MEMORANDUM

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TO: **Dr. Eric D. Loucks, P.E., CFM** – City of Austin, Stormwater Treatment and Stream Restoration

FROM: **Garrett Johnston, P.E., CFM; Kaylyn Hudson, EIT, CFM; Jay Scanlon, P.E., CFM** – Freese and Nichols, Inc.

SUBJECT: **Atlas 14 DCM Revisions – Area Breakdown and IDF Curves**

DATE: August 7, 2019

PROJECT: AU313420 – Revisions to DCM for Incorporation of Atlas 14 Rainfall Depths

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

Freese and Nichols (FNI) has developed rainfall depths and distributions from NOAA Atlas 14, Volume 11 data for incorporation into the City of Austin's Drainage Criteria Manual (DCM). This technical memorandum documents (1) the area breakdown procedure used to calculate the rainfall depths from NOAA National Weather Service (NWS) geospatial data and (2) the procedure used to fit the intensity-duration-frequency (IDF) curves to the rainfall intensities.

Area Breakdowns

As part of Atlas 14, Volume 11, the NWS has provided precipitation frequency estimates for the entire state of Texas on their website. The statewide estimates can be downloaded in geospatial raster format. Because the precipitation estimates vary significantly across the Austin area, FNI evaluated several alternate area breakdowns for averaging the NWS estimates, beginning with the following four breakdowns:

- *Breakdown 1*: City of Austin Metro Area (Single Value Option)
  - Full purpose jurisdiction
  - Full purpose jurisdiction plus 5-mile ETJ
- *Breakdown 2*: Major Watershed Boundaries A
  - Onion Creek with tributaries and South
  - Travis County watersheds north of Onion Creek
  - Williamson County watersheds
- *Breakdown 3*: Major Watershed Boundaries B
  - Watersheds south of Colorado River
  - Watersheds north of Colorado River that drain to river
  - Williamson County watersheds
- *Breakdown 4*: Counties
  - Travis County
  - Williamson County
  - Hays County
  - Bastrop County

After summarizing and discussing the results of the first four breakdowns with City staff, FNI evaluated two additional breakdowns:

- *Breakdown 5*: Counties Split at Colorado River
    - Travis County North of Colorado River
    - Travis County South of Colorado River
    - Williamson County
    - Hays County
    - Bastrop County
- *Breakdown 6*: City of Austin Split at Colorado River
    - Austin South of Colorado River (Zone 1)
    - Austin North of Colorado River (Zone 2)

FNI used ArcMap's Zonal Statistics tool to average the NWS partial-duration precipitation frequency rasters across each of the area breakdowns listed above. For each area in each breakdown, the tool provides a minimum, maximum, range, mean, and standard deviation of the Atlas 14 precipitation frequency estimates. The mean value for each precipitation frequency estimate (e.g. the 100-year 24-hour storm) represents the value that would go into the City's DCM for that area. The minimum, maximum, range, and standard deviation indicate how well the mean value represents the raw Atlas 14 data in that area. The objective of this exercise is to select a simple, easy-to-understand area breakdown while minimizing the variance between the mean value and the actual value from Atlas 14. City staff prefers a maximum variance of 0.5 inches between the mean and actual values.

For Breakdown 1 (City full purpose jurisdiction and ETJ), FNI determined an average 100-year, 24-hour rainfall depth of 12.51 inches, with a maximum of 13.15 inches and a minimum of 11.74 inches. This breakdown does not satisfy the City's preference for less than 0.5 inches of variance.

Breakdowns 2 and 3 also show large variances in rainfall depths. The largest rainfall variance is in the northern areas – for Breakdown 2, Travis County watersheds north of Onion Creek, and for Breakdown 3, watersheds north of the Colorado River. Of the two watershed breakdowns, Breakdown 3 shows the lowest variances in rainfall depth. The Colorado River follows the general direction of the Atlas 14 geospatial 100-year, 24-hour contour bands more closely than Onion Creek.

Breakdown 4 shows that Travis County rainfall depths have more deviation from the mean than rainfall depths in other counties. To decrease this variance, FNI split Travis County at the Colorado River to create Breakdown 5. The Colorado River is a clear line that divides the county into approximate halves. However, Breakdown 5 still resulted in a larger than 0.5-inch difference between maximum and minimum rainfall depths, both north and south of the Colorado River. This is because there is still significant variation between the west and east ends of Travis County.

Breakdown 6 is a combination of Breakdown 1 and Breakdown 5. This breakdown takes the City of Austin full purpose jurisdiction and five mile ETJ plus subsumed communities and divides it at the Colorado River. FNI recommended this as the preferred breakdown as it has the smallest overall standard deviations and ranges of rainfall depth. This breakdown's 100-year, 24-hour rainfall values place 63% of the City within one standard deviation of the actual Atlas 14 value – 59% of the area north of the Colorado River and 66% of the area south of the Colorado River. City staff requested a minor adjustment to include the Hudson Bend area north of Murfin Road in the northern region, selected this breakdown for inclusion in the DCM, and requested that FNI fit IDF curves to the resulting rainfall intensities. All Breakdown 6 values reported in this memo reflect the adjustment at Murfin Road. The area south of the Colorado River and Murfin Road is Zone 1, and the area north of the Colorado River or Murfin Road is Zone 2.

FNI produced maps of the selected breakdown showing the resulting mean, maximum, and minimum rainfall depths for three key combinations of return period and duration: the 100-year 24-hour, 25-year 6-hour, and 25-year 5-minute storms. These maps are included as Figures 1-3. Each map also includes color-coded bands to indicate which areas are approximately within 1, 2, or more standard deviations from the mean. The green bands indicate area where the mean depth is less than 1 standard deviation from the raw Atlas 14 data. For comparison, the 100-year 24-hour maps for Breakdowns 3 and 5 are included as Figure 4 and 5 respectively.

The recommended rainfall depths are shown in Table 1 below. Table 2 provides the range and standard deviation of depths for select durations and recurrence intervals.

Table 1. Recommended Atlas 14 Rainfall Depths (Breakdown 6)

Zone 1

	Rainfall Depth (in.) by Average Recurrence Interval (yr)							
Duration	1	2	5	10	25	100	200	500
5 min	0.43	0.53	0.67	0.80	0.98	1.28	1.45	1.68
10 min	0.69	0.84	1.07	1.28	1.57	2.04	2.30	2.66
15 min	0.87	1.06	1.35	1.60	1.96	2.54	2.87	3.34
30 min	1.24	1.49	1.90	2.25	2.75	3.54	4.01	4.69
60 min	1.61	1.96	2.51	2.99	3.66	4.77	5.45	6.45
2 hr	1.93	2.42	3.15	3.82	4.81	6.57	7.65	9.28
3 hr	2.11	2.70	3.54	4.34	5.55	7.81	9.21	11.31
6 hr	2.43	3.17	4.20	5.21	6.78	9.79	11.65	14.48
12 hr	2.78	3.64	4.84	6.02	7.85	11.37	13.58	16.94
24 hr	3.16	4.14	5.51	6.84	8.90	12.80	15.27	19.05

Zone 2

	Rainfall Depth (in.) by Average Recurrence Interval (yr)							
Duration	1	2	5	10	25	100	200	500
5 min	0.43	0.52	0.66	0.78	0.96	1.26	1.43	1.66
10 min	0.69	0.83	1.05	1.25	1.54	2.02	2.28	2.63
15 min	0.87	1.05	1.32	1.57	1.92	2.51	2.84	3.29
30 min	1.23	1.48	1.87	2.20	2.69	3.50	3.96	4.62
60 min	1.60	1.94	2.46	2.91	3.58	4.70	5.36	6.32
2 hr	1.92	2.39	3.08	3.72	4.68	6.40	7.43	8.97
3 hr	2.08	2.65	3.46	4.23	5.40	7.56	8.89	10.86
6 hr	2.39	3.11	4.10	5.08	6.57	9.41	11.16	13.80
12 hr	2.74	3.57	4.73	5.86	7.60	10.90	12.97	16.10
24 hr	3.13	4.06	5.38	6.65	8.59	12.23	14.54	18.06

Table 2. Variation in Atlas 14 Rainfall (Breakdown 6)

