88	99.30	0.43	37.83	7.46	45.29	36	0.50%	6.69	47.29	Okay

Notes

1. All pipes sized to accommodate the 10-year storm event using Manning's equation.
2. Assumptions include overland times, pipe speed of 3 ft/s, and weighted c-values based on the pond sizing calculations.

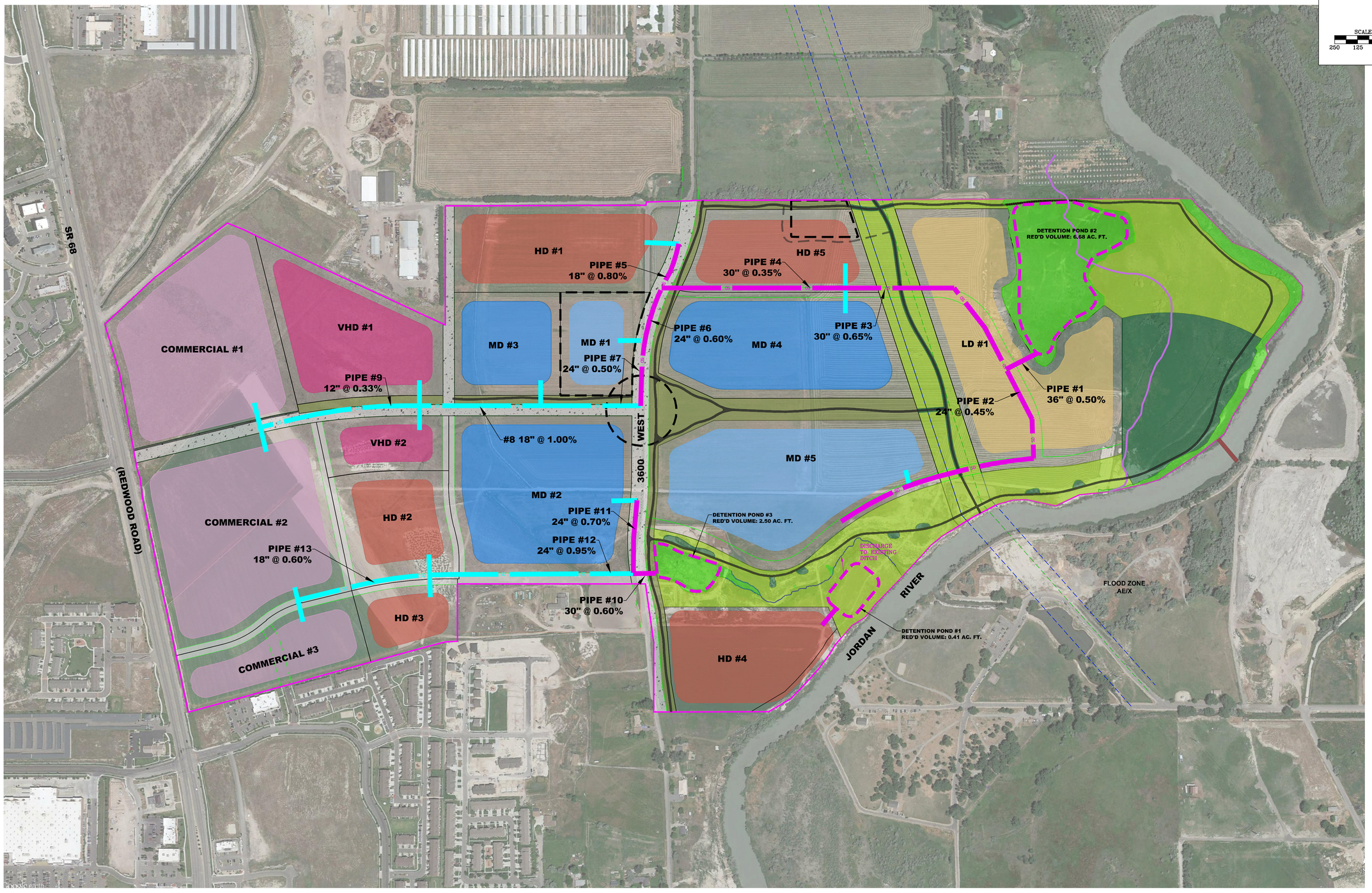
LEGEND

MASTER PLAN LINE

PROJECT LINE

NOTES:

1. THE CONTRIBUTING AREAS FOR POND #3 INCLUDE MD#2, HD#2, HD#3 AND A PORTION OF HD#4.



NORTH

SCALE: 1" = 250'

