Appendix E: Regional Ecosystem Framework Methodology and Calculations

The data utilized in this scoring methodology are derived from the U.S. Environmental Protection Agency (EPA) Region 6 "Geographic Information Systems Screening Tool (GISST) User's Manual," the Texas Grid, and the Regional Ecosystem Assessment Protocol (REAP).[1,2] The units used in scoring the environmental criteria are the cells of the "Texas Grid", which is at a resolution of 1 km^2. Each score represents the average score per factor for all grid cells that have more than 50 percent of their area within the defined polygon.

As stated in the Regional Ecosystem Framework (REF) User's Guide, NCTCOG has identified 10 Vital Ecosystem Information Layers (VEIL) to help identify potential environmental impacts as a result of transportation infrastructure. These layers and their corresponding source are listed in Table E.1:

Table E.1: VEIL Layers used for Regional Ecosystem Framework calculations.

Vital Ecosystem	Data Resource and Agency Acquired From	Data Utilized	Data Resolution
Wetlands	Texas GRID, EPA Region 6	USGS, 2001 National Land Cover Database	1 km^2
Surface Water	Texas GRID, EPA Region 6	USGS, National Hydrological Dataset	1 km^2
Flood zones	Texas GRID, EPA Region 6	FEMA, Digital Flood Insurance Rate Maps	1 km^2
Agricultural lands	Texas GRID, EPA Region 6	USGS, 2001 National Land Cover Database	1 km^2
Wildlife habitats	Texas GRID, EPA Region 6	USGS, 2001 National Land Cover Database	1 km^2
Natural areas	NCTCOG	North Texas 2050, Natural Policy Area	NA
Impaired water segments	Texas GRID, EPA Region 6	Texas Commission on Environmental Quality (TCEQ), 2008 Texas 303(d) List	1 km^2
Diversity	EPA Region 6	EPA Region 6, Regional Ecological Assessment Protocol (REAP)	0.25 km^2
Sustainability	EPA Region 6	EPA Region 6, REAP	0.25 km^2
Rarity	EPA Region 6	EPA Region 6, REAP	0.25 km^2

These layers can be grouped into three major categories of ecological significance or concern.

Green Infrastructure
- Wildlife Habitat
- Natural Areas
- Agricultural Land

Water Quality and Flooding
- Impaired water segments
- Flood zones
- Surface Water Quantity
- Wetlands

Ecosystem Value
- Rarity
- Diversity
- Sustainability

The Natural Areas layer was determined by NCTCOG during the development of North Texas 2050 and identifies those areas considered to be "natural." The nine other layers are cited at the end of this appendix with an accompanying description of the data sources used by EPA and the scoring assessment made to assign individual grid cells a score of 1 to 5 and in one case, 0 to 5.

Convert Grid Cells to Subwatersheds

The methodology to convert the 1 km^2 grid cells to watersheds involved assigning a subwatershed label to each grid cell. This was done utilizing GIS to select those grid cells with their centroids in a selected subwatershed. The total number of subwatersheds that corresponded to the GISST data numbered 282 and cover nearly all of the metropolitan planning area (MPA) boundary.

Calculate Subwatershed Averages for VEIL and Policy Area Layers

This step required the utilization of the following data sets and associated scores located in the GISST data set. This data set was acquired from the Texas Department of Transportation (TxDOT) and it includes a combination of layers from the REAP and Texas Grid. These scores were assigned according to the methodology set forth by EPA and other partners as shown at the end of this appendix:

- DensSC – Surface Water Quantity Score
- Impaired – Clean Water Act 303(d) Segments (State Priority Data) Score
- FloodSc – Floodplain Score
- AgSc – Agricultural Lands Score
- WetSc – Wetlands Score
- WlhSc – Wildlife Habitat Score
- REAPDive – REAP Diversity Score
- REAPSust – REAP Sustainability Score
- REAPRare – REAP Rarity Score

All grid cells for each subwatershed were averaged to produce an average score for each subwatershed for the 9 data fields. The following is a representation of the grid cells and watershed boundary and the averaging method.

Each grid cell in GISST is assigned a value of 0 to 5 or 1 to 5. For example, the bold line in Figure E.1 represents a subwatershed boundary and the grid cells correspond with the following scores assigned: Red = 5, Yellow = 3, and Green = 1. The scores were averaged to create one value for each VEIL layers. In this example, the grid scores add to 28 and there are 12 cells producing an average of 2.333. This method was utilized to calculate averages for each subwatershed for nine VEIL layers.

Calculating VEIL Scores

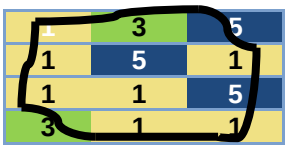


Figure E.1: Subwatershed scores were calculated by averaging the grid cell scores to create one value for each VEIL layer. The bold line represents a watershed boundary.

The Natural Area VEIL layer was calculated by using North Texas 2050[3] Policy Areas by Subwatershed database shown in Appendix G. This database provides the percent Natural Area for each of the 282 subwatersheds. An IF/THEN statement was used to assign Natural Area scores based on the following percentages of each subwatershed's area being "natural."

Table E.2: Natural Area score conversion chart.

Percent of Area that is Natural	Assigned Score
<20%	**1**
20 - 29%	**2**
30 - 39%	**3**
40 - 49%	**4**
>50%	**5**

All averages and the natural area score are determined as shown for the example subwatershed in Table E.3 below.

Table E.3: Example average scores for the 10 VEIL layers for subwatershed with a 12-digit hydrologic unit code (HUC) name of: 111403010101.

Ave of DensSc	Ave of FloodSc	Ave of Impaired	Ave of AgSc	Ave of WetSc	Aveof WlhSc	Ave of REAP	Ave of REAP	Ave of REAP Rare	NAT_ SCORE
1.506060606	0	1.238383838	2.96969697	1.005050505	3.702020202	1.048484848	1.84040404	1.998989899	1

Determine scoring based on natural breaks

Once an average is determined, a score of 1 to 5 is assigned to each layer by subwatersheE. By utilizing the "Natural Breaks (Jenks)" by 5 classes in GIS, these breaks are used to determine which class the averages calculated above fall within. Table E.4 provides an example of six subwatersheds and their corresponding average of the REAP Rarity scores. The averages for all 282 subwatersheds are broken into the Natural Break categories and assigned the corresponding scores. See Table E.5 for an example.

Table E.4: Example REAP Rarity average VEIL scores for several subwatersheds.

HUC12_Name	Average of REAPRare
111403010101	1.998989899
111403010102	2.797250859
111403010103	2.203484321
111403010104	2.535121951
111403010105	2.493010252
111403010201	2.386409061

Table E.5: REAP Rarity natural breaks and corresponding VEIL score.

Rarity	SCORE
<1.36330000	**1**
1.36330001 - 2.3183	**2**
2.31830001 - 2.9939	**3**
2.99390001 - 3.5131	**4**
>3.51310001	**5**

An IF/THEN statement is applied to assign scores based on the natural breaks to determine the corresponding scores for each subwatershed as shown in Table E.6 (a combination of Table E.4 and E.5).

Table E.6: Example subwatersheds with assigned VEIL scores based on natural breaks for REAP Rarity.

HUC12_Name	Average of REAPRare	WS_RARSCScore
111403010101	1.998989899	2
111403010102	2.797250859	3
111403010103	2.203484321	2
111403010104	2.535121951	3
111403010105	2.493010252	3
111403010201	2.386409061	3

Once each VEIL layer has a corresponding table such as Table E.6, the scores for each VEIL layer can be summed to produce a Total VEIL Score as shown in Table E.7.

Table E.7: A subwatershed's composite score based on the 10 VEIL layers.

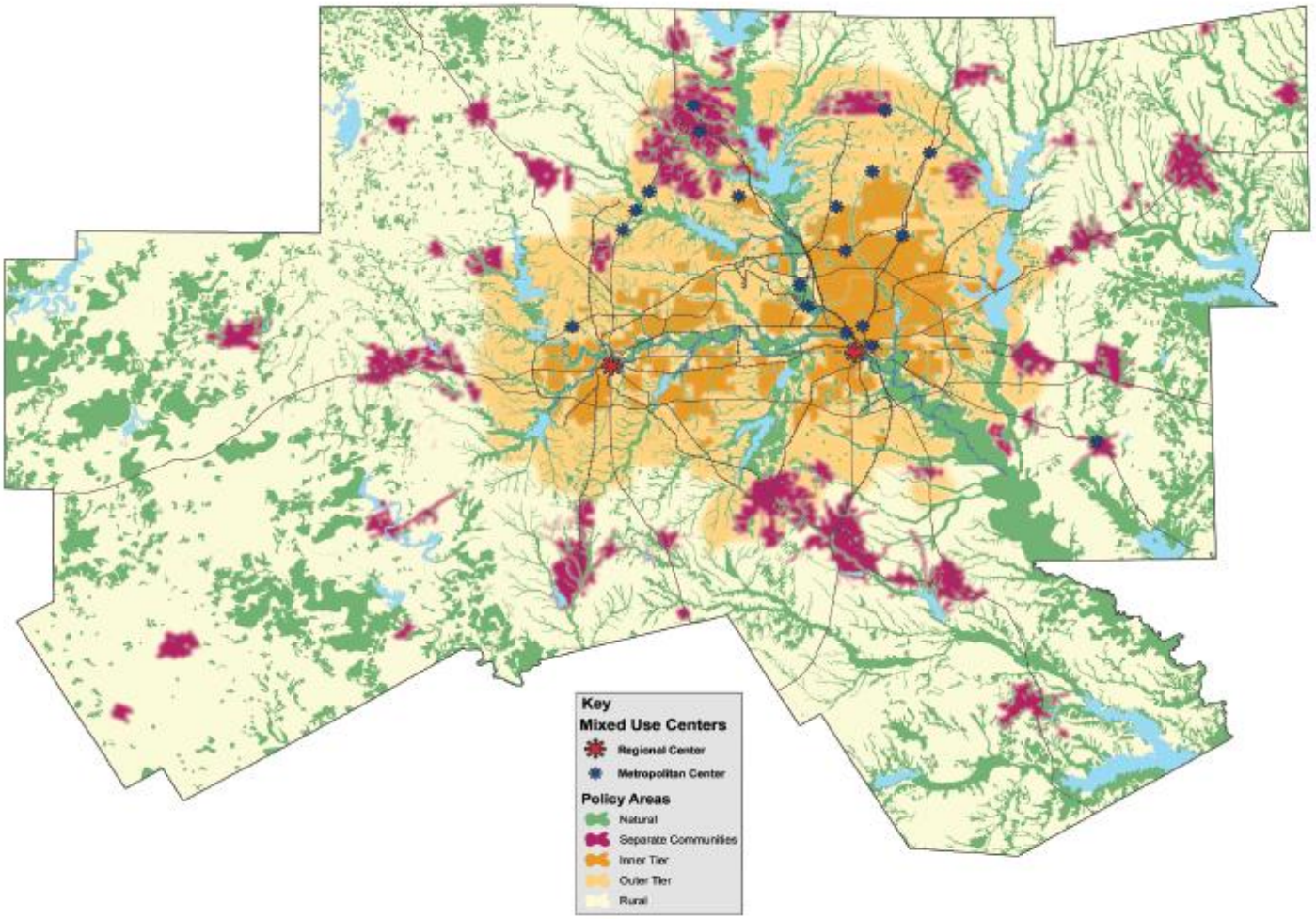
WS_DensSC	WS_FloodSC	WS_ImpairedSC	WS_AGSC	WS_WetlandSC	WS_WLHSC	WS_DIVSC	WS_SUSSC	WS_RARSC	WS_NaturalSC	WS_VTOTSC
2	1	2	4	1	3	1	4	3	1	**22**

Determine Policy Area Scores by VEIL Layer and Subwatershed

Five North Texas 2050 Policy Areas including Natural, Rural, Separate Community, Outer Tier, and Inner Tier areas are used to determine policy area scores by subwatershed. The percentages of each policy area type were provided in the North Texas 2050 Policy Areas by Subwatershed file developed through the Vision North Texas (VNT) program.

Figure E.2 displays the North Texas 2050 Policy Areas and preferred physical development pattern for 2050. This exhibit shows the five policy areas for the North Texas region that correspond to those used in the following REF Policy Area scoring discussion.

Figure E.2. North Texas 16-County Preferred Physical Development Pattern for 2050



Discussion of assigning scores of relative VEIL layer importance in each policy area

The scores shown in Table E.8 indicate the relative importance of each VEIL layer as it is associated with the identified policy area. A scale of 1 to 5 is used with 1 meaning least important and a 5 being most important in the associated policy area. For example, a wetland in a natural environment is of high value to that ecosystem while a wetland in an urbanized, inner tier area is probably of lower value in terms of value to the ecosystem. While these scores represent one value, in reality scores are relative to the specific project, area, and extent to which something is present in a particular policy area. Discussions with resource agencies revealed there may need to be alternate approaches to scoring the relative importance of VEIL layers in individual policy areas depending on the desired goals. For example, the U.S. Army Corps of Engineers (USACE) suggested that a wetland in an Inner Tier/Urbanized area may in fact be most important because it is rare and should therefore be preserved. As discussed in the REF User's Guide, the two approaches of preservation versus restoration are considered important when determining future mitigation options.

Table E.8: VEIL layer and assigned relative importance by Policy Area.

VEIL	Natural	Rural	Separate Community	Outer Tier	Inner Tier
Wetland	5	4	2	3	1
Impaired	5	2	4	3	1
Surface Water Quantity	5	3	4	2	1
Rarity	5	3	4	2	1
Sustainability	5	3	4	2	1
Wildlife Habitat	5	3	4	2	1
Diversity	5	3	4	2	1
Floodplain	1	2	3	4	5
Agricultural	2	5	4	3	1
Natural	2	5	4	3	1

To determine a score for a wetland in a subwatershed the following formula is applied:

Subwatershed Policy Area Score = (%Natural*5) + (%Rural*4) + (%Separate*2) + (%Outer*3) + (%Inner*1) / 100

All 282 subwatersheds will have a score for each VEIL layer. Similar to determining and assigning a score of 1 to 5 for VEIL layers as discussed previously, the scores for each VEIL layer by Policy Area are determined by using Natural Breaks (Jenks) and 5 classes in GIS. Table E.9 provides an example of six subwatersheds and their corresponding Policy Area scores for the REAP Rarity VEIL layer. Table E.10 provides the associated scores of 1 to 5 for REAP Rarity based on Policy Area percentages by Natural Breaks.

Table E.9: Example REAP Rarity Policy Area scores for several subwatersheds.

HUC12_Name	PA_Rar_WTG
111403010101	2.12310000000
111403010102	0.75700000000
111403010103	3.33800000000
111403010104	3.47580000000
111403010105	2.63190000000
111403010201	2.91290000000

Table E.10: REAP Rarity natural breaks and corresponding Policy Area score for that VEIL.

Scoring	Rarity Score
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5

An IF/THEN statement is applied to all VEIL Layers to determine the corresponding scores for each subwatershed as shown in the example in Table E.11. The VEIL and Policy Area Scores and Natural Breaks are shown for all VEIL layers in Table E.12.