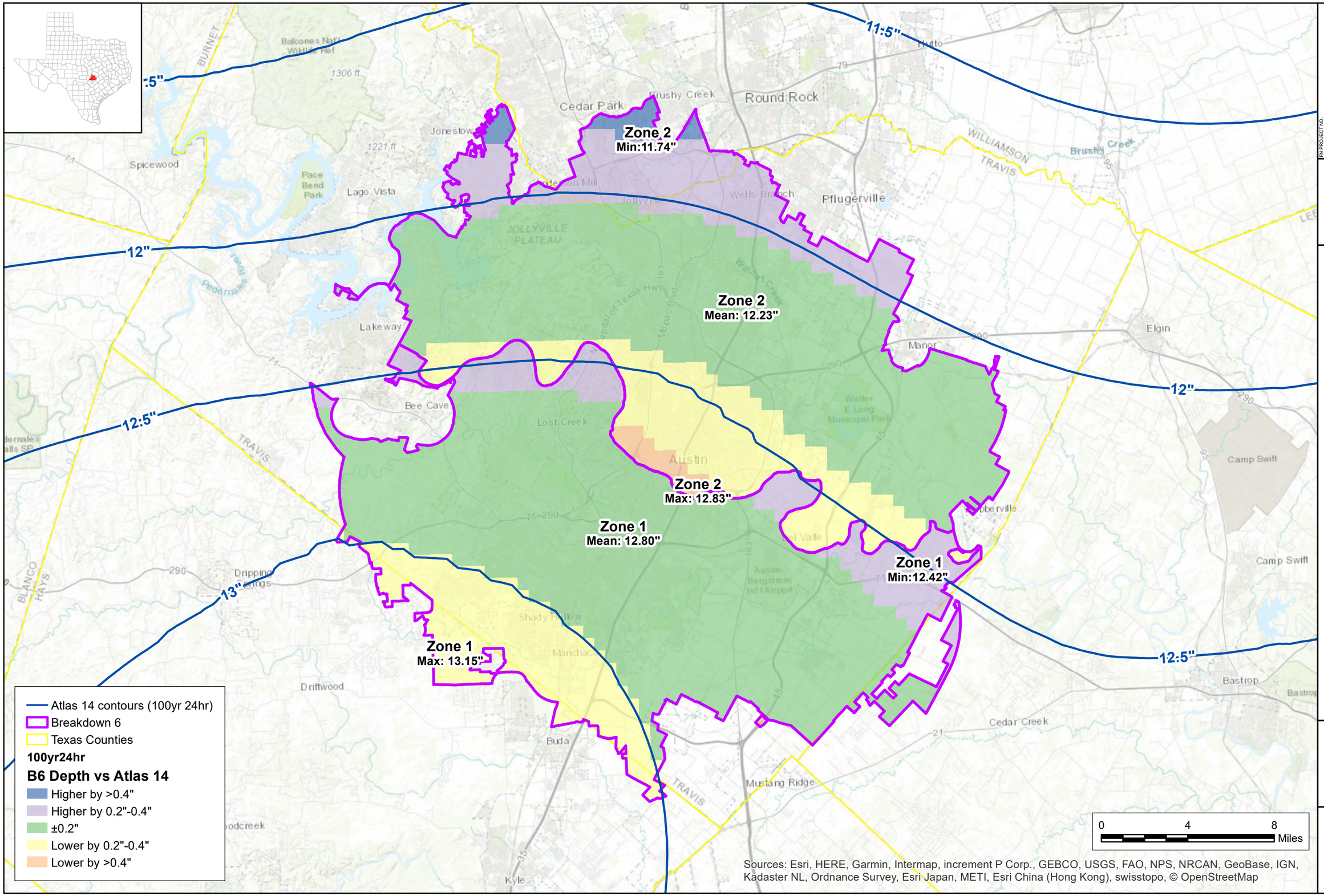
Zone 1

Duration	Value (in.)	Average Recurrence Interval 2-yr	10-yr	25-yr	100-yr
5 min	Mean	**0.53**	**0.80**	**0.98**	**1.28**
	Range	0.51–0.53	0.79–0.81	0.95–1.00	1.22–1.31
	St. dev.	0.003	0.007	0.012	0.024
3 hr	Mean	**2.70**	**4.34**	**5.55**	**7.81**
	Range	2.58–2.74	4.19–4.38	5.36–5.65	7.31–8.03
	St. dev.	0.036	0.034	0.066	0.172
6 hr	Mean	**3.17**	**5.21**	**6.78**	**9.79**
	Range	3.02–3.22	5.01–5.27	6.55–6.90	9.18–10.09
	St. dev.	0.046	0.045	0.077	0.208
24 hr	Mean	**4.14**	**6.84**	**8.90**	**12.80**
	Range	3.97–4.19	6.57–6.96	8.57–9.07	12.42–13.15
	St. dev.	0.050	0.080	0.099	0.169

Zone 2

Duration	Value (in.)	Average Recurrence Interval 2-yr	10-yr	25-yr	100-yr
5 min	Mean	**0.52**	**0.78**	**0.96**	**1.26**
	Range	0.51–0.53	0.77–0.80	0.94–0.99	1.21–1.31
	St. dev.	0.005	0.007	0.011	0.025
3 hr	Mean	**2.65**	**4.23**	**5.40**	**7.56**
	Range	2.54–2.73	4.10–4.34	5.24–5.58	7.13–7.89
	St. dev.	0.050	0.055	0.077	0.167
6 hr	Mean	**3.11**	**5.08**	**6.57**	**9.41**
	Range	2.98–3.22	4.91–5.23	6.38–6.79	8.93–9.84
	St. dev.	0.062	0.070	0.095	0.199
24 hr	Mean	**4.06**	**6.65**	**8.59**	**12.23**
	Range	3.92–4.19	6.42–6.92	8.28–8.97	11.74–12.83
	St. dev.	0.065	0.109	0.141	0.213

The current City DCM rainfall depths are based on rainfall data developed for the City by William Asquith in 2001 based on the original 1996 USGS publication. To provide a similar comparison of the City's current DCM rainfall, FNI prepared a map depicting the difference between the curren8/7/19t DCM 100-year 24-hour value and a geospatial raster of the USGS 100-year 24-hour rainfall depths. This map is shown in Figure 6. Only 13% of the City limits and ETJ is within one standard deviation of the current DCM 100-year 24-hour depth. Compare this with FNI's recommended Breakdown 6, which places 63% of the City limits and ETJ within one standard deviation of the recommended 100-year 24-hour depths.



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FILE NAME Name: bd6_ 90y24hr
PREPARED BY KKH

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CITY OF AUSTIN
WATERSHED PROTECTION DEPARTMENT

Breakdown 6: Atlas 14 100y24hr

FREESE AND NICHOLS, INC.
10431 MORADO CIRCLE
SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512-617-3100
FAX: 512-617-3101

