Final Report

Inferno Analytics

COA Fire Dept

Travis County Watershed Vulnerability Indexing

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Abstract

The City of Austin Fire Department: Wildfire Division (AFDWD) has created numerous amounts of vulnerability analysis looking at areas that are vulnerable to wildfires, but they have never looked at what watersheds are vulnerable to degrading the water quality from a wildfire event. This creates a major need for a spatial analysis to be done so that the AFDWD can determine how to mitigate fire control to protect the watersheds that are at most high risk. This study was done by Inferno Analytics and looked at all of Travis county and parts of Hays, Bastrop, Blanco, Burnet, and Caldwell counties that have watersheds that flow into the Travis county boundaries. Our final spatial analysis will show the watersheds ranked from watersheds of high risk to low risk and also a separate cost distance analysis will be conducted to aid the AFDWD in showing which areas in our study area are more difficult to get to from a fire station because of the terrain. This report will help aid decision makers when it comes to what methods to use to put out fires because of the risk of pollutants getting into the water. Then our online story map can be used by the general public so that they can get involved and see which watersheds are at risk to protect their water supply.

1. Introduction and Problem Statement

1.1. Summary

Inferno Analytics will be presenting their final report with detailed sections explaining the data, methodology, and results of the watershed vulnerability index model. The implementation of this model will help Austin Fire Department – Wildfire Division address watershed issues and wildfire spread to help ensure the safety of all Travis county residents.

1.2. Purpose

Infernal Analytics was tasked by the City of Austin Fire Department Wildfire Division to determine which parts of Travis County can be impacted the most by Wildfire's to help give them guidelines on which area's they might need to focus on putting out first if all other factors are equal. This would also allow them to focus on making sure these regions are more treated for fire mitigation during off seasons. There are many factors that were needed to be included soil type, slope, biomass, and distance to nearest fire station. The pollution of our water ways is becoming more and more of a worry.

1.3. Scope

The scope of study is Travis County (Figure 01) and the surrounding areas of influence. The areas of influence are upstream rivers and creeks. They include Berrent, Hays, Blanco Counties.

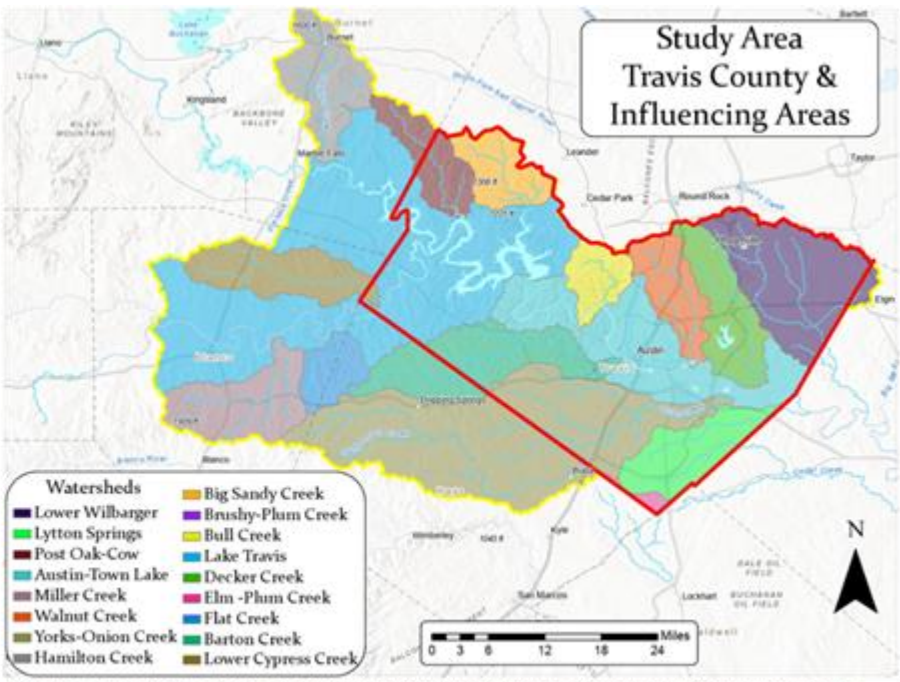

Figure 1 Map of the study area with Travis County outlined in red and influencing areas outlined in yellow

1.4. Problem Statement

Travis county is the 5th largest county in Texas with a population in 2018 of 1,248,743 (World Population Review). To ensure the safety and health of all the residents, the county has begun to take precautionary steps to fight wildfires and protect their watersheds. The City of Austin Fire Department has created vulnerability indexes that focus on areas at risk of wildfires but have not looked at how these areas could affect the watersheds. In cooperation with The City of Austin Fire Department: Wildfire Division, Inferno Analytics has created a vulnerability index of Travis county showing areas that are at risk of wildfires and how much of an effect that area will have on its surrounding watershed.

2. Data

The data outlined in (Table 01) we acquired for our GIS analysis and was all free to access along with from reputable and authoritative sources. We obtained shapefiles for the watersheds from Austin Texas governmental website and for the rest of the area of impact from USGS. Which allowed us to know which area we needed soil data for which was obtained from usda.gov. DEM (Digital elevation model) was obtained from TNRIS. Biomass was from USGS. Our data is projected in NAD (North American Datum) 1983 is one of the two that is most exclusively used in North America and is the most recent of them.

Table 1 Data details for Inferno Analytics

Entity	attribute	Spatial object	Status	Source
Austin data portal	roads		available	https://www.txdot.gov/
County Soil data	Soil type & depth	polygon	available	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Austin Fire Department Wildfire Div.	Wildfire and Mitigation		Not	http://www.austintexas.gov/department/wildfire-division
Austin Texas Government	Austin Watershed		available	http://www.austintexas.gov/department/watershed-protection-master-plan
Slope data/Travis	Percent gradient	raster	available	https://data.tnris.org/
Travis county data	Biomass	polygon	available	ArcGIS online add data
Aspect of Travis County	Wind data	DEM	available	https://data.tnris.org/
Dept. of Homeland	Fire stations	table	available	ArcGIS online add data
USGS	Land Cover	Raster	available	https://data.tnris.org/

3. Methodology

3.1. Data Pre-Processing

3.1.1. Terrain

The Digital Elevation Model (DEM) (Figure 2) mosaic was produced from 4 raster tiles from the United States Geological Survey's (USGS) 2013 National Elevation Dataset, a collection of 10- and 30-meter DEMs. The mosaiced raster was then clipped to a spatial extent of 29.85°N - 30.85°N and 98.6°W - 97.25°W, reducing the overburden of large raster datasets by defining a broad region that contains the study area and a reasonable distance beyond; this same process was carried out for all other datasets. For our analysis, we utilized the dataset with a resolution of 10 meters for generating terrain and hydrologic rasters representing slope, aspect, flow accumulation, and flow direction. We also produced several triangulated irregular networks (TINs) at various qualities that could be used as a 3-D base map (Figure 3), however, due to the limitation of the web map app, we chose a less computational demanding method of creating vertical relief with 2-D hillshade basemaps . Two multi-directional hillshade relief maps (Figure 4) were created, one with a vertical exaggeration of 1.4x for use at scales above 1:250,000, and the other with a vertical exaggeration of 2.0x for use at scales below 1:250,000.

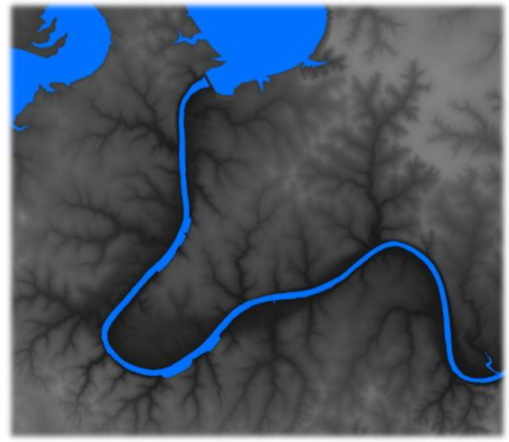

Figure 2. The Digital Elevation Model.

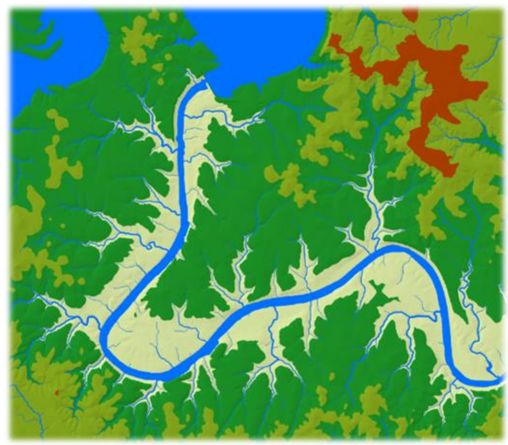

Figure 3. The triangulated irregular network..

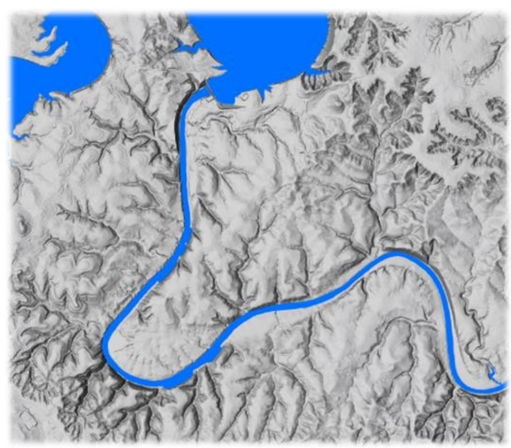

Figure 4. The multidirectional hillshade basemap.

3.1.2. Soil Data

We downloaded the soil type data for Travis, Caldwell, Bastrop, Burnet, and Blanco from the USDA and then clipped it to the extent of our study area of Travis county and the surrounding influencing watersheds. When we downloaded these files it only gave us a three-digit code to represent each soil type and we had 13,000 soil attributes with most of them being repeated in different counties. We then merged all the repeated soil types into one attribute which dropped our soil types total to 233. We then created a excel sheet to join with our layer to give us attribute like the full name of the soil, grain size for the top 24 inches of soil, water table depth, ksat in inches per hour (which is how fast water will move through the soil). Next, we imported the table into ArcGIS Pro and joined the table with the soil layer. Then we converted the soil vector layer into a raster layer so that we can factor the soil layer into our raster calculation for the vulnerability analysis.

3.1.3. Land Cover

For our land cover data that we downloaded from USGS we reclassified it to represent the land cover types based on their difficulty to travers across the terrain. This was done so that we can use this as our input cost raster in our cost distance analysis. We gave land cover types like water a value of 50 since it is very hard for wildfires to traverse and then we gave open grass fields a value of 1 since they would be easy to traverse.

3.1.4. Watersheds

The Hydrologic Unit Codes (HUC) from the USGS's Watershed Boundary Dataset was less than ideal for our analysis due to polygon features encompassing too large of an area, along with the occurrences of features crossing into multiple watersheds. Instead of re-digitizing the HUC layer, we decided to delineate our own watershed layer with 'catchments' that dived the watersheds into near equal sizes while ensuring that no feature boundaries crossed over any drainage divides (Figure 5). To fulfill this task, rasterized watersheds were generated using 'pour points' placed upon the rasterized stream path of the flow accumulation raster. Beginning at the mouth of every major watershed a pour point was placed, followed by a pour point being placed at the mouth of every major tributaries, this process was repeated until the entire study area was broken down into 248 catchments that typically range

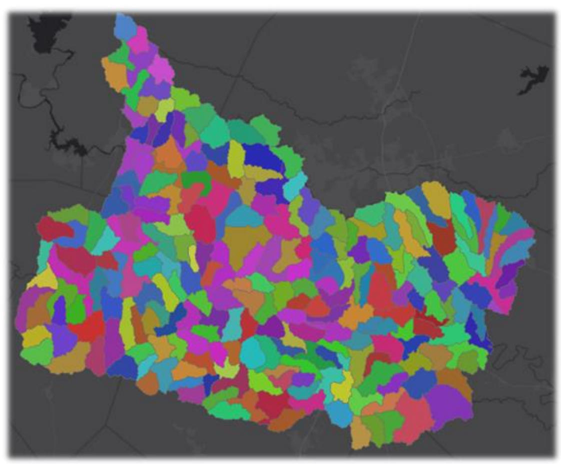

Figure 5. Delineated 'catchment' areas.

from 4,000 to 6,000 acres. Once all pour points had been placed, the points were converted to a raster to be used by the 'Watershed' hydrological tool in GIS. The watershed raster output was next converted to a polygon and simplified, with fields representing the names of the basins, watersheds, and catchments, being manually populated. Acreage for each catchment was calculated and any overlaying waterbody was subtracted from the area; this is necessary for later standardization of the data. The catchments, watersheds, and basins represent the categorical data for our vulnerability index, along with being the features that visually represent the results on the web map.

3.1.5. Streamways

Originally, we were intending to not reinvent the wheel, instead utilizing the GNS-ID field in the USGS's National Hydrological dataset of streams to identify major tributaries and produce stream layers for view at various visual scales. For reasons currently unknown, the web map app randomly fails to draw certain stream layers when using this data; to overcome this we generated our own stream network that incorporates Strahler's stream order method for symbolizing streams by their order value (Figure 6). To do this, we first needed to create a rasterized stream path from the flow accumulation raster by reclassifying value above 1,000 accumulated cells of flow to a value of 1, with all other values being assigned a value 0; this Boolean stream raster, along with flow direction, is required by the 'Stream Order' hydrological tool in GIS. Once the stream network was completed, streams were spatially joined with the river layer from the USGS to add names to our streams. Symbology was adjusted by stream order using graduated polylines with strokes ranging from 0.5pt to 4pt. To symbolize more streams at higher scales, while more importantly avoiding clutter at small scales, a series of layers were created containing various stream orders that become became visible after crossing a visibility threshold; these breaks were set at 1:400k, 1:250k, 1:150k, 1:75k and 1:50k.

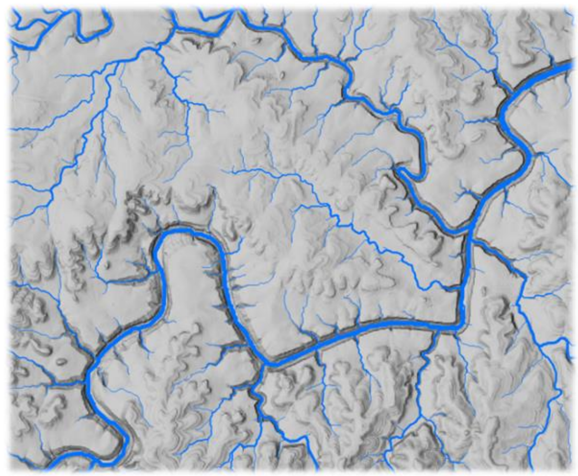

Figure 6. Generated stream networks.

3.2. Vulnerability Analysis & Index

To create an index of vulnerable watersheds, we first needed to carry out a vulnerability analysis to determine the 'risk value' of any given cell. To do this, we used the weighted product model, a method much like the weighted sum model except where the mathematical operators use multiplication instead of addition. The weighted sum method requires similar units, therefore, data typically needs to be reclassified into something of similar units, such as a rank from 1-5, however this method can become far too subjective and was not producing desirable results. The weighted product model allows for the use of variables with various unit types to be calculated together in their native states. Three variables, biomass, slope, and soil grainsize were identified as the most important criteria for our analysis, how each were weighted will be elaborated in the following sections.

3.2.1. Biomass

Biomass is the most import variable in this analysis, without it a devastating wildfire could not be sustained. The biomass raster for the region, produced by the Global Forest Watch, has a mean cell values within the study area of 44.19 C/m2, a median of 47 C/m2, and a standard deviation of 24.25 C/m2 (Figure 7). The data has a reasonably normal distribution with a low skewness of .068. The data is bimodal with the largest single bin of data being in the range of 0-6 with the bulk of the rest of the data between the mean and the first positive standard deviation. Biomass values of around 1-6 tend to correspond with levels of biomass slightly higher than one might expect in an overgrown yard or an urban environment with an usually high number of trees, which wouldn't contain enough fuel to create a fire hot enough to cause hydrophobicity. After analyzing the impact of various weights on the data, it was decided to divide the biomass by a factor of 6, which transforms any values from 0-6 to a fraction which will negatively impact

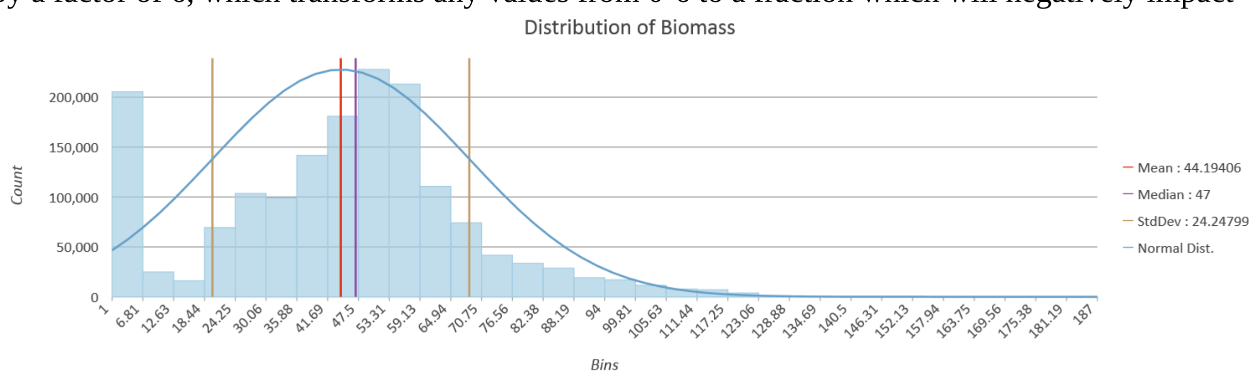

Figure 7. Histogram of values for the biomass raster.

the final value of the cell. By reducing the weight of values by a factor of 6, the mean of values is reduced from 44.2 to 7.36, while bringing down values at the second standard deviation to around 15. While these output values could be considered high for an equation using multipliers, it was our belief that this scheme reduces the potential of the biomass data masking the impact of other variables while still retaining a dominate roll.