Table E.11: Example subwatersheds with corresponding Policy Area scores based on natural breaks for REAP Rarity.

HUC12_Name	PA_Rar_WTG	PA_RarSC
111403010101	2.12310000000	2
111403010102	0.75700000000	1
111403010103	3.33800000000	4
111403010104	3.47580000000	4
111403010105	2.63190000000	3
111403010201	2.91290000000	3

PA_Rar_WTG

Summing the Policy Area scores for each of the 10 VEIL layers does not really tell the appropriate story. The Policy Area layers, rather, are meant to be utilized as overlays to the VEIL individual layers to provide a screening tool when determining whether perhaps preservation or restoration is more desired and what potential mitigation strategies may be most effective for the indicated resource.

Figures E.2 through E.21 display the outcome of this methodology for each of the 10 VEIL layers and the resultant overlay maps for the Policy Areas by VEIL resource. Red indicates those subwatersheds that are either 1) provide constitute green infrastructure (wildlife habitat, natural areas, agricultural land) and/or, 2) indicate subwatersheds that have water quality concerns such as impaired water segments and flood zones where development should be cautioned; and/or 3) indicate the relative presence or quantity of rare, diverse, or sustainable areas when compared to the rest of the eco-region in an individual subwatershed. Green indicates those subwatersheds that offer lower ecological value, and/or have good water quality, and/or provide lower levels of rarity, diversity, or sustainability when compared to the rest of the subject eco-region.

The Vision North Texas and North Texas 2050 defined Policy Areas include:

Table E.12: VEIL and Policy Area scores based on natural breaks.

VEIL SCORES	
Natural Areas	**SCORE**
<20%	1
20 - 29%	2
30 - 39%	3
40 - 49%	4
>50%	5
Surface Water Quantity	**SCORE**
<1.425656	1
1.425657-1.567416	2
1.567417-1.707410	3
1.704110-01.895494	4
>1.895495	5
Floodplain	**SCORE**
< 0.268398	1
0.268399 - 0.962039	2
0.962040 - 1.739914	3
1.739915 - 2.276340	4
> 2.276341	5
Impaired	**SCORE**
<1.084130	1
1.084131 - 1.323843	2
1.323844 - 1.808081	3
1.808082 - 2.488372	4
>2.488373	5
Agricultural	**SCORE**
<1.425160	1
1.425161 - 2.043981	2
2.043982 - 2.743251	3
2.743252 - 3.473971	4
>3.473972	5
Wetland	**SCORE**
<1.029211	1
1.029212 - 1.084102	2
1.084103 - 1.184615	3
1.184616 - 1.345038	4
>1.345039	5
Wildlife Habitat	**SCORE**
<2.340485	1
2.340486 - 3.182827	2
3.182828 - 3.772308	3
3.772309 - 4.371589	4
>4.371590	5
Diversity	**SCORE**
<1.175789	1
1.175790 - 1.435927	2
1.435928 - 1.757735	3
1.757736 - 2.218967	4
>2.218968	5
Sustainability	**SCORE**
<1.152672	1
1.152673 - 1.429217	2
1.429218 - 1.765892	3
1.765893 - 2.170646	4
>2.170647	5
Rarity	**SCORE**
<1.371700	1
1.371701 - 1.823110	2
1.823111 - 2.207851	3
2.207852 - 2.650132	4
>2.650133	5

POLICY AREA SCORES	
Natural Areas	**SCORE**
<1.58900000	1
1.58900001 - 2.62114900	2
2.62114901 - 3.42680000	3
3.42680001 - 4.18690000	4
>4.18690001	5
Surface Water Quantity	**SCORE**
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5
Floodplain	**SCORE**
<1.10180000	1
1.10180001 - 1.72710000	2
1.72710001 - 2.26020000	3
2.26020001 - 2.84570000	4
>2.84570001	5
Impaired	**SCORE**
<1.50937900	1
1.50937901 - 2.36107900	2
2.36107901 - 2.84600000	3
2.84600001 - 3.34259400	4
>3.34259401	5
Agricultural	**SCORE**
<1.58900000	1
1.58900001 - 2.62114900	2
2.62114901 - 3.42680000	3
3.42680001 - 4.18690000	4
>4.18690001	5
Wetland	**SCORE**
<1.60133200	1
1.60133201 - 2.61126600	2
2.61126601 - 3.44990000	3
3.44990001 - 4.00130000	4
>4.00130001	5
Wildlife Habitat	**SCORE**
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5
Diversity	**SCORE**
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5
Sustainability	**SCORE**
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5
Rarity	**SCORE**
<1.36330000	1
1.36330001 - 2.31830000	2
2.31830001 - 2.99390000	3
2.99390001 - 3.51310000	4
>3.51310001	5