FIGURE

1

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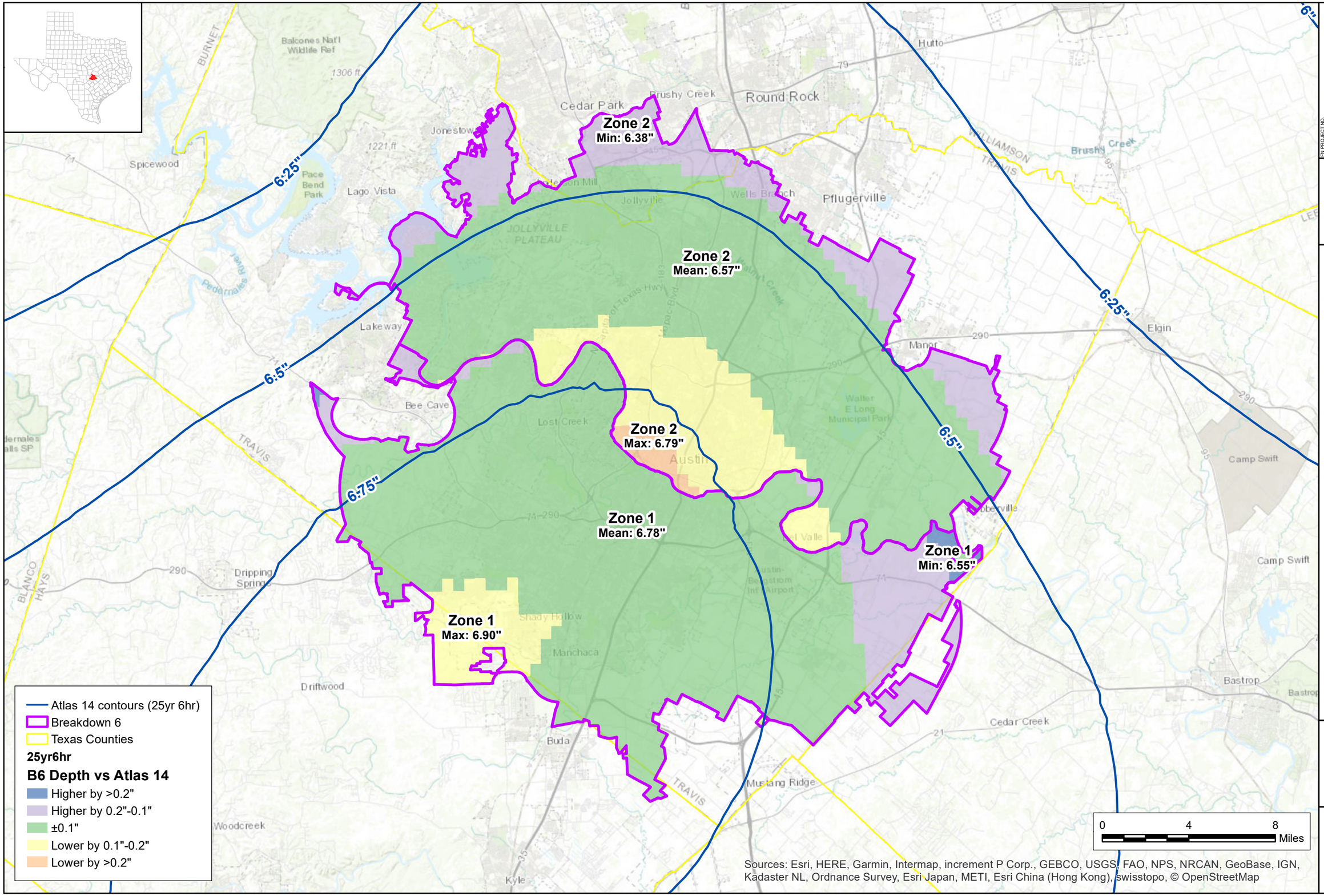

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PREPARED BY KKH

CITY OF AUSTIN
WATERSHED PROTECTION DEPARTMENT

Breakdown 6: Atlas 14 25y6hr

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FIGURE

2

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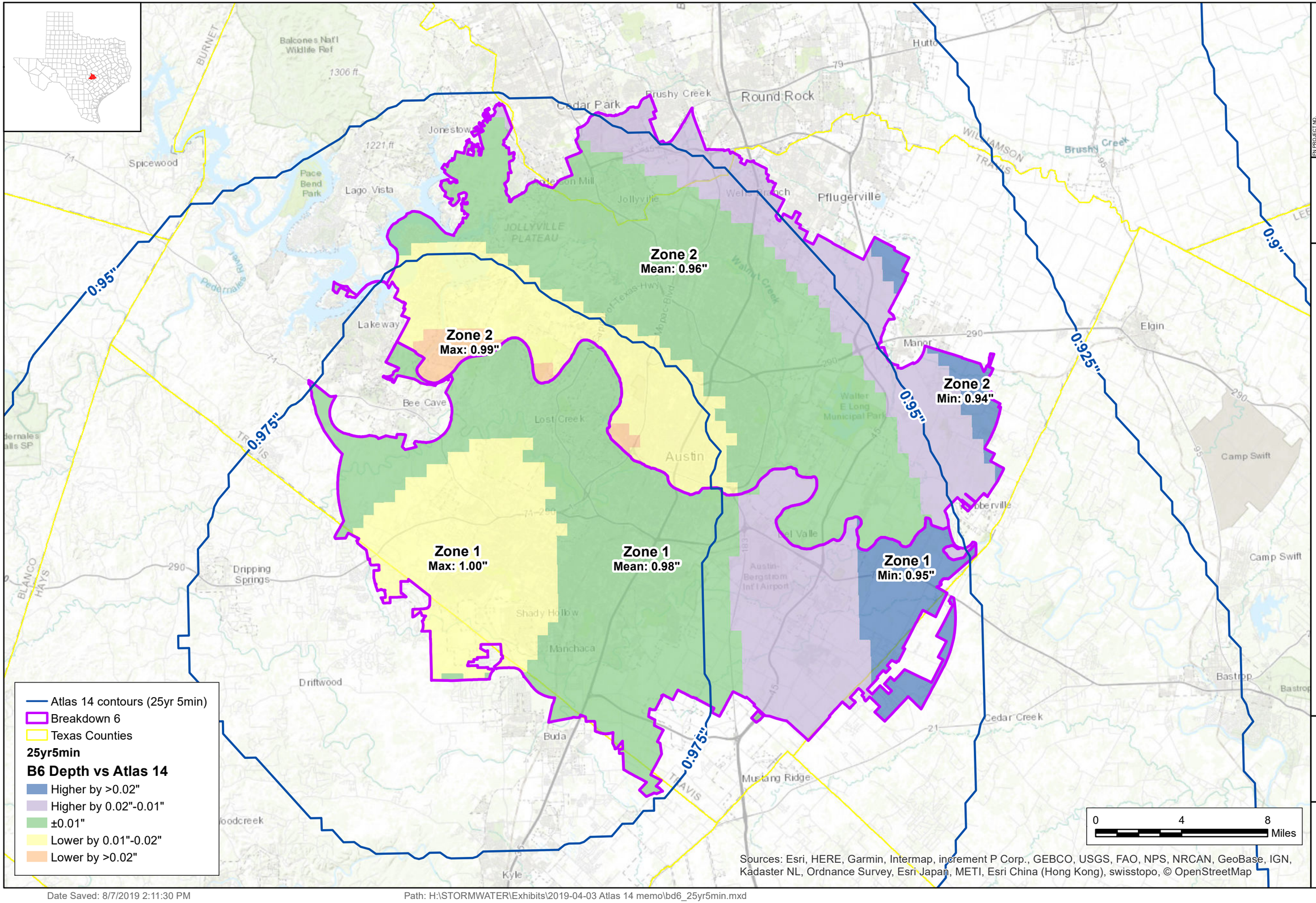

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FILE NAME Name: bd6_25yr5min
PREPARED BY KKH

CITY OF AUSTIN
WATERSHED PROTECTION DEPARTMENT

Breakdown 6: Atlas 14 25y5min

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AUSTIN, TEXAS 78759
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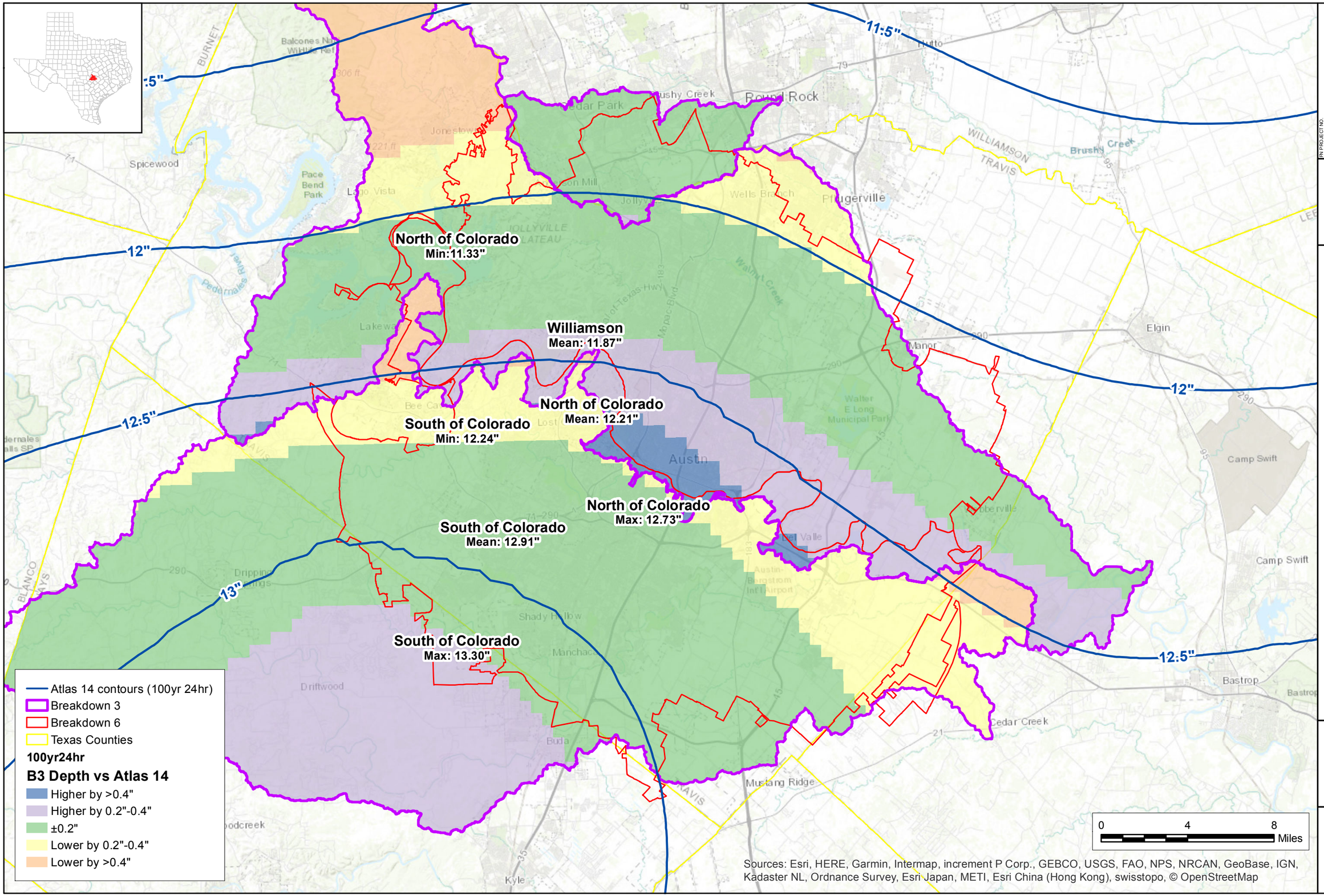
FAX: 512-617-3101