250 125 0 250

LEI

- A Utah Corporation -

ENGINEERS

SURVEYORS

PLANNERS

3302 N. Main Street
Spanish Fork, UT 84660
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Fax: 801.798.9393
office@lei-eng.com
www.lei-eng.com

NOT FOR CONSTRUCTION

COLD SPRING RANCH

LEHI, UTAH

STORM DRAIN MASTER PLAN

REVISIONS

1 -

2 -

3 -

4 -

5 -

LEI PROJECT #: 2015-0125

DRAWN BY: BAP

CHECKED BY: BTG

SCALE: 1" = 250'

DATE: 1/11/2018

SHEET

SD-6

U:\0_LEI PROJECTS\2015\2015-0125 DR HORTON - ALLRED PROPERTY LEHI\CAD\15-0125 COMMUNITY PLAN EXHIBITS 2.DWG 1/11/2018 8:31 AM

Appendix A – Rainfall Intensity Duration Frequency Curves from NOAA

NOAA Atlas 14, Volume 1, Version 5
Location name: Lehi, Utah, USA*
Latitude: 40.397°, Longitude: -111.8971°
Elevation: 4494.09 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	1.45 (1.26-1.69)	1.84 (1.61-2.15)	2.53 (2.21-2.96)	3.17 (2.72-3.72)	4.19 (3.52-4.93)	5.12 (4.19-6.10)	6.22 (4.92-7.45)	7.49 (5.71-9.13)	9.52 (6.91-11.9)	11.4 (7.91-14.4)
10-min	1.10 (0.960-1.28)	1.39 (1.22-1.63)	1.93 (1.68-2.26)	2.41 (2.08-2.83)	3.18 (2.67-3.76)	3.90 (3.18-4.63)	4.73 (3.74-5.67)	5.69 (4.35-6.95)	7.24 (5.26-9.03)	8.64 (6.02-11.0)
15-min	0.908 (0.792-1.06)	1.15 (1.01-1.35)	1.59 (1.39-1.86)	2.00 (1.72-2.34)	2.63 (2.20-3.10)	3.22 (2.63-3.83)	3.90 (3.10-4.68)	4.70 (3.59-5.74)	5.99 (4.35-7.46)	7.14 (4.97-9.08)
30-min	0.612 (0.532-0.714)	0.776 (0.680-0.908)	1.07 (0.934-1.26)	1.34 (1.15-1.58)	1.77 (1.49-2.09)	2.17 (1.77-2.58)	2.63 (2.08-3.16)	3.17 (2.42-3.87)	4.03 (2.93-5.02)	4.81 (3.35-6.11)
60-min	0.379 (0.330-0.442)	0.480 (0.421-0.562)	0.664 (0.578-0.777)	0.831 (0.714-0.975)	1.10 (0.919-1.29)	1.34 (1.10-1.60)	1.63 (1.29-1.95)	1.96 (1.50-2.39)	2.49 (1.81-3.11)	2.98 (2.07-3.78)
2-hr	0.236 (0.212-0.268)	0.294 (0.263-0.336)	0.386 (0.343-0.440)	0.472 (0.414-0.539)	0.609 (0.522-0.700)	0.734 (0.614-0.850)	0.881 (0.714-1.03)	1.05 (0.824-1.26)	1.33 (0.988-1.63)	1.58 (1.13-1.98)
3-hr	0.178 (0.162-0.200)	0.220 (0.200-0.247)	0.281 (0.253-0.315)	0.335 (0.300-0.376)	0.422 (0.370-0.476)	0.499 (0.428-0.567)	0.592 (0.494-0.696)	0.707 (0.568-0.847)	0.895 (0.684-1.10)	1.06 (0.779-1.33)
6-hr	0.114 (0.105-0.125)	0.140 (0.129-0.153)	0.171 (0.157-0.188)	0.199 (0.182-0.219)	0.240 (0.216-0.265)	0.274 (0.243-0.305)	0.315 (0.274-0.354)	0.363 (0.309-0.429)	0.451 (0.371-0.555)	0.539 (0.423-0.674)
