Final Report: Austin Tree-Canopy Resource, Phase II

Urban Forestry Program and Urban Forestry Board, City of Austin, Texas

Spring 2012, Geography 4427, Texas State University
Website: geosites.evans.txstate.edu/g4427/S12
May 4, 2012

Client:

Urban Forestry Program and Urban Forestry Board, City of Austin, Texas

URBAN FORESTRY

Prepared By:

Ashley Zavala-Project Manager and GIS Analyst

Eli Pruitt-GIS Analyst and Editor

Lowell Hughes-GIS Analyst and Editor

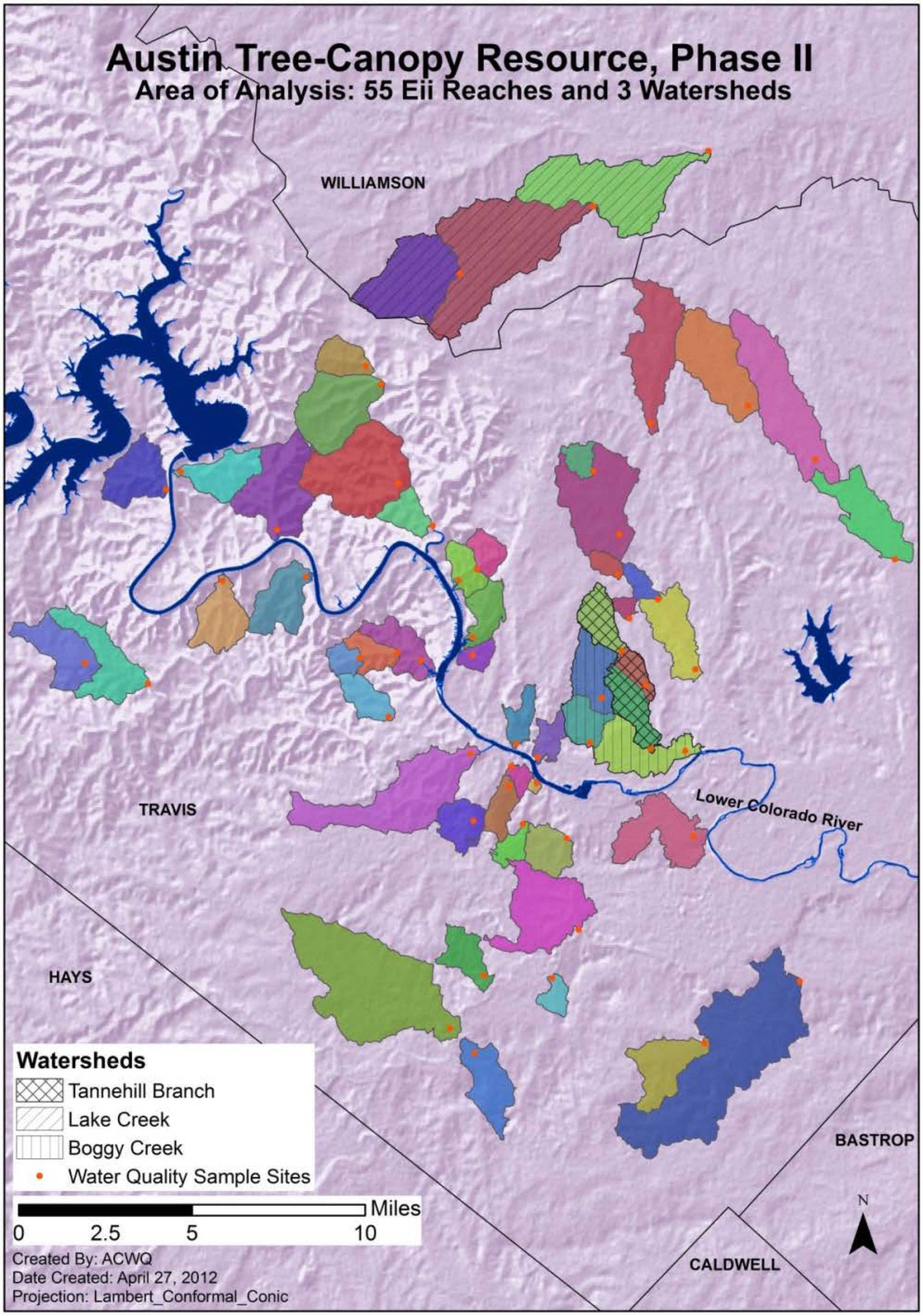
Table of Contents

1. Introduction

When people look at a tree they do not realize the importance of each part. The canopy of the tree is not only important to the tree but the environment around it. At the beginning of the semester the City of Austin (COA) Urban Forestry Program approached the team at Austin Canopy and Water Quality (ACWQ) seeking a research project on this relationship. As GIS analysts and environmental researchers ACWQ possessed the knowledge and skills needed to complete the task. GIS allowed the team to spatially analyze, create, edit, and store data for the project. The team used ArcGIS as the main GIS program when conducting its analysis. Select by location, Iterator, editor, and model builder are some of the tools and techniques the team used during the project. The purpose of ACWQ's research was to determine tree canopy and impervious cover percentages for EII Reaches that met certain parameters as listed by COA. The parameters were to have water quality sampling sites at or within 0.5 miles of the downstream intersect of the creek line and reach boundary and contained data for 3 parameters listed by COA: turbidity, total inorganic nitrogen, and temperature. ACWQ also calculated tree canopy and impervious cover percentages for a 300ft creek line buffer and the COA buffer, which has various widths. Of the selected EII reaches, 3 watersheds that wholly encompassed selected EII reaches were selected so the same analysis could be performed for exploratory purposes. The ultimate goal was to create a relationship between the canopy, impervious cover and water quality data of the sampling sites. Based on our work the Urban Forestry Program will gain insight on where to direct future planting/restoration efforts and the ability to apply for funding set aside specifically for water quality improvements.

2. Scope

The study area of the project was 126 EII reaches as well as the 76 watersheds defined by the Urban Forestry program. To meet the criteria, ACWQ focused its analysis on 55 of the 126 EII reaches. Of the 55 EII reaches, 3 watersheds that wholly encompassed selected EII reaches were selected so the same analysis could be performed for exploratory purposes. The 3 watersheds consist of 9 EII reaches.



Map 1.3. Area of Analysis: 55 EII Reaches and 3 Watersheds

3. Literature Review

3.1 IMPERVIOUS COVER

According to the University of Delaware's Education Manual, impervious cover is any surface that does not allow rainfall to be absorbed or infiltrated through it. Pavement, sidewalks, parking lots, and buildings are all examples of impervious cover. Soil and vegetation naturally absorb rainfall and help filter out pollutants before the runoff enters into the stream system. However, impervious cover disrupts this process and polluted runoff is able to flow into the stream system. As impervious cover in an area grows, the water quality worsens. Pollutants like pesticides, oil, litter, and fertilizers can all be found in impervious cover runoff. "The other impacts on water quality include chemical, physical, and biological degradation. Chemically, an increased presence of bacteria, nutrients, pathogens, and sediment in receiving waters can limit the viability of drinking water and recreational activities. Physically, decreases in stream bank stability, the amount of large woody debris, and channel roughness consequently lower the quality of habitat available for biologic species. Biologically, species diversity declines, biological interactions are altered and pollution-tolerant organisms become more prevalent" (Delaware Sea Grant College Program, 2005).

3.2 WATER QUALITY

Urbanization increases the land area that is covered with impervious surfaces such as streets, sidewalks, driveways, and building rooftops. As a result, rain falling on these surfaces flows quickly which increases the incidence and severity of flooding. Tree canopies intercept rainfall thereby reducing peak discharge into storm water sewers. This interception allows for groundwater recharge, filters toxins and impurities, reduces the cost of storm water disposal, and averts flooding and sedimentation of waterways. Soil, amount of rain, and other factors also affect storm water runoff rates. The amount of tree canopy in urban environments, however, is a *controllable* element that significantly and measurably affects storm water runoff rates and volumes.

Within the last fifteen years, many cities have become aware of the direct relationship between tree canopy and the ecosystem services they provide. Trees reduce the volume of storm water runoff by capturing rain on their leaves and branches; the water is then put back into the water cycle through evapotranspiration. Trees absorb water pollutants and other water filtrates into the soil for a gradual release into streams, rather than running off the land at fast speeds, and extending water availability into dry months when it’s most needed.

Runoff pollution is a major contributor to the decrease of water quality and is often an overlooked environmental problem. A single large-sized tree can release 400 gallons of water into the atmosphere a day. One acre of trees produces enough oxygen for 18 people every day. One acre of tree absorbs enough carbon dioxide per year to match that emitted by driving a car 26,000 miles. Planting a tree can keep water clean and drinkable.

