5.0 Rainfall Tables

5.1 Methodology

Rainfall tables are based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for the counties within the jurisdiction of NCTCOG. NOAA Atlas 14 is produced by the NOAA's National Weather Service, Hydrometeorological Design Studies Center and may be considered as the national standard for precipitation frequency estimates. NOAA Atlas 14 is published in volumes for different geographic areas of the US. The final version of NOAA Atlas 14 Volume 11 for Texas was released on September 2018 and has been peer-reviewed extensively. Volume 11 provides precipitation frequency estimates, upper and lower bounds for 90% confidence intervals for durations of 5-minute through 60-day and recurrence intervals of 1, 2, 5, 10, 25, 50, 100, 200, 500 and 1,000-year for the State of Texas.

Precipitation frequency estimates are computed using regional frequency analysis based on L-moment statistics calculated from annual maxima series (AMS). NOAA Atlas 14 employs a regionalization approach wherein the L-moment statistics are calculated by grouping stations within a 60-mile radius. This results in 700 to 1,800 years of data for daily durations and 200 to 700 years for hourly durations. Several distribution functions were examined and ultimately the generalized extreme value (GEV) distribution was adopted for fall stations and durations. The upper and lower 90% confidence intervals are based on a Monte-Carlo simulation approach.

Gridded precipitation frequency estimates at a spatial resolution of 30-arc second are also available for all durations and recurrence intervals discussed above. The gridded frequency estimates are generated from grids of mean annual maxima which are derived from at-stations mean annual maxima using the PRISM interpolation methodology (http://www.prism.oregonstate.edu/). The precipitation frequency grids are the basis of the NOAA Precipitation Frequency Data Server (PFDS) for retrieval of precipitation frequency estimates by co-ordinates.

Based on the review of the NOAA Atlas 14 methodology, it is apparent that a robust and standardized technique has been adopted for the development of precipitation frequency estimates. The methods and results have also been extensively peer reviewed. In addition, Atlas 14 also uses a long period of data for the development of frequency estimates (average record length of approximately 60 years) and more recent data, as available.

Rainfall tables have been generated at the center of each county within the jurisdiction of the North Central Texas Council of Governments (NCTCOG). AMS based precipitation frequency grids for all available recurrence intervals and durations were first downloaded from the NOAA PFDS[1]. Subsequently, at the centroid of each county, the value associated with each duration and recurrence interval was extracted from the respective AMS frequency grids in ArcGIS. The compiled precipitation frequencies for each county in a tabular format are provided below. Note that the estimates for 1-yr recurrence interval are based on the frequency analysis of partial duration series (PDS).

While precipitation frequency estimates at the centroid of a county is a reasonable approach for summarizing the NOAA Atlas 14 data, these estimates may not be representative of smaller areas such as a metropolitan area or census block. For such cases, precipitation frequency estimates may be directly downloaded from the NOAA PFDS[2] by specifying the desired geographic co-ordinates.

5.3 References

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite (2018). *NOAA Atlas 14 Volume 11 Version 2, Precipitation-Frequency Atlas of the United States, Texas*. NOAA, National Weather Service, Silver Spring, MD.

[1] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html
[2] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

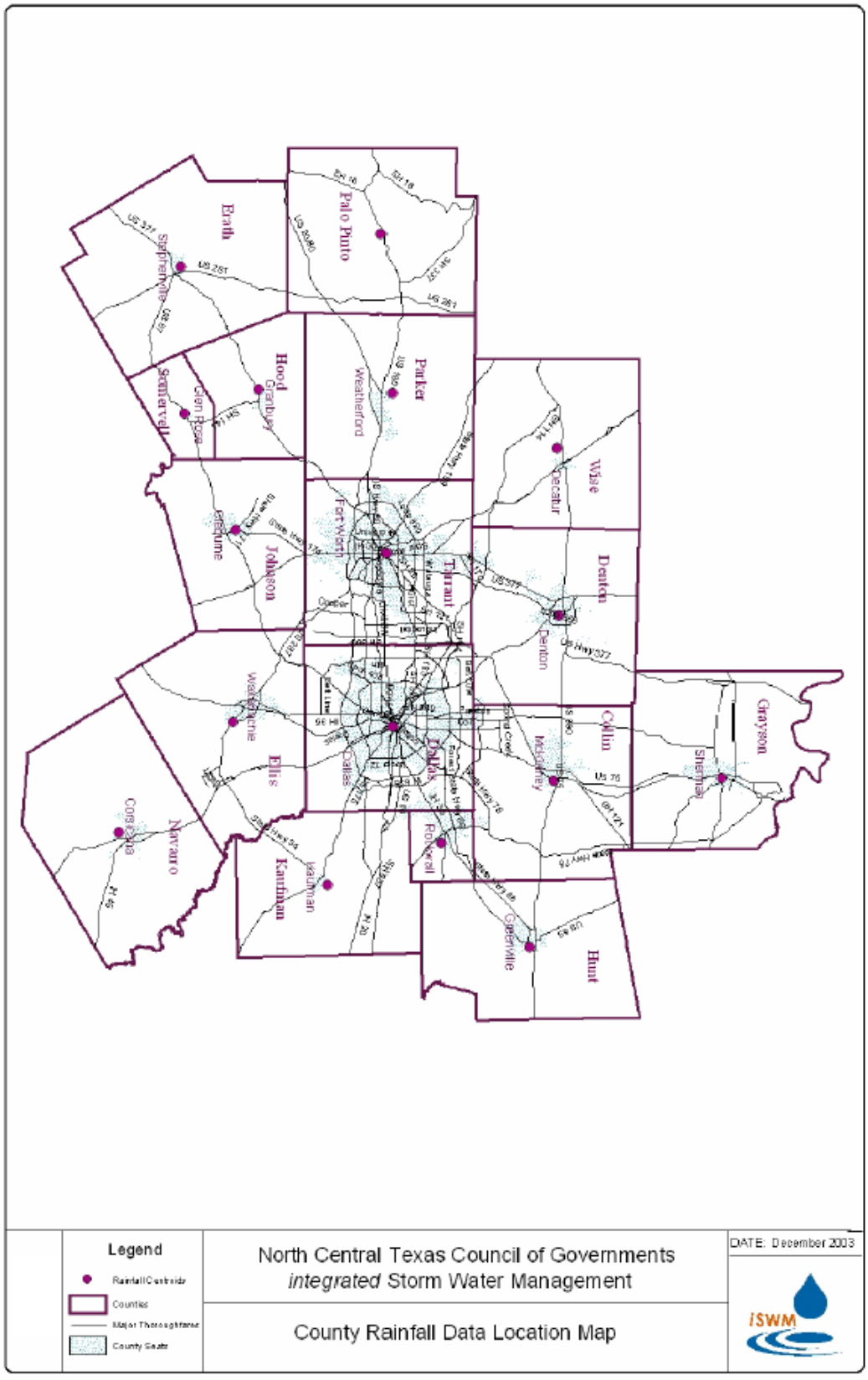

Figure 5.1 County Rainfall Data Location Map

Table 5.1 AMS-based precipitation frequency estimates for Collin County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.430	0.462	0.588	0.683	0.806	0.897	0.987	1.077	1.198	1.289
10-min	0.687	0.739	0.943	1.095	1.293	1.441	1.585	1.725	1.904	2.034
15-min	0.858	0.921	1.171	1.358	1.601	1.779	1.956	2.133	2.369	2.547
30-min	1.195	1.282	1.625	1.881	2.212	2.453	2.693	2.942	3.278	3.537
60-min	1.554	1.670	2.128	2.470	2.915	3.240	3.569	3.915	4.390	4.763
2-hr	1.898	2.056	2.666	3.130	3.749	4.215	4.696	5.206	5.915	6.478
3-hr	2.100	2.287	3.001	3.550	4.292	4.861	5.456	6.088	6.968	7.671
6-hr	2.482	2.719	3.615	4.311	5.263	6.005	6.788	7.623	8.791	9.729
12-hr	2.938	3.224	4.302	5.138	6.281	7.171	8.113	9.121	10.539	11.682
24-hr	3.456	3.790	5.054	6.032	7.364	8.395	9.487	10.666	12.334	13.684
48-hr	4.032	4.412	5.855	6.968	8.477	9.634	10.864	12.210	14.135	15.707
3-day	4.407	4.816	6.376	7.578	9.207	10.453	11.778	13.237	15.328	17.040
4-day	4.670	5.105	6.757	8.032	9.767	11.100	12.519	14.078	16.311	18.138
7-day	5.221	5.714	7.568	9.011	10.992	12.537	14.187	15.975	18.518	20.585
10-day	5.708	6.243	8.259	9.827	11.982	13.669	15.461	17.387	20.103	22.297
20-day	7.470	8.096	10.503	12.339	14.795	16.656	18.585	20.636	23.488	25.762
30-day	8.964	9.660	12.384	14.433	17.116	19.099	21.115	23.237	26.151	28.446
45-day	11.030	11.840	15.054	17.445	20.525	22.765	24.986	27.265	30.320	32.668
60-day	12.866	13.782	17.444	20.151	23.603	26.093	28.517	30.945	34.131	36.520

Table 5.2 AMS-based precipitation frequency estimates for Dallas County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.428	0.462	0.595	0.695	0.824	0.919	1.014	1.111	1.239	1.338
10-min	0.684	0.738	0.952	1.112	1.320	1.474	1.626	1.776	1.971	2.115
15-min	0.856	0.923	1.188	1.385	1.641	1.828	2.014	2.203	2.456	2.650
30-min	1.199	1.291	1.657	1.929	2.280	2.535	2.790	3.054	3.412	3.690
60-min	1.560	1.684	2.169	2.532	3.004	3.348	3.696	4.063	4.567	4.963
2-hr	1.903	2.068	2.702	3.185	3.827	4.310	4.809	5.339	6.072	6.656
3-hr	2.103	2.295	3.027	3.590	4.351	4.935	5.545	6.193	7.097	7.818
6-hr	2.466	2.707	3.613	4.318	5.286	6.043	6.847	7.705	8.913	9.885
12-hr	2.865	3.155	4.240	5.090	6.264	7.190	8.182	9.255	10.781	12.020
24-hr	3.316	3.657	4.930	5.929	7.312	8.401	9.577	10.864	12.713	14.229
48-hr	3.857	4.248	5.714	6.858	8.433	9.658	10.984	12.462	14.611	16.390
3-day	4.215	4.636	6.222	7.455	9.148	10.460	11.878	13.465	15.780	17.700
4-day	4.466	4.910	6.580	7.881	9.667	11.053	12.551	14.220	16.646	18.653
7-day	4.995	5.486	7.327	8.765	10.749	12.303	13.975	15.805	18.428	20.576
10-day	5.460	5.986	7.962	9.504	11.625	13.287	15.063	16.987	19.722	21.945
20-day	7.127	7.725	10.033	11.790	14.130	15.885	17.720	19.723	22.565	24.871
30-day	8.532	9.189	11.776	13.713	16.233	18.064	19.944	21.994	24.883	27.215
45-day	10.454	11.221	14.270	16.534	19.442	21.541	23.635	25.820	28.787	31.097
60-day	12.156	13.029	16.509	19.087	22.385	24.777	27.106	29.424	32.455	34.719

Table 5.3 AMS-based precipitation frequency estimates for Denton County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.419	0.452	0.584	0.682	0.808	0.901	0.992	1.085	1.207	1.299
10-min	0.671	0.725	0.936	1.094	1.298	1.448	1.595	1.737	1.920	2.055
15-min	0.836	0.902	1.162	1.356	1.606	1.788	1.967	2.148	2.387	2.568
30-min	1.162	1.252	1.610	1.875	2.217	2.463	2.708	2.959	3.297	3.557
60-min	1.508	1.627	2.100	2.452	2.907	3.237	3.569	3.915	4.388	4.757
2-hr	1.842	2.000	2.612	3.076	3.690	4.149	4.621	5.121	5.814	6.363
3-hr	2.040	2.223	2.927	3.465	4.189	4.741	5.315	5.927	6.779	7.460
6-hr	2.407	2.635	3.502	4.172	5.085	5.791	6.536	7.335	8.458	9.363
12-hr	2.833	3.106	4.143	4.944	6.033	6.872	7.760	8.723	10.088	11.194
24-hr	3.310	3.630	4.847	5.785	7.056	8.030	9.062	10.189	11.796	13.105
48-hr	3.838	4.206	5.606	6.684	8.143	9.258	10.440	11.732	13.573	15.074
3-day	4.180	4.580	6.102	7.275	8.867	10.088	11.382	12.794	14.806	16.444
4-day	4.420	4.848	6.465	7.718	9.429	10.753	12.162	13.696	15.880	17.659
7-day	4.922	5.413	7.241	8.677	10.672	12.253	13.954	15.795	18.416	20.548
10-day	5.362	5.901	7.896	9.470	11.665	13.416	15.302	17.335	20.222	22.567
20-day	6.930	7.566	9.970	11.833	14.377	16.347	18.442	20.713	23.939	26.559
30-day	8.254	8.968	11.704	13.798	16.614	18.752	20.998	23.431	26.872	29.657
45-day	10.090	10.933	14.181	16.657	19.966	22.475	25.066	27.801	31.580	34.576
60-day	11.723	12.687	16.403	19.233	23.012	25.891	28.826	31.841	35.918	39.080

Table 5.4 AMS-based precipitation frequency estimates for Ellis County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.429	0.465	0.607	0.714	0.856	0.963	1.072	1.186	1.341	1.462
10-min	0.685	0.744	0.971	1.143	1.372	1.546	1.721	1.896	2.130	2.307
15-min	0.859	0.932	1.215	1.429	1.709	1.917	2.128	2.349	2.652	2.891
30-min	1.202	1.302	1.691	1.984	2.368	2.651	2.940	3.250	3.680	4.024
60-min	1.559	1.691	2.205	2.595	3.111	3.497	3.897	4.329	4.937	5.427
2-hr	1.887	2.065	2.738	3.259	3.971	4.522	5.108	5.744	6.647	7.381
3-hr	2.074	2.283	3.060	3.671	4.520	5.192	5.917	6.703	7.824	8.739
6-hr	2.420	2.682	3.642	4.408	5.488	6.359	7.312	8.353	9.852	11.082
12-hr	2.806	3.119	4.264	5.179	6.474	7.520	8.674	9.954	11.819	13.366
24-hr	3.255	3.619	4.955	6.019	7.518	8.717	10.045	11.541	13.750	15.599
48-hr	3.831	4.242	5.772	6.973	8.639	9.936	11.371	13.034	15.534	17.655
3-day	4.213	4.651	6.296	7.578	9.341	10.698	12.192	13.934	16.557	18.787
4-day	4.476	4.933	6.655	7.995	9.835	11.252	12.803	14.592	17.263	19.519
7-day	5.020	5.517	7.386	8.842	10.842	12.397	14.075	15.937	18.635	20.862
10-day	5.497	6.024	8.009	9.551	11.661	13.301	15.048	16.949	19.656	21.860
20-day	7.189	7.772	10.042	11.757	14.017	15.686	17.421	19.320	22.014	24.201
30-day	8.622	9.255	11.777	13.646	16.039	17.739	19.469	21.368	24.050	26.217
45-day	10.615	11.354	14.332	16.520	19.280	21.224	23.140	25.146	27.864	29.978
60-day	12.389	13.236	16.653	19.159	22.310	24.542	26.687	28.818	31.592	33.651

Table 5.5 AMS-based precipitation frequency estimates for Erath County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.417	0.451	0.585	0.687	0.821	0.923	1.024	1.124	1.255	1.354
10-min	0.666	0.722	0.937	1.101	1.317	1.483	1.645	1.799	1.995	2.136
15-min	0.834	0.902	1.166	1.366	1.631	1.832	2.031	2.228	2.484	2.675
30-min	1.165	1.258	1.620	1.894	2.255	2.528	2.801	3.075	3.439	3.716
60-min	1.509	1.634	2.118	2.485	2.971	3.335	3.706	4.088	4.605	5.008
2-hr	1.827	1.997	2.652	3.151	3.820	4.326	4.853	5.416	6.202	6.833
3-hr	2.007	2.209	2.980	3.571	4.369	4.977	5.618	6.315	7.303	8.104
6-hr	2.326	2.581	3.547	4.295	5.315	6.101	6.941	7.864	9.189	10.274
12-hr	2.644	2.951	4.099	4.997	6.237	7.210	8.257	9.407	11.060	12.416
24-hr	3.016	3.371	4.695	5.733	7.173	8.312	9.536	10.868	12.768	14.317
48-hr	3.545	3.936	5.407	6.552	8.125	9.358	10.666	12.064	14.028	15.609
3-day	3.897	4.307	5.858	7.059	8.698	9.973	11.316	12.743	14.735	16.329
4-day	4.135	4.558	6.166	7.407	9.090	10.390	11.754	13.205	15.231	16.853
7-day	4.621	5.069	6.790	8.105	9.868	11.205	12.601	14.101	16.205	17.898
10-day	5.035	5.504	7.319	8.697	10.529	11.901	13.328	14.869	17.036	18.781
20-day	6.415	6.951	9.046	10.624	12.695	14.225	15.791	17.461	19.780	21.624
30-day	7.568	8.163	10.499	12.251	14.535	16.213	17.912	19.696	22.140	24.060
45-day	9.180	9.867	12.581	14.606	17.230	19.149	21.063	23.033	25.681	27.724
60-day	10.615	11.388	14.452	16.732	19.673	21.822	23.941	26.084	28.924	31.080

Table 5.6 AMS-based precipitation frequency estimates for Hood County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.399	0.434	0.569	0.671	0.805	0.905	1.005	1.108	1.245	1.351
10-min	0.641	0.697	0.915	1.079	1.295	1.457	1.618	1.776	1.983	2.137
15-min	0.792	0.862	1.136	1.342	1.611	1.810	2.007	2.206	2.468	2.665
30-min	1.096	1.191	1.563	1.842	2.205	2.474	2.742	3.018	3.389	3.675
60-min	1.424	1.547	2.030	2.393	2.870	3.223	3.582	3.960	4.477	4.885
2-hr	1.750	1.911	2.530	3.002	3.636	4.119	4.618	5.142	5.866	6.439
3-hr	1.945	2.131	2.839	3.386	4.127	4.701	5.300	5.929	6.800	7.490
6-hr	2.298	2.531	3.406	4.086	5.018	5.747	6.517	7.332	8.469	9.377
12-hr	2.678	2.962	4.038	4.870	6.003	6.877	7.804	8.811	10.242	11.405
24-hr	3.105	3.441	4.722	5.706	7.037	8.050	9.128	10.324	12.048	13.466
48-hr	3.606	3.983	5.425	6.534	8.030	9.166	10.379	11.737	13.708	15.339
3-day	3.944	4.346	5.877	7.056	8.650	9.864	11.161	12.608	14.704	16.435
4-day	4.193	4.614	6.220	7.454	9.124	10.395	11.749	13.250	15.416	17.197
7-day	4.734	5.195	6.958	8.311	10.135	11.524	12.988	14.584	16.850	18.691
10-day	5.186	5.678	7.562	9.006	10.946	12.422	13.967	15.632	17.974	19.862
20-day	6.599	7.161	9.330	10.982	13.183	14.845	16.564	18.391	20.930	22.953
30-day	7.764	8.387	10.805	12.637	15.065	16.887	18.755	20.722	23.433	25.574
45-day	9.387	10.122	12.989	15.153	18.000	20.126	22.279	24.509	27.536	29.892
60-day	10.825	11.669	14.971	17.455	20.710	23.134	25.566	28.052	31.387	33.953