3.2.2. Slope

Slope is considered the second most important variable, and, besides being able to strongly impact the surface fire behavior and temperature, areas with extreme slopes have the greatest potential of creating high runoff velocities promoting entrainment of sediments. River bluffs tend to be highly covered in biomass, mostly due to the difficulty of developing such steep terrains, and while there is a weak positive correlation between the biomass and slope raster as a whole, when comparing values only above the second standard deviation there is a strong correlation. We wanted slope to play a major role in the equation, but it needed to blend with the other variables without becoming an absolute selector based on areas that are extremely steep. Within the study area, the mean of the slope dataset is 3.27° and is heavily skewed to the left with half of the study area falling below a slope of 2.08° (Figure 08). After trying several weights, we settled on dividing the slope by a factor of 3; between the median but below the mean. In a similar fashion to biomass, any cell below a 3° slope was reduce to a fraction resulting in a lower calculated risk value; while data at the first standard deviation was reduced threefold from 6 to 2. Very little of the data exceeds 21°, meaning only extreme outliers will represent any multipliers greater than 7x, with the bulk of the data being below 4x. The maximum highest possible multiplier that can occur is around 11x, and this only occurs on the

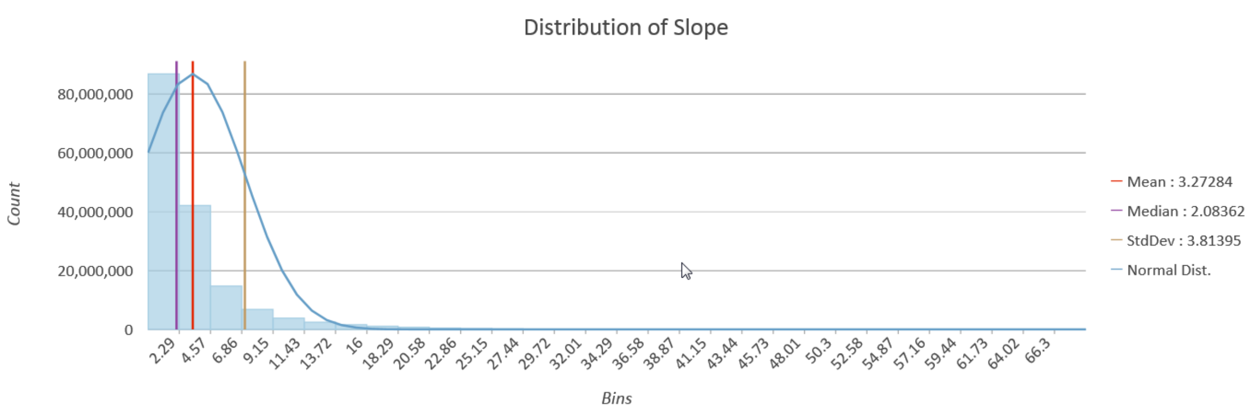

Figure 8. Histogram of values for the slope raster.

most extreme bluffs. While this doesn't necessarily eliminate the impact of outliers on our calculations, and nor should it, it certainly makes it the outputting data range far less extreme.

3.2.3. Soil

Soil grainsize was the final, and no less important, variable used in the analysis. As suggested in the literature review, but also noting the actual underlying cause of hydrophobicity is an ongoing debate, for the most it is observed that soils with higher grainsizes have a higher prospect of developing hydrophobic soils. The grainsize size identified as most at risk were coarse sands to fine gravels with a grain size of 1mm -2mm, noted for being able to conduct heat well while also being porous enough to allow waxy vapors to penetrate (Figure 09). Some literature had noted diminishing returns occurring at grain sizes greater than gravel around 3-4mm and while some consideration was given on removing areas with high values, it was noted in other literature that if conditions were correct, the waxy vapors can 'plug the hole' and cause an area, that would otherwise be well-drained, to repel water. For this reason, we instead opted for a cutoff at 2mm where values could go no higher. The soil data is multi-modal, with higher occurrences in the following order: clay/silt, coarse sand, gravel, medium sand, and fine sand.

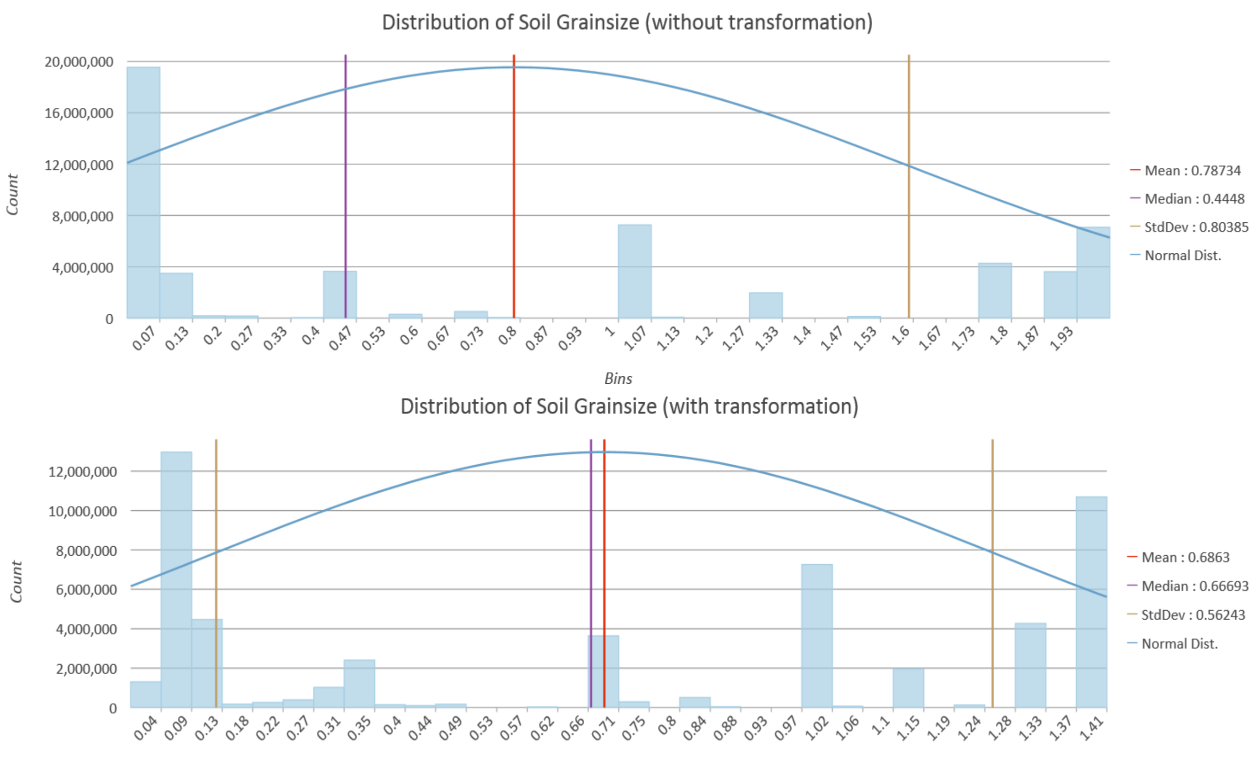

Figure 9. Histogram of values for the soil grainsize raster before the transformation(top) and after the transformation(bottom).

Small sand grains are meniscal in size, much smaller than most would imagine around a tenth of a mm in diameter, and would essentially eliminate an area from being identified as a potential risk; however it has been noted in past studies that certain fine soils can become hydrophobic if the fire burns hot enough for the correct duration of time and doesn't over cook it. To lessen the impact of the soil grain size values, a square root transformation was used to bring values below one up, while reducing the value of higher grain sizes above 1. The fine sand grain that previously had a value of 0.1 are now valued at .32, while keeping values at 1 where they are at, and lowering max potential grain size values of 2 down to 1.4; it should be noted that none of this actually impacts the ranking the data.

3.2.4. Procedure

To calculate the ' risk value' of any given cell across the study area, we utilized the raster calculator function in GIS to compute the hypothetical empirical relationship formula we created, (Biomass / 6) x (Slope/ 3) x sqrt(Soil); it should be noted that this hypothetical empirical relationship has not been supported by any actual experiment. We attempted many configurations of the formula with different weights and various data transformations, many of which were similar to our final results and possibly just as viable, but we chose our final results based on the distribution of the data, comparisons to expectations, and overall simplicity of the formula. Once a 'risk value' was calculated for each cell across the study area (Figure 10), the 'zonal statistics' spatial analyst tool was used to calculate the sum of all the cells in each watershed 'catchment' area. The data had to first be converted to an integer value before any conversation from raster to polygon could occur. Due to the irregular shape of some catchment areas, a few centroids of polygons were outside their boundaries, making a perfect spatial join impossible to achieve. To get around this dilemma, centroids were generated and any located outside the boundaries of their corresponding polygon were manually relocated. A spatial join was then carried out between the centroids and the polygons representing the

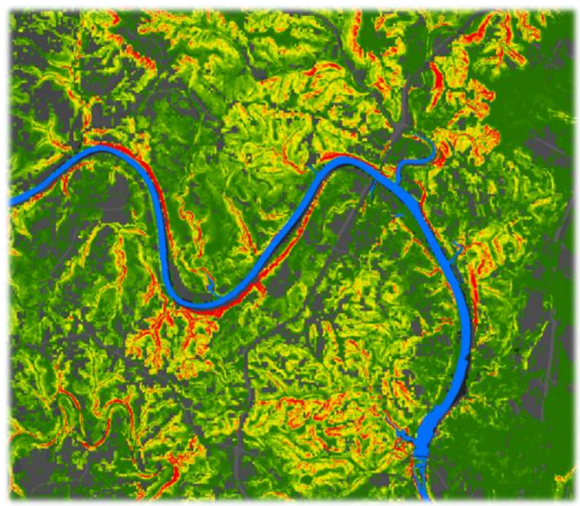

Figure 10. An example of the output from our raster calculation, areas in red have high risk values, while green areas have low risk values, and yellow represents areas close to the middle of the range.

results of the zonal statistics, followed by a join by FID to the original watershed layer. Three new fields were created in the attribute table, the first was populated with the value representing the accumulated summation of all the cells in an area; the join was then released. In the second field, the data was standardized by dividing it by the acreage of the area. Finally, a square root transformation was used to attempt to normalize the data (Figure 11).

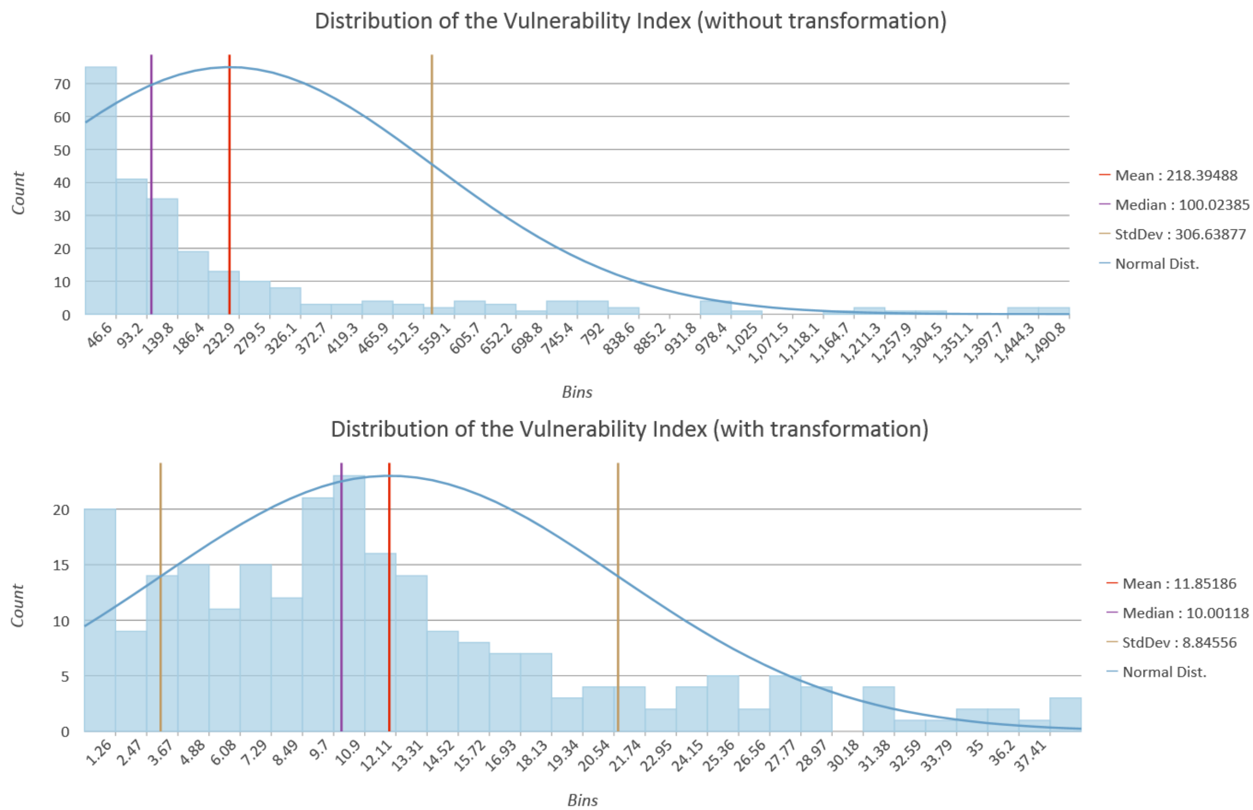

Figure 11. Histogram of the vulnerability index risk values before the transformation(top) and after the transformation(bottom).

While the data after the transformation is still skewed with a value of 1.04, and a kurtosis value of 3.62 implying most of the data still lies in the tails, these values are less than half of what the original values. We ran the analysis excluding soil grain size from calculation to look for any notable difference in the data and to attempt to gage how soil impacts the analysis. It is worth noting that the mean, median, range and standard deviation of both methods are extremely similar to one another (figure 12 on following page). At face value it would appear that soil had little impact on the distribution of the data, however, when comparing the choropleth maps (figure on next page), there are noticeable differences. By including soil into the equation, the areas at risk migrated toward the west into the foothills of the Balcones Escarpment, where soil grainsize increases from the finer clay and silt sediments found in the plains east of BFZ zone.

For the highest data values, both methods indicated the same at-risk locations due to these areas. The reason for this is, areas with high slope, which tend to have high biomass due to the difficulty of development, also tend to be located in areas with shallow soil above rocky Edwards limestone with high grainsizes. Some areas, such as on the upper portion of Lake Travis, saw a drastic shift of values away from the lake were more clay, silt, and fine sand deposits in the low-lying areas.