3.3 TREE CANOPY

An article presented by the American Forest explains the benefits of tree cover on water quality. In the early 1970s the quality of the nation’s waterways was so bad that Congress passed the Clean Water Act in 1972, whose main goal was to remove pollution from the nation’s waterways, bring back the fish, and make safe swimming possible. As urban development increases a new challenge arises for storm water managers: how to reduce volume and improve the quality of the water that drains from impervious surfaces as it makes its way into surrounding waterways. The traditional engineering goal was to transfer storm water out of reach of the general population as resourcefully as possible through a network of gutters, sewers, and drainage ditches. However, learning from experience shows that to move water slowly through cities is much more beneficial as it allows for infiltration on site, minimizing flooding and maintaining water quality (American Forests, 2000). This is encouraging a shift from built infrastructure to nonstructural methods, such as increasing tree canopy cover for slowing storm water runoff, as a best management practice (American Forests, 2000). American Forests' studies have shown that one of the benefits of trees in the urban environment is that they serve as environmental quality indicators as it reduces storm water flow and improves water quality. Trees are also natural pollution filters (American Forests, 2000). Their canopies, trunks, roots, and associated soil and other natural elements of the landscape filter polluted particulate matter out of the flow toward the storm sewers (American Forests, 2000). So by reducing the flow of storm water not only are we providing trees with their necessary nutrients like nitrogen, phosphorus, and potassium byproducts of urban living but it reduces the amount of pollution that is washed into a drainage area or into a stream. During heavy rains trees slow the flow of storm water which reduces the potential for flooding. During light rains, trees provide their greatest benefit by promoting soil permeability to facilitate groundwater recharge; reducing impervious surfaces and increasing tree cover promotes the movement of water into the water table (American Forests, 2000). A study in Garland, TX showed that if Garland's existing tree canopy cover was removed the city would have to contend with 19 million additional cubic feet of storm water (American Forests, 2000). Trees serve as environmental quality indicators, lessen the damage caused by storm water, are natural pollution filters, and improve water quality.

4. Data

The original datasets provided by The City of Austin's (CoA), Urban Forestry Program (UFP) for our use in this project include: CoA creek polyline layer; Creek buffer polygon layer; Watershed EII reach polygon layer; Tree canopy 2006 polygon layer; Receiving water polygon layer; Digital elevation model (DEM) a raster layer; Water quality sample sites point layer. The vector datasets acquired came projected in the Lambert Conformal Conic projection and used the NAD 1983 State Plane Texas Central FIPS 4203ft. coordinate system. All the datasets came in the same projection and used the same coordinate system.

Additional datasets were procured through various federal, and local agency websites via download, include: Impervious cover raster layer; Land cover raster layer; National hydrography dataset; Hill shade raster layer; County polyline layer. These datasets were acquired from agency's that include: The City of Austin; USGS; Texas Parks and Wildlife; Barton Springs Edwards Aquifer Conservation District (BSEACD). ArcMap's "project on fly" functionality allowed for a seamless transition as datasets were added and projected in Lambert Conformal Conic projection and the NAD 1983 State Plane Texas Central FIPS 4203ft. coordinate system.

ACWQ primary objective was to explore how water quality is related to the presence of tree canopy coverage with in the designated EII watershed reaches. Esri ArcMap will allow the team to calculate the percentage of tree canopy and impervious cover within the designated EII watershed reaches. The tree canopy and impervious cover data was extracted from within the creek line buffer. This information, along with the water quality data received from the water uality sample sites located within the EII reaches, will allow for thorough analysis of possible trends that may exist between water quality and tree canopy.

Table 1. Data

Data Set	Source
Tree Canopy	City of Austin (COA)
Watershed	City of Austin (COA)
Creek lines	City of Austin (COA)
County Lines	City of Austin (COA)
City boundary	City of Austin (COA)
Receiving Waters	City of Austin (COA)
EII REACH Watersheds	COA Urban Forestry Program
Digital Elevation Model (DEM)	COA Urban Forestry Program
Hillshade raster layer	Barton Springs Edwards Aquifer Conservation District (BSEACD)
Water Quality Monitoring Stations	Texas Commission on Environmental Quality (TCEQ)
Impervious Cover raster layer	United States Geological Survey (USGS)
Land Cover raster layer	United States Geological Survey (USGS)
National Hydrography dataset	United States Geological Survey (USGS)

5. Methodology

The first step in this analysis was examining the available datasets and interpreting what attributes and features were present. Since a stream network did not exist, and water quality sample sites were not located at the drainage point for every EII reach, ACWQ employed a methodology for selecting only those EII reaches that contain water quality sample sites, within 0.5 mile from the drainage point, fit the scope of the project.

After creating the “Drainage_PTS” layer ACWQ performed a spatial query to identify the watersheds whose sample stations (layer “SampleSites”) were within a distance of 0.5 miles away from the “Drainage_PTS” of that watershed, as that was agreed upon by ACWQ and The City of Austin. The result was 30 watersheds. ACWQ exported this data and named the exported layer “Watershed3.”

ACWQ clipped the “creek lines” layer (that was given to us by COA) by the “Watershed2” layer and named it “Creek2” to represent the current creek layer as it corresponded to our study area of 30 watersheds. ACWQ also clipped the “WPOBuffers” layer given to us by the city of Austin (that had varied buffers depending on stream reach width). ACWQ renamed the buffer layer “Buffer2.”

Afterwards we realized that we needed to go back and verify that the “Select By Location” query ran as intended. So we went through and individually checked the 30 watersheds, of the “Watershed3” layer, and found that we needed to delete 6 sample sites and corresponding watersheds (site: 1216 watershed: SouthForkCreek; site: 1087 watershed: BearCreek; site: 1097 watershed: RattanCreek; site: 1101 watershed: LittleBearCreek; site: 1474 watershed: WestCountryClub-CountryClubWest; site: 2794 watershed: WestBouldin) as the query ran and selected the 0.5 mile distance to the nearest drainage point even if it was in another watershed. So we used our editor tool to delete the rows in the attribute table of the “Watershed3” layer. Our study area is now composed of 24 watersheds. We deleted the sample sites that were not needed as they were not within a 0.5 mile Euclidean distance of the drainage point and renamed that layer “SampleSites2.” We also clipped the Bufferf2 layer to match our new 24 watershed study area and renamed the buffer layer “Buffer3.”

The canopy per watershed was clipped so that we could later calculate the percentage per watershed of canopy cover later. To do this ACWQ performed the same two tasks repeatedly for the 24 watersheds as ACWQ did not want any model or script to slow down the performance of our school computers and utilize the time we had most efficiently.

ACWQ went through and individually exported each watershed, simultaneously ACWQ was clipping canopy to each newly exported watershed. The new exported watersheds were named after the name given in the “WATERSHE_1” field in the attribute table, the newly clipped canopy layer per watershed was given the same name as the watershed plus “_C” for example Barton Creek when exported from the “Watershed3” layer was named “BartonCreek” and the canopy that was clipped to that watershed was named “BartonCreek_C” and so did each of the additional 23 watersheds after that.

ACWQ created the 300ft centerline buffer. The “X” in the “Output Feature Class” is because ACWQ reinserted all of the info after the fact that ACWQ did it in the even that it would not work. ACWQ named the new buffer “Buffer_300.” Then we ACWQ clipped “Creek2” by “Watershed3” to accurately represent the 30 watersheds we have narrowed our study area to (the 24 watersheds), and now we have “Creek3” that accurately represents our creek lines layer that corresponds to our “Watershed3” layer.

The team clipped each canopy per watershed to the 300ft centerline buffer so ACWQ performed clips for all 24 watersheds (as shown in Table 2 below). And ACWQ named these layers the same as the canopy layer plus “300” example “LakeCreek_C300”

The team then clipped each canopy per watershed to the buffer layer that was given to us by the City of Austin. So ACWQ performed clips for all 24 watershed. ACWQ named these layers the same as the watershed layer plus Au to signify Austin's layer. example "LakeCreek_CAu" To keep all of the individual watersheds organized ACWQ grouped them and called the group: "Watersheds_Indvdl"

The sample site numbers were then manually entered into the filter tool located on the water quality data set on data.austintexas.gov. The data from these 55 sites were then exported into a Microsoft Excel csv format. The first step was to sort the spreadsheet by site number. Two columns were then added to the worksheet. In one of the columns the following equation was entered =mid (first data entry with sampling date,7,4). The purpose of this was to take the take the year out of the sampling date. Once this was done the formula was dragged to the bottom of the sheet so that every entry in the column had the year from the corresponding sampling date. This column was then copied and the value was pasted into the second blank column that was created. After doing this, the entire worksheet was sorted by this column. This sorted the sampling site data into ascending site number and ascending sampling date order. This allowed for the deletion of data that was not from 2011. Next, the team manually went through and deleted water quality data that was not a measure of Nitrogen, Turbidity, and Water Temperature. The spreadsheet was then formatted to only include the following columns, watershed, siteno (site number), site type, medium, temperature, nitrate, turbidity, location. Most sampling sites had multiple measurement records so these numbers were then manually averaged to create one number for each water quality measure for each sampling sample site. This data was then joined to sampling site layer based upon the sampling site number field in the layer and spreadsheet.