Regional Ecosystem Map Resources Guide – VEIL Layers

Figure E.1: Regional Ecosystem Framework VEIL Composite Score

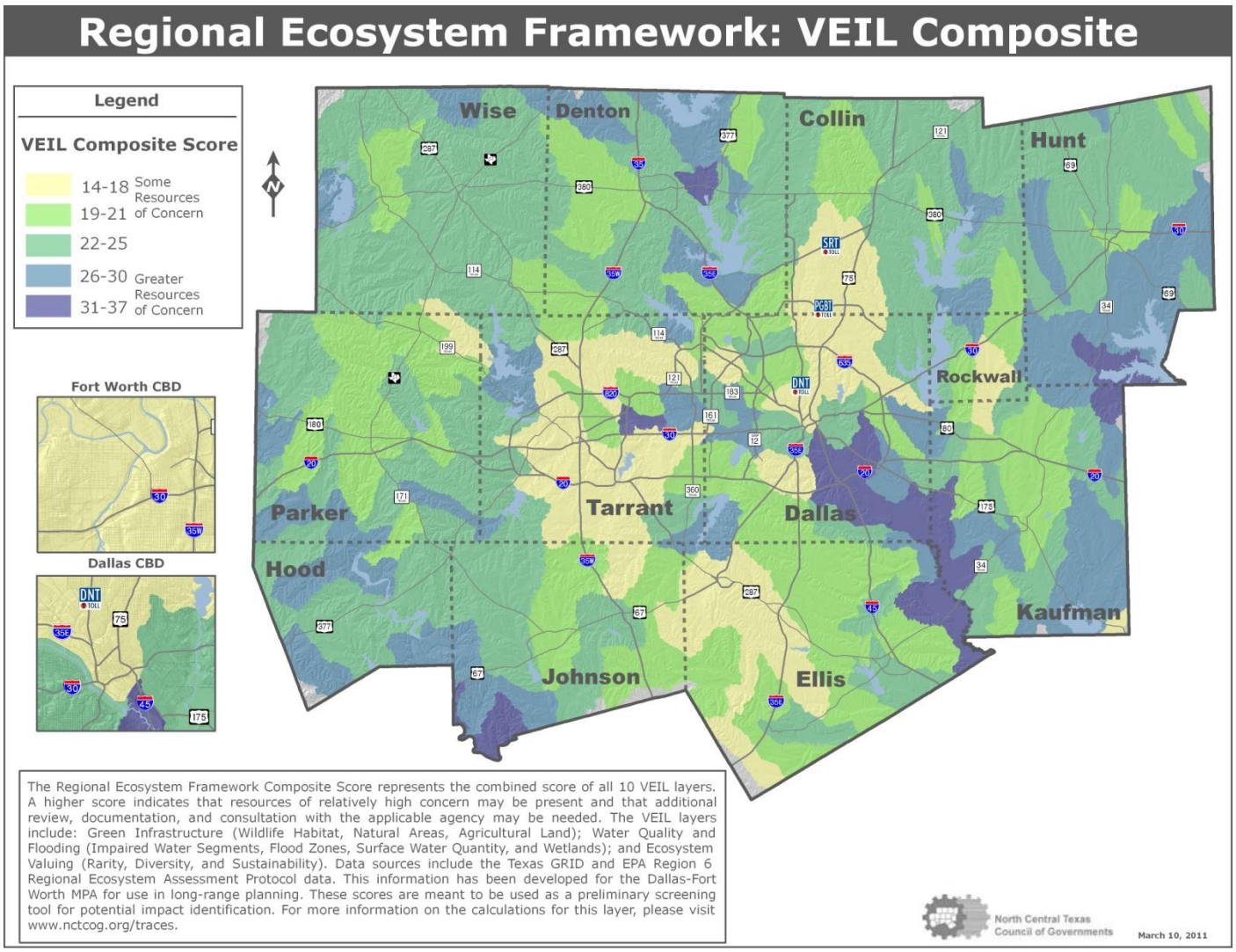


Figure E.2: Regional Ecosystem Framework Agricultural Lands Score

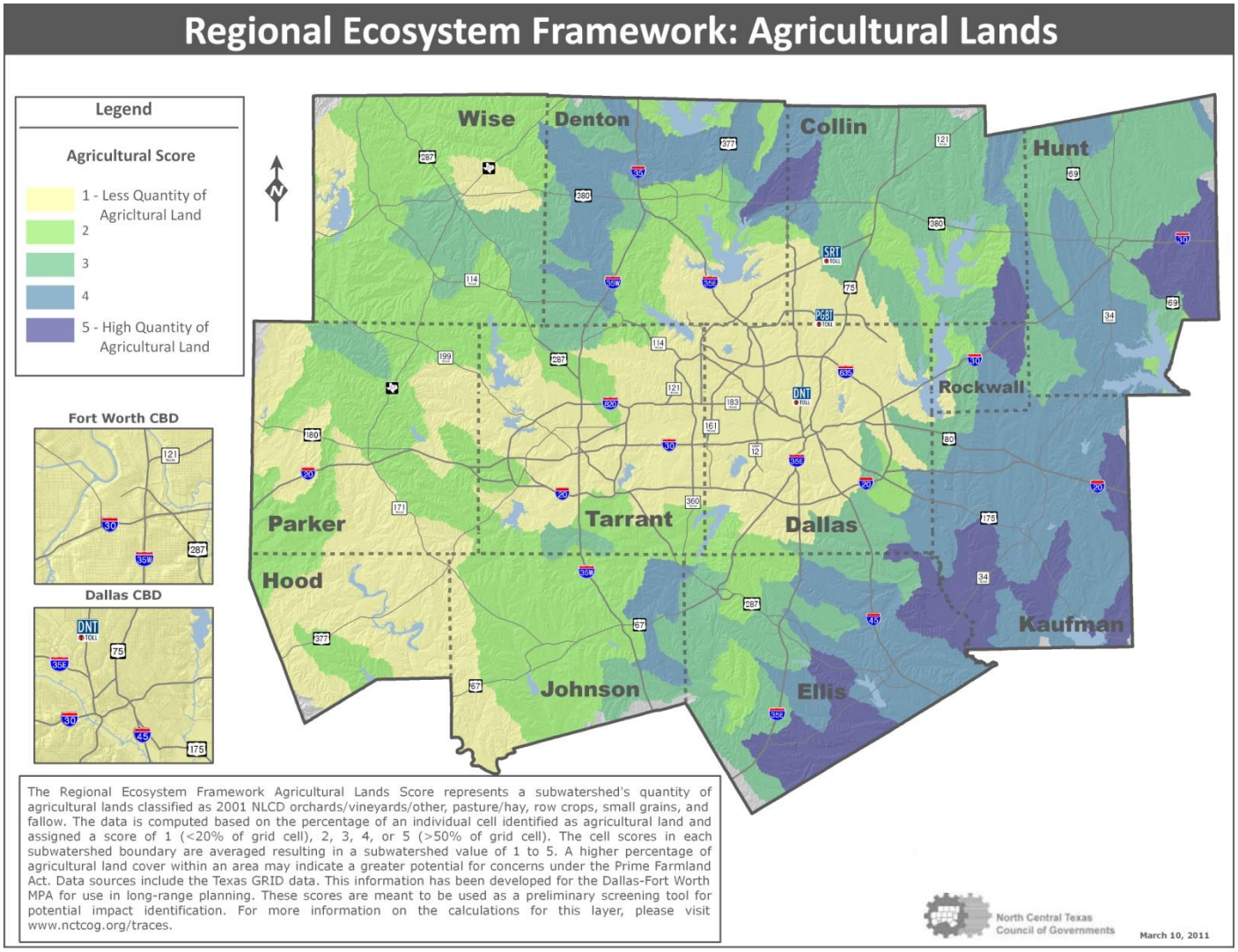


Figure E.3: Regional Ecosystem Framework Diversity Score

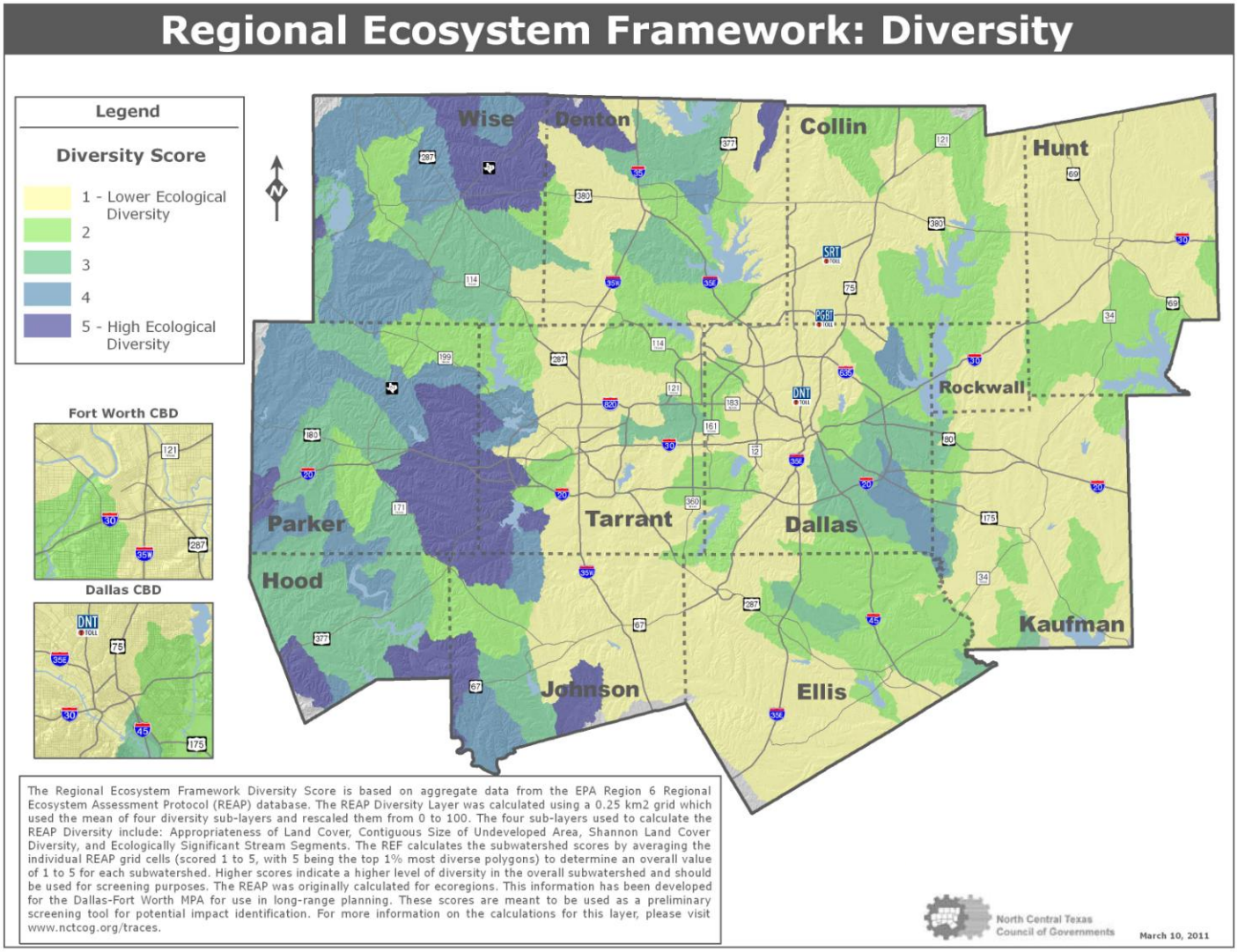


Figure E.4: Regional Ecosystem Framework Flood Zones Score

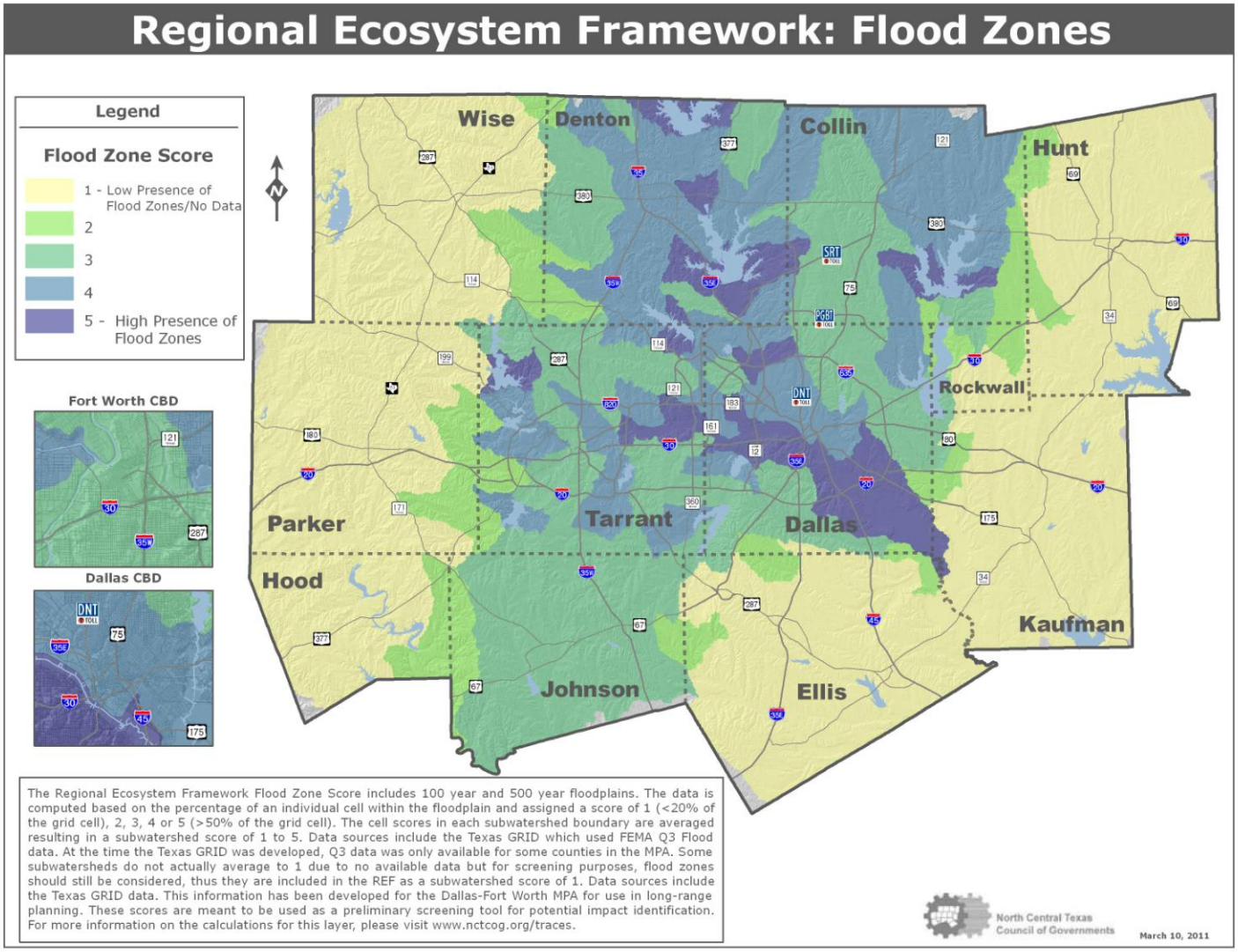


Figure E.5: Regional Ecosystem Framework Impaired Water Segment Score

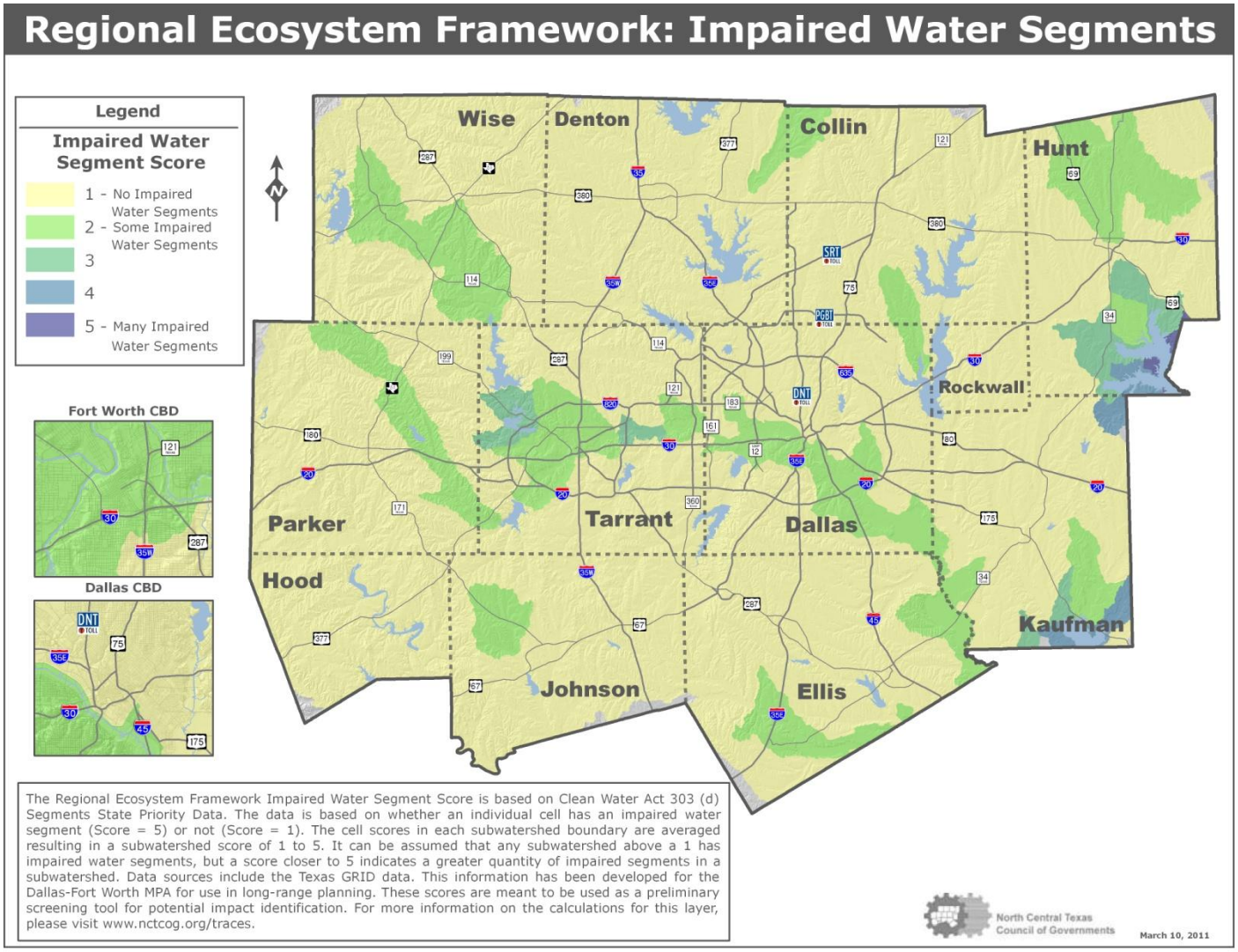


Figure E.6: Regional Ecosystem Framework Natural Areas Score

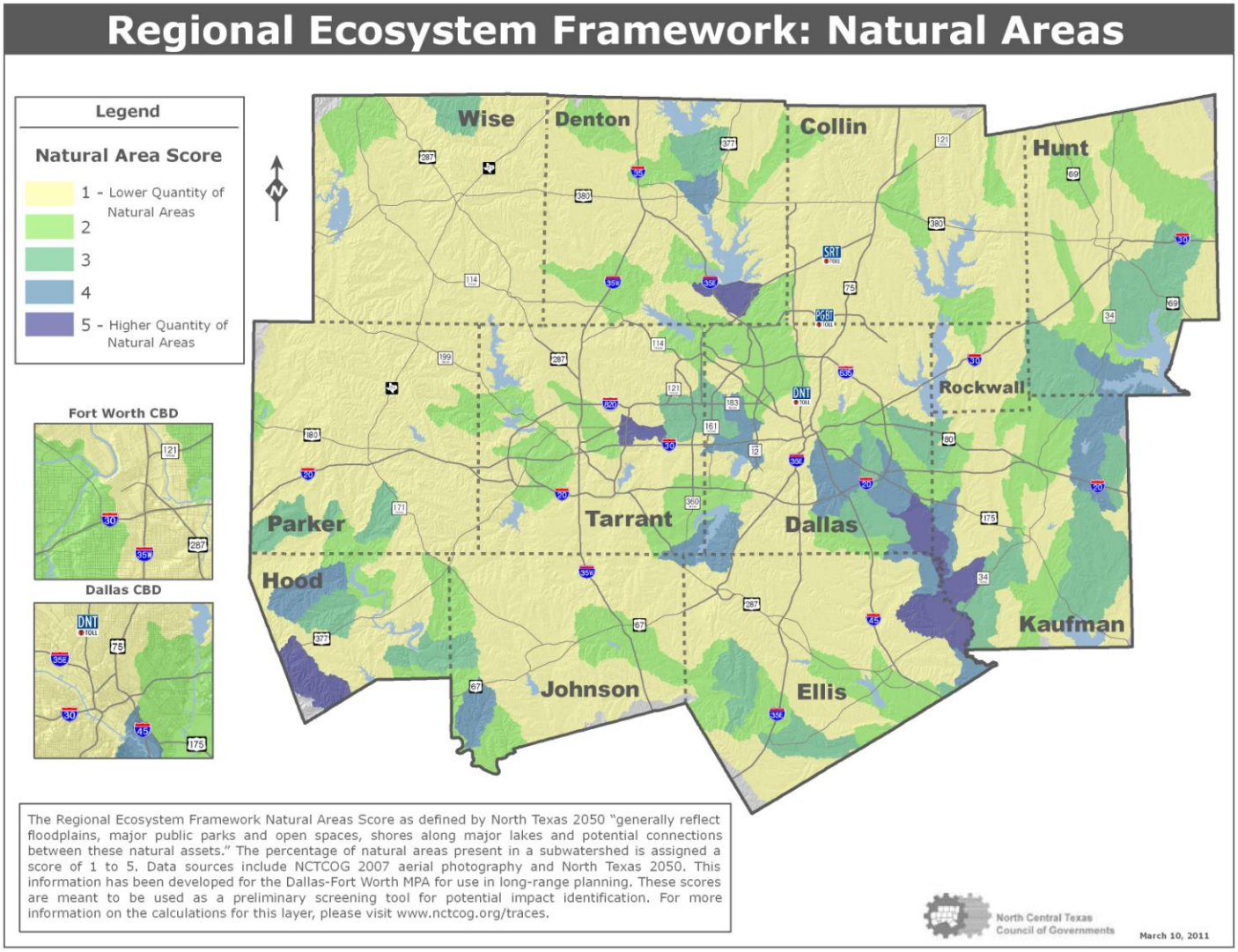


Figure E.7: Regional Ecosystem Framework Rarity Score

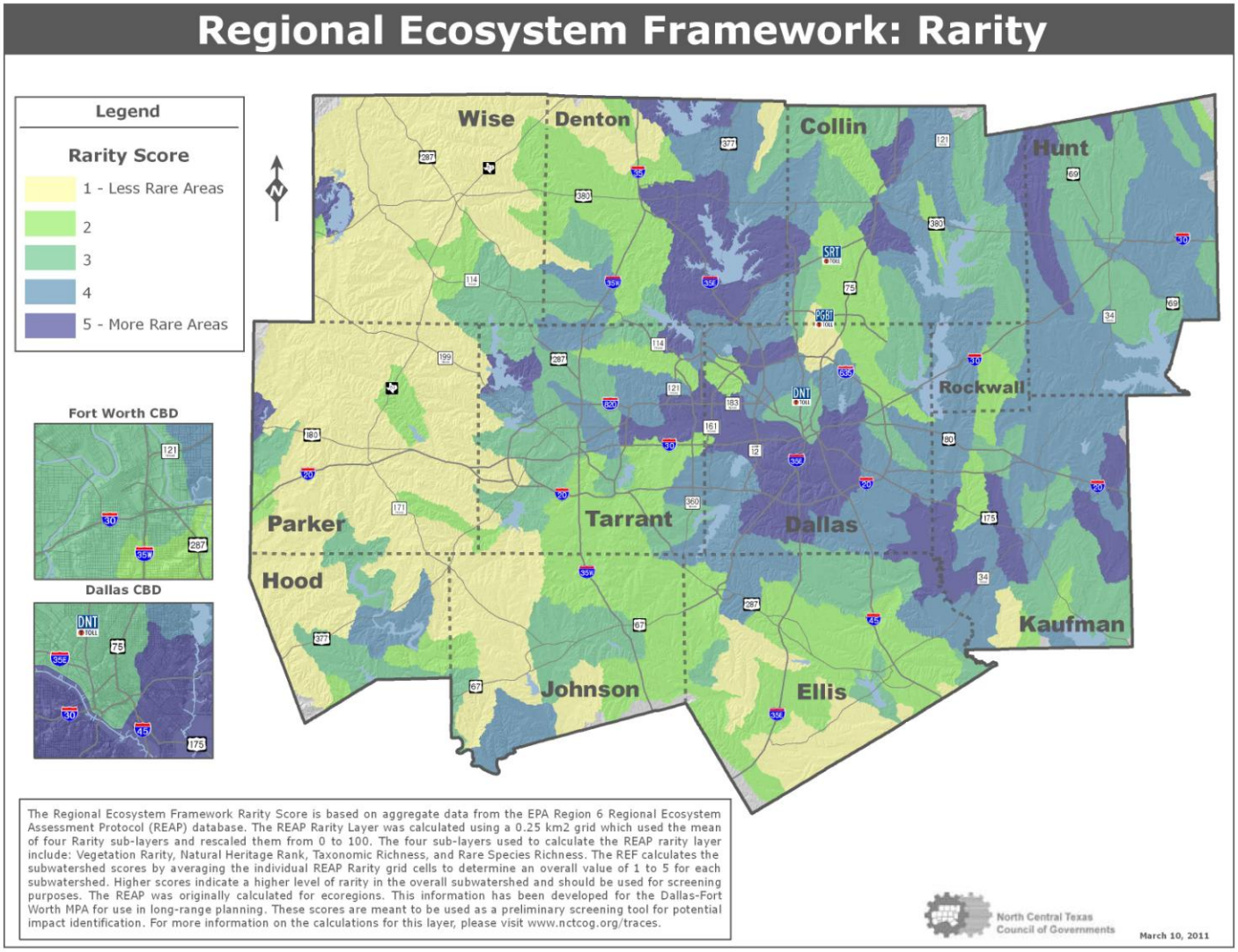