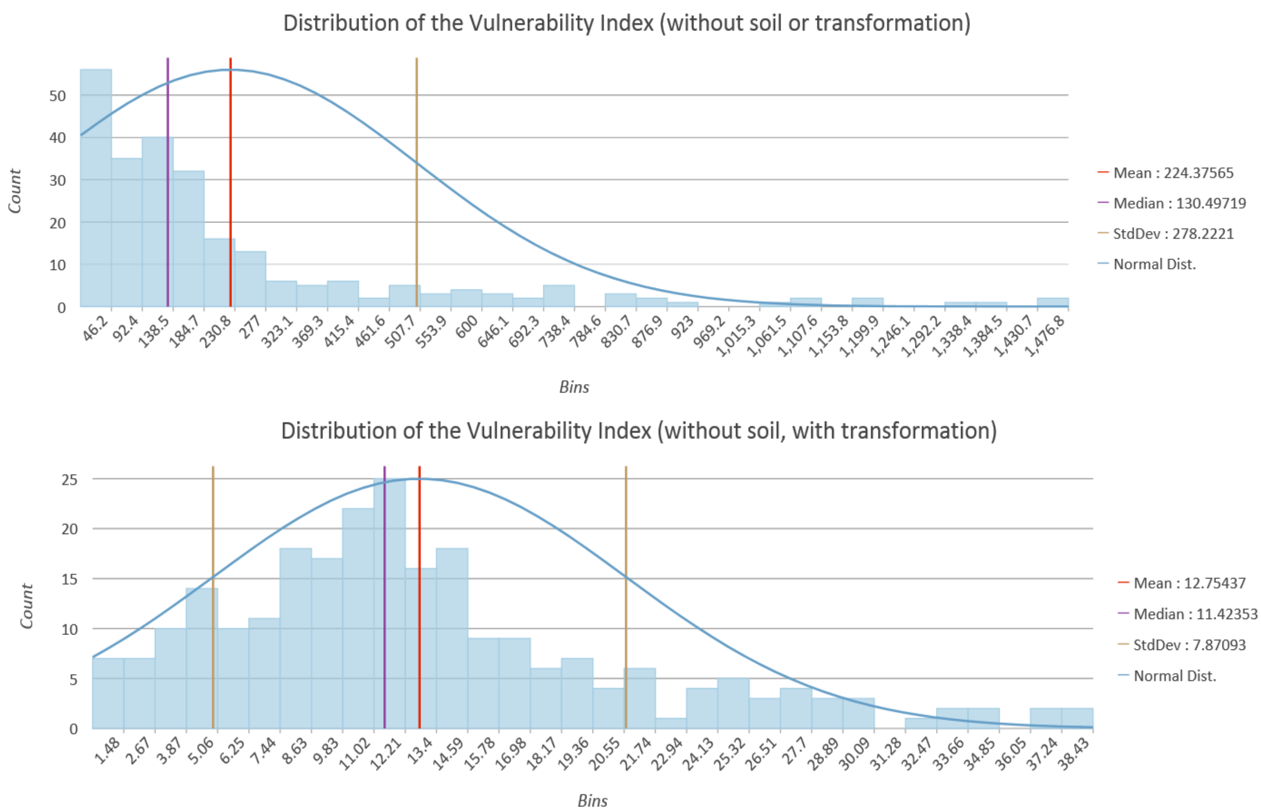

Figure 12.Histogram of the vulnerability index risk values when excluding soil grainsize from the calculation. Top is before the transformation and the bottom is after the transformation.

3.3. Cost Distance Analysis

This cost distance raster is intended to be used in the suitability model. The raster includes all the main roads in the area of study. Along with cost of how hard it is for a fire to theoretically cross certain terrain. The terrain data came from land cover (1.1.3) that was the base data that was used for the cost distance. We needed to reclassify the land cover to fit the terrain cost for the fire. These two pieces of data, road network and terrain cost create our cost distance rater. Then there are the points of origin. These points are the fire stations. The group decided to go outside of hays county for fire station points because in the first run of cost distance some areas in Travis county were counted as high risk when there was a fire station right outside of the county boundaries.

The original roads network was a vector data set that we converted to a polyline raster. The poly line layer was reclassified into 3 categories before being merged with the terrain layer, they are Single Roadbed, nearly all other roads types like left/ right fontange roads, then connectors/turn arounds. The cost distance is shown in (*Figure 13).*

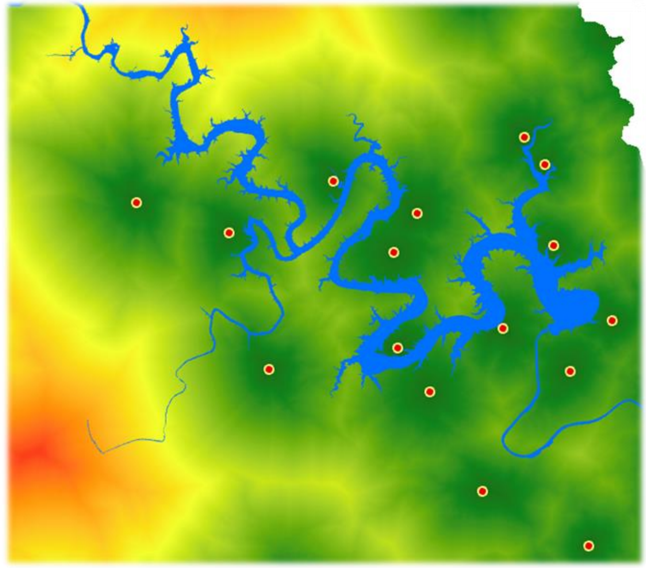

Figure 13. The cost distance analysis output around Lake Travis. Red represents areas that will be more difficult to reach, while green represents areas easily accessible. Yellow represents the middle of the data distribution. Points represent fire stations.

3.4. Flow Distance Analysis

With data from the TCEQ it was discovered that nearly all surface water major pumps in Travis County are located on Lake Austin & Lake Travis in, and around, watersheds identified by the vulnerability analysis as being most at risk. We created a raster representing the distance upstream from the nearest municipal water supply intake. To do this, we created an upstream flow distance raster from each of the points on the map in (Figure 14) on the right. From there, we used the raster calculator to merge the various flow distances rasters while retaining only minimum value from overlaying rasters; by doing so the distance counter resets with every upstream surface water

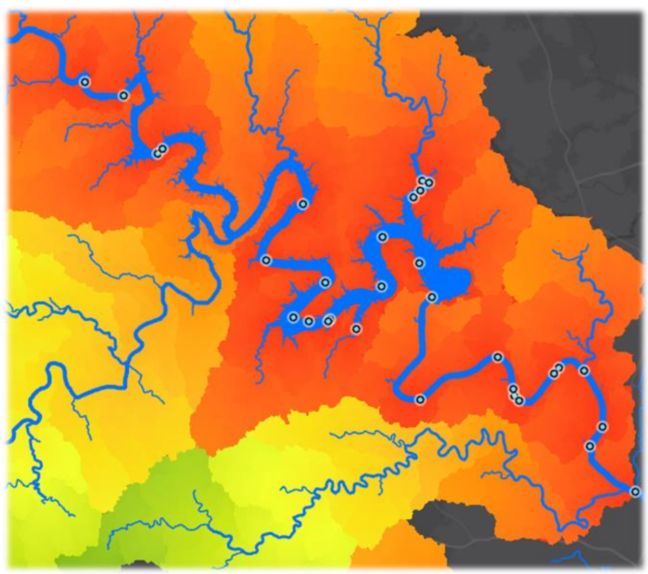

Figure 14. Flow distance raster where red represents short travel distances and green represents longer distances. Yellow represents the middle of the data distribution. Points represent municipal water supply intakes.

intake. What is really highlighted by this analysis is the close proximity of municipal surface water intakes to areas with the highest potential to degrade water quality.

3.1. Flowchart

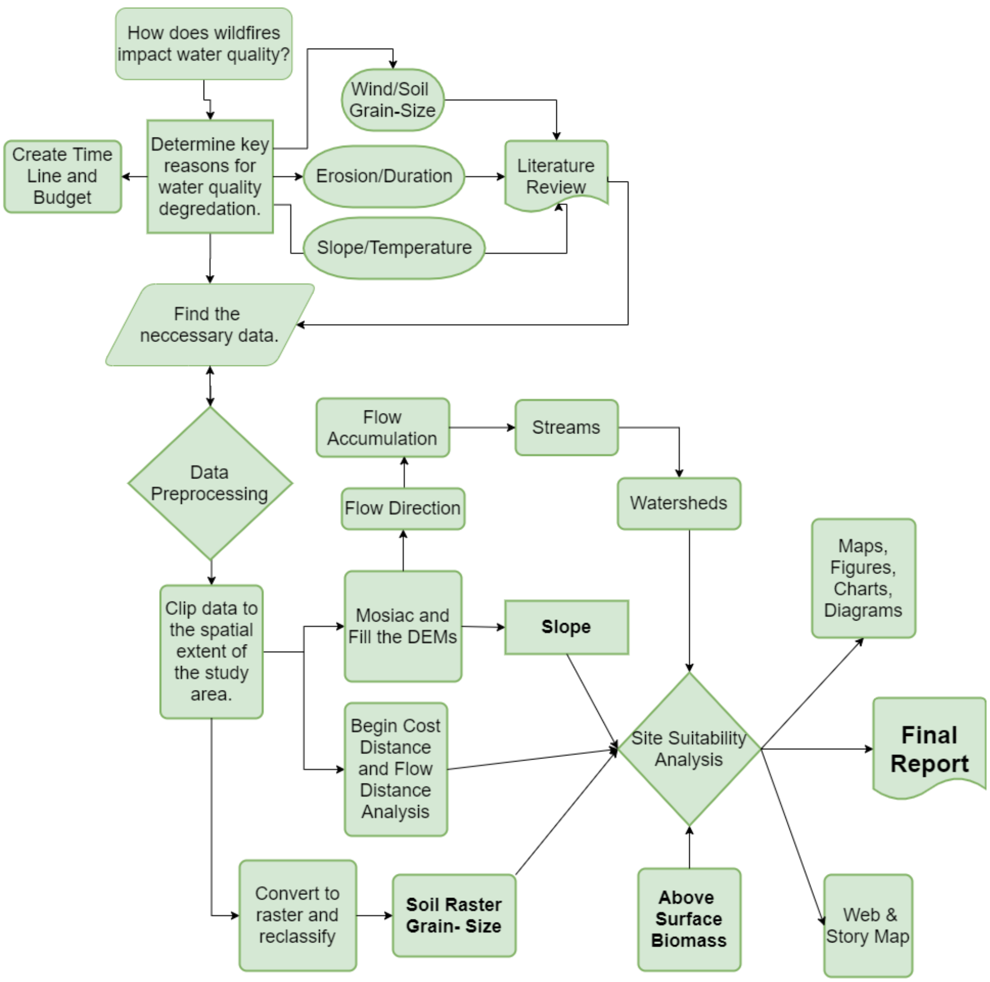

Figure 152 Flowchart of our basic actions

4. Results & Discussion

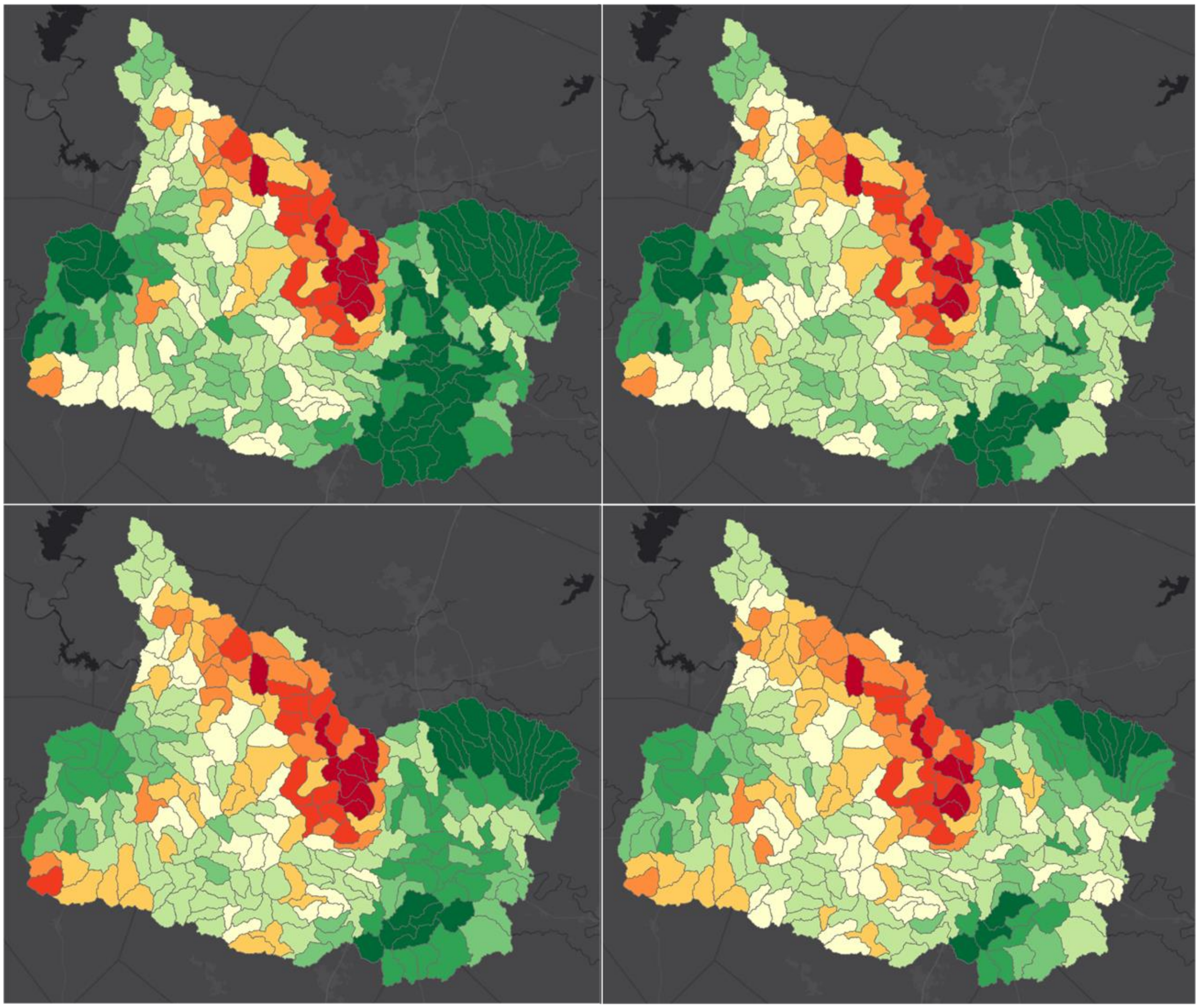

Figure 16. An overview of the Watershed Vulnerability Index using two methods, one that includes soil and one without. On the left is the analysis outlined on the previous pages, on the right soil has been excluded from the analysis; the top maps represent the data that has only been standardized, while the bottom maps represents the data after a square root transformation. The red hues represent 'catchment' areas most at risk of degrading water quality, while green areas represent areas least at risk. Neutral beige hues represent the data near the mean, while the second orange hue represents the data near the first standard deviation and the second red hue represents the data near the second standard deviation. See Appendix III for higher detailed maps of the final output which includes the range of values for the symbology.

It was our expectation that the analysis would result in a large hotspot stretching from Cow Creek at the Balcones Canyonlands National Wildlife Refuge, east past Lago Vista to Jonestown, spreading both south along the western edge of Lake Travis and east past Four Corners toward the Bull Creek Greenbelt, across Lake Austin into West Lake Hills and finally south into the Barton Creek Greenbelt Wilderness Area; this is exactly what was indicated in analysis (Figure 16 above). (Table 02) on the next page represents the top 20 most at risk catchment areas indicated by the analysis, of which, 19 are in the regions described on the previous page. We had expectations of other smaller hotspots along Lake Austin near Bee Caves on a densely vegetated cutback, and in the woodlands of Pedernales Falls State Park; this also held up to be true for our analysis. Other hotspots that we hadn't anticipated were identified within the headwater regions of both Miller Creek near Johnson City on the Pedernales River and Onion Creek on the southern edge of Travis County into Hays County, along with a major tributary of Onion Creek called Bear Creek. Of Lake Austin's 13 catchments, 6 made it into the top 20 list, while the only major tributary for Lake Austin, Bull Cr., has 3 of its 5 catchments on the list. When viewing this data by the means of larger sub-basins, the Lake Austin area ranks the highest (Figure 17). Overall, both analyses, along with many variations of them, all identified the watersheds around Lake Travis and Lake Austin as the most at risk.

The cost distance analysis indicated that the majority of catchments identified as high risk are generally accessible, with a major exception for the rugged terrain around Pedernales Falls State Park. The cost distance analysis represents areas that are more difficult to get to from a fire station because of the terrain. This means in the event of a fire; high-risk areas are likely to suffer more damage because it will take more time for

Table 2. The top 20, out of 248, most at risk catchments and their corresponding watershed. See appendix IV for the complete index with calculated values.

Rank	Catchment Area	Watershed
1	Lower Bull Cr.	Bull Cr.
2	West Lake	Lake Austin
3	Bee Cr. (Lake Austin)	Lake Austin
4	West Bull Cr.	Bull Cr.
5	Lower Little Cypress Cr.	Little Cypress Cr.
6	Post Oak Cr.	Cow Cr.
7	Panther Hollow	Lake Austin
8	Middle Bull Cr.	Bull Cr.
9	Emma Long Park	Lake Austin
10	Upper Little Cypress Cr.	Little Cypress Cr.
11	Barton Cr. Greenbelt	Barton Cr.
12	Lost Cr.	Barton Cr.
13	Lower Big Sandy Cr.	Big Sandy Cr.
14	Lakeway-Bee Caves	Lake Austin
15	Cherry Hollow	Big Sandy Cr.
16	Lime Cr.	Big Sandy Cr.
17	Jones Town	Lake Travis
18	Cuernavaca	Lake Austin
19	Balcones Wildlife Refug.	Cow Cr.
20	South Miller Fk.	Miller Cr.

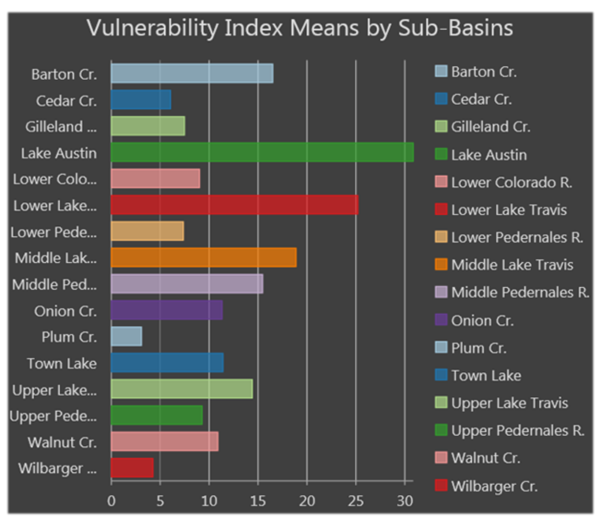

Figure 17. Ranking of major sub-basins by the means of the catchments in the area.

emergency vehicles to respond. The vulnerability analysis shows areas near West Lake Hills, Bull Creek, lower part of Barton Creek, and the Balcones Wildlife preserve are at high-risk for watershed degradation in the event of a fire. These are the areas Austin Fire Department wanted Inferno analytics to identify, so planning could be done to alleviate the potential damage high-risk areas could face.