Table 5.7 AMS-based precipitation frequency estimates for Hunt County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.443	0.474	0.596	0.687	0.806	0.894	0.981	1.069	1.187	1.278
10-min	0.708	0.757	0.954	1.101	1.292	1.435	1.574	1.710	1.886	2.016
15-min	0.885	0.946	1.188	1.368	1.603	1.775	1.946	2.120	2.351	2.528
30-min	1.237	1.321	1.653	1.901	2.222	2.457	2.691	2.936	3.267	3.525
60-min	1.617	1.731	2.177	2.511	2.945	3.261	3.583	3.924	4.394	4.767
2-hr	1.996	2.153	2.763	3.224	3.830	4.278	4.740	5.239	5.939	6.501
3-hr	2.222	2.409	3.134	3.684	4.414	4.959	5.526	6.142	7.012	7.715
6-hr	2.637	2.877	3.799	4.504	5.450	6.167	6.919	7.739	8.902	9.846
12-hr	3.102	3.394	4.505	5.363	6.528	7.426	8.373	9.395	10.837	12.002
24-hr	3.620	3.963	5.262	6.267	7.638	8.700	9.826	11.042	12.761	14.152
48-hr	4.197	4.581	6.046	7.171	8.690	9.842	11.070	12.443	14.432	16.075
3-day	4.585	4.994	6.565	7.767	9.380	10.591	11.885	13.346	15.483	17.259
4-day	4.875	5.306	6.962	8.229	9.931	11.210	12.574	14.105	16.333	18.178
7-day	5.512	5.995	7.838	9.254	11.165	12.624	14.161	15.831	18.198	20.118
10-day	6.064	6.585	8.576	10.103	12.162	13.736	15.380	17.129	19.569	21.519
20-day	7.938	8.537	10.888	12.651	14.954	16.649	18.365	20.165	22.626	24.558
30-day	9.511	10.173	12.819	14.775	17.268	19.052	20.816	22.644	25.108	27.013
45-day	11.700	12.469	15.582	17.860	20.717	22.729	24.667	26.615	29.170	31.084
60-day	13.645	14.516	18.058	20.639	23.847	26.094	28.217	30.293	32.953	34.889

Table 5.8 AMS-based precipitation frequency estimates for Johnson County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.406	0.442	0.583	0.691	0.836	0.947	1.062	1.182	1.347	1.477
10-min	0.649	0.708	0.934	1.107	1.341	1.521	1.705	1.893	2.146	2.342
15-min	0.809	0.882	1.162	1.376	1.663	1.884	2.111	2.348	2.672	2.928
30-min	1.125	1.226	1.612	1.908	2.304	2.605	2.917	3.247	3.702	4.063
60-min	1.466	1.599	2.108	2.498	3.023	3.423	3.840	4.286	4.908	5.406
2-hr	1.806	1.978	2.631	3.137	3.826	4.361	4.927	5.533	6.386	7.073
3-hr	2.010	2.208	2.954	3.535	4.335	4.962	5.629	6.346	7.358	8.175
6-hr	2.382	2.627	3.540	4.256	5.247	6.030	6.869	7.775	9.059	10.101
12-hr	2.797	3.089	4.182	5.037	6.217	7.144	8.139	9.222	10.768	12.028
24-hr	3.258	3.599	4.883	5.882	7.255	8.323	9.469	10.725	12.526	14.001
48-hr	3.774	4.165	5.645	6.790	8.350	9.551	10.835	12.252	14.291	15.965
3-day	4.117	4.538	6.136	7.370	9.045	10.330	11.699	13.211	15.386	17.171
4-day	4.368	4.811	6.491	7.788	9.550	10.902	12.342	13.924	16.193	18.049
7-day	4.911	5.397	7.238	8.661	10.601	12.099	13.688	15.411	17.857	19.842
10-day	5.378	5.896	7.861	9.379	11.442	13.033	14.715	16.531	19.098	21.175
20-day	6.938	7.520	9.781	11.492	13.755	15.428	17.182	19.134	21.939	24.242
30-day	8.236	8.877	11.402	13.288	15.737	17.498	19.329	21.392	24.376	26.839
45-day	10.011	10.777	13.797	16.054	18.983	21.109	23.276	25.610	28.865	31.468
60-day	11.576	12.468	15.972	18.601	22.034	24.576	27.122	29.728	33.228	35.921

Table 5.9 AMS-based precipitation frequency estimates for Kaufman County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.437	0.471	0.603	0.701	0.829	0.923	1.017	1.113	1.241	1.339
10-min	0.698	0.751	0.964	1.122	1.328	1.482	1.631	1.778	1.968	2.108
15-min	0.875	0.942	1.203	1.398	1.650	1.835	2.019	2.205	2.455	2.646
30-min	1.229	1.320	1.681	1.949	2.295	2.544	2.794	3.057	3.415	3.696
60-min	1.602	1.725	2.209	2.570	3.039	3.380	3.727	4.099	4.617	5.030
2-hr	1.955	2.124	2.770	3.265	3.929	4.432	4.959	5.529	6.333	6.982
3-hr	2.159	2.360	3.117	3.704	4.509	5.135	5.801	6.523	7.546	8.376
6-hr	2.532	2.788	3.738	4.489	5.536	6.372	7.277	8.261	9.669	10.820
12-hr	2.938	3.251	4.394	5.306	6.593	7.632	8.771	10.023	11.833	13.324
24-hr	3.409	3.775	5.119	6.190	7.702	8.919	10.258	11.742	13.901	15.691
48-hr	4.011	4.423	5.964	7.171	8.842	10.150	11.576	13.179	15.531	17.490
3-day	4.408	4.848	6.506	7.795	9.562	10.925	12.404	14.071	16.516	18.553
4-day	4.681	5.142	6.882	8.234	10.084	11.513	13.056	14.784	17.302	19.390
7-day	5.245	5.751	7.652	9.134	11.172	12.764	14.469	16.327	18.979	21.143
10-day	5.739	6.278	8.308	9.888	12.054	13.747	15.544	17.474	20.195	22.391
20-day	7.473	8.080	10.439	12.223	14.579	16.329	18.138	20.089	22.825	25.024
30-day	8.947	9.609	12.240	14.193	16.698	18.489	20.299	22.251	24.968	27.136
45-day	11.027	11.786	14.849	17.096	19.927	21.921	23.872	25.885	28.582	30.653
60-day	12.889	13.742	17.202	19.729	22.886	25.110	27.224	29.302	31.979	33.939

Table 5.10 AMS-based precipitation frequency estimates for Navarro County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.431	0.469	0.611	0.720	0.865	0.977	1.091	1.208	1.366	1.489
10-min	0.688	0.748	0.977	1.152	1.387	1.569	1.752	1.931	2.165	2.339
15-min	0.864	0.937	1.219	1.434	1.722	1.941	2.164	2.393	2.700	2.937
30-min	1.215	1.315	1.702	1.996	2.389	2.685	2.990	3.312	3.756	4.107
60-min	1.575	1.710	2.230	2.627	3.159	3.562	3.984	4.442	5.089	5.613
2-hr	1.887	2.076	2.784	3.336	4.095	4.686	5.327	6.046	7.098	7.974
3-hr	2.061	2.287	3.122	3.782	4.706	5.436	6.243	7.162	8.525	9.671
6-hr	2.389	2.677	3.724	4.562	5.752	6.710	7.783	9.014	10.859	12.422
12-hr	2.780	3.119	4.344	5.333	6.745	7.894	9.187	10.665	12.876	14.747
24-hr	3.243	3.630	5.033	6.164	7.777	9.088	10.558	12.229	14.718	16.816
48-hr	3.832	4.266	5.868	7.138	8.917	10.328	11.889	13.661	16.290	18.498
3-day	4.222	4.683	6.404	7.753	9.620	11.077	12.674	14.490	17.178	19.433
4-day	4.491	4.970	6.762	8.163	10.098	11.606	13.249	15.102	17.823	20.093
7-day	5.050	5.563	7.480	8.979	11.048	12.668	14.415	16.335	19.098	21.367
10-day	5.539	6.077	8.097	9.670	11.832	13.520	15.321	17.273	20.045	22.298
20-day	7.270	7.862	10.165	11.905	14.200	15.899	17.658	19.564	22.247	24.410
30-day	8.736	9.373	11.917	13.798	16.200	17.905	19.626	21.487	24.083	26.158
45-day	10.780	11.500	14.427	16.562	19.219	21.059	22.850	24.716	27.229	29.169
60-day	12.601	13.401	16.685	19.062	21.981	23.982	25.874	27.762	30.213	32.027

Table 5.11 AMS-based precipitation frequency estimates for Palo Pinto County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.392	0.426	0.558	0.656	0.785	0.878	0.974	1.075	1.217	1.329
10-min	0.631	0.685	0.898	1.058	1.265	1.418	1.572	1.729	1.942	2.106
15-min	0.779	0.845	1.106	1.300	1.553	1.736	1.922	2.121	2.399	2.620
30-min	1.069	1.159	1.513	1.777	2.117	2.361	2.611	2.884	3.269	3.580
60-min	1.376	1.493	1.957	2.303	2.753	3.080	3.416	3.783	4.303	4.724
2-hr	1.672	1.826	2.419	2.870	3.474	3.928	4.401	4.909	5.620	6.191
3-hr	1.846	2.024	2.702	3.225	3.935	4.484	5.059	5.668	6.516	7.192
6-hr	2.162	2.385	3.216	3.869	4.773	5.492	6.254	7.057	8.174	9.065
12-hr	2.504	2.776	3.773	4.568	5.689	6.597	7.581	8.633	10.121	11.326
24-hr	2.897	3.220	4.398	5.340	6.676	7.761	8.949	10.240	12.092	13.609
48-hr	3.399	3.767	5.132	6.208	7.706	8.893	10.185	11.613	13.681	15.388
3-day	3.732	4.127	5.604	6.759	8.352	9.596	10.943	12.444	14.624	16.429
4-day	3.965	4.378	5.932	7.143	8.807	10.100	11.498	13.054	15.315	17.187
7-day	4.450	4.902	6.605	7.927	9.738	11.140	12.647	14.317	16.732	18.722
10-day	4.862	5.344	7.167	8.581	10.511	12.002	13.599	15.360	17.896	19.979
20-day	6.202	6.774	8.946	10.623	12.902	14.657	16.517	18.538	21.411	23.744
30-day	7.318	7.963	10.422	12.315	14.880	16.851	18.924	21.152	24.286	26.811
45-day	8.881	9.633	12.513	14.720	17.694	19.969	22.337	24.846	28.330	31.105
60-day	10.273	11.121	14.379	16.869	20.208	22.754	25.382	28.136	31.923	34.912

Table 5.12 AMS-based precipitation frequency estimates for Parker County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.395	0.430	0.565	0.668	0.806	0.911	1.018	1.126	1.270	1.382
10-min	0.635	0.691	0.909	1.075	1.297	1.467	1.639	1.807	2.029	2.195
15-min	0.785	0.854	1.122	1.325	1.597	1.804	2.015	2.228	2.513	2.732
30-min	1.080	1.175	1.542	1.821	2.192	2.472	2.758	3.050	3.445	3.752
60-min	1.399	1.523	2.002	2.367	2.854	3.225	3.604	3.994	4.523	4.934
2-hr	1.720	1.878	2.475	2.937	3.567	4.062	4.572	5.091	5.791	6.332
3-hr	1.915	2.094	2.766	3.291	4.016	4.596	5.198	5.805	6.621	7.250
6-hr	2.272	2.493	3.311	3.956	4.859	5.591	6.357	7.129	8.168	8.971
12-hr	2.670	2.943	3.953	4.750	5.859	6.754	7.697	8.662	9.978	11.007
24-hr	3.122	3.449	4.672	5.631	6.956	8.009	9.122	10.289	11.906	13.191
48-hr	3.655	4.030	5.442	6.539	8.043	9.215	10.461	11.803	13.699	15.234
3-day	3.997	4.402	5.939	7.128	8.744	9.989	11.313	12.760	14.826	16.511
4-day	4.235	4.664	6.288	7.544	9.252	10.567	11.966	13.498	15.686	17.473
7-day	4.726	5.203	7.008	8.407	10.318	11.798	13.373	15.084	17.519	19.499
10-day	5.144	5.660	7.607	9.117	11.179	12.778	14.478	16.320	18.934	21.057
20-day	6.524	7.129	9.448	11.225	13.616	15.427	17.343	19.451	22.469	24.936
30-day	7.681	8.364	10.996	13.000	15.675	17.679	19.789	22.121	25.465	28.204
45-day	9.318	10.135	13.271	15.669	18.884	21.320	23.870	26.627	30.516	33.656
60-day	10.782	11.726	15.333	18.104	21.848	24.726	27.726	30.896	35.296	38.796

Table 5.13 AMS-based precipitation frequency estimates for Rockwall County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.438	0.470	0.596	0.690	0.812	0.900	0.988	1.078	1.199	1.291
10-min	0.700	0.752	0.954	1.106	1.301	1.446	1.587	1.725	1.905	2.038
15-min	0.875	0.938	1.188	1.374	1.613	1.788	1.960	2.137	2.373	2.553
30-min	1.223	1.310	1.653	1.908	2.235	2.471	2.706	2.953	3.289	3.552
60-min	1.593	1.709	2.168	2.510	2.951	3.271	3.594	3.938	4.415	4.792
2-hr	1.950	2.108	2.722	3.187	3.803	4.263	4.738	5.244	5.949	6.512
3-hr	2.160	2.348	3.067	3.618	4.358	4.922	5.511	6.138	7.013	7.713
6-hr	2.546	2.785	3.690	4.390	5.346	6.088	6.872	7.712	8.892	9.842
12-hr	2.983	3.273	4.363	5.212	6.376	7.284	8.253	9.307	10.807	12.029
24-hr	3.476	3.817	5.099	6.096	7.464	8.527	9.669	10.930	12.747	14.242
48-hr	4.049	4.436	5.903	7.036	8.576	9.753	11.019	12.444	14.527	16.259
3-day	4.426	4.842	6.426	7.645	9.297	10.551	11.899	13.423	15.655	17.513
4-day	4.693	5.133	6.804	8.092	9.842	11.177	12.610	14.218	16.559	18.500
7-day	5.258	5.749	7.602	9.042	11.017	12.553	14.194	15.979	18.524	20.598
10-day	5.754	6.284	8.282	9.835	11.965	13.629	15.392	17.278	19.928	22.061
20-day	7.520	8.127	10.478	12.263	14.632	16.412	18.245	20.186	22.875	25.010
30-day	9.016	9.685	12.326	14.298	16.851	18.709	20.581	22.547	25.238	27.349
45-day	11.094	11.870	14.979	17.272	20.187	22.272	24.313	26.392	29.156	31.259
60-day	12.945	13.822	17.363	19.959	23.226	25.546	27.770	29.966	32.812	34.912

Table 5.14 AMS-based precipitation frequency estimates for Somervell County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.409	0.443	0.578	0.679	0.812	0.910	1.009	1.110	1.246	1.351
10-min	0.656	0.711	0.928	1.091	1.305	1.466	1.624	1.780	1.984	2.136
15-min	0.813	0.882	1.150	1.352	1.618	1.817	2.015	2.213	2.472	2.668
30-min	1.127	1.220	1.586	1.861	2.220	2.487	2.754	3.028	3.398	3.684
60-min	1.462	1.585	2.067	2.429	2.903	3.252	3.608	3.986	4.507	4.920
2-hr	1.796	1.959	2.589	3.069	3.711	4.196	4.701	5.239	5.990	6.591
3-hr	1.993	2.184	2.913	3.474	4.233	4.816	5.429	6.084	7.003	7.741
6-hr	2.338	2.579	3.487	4.192	5.155	5.905	6.700	7.558	8.770	9.752
12-hr	2.681	2.974	4.086	4.945	6.116	7.017	7.979	9.036	10.553	11.795
24-hr	3.065	3.409	4.718	5.728	7.097	8.144	9.263	10.508	12.308	13.793
48-hr	3.545	3.927	5.374	6.494	8.021	9.197	10.457	11.853	13.868	15.527
3-day	3.878	4.282	5.810	6.994	8.612	9.862	11.199	12.670	14.785	16.519
4-day	4.132	4.553	6.151	7.387	9.072	10.372	11.758	13.272	15.437	17.204
7-day	4.700	5.159	6.909	8.255	10.075	11.468	12.933	14.512	16.736	18.530
10-day	5.175	5.662	7.528	8.956	10.873	12.332	13.852	15.476	17.744	19.561
20-day	6.652	7.198	9.320	10.924	13.040	14.613	16.229	17.952	20.345	22.251
30-day	7.860	8.457	10.804	12.562	14.851	16.528	18.230	20.036	22.527	24.499
45-day	9.515	10.210	12.972	15.024	17.666	19.581	21.484	23.445	26.083	28.118
60-day	10.970	11.763	14.927	17.268	20.259	22.420	24.527	26.638	29.409	31.489

Table 5.15 AMS-based precipitation frequency estimates for Tarrant County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.405	0.439	0.572	0.673	0.807	0.909	1.012	1.117	1.261	1.371
10-min	0.649	0.704	0.919	1.081	1.297	1.462	1.627	1.791	2.008	2.171
15-min	0.807	0.875	1.137	1.336	1.601	1.801	2.004	2.212	2.493	2.711
30-min	1.117	1.210	1.570	1.842	2.203	2.475	2.752	3.041	3.436	3.746
60-min	1.449	1.572	2.047	2.408	2.888	3.248	3.619	4.011	4.553	4.983
2-hr	1.773	1.935	2.555	3.031	3.671	4.159	4.669	5.215	5.977	6.588
3-hr	1.966	2.154	2.871	3.423	4.173	4.752	5.361	6.013	6.930	7.668
6-hr	2.323	2.558	3.446	4.135	5.077	5.810	6.586	7.419	8.591	9.536
12-hr	2.733	3.016	4.089	4.919	6.051	6.928	7.852	8.840	10.224	11.336
24-hr	3.191	3.522	4.776	5.747	7.069	8.096	9.175	10.321	11.921	13.201
48-hr	3.692	4.063	5.447	6.532	8.033	9.225	10.488	11.816	13.663	15.136
3-day	4.018	4.417	5.901	7.067	8.686	9.976	11.348	12.792	14.805	16.411
4-day	4.258	4.680	6.252	7.488	9.204	10.573	12.030	13.569	15.716	17.433
7-day	4.771	5.249	7.037	8.438	10.375	11.908	13.541	15.281	17.726	19.693
10-day	5.216	5.736	7.688	9.211	11.306	12.950	14.699	16.573	19.213	21.343
20-day	6.739	7.340	9.640	11.404	13.780	15.588	17.492	19.564	22.505	24.891
30-day	8.012	8.684	11.283	13.257	15.883	17.846	19.898	22.138	25.318	27.899
45-day	9.755	10.569	13.712	16.103	19.289	21.690	24.175	26.822	30.508	33.449
60-day	11.294	12.248	15.917	18.720	22.477	25.346	28.296	31.362	35.554	38.840

Table 5.16 AMS-based precipitation frequency estimates for Wise County (inches)

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.404	0.437	0.569	0.667	0.795	0.889	0.983	1.078	1.206	1.303
10-min	0.648	0.702	0.914	1.072	1.278	1.431	1.581	1.729	1.922	2.066
15-min	0.804	0.870	1.131	1.326	1.578	1.763	1.946	2.133	2.384	2.576
30-min	1.111	1.201	1.560	1.826	2.170	2.418	2.667	2.925	3.274	3.546
60-min	1.438	1.557	2.027	2.377	2.832	3.165	3.500	3.850	4.327	4.700
2-hr	1.762	1.916	2.508	2.959	3.561	4.018	4.485	4.970	5.633	6.151
3-hr	1.955	2.131	2.803	3.321	4.023	4.568	5.133	5.715	6.509	7.130
6-hr	2.303	2.523	3.346	3.990	4.879	5.587	6.328	7.090	8.129	8.943
12-hr	2.682	2.954	3.963	4.757	5.863	6.753	7.691	8.654	9.969	11.000
24-hr	3.105	3.432	4.645	5.602	6.937	8.011	9.148	10.326	11.948	13.228
48-hr	3.592	3.969	5.376	6.481	8.013	9.231	10.531	11.912	13.850	15.407
3-day	3.920	4.330	5.864	7.066	8.726	10.036	11.437	12.950	15.094	16.834
4-day	4.168	4.604	6.233	7.510	9.277	10.670	12.165	13.787	16.096	17.976
7-day	4.714	5.207	7.040	8.482	10.487	12.076	13.790	15.655	18.322	20.501
10-day	5.173	5.709	7.701	9.269	11.450	13.181	15.049	17.084	19.994	22.373
20-day	6.619	7.255	9.641	11.504	14.067	16.074	18.224	20.567	23.911	26.639
30-day	7.814	8.533	11.244	13.348	16.229	18.468	20.852	23.439	27.114	30.101
45-day	9.485	10.339	13.557	16.059	19.488	22.167	25.003	28.028	32.270	35.679
60-day	10.968	11.949	15.634	18.506	22.455	25.565	28.841	32.283	37.055	40.850

iSWM Criteria Community Inventory

Land Use Conditions

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

Halff Associates, Tetra Tech Inc., and Urban EcoPlan, in partnership with NCTCOG, has completed their Stormwater Criteria Community Inventory.