12-hr	0.070 (0.065-0.076)	0.086 (0.079-0.094)	0.104 (0.096-0.113)	0.119 (0.109-0.130)	0.141 (0.128-0.155)	0.159 (0.142-0.176)	0.177 (0.156-0.199)	0.199 (0.172-0.226)	0.235 (0.197-0.279)	0.271 (0.217-0.338)
24-hr	0.039 (0.036-0.042)	0.048 (0.045-0.051)	0.057 (0.053-0.061)	0.065 (0.060-0.069)	0.075 (0.070-0.080)	0.082 (0.077-0.089)	0.090 (0.083-0.101)	0.101 (0.090-0.115)	0.119 (0.100-0.141)	0.137 (0.110-0.172)
2-day	0.022 (0.021-0.024)	0.027 (0.026-0.029)	0.032 (0.030-0.035)	0.037 (0.034-0.039)	0.042 (0.040-0.045)	0.046 (0.044-0.049)	0.051 (0.047-0.054)	0.055 (0.051-0.059)	0.060 (0.056-0.071)	0.069 (0.059-0.087)
3-day	0.016 (0.015-0.017)	0.020 (0.018-0.021)	0.023 (0.022-0.025)	0.026 (0.025-0.028)	0.031 (0.029-0.033)	0.034 (0.031-0.036)	0.037 (0.034-0.040)	0.040 (0.037-0.043)	0.045 (0.041-0.050)	0.049 (0.044-0.058)
4-day	0.013 (0.012-0.014)	0.016 (0.015-0.017)	0.019 (0.018-0.020)	0.021 (0.020-0.023)	0.025 (0.023-0.026)	0.027 (0.025-0.029)	0.030 (0.028-0.032)	0.033 (0.030-0.035)	0.037 (0.033-0.039)	0.039 (0.036-0.044)
7-day	0.009 (0.008-0.009)	0.011 (0.010-0.011)	0.013 (0.012-0.013)	0.014 (0.013-0.015)	0.016 (0.015-0.017)	0.018 (0.017-0.019)	0.019 (0.018-0.021)	0.021 (0.019-0.023)	0.023 (0.021-0.025)	0.024 (0.022-0.026)
10-day	0.007 (0.006-0.007)	0.008 (0.008-0.009)	0.010 (0.009-0.010)	0.011 (0.010-0.012)	0.012 (0.012-0.013)	0.014 (0.013-0.014)	0.015 (0.014-0.016)	0.016 (0.014-0.017)	0.017 (0.016-0.018)	0.018 (0.016-0.019)
20-day	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.007-0.008)	0.008 (0.007-0.008)	0.009 (0.008-0.009)	0.009 (0.009-0.010)	0.010 (0.009-0.010)	0.010 (0.010-0.011)	0.011 (0.010-0.012)
30-day	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.005)	0.006 (0.005-0.006)	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 (0.008-0.009)	0.009 (0.008-0.009)
45-day	0.003 (0.003-0.003)	0.003 (0.003-0.004)	0.004 (0.004-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.006 (0.006-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.007)
60-day	0.003 (0.002-0.003)	0.003 (0.003-0.003)	0.004 (0.003-0.004)	0.004 (0.004-0.004)	0.004 (0.004-0.005)	0.005 (0.004-0.005)	0.005 (0.005-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.006 (0.005-0.006)