5. Conclusions

Inferno Analytics was able to successfully create a vulnerability index, a terrain cost distance raster representing the perceived difficulty of a fire response crew to reach a location, and a flow distance raster representing the distance upstream from the nearest municipal water supply intake. Through the vulnerability analysis, we identified the watersheds in Travis County, along with the surrounding areas of influence, that have the greatest potential of degrading water quality if a wildfire was to occur. While we believe our analysis to be accurate, it should be mentioned once more that this hypothetical empirical relationship has not been supported by any actual experiments. Through our cost distance analysis, we identified areas that would receive slow fire rescue response times because of the difficulty of traversing the terrain. This too should be taken more as a reference and not an absolute, as determining the cost to traverse a terrain can become very subjective. Through our flow distance analysis, we were able to calculate the distance that water would flow to reach the nearest downstream water supply intake. While this information does give us the flow distance, this alone does not determine the exact travel time and areas that's may promote entrainment and/or transportation of sediments. Future analysis might look at catchments identified as high risk and attempt to quantify potential stream power under different flow regimes using stream discharge data from the USGS and the DEM; this could potential allow for some indication on how far different grain sizes will travel along any given stretch. We hope that our outputs will be of good use to the AFDWD when it comes time to determine how they mitigate fire relief to best protect the watersheds to preserve the water quality of Travis county.

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Appendix I: Group Members Contribution

Melanie Butler

Proposal – I collaborated with Clayton to write the literature review. I wrote the sections talking about watersheds and biomass. I helped edit the final document to make everyone's section flow together. I helped write some introduction paragraphs.
Progress report – I produced content for the work completed, present work, scheduled work, and problem sections. I created the presentation and put most of the content in the PowerPoint and I gave the presentation
Analysis – I aided in the beginning of the cost distance analysis by working with Corban to collect, implement, and reclassify land cover data
Final deliverables - I wrote the problem statement, scope, references, and summary for the final report. I contributed to the conclusion on the final report. I created final maps for watersheds and vulnerability index. I made the poster.

Corban Rosenauer

Proposal – Worked with literature review initially in trying to find wind data but then delegated to other group members. Primarily focused on getting the scope instruction and other minor parts of the report. Also built the flow chart with Syrus's edits and revisions. Also made the group logo.
Progress report - Collaborated with the group in making the presentation, the Present work, and scope/summary. This was the time our group was working on the early cost distance.
Analysis – Produced an early cost distance collaborating with Melanie, and with the guidance of Syrus helping both of us. The final cost distance, the scope was expanded, and new fire stations were put in this was completed with help assistance of Syrus on more minor matters.
Final deliverables - Worked on the cost distance methodology, metadata, and map. All in the final report. I contributed to final report by helping organize the document and making sure the sections of the report matched the final proposal expectations. Also updated the flow chart for the final proposal as a few things have changed from the original.

Clayton Buehring

Proposal – I first worked on the literature review with Melanie. We split the literature up, so I focused on researching information about soil and slope. I also worked on the introduction with Melanie, but I primarily focused on the summary and purpose paragraphs.

Progress Report – For the progress report I wrote most of the introduction and wrote the section under the task completed about soils. I also created the excel sheet for the soils that contained the three-digit code, name of soil, grain size, and other important attributes. I also wrote the conclusion and helped with the present work and work scheduled.

Analysis - My first task was to go through all the soil types we had in our study area and create a excel sheet that would add attributes for those soils like the name, grain size, ksat, water table depth. I then worked on joining the table to the layer and then converting it to a raster once I went through the attribute table and merged all the soil attributes that were the same but just in different counties. I originally started out working on the suitability model trying it a few ways, but then we ended up using the outputs that Syrus created from his suitability model since he worked with raw values and reclassified them at the end.

Final Deliverables- For the final deliverables I wrote all the information for the website. I then wrote the abstract, conclusion, preprocessing for the soil and land cover, and the metadata for the soil layer, vulnerability index.....

Ken Satchell

Proposal – I focused on the timeline, budget, collaborating on the proposal and helping others with operating ArcGis. Offering advice on how we should go about this project.

Progress Report – Spent most of my time trying to get ArcGIS pro working on my computers, along with finding Wind data for prevailing directions for the Austin area. Though everything was for current or much higher elevation than what we were wanting. Also tweaked our timeline and Budget be more representable. Along with helping others with more advice and contributing to writing up the Progress report. Making sure the figures and tables were labeled correctly.

Analysis – With contacting Samuel Ross about issue with getting Wind data, he advised just using the slope data, since wind has not been averaged out for the local area to determine which areas would have which prevailing direction. I continued to help and give advice on others working on their parts.

Final Deliverables – Worked on the Final Report, Power point and continued making sure the paper layout and fonts were correct and followed the same pattern.

Syrus Borers

Proposal – Focused on data gathering and generating terrain/hydrologic rasters representing slope, aspect, flow accumulation, and flow direction. Reviewed literature to determine which variables maybe of use in the vulnerability analysis. Wrote the methodology, data, and expectations sections. Produced figures, maps, and the flow chart for the paper and presentation. Made final revisions to the paper and powerpoint for submission.

Progress Report – Worked on delineating watershed catchment areas and producing a stream layer, wrote sections detailing this in the progress report.

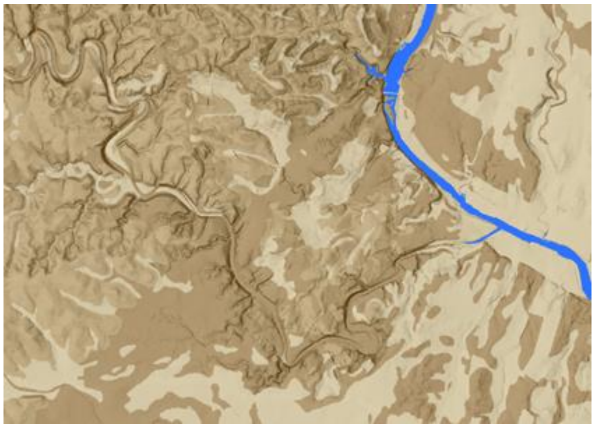
Analysis – Produced the vulnerability index and flow distance raster. Wrote the results & discussion, conclusion, and the majority of the methodology. Produced maps, charts, and figures for the final report and presentation.

Final Deliverables – Focused on completing any GIS related task, such as confirming the data is accurate and free of errors, organizing layers under the contents tab, uploading the map package to ArcOnline, collecting the most important data to be compressed, producing charts, figures & maps, and the web map application.

Appendix II: Metadata

Soil Grain Size

Type: Raster Dataset



Tags: soil, USDA, Travis, Hays, Caldwell, Blanco, Bastrop, Burnet, watershed, vulnerability, fire, Austin

Summary

This soil type layer is intended to be used as a factor to develop a vulnerability index for water quality degradation for the watersheds in Travis County and the watersheds around Travis county that could eventually flow into Travis county.

Description

This soil classification raster includes all 233 soil types inside our study area that includes Travis county and parts of Blanco, Bastrop, Caldwell, and Hays county. The extent of the layer is all the watersheds that are within Travis county or that would impact Travis county. Each soil type has attributes like soil name, grain size in millimeters, depth to water table, ksat in inches per hour. The grain size assigned to each soil type is based off the average grain size for the top 24 inches of soil, because that is about the extent of how deep hydrophobicity can affect the soils. Then the ksat values represents how fast water can move through the soil in inches of soil per hour. This soil layer was downloaded from the USDA and then modified to add all the attributes once in ArcGIS PRO.

Credits

The United States Department of Agriculture (USDA)

Use limitations

This data source is intended for the use of The City of Austin Fire Department: Wildfire Division

Extent

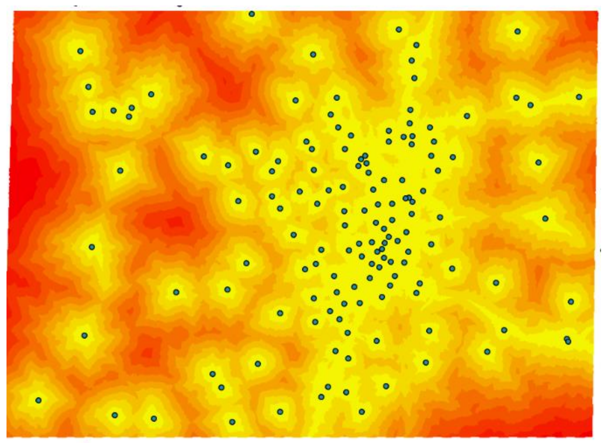
West	-98.500149	East	-97.343413
North	30.831459	South	29.981070

Scale Range

Maximum (zoomed in)	1:5,000
Minimum (zoomed out)	1:500,000

Cost Distance

Type: Raster



Tags: Roads, TXDOT, Travis, Hays, Caldwell, Blanco, Bastrop, vulnerability, fire, Austin, Cost Distance

Summary: This Cost Distance raster is intended to be used in the suitability model. This raster includes all the main roads in the area of study. Along with cost of how hard it is for a fire to theoretically cross certain terrain. These two pieces of data, road network and terrain cost create our cost distance rater.

Description: The cost distance includes two main data sets along with the points of origin. These points are the fire stations. The group decided to go outside of hays county for fire station points because in the first run of cost distance some areas in Travis county were counted as high risk when there was a fire station right outside of the county boundaries. The roads layer was reclassified into 3 categories before being merged with the terrain layer, they are Single Roadbed, nearly all other roads types like left/ right fontange roads, then connectors/turn arounds.

Credits:

Txdot open data portal
USGS
Dept. of Homeland Security

Use limitations

This data is limited to the surrounding areas of Austin and Tavis county.

Hill Shade Map

Type: Multidirectional Hill shaded Relief Raster Base map

Tags: Hill shade, Base map, Travis, Austin

Summary

The hill shade map will be used as our background to give the viewer a visualization of the terrain depth.

Description

This hill shade map was created using our DEM and is intended to be used as our background map for our final products. We choose to display a hill shade map to show the depth changes of the terrain since slope was a major factor in our analysis.

Credits

TNRIS

Use limitations

This data source is intended for the use of The City of Austin Fire Department: Wildfire Division

Extent

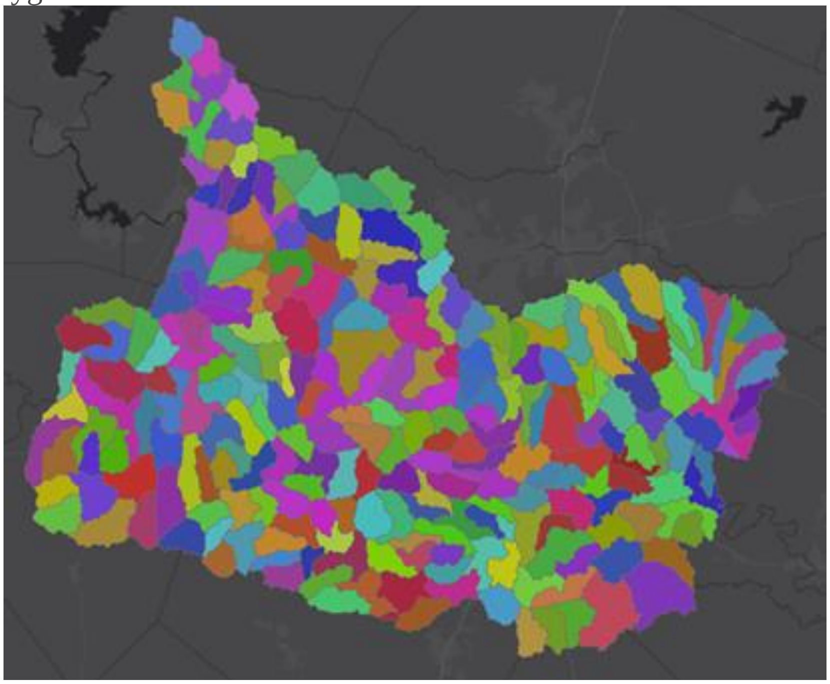
West	-98.500149	East	-97.343413
North	30.831459	South	29.981070

Scale Range

Maximum (zoomed in)	1:50,000
Minimum (zoomed out)	1:800,000

Watersheds

Type: Vector Polygon



Tags: watersheds, Travis, Burnet, Bastrop, Blanco, Hays, Caldwell

Summary

Our watershed layer will be used as our study area in order to clip all our other datasets to be the same area as our watersheds of interest. The watershed layer will be used in various ways to generate the statistics to assign the values for our vulnerability index.

Description

The watershed layer will be used to create our vulnerability index by calculating the sum of the risk values that fall within the watershed and then applying that value to the watershed. We then display the watersheds with their index rating to visualize what watersheds are more vulnerable than others.

Use limitations

This data source is intended for the use of The City of Austin Fire Department: Wildfire Division

Extent

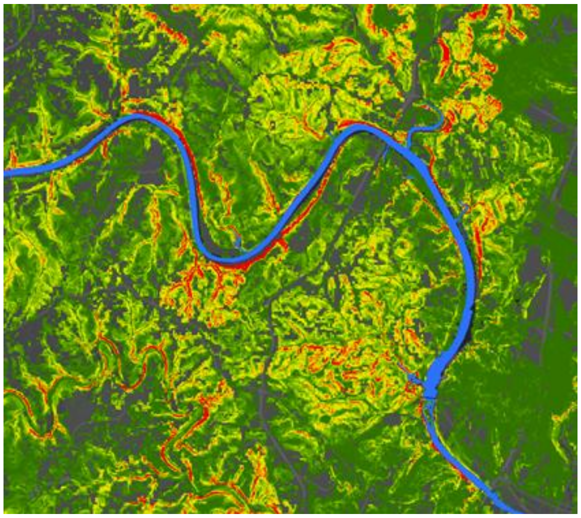
West	-98.500149	East	-97.343413
North	30.831459	South	29.981070

Scale Range

Maximum (zoomed in)	1:5,000
Minimum (zoomed out)	1:500,000

Continuous Vulnerability Analysis

Type: Raster dataset



Tags: vulnerability, watersheds, Travis, Blanco, Burnet, Bastrop, Caldwell, Hays

Summary

This continuous vulnerability analysis is the result from our weighted product model to highlight the areas that are vulnerable to water quality degradation.

Description

This continuous vulnerability analysis will be used to create an index to show the rankings for the watersheds based off their vulnerability risk value. We created this output by taking the slope dividing it by its mean which is 3 multiplied by biomass divided by its mean which is 6 and multiplied by the square root of the soil grain size divided by 2. We also set where the highest value for soil is 2 so that all soil grain sizes over 2mm is assigned 2.

Credits

TNRIS, USGS

Use limitations

This data source is intended for the use of The City of Austin Fire Department: Wildfire Division

Extent

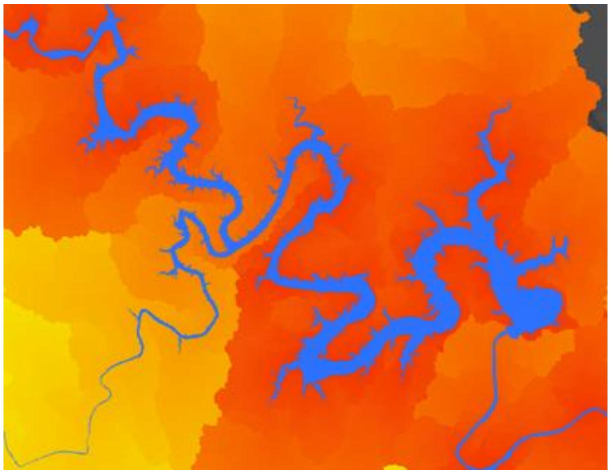
West	-98.500149	East	-97.343413
North	30.831459	South	29.981070

Scale Range

Maximum (zoomed in)	1:50,000
Minimum (zoomed out)	1:800,000

Distance to Closest Municipal Water Inlets

Type: Raster dataset



Tags: distance, watersheds, inlet, Travis, Blanco, Burnet, Bastrop, Caldwell, Hays

Summary

This dataset will display how far water will have to travel in order to reach one of the municipal water inlets. This dataset may help the viewer distinguish how far the debris will have to travel before it reaches a desired downstream inlet.

Description

This distance municipal water inlet map displays how far in meters water will have to travel downstream to a water inlet based on where the water fell along the terrain.