FIGURE

3



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CITY OF AUSTIN
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Breakdown 3: Atlas 14 100y24hr

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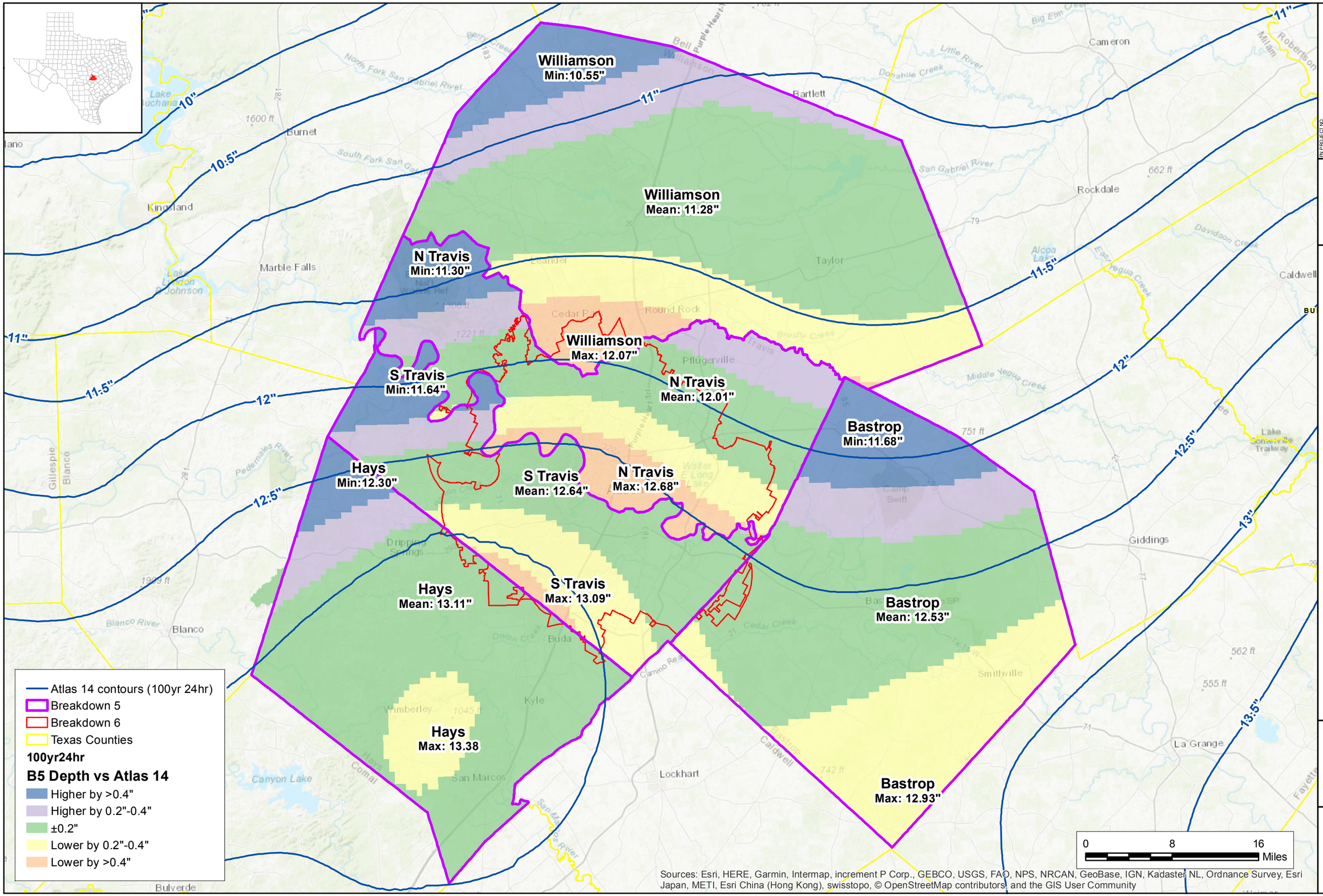
SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512-617-3100
FAX: 512-617-3101

FIGURE

4



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FILE NAME: Name: bd5_ 90yr24hr
PREPARED BY: KKH

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Breakdown 5: Atlas 14 100y24hr

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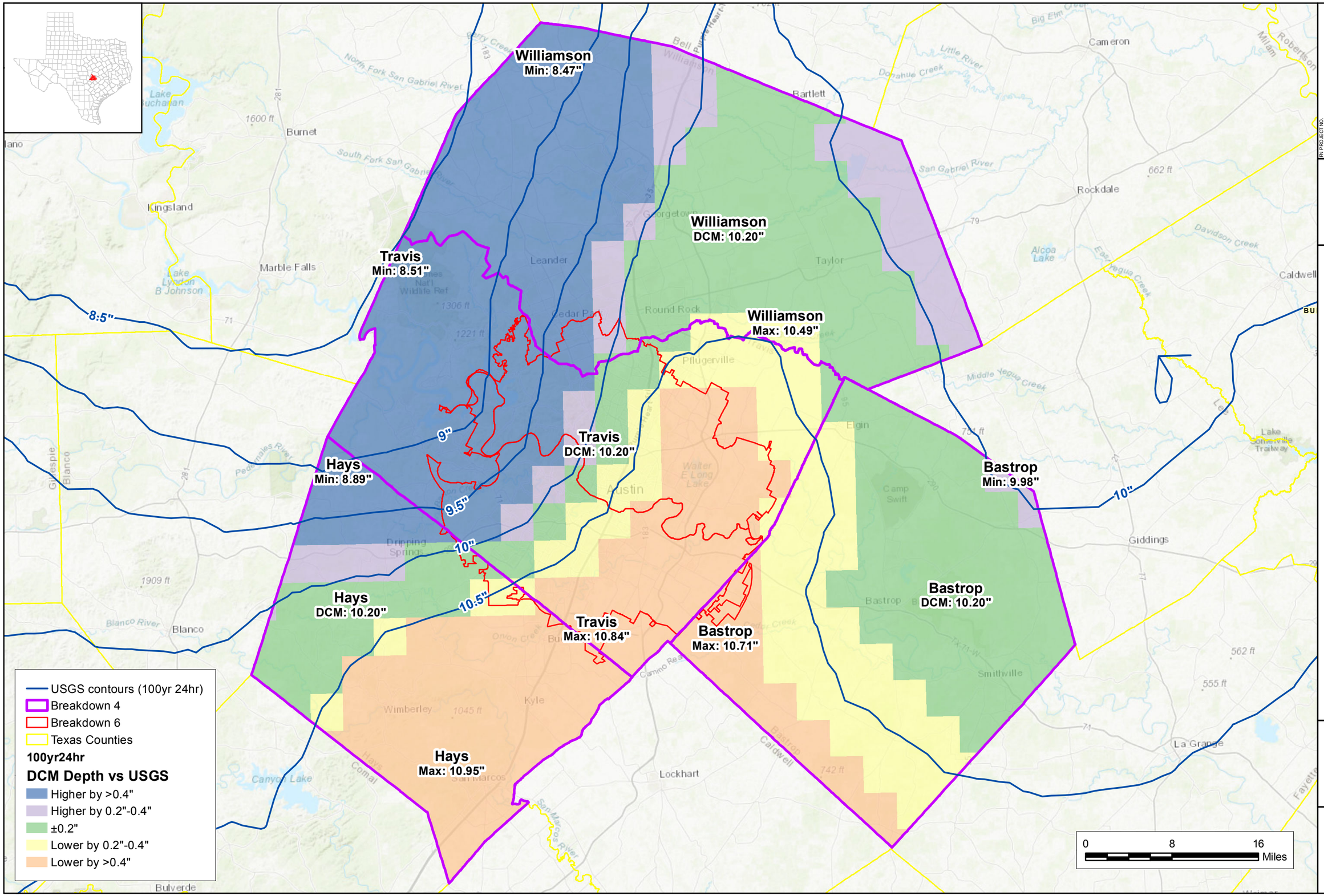
10431 MORADO CIRCLE
SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512-617-3100
FAX: 512-617-3101