Figure E.8: Regional Ecosystem Framework Surface Water Quantity Score

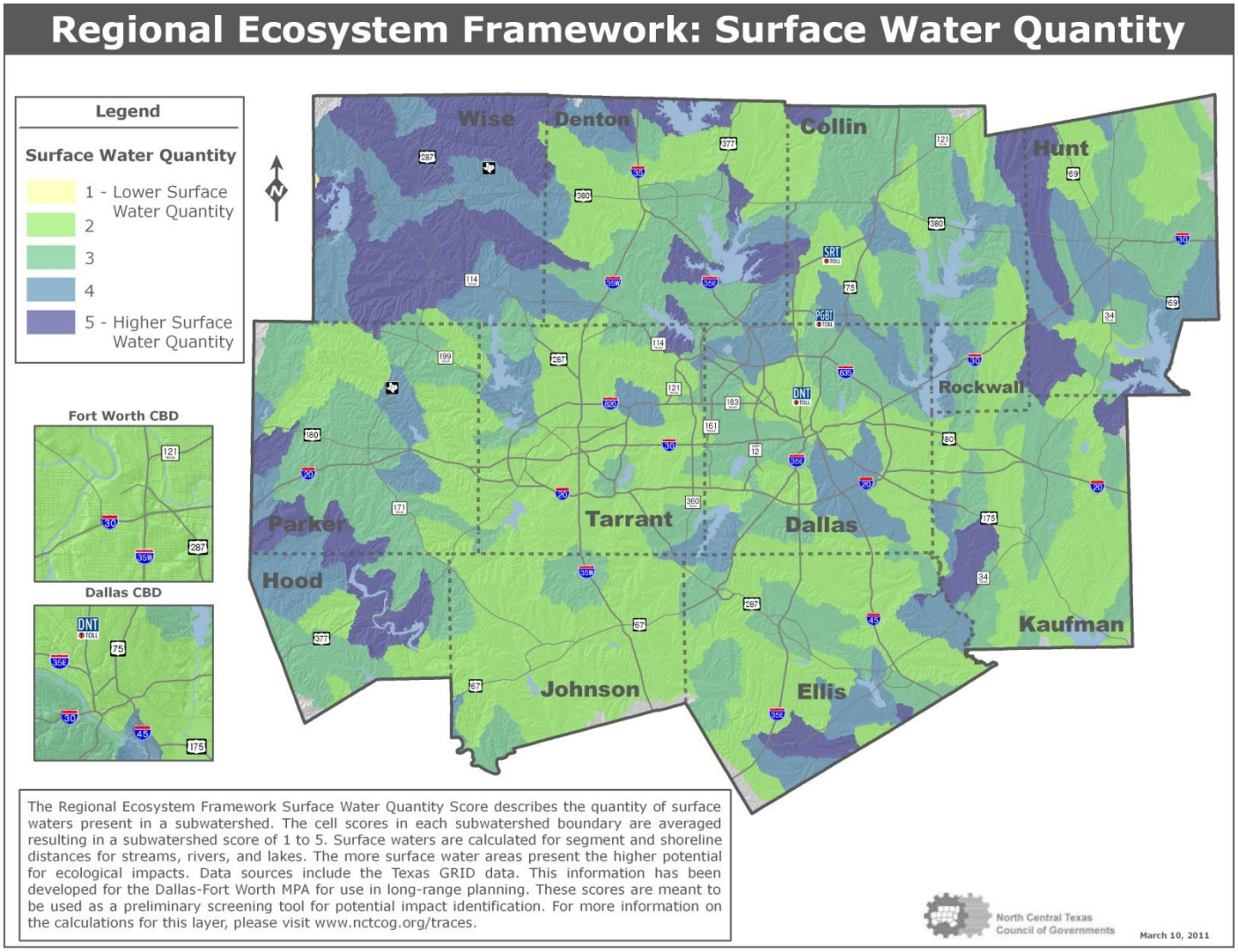


Figure E.9: Regional Ecosystem Framework Sustainability Score

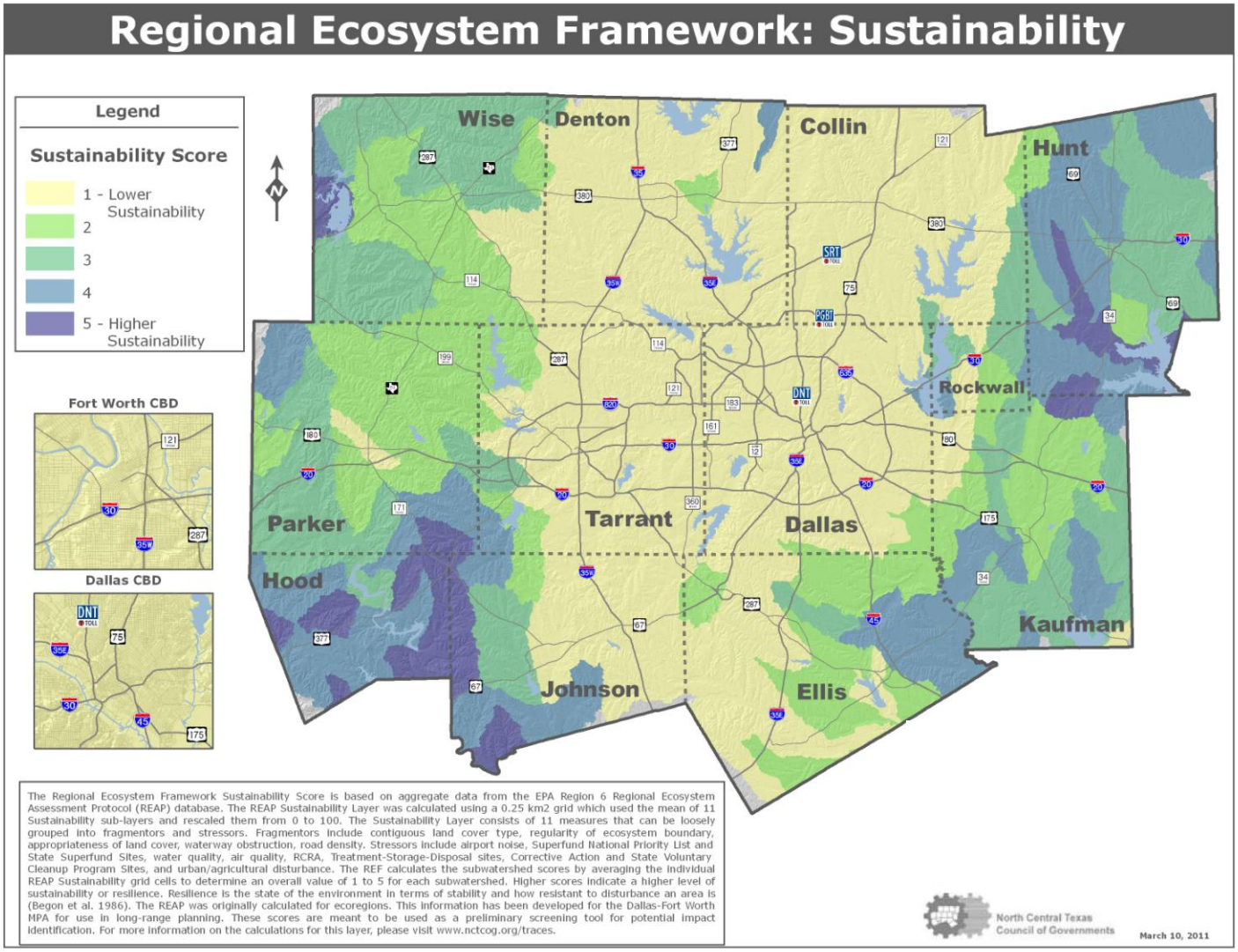


Figure E.10: Regional Ecosystem Framework Wildlife Habitat Score

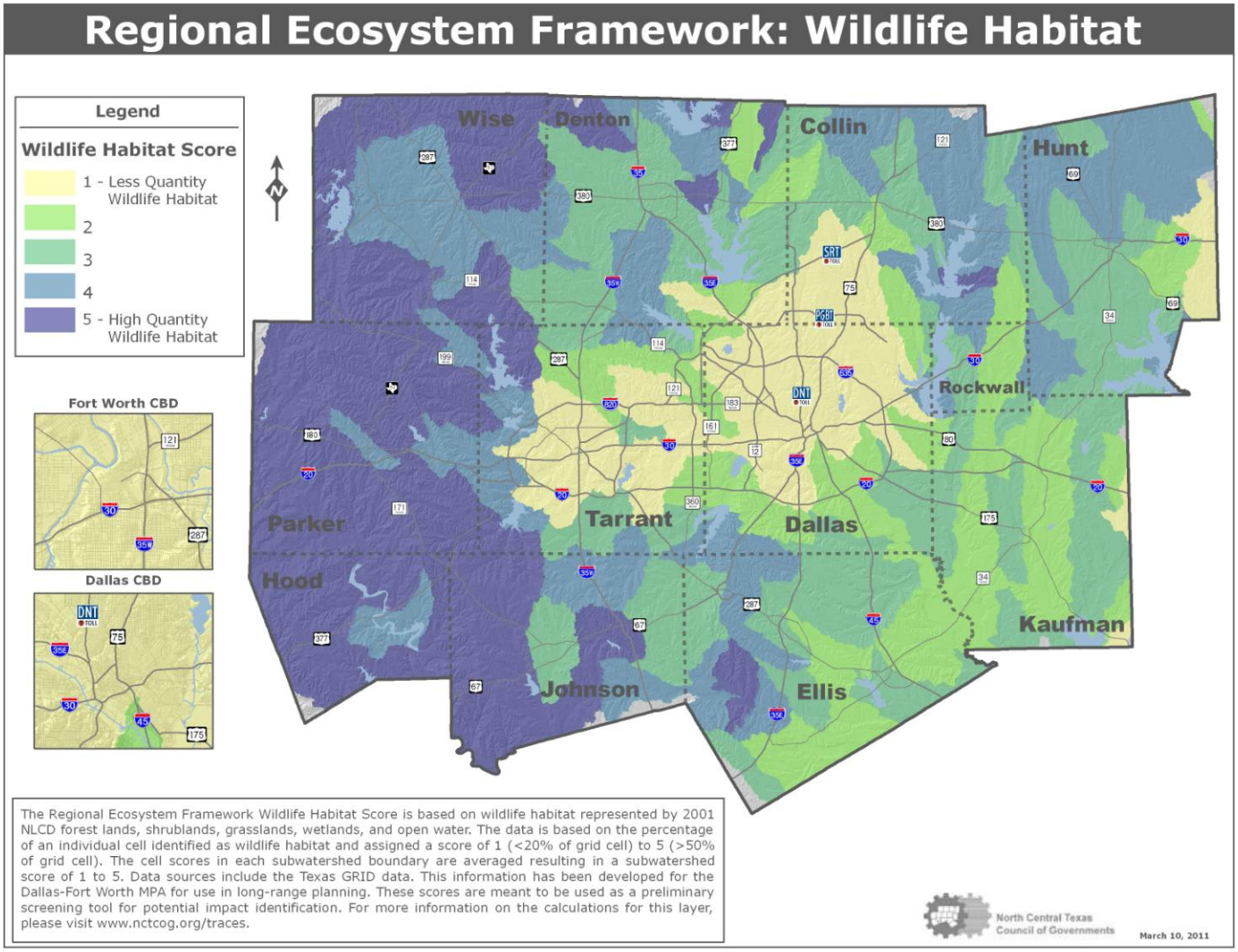
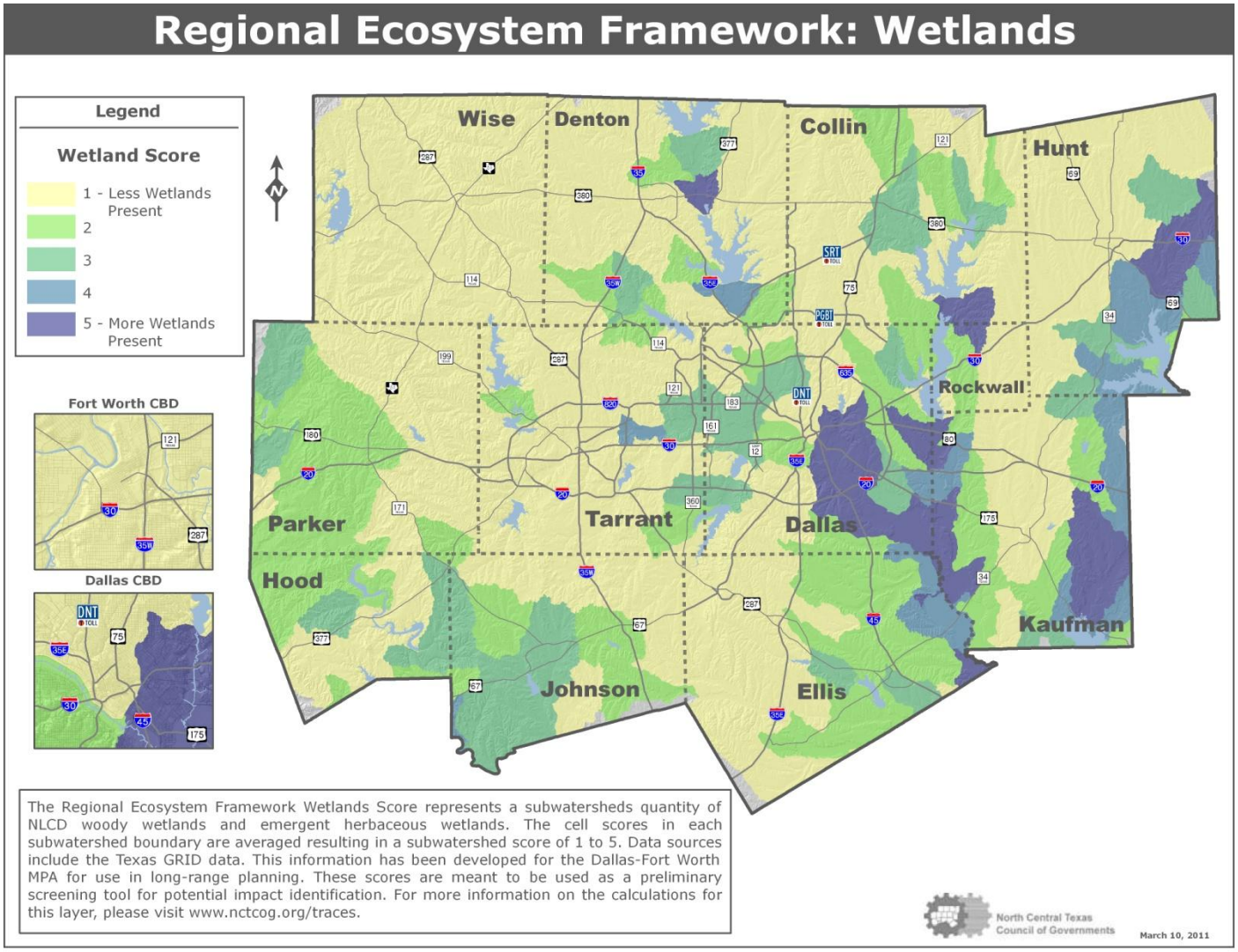


Figure E.11: Regional Ecosystem Framework Wetlands Score



Regional Ecosystem Map Resources Guide – VEIL Layers by North Texas 2050 Policy Areas

Figure E.12: Scores by subwatershed for the Agricultural Lands by Policy Area in the 12-county MPA. These scores are based on the following scale for agricultural lands in by each North Texas 2050 defined policy area: Natural = 2; Rural = 5; Separate Community = 4; Outer Tier = 3; and Inner Tier = 1.