Table 2. Sample Site and Water Quality Data

Reach	SiteNo	Phase	SiteName	State83x	State83y	WshedNo	WATERSHED	SiteNo_1	SITE_TYPE	MEDIUM	Temperatur	Nitrate	Turbidity
BAR1	879	1	Barton Creek Between Dams Above Pool	3104986	10068924	1	Barton Creek	879	Stream	Surface Water	28.48	0.203	18.96
BEE1	319	2	Bee Creek @ Lake Austin	3097420	10083120	11	Bee Creek	319	Stream	Surface Water	12.43	3.36	0.34
BEE2	322	2	Bee Creek @ Road Runner Road	3093880	10084333	11	Bee Creek	322	Stream	Surface Water	12.67	2.37	2.24
BEE3	1104	2	Bee Creek @ Loop 360	3088077	10083483	11	Bee Creek	1104	Stream	Surface Water	15.67	2.31	1.37
BLU1	180	1	Blunn Creek @ Riverside Drive	3115069	10064410	15	Blunn Creek	180	Stream	Surface Water	27.69	0.008	5.52
BLU3	362	1	Blunn Creek @ Long Bow (Preserve at Little Bridge)	3112962	10058181	15	Blunn Creek	362	Stream	Surface Water	23.12	0.649	3.73
BMK1	851	1	Buttermilk Creek @ Little Walnut Creek	3133581	10092440	16	Buttermilk Branch	851	Stream	Surface Water	28.84	0.08	1.62
BMK3	3861	1	Buttermilk Creek @ Victory Christian Center	3127475	10096168	16	Buttermilk Branch	3861	Stream	Surface Water	24.45	1.96	1.1
BOG1	493	1	North Boggy Creek @ Delwau Lane	3137720	10069350	17	Boggy Creek	493	Stream	Surface Water	29.93	0.008	10.66
BOG2	837	1	North Boggy Creek @ Nile Street	3123204	10070615	17	Boggy Creek	837	Stream	Surface Water	25.5	0.022	2.43
BOG3	2754	1	North Boggy Creek @ Manor Rd	3125001	10077413	17	Boggy Creek	2754	Stream	Surface Water	21.79	0.0145	2.15
BRW1	1224	2	Bear Creek (West) @ Fritz Hughes Park Road	3060817	10111903	20	Bear Creek West	1224	Stream	Surface Water	8.82	1.19	0.37
BUL3	349	2	Bull Creek Above Tributary 7 (Franklin)	3091358	10125201	7	Bull Creek	349	Stream	Surface Water	16.02	0.632	0.76
BUL4	1164	2	Tributary 5 Below Hanks Tract Property Line	3088985	10128017	7	Bull Creek	1164	Stream	Surface Water	13.36	0.712	0.52
CAR1	1094	2	Carson Creek @ Shady Spring Subdivision	3138944	10056294	23	Carson Creek	1094	Stream	Surface Water	11.48	1.84	1.15
CCW2	850	1	West Country Club Creek @ East Oltorf St	3119645	10056029	120	Country Club West	850	Stream	Surface Water	23.22	0.013	3.81
CMF1	1048	2	Common Ford Tributary in Common Ford Metro Park	3067136	10095252	125	Commons Ford Creek	1048	Stream	Surface Water	12.08	2.06	0.37
CRN1	1222	2	Cuernavaca Creek @ River Hills Road	3079906	10095902	126	Cuernavaca Creek	1222	Stream	Surface Water	12.39	4.21	0.21
DRE2	1211	2	Dry Creek @ Pearce Road	3155188	10034171	41	Dry Creek East	1211	Stream	Surface Water	8.31	0.471	15.35
DRN1	1108	2	Dry Creek (North) @ Mt Bonnel Rd	3103129	10095349	42	Dry Creek North	1108	Stream	Surface Water	9.9	0.368	1.39
DRN2	1109	2	Dry Creek (North) @ FM 2222	3105950	10097042	42	Dry Creek North	1109	Stream	Surface Water	14.67	0.44	0.82
EAN2	1106	2	Eanes Creek @ Camp Craft Road	3092493	10074520	118	Eanes Creek	1106	Stream	Surface Water	11.13	0.953	0.42
EBO1	1338	1	East Bouldin Creek @ Post Oak	3111184	10066970	4	East Bouldin Creek	1338	Sediment	Surface Water	19.53	0.008	2.15
EBO2	119	1	East Bouldin Creek @ Elizabeth St	3110839	10063953	4	East Bouldin Creek	119	Stream	Surface Water	24.47	0.024	2.02
FOR4	126	1	Fort Branch Creek @ Glencrest Drive	3129201	10089534	9	Fort Branch	126	Stream	Surface Water	19.99	0.008	3.72
GIL3	1191	1	Gilleland Creek @ West Parsons St	3169717	10098527	48	Gilleland Creek	1191	Stream	Surface Water	24.43	14.26	13.75
GIL4	1194	1	West Gilleland Creek @ Cameron Road	3157566	10113776	48	Gilleland Creek	1194	Stream	Surface Water	20.09	0.016	41.45
HRS2	1199	1	Harris Branch Creek @ Crystal Bend Drive	3147301	10121975	59	Harris Branch	1199	Stream	Surface Water	19.97	1.77	3.58
LBA1	77	2	Little Barton Creek @ Barton Creek (LBC)	3055834	10079591	63	Little Barton Creek	77	Stream	Surface Water	10.23	0.867	0.4
LBA2	1114	2	Little Barton Creek @ Great Divide Dr	3046194	10082733	63	Little Barton Creek	1114	Stream	Surface Water	10.56	1.75	0.59
LKC1	1098	2	Lake Creek @ Sugar Berry Cove	3141258	10160810	70	Lake Creek	1098	Stream	Surface Water	13.57	0.639	2.28
LKC2	3978	2	Lake Creek @ Shadowbrook Club	3123694	10152317	70	Lake Creek	3978	Stream	Surface Water	6.57	1.17	7.43
LKC3	1100	2	Lake Creek Below Meadowheath Drive	3103341	10142101	70	Lake Creek	1100	Stream	Surface Water	10.71	3.99	0.82
LWA1	634	1	Little Walnut Creek @ US183	3139287	10081771	6	Little Walnut Creek	634	Stream	Surface Water	26.61	0.0125	5.77
LWA3	3860	1	Little Walnut Creek @ Georgian Dr	3127653	10102320	6	Little Walnut Creek	3860	Stream	Surface Water	29.83	0.017	1.02
LWA4	838	1	Little Walnut Creek @ Golden Meadow Rd	3123733	10111951	6	Little Walnut Creek	838	Stream	Surface Water	23.69	0.008	2.6
MAR1	231	2	Marble Creek Above Onion Creek (M1)	3117424	10034668	76	Marble Creek	231	Stream	Surface Water	7.97	0.658	1.14
PAN1	1223	2	Panther Hollow Creek @ Big View Road	3075458	10103031	83	Panther Hollow	1223	Stream	Surface Water	10.61	3.46	0.76

A digital elevation model (DEM) was used to determine creek flow direction. A digital elevation model is simply a two-dimensional array of elevation points with a constant x and y spacing, its simple data structure make them a good source for digital terrain modeling and watershed characterization. A flow chart model or (algorithm) developed utilized three tools; interpolate shape, add Z information, and polyline to raster. A z-value was added to the interpolated shape output and the polyline was then converted to raster, refer to Figure 1. A z-value typically represents elevations or heights and can be used to display features in three dimensions.