Ordinances and Drainage Criteria Manuals of fifty-three (53) communities were reviewed and compared to seventeen (17) iSWM Design Criteria:

Site Plan Review Applicability
Land Use Conditions
Hydrologic Methods
Open Channel Velocity Criteria/Energy Dissipation
Detention Structure Discharge Criteria
Streambank Protection
Flood mitigation/Downstream Assessments
Construction Controls
Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

Data was also collected from an NCTCOG email survey completed in December 2018 asking if use of fully developed land use conditions was required in drainage criteria. The iSWM criteria review was based off the NCTCOG Tiered Measurement Form which is utilized as a checklist that can be used to determine iSWM status when applying to become an iSWM certified community.

Upon review, each criterion reviewed for each community was placed in one of the three categories:
Follows iSWM criteria
Partially follows iSWM criteria
No coordinating criteria found

Date Completed: 4/20/2020

Showing for reference:
- Watershed Boundary (HUC 08)
- Waterway

Montague
Cooke
Grayson
Wise
Denton
Collin
Hunt
Rains
Rockwall
Kaufman
Parker
Tarrant
Dallas
Hood
Johnson
Ellis
Somervell
Hill
Bosque
Henderson
Navarro

Sanger
Denton
Corinth
Little Elm
Frisco
McKinney
Allen
Plano
Wylie
Greenville
The Colony
Lewisville
Flower Mound
Carrollton
Richardson
Sachse
Garland
Rowlett
Rockwall
Southlake
Grapevine
Coppell
Farmers Branch
Keller
Saginaw
Watauga
Colleyville
DFW Airport
North Richland Hills
Bedford
Euless
Irving
Hurst
Haltom City
Dallas
Mesquite
Balch Springs
Weatherford
Fort Worth
Benbrook
Grand Prairie
Arlington
Kennedale
Duncanville
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne

North Central Texas Council of Governments
Environment & Development
HALFF

iSWM Criteria Community Inventory

Site Plan Review Applicability Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

Halff Associates, Tetra Tech Inc., and Urban EcoPlan, in partnership with NCTCOG, has completed their Stormwater Criteria Community Inventory.

Ordinances and Drainage Criteria Manuals of fifty-three (53) communities were reviewed and compared to seventeen (17) iSWM Design Criteria:

Site Plan Review Applicability
Land Use Conditions
Hydrologic Methods
Open Channel Velocity Criteria/Energy Dissipation
Detention Structure Discharge Criteria
Streambank Protection
Flood mitigation/Downstream Assessments
Construction Controls
Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

Data was also collected from an NCTCOG email survey completed in December 2018 asking if use of fully developed land use conditions was required in drainage criteria. The iSWM criteria review was based off the NCTCOG Tiered Measurement Form which is utilized as a checklist that can be used to determine iSWM status when applying to become an iSWM certified community.

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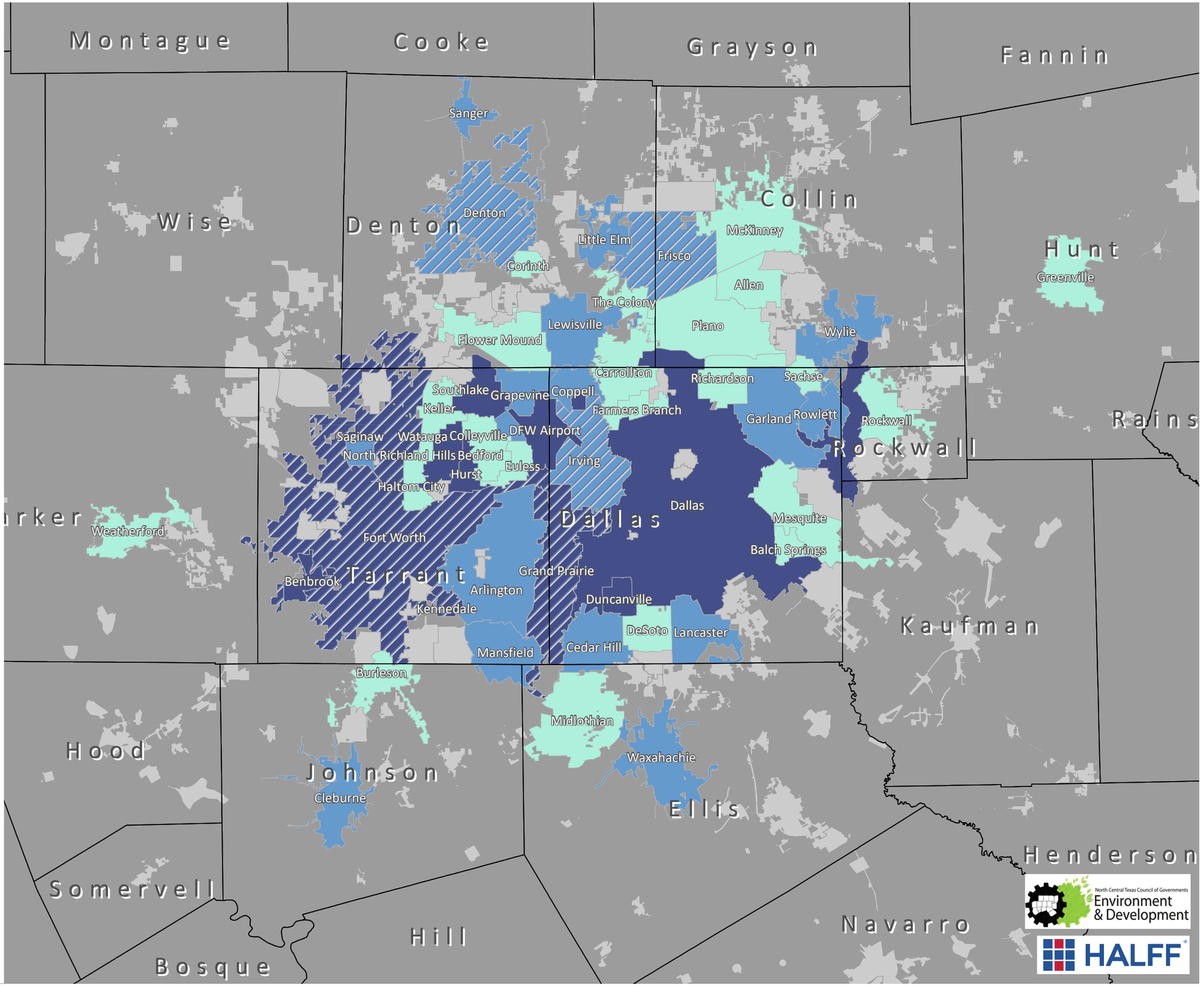
Partially follows iSWM criteria
No coordinating criteria found

Date Completed: 4/20/2020



North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Land Use Conditions

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Water Quality Protection
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Follows iSWM criteria
Partially follows iSWM criteria
No coordinating criteria found

Date Completed: 4/20/2020

Montague
Cooke
Grayson
Fannin
Wise
Denton
Collin
Hunt
Rains
Rockwall
Kaufman
Parker
Tarrant
Dallas
Hood
Johnson
Ellis
Somervell
Hill
Bosque
Henderson
Navarro

Sanger
Denton
Corinth
Little Elm
Frisco
McKinney
Allen
Plano
Wylie
Greenville
The Colony
Lewisville
Flower Mound
Carrollton
Coppell
Farmers Branch
Richardson
Sachse
Garland
Rowlett
Rockwall
Southlake
Grapevine
Keller
Saginaw
Watauga
Colleyville
DFW Airport
North Richland Hills
Bedford
Euless
Hurst
Haltom City
Irving
Dallas
Mesquite
Balch Springs
Weatherford
Fort Worth
Benbrook
Arlington
Grand Prairie
Kennedale
Duncanville
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne

North Central Texas Council of Governments
Environment & Development

HALFF

iSWM Criteria Community Inventory

Hydrologic Methods criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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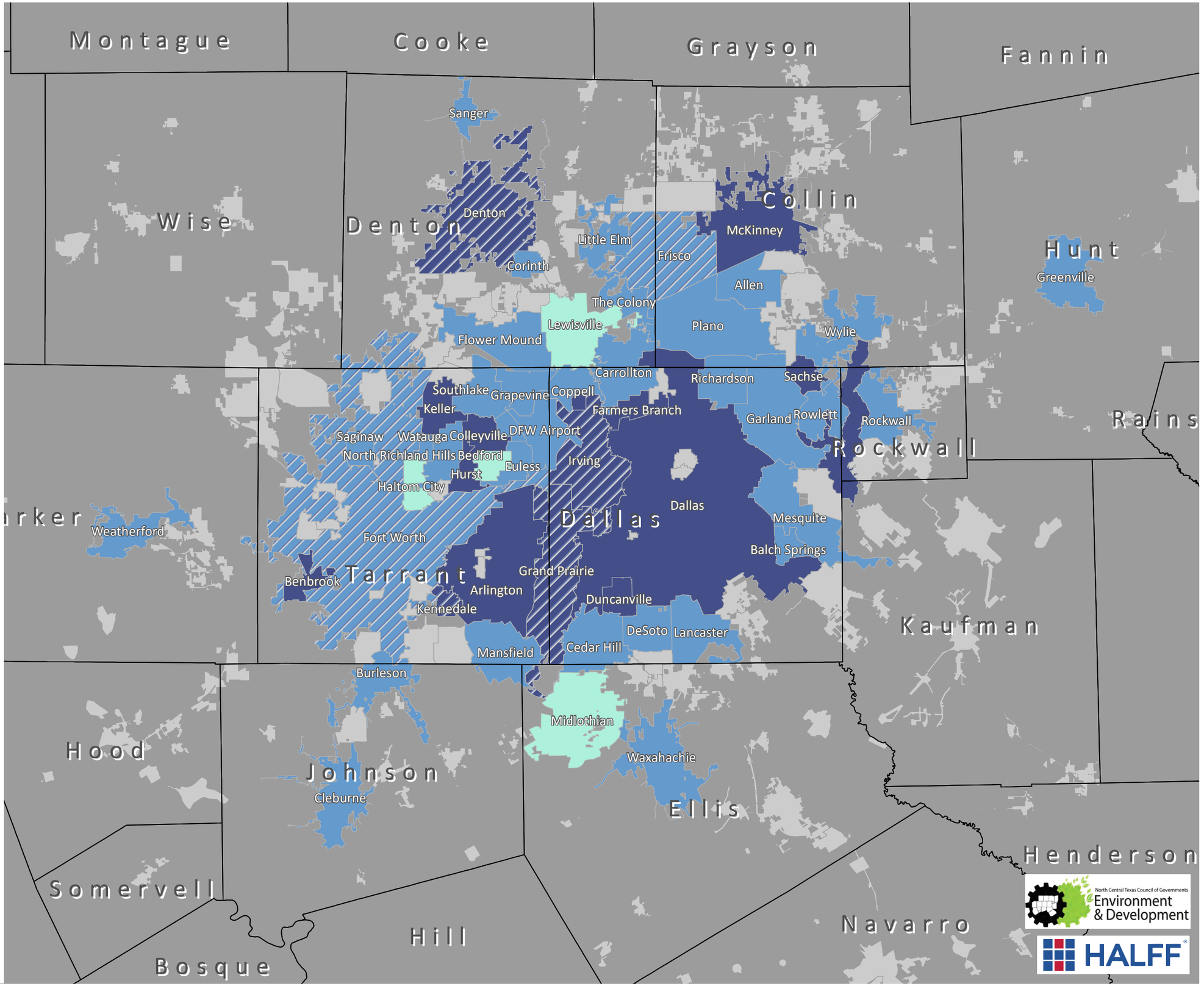

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Open Channel Velocity Criteria/Energy Dissipation

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Conveyance Limits
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Water Quality Protection
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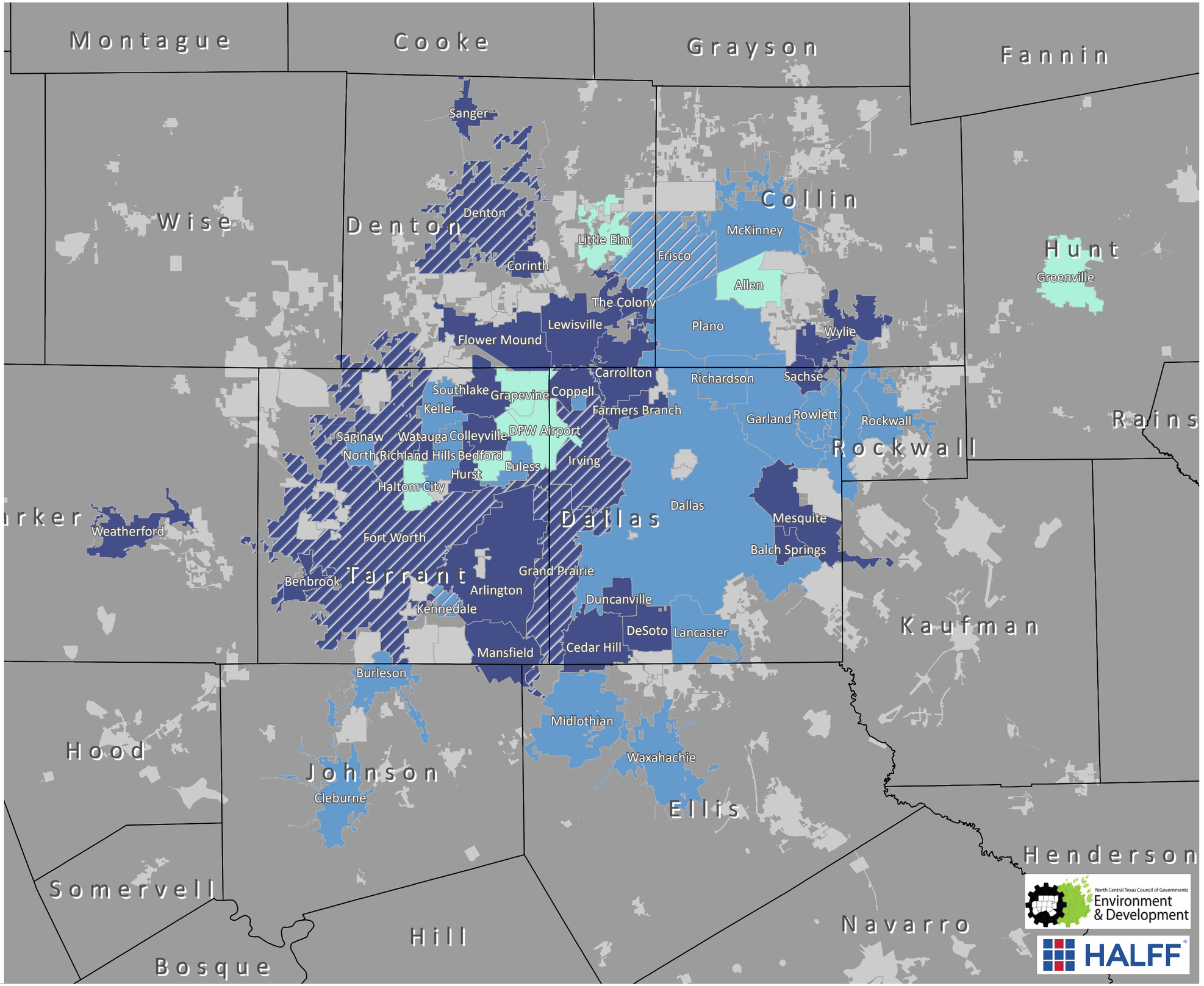

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Detention Structure Discharge Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Construction Controls
Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
Freeboard Criteria
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Water Quality Protection
Drainage and Floodplain Easements

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No coordinating criteria found