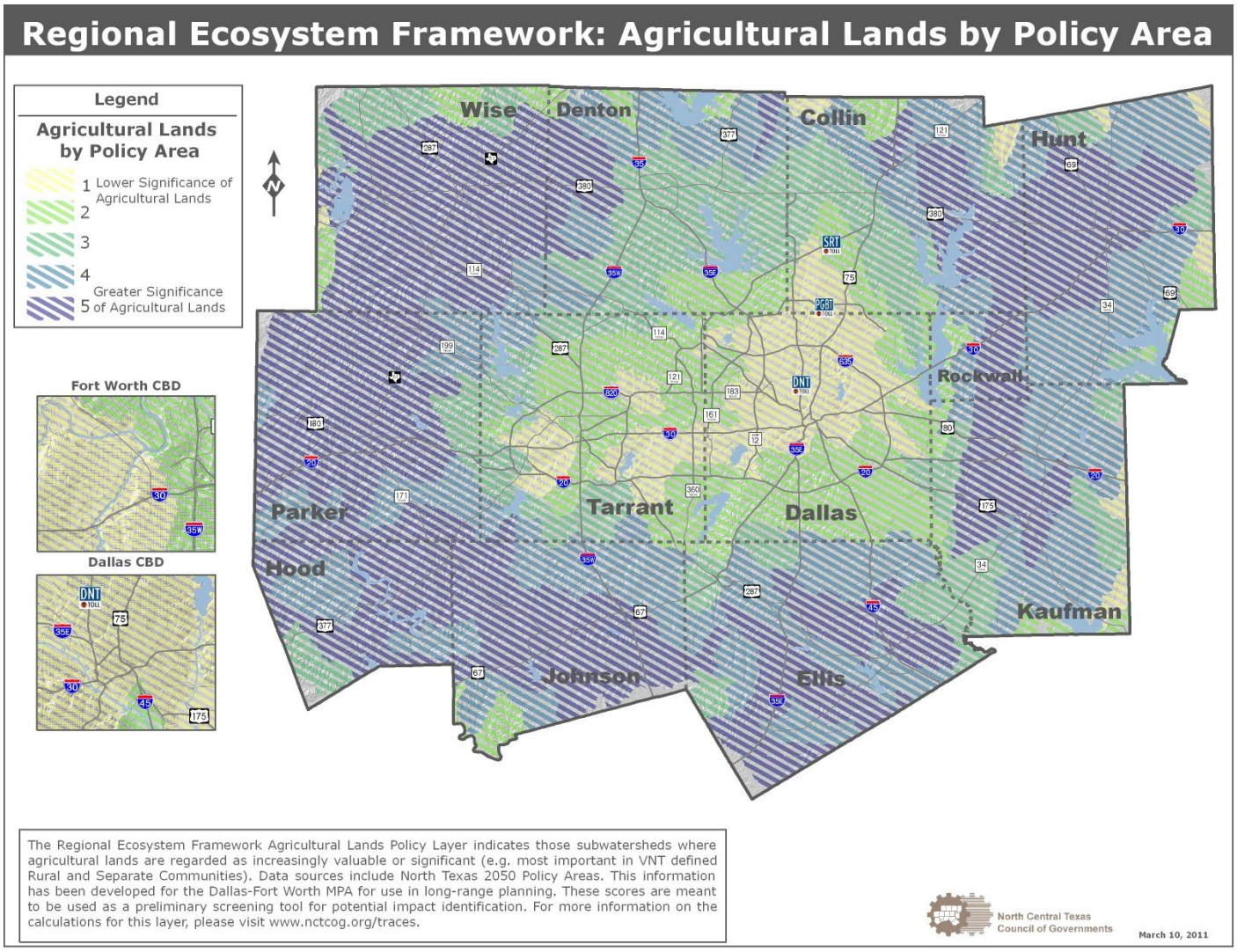


Figure E.13: Scores by subwatershed for the REAP Diversity by Policy Area in the 12-county MPA. These scores are based on the following scale for diversity by each North Texas 2050 defined policy area: Natural = 5; Rural = 3; Separate Community = 4; Outer Tier = 2; and Inner Tier = 1.

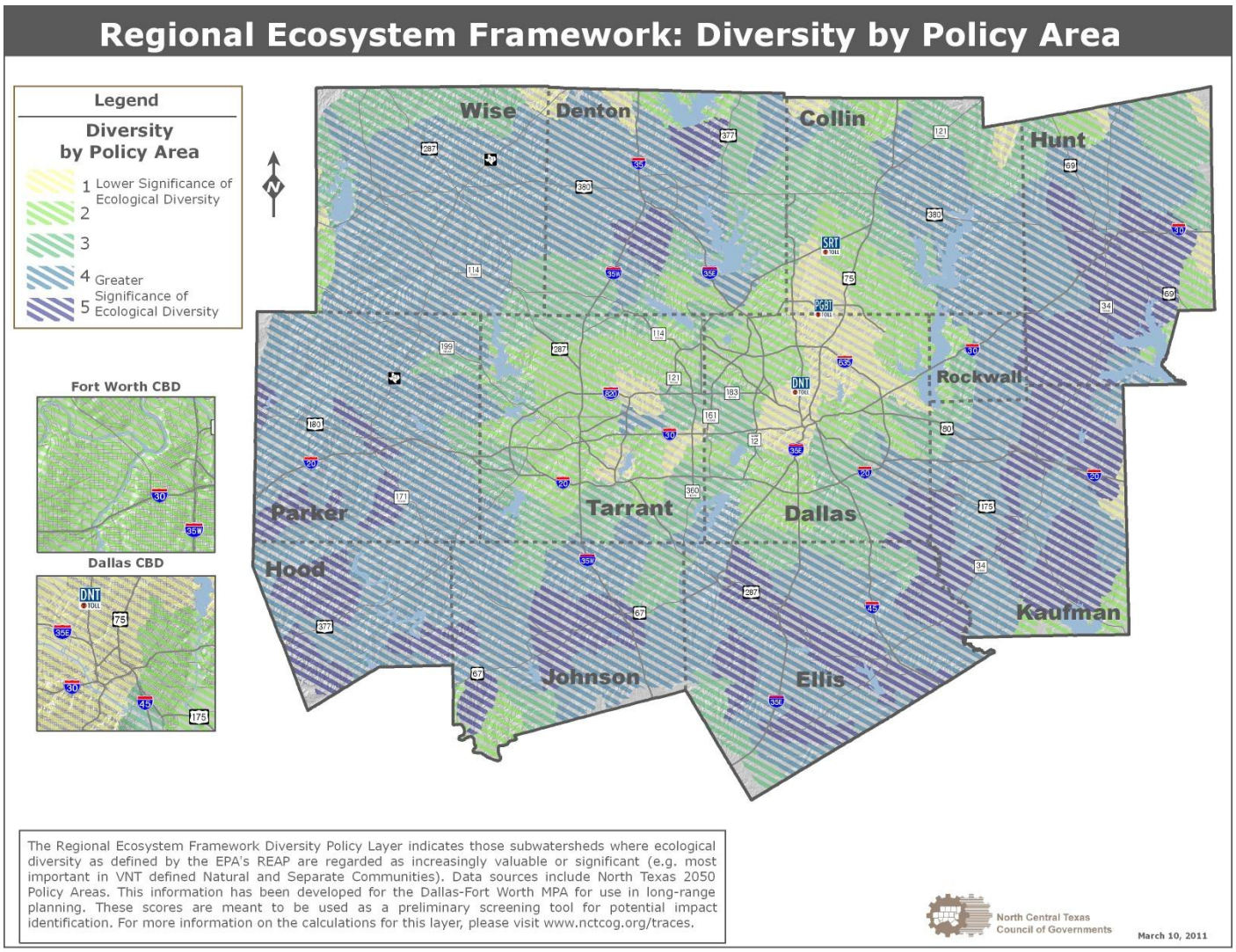


Figure E.14: Scores by subwatershed for the Flood Zones by Policy Area in the 12-county MPA. These scores are based on the following scale for flood zones by each North Texas 2050 defined policy area: Natural = 1; Rural = 2; Separate Community = 3; Outer Tier = 4; and Inner Tier = 5.

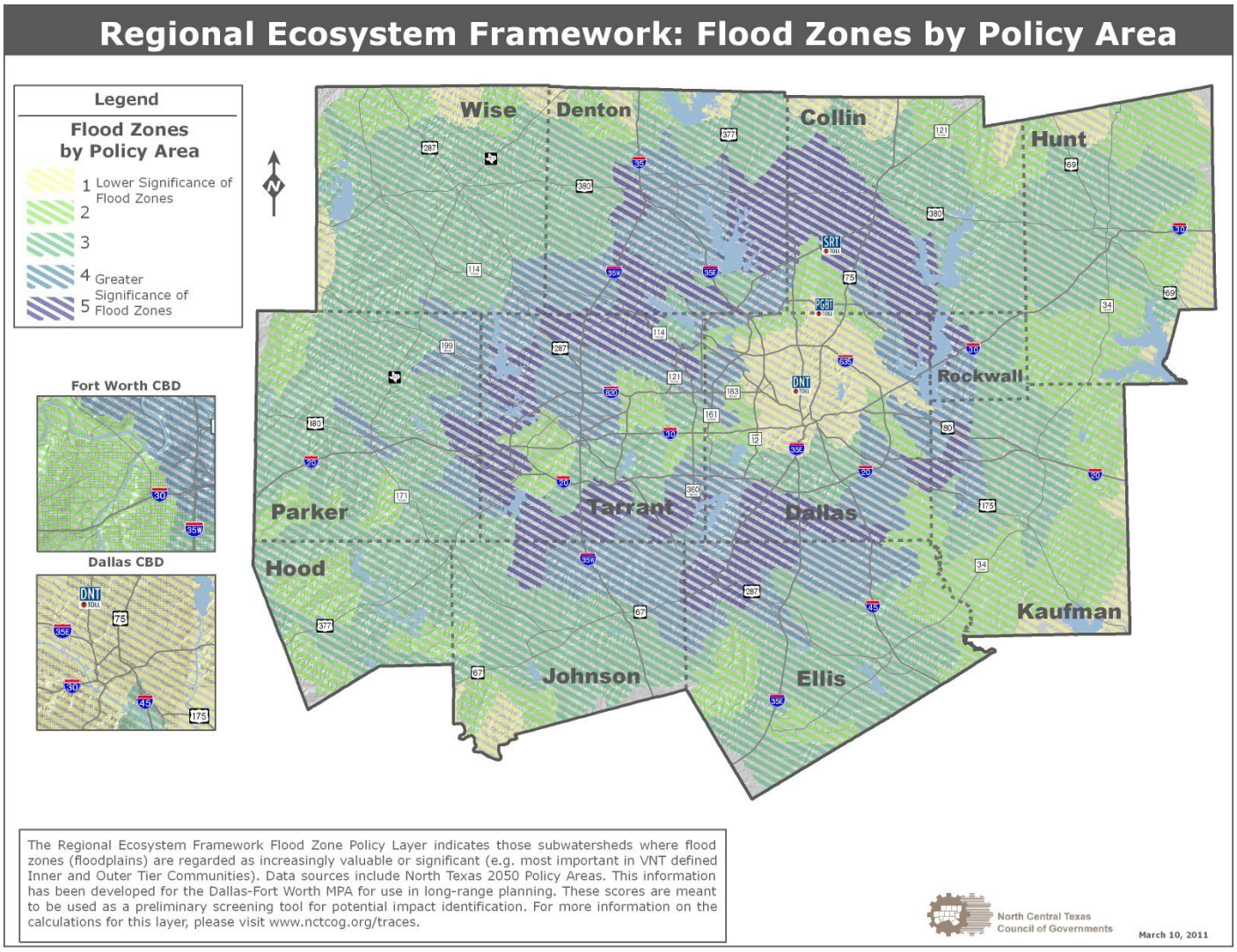


Figure E.15: Scores by subwatershed for the Natural Areas by Policy Area in the 12-county MPA. These scores are based on the following scale for natural areas in by each North Texas 2050 defined policy area: Natural = 2; Rural = 5; Separate Community = 4; Outer Tier = 3; and Inner Tier = 1.