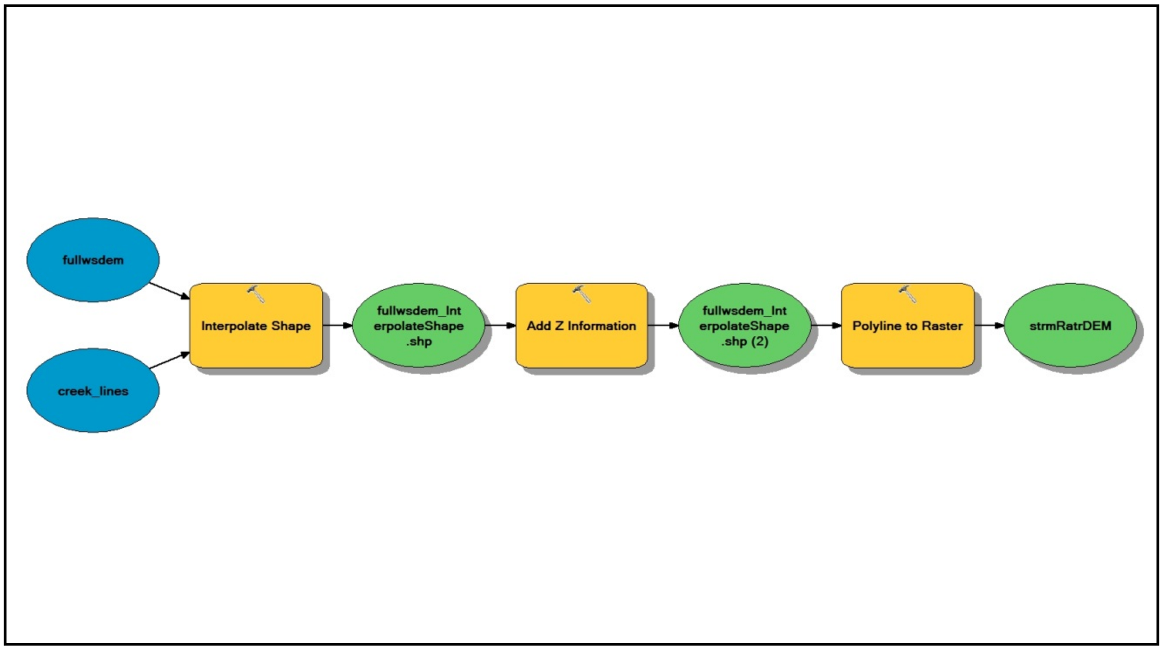


Figure 1. Stream flow Direction Model

ACWQ created a 300ft centerline buffer encompassing the creek line layer provide by the Urban Forestry Program. This will allow for consistency throughout all of the selected EII reaches. Regarding water quality used three parameters total inorganic N, turbidity, and water temperature. We selected the EII reaches that have a sampling site at or 0.5 miles away from the drainage of the reach and contain all three water quality parameters; Of the 126 EII reaches present in the study area, 55 EII reaches were selected that contain water quality sample sites, within 0.5 mile from the drainage point, 9 of the EII reaches chosen encompass 3 individual watersheds.

The LiDAR based 2006 tree canopy layer was clipped by watershed reach EII designation and the watershed EII reach data was spatial joined. The Urban Forestry Program provided a WPO creek line buffer that ranged from 100ft to 300ft buffer segments, decreasing the farther from the main creek channel. ACWQ noticed that the creek buffer provided, excluded many creek segments present in the original creek layer dataset provide by the UFP. A new 300ft centerline buffer was developed encompassing the creek line layer provided by the Urban Forestry Program. This will allow for consistency throughout all of the selected EII reaches.

Applying the iterate feature class function to the clip model and utilizing the watershed EII reach dataset as the input feature. The tree canopy polygon layer was clipped to each delineated watershed EII reach. Next, both the newly created 300ft creek line buffer and the WPO creek line buffer were clipped to the tree canopy polygon layer extracting the tree canopy features present within each watershed EII reach, refer to Figure 2. In order to calculate the geometry of the tree canopy present within each watershed EII reach and both creek line buffers, a new “double-type” field was added to the attribute table of each output feature class, and the field calculator was used to populate the new field column with the geometry of the tree canopy in square feet based on area of the polygons present within the EII Reach, creek line 300ft. and the WPO creek line buffer provided by the UFP. The total area of each watershed EII reach was also calculated in square feet. The length of the creek line located within each watershed EII reach was calculated in miles. The accumulation of this data is essential in the analysis of the tree canopy and a possible correlation to water quality.

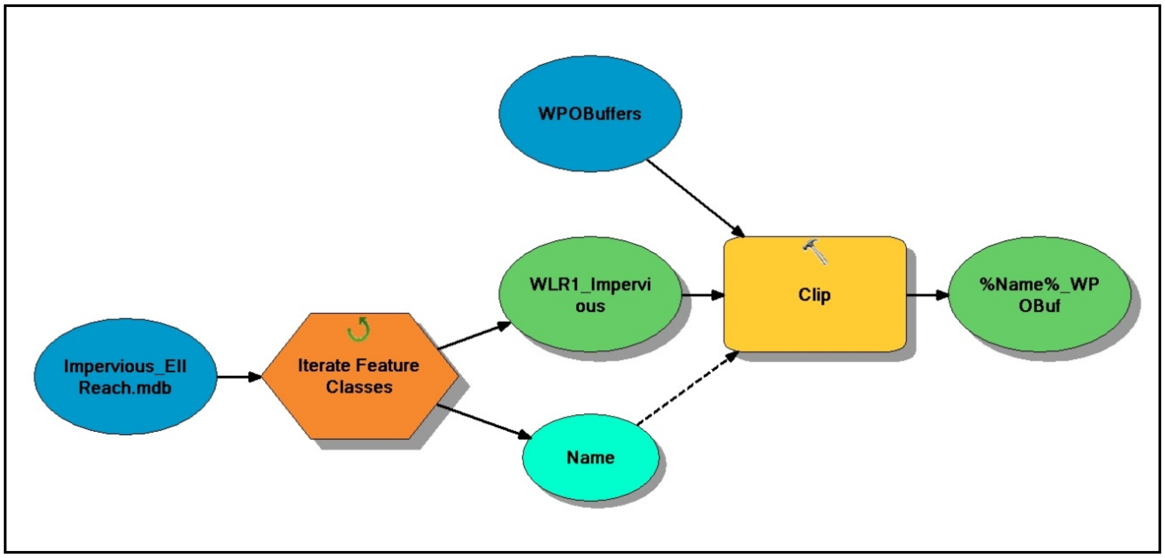


Figure 2. Feature Class Clip Model

Next the impervious cover raster file was examined. ACWQ reclassified the impervious cover raster file, by reclassifying the values in the input raster based impervious cover grouping entries. The non-imperious cover was labeled "0" and the impervious cover labeled "1". The impervious cover raster file was then converted into a vector file, which consisted of non-impervious and impervious cover features. The non-impervious features were then deleted by going into the attribute table and using the select by attribute function, selecting only the non-imperious "grid code 0". The non-imperious cover features selected were deleted. The resulting feature class consisted of only of impervious cover.

After this step was complete, applying the iterate feature class function to the clip model and utilizing the watershed EII reach dataset as the input feature. The impervious cover polygon layer was clipped to each delineated watershed EII reach. Next, both the newly created 300ft creek line buffer and the WPO creek line buffer were clipped to the impervious cover features within each watershed EII reach. The same method as earlier was used to calculate the geometry of the area of impervious cover. A new double-type field was added to the attribute table and populated with the area of impervious cover calculated in square feet using the field calculator tool.

The figures extracted from calculating the tree canopy and impervious cover located within both creek line buffers and the each individual watershed EII reach was exported into a Microsoft Excel spreadsheet to analyze any trends that might be present. Microsoft Excel provides an excellent platform for calculating the percentages of tree canopy present in the EII reaches and creek line buffers. The Excel spreadsheet consists of rows and columns. The rows were populated with EII reach names and the columns were populated with field names such as: EII Reach area square feet, tree canopy square feet, tree canopy percent, tree canopy 300ft buffer, tree canopy 300ft buffer percent, tree canopy WPO buffer, tree canopy WPO buffer percent. Impervious cover field names matched those of the tree canopy list above, and the fields were populated with the appropriate data. Simple formulas were created in Excel spreadsheet to calculate the sum and percentages (i.e. =A1/B1*100), refer to Table 3.