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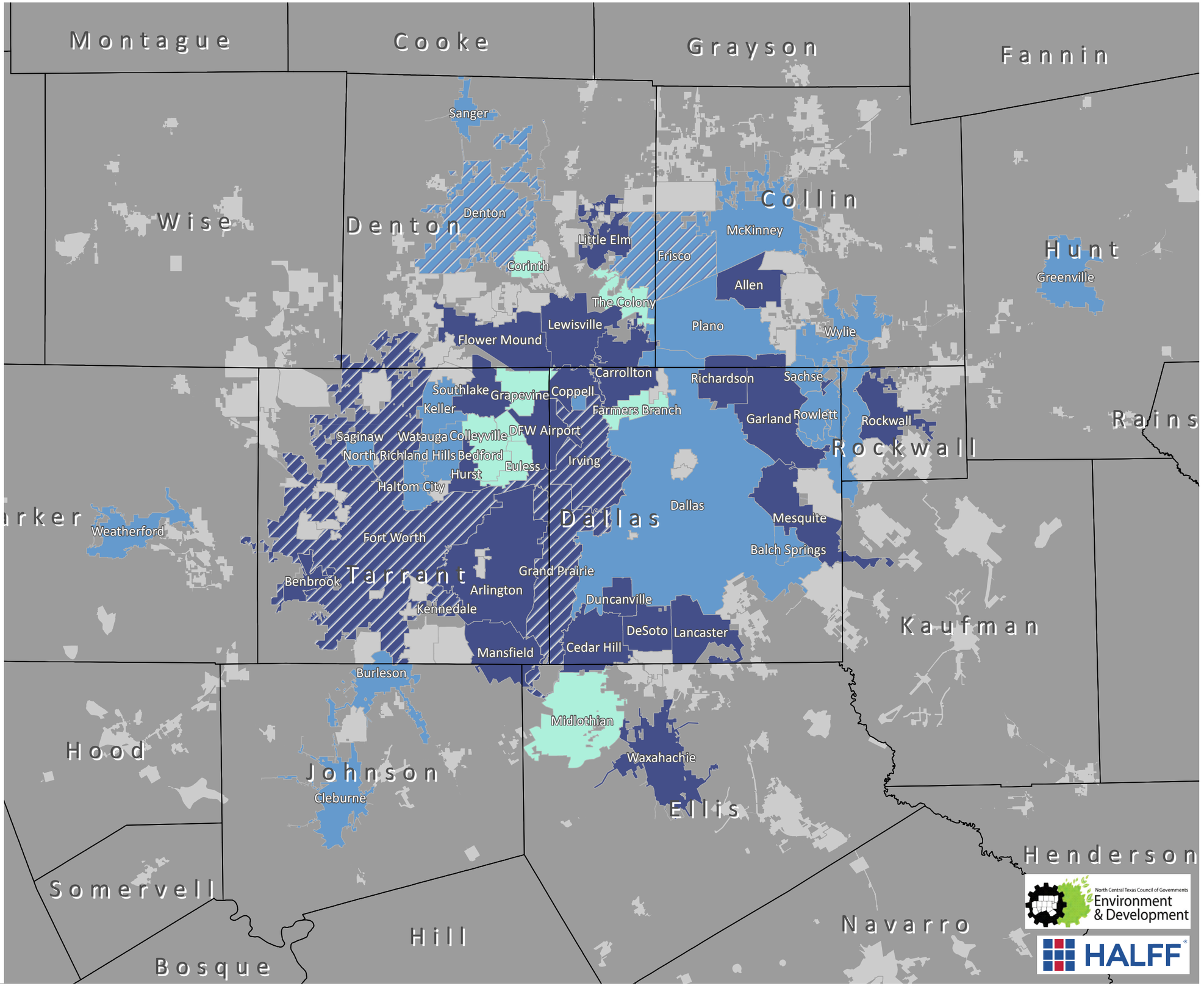

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Streambank Protection Downstream Assessment Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Freeboard Criteria
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Water Quality Protection
Drainage and Floodplain Easements

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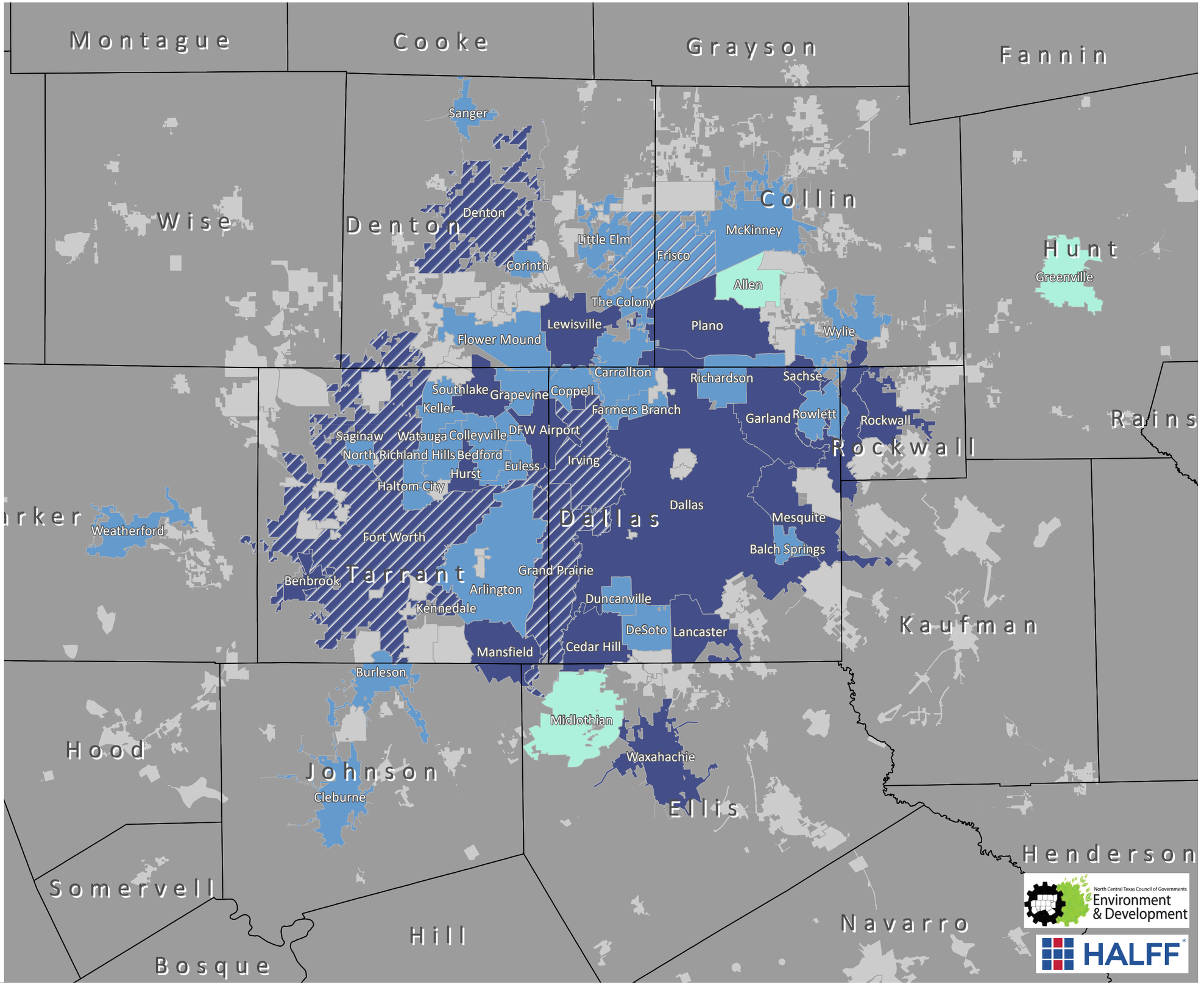

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Flood Mitigation Downstream Assessment Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

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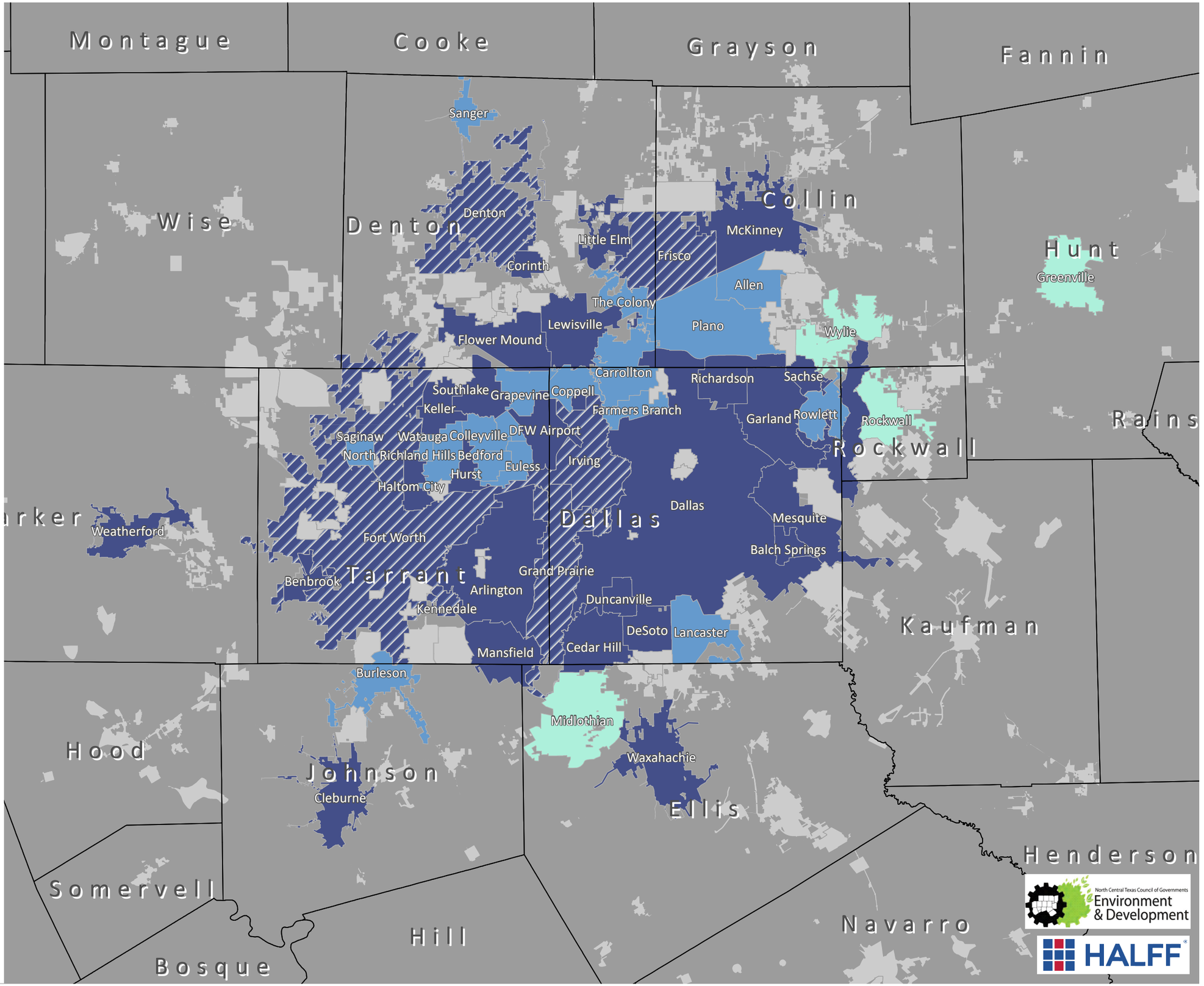

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Construction Controls

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Construction Controls
Operations and Maintenance
Conveyance Limits
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Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

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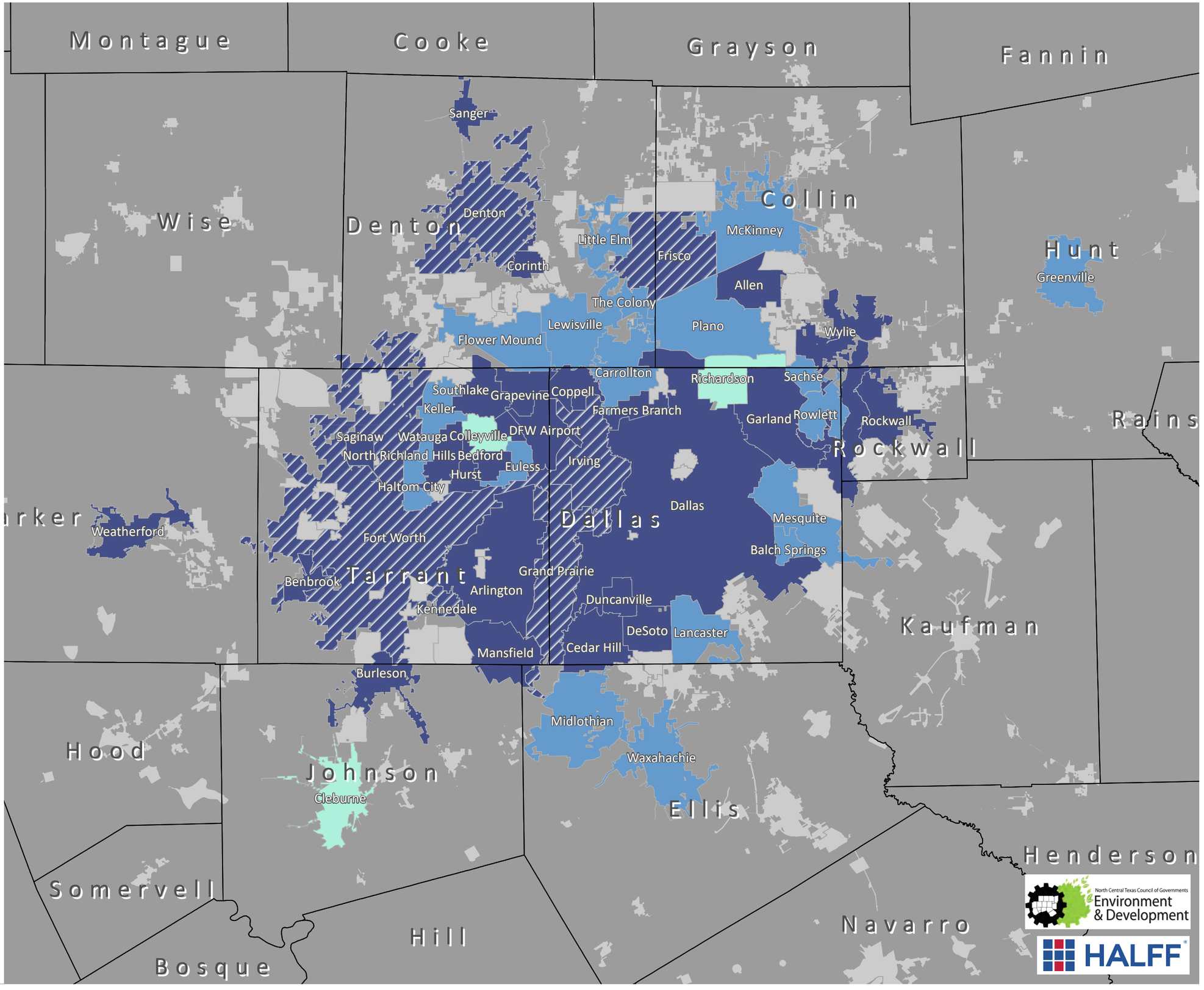

North Central Texas Council of Governments
Environment & Development

HALFF

iSWM Criteria Community Inventory

Operations and Maintenance

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Construction Controls
Operations and Maintenance
Conveyance Limits
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Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

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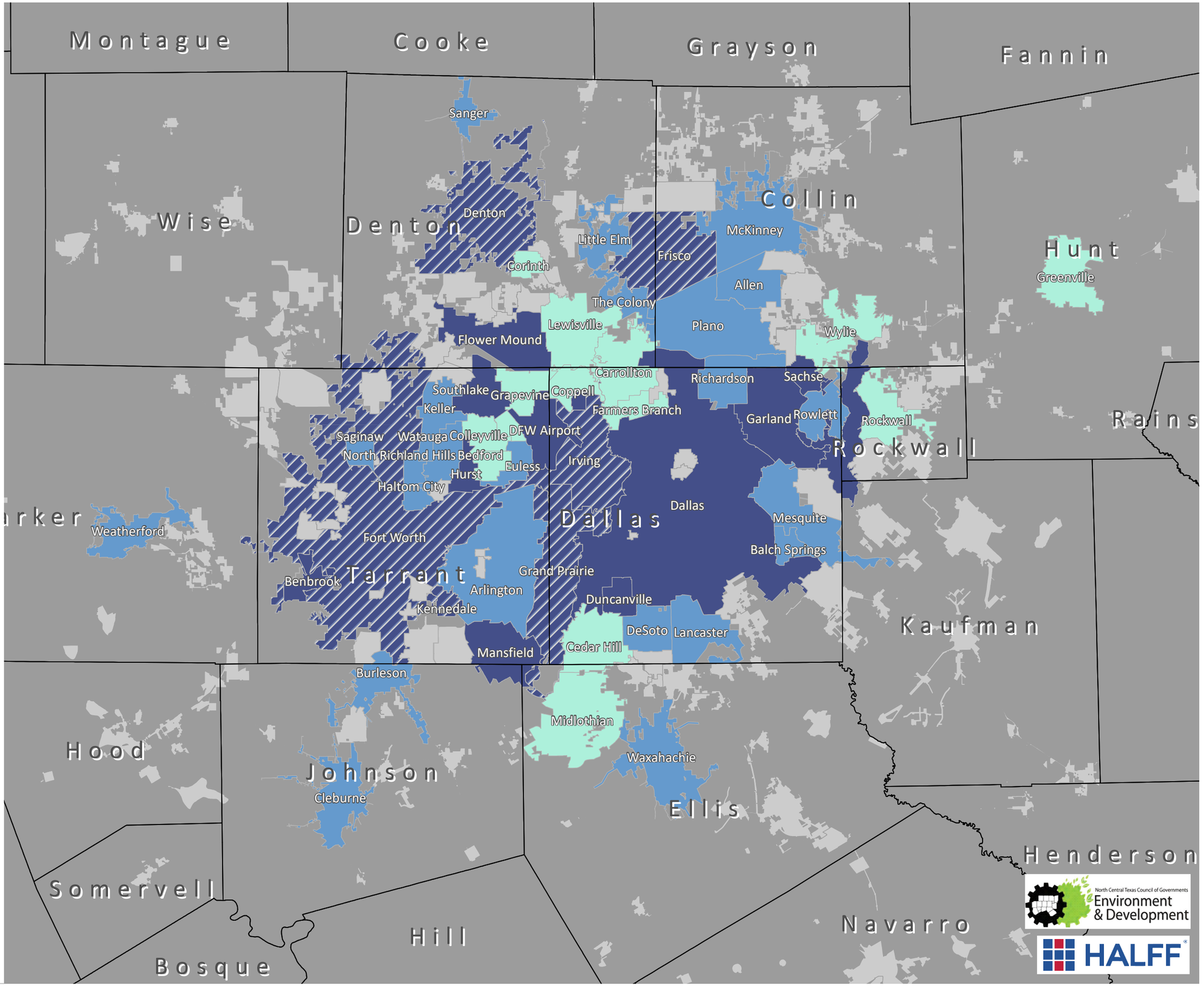

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Conveyance Limits

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
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0 50,000 100,000 Feet