FIGURE
5



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DATUM & COORDINATE SYSTEM: NAD83 State Plane (feet) Texas Central
FILE NAME: Name: usgs_100yr24hr
PREPARED BY: KKH

CITY OF AUSTIN
WATERSHED PROTECTION DEPARTMENT

Breakdown 4: USGS 2001 100y24hr

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AUSTIN, TEXAS 78759
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FIGURE
6

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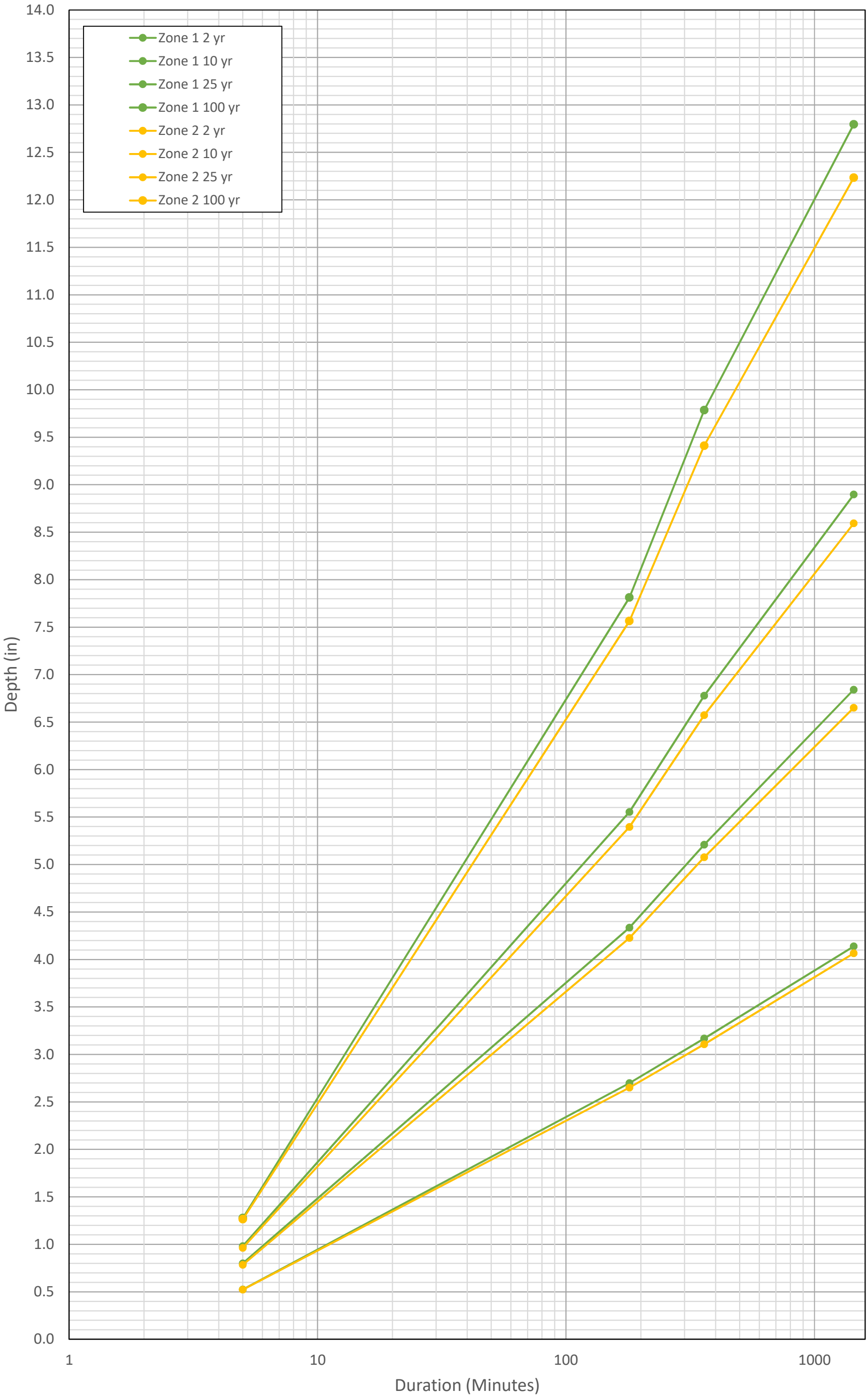
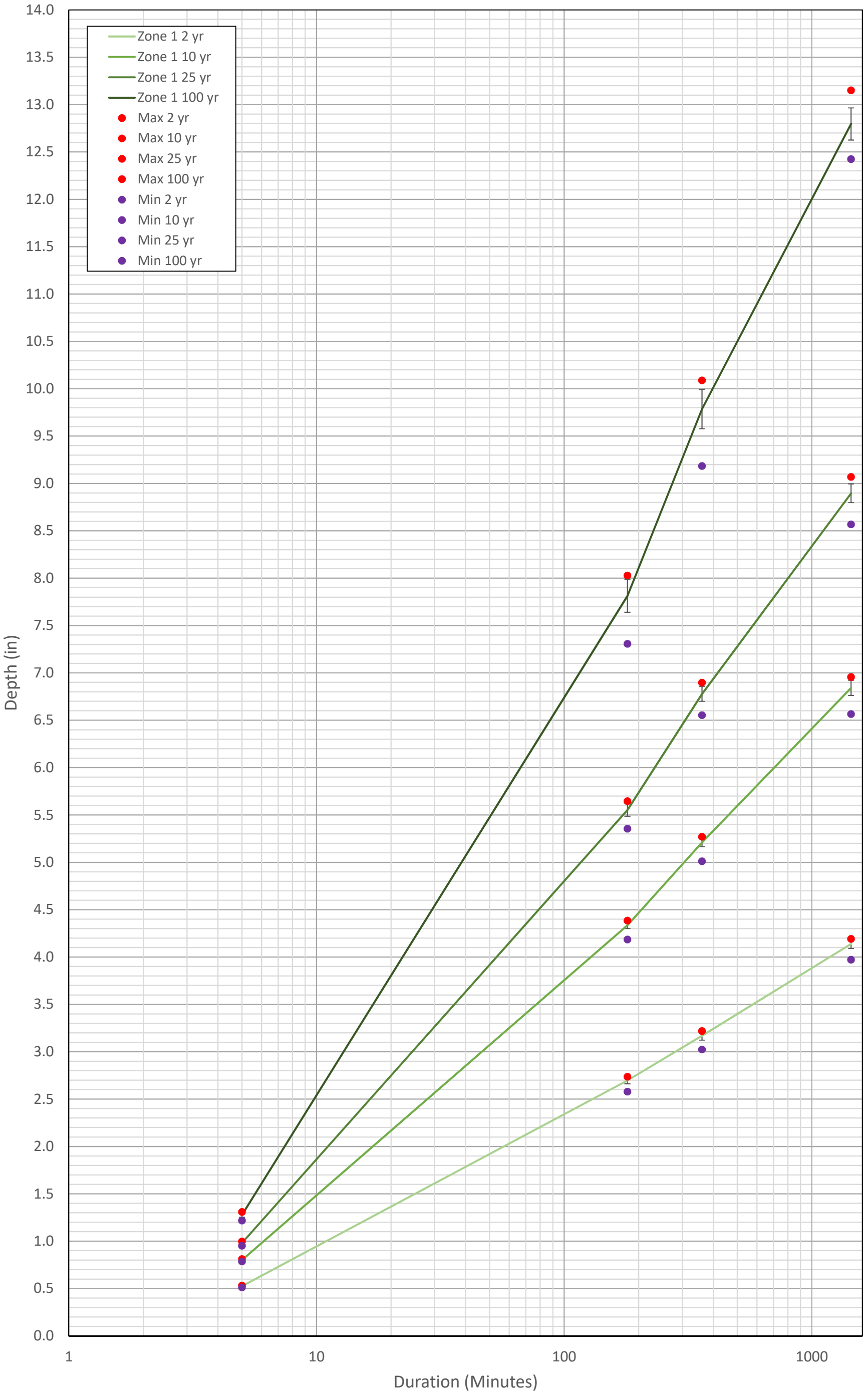
City of Austin Atlas 14 DCM Revisions