Credits

TNRIS

Use limitations

This data source is intended for the use of The City of Austin Fire Department: Wildfire Division

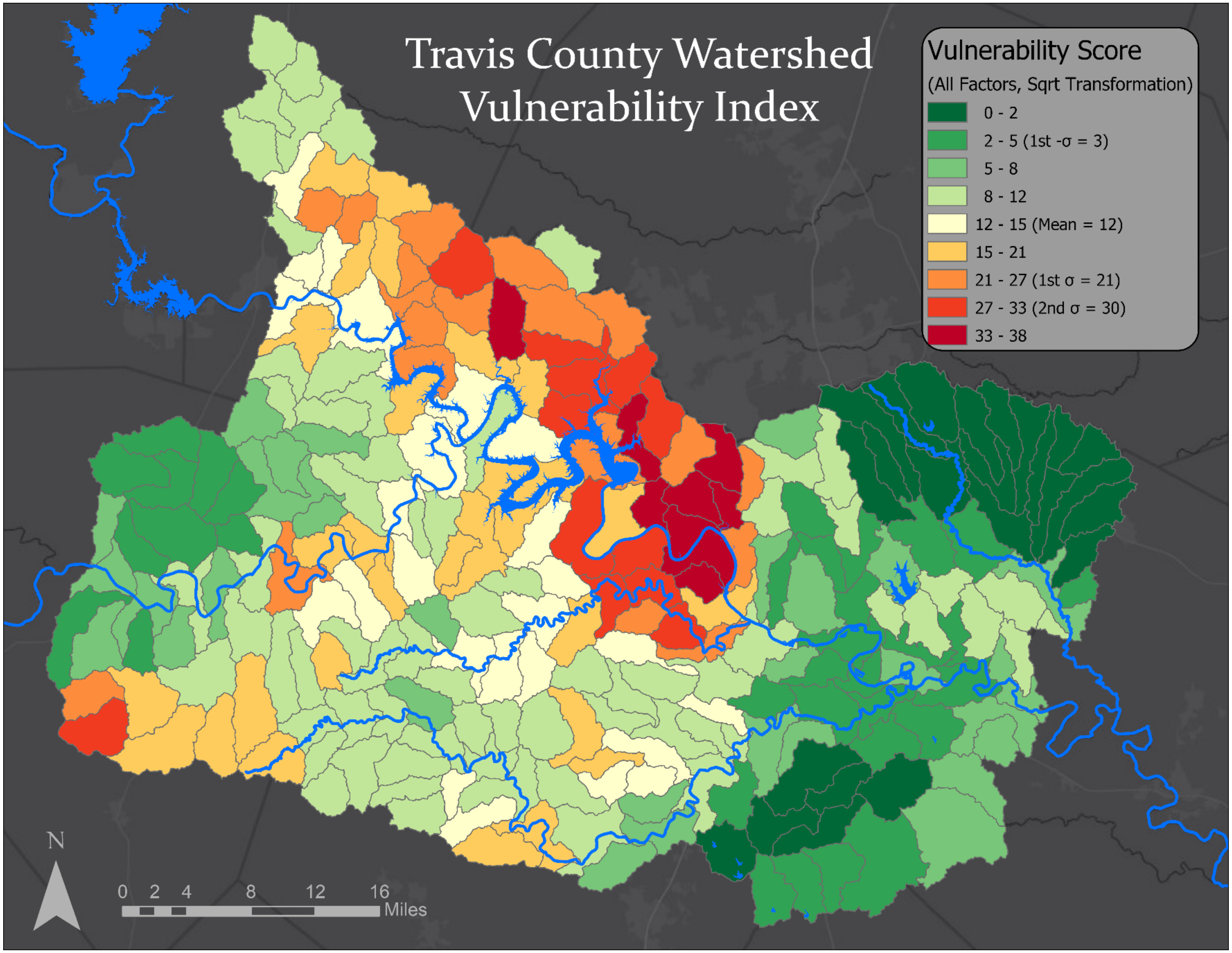
Extent

West	-98.500149	East	-97.343413
North	30.831459	South	29.981070

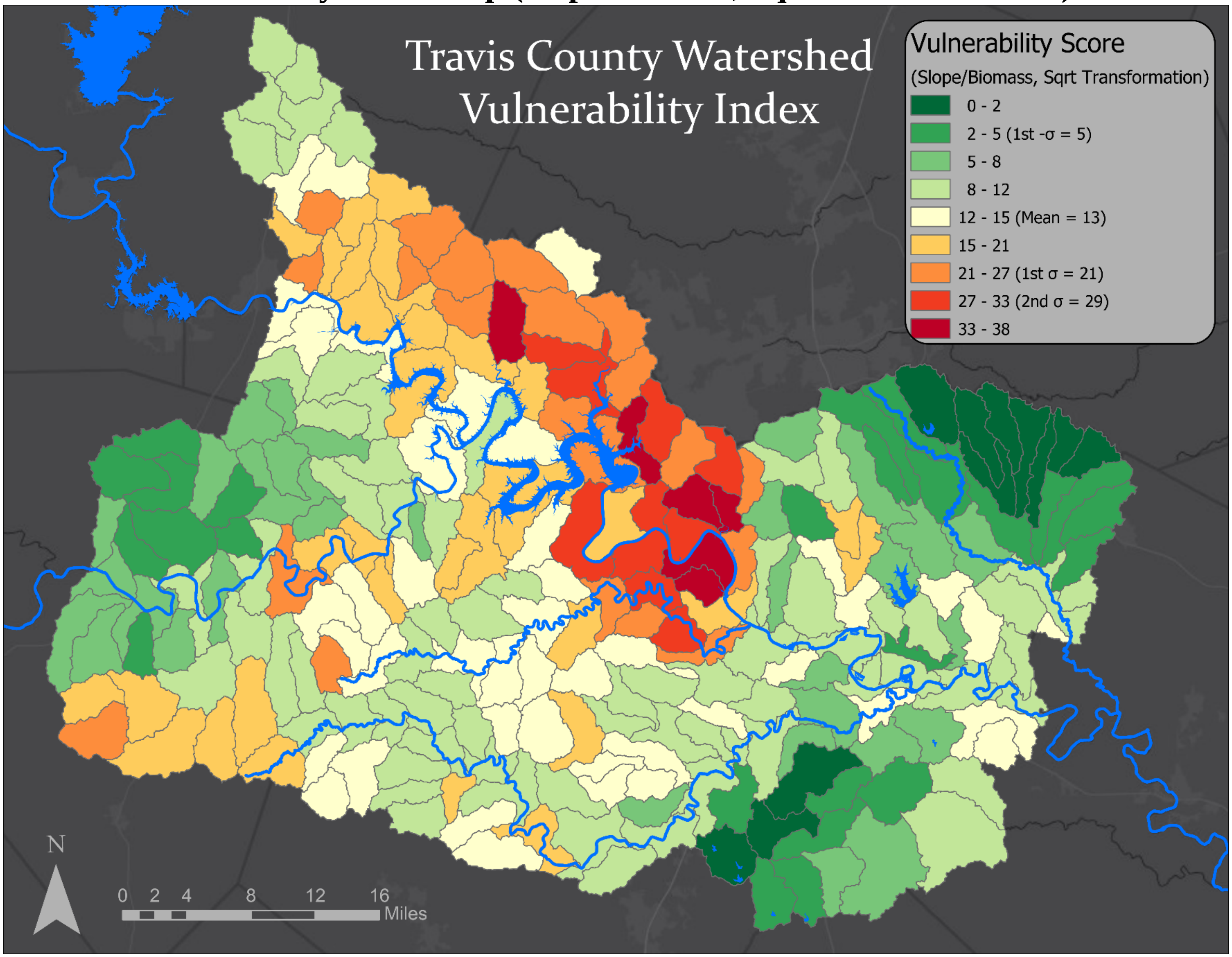
Scale Range

Maximum (zoomed in)	1:50,000
Minimum (zoomed out)	1:800,000

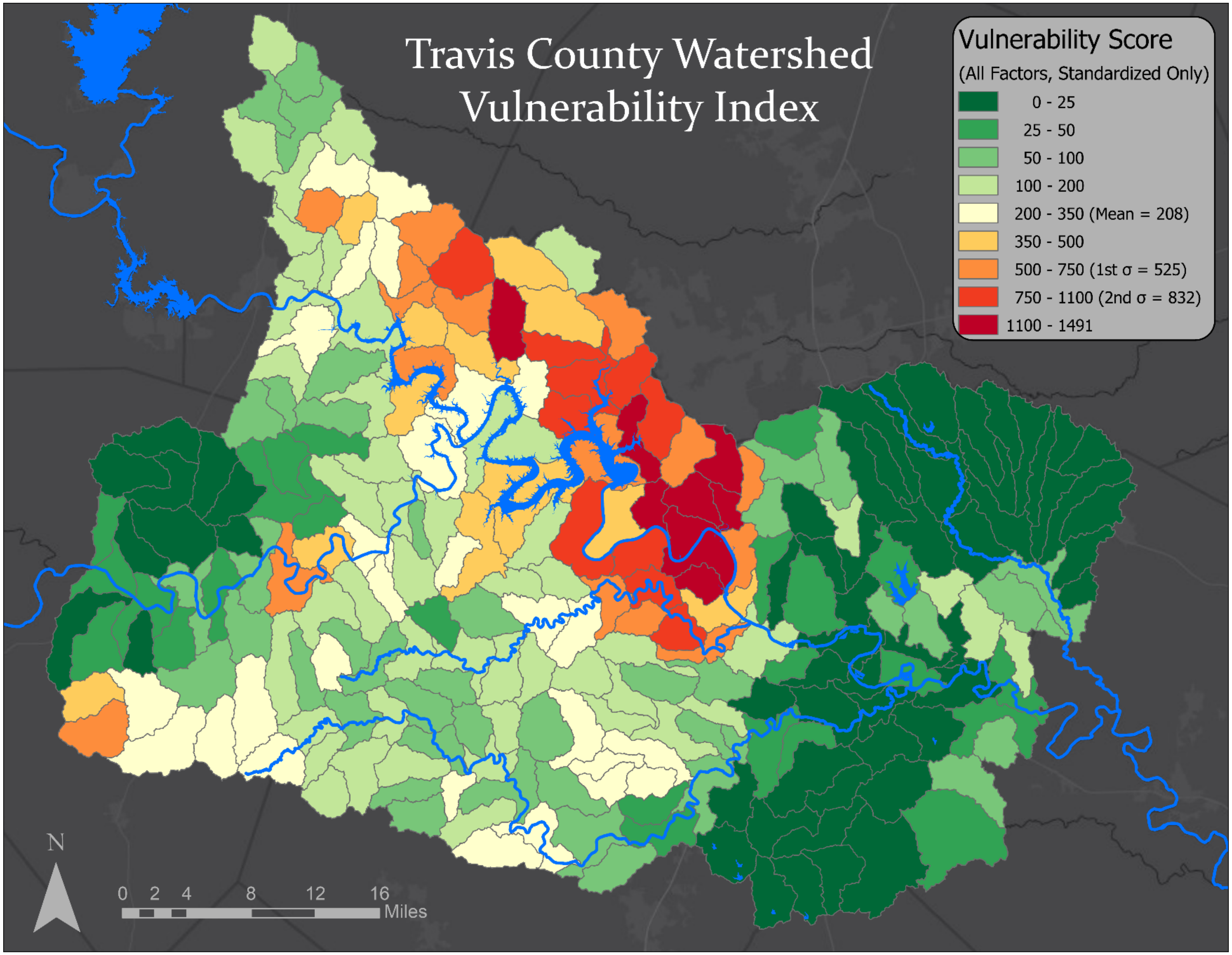
Appendix III: Vulnerability Index Map (All Factors, Sqrt. Transformation)



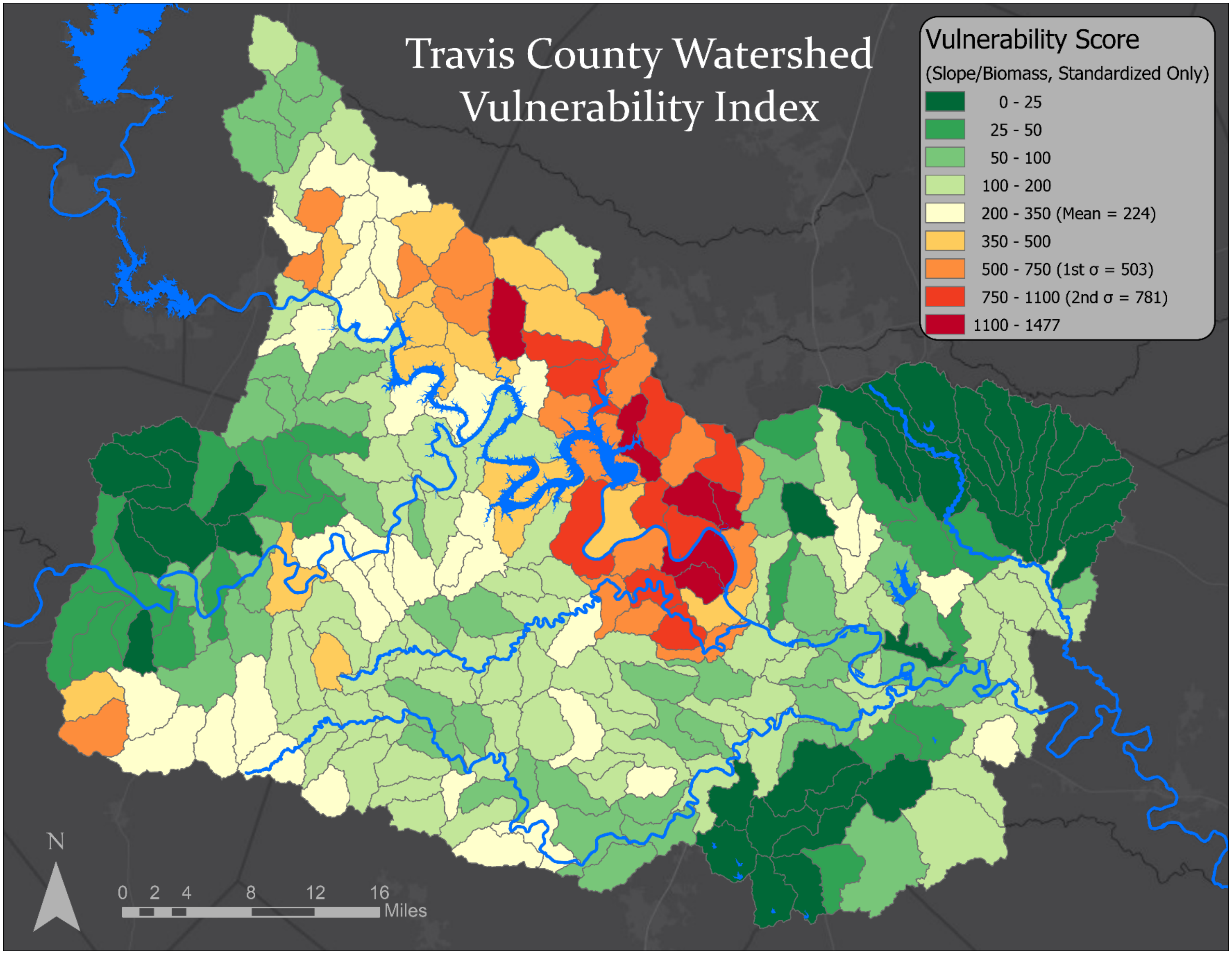
Appendix III: Vulnerability Index Map (Slope/Biomass, Sqrt. Transformation)



Appendix III: Vulnerability Index Map (All, Standardized Only)



Appendix III: Vulnerability Index Map (Slope/Biomass, Standardized Only)



Appendix IV: Vulnerability Index

Table 3. Vulnerability Index (with all variables included)

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
1	Lower Bull Cr.	Bull Cr.	Lake Austin	2408	3589942	1490.840	38.611
2	West Lake	Lake Austin	Lake Austin	3626	5366877	1480.109	38.472
3	Bee Cr.	Lake Austin	Lake Austin	3061	4412607	1441.557	37.968
4	West Bull Cr.	Bull Cr.	Lake Austin	4469	6246865	1397.822	37.387
5	Lower Little Cypress Cr.	Little Cypress Cr.	Lower Lake Travis	4392	5559921	1265.920	35.580
6	Post Oak Cr.	Cow Cr.	Middle Lake Travis	6151	7551400	1227.670	35.038
7	Panther Hollow	Lake Austin	Lake Austin	3269	3858026	1180.185	34.354
8	Middle Bull Cr.	Bull Cr.	Lake Austin	4908	5726842	1166.838	34.159
9	Emma Long	Lake Austin	Lake Austin	3626	4106818	1132.603	33.654
10	Upper Little Cypress Cr.	Little Cypress Cr.	Lower Lake Travis	5831	5957113	1021.628	31.963
11	Barton Cr. Greenbelt	Lower Barton Cr.	Barton Cr.	4179	4010153	959.596	30.977
12	Lost Creek	Lower Barton Cr.	Barton Cr.	4207	4029367	957.777	30.948
13	Lower Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	5990	5678300	947.963	30.789
14	Lakeway-Bee Caves	Lake Austin	Lake Austin	8397	7866116	936.777	30.607
15	Cherry Hollow	Big Sandy Cr.	Lower Lake Travis	4618	3862559	836.414	28.921
16	Lime Cr.	Big Sandy Cr.	Lower Lake Travis	4678	3714079	793.946	28.177
17	Jones Town	Lower Lake Travis	Lower Lake Travis	4619	3575472	774.079	27.822
18	Cuernavaca	Lake Austin	Lake Austin	4539	3508682	773.008	27.803
19	Balcones Wildlife Refuge	Cow Cr.	Middle Lake Travis	7445	5648976	758.761	27.546
20	South Miller Fk.	Miller Cr.	Upper Pedernales R.	6558	4914442	749.381	27.375
21	Dittmar Hill	Lower Barton Cr.	Barton Cr.	4044	2976159	735.944	27.128
22	Upper Bull Cr.	Bull Cr.	Lake Austin	5352	3891855	727.178	26.966
23	Little Hickory Cr.	Hickory Cr.	Upper Lake Travis	2661	1912803	718.829	26.811
24	Bloody Hollow	Big Sandy Cr.	Lower Lake Travis	6320	4437807	702.185	26.499
25	Laurel Oaks Cr.	Bull Cr.	Lake Austin	2930	1963642	670.185	25.888
26	Hudson Bend	Lower Lake Travis	Lower Lake Travis	4619	2906390	629.225	25.084