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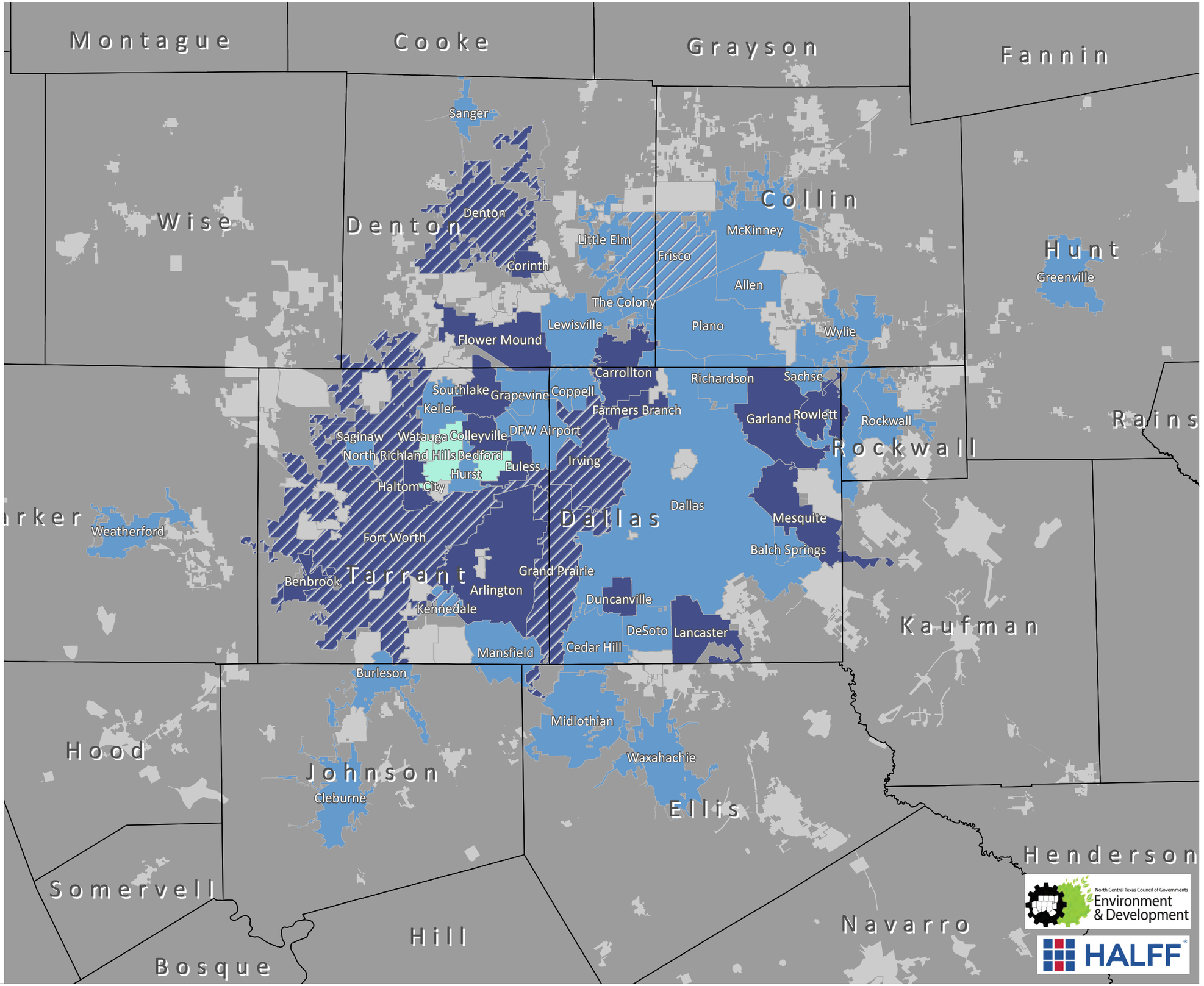

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Storm Drain Velocity Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Water Quality Protection
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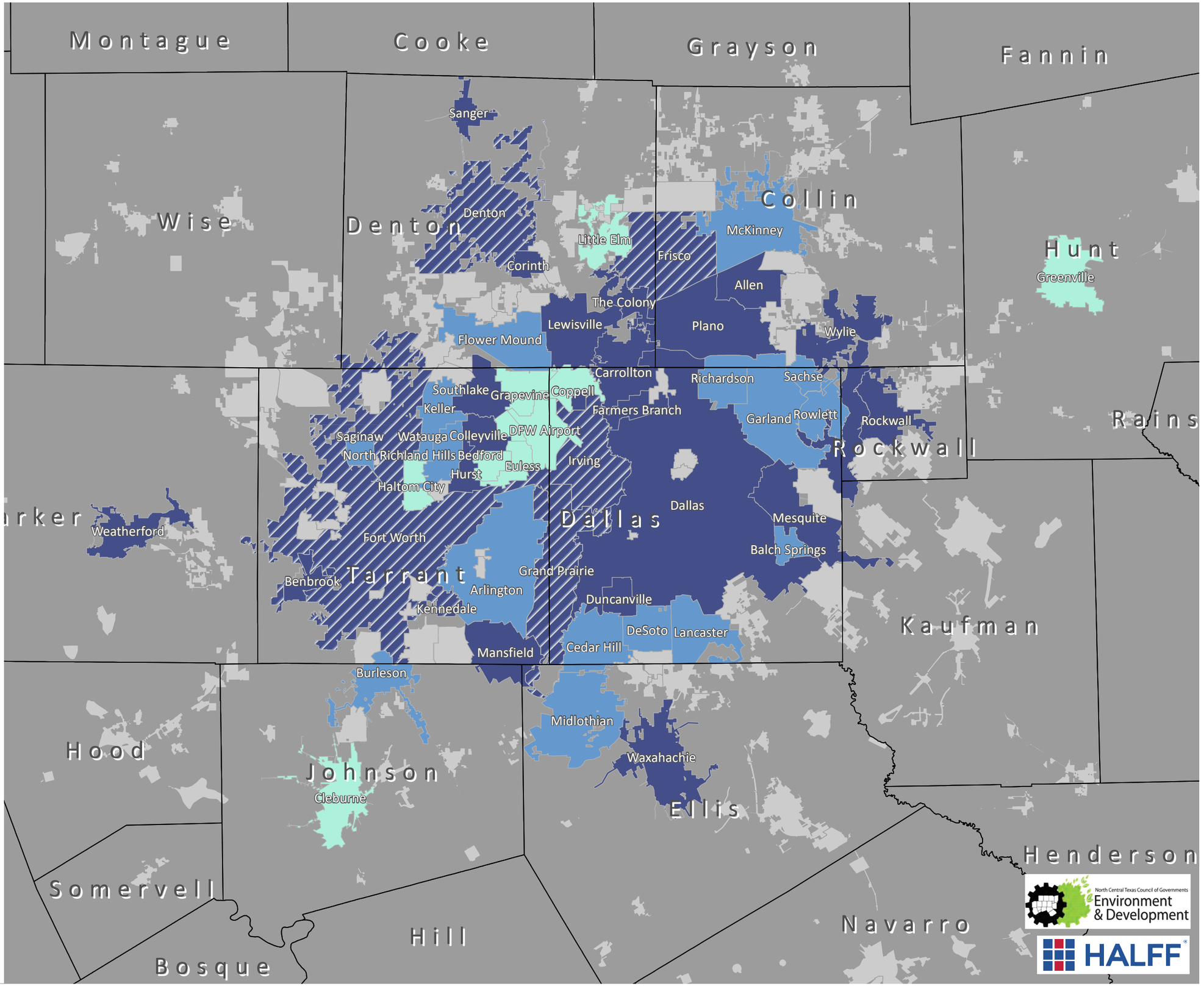

North Central Texas Council of Governments Environment & Development

HALFF

iSWM Criteria Community Inventory

Spread Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Construction Controls
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Water Quality Protection
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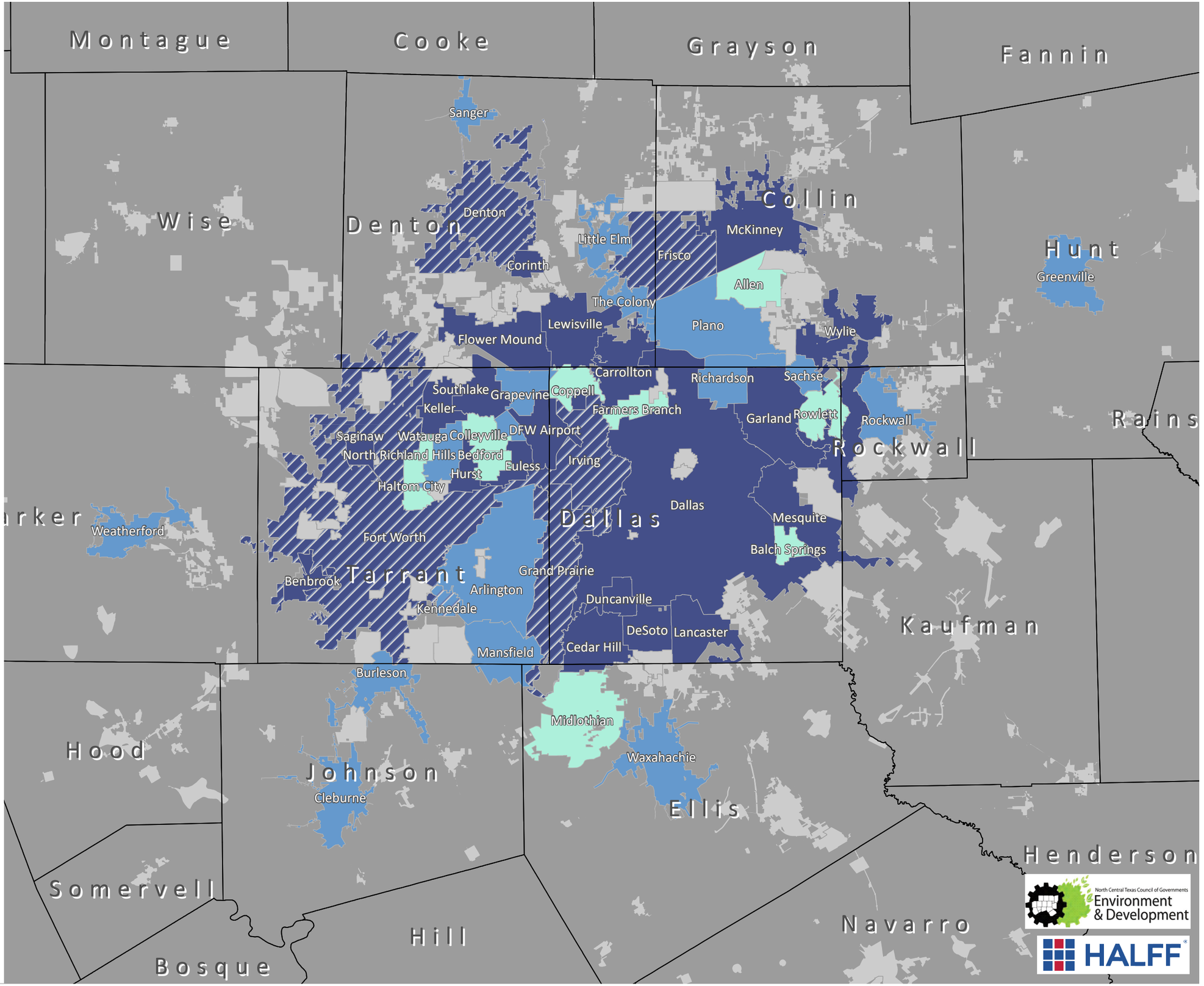

North Central Texas Council of Governments
Environment & Development

HALFF

iSWM Criteria Community Inventory

Freeboard Criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Construction Controls
Operations and Maintenance
Conveyance Limits
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Spread Criteria
Freeboard Criteria
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Water Quality Protection
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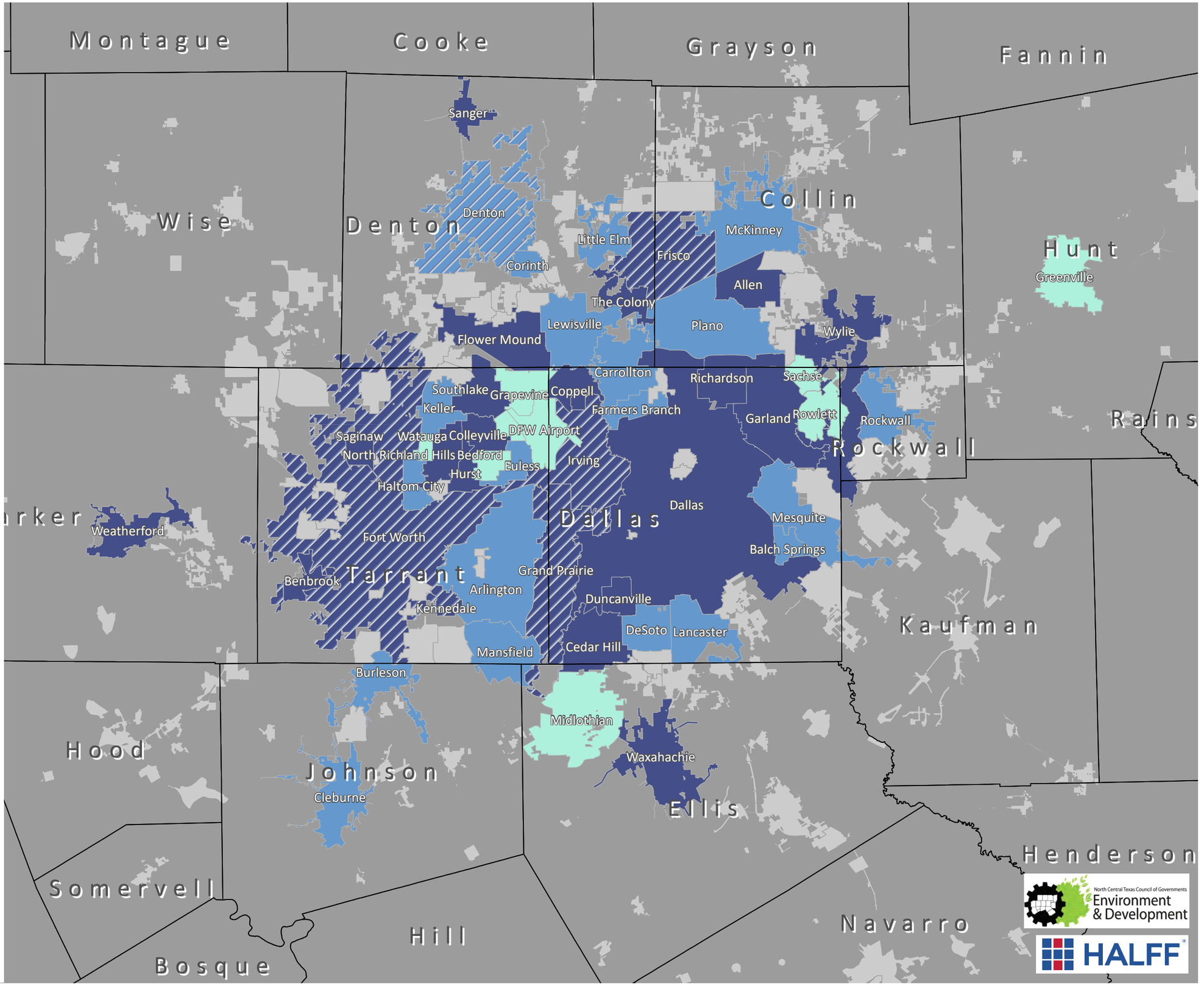

North Central Texas Council of Governments
Environment & Development

HALFF

iSWM Criteria Community Inventory

Finished Floor Elevations

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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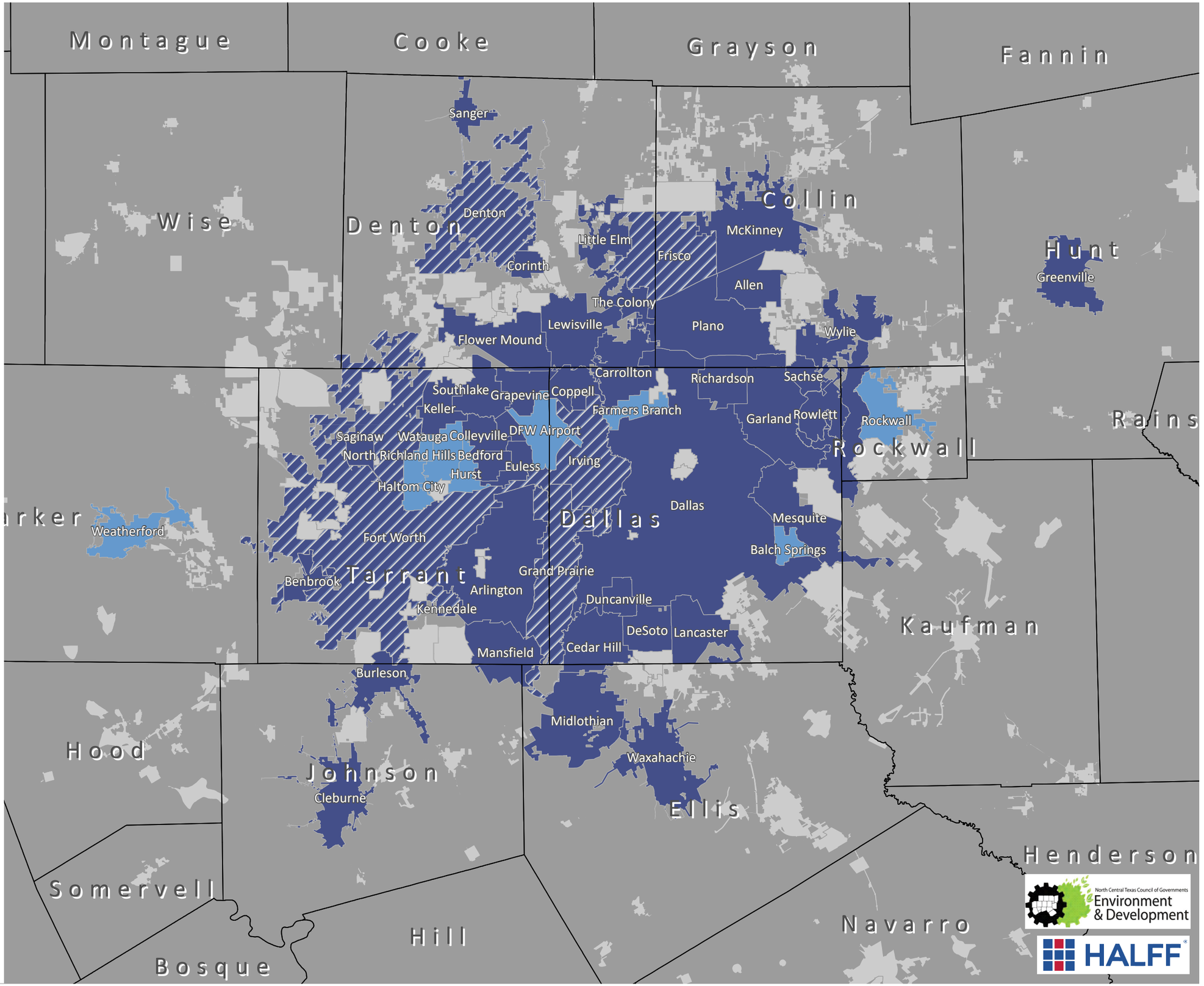

iSWM Criteria Community Inventory

Water Quality Protection

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

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Site Plan Review Applicability
Land Use Conditions
Hydrologic Methods
Open Channel Velocity Criteria/Energy Dissipation
Detention Structure Discharge Criteria
Streambank Protection
Flood mitigation/Downstream Assessments
Construction Controls
Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
Freeboard Criteria
Finished Floor Elevations
Water Quality Protection
Drainage and Floodplain Easements

Data was also collected from an NCTCOG email survey completed in December 2018 asking if use of fully developed land use conditions was required in drainage criteria. The iSWM criteria review was based off the NCTCOG Tiered Measurement Form which is utilized as a checklist that can be used to determine iSWM status when applying to become an iSWM certified community.