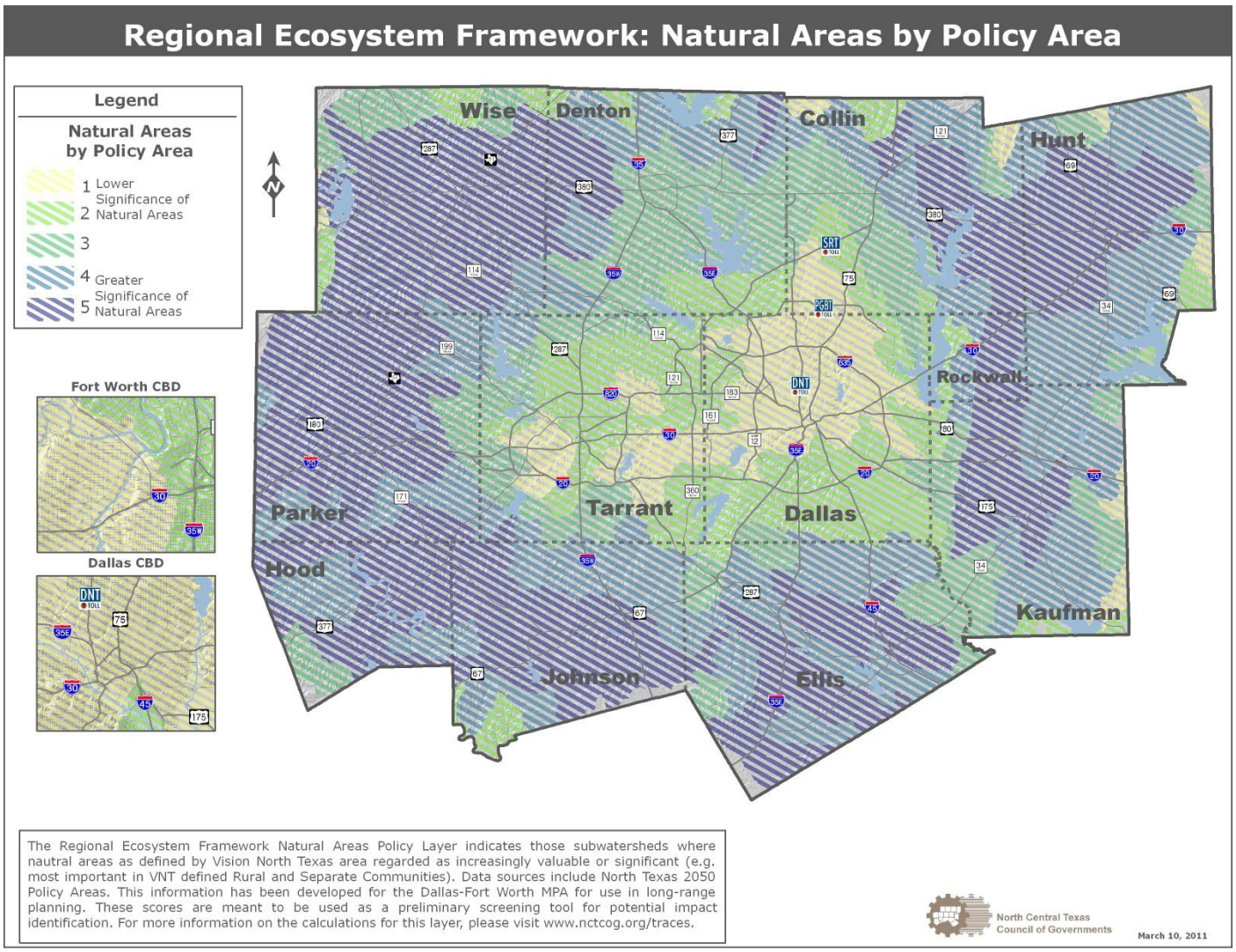


Figure E.16: Scores by subwatershed for the Surface Water Quantity by Policy Area in the 12-county MPA. These scores are based on the following scale for surface water quantity in by each North Texas 2050 defined policy area: Natural = 5; Rural = 3; Separate Community = 4; Outer Tier = 2; and Inner Tier = 1.

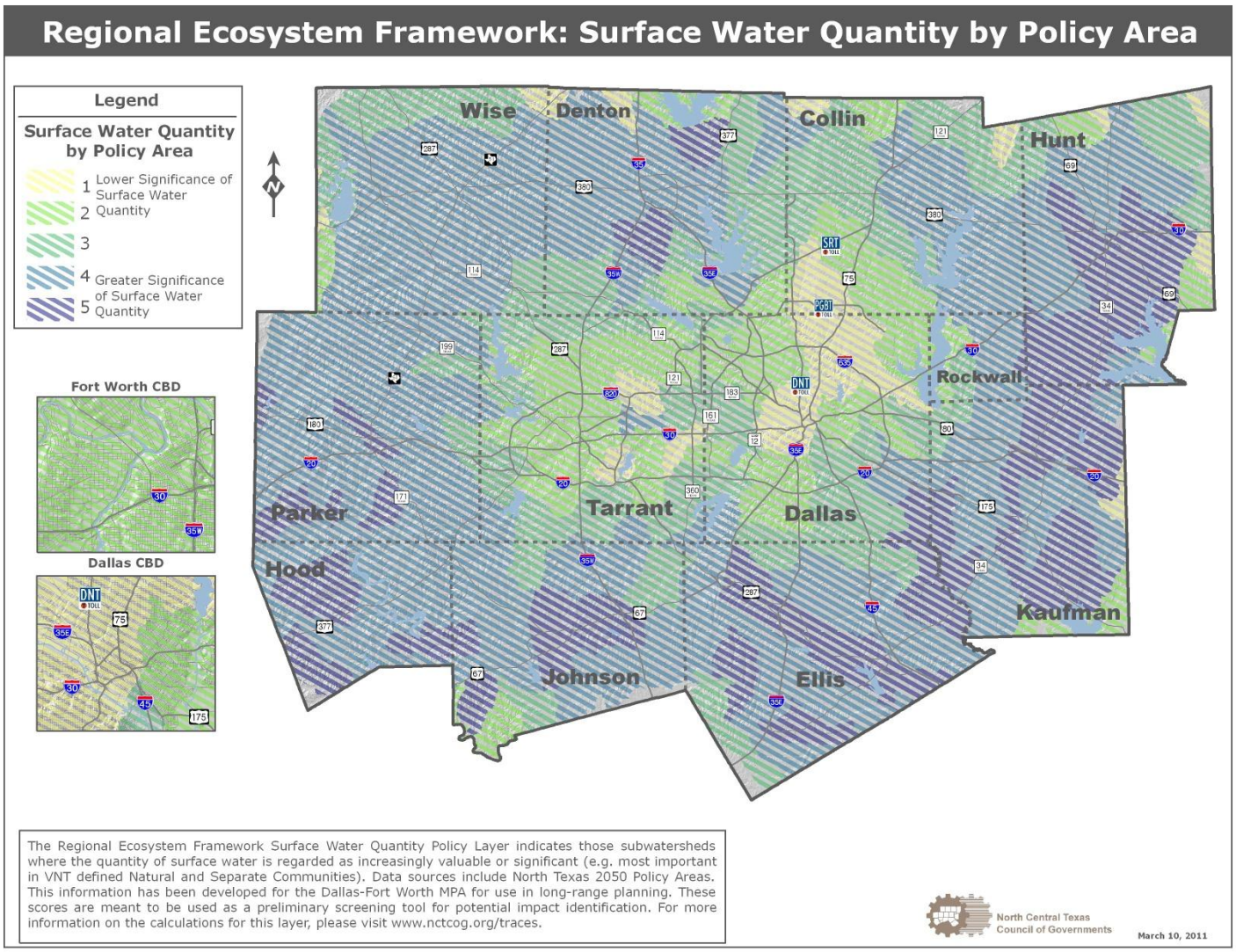


Figure E.17: Scores by subwatershed for the REAP Rarity by Policy Area in the 12-county MPA. These scores are based on the following scale for rarity by each North Texas 2050 defined policy area: Natural = 5; Rural = 3; Separate Community = 4; Outer Tier = 2; and Inner Tier = 1.

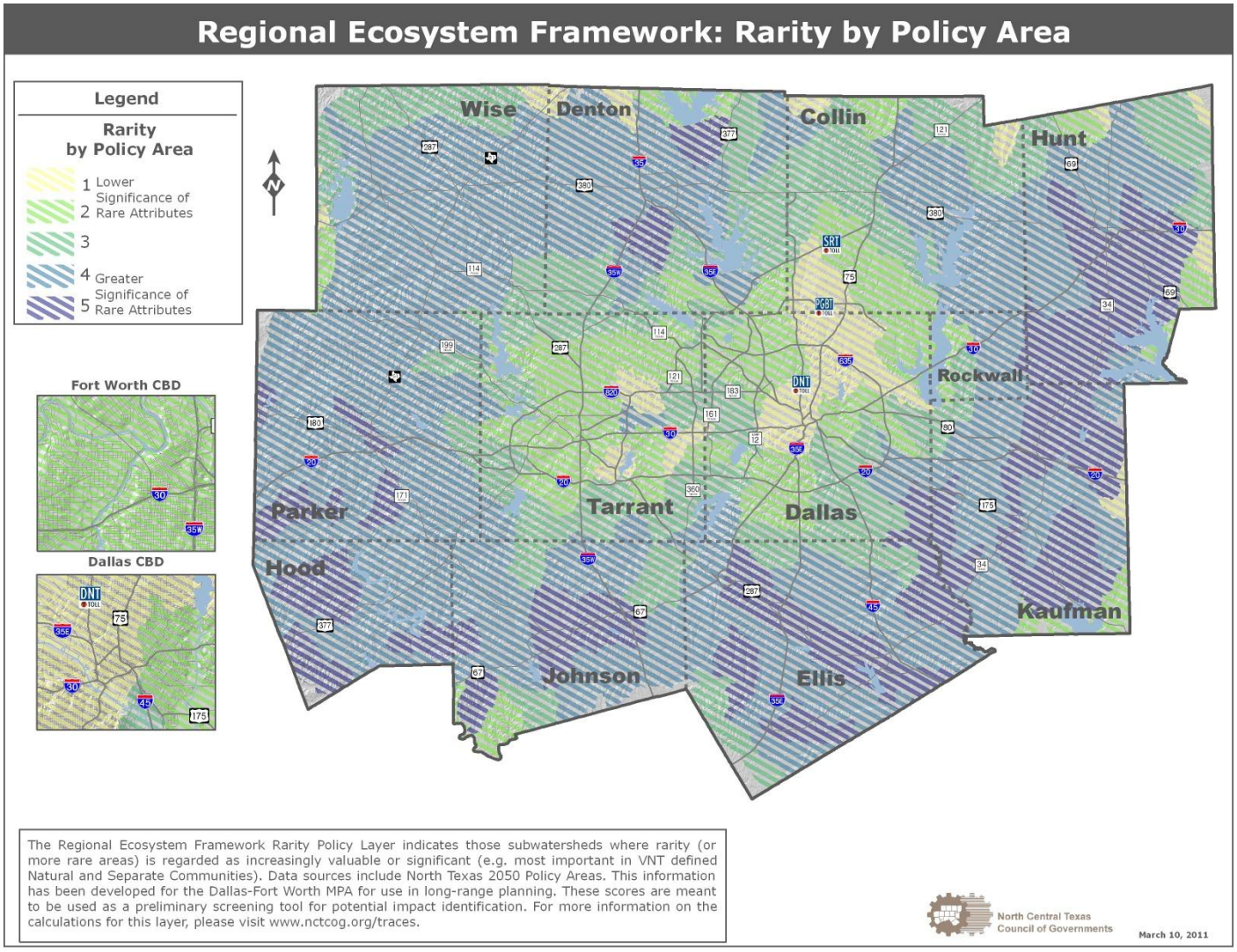


Figure E.18: Scores by subwatershed for the REAP Sustainability by Policy Area in the 12-county MPA. These scores are based on the following scale for sustainability by each North Texas 2050 defined policy area: Natural = 5; Rural = 3; Separate Community = 4; Outer Tier = 2; and Inner Tier = 1.

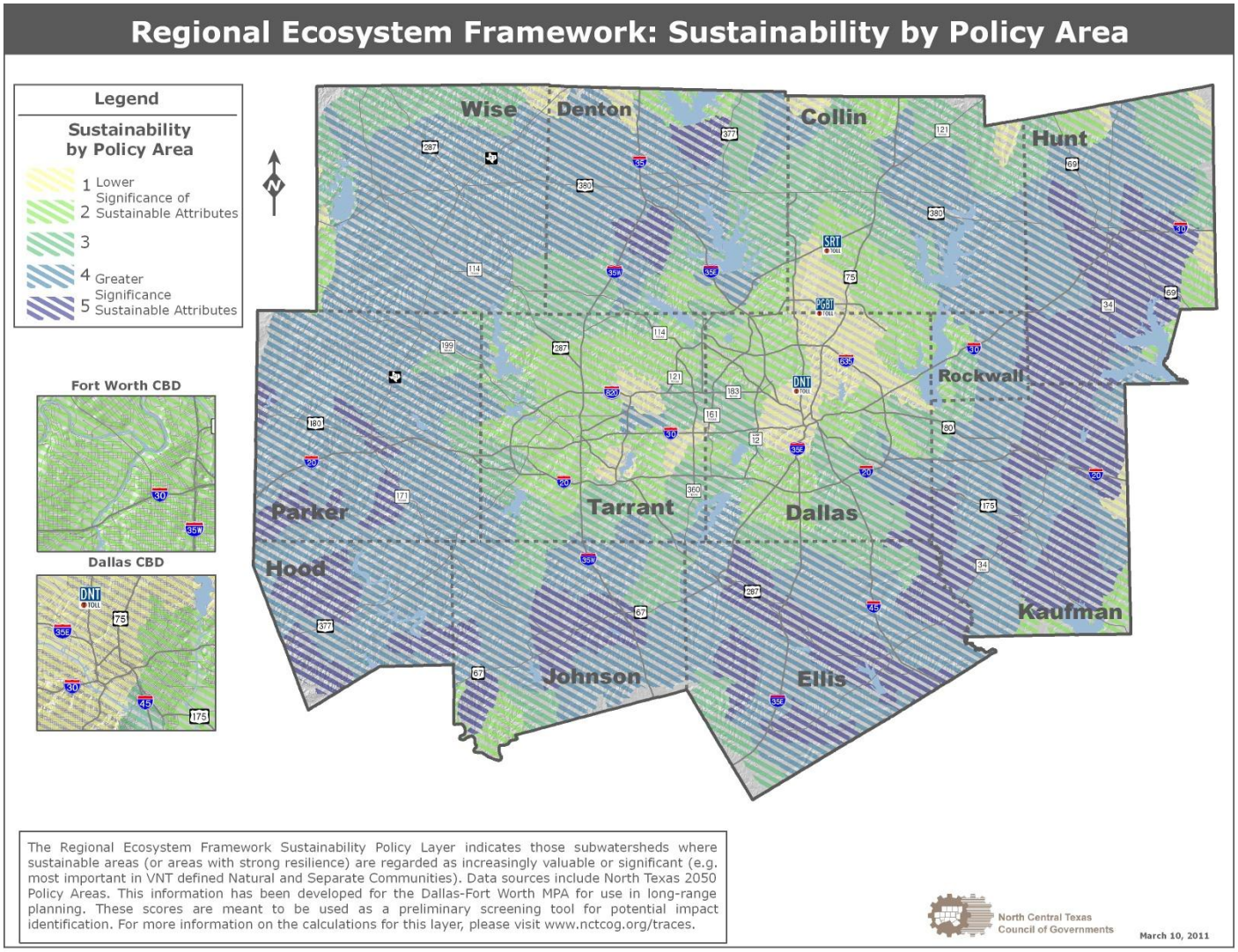


Figure E.19: Scores by subwatershed for the Wetland by Policy Area in the 12-county MPA. These scores are based on the following scale for wetland by each North Texas 2050 defined policy area: Natural = 5; Rural = 4; Separate Community = 2; Outer Tier = 3; and Inner Tier = 1.