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
27	Barton Springs	Lower Barton Cr.	Barton Cr.	3860	2399004	621.504	24.930
28	Middle Cow Cr.	Cow Cr.	Middle Lake Travis	4902	3015795	615.217	24.804
29	Tater Hill	Cow Cr.	Middle Lake Travis	6659	4027597	604.835	24.593
30	Pedernales Falls S.P.	Middle Pedernales R.	Middle Pedernales R.	7139	4187819	586.611	24.220
31	Short Spring Br.	Lower Barton Cr.	Barton Cr.	3073	1784181	580.599	24.096
32	Mount Bonnel	Lake Austin	Lake Austin	3521	2036520	578.393	24.050
33	Lower Hickory	Hickory Cr.	Upper Lake Travis	2546	1385416	544.154	23.327
34	Burger Hollow	Hamilton Cr.	Upper Lake Travis	3980	2158099	542.236	23.286
35	Turkey Bend	Upper Lake Travis	Upper Lake Travis	4242	2128661	501.806	22.401
36	Snake Hollow	Big Sandy Cr.	Lower Lake Travis	6900	3426744	496.630	22.285
37	Middle Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	8475	3985817	470.303	21.686
38	Bald Mountain	Upper Lake Travis	Upper Lake Travis	4042	1868097	462.171	21.498
39	North Miller Fk.	Miller Cr.	Upper Pedernales R.	4953	2279852	460.297	21.455
40	Upper Sycamore Cr.	Sycamore Cr.	Upper Lake Travis	3504	1556810	444.295	21.078
41	Steiner Ranch	Lake Austin	Lake Austin	8397	3531952	420.621	20.509
42	Arkansas Bend	Middle Lake Travis	Middle Lake Travis	9511	3823226	401.979	20.049
43	Muleshoe Bend	Upper Lake Travis	Upper Lake Travis	4457	1789563	401.517	20.038
44	Lower Cow Cr.	Cow Cr.	Middle Lake Travis	5349	2084043	389.614	19.739
45	Bee Cr.	Bee Cr.	Middle Lake Travis	8034	2928153	364.470	19.091
46	Turkey Bend	Middle Pedernales R.	Middle Pedernales R.	4891	1751089	358.023	18.921
47	Red Bud	Town Lake	Town Lake	5036	1764033	350.285	18.716
48	Upper Sycamore Cr.	Flat Cr.	Middle Pedernales R.	3921	1276718	325.610	18.045
49	N. Lago Vista	Middle Lake Travis	Middle Lake Travis	9511	3023202	317.864	17.829
50	Upper Hickory Cr.	Hickory Cr.	Upper Lake Travis	4427	1368265	309.073	17.580
51	Murtle-Grape Cr.	Upper Barton Cr.	Barton Cr.	5631	1712727	304.160	17.440
52	Upper Miller Cr.	Miller Cr.	Upper Pedernales R.	7289	2174101	298.272	17.271
53	McCall Cr.	Miller Cr.	Upper Pedernales R.	9241	2728165	295.224	17.182
54	Bee Hollow	Bee Cr.	Middle Lake Travis	3253	938351	288.457	16.984
55	Lower Hairston Cr.	Hamilton Cr.	Upper Lake Travis	5634	1590833	282.363	16.804
56	Upper Cow Cr.	Cow Cr.	Middle Lake Travis	5425	1492220	275.064	16.585
57	Middle Cr.	Miller Cr.	Upper Pedernales R.	6100	1672252	274.140	16.557

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
58	Fearless Treadway	Middle Pedernales R.	Middle Pedernales R.	4056	1065620	262.727	16.209
59	Lower Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	6048	1577065	260.758	16.148
60	Yorks Cr.	Middle Onion Cr.	Onion Cr.	6082	1551627	255.118	15.972
61	Rutherford Ranch	Middle Onion Cr.	Onion Cr.	5712	1440102	252.119	15.878
62	Roy Cr.	Middle Pedernales R.	Middle Pedernales R.	3320	802349	241.671	15.546
63	Middle Bear Cr.	Bear Cr.	Onion Cr.	5915	1397870	236.326	15.373
64	Onion Cr. - White Branch	Upper Onion Cr.	Onion Cr.	5882	1382871	235.102	15.333
65	Little Bear Draw	Little Bear Cr.	Onion Cr.	2749	645990	234.991	15.329
66	Yeager Cr.	Miller Cr.	Upper Pedernales R.	8372	1930236	230.559	15.184
67	Camp Cr.	Upper Lake Travis	Upper Lake Travis	4247	969432	228.263	15.108
68	Lower Little Bear Cr.	Little Bear Cr.	Onion Cr.	3280	722996	220.426	14.847
69	Post Oak - Carpenter Bend	Middle Lake Travis	Middle Lake Travis	6454	1360237	210.759	14.518
70	Chalk Knob	Upper Barton Cr.	Barton Cr.	5619	1178134	209.670	14.480
71	Lake Travis - Pedernales R.	Lower Pedernales R.	Lower Pedernales R.	8744	1826191	208.851	14.452
72	Lower Gatlin Cr.	Gatlin Cr.	Onion Cr.	2364	486585	205.831	14.347
73	Middle Little Bear Cr.	Little Bear Cr.	Onion Cr.	3260	654726	200.836	14.172
74	Lower Bear Cr.	Bear Cr.	Onion Cr.	4677	938425	200.647	14.165
75	Middle Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	5001	989183	197.797	14.064
76	Lower Sycamore Cr.	Sycamore Cr.	Upper Lake Travis	2877	558399	194.091	13.932
77	Smithwick	Upper Lake Travis	Upper Lake Travis	5686	1086183	191.028	13.821
78	Long Branch	Upper Barton Cr.	Barton Cr.	4351	821637	188.839	13.742
79	Spicewood Beach	Upper Lake Travis	Upper Lake Travis	5686	1007375	177.168	13.310
80	Marble Falls	Upper Lake Travis	Upper Lake Travis	4561	798077	174.979	13.228
81	Roy Branch - Cambrian Cr.	Upper Barton Cr.	Barton Cr.	5708	987167	172.944	13.151
82	N. Upper Williamson Cr.	Williamson Cr.	Onion Cr.	4779	805603	168.571	12.984
83	Barton Ranch	Upper Barton Cr.	Barton Cr.	5172	861962	166.659	12.910
84	Boggy Cr.	Lower Onion Cr.	Onion Cr.	3036	499745	164.606	12.830
85	Lower Flat Cr.	Flat Cr.	Middle Pedernales R.	5829	957547	164.273	12.817
86	Reimers - Hupedo Ranch	Lower Pedernales R.	Lower Pedernales R.	4557	748050	164.154	12.812
87	S. Lago Vista	Middle Lake Travis	Middle Lake Travis	9511	1549155	162.880	12.762
88	Dead Mans Hole	Middle Pedernales R.	Middle Pedernales R.	5325	862938	162.054	12.730

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
89	Hamilton Cr.	Middle Pedernales R.	Middle Pedernales R.	5531	893410	161.528	12.709
90	Flat Cr.	Upper Onion Cr.	Onion Cr.	4540	730419	160.885	12.684
91	Hurst Cr.	Middle Lake Travis	Middle Lake Travis	5235	841686	160.781	12.680
92	Lower Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	2749	424882	154.559	12.432
93	Lower Little Barton Cr.	Little Barton Cr.	Barton Cr.	3862	562094	145.545	12.064
94	Lower Fall Cr.	Fall Cr.	Lower Pedernales R.	5580	795925	142.639	11.943
95	Middle Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	3580	510011	142.461	11.936
96	Upper Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	5985	850971	142.184	11.924
97	Middle S. Onion Cr.	S. Onion Cr.	Onion Cr.	6108	855896	140.127	11.838
98	Upper S. Onion Cr.	S. Onion Cr.	Onion Cr.	4118	572514	139.027	11.791
99	Upper Slaughter Cr.	Slaughter Cr.	Onion Cr.	4955	677700	136.771	11.695
100	Upper Little Barton Cr.	Little Barton Cr.	Barton Cr.	3536	480952	136.016	11.663
101	Lower Little Cypress Cr.	Little Cypress Cr.	Upper Lake Travis	4902	665839	135.830	11.655
102	S. Mopac	Slaughter Cr.	Onion Cr.	3166	423772	133.851	11.569
103	Lick Cr.	Lower Pedernales R.	Lower Pedernales R.	4561	597308	130.960	11.444
104	Driftwood	Upper Onion Cr.	Onion Cr.	3501	452360	129.209	11.367
105	Upper Hairston Cr.	Hamilton Cr.	Upper Lake Travis	5678	720863	126.957	11.268
106	Upper Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	5270	668893	126.925	11.266
107	Mustang Branch	Upper Onion Cr.	Onion Cr.	2909	348600	119.835	10.947
108	Middle Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	4209	503145	119.540	10.933
109	Gainer Mountain	Upper Onion Cr.	Onion Cr.	3721	429940	115.544	10.749
110	Lower S. Onion Cr.	S. Onion Cr.	Onion Cr.	5050	582140	115.275	10.737
111	Upper Flat Cr.	Flat Cr.	Middle Pedernales R.	6489	741983	114.345	10.693
112	Coleman Branch	Lower Colorado R.	Lower Colorado R.	3434	383913	111.798	10.573
113	Highland Lake Estates	Hamilton Cr.	Upper Lake Travis	3425	380580	111.118	10.541
114	South Austin	Town Lake	Town Lake	6875	756129	109.982	10.487
115	Univ. of Saint Augustine	Slaughter Cr.	Onion Cr.	3594	382795	106.509	10.320
116	Webberville Cr.	Lower Colorado R.	Lower Colorado R.	5401	574769	106.419	10.316
117	Schoolhouse Hollow	Upper Barton Cr.	Barton Cr.	4587	483079	105.315	10.262
118	Onion Cr. - Cadell Branch	Upper Onion Cr.	Onion Cr.	4154	436653	105.116	10.253
119	Pier Branch	Upper Onion Cr.	Onion Cr.	3460	362926	104.892	10.242

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
120	Lower Cypress Cr.	Cypress Cr.	Lower Pedernales R.	6618	675206	102.026	10.101
121	Jordan Pioneer Settlement	Walnut Cr.	Walnut Cr.	3357	341841	101.829	10.091
122	Honey Cr.	Hamilton Cr.	Upper Lake Travis	6557	667393	101.783	10.089
123	Shady Hollow	Slaughter Cr.	Onion Cr.	4846	490341	101.185	10.059
124	Pace Bend	Middle Lake Travis	Middle Lake Travis	6454	647790	100.370	10.018
125	S. Upper Williamson Cr.	Williamson Cr.	Onion Cr.	5189	517226	99.677	9.984
126	Little Barton Cr.	Upper Barton Cr.	Barton Cr.	3875	384109	99.125	9.956
127	Lower Sycamore Cr.	Flat Cr.	Middle Pedernales R.	3297	326232	98.948	9.947
128	Calohan Cr.	Flat Cr.	Middle Pedernales R.	4179	410276	98.176	9.908
129	Upper Dry Cr.	Wilbarger Cr.	Wilbarger Cr.	6287	606465	96.463	9.822
130	Delaware Cr.	Hamilton Cr.	Upper Lake Travis	3986	384290	96.410	9.819
131	Reeves Lake	Upper Onion Cr.	Onion Cr.	4805	460880	95.917	9.794
132	Hanson Aggregates	Hamilton Cr.	Upper Lake Travis	6745	631896	93.684	9.679
133	Upper Little Cypress Cr.	Little Cypress Cr.	Upper Lake Travis	5046	463651	91.885	9.586
134	Upper Bear Cr.	Bear Cr.	Onion Cr.	6833	615998	90.150	9.495
135	Sprouse Hollow	Upper Barton Cr.	Barton Cr.	5004	434456	86.822	9.318
136	Jackson Branch	Upper Onion Cr.	Onion Cr.	3739	324042	86.665	9.309
137	Rattlesnake Lake	Upper Onion Cr.	Onion Cr.	6588	566414	85.977	9.272
138	North Gatlin Cr.	Gatlin Cr.	Onion Cr.	3281	281001	85.645	9.254
139	Alligator Cr.	Upper Lake Travis	Upper Lake Travis	6450	542451	84.101	9.171
140	Rocky Cr.	Upper Barton Cr.	Barton Cr.	6143	515681	83.946	9.162
141	Stubbs - Pepper Flat	Upper Pedernales R.	Upper Pedernales R.	5644	472734	83.759	9.152
142	The Quarries Park	Walnut Cr.	Walnut Cr.	4961	409049	82.453	9.080
143	South Gatlin Cr.	Gatlin Cr.	Onion Cr.	4457	364437	81.767	9.043
144	Ruby Ranch	Middle Onion Cr.	Onion Cr.	8271	670653	81.085	9.005
145	Upper Little Bear Cr.	Little Bear Cr.	Onion Cr.	5470	434862	79.499	8.916
146	Cedar Mountain	Double Horn Cr.	Upper Lake Travis	2778	215926	77.727	8.816
147	Lower Dry Cr.	Wilbarger Cr.	Wilbarger Cr.	1138	86929	76.388	8.740
148	Lower Slaughter Cr.	Slaughter Cr.	Onion Cr.	3088	232069	75.152	8.669
149	Middle Miller Cr.	Miller Cr.	Upper Pedernales R.	8233	618419	75.115	8.667
150	Lower Miller Cr.	Miller Cr.	Upper Pedernales R.	5890	435795	73.989	8.602

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
151	Upper Elm Cr.	Elm Cr.	Gilleland Cr.	2801	205240	73.274	8.560
152	Upper Shoal Cr.	Town Lake	Town Lake	4285	313846	73.243	8.558
153	Twin Creeks	Middle Onion Cr.	Onion Cr.	7578	545161	71.940	8.482
154	Reimers Ranch Gully	Lower Pedernales R.	Lower Pedernales R.	2067	148241	71.718	8.469
155	Turkey-Hog Hollow	Upper Onion Cr.	Onion Cr.	4472	315497	70.549	8.399
156	Coxville	Walnut Cr.	Walnut Cr.	6405	436886	68.210	8.259
157	Burnet	Hamilton Cr.	Upper Lake Travis	4389	298418	67.992	8.246
158	Middle Williamson Cr.	Williamson Cr.	Onion Cr.	5197	349618	67.273	8.202
159	Decker Cr.	Decker Cr.	Gilleland Cr.	4782	321025	67.132	8.193
160	Hill Ranch	Upper Pedernales R.	Upper Pedernales R.	6249	406545	65.058	8.066
161	Mustang Branch	Middle Onion Cr.	Onion Cr.	5441	327704	60.229	7.761
162	Upper Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	6146	366412	59.618	7.721
163	Dripping Springs	Upper Onion Cr.	Onion Cr.	5327	291688	54.757	7.400
164	Middle Wilbarger Cr.	Wilbarger Cr.	Wilbarger Cr.	6666	356679	53.507	7.315
165	Lower Maha Cr.	Maha Cr.	Cedar Cr.	6776	359154	53.004	7.280
166	Red Gully Cr.	Dry Cr.	Lower Colorado R.	4257	215535	50.631	7.116
167	Fitzhugh Cr.	Upper Barton Cr.	Barton Cr.	4041	201153	49.778	7.055
168	Flat Cr.	Towhead Cr.	Upper Pedernales R.	6517	322122	49.428	7.031
169	Lower Shoal Cr.	Town Lake	Town Lake	4028	197252	48.970	6.998
170	Buda	Middle Onion Cr.	Onion Cr.	5380	262130	48.723	6.980
171	Upper Fall Cr.	Fall Cr.	Lower Pedernales R.	4418	210059	47.546	6.895
172	Upper Walnut Cr.	Walnut Cr.	Walnut Cr.	5630	265240	47.112	6.864
173	Cleveland Br.	Cypress Cr.	Lower Pedernales R.	8256	386774	46.848	6.845
174	Buffalo Cr.	Upper Pedernales R.	Upper Pedernales R.	3479	161703	46.480	6.818
175	Middle Cypress Cr.	Cedar Cr.	Cedar Cr.	15326	708054	46.200	6.797
176	Decker Lake	Decker Cr.	Gilleland Cr.	4855	221708	45.666	6.758
177	Garlic Cr.	Middle Onion Cr.	Onion Cr.	3879	174646	45.023	6.710
178	Brock Hollow	Upper Pedernales R.	Upper Pedernales R.	4877	217553	44.608	6.679
179	Kelley Ranch	Cypress Cr.	Lower Pedernales R.	3418	136922	40.059	6.329
180	Trail Ends	Upper Pedernales R.	Upper Pedernales R.	4650	149759	32.206	5.675
181	Lower Dry Cr.	Dry Cr.	Lower Colorado R.	6213	200055	32.199	5.674