Upon review, each criterion reviewed for each community was placed in one of the three categories:
Follows iSWM criteria
Partially follows iSWM criteria
No coordinating criteria found

Date Completed: 4/20/2020

Montague
Cooke
Grayson
Fannin
Wise
Denton
Collin
Hunt
Rains
Rockwall
Kaufman
Henderson
Navarro
Ellis
Hill
Johnson
Somervell
Hood
Bosque
Tarrant
Dallas
Parker
Sanger
Denton
Corinth
Little Elm
Frisco
McKinney
Allen
Plano
Wylie
Greenville
The Colony
Lewisville
Flower Mound
Carrollton
Richardson
Sachse
Garland
Rowlett
Rockwall
Coppell
Farmers Branch
Grapevine
Southlake
Keller
Saginaw
Watauga
Colleyville
DFW Airport
North Richland Hills
Bedford
Euless
Irving
Hurst
Haltom City
Weatherford
Fort Worth
Benbrook
Arlington
Grand Prairie
Mesquite
Balch Springs
Duncanville
Kennedale
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne

North Central Texas Council of Governments
Environment & Development

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iSWM Criteria Community Inventory

Drainage and Floodplain Easements

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 50,000 100,000 Feet

Halff Associates, Tetra Tech Inc., and Urban EcoPlan, in partnership with NCTCOG, has completed their Stormwater Criteria Community Inventory.

Ordinances and Drainage Criteria Manuals of fifty-three (53) communities were reviewed and compared to seventeen (17) iSWM Design Criteria:

Site Plan Review Applicability
Land Use Conditions
Hydrologic Methods
Open Channel Velocity Criteria/Energy Dissipation
Detention Structure Discharge Criteria
Streambank Protection
Flood mitigation/Downstream Assessments
Construction Controls
Operations and Maintenance
Conveyance Limits
Storm Drain Velocity Criteria
Spread Criteria
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No coordinating criteria found

Date Completed: 4/20/2020

Montague
Cooke
Grayson
Fannin
Wise
Denton
Collin
Hunt
Rains
Rockwall
Kaufman
Henderson
Navarro
Ellis
Hill
Johnson
Somervell
Hood
Bosque
Tarrant
Dallas
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Sanger
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Little Elm
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McKinney
Allen
Plano
Wylie
Greenville
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Lewisville
Flower Mound
Carrollton
Richardson
Sachse
Garland
Rowlett
Rockwall
Coppell
Farmers Branch
Southlake
Grapevine
Keller
Saginaw
Watauga
Colleyville
DFW Airport
North Richland Hills
Bedford
Euless
Hurst
Irving
Haltom City
Fort Worth
Dallas
Mesquite
Balch Springs
Weatherford
Benbrook
Arlington
Grand Prairie
Duncanville
Kennedale
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne

North Central Texas Council of Governments
Environment & Development

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iSWM Criteria
County Inventory

Land Use Conditions

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 70,000 140,000 Feet

Halff Associates, Tetra Tech Inc., and Urban EcoPlan, in partnership with NCTCOG, has completed their Stormwater Criteria Community Inventory.

Ordinances and Drainage Criteria Manuals of eight (8) counties were reviewed and compared to seven (7) iSWM Design Criteria:

Land Use Conditions
Streambank Protection
Flood mitigation/Downstream Assessments
Operations and Maintenance
Conveyance Limits
Finished Floor Elevations
Water Quality Protection

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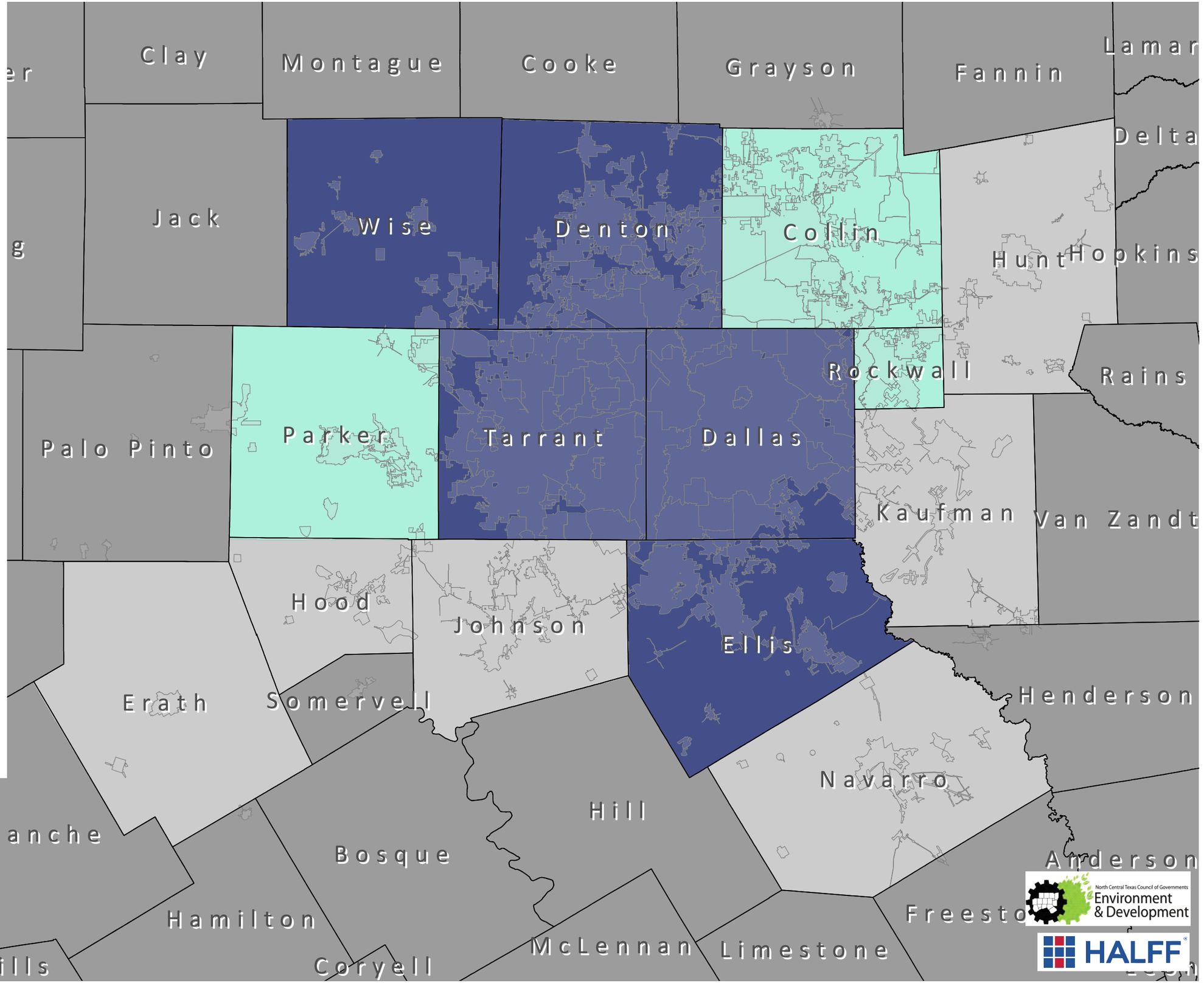
Partially follows iSWM criteria
No coordinating criteria found

Date Completed:
4/20/2020



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Environment & Development

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iSWM Criteria
County Inventory
Streambank Protection
Downstream Assessment Criteria

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 70,000 140,000 Feet

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Montague
Cooke
Grayson
Fannin
Lamar
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Dallas
Kaufman
Van Zandt
Palo Pinto
Hood
Johnson
Ellis
Henderson
Erath
Somervell
Navarro
Hill
Comanche
Bosque
Anderson
Brown
Hamilton
McLennan
Limestone
Mills
Coryell

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iSWM Criteria
County Inventory
Flood Mitigation Downstream Assessment Criteria

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
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- Not reviewed

0 70,000 140,000 Feet

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Hamilton
McLennan
Limestone
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Mills
Coryell

North Central Texas Council of Governments
Environment & Development

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iSWM Criteria
County Inventory

Operations and Maintenance

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 70,000 140,000 Feet

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Operations and Maintenance
Conveyance Limits
Finished Floor Elevations
Water Quality Protection

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Hamilton
McLennan
Limestone
Freesto
Mills
Coryell

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Environment & Development

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iSWM Criteria
County Inventory

Conveyance Limits

LEGEND

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- Partially follows iSWM criteria
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- Not reviewed

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Water Quality Protection

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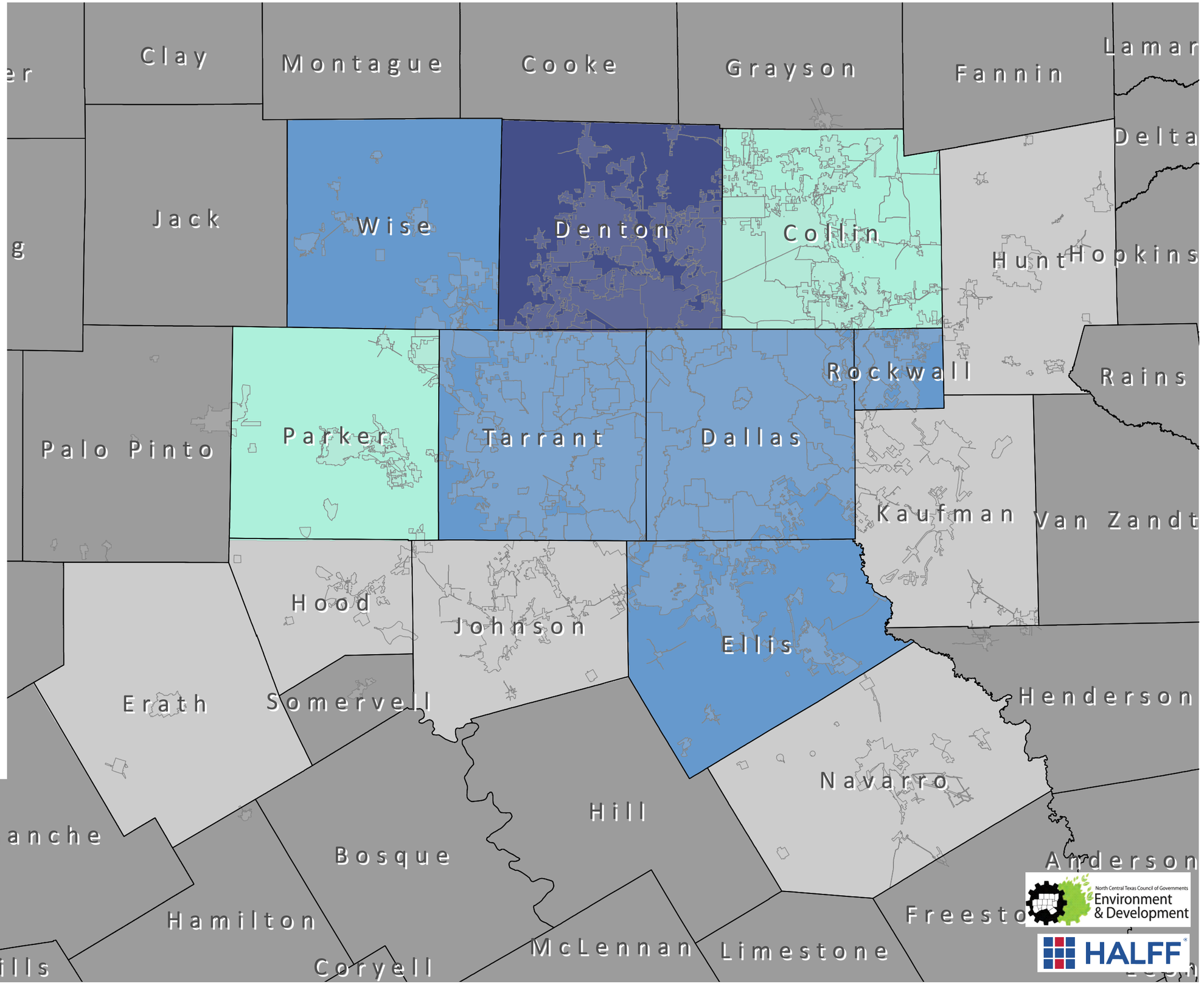
4/20/2020



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Environment & Development

HALFF

iSWM Criteria
County Inventory

Finished Floor Elevations

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 70,000 140,000 Feet

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Flood mitigation/Downstream Assessments
Operations and Maintenance
Conveyance Limits
Finished Floor Elevations
Water Quality Protection

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4/20/2020

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Lamar
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Hopkins
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Jack
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Denton
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Hunt
Rockwall
Palo Pinto
Parker
Tarrant
Dallas
Kaufman
Van Zandt
Hood
Johnson
Ellis
Henderson
Erath
Somervell
Navarro
Hill
Comanche
Bosque
Anderson
Brown
Hamilton
McLennan
Limestone
Mills
Coryell

North Central Texas Council of Governments
Environment & Development

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iSWM Criteria
County Inventory

Water Quality Protection

LEGEND

- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 70,000 140,000 Feet

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Flood mitigation/Downstream Assessments
Operations and Maintenance
Conveyance Limits
Finished Floor Elevations
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Follows iSWM criteria
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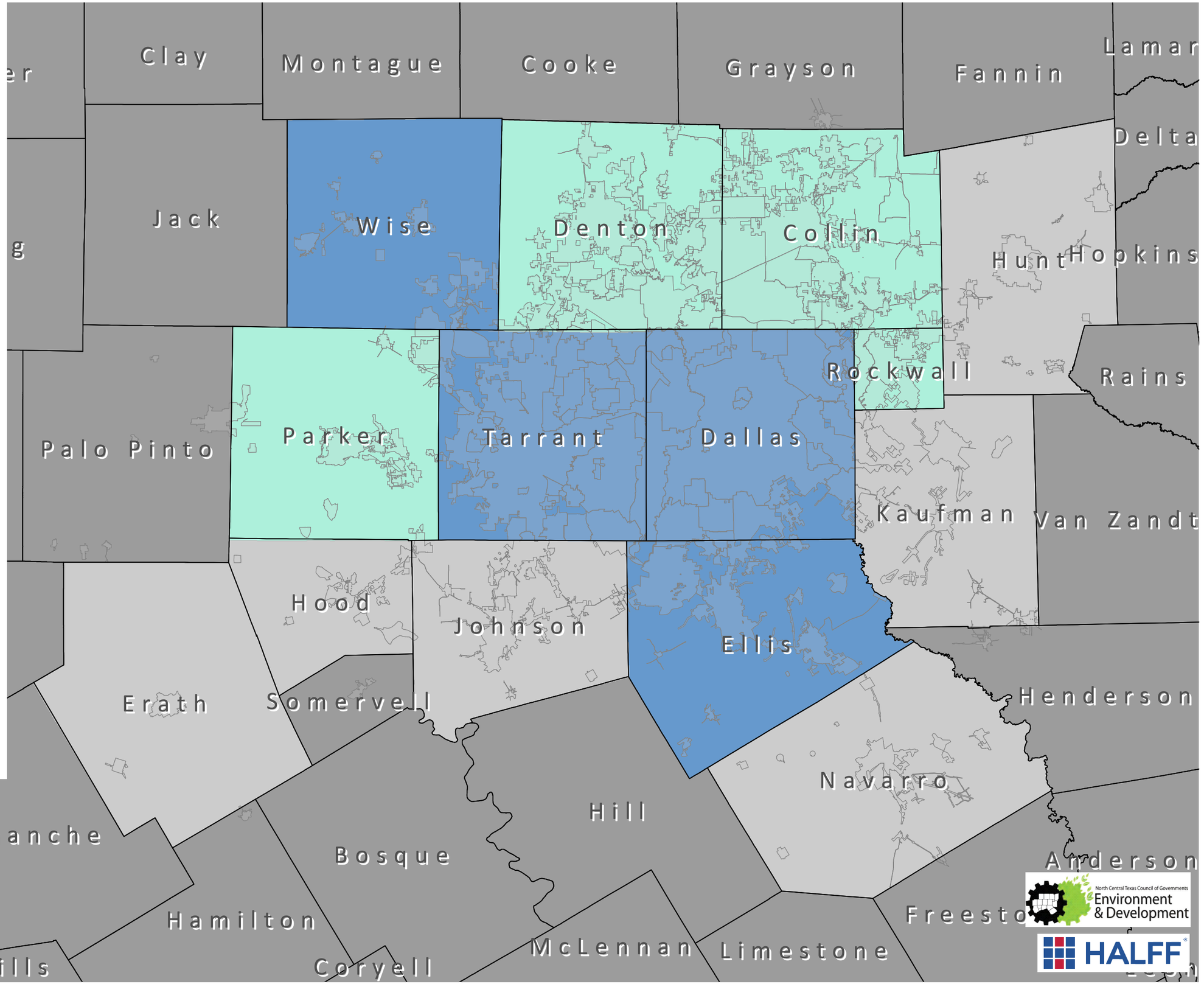
Date Completed:
4/20/2020