Figure 7: Breakdown 6 Rainfall Depths



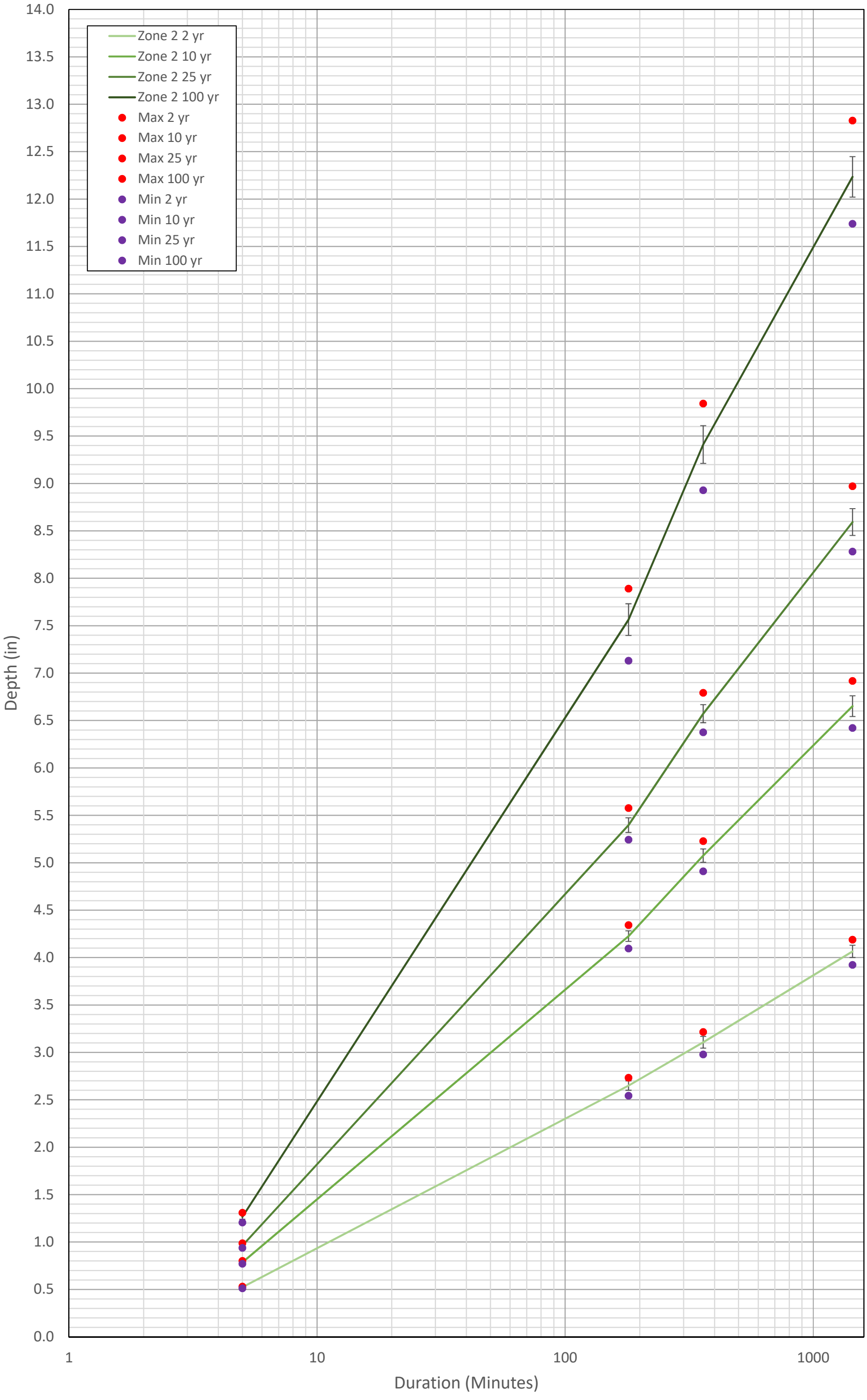
City of Austin Atlas 14 DCM Revisions

Figure 8: Zone 1 Rainfall Depth Variation



City of Austin Atlas 14 DCM Revisions

Figure 9: Zone 2 Rainfall Depth Variation



Intensity-Duration-Frequency Curves

The City's DCM provides a depth-duration-frequency (DDF) table, an intensity-duration-frequency (IDF) table, and a set of parameters fitted to the IDF power-law equation $i = {a}/{(b+t)^c}$. The parameters *a*, *b*, and *c* are provided for each return period and used in conjunction with the time of concentration *t* (in minutes) to produce the rainfall intensity in inches per hour for use with the Rational Method. These parameters need to be updated to match the new Atlas 14 data from Breakdown 6 as described above. The selected area breakdown includes one set of rainfall depths for each Zone. This will require two sets of IDF tables, curves, and parameters.

The Atlas 14 data does not necessarily follow a smooth, idealized set of IDF curves. The objective of the IDF curve-fitting process is to produce a set of parameters that minimize the difference between the fitted curves and the mean values for the selected area breakdown. Each set of parameters was fitted to both unadjusted Atlas 14 data and smoothed data. The unadjusted Atlas 14 rainfall depths come directly from the zonal statistics for each breakdown area. The smoothed data was produced using the WinTR-20 procedure as described in the NRCS National Engineering Handbook (NEH), Part 630 Hydrology, Chapter 4, Section 630.0403 (c) and Appendix 4B; this procedure maintains the unadjusted 1-hour and 24-hour rainfall depths and smooths the curve by adjusting rainfall depths for all other durations. The process also rounds all rainfall depths to three significant digits.

FNI used the evolutionary algorithm in Excel's Solver to fit the *a*, *b*, and *c* parameters to both the unadjusted and smoothed rainfall data. The objective of the Solver procedure was to minimize the sum of squared differences between the original intensity value and the calculated value by adjusting the *a*, *b*, and *c* parameters. Because the IDF curves are typically used for rational method calculations with a drainage area less than 100 acres, these curves are rarely needed for times of concentration exceeding 120 minutes. Therefore, FNI weighted the sums of squared differences more heavily for the lower durations to encourage a closer match to those values. The sums of squared differences were also weighted more heavily when the calculated value was below the original value. These adjustments encouraged the algorithm to produce curves that fit the original rainfall values as closely as possible without significantly underestimating rainfall for any duration between 5 minutes and 2 hours.

The first pass of the algorithm was run using broad minimum and maximum values for the *a*, *b*, and *c* parameters. This first pass produced a set of parameters that fit the curves well but may have exhibited inconsistencies between return periods. For example, the *a* and *b* values are generally expected to increase with return period while the *c* value is generally expected to decrease. FNI therefore ran a second pass of the algorithm for each return period using the neighboring storm event parameters as minimum and maximum values. This allowed the algorithm to find alternate solutions that preserved consistency between return periods.

After completing the curve-fitting process, FNI compared the sets of fitted curves to the unadjusted Atlas 14 data. The resulting calculated intensities are generally within 2% of the Atlas 14 value for the 1- through 10-year storms and within 4% for the 25- through 500-year storms. For durations under 1 hour, calculated intensities are within 1% of the Atlas 14 values, except for the 2-year 15-minute, 1-year 15-minute, and 1-year 10-minute depths, which are each about 1.5% higher than the Atlas 14 value.