Table 3. Tree Canopy and Impervious Cover Percentages; EII Reach Attribute Table

Table

EIIReach_55

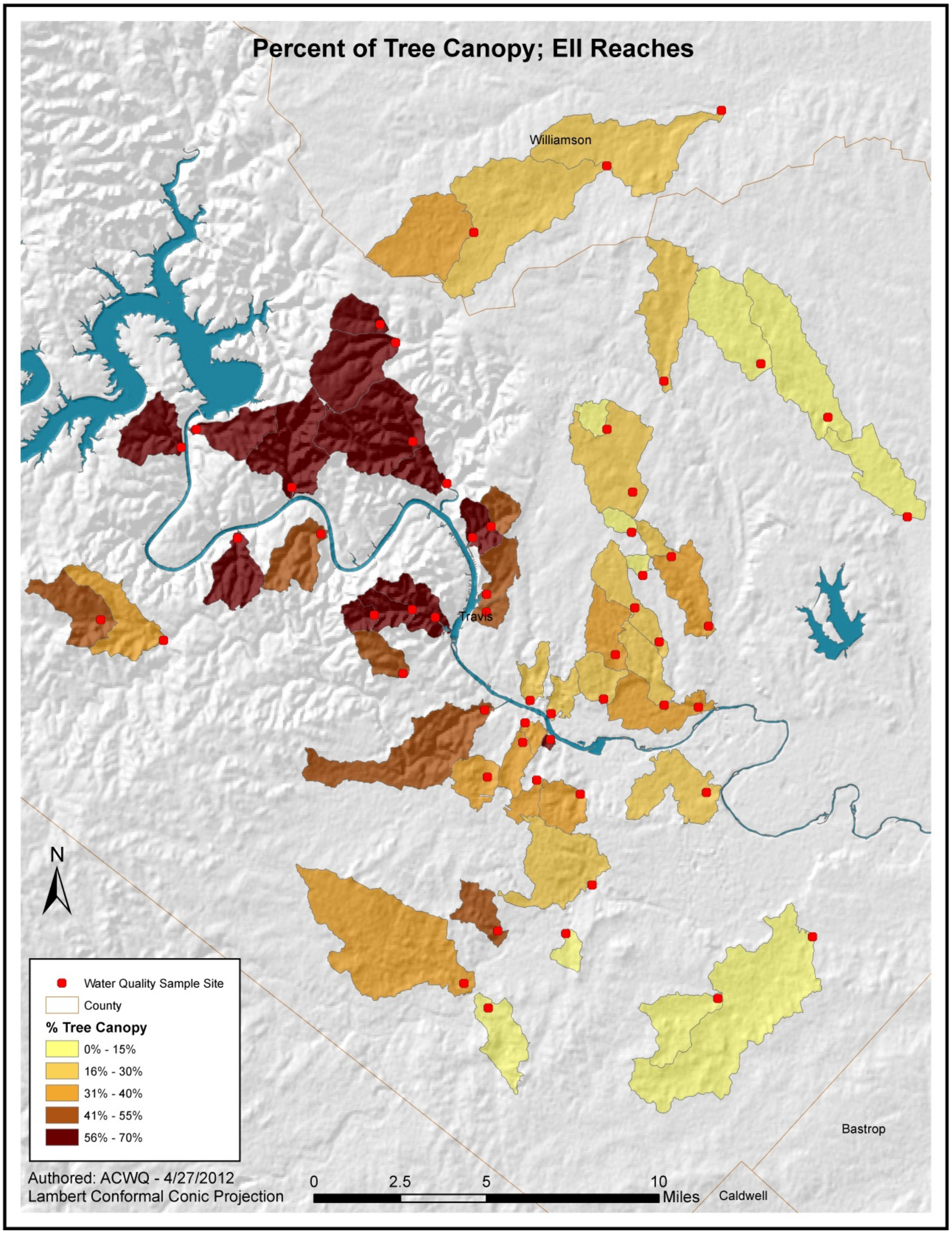
Watershed_Name	EII_Reach	Canopy_EIIReach_sqft	Canopy_EIIReach_Prct	Canopy_WPOBuffer _sqft	Canopy_WPOBuffer_Prct	WATERSHED_Name1	Canopy_300ft_Buffer_sqft	Canopy_300ft_Buffer_P
Barton Creek	BAR1	86122173.212511	50.631963	27078415.67052	31.441863	Barton Creek	58488850.066546	67.
Bee Creek	BEE1	34139824.211118	66.025424	5695944.066144	16.684163	Bee Creek	27346038.550232	80.
Bee Creek	BEE2	20354320.382198	68.819153	4188925.476986	20.580031	Bee Creek	16757399.354602	82.
Bee Creek	BEE3	11614624.757948	58.485691	1047494.771137	9.018757	Bee Creek	9175103.529281	78.
Blunn Creek	BLU1	1969336.716486	59.100495	893227.794544	45.356784	Blunn Creek	1617945.656657	82.
Blunn Creek	BLU3	6112005.311414	29.727606	1784984.674115	29.204567	Blunn Creek	4503262.737116	73.
Buttermilk Branch	BMK1	3111640.613809	18.093094	1275628.724329	40.995375	Buttermilk Branch	1934677.268595	62.
Buttermilk Branch	BMK3	2267886.55813	15.371804	100231.772454	4.419611	Buttermilk Branch	405714.92222	17
Boggy Creek	BOG1	23139912.716454	30.23456	5718057.012315	24.710798	Boggy Creek	16079709.890593	69.
Boggy Creek	BOG2	10966076.898957	27.868249	1799862.317592	16.413001	Boggy Creek	4692771.215168	42.
Boggy Creek	BOG3	17474780.016304	30.540557	3103445.610506	17.759569	Boggy Creek	9833753.913552	56.
Bear Creek West	BRW1	35062697.145453	58.509345	7803426.773085	22.255637	Bear Creek West	23453403.516683	66.
Bull Creek	BUL3	70190752.899176	62.347451	11455502.671339	16.32053	Bull Creek	38212623.454281	54.
Bull Creek	BUL4	22167126.214455	58.930816	3438039.422973	15.509631	Bull Creek	12897473.958669	58.
Carson Creek	CAR1	24371062.373523	25.409198	7037889.007923	28.878056	Carson Creek	15120814.453822	62.
Country Club West	CCW2	14237271.928573	31.6031	2194993.907615	15.417237	Country Club West	9363280.887932	65.
Commons Ford Creek	CMF1	38482639.269815	61.05723	7076458.333751	18.388703	Commons Ford Creek	29502487.99454	76.
Cuernavaca Creek	CRN1	36313070.764735	53.799975	7893893.904298	21.738437	Cuernavaca Creek	21780041.831715	59.
Dry Creek East	DRE2	12301518.767035	3.583484	4422375.77158	35.949836	Dry Creek East	10529854.036378	
Dry Creek North	DRN1	20204836.950659	62.103464	4010539.336997	19.849402	Dry Creek North	16572754.214513	82.
Dry Creek North	DRN2	13990104.471781	52.059531	1843871.53241	13.179827	Dry Creek North	8793876.333466	62.
Eanes Creek	EAN2	19560411.911218	52.433118	3259756.256555	16.66507	Eanes Creek	11019153.325211	56.
East Bouldin Creek	EBO1	4592793.609747	38.069799	1866852.044611	40.647419	East Bouldin Creek	2955633.449402	64.
East Bouldin Creek	EBO2	12106713.370082	39.972174	2068327.453099	17.084137	East Bouldin Creek	5720525.408464	47.
Fort Branch	FOR4	1425366.69667	15.787155	102542.061688	7.194083	Fort Branch	307533.638298	21.
Gilleland Creek	GIL3	11789850.073696	12.970297	7960812.971611	67.522597	Gilleland Creek	10596206.894549	89.
Gilleland Creek	GIL4	20527332.616816	12.356664	8807547.359822	42.906439	Gilleland Creek	15811370.369785	77.
Harris Branch	HRS2	18784728.184516	15.414119	7488093.959842	39.862669	Harris Branch	12715752.797812	67.
Little Barton Creek	LBA1	29757165.676827	35.834324	8669444.111764	29.133971	Little Barton Creek	20740653.532442	69.
Little Barton Creek	LBA2	32638806.699063	43.754996	5379110.99865	16.480722	Little Barton Creek	20528403.304816	62.
Lake Creek	LKC1	35689966.948865	18.740719	9407715.621359	26.359553	Lake Creek	20794336.792926	58.
Lake Creek	LKC2	61654115.495336	24.302583	14727405.822272	23.887142	Lake Creek	33832549.975374	54.
Lake Creek	LKC3	47524790.020361	34.772262	5220875.384308	10.985583	Lake Creek	21786744.181336	45.
Little Walnut Creek	LWA1	28231304.121398	38.516768	5547393.803945	19.649796	Little Walnut Creek	19714109.091184	69.
Little Walnut Creek	LWA3	28528282.95451	20.445194	5582141.613336	19.567044	Little Walnut Creek	14253665.492062	49.
Little Walnut Creek	LWA4	1694918.231598	8.273892	254105.770382	14.992214	Little Walnut Creek	728100.333316	42.
Marble Creek	MAR1	1913411.297686	10.077709	908480.695234	47.479635	Marble Creek	1548275.000133	80.
Panther Hollow	PAN1	65463862.628713	55.39512	11437183.261959	17.470988	Panther Hollow	49904372.675239	76