North Central Texas Council of Governments
Environment & Development

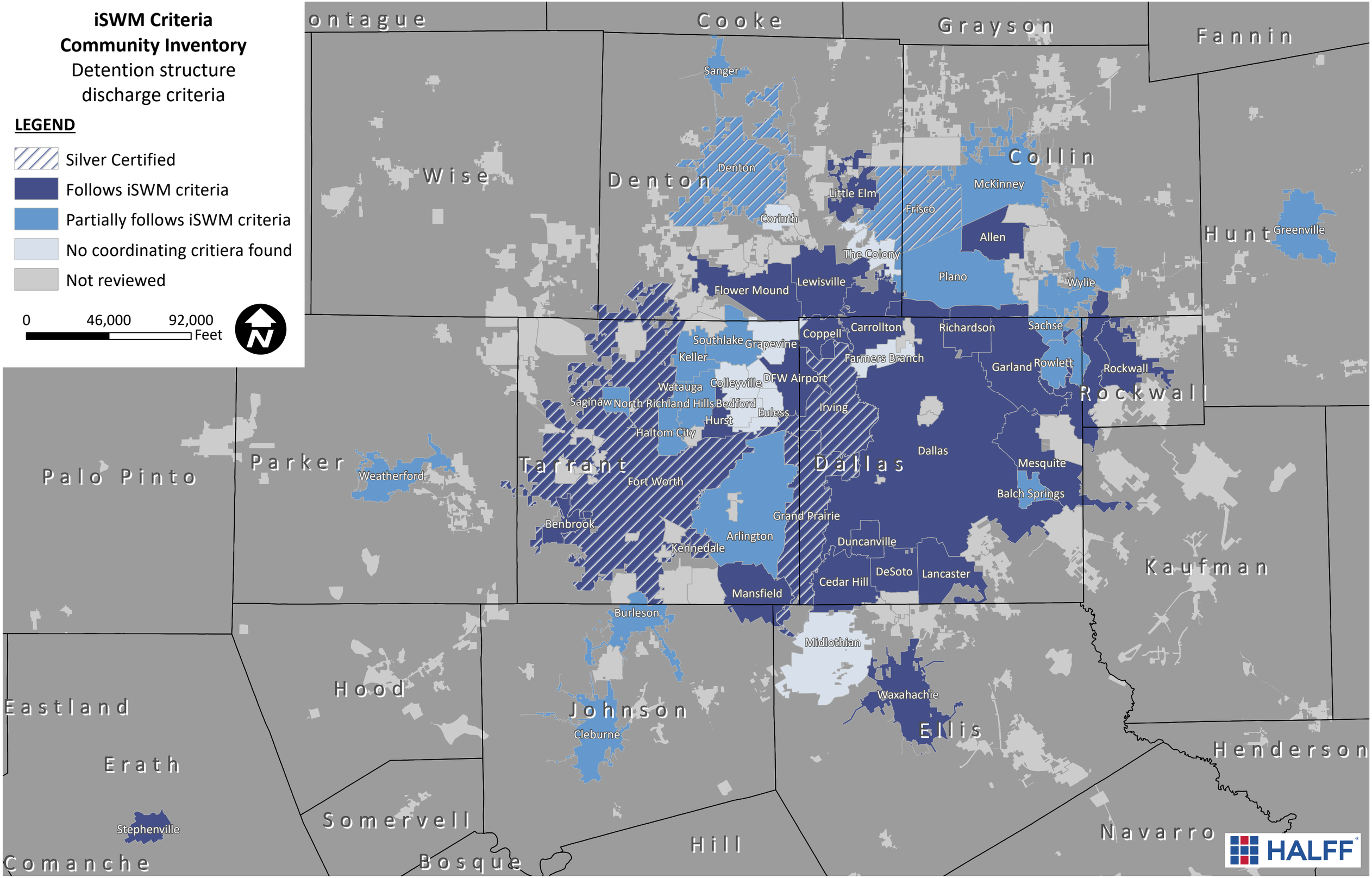
HALFF

iSWM Criteria
Community Inventory
Detention structure
discharge criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet



iSWM Criteria
Community Inventory
Finished floor
elevation criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet

ontague
Cooke
Grayson
Fannin
Wise
Denton
Collin
Hunt
Rockwall
Kaufman
Parker
Tarrant
Dallas
Palo Pinto
Hood
Johnson
Ellis
Eastland
Erath
Somervell
Hill
Navarro
Henderson
Comanche
Bosque

Sanger
Denton
Corinth
Little Elm
Frisco
McKinney
Allen
Plano
Wylie
Greenville
The Colony
Lewisville
Flower Mound
Coppell
Carrollton
Farmers Branch
Richardson
Sachse
Garland
Rowlett
Rockwall
Southlake
Grapevine
Keller
Watauga
Colleyville
DFW Airport
Saginaw
North Richland Hills
Bedford
Euless
Hurst
Haltom City
Irving
Dallas
Mesquite
Balch Springs
Weatherford
Fort Worth
Benbrook
Grand Prairie
Arlington
Kennedale
Duncanville
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne
Stephenville

HALFF

iSWM Criteria
Community Inventory
Fully-developed conditions
land use critieria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet

Montague
Cooke
Grayson
Fannin
Wise
Denton
Collin
Hunt
Rockwall
Kaufman
Parker
Tarrant
Dallas
Palo Pinto
Hood
Johnson
Ellis
Henderson
Eastland
Erath
Somervell
Hill
Navarro
Comanche
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Arlington
Kennedale
Duncanville
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne
Stephenville

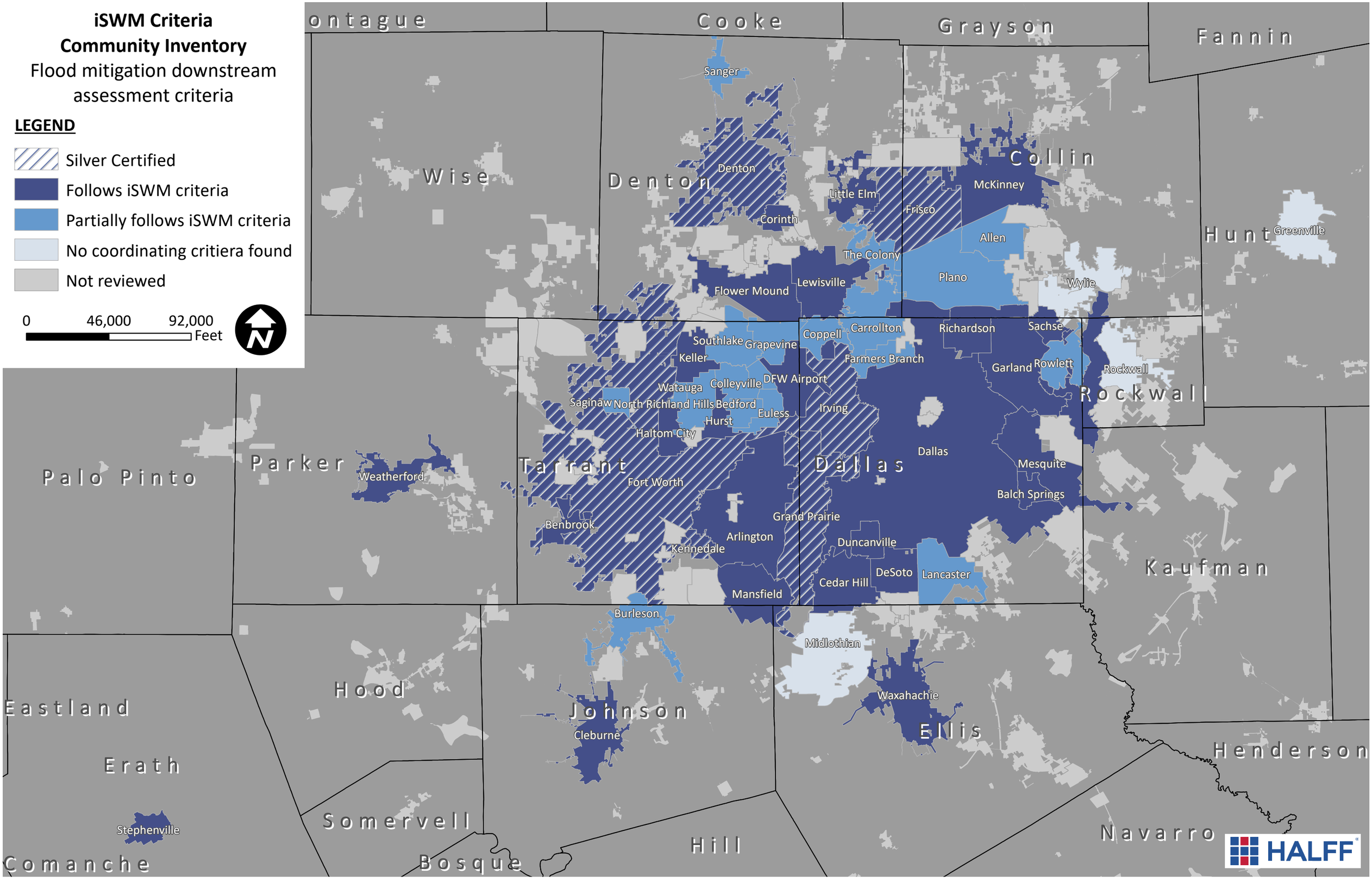
HALFF

iSWM Criteria
Community Inventory
Flood mitigation downstream assessment criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet



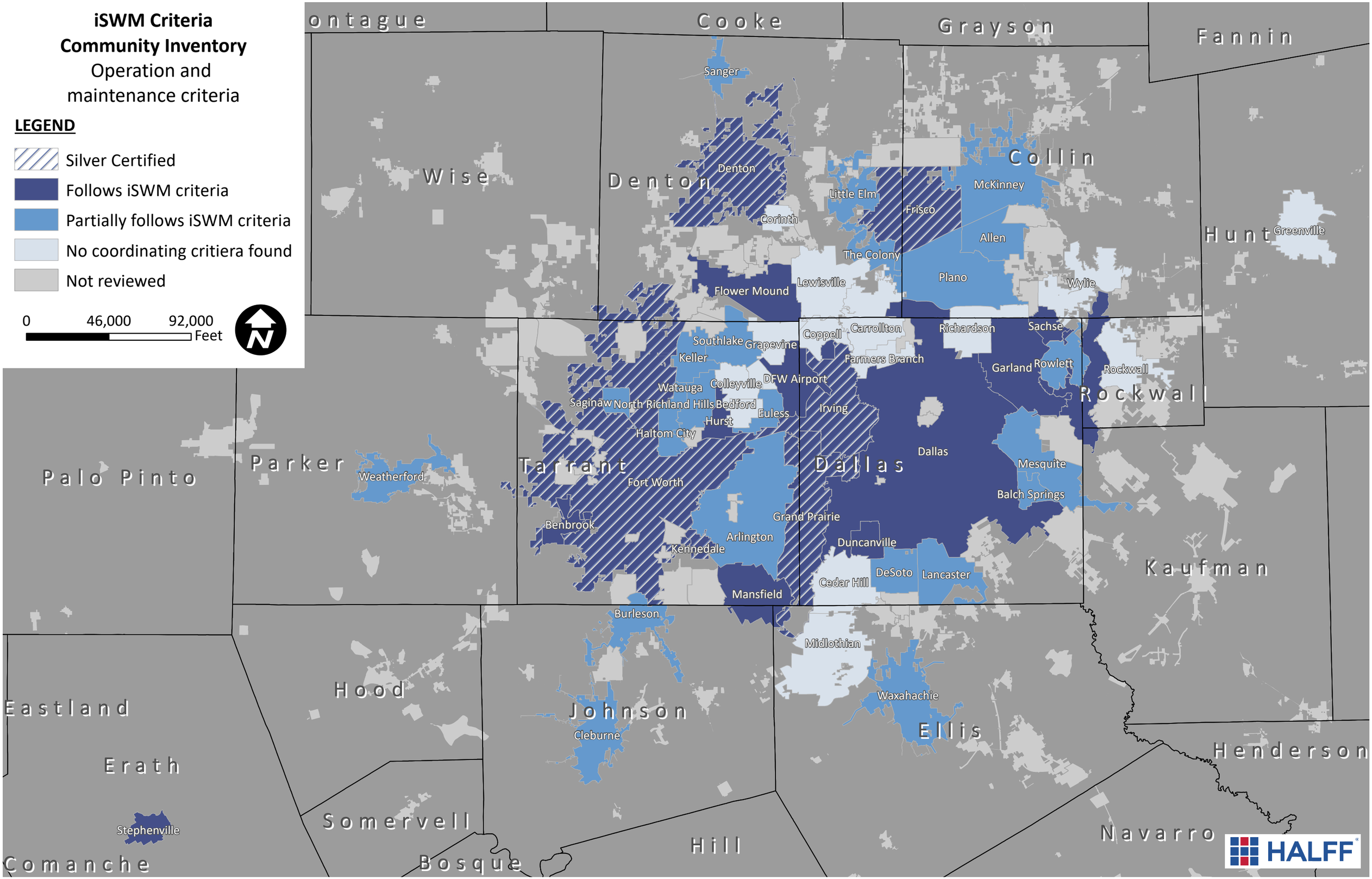
HALFF

iSWM Criteria
Community Inventory
Operation and
maintenance criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet



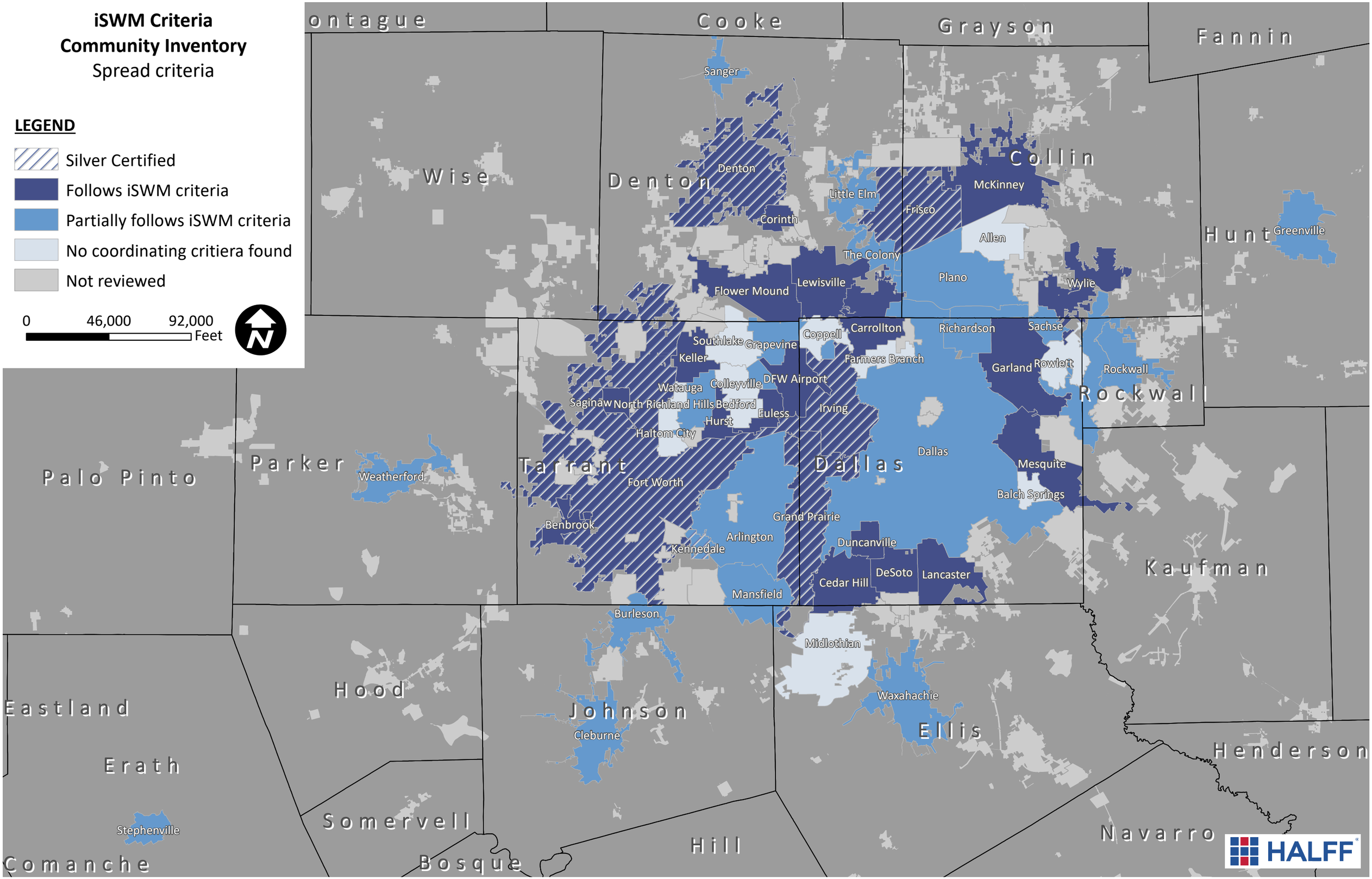
HALFF

iSWM Criteria
Community Inventory
Spread criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet



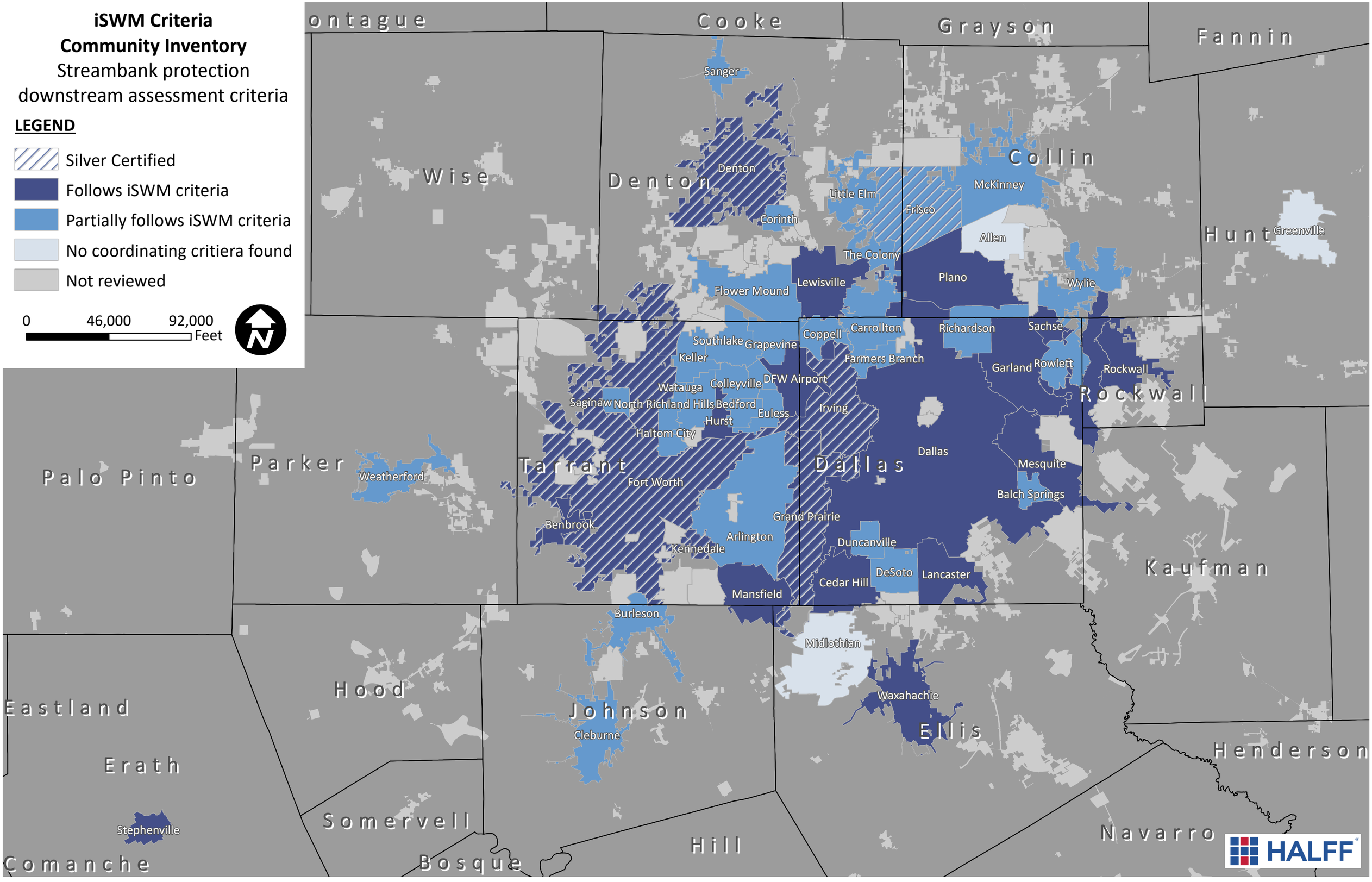
HALFF

iSWM Criteria
Community Inventory
Streambank protection
downstream assessment criteria