Based on the results, FNI recommends that the City adopt the IDF parameters created from fitting to the unadjusted Atlas 14 data. First, this avoids introducing an extra set of assumptions involved in the Win-TR20 smoothing procedure. Second, the Win-TR20 smoothing procedure considers the entire curve out to a 24-hour duration, allowing longer-duration depths to influence the shape of the curve for lower durations. The attached results show that curves fitted to the smoothed Win-TR20 data result in a larger difference between calculated intensities and the unadjusted Atlas 14 intensities, especially in the lower durations. Because the IDF parameters will primarily be used for design and analysis of small basins with low times of concentration, FNI recommends using the IDF parameters fitted to the unadjusted data.

The recommended IDF parameters are shown below. A summary of the IDF curve-fitting procedure is shown in Figures 7–11 and Tables 3–4. These figures and tables include alternate IDF parameters, comparison tables, and plots.

Table 3. IDF Parameters – Fit to Unadjusted Atlas 14 Data

	Zone 1			Zone 2		
Return Period	*a*	*b*	*c*	*a*	*b*	*c*
1-yr	43.35	10.56	0.7743	45.60	10.92	0.7855
2-yr	45.24	9.34	0.7399	46.99	9.57	0.7517
5-yr	53.47	8.65	0.7228	56.57	9.18	0.7402
10-yr	61.25	8.35	0.7147	60.75	8.36	0.7185
25-yr	69.96	7.94	0.6954	64.56	7.38	0.6814
50-yr	73.59	7.33	0.6732	70.73	7.02	0.6681
100-yr	77.31	6.83	0.6524	76.90	6.73	0.6554
500-yr	77.48	4.97	0.5837	80.36	5.22	0.5979

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Figure 10: Rainfall Intensity Curves – Zone 1

Unadjusted

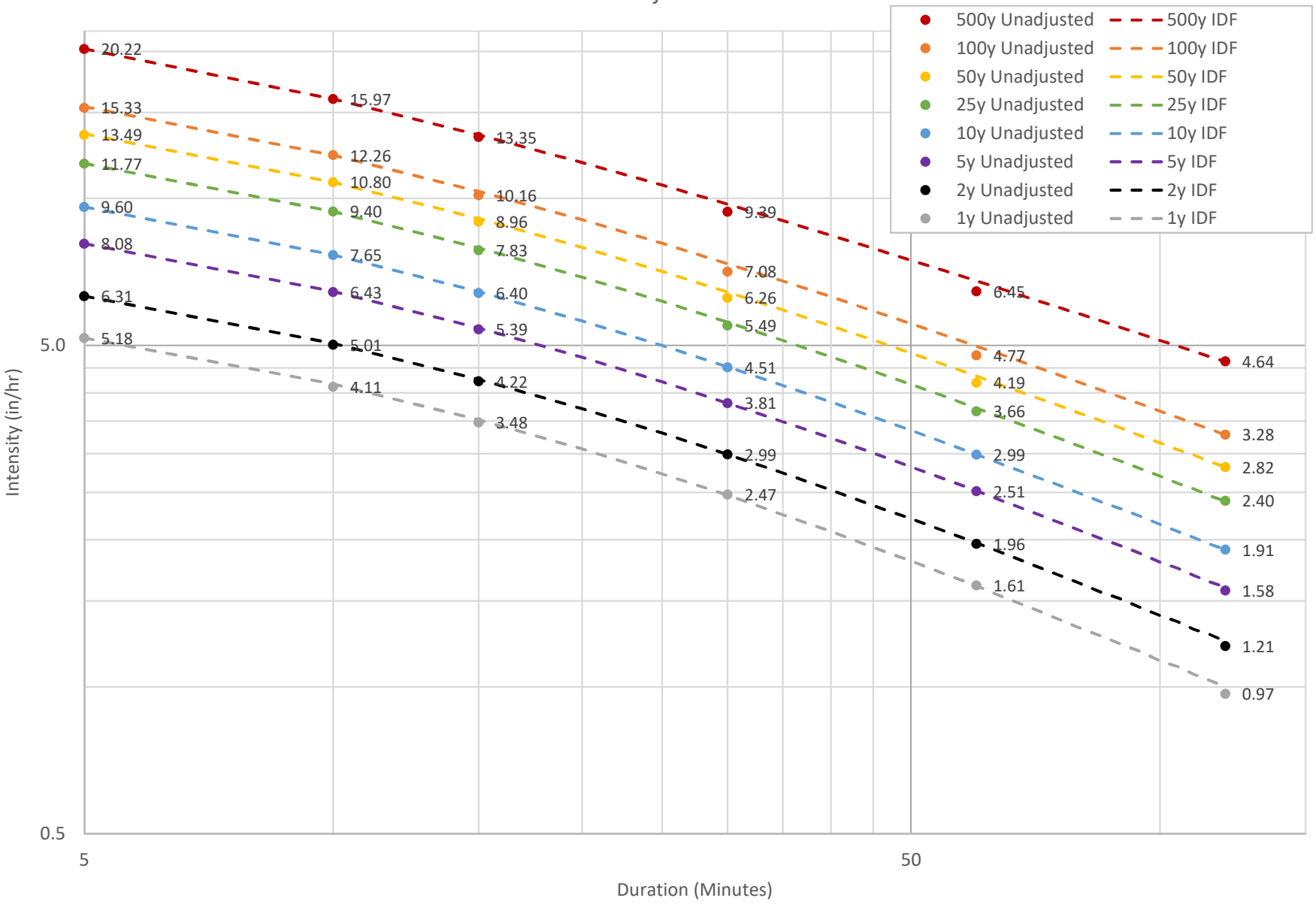
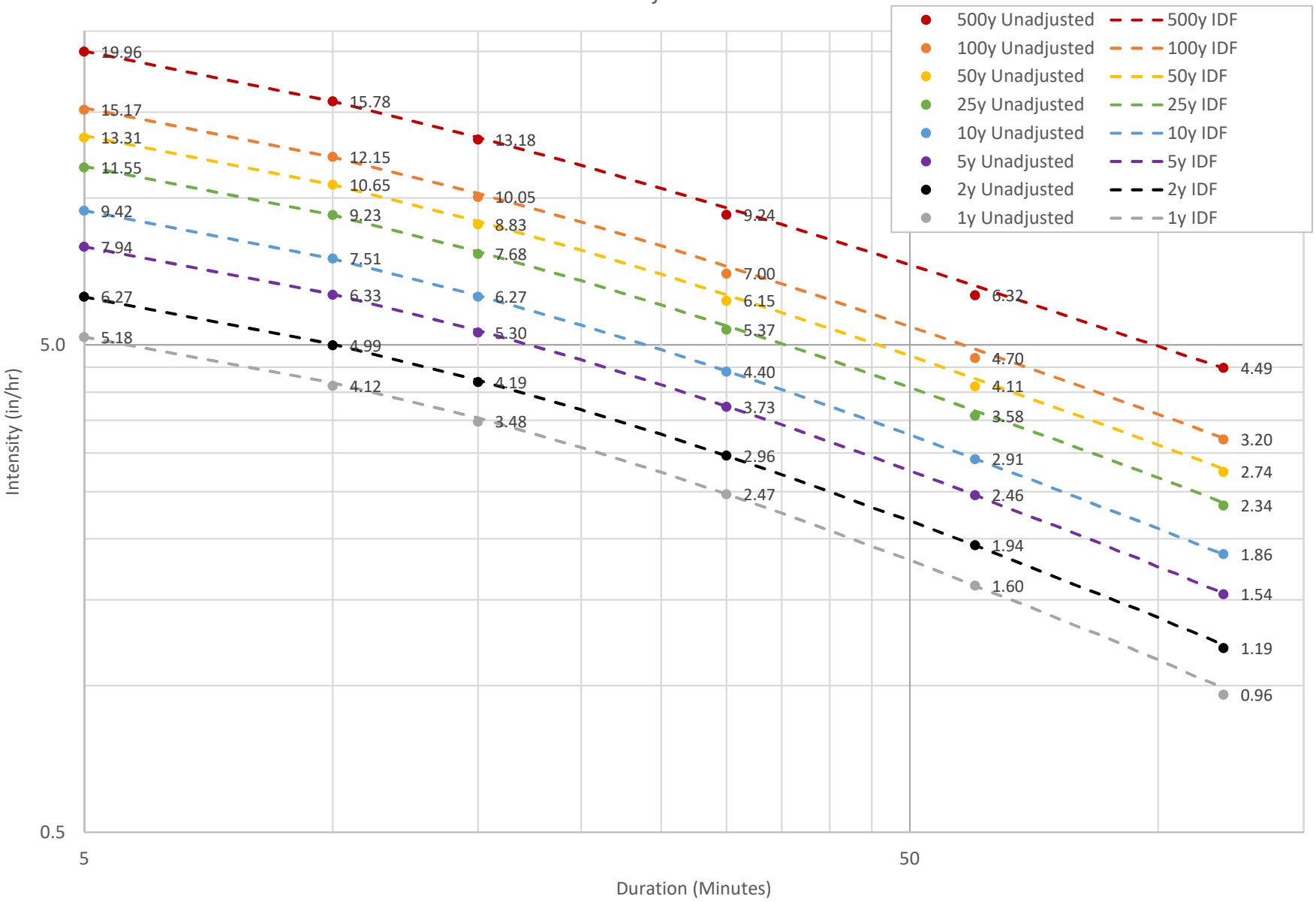