[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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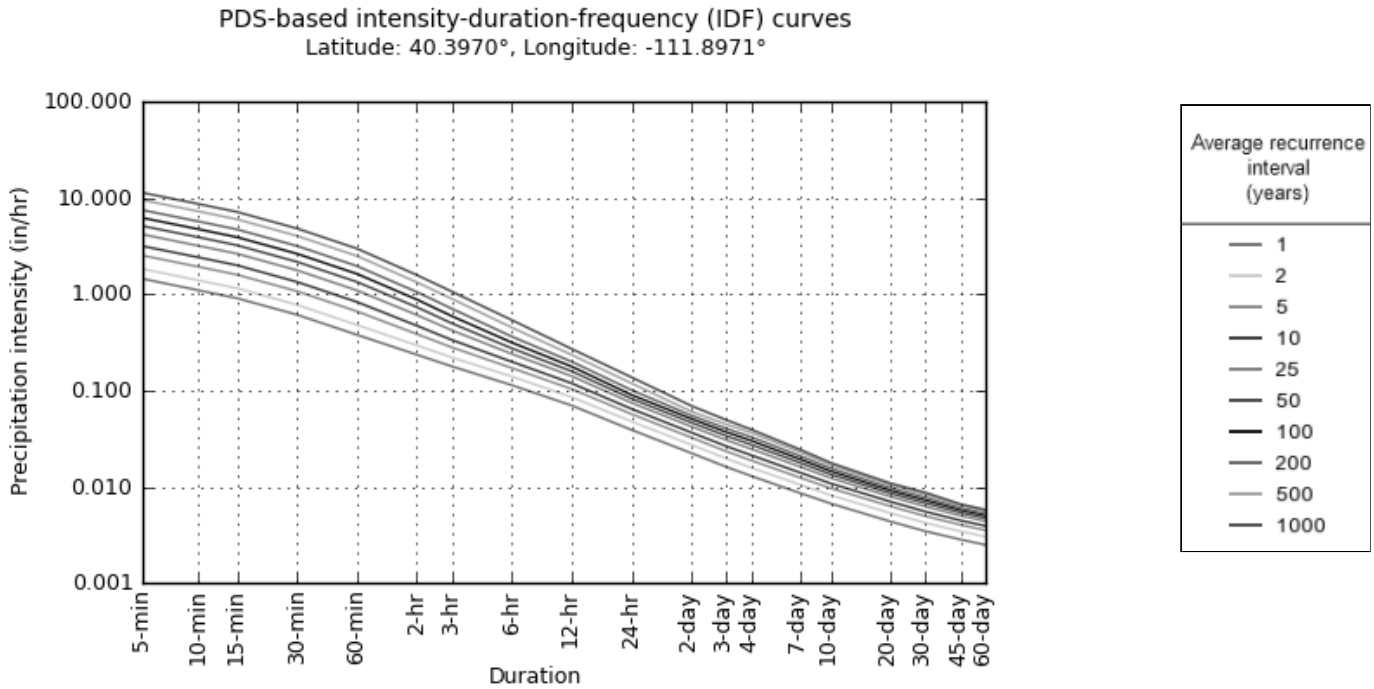
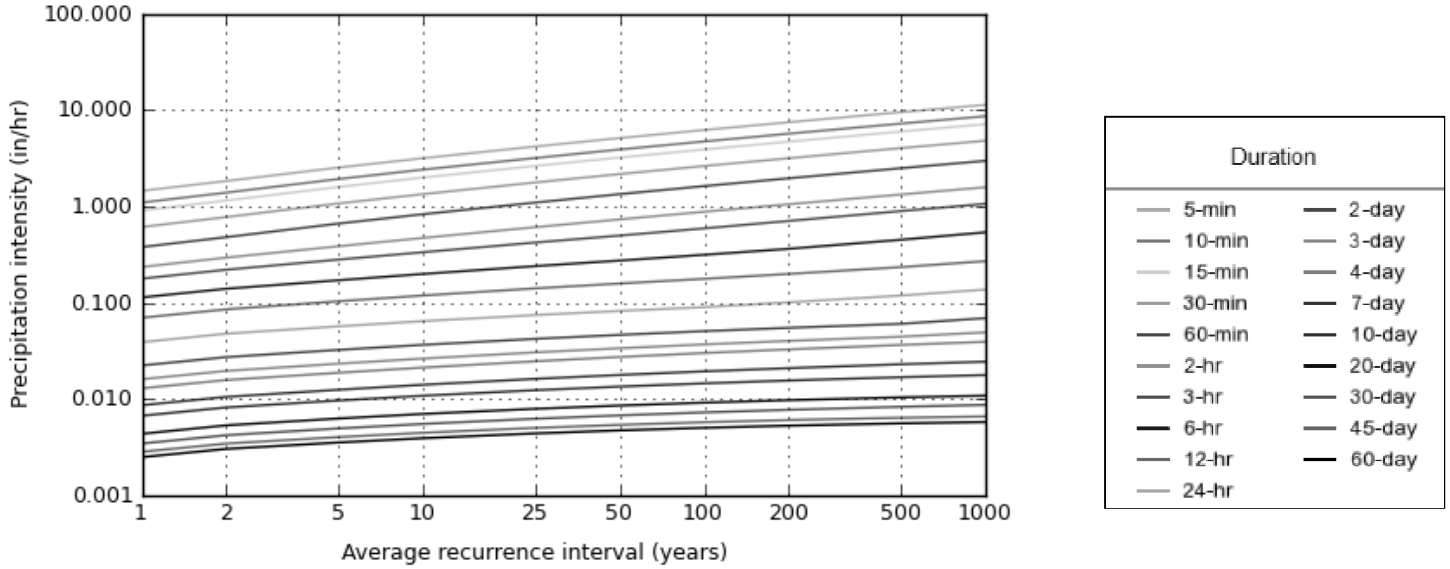
PF graphical





NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Wed Nov 23 15:58:37 2016

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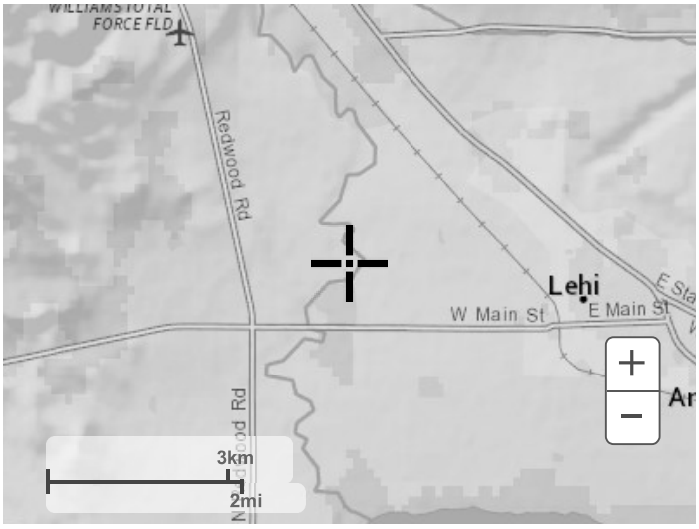
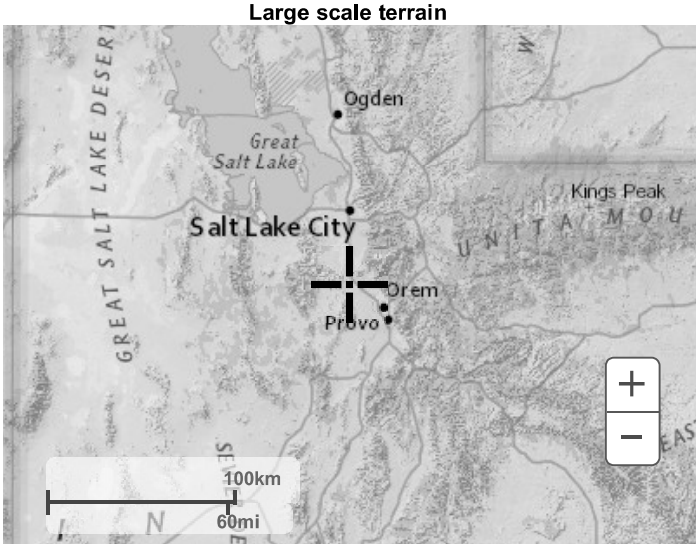
Maps & aerials

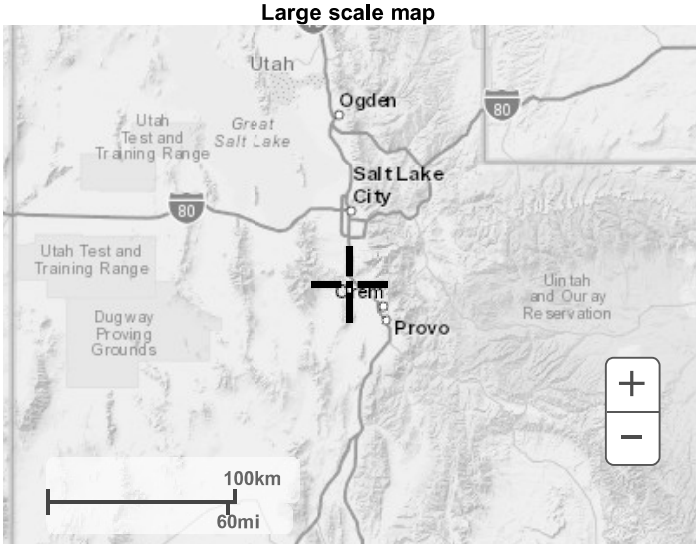
Small scale terrain



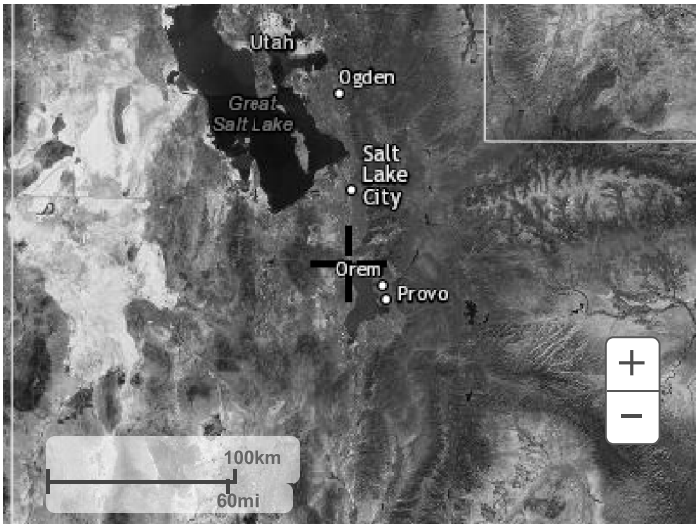
Large scale terrain



Large scale map



Large scale aerial



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