Start 12:00 AM 4/29/2012

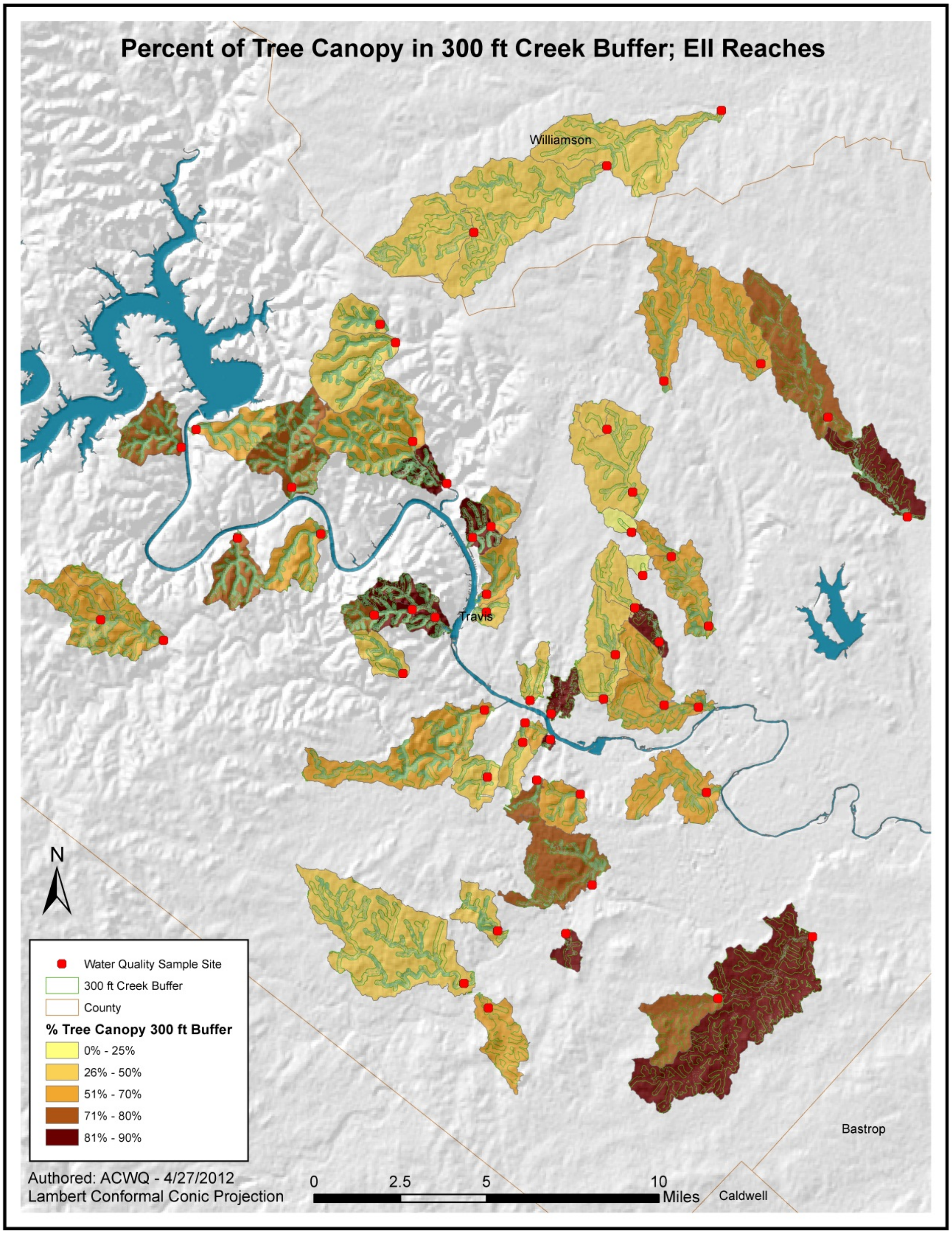
The Excel spreadsheet containing the water quality data, nitrogen, turbidity, and water temperature obtained from data.austintexas.gov was merged with the tree canopy and impervious cover excel spreadsheet. A wealth of information was now contained in one organized structure. The Excel spreadsheet was then joined with the EII reach polygon layer, using ArcMap's "Join" tool. This allowed for the information contained in the Excel spreadsheet to join with the attribute of the EII reach polygon layer. Subsequent maps were developed utilizing this new information. Manipulating the symbology of the attributes as they relate to tree canopy and impervious cover percentages within the EII reaches, 300ft, and WPO buffer, ACWQ was able to transform maps depicting areas that contain high or low tree canopy and impervious cover. The water quality data was analyzed in conjunction with the tree canopy and impervious cover data and no obvious trend was noticed.

6. Results

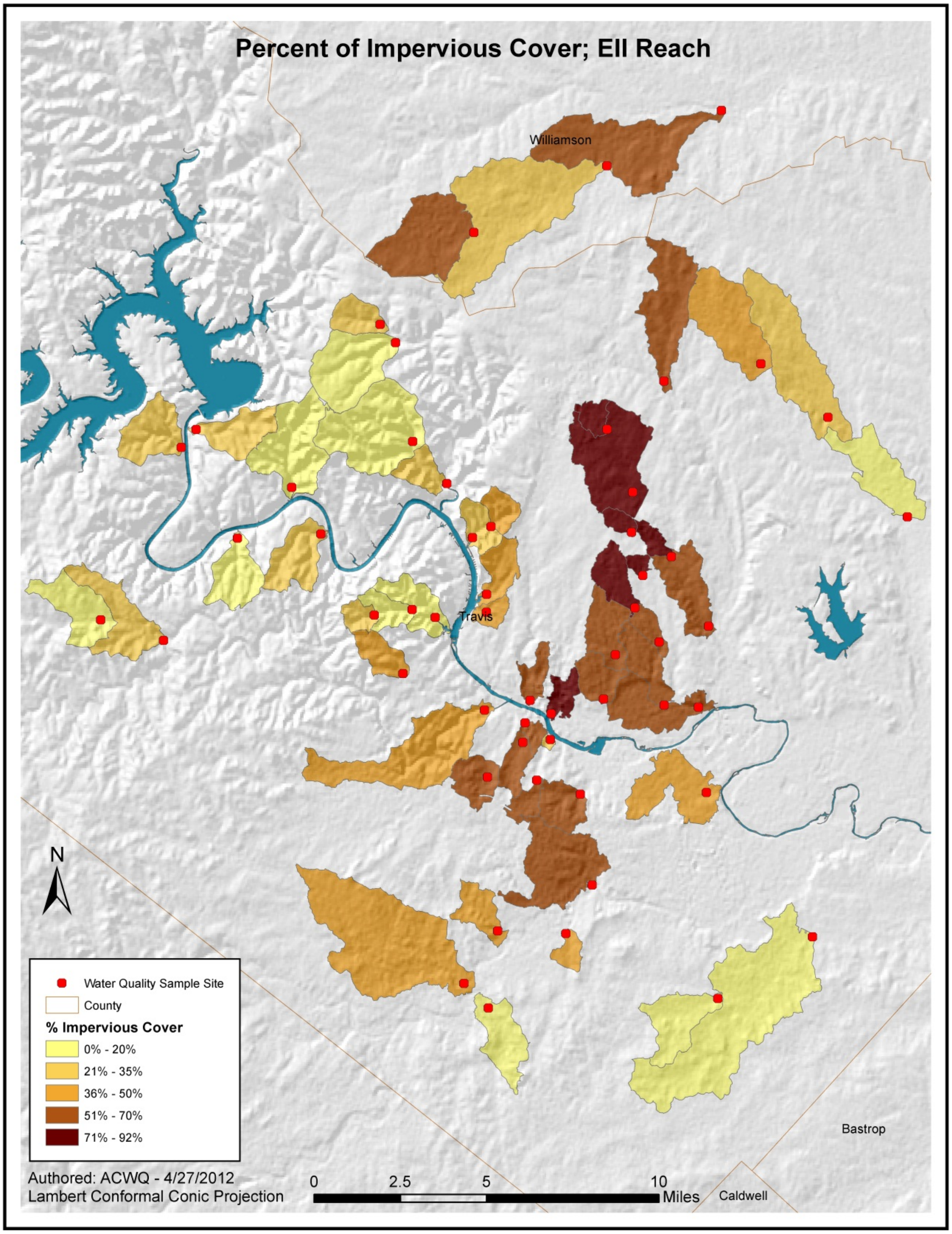
After analysis ACWQ was unable to create a direct relationship between water quality and the presence of tree canopy/impervious cover within the EII reaches. The obvious conclusion indicates that the farther away from the City of Austin the EII reaches are located, the presence of tree canopy increases and the impervious cover decreases, however the water quality data obtained from the associated water quality sample site locations do not suggest a trend. The water quality data only fluctuated in meniscal amounts from water quality sample site. Map 2.1 (below) represents the EII reaches that contain the greatest percent of tree canopy.