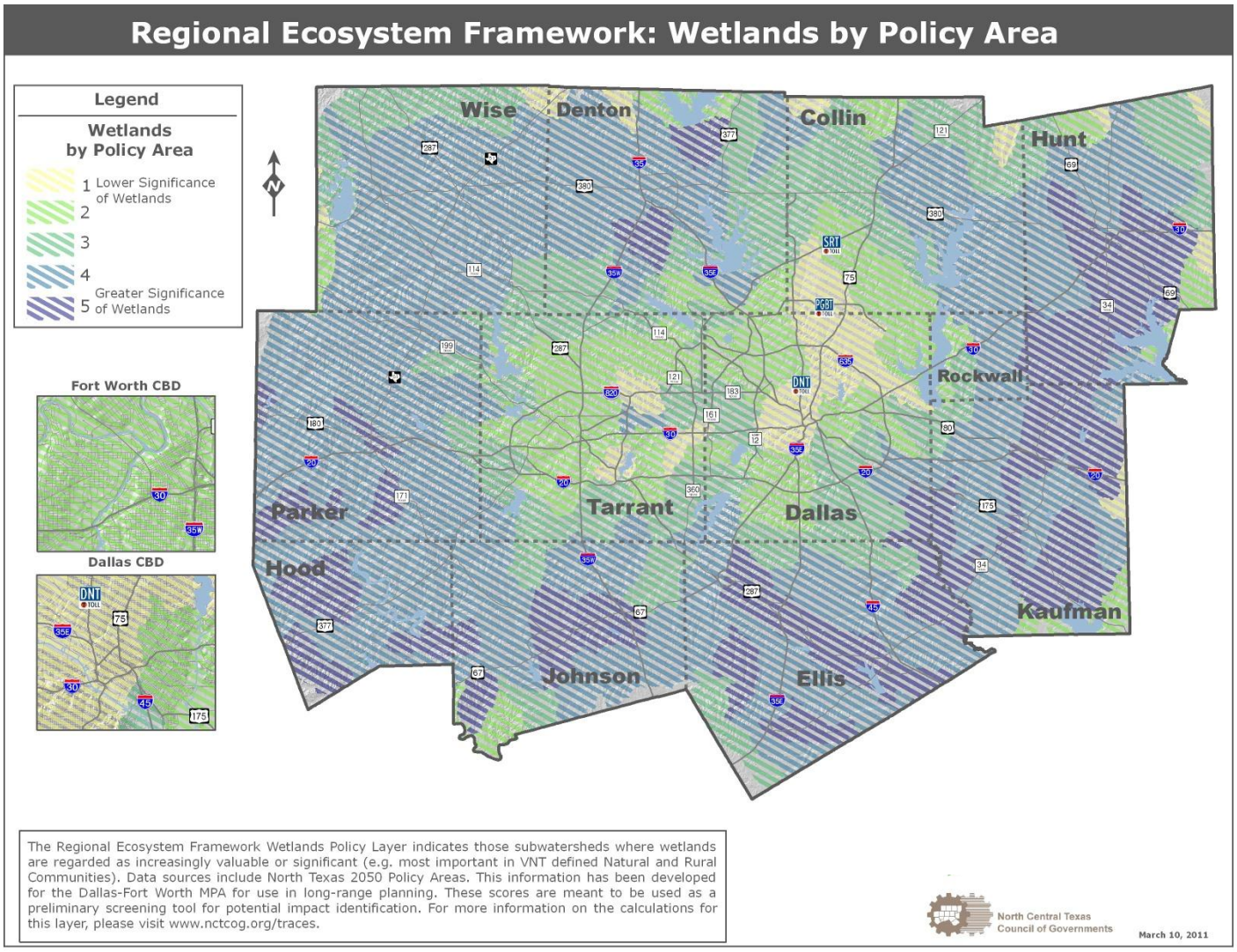
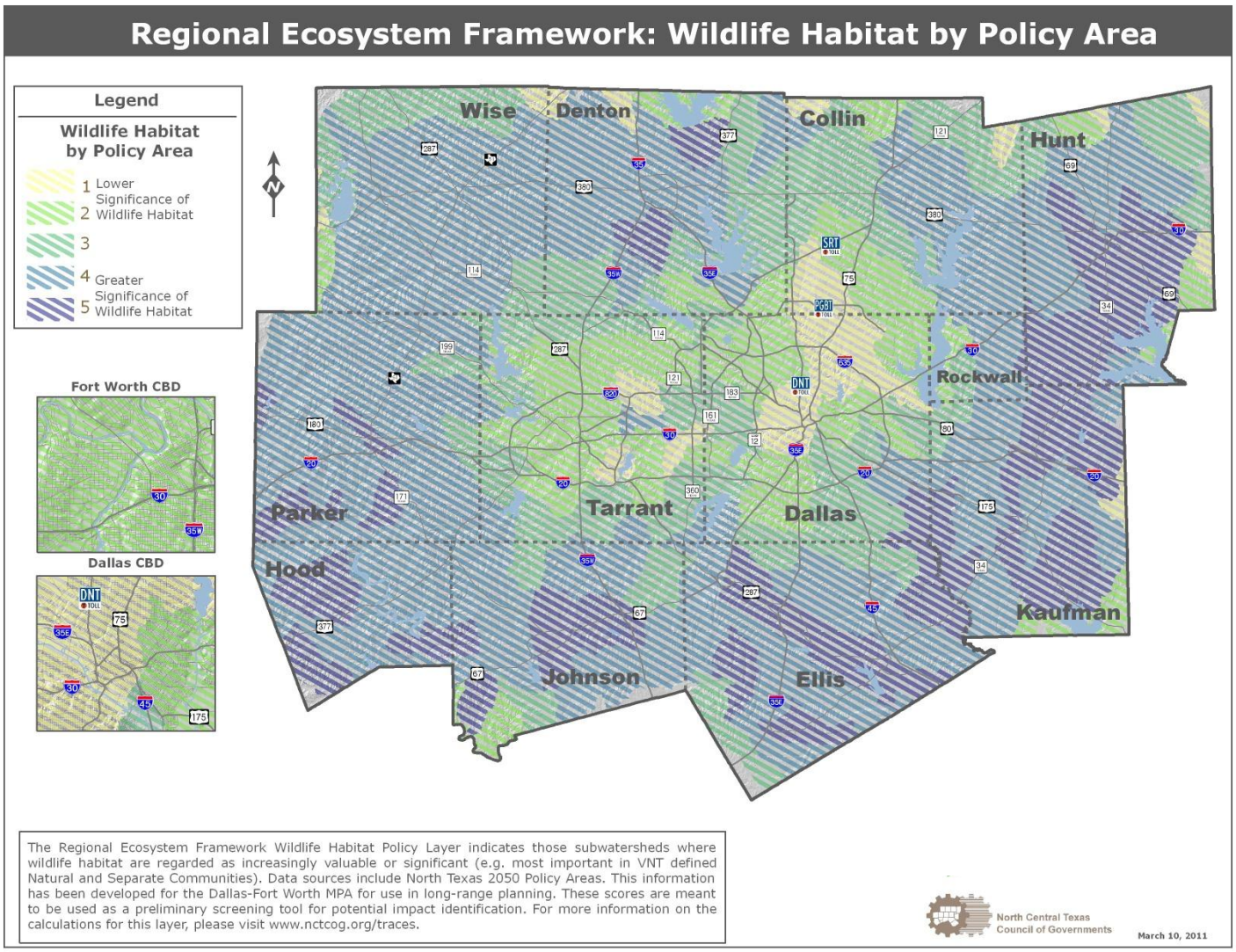


Figure E.20: Scores by subwatershed for the Wildlife Habitat by Policy Area in the 12-county MPA. These scores are based on the following scale for wildlife habitat in by each North Texas 2050 defined policy area: Natural = 5; Rural = 3; Separate Community = 4; Outer Tier = 2; and Inner Tier = 1.



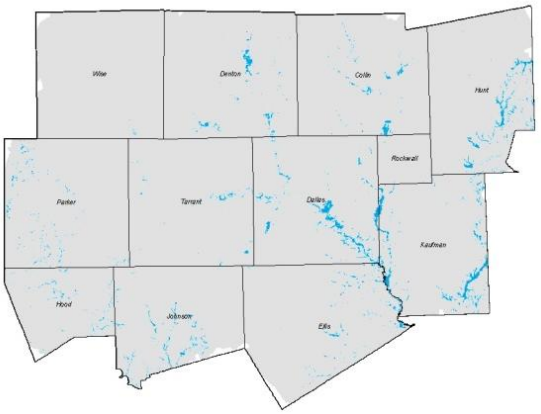
Criteria and Score Methodology

The following "fact sheets" provide scoring details and results for the 10 VEIL layers.[2, 3]

Wetlands

D_V, D_I Criterion: Wetlands

% of Area	Score
< 20%	1
20-39%	2
30-39%	3
40-49%	4
≥ 50%	5



Databases:

U.S. Geological Survey. 2000 National Land Cover Database. Compiled from Landsat satellite™ imagery (circa 1992) with a spatial resolution of 30 meters.

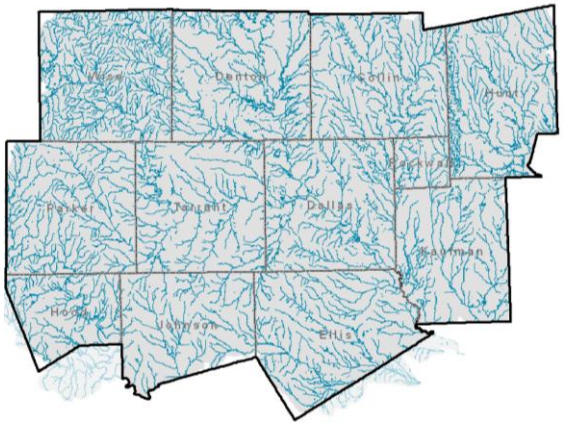
Definitions, Assumptions, Limitations, Uncertainties:

1. Wetlands are represented by the lands classified as Woody Wetlands (NLCD code 91) and Emergent Herbaceous Wetlands (NLCD Code 92).
2. Percent coverage is quantitative only. No decisions as to wetland quality were made. Major lake areas are included for '% of area' computation.
3. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
4. It is assumed that wetlands are affected if they are located within the project or geographic boundaries.
5. The wetlands affected reflect the percentage of wetland area within the project or geographic boundary.

Surface Waters

D_V Criterion: Surface Water Quantity

mi /mi² shore or stream length	Score
< 0.917	1
0.917-1.15	2
1.16-1.43	3
1.44-1.7	4
> 1.7	5



Databases:

U.S. Census Bureau, 2001. TIGER/Line Files, Census 2000. Washington, D.C.
National Resource Conservation Service (NRCS), State Soil Geographic Database (STATSGO), 1/250,000 scale, variable dates for data.
USGS, 1999. National Hydrography Dataset. USGS, Reston, VA.

References:

U.S. Army Corps of Engineers, Section 10 Rivers and Harbors Act of 1899.
U.S. EPA. Clean Water Act, Section 401 and 404, Regulations and Guidance.

Definitions, Assumptions, Limitations, Uncertainties:

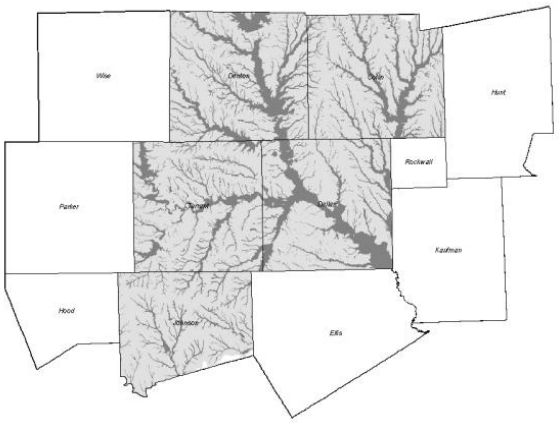
1. Surface waters are calculated for segment and shoreline distances for streams, rivers, and lakes. Scaling scores (rankings) are derived from total miles in a watershed or project area divided by the area in square miles of associated HUCs.

2. River and lake surface water areas and depths are not considered.
3. The more surface water area present, the higher potential for ecological impacts.
4. Shoreline is of considerable interest because of the sensitivity of associated ecological communities.
5. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
6. The area of analysis may be broken into 1 km grid cells for GISST criteria computation.

Flood Zones

D_V, D_I Criterion: Floodplain

% of area	Score
No data	0
< 20%	1
20-29%	2
30-39%	3
40-49%	4
≥ 50%	5



Databases:

Federal Emergency Management Agency. Q3 Flood Data (mid-90's data).

References:

Executive Order 11988, 1977. Flood Plain Management.

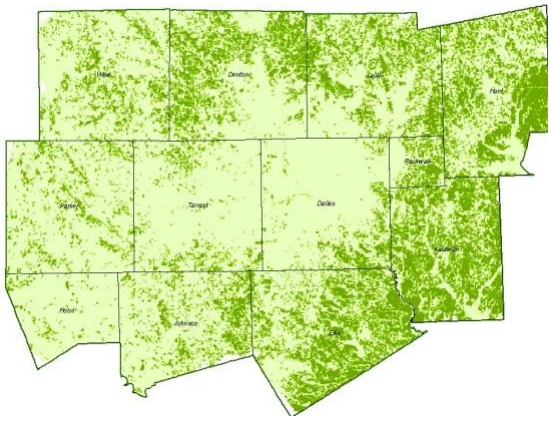
Definitions, Assumptions, Limitations, Uncertainties:

1. Floodplains are digitized from FEMA FIRMR maps.
2. Percent coverage is quantitative only. No decisions as to floodplain quality were made.
3. Floodplains are defined as the areas where the zone = A (100 year flood plain) or the zone = X500 (500 year flood plain).
4. Changes in upstream hydrology will affect future floodplain extent.
5. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
6. The area of analysis may be broken into 1 km grid cells for GISST criteria computation.

Agricultural Lands

D_V, D_I Criterion: Agricultural Lands

% of Area	Score
< 20%	1
20-39%	2
30-39%	3
40-49%	4
≥ 50%	5



Databases:

U.S. Geological Survey. 2000 National Land Cover Database.
Compiled from Landsat satellite TM imagery (circa 1992) with a spatial resolution of 30 meters.

Definitions, Assumptions, Limitations, Uncertainties:

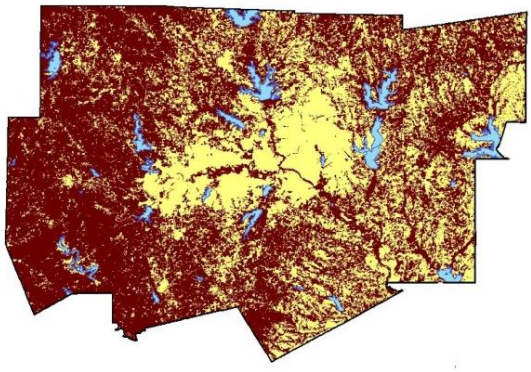
1. Agricultural lands are represented by the lands classified as Orchards/Vineyards/Other, Pasture/Hay, Row Crops, Small Grains, and Fallow (NLCD Codes 61 and 81-84).