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
182	McKinney Falls	Lower Onion Cr.	Onion Cr.	6503	207805	31.955	5.653
183	Weber Loco Grande Ranch	Upper Pedernales R.	Upper Pedernales R.	5224	158316	30.306	5.505
184	Johnson City	Upper Pedernales R.	Upper Pedernales R.	5921	177028	29.898	5.468
185	Austins' Colony	Lower Colorado R.	Lower Colorado R.	4419	131729	29.810	5.460
186	East Webberville	Lower Colorado R.	Lower Colorado R.	4865	131357	27.000	5.196
187	Boggy Cr. (Austin)	Lower Colorado R.	Lower Colorado R.	8453	227469	26.910	5.187
188	Cottonmouth Cr.	Lower Onion Cr.	Onion Cr.	3450	89431	25.922	5.091
189	Country Club Cr.	Lower Colorado R.	Lower Colorado R.	2921	75707	25.918	5.091
190	Youngblood Ranch	Cypress Cr.	Lower Pedernales R.	4797	121510	25.330	5.033
191	Round Mountain	Cypress Cr.	Lower Pedernales R.	6882	157029	22.817	4.777
192	Towhead Cr.	Towhead Cr.	Upper Pedernales R.	7277	164641	22.625	4.757
193	Del Valle	Lower Colorado R.	Lower Colorado R.	3024	68030	22.497	4.743
194	Lower Williamson Cr.	Williamson Cr.	Onion Cr.	4235	90232	21.306	4.616
195	Garfield - Webberville	Lower Colorado R.	Lower Colorado R.	6406	127407	19.889	4.460
196	Deer Cr.	Upper Pedernales R.	Upper Pedernales R.	3711	68899	18.566	4.309
197	Lower Walnut Cr.	Walnut Cr.	Walnut Cr.	3639	67331	18.503	4.301
198	Youngs Prairie	Wilbarger Cr.	Wilbarger Cr.	2493	46082	18.485	4.299
199	North Cypress Cr.	Cypress Cr.	Lower Pedernales R.	5824	107356	18.433	4.293
200	Upper Cypress Cr.	Cypress Cr.	Lower Pedernales R.	6093	108762	17.850	4.225
201	Upper Cedar Cr.	Cedar Cr.	Cedar Cr.	14837	254823	17.175	4.144
202	Middle Cypress Cr.	Cypress Cr.	Lower Pedernales R.	4791	80163	16.732	4.090
203	Montopolis	Lower Colorado R.	Lower Colorado R.	5541	88116	15.903	3.988
204	Johnson High	Walnut Cr.	Walnut Cr.	3820	56225	14.719	3.836
205	Lower Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	2660	36169	13.597	3.687
206	Manor - New Katy	Upper Wilbarger Cr.	Wilbarger Cr.	7642	98134	12.841	3.583
207	Lower Little Walnut Cr.	Little Walnut Cr.	Walnut Cr.	3302	41146	12.461	3.530
208	Three Island	Lower Onion Cr.	Onion Cr.	3984	47014	11.801	3.435
209	Voyles Lazy Ranch	Upper Pedernales R.	Upper Pedernales R.	3417	39448	11.545	3.398
210	Bergstrom Int. Airport	Lower Onion Cr.	Onion Cr.	6561	74343	11.331	3.366
211	Cowpen Cr.	Elm Cr.	Plum Cr.	5209	57493	11.037	3.322
212	Manor	Gilleland Cr.	Gilleland Cr.	7263	74887	10.311	3.211

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
213	Mysterious Dry Cr.	Dry Cr.	Lower Colorado R.	5421	55734	10.281	3.206
214	Hardin Russel Hollow	Upper Pedernales R.	Upper Pedernales R.	4601	43478	9.450	3.074
215	Mustang Ridge	Cedar Cr.	Cedar Cr.	5470	47753	8.730	2.955
216	Cottonwood Cr.	Upper Pedernales R.	Upper Pedernales R.	9261	74569	8.052	2.838
217	Carson Cr.	Lower Colorado R.	Lower Colorado R.	3400	24517	7.211	2.685
218	Lower Elm Cr.	Elm Cr.	Gilleland Cr.	2639	16905	6.406	2.531
219	Rinard Cr.	Middle Onion Cr.	Onion Cr.	5116	32661	6.384	2.527
220	Elm Cr.	Elm Cr. (Plum Cr.)	Plum Cr.	5492	33033	6.015	2.452
221	South Cypress Cr.	Cypress Cr.	Lower Pedernales R.	5517	31164	5.649	2.377
222	Waller Cr.	Town Lake	Town Lake	3586	18172	5.067	2.251
223	Middle Dry Cr.	Dry Cr.	Lower Colorado R.	6345	29577	4.661	2.159
224	Upper Little Wanut Cr.	Little Walnut Cr.	Walnut Cr.	5091	22055	4.332	2.081
225	Middle Maha Cr.	Maha Cr.	Cedar Cr.	7700	24480	3.179	1.783
226	Elgin River	Wilbarger Cr.	Wilbarger Cr.	4265	11761	2.758	1.661
227	Upper Maha Cr.	Maha Cr.	Cedar Cr.	5553	13169	2.372	1.540
228	Harris Branch	Gilleland Cr.	Gilleland Cr.	7385	16367	2.216	1.489
229	Upper Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	7720	11618	1.505	1.227
230	East Dry Cr.	Dry Cr.	Wilbarger Cr.	5702	7798	1.368	1.169
231	Pflugerville	Gilleland Cr.	Gilleland Cr.	3779	3519	0.931	0.965
232	Elroy	Dry Cr.	Lower Colorado R.	4107	3727	0.907	0.953
233	Creedmoor	Maha Cr.	Cedar Cr.	5455	4889	0.896	0.947
234	Dry Cr.	Dry Cr.	Wilbarger Cr.	6247	5542	0.887	0.942
235	Upper Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	7794	6523	0.837	0.915
236	Upper Dry Cr.	Dry Cr.	Lower Colorado R.	8860	5951	0.672	0.820
237	West Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	5912	3664	0.620	0.787
238	Lower Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	5601	2682	0.479	0.692
239	Brushy Cr.	Elm Cr.	Plum Cr.	5845	2255	0.386	0.621
240	Lower Willow Cr.	Willow Cr.	Wilbarger Cr.	3865	946	0.245	0.495
241	E. Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	5425	709	0.131	0.362
242	East Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	8200	662	0.081	0.284
243	Upper Willow Cr.	Willow Cr.	Wilbarger Cr.	3947	271	0.069	0.262

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
244	New Sweden	Cottonwood Cr.	Wilbarger Cr.	5377	317	0.059	0.243
245	Little Willow Cr.	Willow Cr.	Wilbarger Cr.	3617	116	0.032	0.179
246	W. Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	4682	127	0.027	0.165
247	Cottonwood Branch	Cottonwood Cr.	Wilbarger Cr.	4627	90	0.019	0.139
248	Willow Branch	Willow Cr.	Wilbarger Cr.	3120	11	0.004	0.059

Table 4. Vulnerability Index (without soil grain size)

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
1	Lower Bull Cr.	Bull Cr.	Lake Austin	2408	3556133	1476.799	38.429
2	Bee Cr.	Lake Austin	Lake Austin	3061	4417858	1443.273	37.990
3	West Lake	Lake Austin	Lake Austin	3626	5016602	1383.509	37.196
4	West Bull Cr.	Bull Cr.	Lake Austin	4469	5957632	1333.102	36.512
5	Post Oak Cr.	Cow Cr.	Middle Lake Travis	6151	7300725	1186.917	34.452
6	Lower Little Cypress Cr.	Little Cypress Cr.	Lower Lake Travis	4392	5133097	1168.738	34.187
7	Panther Hollow	Lake Austin	Lake Austin	3269	3539665	1082.797	32.906
8	Emma Long	Lake Austin	Lake Austin	3626	3887219	1072.041	32.742
9	Middle Bull Cr.	Bull Cr.	Lake Austin	4908	4998593	1018.458	31.913
10	Lower Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	5990	5404199	902.204	30.037
11	Lost Creek	Lower Barton Cr.	Barton Cr.	4207	3676681	873.944	29.563
12	Lakeway-Bee Caves	Lake Austin	Lake Austin	8397	7178656	854.907	29.239
13	Upper Little Cypress Cr.	Little Cypress Cr.	Lower Lake Travis	5831	4842720	830.513	28.819
14	Barton Cr. Greenbelt	Lower Barton Cr.	Barton Cr.	4179	3331587	797.221	28.235
15	Cherry Hollow	Big Sandy Cr.	Lower Lake Travis	4618	3660554	792.671	28.154
16	Cuernavaca	Lake Austin	Lake Austin	4539	3318184	731.039	27.038
17	Mount Bonnel	Lake Austin	Lake Austin	3521	2548728	723.865	26.905
18	Dittmar Hill	Lower Barton Cr.	Barton Cr.	4044	2874460	710.796	26.661
19	Balcones Wildlife Refuge	Cow Cr.	Middle Lake Travis	7445	5257730	706.210	26.575
20	Lime Cr.	Big Sandy Cr.	Lower Lake Travis	4678	3258791	696.621	26.394
21	Laurel Oaks Cr.	Bull Cr.	Lake Austin	2930	1928653	658.243	25.656

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
22	Bloody Hollow	Big Sandy Cr.	Lower Lake Travis	6320	4106301	649.731	25.490
23	Jones Town	Lower Lake Travis	Lower Lake Travis	4619	2954732	639.691	25.292
24	Short Spring Br.	Lower Barton Cr.	Barton Cr.	3073	1897413	617.446	24.848
25	Middle Cow Cr.	Cow Cr.	Middle Lake Travis	4902	2960104	603.856	24.573
26	Burger Hollow	Hamilton Cr.	Upper Lake Travis	3980	2369642	595.387	24.401
27	Upper Bull Cr.	Bull Cr.	Lake Austin	5352	3162532	590.907	24.309
28	South Miller Fk.	Miller Cr.	Upper Pedernales R.	6558	3775822	575.758	23.995
29	Hudson Bend	Lower Lake Travis	Lower Lake Travis	4619	2571497	556.722	23.595
30	Little Hickory Cr.	Hickory Cr.	Upper Lake Travis	2661	1445488	543.212	23.307
31	Barton Springs	Lower Barton Cr.	Barton Cr.	3860	2084227	539.955	23.237
32	Lower Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	2749	1413014	514.010	22.672
33	Tater Hill	Cow Cr.	Middle Lake Travis	6659	3101486	465.759	21.581
34	Snake Hollow	Big Sandy Cr.	Lower Lake Travis	6900	3203003	464.203	21.545
35	Pedernales Falls S.P.	Middle Pedernales R.	Middle Pedernales R.	7139	3309130	463.529	21.530
36	Middle Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	8475	3923953	463.003	21.518
37	Upper Sycamore Cr.	Flat Cr.	Middle Pedernales R.	3921	1813651	462.548	21.507
38	Lower Hickory	Hickory Cr.	Upper Lake Travis	2546	1096142	430.535	20.749
39	Steiner Ranch	Lake Austin	Lake Austin	8397	3529992	420.387	20.503
40	Turkey Bend	Upper Lake Travis	Upper Lake Travis	4242	1710815	403.304	20.082
41	Lower Cow Cr.	Cow Cr.	Middle Lake Travis	5349	2145464	401.096	20.027
42	Red Bud	Town Lake	Town Lake	5036	2018028	400.720	20.018
43	Lower Sycamore Cr.	Sycamore Cr.	Upper Lake Travis	2877	1072178	372.672	19.305
44	Bald Mountain	Upper Lake Travis	Upper Lake Travis	4042	1493711	369.548	19.224
45	Arkansas Bend	Middle Lake Travis	Middle Lake Travis	9511	3513058	369.368	19.219
46	North Miller Fk.	Miller Cr.	Upper Pedernales R.	4953	1787448	360.882	18.997
47	Roy Cr.	Middle Pedernales R.	Middle Pedernales R.	3320	1124548	338.719	18.404
48	Upper Sycamore Cr.	Sycamore Cr.	Upper Lake Travis	3504	1182802	337.558	18.373
49	Bee Cr.	Bee Cr.	Middle Lake Travis	8034	2686413	334.381	18.286
50	Muleshoe Bend	Upper Lake Travis	Upper Lake Travis	4457	1445603	324.344	18.010
51	Murtle-Grape Cr.	Upper Barton Cr.	Barton Cr.	5631	1756485	311.931	17.662
52	N. Lago Vista	Middle Lake Travis	Middle Lake Travis	9511	2949674	310.133	17.611

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
53	Camp Cr.	Upper Lake Travis	Upper Lake Travis	4247	1297948	305.615	17.482
54	Highland Lake Estates	Hamilton Cr.	Upper Lake Travis	3425	997294	291.181	17.064
55	Bee Hollow	Bee Cr.	Middle Lake Travis	3253	939227	288.726	16.992
56	Fearless Treadway	Middle Pedernales R.	Middle Pedernales R.	4056	1131183	278.891	16.700
57	Turkey Bend	Middle Pedernales R.	Middle Pedernales R.	4891	1331813	272.299	16.501
58	Rutherford Ranch	Middle Onion Cr.	Onion Cr.	5712	1543706	270.257	16.439
59	Jordan Pioneer Settlement	Walnut Cr.	Walnut Cr.	3357	877662	261.442	16.169
60	Upper Hickory Cr.	Hickory Cr.	Upper Lake Travis	4427	1128867	254.996	15.969
61	Smithwick	Upper Lake Travis	Upper Lake Travis	5686	1437931	252.890	15.903
62	Onion Cr. - White Branch	Upper Onion Cr.	Onion Cr.	5882	1484621	252.401	15.887
63	Middle Bear Cr.	Bear Cr.	Onion Cr.	5915	1491767	252.201	15.881
64	Upper Miller Cr.	Miller Cr.	Upper Pedernales R.	7289	1816437	249.202	15.786
65	McCall Cr.	Miller Cr.	Upper Pedernales R.	9241	2268077	245.436	15.666
66	Middle Cr.	Miller Cr.	Upper Pedernales R.	6100	1461134	239.530	15.477
67	Johnson High	Walnut Cr.	Walnut Cr.	3820	897116	234.847	15.325
68	Lower Gatlin Cr.	Gatlin Cr.	Onion Cr.	2364	551063	233.106	15.268
69	Yeager Cr.	Miller Cr.	Upper Pedernales R.	8372	1934710	231.093	15.202
70	Upper Cow Cr.	Cow Cr.	Middle Lake Travis	5425	1246996	229.861	15.161
71	Lower Hairston Cr.	Hamilton Cr.	Upper Lake Travis	5634	1251041	222.052	14.901
72	Red Gully Cr.	Dry Cr.	Lower Colorado R.	4257	932457	219.041	14.800
73	Yorks Cr.	Middle Onion Cr.	Onion Cr.	6082	1323209	217.561	14.750
74	Middle Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	3580	758776	211.949	14.558
75	Post Oak - Carpenter Bend	Middle Lake Travis	Middle Lake Travis	6454	1362014	211.034	14.527
76	Dead Mans Hole	Middle Pedernales R.	Middle Pedernales R.	5325	1103784	207.283	14.397
77	Lower Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	6048	1242327	205.411	14.332
78	Upper S. Onion Cr.	S. Onion Cr.	Onion Cr.	4118	837011	203.257	14.257
79	Lower Little Bear Cr.	Little Bear Cr.	Onion Cr.	3280	662357	201.938	14.210
80	Hamilton Cr.	Middle Pedernales R.	Middle Pedernales R.	5531	1108374	200.393	14.156
81	Flat Cr.	Upper Onion Cr.	Onion Cr.	4540	903306	198.966	14.106