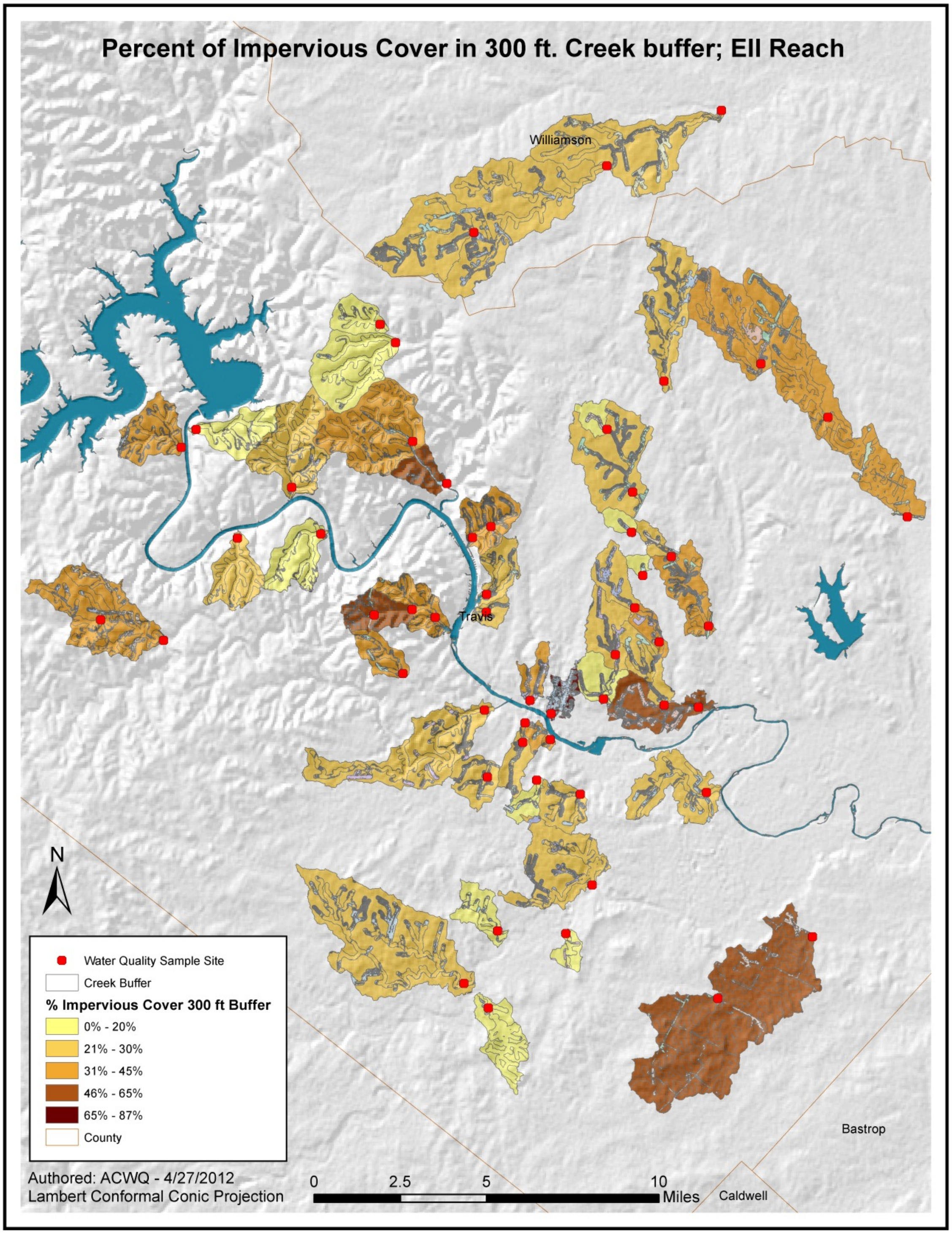
Map 2.1. Percent of Tree Canopy; EII Reaches



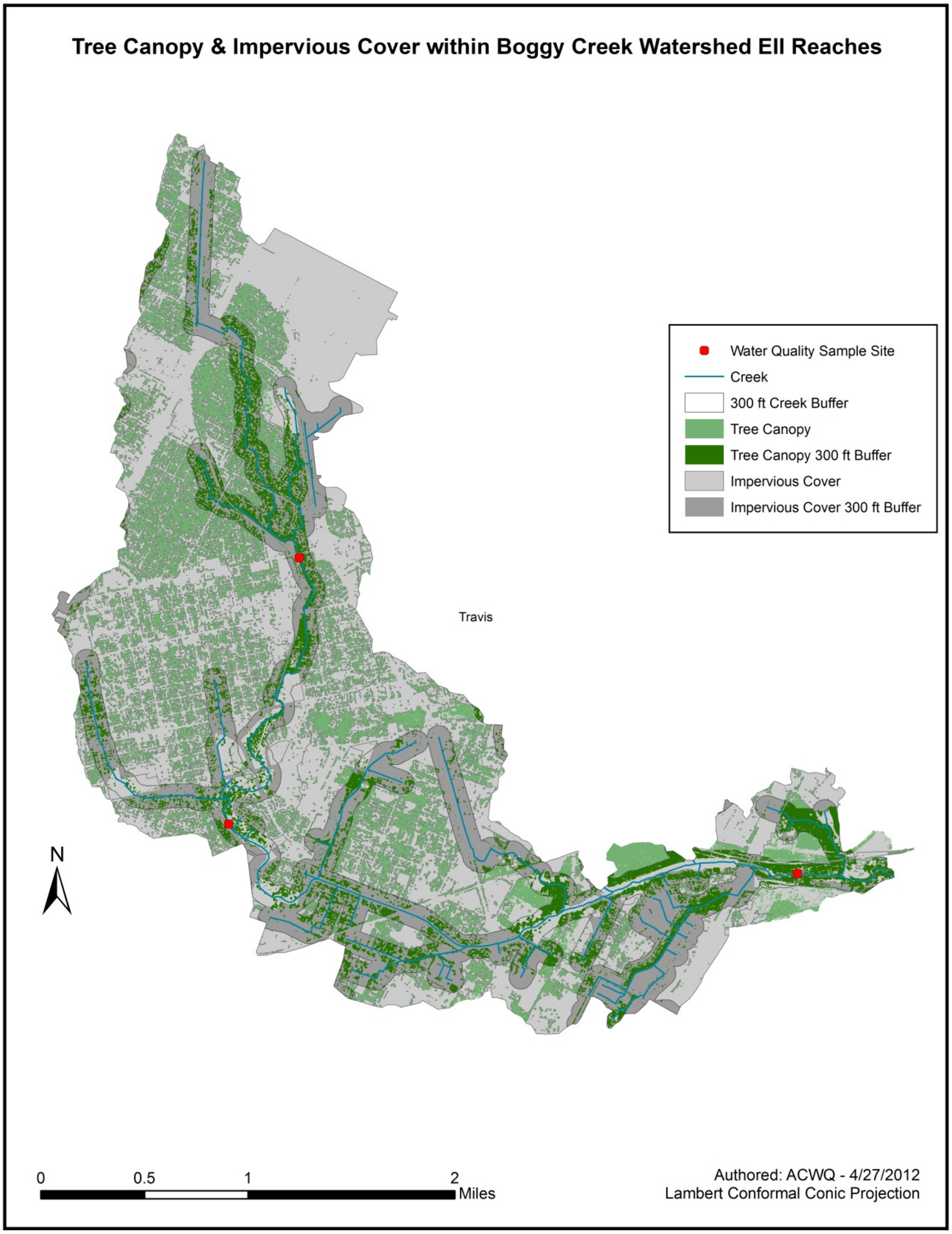
Map 2.2. Percent of Tree Canopy in 300ft Creek Buffer; EII Reaches