2. Percent coverage is quantitative only. No decisions as to agricultural land quality were made.
3. A higher percentage of agricultural land cover within an area may indicate a greater potential for concerns under the Prime Farmland Act.
4. For DI, it is assumed that farmlands are affected if they are located within the project or geographic boundaries.
5. For DI, the farmlands affected reflect the percentage of wetland area within the project or geographic boundary.
6. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
7. The area of analysis may be broken into 1 km grid cells for GISST criteria computation.

Wildlife Habitats

D_V, D_I Criterion: Wildlife Habitat

% of Area	Score
< 20%	1
20-39%	2
30-39%	3
40-49%	4
≥ 50%	5



Databases:

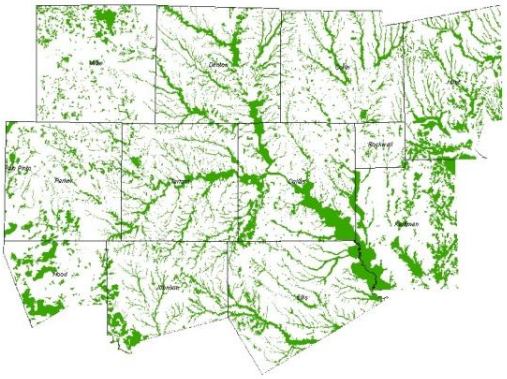
U.S. Geological Survey. 2000 National Land Cover Database.
Compiled from Landsat satellite TM imagery (circa 1992) with a spatial resolution of 30 meters.

Definitions, Assumptions, Limitations, Uncertainties:

1. Habitats are represented by Forest Lands, Shrublands, Grasslands, Wetlands, and open Water (NLCD Codes 11,41-43, 51, 71, 91-92).
2. Percent coverage is quantitative only. No decisions as to wildlife habitat quality were made.
3. There is no association between this vulnerability score for wildlife habitats and the potential effect, if any, on listed Federal Endangered and Threatened Species, subject to the requirements of the ESA.
4. The EPA will conduct a separate review with the U.S. Army Corps of Engineers and/or the U.S. Natural Resources Conservation Service, as necessary, to document compliance with Section 404 of the Clean Water Act.
5. For DI, it is assumed that wildlife habitat is affected if it is located within project or geographic boundaries.
6. For DI, the wildlife habitat affected reflects the percentage of habitat area within project or geographic boundary.
7. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
8. The area of analysis may be broken into 1 km grid cells for GISST criteria computation.

Natural Areas

% of Area	Score
< 20%	1
20-39%	2
30-39%	3
40-49%	4
≥ 50%	5



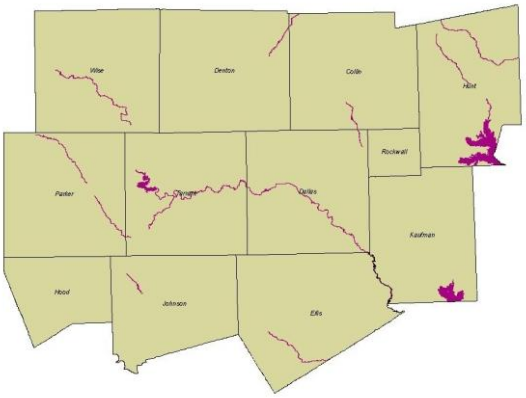
Databases:

NLCD, 2001.
North Texas 2050. NCTCOG, 2010.

Definitions, Assumptions, Limitations, Uncertainties:

1. Natural Areas as defined by North Texas 2050 "generally reflect floodplains, major public parks and open spaces, shores along major lakes and potential connections between these natural assets."

2. The natural areas were compared to 2007 aerial photography and digitally reproduced to be more accurate based on recent development trends.



Impaired Water Segments

D_V Criterion: Clean Water Act 303(d) Segments (State Priority Data)

Present in Grid Cell	Score
No	1
Yes	5

Databases:

TCEQ, 2001. Stream Segments 2000. TCEQ, Austin, TX.
EPA, 2003. Texas Interstate 69 Baseline Analysis Grid. EPA, Region 6, Dallas, TX.

References:

EPA. Clean Water Act 303(d) Regulations & Guidance.
Texas Water Quality standards.

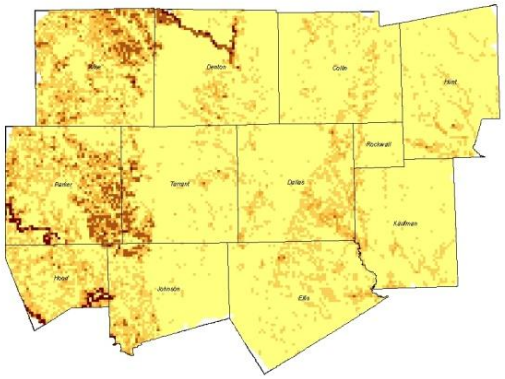
Definitions, Assumptions, Limitations, Uncertainties:

1. CWA 303(d) assessments are done by States and approved by EPA.
2. TMDL= Total Maximum Daily Load.
3. Segments listed as impaired in the file are used in this criteria. Impaired segments receive a score of 5.
4. Stream segments with no data are assumed to be good quality.
5. Designated uses are defined in the State Water Quality Standards.
6. This criterion may be calculated for the most appropriate geographic area and scale (e.g., watershed subunits, transportation corridors, or project areas).
7. The area of analysis may be broken into 1 km grid cells for GISST criteria computation.

Diversity

DRAFT D_V Criterion: TEAP Diversity

Percent in 1km^2	Score
lowest 51-100%	1
26-50%	2
11-25%	3
2-10%	4
top 1% most diverse polygons	5



Databases:

USGS. 2000. Texas National Land Cover Data Set (circa 1992), http://landcover.usgs.gov/natllandcover.asp.
TPWD. 1995. Ecological Stream Segments of Concern Fire Sciences Laboratory, Rocky Mountain Research Station, 2001, Kuchler's Potential Natural Vegetation Groups, Version 2000, Missoula, MT.

References:

Osowski, S. L., J. E. Danielson, S. Schwelling, D. German, S. Gilbert, D. Lueckenhoff, D. Parrish, A. K. Ludekeand J. Bergan. 2004. Texas Environmental Resource Stewards (TERS) Texas Ecological Assessment Protocol (TEAP) Results, Pilot Project Report. Report Number EPA-906-C-05-001. US Environmental Protection Agency Region 6, Dallas, TX.
Küchler, A. W. 1975. Potential natural vegetation of the conterminous United States. 2d ed. Map 1:3,168,000. American Geographical Society.

Definitions, Assumptions, Limitations, Uncertainties:*

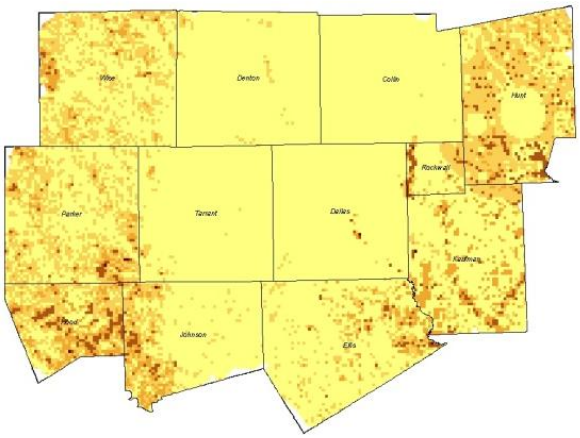
1. Because the TEAP was calculated using a 1km2 grid developed by Texas Parks and Wildlife Department, the scores for this criteria may be up to 0.5 km2 off from the original 1km2 grid developed by EPA Region 6 for the GISST calculation for IH69.
2. The diversity layer consists of four sub-layers: appropriateness of land cover, contiguous size of undeveloped area, Shannon land cover diversity, and ecologically significant stream segments.
3. The overall diversity layer was calculated by taking the mean of the four diversity sub-layers and rescaling on a 0-100 scale. Higher scores indicate a higher level of diversity. The values of the 30 m pixels that made up each 1 km2 (one kilometer square) grid cell were averaged to determine the Diversity Index score for each cell.
4. A US EPA program, ATTiLA was used to calculate Shannon land cover diversity.
5. Further details on TEAP calculations can be found in the TEAP Results Report.

***These assumptions were provided in the GISST Manual which utilized data from the TEAP, the precursor to the REAP. Updated documentation for the REAP is currently not available but NCTCOG assumes these same Definitions, Assumptions, Limitations, and Uncertainties are warranted for the REAP.

Sustainability

DRAFT D_V Criterion: TEAP Sustainability

Percent in 1km²	Score
lowest 51-100%	1
26-50%	2
11-25%	3
2-10%	4
top 1% most sustainable polygons	5



Databases:

USGS, 2000, Texas National Land Cover Data Set, http://landcover.usgs.gov/natllandcover.asp.
Fire Sciences Laboratory, Rocky Mountain Research Station, 2001, Kuchler's Potential Natural Vegetation Groups, Version 2000, Missoula, MT.
U.S. Bureau of the Census, 2000, TIGER/Line Files. Census Bureau, Washington, D.C.
U.S. EPA, 2003, National Priority List Database. EPA Region 6, Dallas, TX.
TCEQ, 2003, State Superfund Sites. Austin, TX.
U.S. EPA, 2003, RCRA TSD database. EPA Region 6, Dallas, TX.
U.S. EPA, 2003, Corrective Action database. EPA Region 6, Dallas, TX.
TCEQ, 2003, Voluntary Cleanup Program database. TCEQ, Austin, TX.
Bureau of Transporation Statistics, 2002, U.S. Airport Database. BTS, Washington, D.C.
U.S. EPA, 2003, Ozone Nonattainment Areas. EPA Region 6, Dallas, TX
TCEQ, 2003, State Near Nonattainment Areas. TCEQ, Austin, TX.
TCEQ, 2002, Dam Dataset. TCEQ, Austin, TX.
TCEQ, 2000, 303d Stream Segments of Concern. TCEQ, Austin, TX.

References:

Osowski, S. L., J. E. Danielson, S. Schwelling, D. German, S. Gilbert, D. Lueckenhoff, D. Parrish, A. K. Ludekeand J. Bergan. 2004. Texas Environmental Resource Stewards (TERS) Texas Ecological Assessment Protocol (TEAP) Results, Pilot Project Report. Report Number EPA-906-C-05-001. US Environmental Protection Agency Region 6, Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

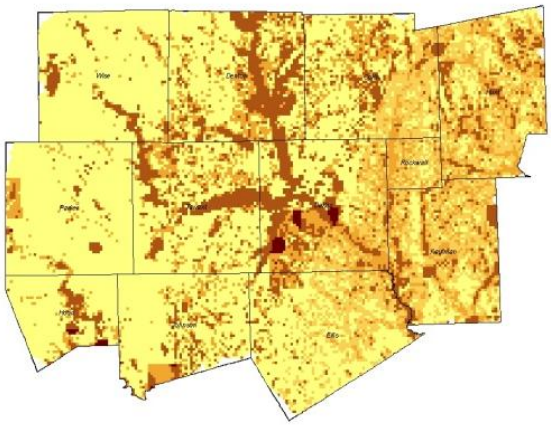
1. The sustainability layer describes the state of the environment in terms of stability, that is, how resistant to disturbance an area is, and how capable is the area in returning to its predisturbance state, that is, resilience (Begon et al. 1986). Sustainable areas are those that can maintain themselves into the future without human management.

2. Because the TEAP was calculated using a 1km2 grid developed by Texas Parks and Wildlife Department, the scores for this criteria may be up to 0.5 km2 off from the original 1km2 grid developed by EPA Region 6 for the GISST calculation for IH69.
3. The sustainability layer consists of eleven measures that can be loosely grouped into fragmentors: contiguous land cover type, regularity of ecosystem boundary, appropriateness of land cover, waterway obstruction, road density and stressors: airport noise, Superfund National Priority List and State Superfund Sites, water quality, air quality, RCRA, Treatment-Storage-Disposal sites, Corrective Action and State Voluntary Cleanup Program Sites, and urban/agricultural disturbance.
4. The overall sustainability layer was calculated by taking the mean of the eleven sub-layers and rescaling on a 0-100 scale. Higher scores indicate a higher level of sustainability. The values of the 30 m pixels that made up each 1 km2 (one kilometer square) grid cell were averaged to determine the Sustainability Index score for each cell.
5. Further details on TEAP calculations can be found in the TEAP Results Draft Report.

Rarity

DRAFT D_V Criterion: TEAP Rarity

Percent in 1km^2	Score
lowest 51-100%	1
26-50%	2
11-25%	3
2-10%	4
top 1% rarity	5



Databases:

USGS, 2000, Texas National Land Cover Data Set, http://landcover.usgs.gov/natllandcover.asp.
TPWD TXBCD & Natural Heritage data

References:

Osowski, S. L., J. E. Danielson, S. Schwelling, D. German, S. Gilbert, D. Lueckenhoff, D. Parrish, A. K. Ludekeand J. Bergan. 2004. Texas Environmental Resource Stewards (TERS) Texas Ecological Assessment Protocol (TEAP) Results, Pilot Project Report. Report Number EPA-906-C-05-001. US Environmental Protection Agency Region 6, Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

1. Because the TEAP was calculated using a 1km2 grid developed by Texas Parks and Wildlife Department, the scores for this criteria may be up to 0.5 km2 off from the original 1km2 grid developed by EPA Region 6 for the GISST calculation for IH69.
2. The rarity layer consists of four sub-layers: vegetation rarity, natural heritage rank, taxonomic richness, and rare species richness.
3. The overall rarity layer was calculated by taking the mean of the four Rarity layer sub-layers and rescaling on a 0-100 scale. Higher scores indicate a higher level of rarity. The values of the 30 m pixels that made up each 1 km2 grid cell were averaged to determine the Rarity Index score for each cell. Overall rarity was calculated by recoding rarity ranks using an exponential growth function 0-250 to produce a statewide land cover rarity data set. Data were scaled 0-250, due to machine processing of 8-bit data. Because the input data sets for Texas were large, rescaling the data from 1-250 (8-bit) allowed for much faster machine processing without any significant loss of granularity. Exponential scaling was chosen to give appropriate weight to rarer features. The statewide land cover rarity data set and the land cover rarity by ecoregion data set were input into an averaging model to compute the mean value of each grid cell for the combined data sets.
4. Further details on TEAP calculations can be found in the TEAP Results Report

References

[1]U.S. Environmental Protection Agency Region 6. "Geographic Information Systems Screening Tool (GISST) User's Manual." Version 1.1, November 2005 U. S. Environmental Protection Agency Region 6 Compliance Assurance and Enforcement Division, Office of Planning and Coordination, Dallas, TX S. L. Osowski, G. D. Carney, J. D. Swick, J. A. Danielson, D. A. Parrish, and D. Lueckenhoff. http://www.epa.gov/earth1r6/6en/xp/enxp2a3.htm.

[2]U.S. Environmental Protection Agency Region 6, et al. "Texas Ecological Assessment Protocol (TEAP) Report." 2005, http://www.epa.gov/region6/6en/xp/enxp2a4.htm.

[3]Vision North Texas. "North Texas 2050." 2010, http://www.visionnorthtexas.org/regional_summit/North_Texas_2050.pdf.