Figure 11: Rainfall Intensity Curves – Zone 2

Unadjusted



City of Austin Atlas 14 DCM Revisions

Table 4: IDF Curve Fitting Results

ZONE 1 – Unadjusted Atlas 14 Intensities (in/hr) vs. IDF Curves (Fit to Unadjusted)

Duration	1y			2y			5y			10y			25y			50y			100y			500y		
	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ
5 min	5.18	5.18	0.0%	6.31	6.31	0.1%	8.08	8.08	0.1%	9.60	9.61	0.1%	11.77	11.79	0.1%	13.49	13.56	0.5%	15.33	15.42	0.6%	20.22	20.24	0.1%
10 min	4.11	4.17	1.4%	5.01	5.05	0.7%	6.43	6.45	0.3%	7.65	7.66	0.1%	9.40	9.40	0.0%	10.80	10.79	-0.1%	12.26	12.26	0.0%	15.97	15.97	0.0%
15 min	3.48	3.52	1.2%	4.22	4.26	0.9%	5.39	5.43	0.7%	6.40	6.44	0.6%	7.83	7.92	1.1%	8.96	9.09	1.5%	10.16	10.34	1.8%	13.35	13.49	1.1%
30 min	2.47	2.47	-0.2%	2.99	2.99	0.0%	3.81	3.81	0.0%	4.51	4.52	0.3%	5.49	5.58	1.6%	6.26	6.43	2.8%	7.08	7.35	3.8%	9.39	9.73	3.6%
1 hr	1.61	1.61	-0.2%	1.96	1.97	0.4%	2.51	2.52	0.3%	2.99	2.99	0.0%	3.66	3.72	1.5%	4.19	4.33	3.3%	4.77	4.98	4.4%	6.45	6.78	5.1%
2 hr	0.97	1.00	3.4%	1.21	1.24	2.3%	1.58	1.60	1.6%	1.91	1.91	0.1%	2.40	2.40	-0.2%	2.82	2.82	0.1%	3.28	3.28	-0.1%	4.64	4.63	-0.2%
3 hr	*0.70*	*0.74*	*5.2%*	*0.90*	*0.93*	*3.4%*	*1.18*	*1.21*	*2.7%*	*1.45*	*1.45*	*0.3%*	*1.85*	*1.83*	*-1.1%*	*2.20*	*2.17*	*-1.4%*	*2.60*	*2.55*	*-2.1%*	*3.77*	*3.68*	*-2.4%*
6 hr	*0.40*	*0.44*	*8.8%*	*0.53*	*0.57*	*7.9%*	*0.70*	*0.75*	*7.2%*	*0.87*	*0.90*	*3.7%*	*1.13*	*1.15*	*1.8%*	*1.36*	*1.38*	*1.4%*	*1.63*	*1.64*	*0.6%*	*2.41*	*2.48*	*2.8%*
12 hr	*0.23*	*0.26*	*12.4%*	*0.30*	*0.34*	*12.0%*	*0.40*	*0.46*	*14.1%*	*0.50*	*0.55*	*9.6%*	*0.65*	*0.72*	*10.0%*	*0.79*	*0.87*	*10.2%*	*0.95*	*1.05*	*10.8%*	*1.41*	*1.66*	*17.6%*
1 day	*0.13*	*0.15*	*14.0%*	*0.17*	*0.21*	*21.8%*	*0.23*	*0.28*	*22.0%*	*0.29*	*0.34*	*19.3%*	*0.37*	*0.44*	*18.7%*	*0.45*	*0.55*	*23.4%*	*0.53*	*0.67*	*25.7%*	*0.79*	*1.11*	*39.9%*
Average Δ (5-min to 2-hr):			1.1%			0.7%			0.5%			0.2%			0.8%			1.4%			1.8%			1.7%

ZONE 2 – Unadjusted Atlas 14 Intensities (in/hr) vs. IDF Curves (Fit to Unadjusted)

Duration	1y			2y			5y			10y			25y			50y			100y			500y		
	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ	Atlas 14 (Unadj.)	Fitted (Unadj.)	Δ
5 min	5.18	5.19	0.1%	6.27	6.27	0.0%	7.94	7.95	0.1%	9.42	9.43	0.1%	11.55	11.62	0.6%	13.31	13.43	0.9%	15.17	15.31	0.9%	19.96	20.02	0.3%
10 min	4.12	4.18	1.5%	4.99	5.02	0.6%	6.33	6.35	0.3%	7.51	7.51	0.0%	9.23	9.23	0.0%	10.65	10.65	0.0%	12.15	12.14	-0.1%	15.78	15.78	0.0%
15 min	3.48	3.54	1.8%	4.19	4.23	0.8%	5.30	5.35	1.0%	6.27	6.31	0.6%	7.68	7.77	1.2%	8.83	8.96	1.5%	10.05	10.22	1.7%	13.18	13.31	1.0%
30 min	2.47	2.47	0.1%	2.96	2.96	-0.1%	3.73	3.74	0.2%	4.40	4.42	0.4%	5.37	5.47	1.8%	6.15	6.33	2.8%	7.00	7.25	3.6%	9.24	9.55	3.3%
1 hr	1.60	1.60	-0.3%	1.94	1.94	0.0%	2.46	2.46	0.1%	2.91	2.92	0.2%	3.58	3.66	2.4%	4.11	4.26	3.6%	4.70	4.90	4.3%	6.32	6.61	4.6%
2 hr	0.96	0.99	3.3%	1.19	1.21	1.3%	1.54	1.55	0.6%	1.86	1.86	0.0%	2.34	2.37	1.3%	2.74	2.78	1.3%	3.20	3.22	0.7%	4.49	4.48	-0.1%
3 hr	*0.69*	*0.74*	*6.5%*	*0.88*	*0.91*	*3.0%*	*1.15*	*1.17*	*1.5%*	*1.41*	*1.41*	*0.1%*	*1.80*	*1.83*	*1.7%*	*2.14*	*2.15*	*0.7%*	*2.52*	*2.50*	*-0.9%*	*3.62*	*3.54*	*-2.2%*
6 hr	*0.40*	*0.44*	*10.3%*	*0.52*	*0.55*	*6.2%*	*0.68*	*0.71*	*3.8%*	*0.85*	*0.87*	*2.8%*	*1.10*	*1.15*	*5.0%*	*1.31*	*1.37*	*4.2%*	*1.57*	*1.60*	*2.0%*	*2.30*	*2.36*	*2.6%*
12 hr	*0.23*	*0.26*	*13.7%*	*0.30*	*0.33*	*10.8%*	*0.39*	*0.43*	*9.1%*	*0.49*	*0.53*	*8.5%*	*0.63*	*0.72*	*13.7%*	*0.76*	*0.87*	*14.4%*	*0.91*	*1.02*	*12.3%*	*1.34*	*1.57*	*17.0%*
1 day	*0.13*	*0.15*	*14.9%*	*0.17*	*0.20*	*18.1%*	*0.22*	*0.26*	*15.9%*	*0.28*	*0.33*	*19.1%*	*0.36*	*0.45*	*25.7%*	*0.43*	*0.55*	*28.5%*	*0.51*	*0.65*	*27.5%*	*0.75*	*1.04*	*38.2%*
Average Δ (5-min to 2-hr):			1.2%			0.5%			0.4%			0.2%			1.2%			1.7%			1.9%			1.6%