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
82	Long Branch	Upper Barton Cr.	Barton Cr.	4351	842799	193.702	13.918
83	Boggy Cr.	Lower Onion Cr.	Onion Cr.	3036	583129	192.071	13.859
84	Roy Branch - Cambrian Cr.	Upper Barton Cr.	Barton Cr.	5708	1061604	185.985	13.638
85	Little Bear Draw	Little Bear Cr.	Onion Cr.	2749	508792	185.083	13.605
86	Marble Falls	Upper Lake Travis	Upper Lake Travis	4561	835991	183.291	13.539
87	Lake Travis - Pedernales R.	Lower Pedernales R.	Lower Pedernales R.	8744	1600157	183.001	13.528
88	Lower Bear Cr.	Bear Cr.	Onion Cr.	4677	855060	182.822	13.521
89	Mustang Branch	Upper Onion Cr.	Onion Cr.	2909	530068	182.217	13.499
90	N. Upper Williamson Cr.	Williamson Cr.	Onion Cr.	4779	864217	180.836	13.448
91	Chalk Knob	Upper Barton Cr.	Barton Cr.	5619	1014621	180.570	13.438
92	Three Island	Lower Onion Cr.	Onion Cr.	3984	697839	175.160	13.235
93	Lower Dry Cr.	Wilbarger Cr.	Wilbarger Cr.	1138	198414	174.353	13.204
94	Webberville Cr.	Lower Colorado R.	Lower Colorado R.	5401	901239	166.865	12.918
95	Hurst Cr.	Middle Lake Travis	Middle Lake Travis	5235	861974	164.656	12.832
96	Upper Slaughter Cr.	Slaughter Cr.	Onion Cr.	4955	809457	163.362	12.781
97	Pier Branch	Upper Onion Cr.	Onion Cr.	3460	564088	163.031	12.768
98	Middle Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	5001	810367	162.041	12.730
99	Lower Flat Cr.	Flat Cr.	Middle Pedernales R.	5829	937977	160.916	12.685
100	Country Club Cr.	Lower Colorado R.	Lower Colorado R.	2921	466184	159.597	12.633
101	Spicewood Beach	Upper Lake Travis	Upper Lake Travis	5686	886174	155.852	12.484
102	Middle Little Bear Cr.	Little Bear Cr.	Onion Cr.	3260	507826	155.775	12.481
103	Lower Dry Cr.	Dry Cr.	Lower Colorado R.	6213	956069	153.882	12.405
104	Lower Little Walnut Cr.	Little Walnut Cr.	Walnut Cr.	3302	505404	153.060	12.372
105	S. Lago Vista	Middle Lake Travis	Middle Lake Travis	9511	1436650	151.051	12.290
106	Middle S. Onion Cr.	S. Onion Cr.	Onion Cr.	6108	918928	150.447	12.266
107	Upper Big Sandy Cr.	Big Sandy Cr.	Lower Lake Travis	5985	898018	150.045	12.249
108	Lower Walnut Cr.	Walnut Cr.	Walnut Cr.	3639	532515	146.336	12.097
109	Lower Little Barton Cr.	Little Barton Cr.	Barton Cr.	3862	562010	145.523	12.063
110	Sprouse Hollow	Upper Barton Cr.	Barton Cr.	5004	726806	145.245	12.052

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
111	Barton Ranch	Upper Barton Cr.	Barton Cr.	5172	746478	144.331	12.014
112	Upper Bear Cr.	Bear Cr.	Onion Cr.	6833	986049	144.307	12.013
113	Lower Sycamore Cr.	Flat Cr.	Middle Pedernales R.	3297	475554	144.238	12.010
114	Middle Wilbarger Cr.	Wilbarger Cr.	Wilbarger Cr.	6666	957148	143.587	11.983
115	Lower Williamson Cr.	Williamson Cr.	Onion Cr.	4235	605164	142.896	11.954
116	Little Barton Cr.	Upper Barton Cr.	Barton Cr.	3875	545278	140.717	11.862
117	Schoolhouse Hollow	Upper Barton Cr.	Barton Cr.	4587	638273	139.148	11.796
118	Onion Cr. - Cadell Branch	Upper Onion Cr.	Onion Cr.	4154	571596	137.601	11.730
119	Middle Cypress Cr.	Cedar Cr.	Cedar Cr.	15326	2074621	135.366	11.635
120	Upper Hairston Cr.	Hamilton Cr.	Upper Lake Travis	5678	765898	134.889	11.614
121	Upper Flat Cr.	Flat Cr.	Middle Pedernales R.	6489	875053	134.852	11.613
122	Reeves Lake	Upper Onion Cr.	Onion Cr.	4805	647323	134.719	11.607
123	Upper Little Barton Cr.	Little Barton Cr.	Barton Cr.	3536	475808	134.561	11.600
124	Gainer Mountain	Upper Onion Cr.	Onion Cr.	3721	486764	130.815	11.437
125	Lower S. Onion Cr.	S. Onion Cr.	Onion Cr.	5050	657404	130.179	11.410
126	South Austin	Town Lake	Town Lake	6875	893540	129.969	11.400
127	Reimers - Hupedo Ranch	Lower Pedernales R.	Lower Pedernales R.	4557	591361	129.770	11.392
128	Lick Cr.	Lower Pedernales R.	Lower Pedernales R.	4561	576816	126.467	11.246
129	Coleman Branch	Lower Colorado R.	Lower Colorado R.	3434	429019	124.933	11.177
130	Twin Creeks	Middle Onion Cr.	Onion Cr.	7578	944210	124.599	11.162
131	Lower Shoal Cr.	Town Lake	Town Lake	4028	500256	124.195	11.144
132	Lower Fall Cr.	Fall Cr.	Lower Pedernales R.	5580	686326	122.997	11.090
133	S. Mopac	Slaughter Cr.	Onion Cr.	3166	368899	116.519	10.794
134	East Webberville	Lower Colorado R.	Lower Colorado R.	4865	564783	116.091	10.775
135	Driftwood	Upper Onion Cr.	Onion Cr.	3501	404951	115.667	10.755
136	Lower Maha Cr.	Maha Cr.	Cedar Cr.	6776	781870	115.388	10.742
137	Upper Hamilton Cr.	Hamilton Cr.	Upper Lake Travis	5270	607146	115.208	10.733
138	Del Valle	Lower Colorado R.	Lower Colorado R.	3024	347762	115.001	10.724
139	Lower Little Cypress Cr.	Little Cypress Cr.	Upper Lake Travis	4902	554731	113.164	10.638
140	Calohan Cr.	Flat Cr.	Middle Pedernales R.	4179	469741	112.405	10.602
141	North Gatlin Cr.	Gatlin Cr.	Onion Cr.	3281	367362	111.966	10.581

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
142	Upper Elm Cr.	Elm Cr.	Gilleland Cr.	2801	312547	111.584	10.563
143	Upper Dry Cr. (Wilbarger Cr.)	Wilbarger Cr.	Wilbarger Cr.	6287	685738	109.072	10.444
144	Univ. of Saint Augustine	Slaughter Cr.	Onion Cr.	3594	387995	107.956	10.390
145	McKinney Falls	Lower Onion Cr.	Onion Cr.	6503	690313	106.153	10.303
146	Coxville	Walnut Cr.	Walnut Cr.	6405	662006	103.358	10.166
147	South Gatlin Cr.	Gatlin Cr.	Onion Cr.	4457	460005	103.210	10.159
148	Pace Bend	Middle Lake Travis	Middle Lake Travis	6454	663994	102.881	10.143
149	Decker Cr.	Decker Cr.	Gilleland Cr.	4782	477779	99.912	9.996
150	Rattlesnake Lake	Upper Onion Cr.	Onion Cr.	6588	657874	99.859	9.993
151	Middle Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	4209	419301	99.620	9.981
152	Hanson Aggregates	Hamilton Cr.	Upper Lake Travis	6745	662030	98.151	9.907
153	The Quarries Park	Walnut Cr.	Walnut Cr.	4961	484890	97.740	9.886
154	Lower Slaughter Cr.	Slaughter Cr.	Onion Cr.	3088	299511	96.992	9.848
155	S. Upper Williamson Cr.	Williamson Cr.	Onion Cr.	5189	488872	94.213	9.706
156	Rocky Cr.	Upper Barton Cr.	Barton Cr.	6143	575012	93.604	9.675
157	Shady Hollow	Slaughter Cr.	Onion Cr.	4846	451675	93.206	9.654
158	Middle Williamson Cr.	Williamson Cr.	Onion Cr.	5197	463601	89.206	9.445
159	Garfield - Webberville	Lower Colorado R.	Lower Colorado R.	6406	570512	89.059	9.437
160	Turkey-Hog Hollow	Upper Onion Cr.	Onion Cr.	4472	394846	88.293	9.396
161	Lower Cypress Cr.	Cypress Cr.	Lower Pedernales R.	6618	568114	85.844	9.265
162	Jackson Branch	Upper Onion Cr.	Onion Cr.	3739	315372	84.347	9.184
163	Youngs Prairie	Wilbarger Cr.	Wilbarger Cr.	2493	207446	83.211	9.122
164	Boggy Cr.	Lower Colorado R.	Lower Colorado R.	8453	700155	82.829	9.101
165	Upper Little Cypress Cr.	Little Cypress Cr.	Upper Lake Travis	5046	414885	82.221	9.068
166	Austins' Colony	Lower Colorado R.	Lower Colorado R.	4419	353273	79.944	8.941
167	Hill Ranch	Upper Pedernales R.	Upper Pedernales R.	6249	496483	79.450	8.913
168	Lower Miller Cr.	Miller Cr.	Upper Pedernales R.	5890	456181	77.450	8.801
169	Mustang Branch	Middle Onion Cr.	Onion Cr.	5441	417798	76.787	8.763
170	Honey Cr.	Hamilton Cr.	Upper Lake Travis	6557	501196	76.437	8.743
171	Delaware Cr.	Hamilton Cr.	Upper Lake Travis	3986	302259	75.830	8.708

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
172	Buda	Middle Onion Cr.	Onion Cr.	5380	397893	73.958	8.600
173	Burnet	Hamilton Cr.	Upper Lake Travis	4389	311318	70.931	8.422
174	Montopolis	Lower Colorado R.	Lower Colorado R.	5541	392628	70.859	8.418
175	Upper Little Bear Cr.	Little Bear Cr.	Onion Cr.	5470	375919	68.724	8.290
176	Fitzhugh Cr.	Upper Barton Cr.	Barton Cr.	4041	277078	68.567	8.281
177	Ruby Ranch	Middle Onion Cr.	Onion Cr.	8271	559534	67.650	8.225
178	Middle Miller Cr.	Miller Cr.	Upper Pedernales R.	8233	555379	67.458	8.213
179	Alligator Cr.	Upper Lake Travis	Upper Lake Travis	6450	434298	67.333	8.206
180	Stubbs - Pepper Flat	Upper Pedernales R.	Upper Pedernales R.	5644	373823	66.234	8.138
181	Dripping Springs	Upper Onion Cr.	Onion Cr.	5327	351039	65.898	8.118
182	Upper Shoal Cr.	Town Lake	Town Lake	4285	272775	63.658	7.979
183	Decker Lake	Decker Cr.	Gilleland Cr.	4855	306628	63.157	7.947
184	Cedar Mountain	Double Horn Cr.	Upper Lake Travis	2778	174197	62.706	7.919
185	Upper Double Horn Cr.	Double Horn Cr.	Upper Lake Travis	6146	375243	61.055	7.814
186	Reimers Ranch Gully	Lower Pedernales R.	Lower Pedernales R.	2067	124761	60.358	7.769
187	Upper Cedar Cr.	Cedar Cr.	Cedar Cr.	14837	889252	59.935	7.742
188	Bergstrom Int. Airport	Lower Onion Cr.	Onion Cr.	6561	377366	57.517	7.584
189	Garlic Cr.	Middle Onion Cr.	Onion Cr.	3879	220723	56.902	7.543
190	Carson Cr.	Lower Colorado R.	Lower Colorado R.	3400	175133	51.510	7.177
191	Cottonmouth Cr.	Lower Onion Cr.	Onion Cr.	3450	172882	50.111	7.079
192	Flat Cr.	Towhead Cr.	Upper Pedernales R.	6517	311872	47.855	6.918
193	Lower Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	2660	121464	45.663	6.757
194	Upper Walnut Cr.	Walnut Cr.	Walnut Cr.	5630	255518	45.385	6.737
195	Upper Fall Cr.	Fall Cr.	Lower Pedernales R.	4418	200465	45.375	6.736
196	Manor - New Katy	Upper Wilbarger Cr.	Wilbarger Cr.	7642	345838	45.255	6.727
197	Buffalo Cr.	Upper Pedernales R.	Upper Pedernales R.	3479	149877	43.080	6.564
198	Waller Cr.	Town Lake	Town Lake	3586	152279	42.465	6.517
199	Manor	Gilleland Cr.	Gilleland Cr.	7263	296451	40.817	6.389
200	Cleveland Br.	Cypress Cr.	Lower Pedernales R.	8256	335139	40.593	6.371
201	Brock Hollow	Upper Pedernales R.	Upper Pedernales R.	4877	186555	38.252	6.185
202	Kelley Ranch	Cypress Cr.	Lower Pedernales R.	3418	126248	36.936	6.078

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
203	Middle Dry Cr.	Dry Cr.	Lower Colorado R.	6345	224800	35.429	5.952
204	Karen Loco Grande Ranch	Upper Pedernales R.	Upper Pedernales R.	5224	175099	33.518	5.789
205	Mysterious Dry Cr.	Dry Cr.	Lower Colorado R.	5421	176793	32.613	5.711
206	Harris Branch	Gilleland Cr.	Gilleland Cr.	7385	228284	30.912	5.560
207	Johnson City	Upper Pedernales R.	Upper Pedernales R.	5921	171784	29.013	5.386
208	Upper Cypress Cr.	Cypress Cr.	Lower Pedernales R.	6093	171928	28.217	5.312
209	Mustang Ridge	Cedar Cr.	Cedar Cr.	5470	150986	27.603	5.254
210	Towhead Cr.	Towhead Cr.	Upper Pedernales R.	7277	193413	26.579	5.155
211	Trail Ends	Upper Pedernales R.	Upper Pedernales R.	4650	117266	25.218	5.022
212	Youngblood Ranch	Cypress Cr.	Lower Pedernales R.	4797	120721	25.166	5.017
213	Deer Cr.	Upper Pedernales R.	Upper Pedernales R.	3711	90693	24.439	4.944
214	Upper Gilleland Cr.	Gilleland Cr.	Gilleland Cr.	7720	183800	23.808	4.879
215	North Cypress Cr.	Cypress Cr.	Lower Pedernales R.	5824	130970	22.488	4.742
216	Middle Cypress Cr.	Cypress Cr.	Lower Pedernales R.	4791	101492	21.184	4.603
217	Pflugerville	Gilleland Cr.	Gilleland Cr.	3779	78481	20.768	4.557
218	Round Mountain	Cypress Cr.	Lower Pedernales R.	6882	142388	20.690	4.549
219	Elgin River	Wilbarger Cr.	Wilbarger Cr.	4265	83351	19.543	4.421
220	Upper Little Wanut Cr.	Little Walnut Cr.	Walnut Cr.	5091	96957	19.045	4.364
221	Upper Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	7794	145791	18.706	4.325
222	Rinard Cr.	Middle Onion Cr.	Onion Cr.	5116	90716	17.732	4.211
223	Dry Cr.	Dry Cr.	Wilbarger Cr.	6247	104323	16.700	4.087
224	Cowpen Cr.	Elm Cr. (Plum Cr.)	Plum Cr.	5209	84566	16.235	4.029
225	West Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	5912	81476	13.781	3.712
226	Lower Elm Cr.	Elm Cr.	Gilleland Cr.	2639	33788	12.803	3.578
227	Elm Cr.	Elm Cr. (Plum Cr.)	Plum Cr.	5492	70194	12.781	3.575
228	East Dry Cr.	Dry Cr.	Wilbarger Cr.	5702	71509	12.541	3.541
229	Voyles Lazy Ranch	Upper Pedernales R.	Upper Pedernales R.	3417	40014	11.710	3.422
230	Lower Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	5601	59746	10.667	3.266
231	Cottonwood Cr. (Pedernales R.)	Upper Pedernales R.	Upper Pedernales R.	9261	87842	9.485	3.080

Rank	Catchment	Watershed	Sub-basin	Acreage	Risk Value	Standardized	Transform.
232	Hardin Russel Hollow	Upper Pedernales R.	Upper Pedernales R.	4601	43563	9.468	3.077
233	Middle Maha Cr.	Maha Cr.	Cedar Cr.	7700	62301	8.091	2.844
234	South Cypress Cr.	Cypress Cr.	Lower Pedernales R.	5517	41703	7.559	2.749
235	Elroy	Dry Cr.	Lower Colorado R.	4107	23991	5.841	2.417
236	Lower Willow Cr.	Willow Cr.	Wilbarger Cr.	3865	21200	5.485	2.342
237	Upper Maha Cr.	Maha Cr.	Cedar Cr.	5553	30309	5.458	2.336
238	Creedmoor	Maha Cr.	Cedar Cr.	5455	17833	3.269	1.808
239	E. Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	5425	15876	2.926	1.711
240	Upper Dry Cr.	Dry Cr.	Lower Colorado R.	8860	25694	2.900	1.703
241	Brushy Cr.	Elm Cr.	Plum Cr.	5845	15522	2.656	1.630
242	East Wilbarger Cr.	Upper Wilbarger Cr.	Wilbarger Cr.	8200	14647	1.786	1.336
243	New Sweden - Cele	Cottonwood Cr.	Wilbarger Cr.	5377	6888	1.281	1.132
244	Upper Willow Cr.	Willow Cr.	Wilbarger Cr.	3947	4917	1.246	1.116
245	Little Willow Cr.	Willow Cr.	Wilbarger Cr.	3617	2597	0.718	0.847
246	W. Cottonwood Cr.	Cottonwood Cr.	Wilbarger Cr.	4682	2925	0.625	0.790
247	Cottonwood Branch	Cottonwood Cr.	Wilbarger Cr.	4627	2014	0.435	0.660
248	Willow Branch	Willow Cr.	Wilbarger Cr.	3120	264	0.085	0.291