LEGEND

- Silver Certified
- Follows iSWM criteria
- Partially follows iSWM criteria
- No coordinating critiera found
- Not reviewed

0 46,000 92,000 Feet



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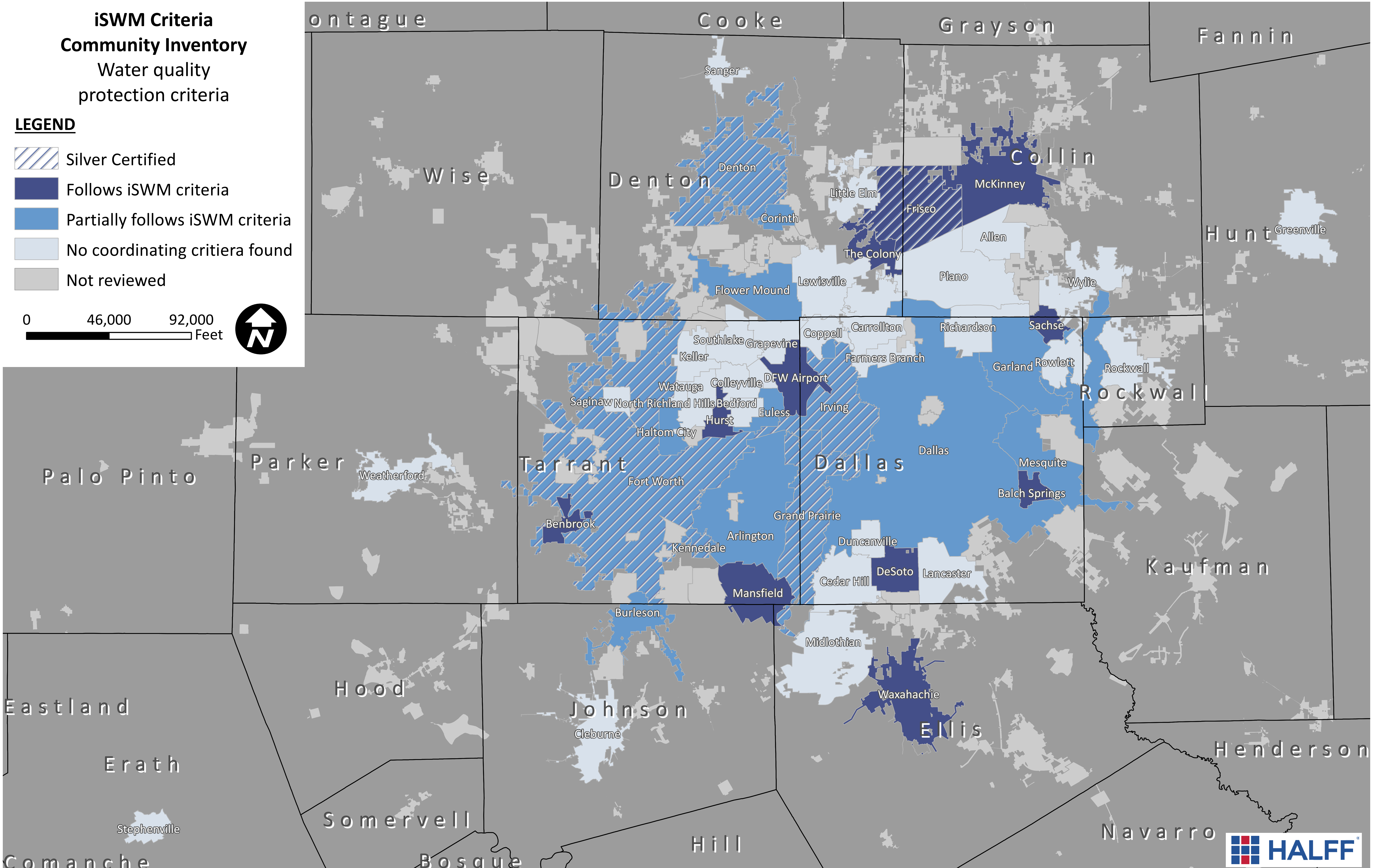
iSWM Criteria
Community Inventory
Water quality
protection criteria
LEGEND
Silver Certified
Follows iSWM criteria
Partially follows iSWM criteria
No coordinating critiera found
Not reviewed
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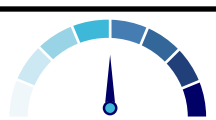
Arlington
Duncanville
Kennedale
DeSoto
Lancaster
Cedar Hill
Mansfield
Burleson
Midlothian
Waxahachie
Cleburne
Stephenville
HALFF

TABLE 2.1 Design Pollutant Removal Efficiencies for Stormwater Controls

Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Fecal Coliform	Metals
Bioretention Areas					
Grass Channel					
Enhanced Dry Swale					
Enhanced Wet Swale					
Alum Treatment					
Filter Strip					
Modified Extended Detention					
Organic Filter					
	Low		Moderate		High

MEMORANDUM

TO:	North Central Texas Council of Governments iSWM Implementation Subcommittee	**DATE:**	April 20, 2020
FROM:	Ben Pylant, PE, CFM Halff Associates, Inc.	Ashley Lowrie, PE, CFM Halff Associates, Inc.	
SUBJECT:	Recommendations for Technical Feedback from iSWM Adopters		

INTRODUCTION

The North Central Texas Council of Government's (NCTCOG) integrated Stormwater Management (iSWM) Implementation Subcommittee in coordination with the NCTCOG staff asked Halff Associates, Inc. (Halff) to facilitate discussion with communities that have adopted iSWM. This was a part of the Task Order 3 Scope of Services, specifically Task 4 'Technical Meeting of iSWM Adopters'.

The goal was to understand the challenges or problems iSWM communities have experienced under the program as well as possible solutions. In the following sections, the comments are grouped by the iSWM documents. Comments were received regarding the Construction Controls Technical Manual (Link 1), the Hydrology and Hydraulics Technical Manuals (Links 2 and 3), as well as comments about implementation and enforcement of iSWM. Additional comments were received regarding the Site Development Controls Technical Manual; however, these comments are being addressed in a separate task.

In this memorandum, Halff has summarized recommendations to address the technical issues brought up by iSWM communities. If a recommendation would require an update it is noted by red text. The potential recommendations were summarized in a webinar presentation on March 30, 2020. Based on the feedback from that webinar the recommendations were modified as needed and are included in this memorandum. The iSWM implementation subcommittee and NCTCOG staff will have responsibility for the final decisions regarding these recommendations.

COLLECTING FEEDBACK

In order to provide iSWM communities an opportunity to provide feedback, an online survey was sent from December 9, 2019 to January 31, 2020 to communities who have adopted the iSWM program. Five (5) out of nineteen (19) iSWM communities responded. See Attachment A of this memorandum for a summary of the results. This survey gave communities an opportunity to provide open ended technical feedback. The specific technical comments received from this survey is discussed in the following sections. However, some comments were sent directly to NCTCOG by email. Concerns or question regarding the iSWM program should be communicated by email to NCTCOG at iswm@nctcog.org or on the website at http://iswm.nctcog.org/contact.html.

All four comments received were regarding Section 3.9 Sediment Basin design.

COMMENT #1

- There is an inconsistent draw down time requirement. On pages CC-115 and CC-118, it states that the required drawn down time is 36 hours however, on page CC-135 of the Sediment Basin Design Procedures Step 14 (a) it states to use 6 hours

RECOMMENDATION #1

- After checking several different entities' requirements and other documentation, the majority of reviewed sources require a minimum draw down time of 24 hours or higher. These entities included NRCS which required 24-hours, City of Austin required 72 hours, and Texas Department of Transportation (TxDOT) required 40 hours. It is recommended that iSWM technical manual require a minimum dewatering time of 36 hours. To correct this in the Construction Controls technical manual, this will require a revision to the wording on page CC-135 Step 14 (a). The wording will be needed to change from a 6-hour drawdown time to 36 hours. Also, the 21,600 seconds representing 6 hours will need to be increased to 129,600 seconds representing 36 hours.

COMMENT #2

- Also, within the Sediment Basin Section 3.9, the comment was to include wording that an orifice outlet should be no less than 3" in diameter to prevent clogging issues

RECOMMENDATION #2

- This comment also does not required updates to the manual. On pages CC-135 it states "Diameter of the dewatering orifice should never be less than 3 inches in order to help prevent clogging by soil or debris"

COMMENT #3

- On page CC-125, Step 1 of the Sediment Basin Design procedures, it was requested to add a reference to the Hydrology Technical Manual for required volume calculations.
- It was also requested to clarify what is the source or origin of Equation 3.2.

RECOMMENDATION #3

- This section currently refers to Section 3.8 in the Criteria Manual which is for selecting which stormwater control is appropriate for your site. We recommend removing the reference to 3.8 of the criteria manual and replace with a reference to Section 1.0 or Table 1.1 in the Hydrologic Technical Manual to determine which hydrologic method is appropriate for their site.
- This equation is an approximate method used to estimate the volume of the proposed basin based on the dimensions already determined. This equation assumes a bowl-shaped basin and cannot be used to determine the required volume but rather is used to ensure the proposed basins meets the detention requirements.

COMMENT #4

- The last comment regarding the Sediment Basin design section is that a better explanation of surface skimmers is needed to encourage the use of them. It was suggested to highlight that surface skimmers can be reusable.
- In relation to this section it was also recommended to remove reference to a perforated riser. Since the goal of a sediment basin is to capture muddy water and allow the sediment to settle to the bottom a surface skimmer is most efficient because it works from the top down releasing the cleanest water near the surface

RECOMMENDATION #4

- In order to address this, we recommend adding wording to Section 3.9.3 on page CC-118 that surface skimmers may be reusable.
- The current TPDES General Permit (Link 4) TXR150000, Part III, Sec. F, Paragraph 2(c)i(4) on page 35 says "Unless infeasible, when discharging from sedimentation basins and impoundments, the permittee shall utilize outlet structures that withdraw water from the surface." On the last bullet point on page CC-118 it states, "A perforated riser can be used as an outlet when surface discharge is not feasible." The manual also warns that it has the lowest sediment removal efficiency. It is recommended to change the wording to "A perforated riser can be used as an outlet only when surface discharge is not feasible." Unless NCTCOG desires to not allow perforated risers as a part of the criteria at all, we do not recommend removing Figure 3.22 Schematic of Basin Embankment with Perforated Riser on page CC-124.

HYDROLOGY & HYDRAULICS TECHNICAL MANUALS

COMMENT #5

- In the Hydraulic Technical Manual Section 2.1.3, there was an error found in the frustrum of a pyramid formula. The frustrum of a pyramid formula is expressed as:
  - $V = (d/3)[A_1 + (A_1 \times A_2)^{0.5} + A_2]/3$

RECOMMENDATION #5

- Currently in the equation it includes an extra division by three which is incorrect. It is recommended to correct the equation on page HA-94 to:
  - $V = (d/3)[A_1 + (A_1 \times A_2)^{0.5} + A_2]$

COMMENT #6

- Currently the Hydraulic Manual does not include calculations for an on-grade inlet for a parabolic crowned street. The current iSWM manual utilizes HEC-12 FHWA for inlet calculations

RECOMMENDATION #6

- Currently the iSWM Hydraulic Technical Manual references the City of Austin Drainage Criteria Manual in Section 1.2.4. However, it appears that the City of Austin Drainage Criteria Manual or the iSWM Hydraulic Manual do not address on-grad inlet calculations for a parabolic crowned street. The TxDOT Hydraulics Manual (Link 5) references the Federal Highway Administrations (FHA) HEC-22 Urban Drainage Design Manual (Link 6) for gutter and inlet calculations for parabolic roadway sections on page 10-24 in Chapter 10 Section 6 of the TxDOT manual. These guidelines are located in Appendix B.3 – Spread-Discharge Relationships for Parabolic Cross Sections of the FHA HEC-22 Manual. It is recommended to consult the iSWM Subcommittee members to understand the preference to reference the City of Austin instead of the

HEC-22 manual. If there is not a strong preference to reference the City of Austin, it is recommended to remove all text in in the 'Parabolic Cross Slope' section on pages HA-14 to the end of Section 1.2.4 on page HA-16 and replace with this reference, "The FHWA publication "Urban Drainage Design Manual" (HEC-22) should be consulted for parabolic and other shape roadway sections."

COMMENT #7

- In the Hydrology Technical Manual, it was suggested that there should be a more concise section about detention sizing.
- This comment was also followed by questions regarding Section 1.5 the Modified Rational Method for detention design:
    - Is it OK to use only for preliminary design and approximation?
    - Why provide non-iterative approach when statement says it is usually done in a spreadsheet?

RECOMMENDATION #7

- There are several hydrologic methodologies discussed in the technical manual and there are several options that can be used for detention design as it depends on the specifics of the site. In Section 1.0, Table 1.1 states what hydrologic methodologies can be used for storage facilities design and Table 1.2 determines the limits of those methodologies. For this comment we recommend no update to the technical manual.
- On page HO-7 it states, "The normal use of the Modified Rational method significantly under predicts detention volumes, but the improved method in Section 1.5 corrects this deficiency in the method and can be used for detention design for drainage areas up to 200 acres."
- Reorganizing the sections for detention design throughout the hydrology and hydraulic manuals is out of the scope of this task. If deemed necessary by NCTCOG, this could be addressed when a formal review of the criteria manual and technical manuals are performed, which is not occurring at this time.

COMMENT #8

- The Soil Conservation Service (SCS) Unit Hydrograph method peak flow seems very large compared to the rational method.

RECOMMENDATION #8

- The SCS Unit Hydrograph method is used widely throughout the metroplex and the state. A potential solution is to recommend a minimum basin size for this hydrologic method. Technical Paper-149, A Method for Estimating Volume and Rate of Runoff in Small Watersheds (Link 7) published by SCS in 1973 estimates the volume and flow rate for watersheds with areas between 5 and 2,000 acres. However, it does not state 5 acres as the minimum limit for this methodology. Other sources were researched, however a verifiable source to set a minimum basin for this methodology could not be found. It is not recommended to establish a minimum recommended basin size since there is not verifiable technical references for this change. If a recommended minimum size were established, this might result in a requirement that engineers change hydrology methods for one basin when the study may include numerous basins of a slightly larger size that would benefit from the use of a unit hydrograph method. If the subcommittee prefers to acknowledge that basins smaller than 5 acres may be outside of the thresholds used to develop the method, then a note might be appropriate.

COMMENT #9

- In Section 1.3.7 Simplified SCS Peak Runoff, the method as described is not complete method. It would be preferred to just have a note referring anyone who wished to use the method to TR-55 for the full description. It is suggested to remove this section or remove equations and reference software programs. Please add reference to when, where, why this method is applicable.

RECOMMENDATION #9

- In order to address this comment, it is recommended to revise the wording on page HO-23, "The following SCS procedures were taken from the SCS Technical Release 55 (USDA, 1986) which presents simplified procedures to calculate storm runoff volume and peak rate of discharges. For full description and compliance with methodology please refer to SCS Technical Release 55 (USDA, 1986)." In the same paragraph the technical manual states, "These procedures are applicable to small drainage areas (typically less than 2,000 acres) with homogeneous land uses, which can be described by a single CN value." No further clarification is recommended at this time.

ISWM IMPLEMENTATION & ENFORCEMENT

COMMENT #10

- Clarify times when iSWM applies and when it doesn't. What if the property was platted before iSWM was adopted by municipality?

RECOMMENDATION #10

- For new developments and redevelopments, iSWM is applicable. See page 2 of the iSWM Criteria Manual for Site Development and Construction (Link 8). In Section 2.2 Step 3 of the same manual, iSWM requires the design engineer to develop and submit a Conceptual iSWM Plan before preliminary design. Regarding legal non-conforming, that is a city by city decision. One would need to contact the local municipality were the site is located. There is no recommended update to address this comment.

COMMENT #11

- Developers aren't familiar with iSWM requirements and the additional costs to comply
- Developers and engineer's dealing with the various local changes adopted by the many DFW communities.
- Training on using iSWM manual to design storm drainage pipe system

RECOMMENDATION #11

- It is recommended to incorporate these topics into NCTCOG's training agenda. Existing training materials available on the iSWM website (Link 9) that maybe be helpful are:
    - New iSWM Implementation Approach
    - Rules of Thumb for Engineers and iSWM Lessons Learned
    - iSWM Implementation Training

LINKS

1. Construction Controls Technical Manual - http://iswm.nctcog.org/Documents/technical_manual/Construction%20Controls_9-2014.pdf
2. Hydraulic Technical Manual - http://iswm.nctcog.org/Documents/technical_manual/Hydraulics_9-2014.pdf
3. Hydrology Manual - http://iswm.nctcog.org/Documents/technical_manual/Hydrology_9-2014.pdf
4. TCEQ General Permit to Discharge Under the Texas Pollutant Discharge Elimination System (TPDES) Stormwater Discharges Associated with Construction Activities TXR150000 - https://www.tceq.texas.gov/assets/public/permitting/stormwater/txr150000-cgp.pdf
5. TxDOT Hydraulic Design Manual - http://onlinemanuals.txdot.gov/txdotmanuals/hyd/hyd.pdf
6. FHWA Hydraulic Engineering Circular No.22, Third Edition Urban Drainage Design Manual - https://www.fhwa.dot.gov/engineering/hydraulics/pubs/10009/10009.pdf
7. U.S. Department of Agriculture Soil Conservation Service “A Method for Estimating Volume and Rate of Runoff for Small Watersheds” SCS-TP-149 - https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/TRsTPs/TP149.pdf
8. iSWM Criteria Manual for Site Development and Construction - http://iswm.nctcog.org/Documents/iSWM_Criteria_Manual_01142015.pdf
9. Available Training Materials - http://iswm.nctcog.org/training.html#RulesofThumb

ATTACHMENT A: ONLINE SURVEY RESULTS

- **Please check all of the components of iSWM you or your staff have utilized**

	Votes
Criteria Manual (adopted iSWM version with local changes)	5
Criteria Manual (developed City specific manual with some iSWM language)	0
Technical Manual	0
Supporting Documents & Guidance	0
Training	0

- **Where do you see is the greatest need for additional training and clarity regarding iSWM requirements?**

	Votes
For Developers	4
For Designers	1
For City staff/reviewers	0

- **Have you had challenges implementing or enforcing iSWM criteria?**

	Votes
Yes	1
No	2
Somewhat	1

- **What is the general level of concern in your community regarding the downstream impacts on other cities (water quality, erosion, trash/debris management, etc.) associated with a lack of post construction BMP implementation?**

	Votes
Very high	1
Somewhat high	2
Somewhat low	0
Very low	1

- **Has iSWM helped you achieve your communities' goals? If so, how? If not, why**

	Votes
Yes	4
No	0