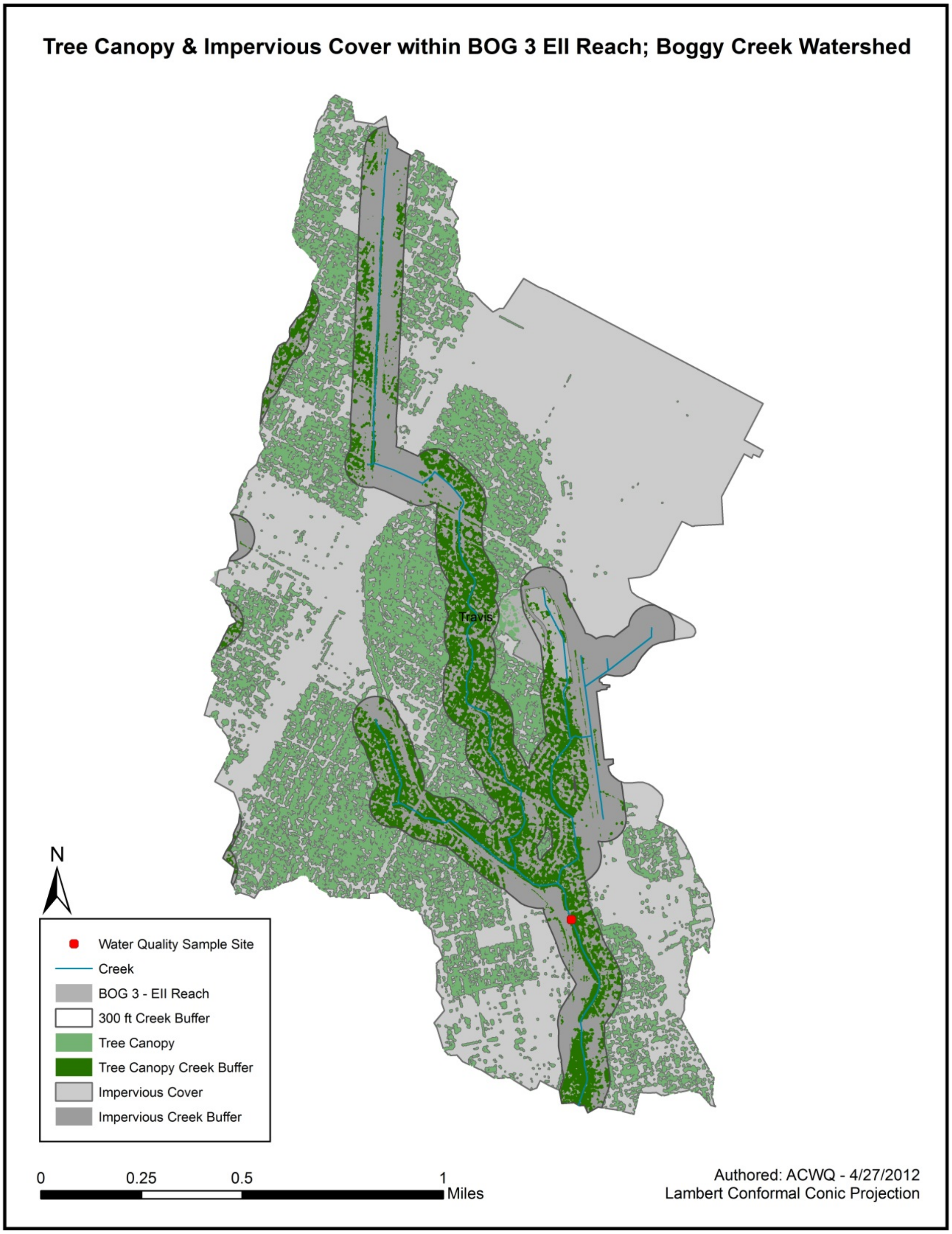
Map 3.1. Percent of Impervious Cover; EII Reaches



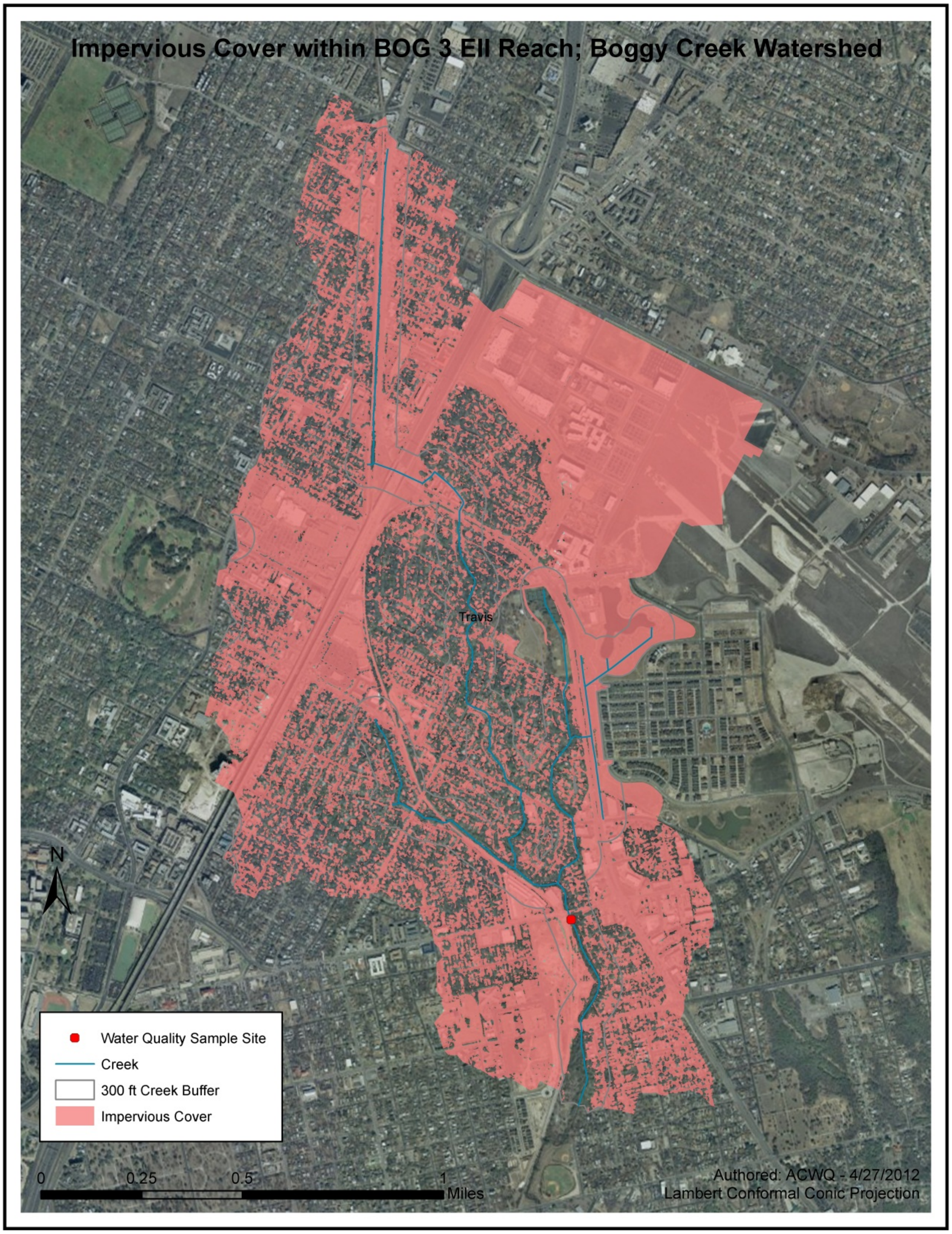
Map 3.5. Percent of Impervious Cover in 300ft Creek Buffer; EII reach



Map 2.10 Tree canopy and Impervious Cover within Boggy Creek Watershed; BOG EII Reaches



Map 2.11. Tree canopy and Impervious Cover within BOG 3 EII Reach; Boggy Creek Watershed



Map 3.2 Impervious Cover within BOG 3 EII Reach; Boggy Creek Watershed

7. Discussion

The team was able to successfully calculate percentages for canopy and impervious cover for the 55 EII reaches and 3 watersheds as well as the City of Austin buffer and the 300ft buffer and analyze the associated water quality data. When looking at the results the team was unable to create a direct relationship between the percentages and water quality. The water quality data from each site was too similar to see a change in quality as the percentages of impervious cover and canopy changed.

The team believes that the results of the project were severely limited by the data that was provided. The first problem was the inability to create a stream network. This was caused by the poor quality of the creek line layer that broke the line segments into thousands of features. Under a time constraint the team was unable to create a network from this layer, which would have allowed for the creation of a model that could cumulatively calculate the upstream percentage of canopy and impervious cover that contributed to a sample site. When looking at the water quality data it is important to note that there is not a record for the environmental conditions at the time the sample was taken. This is extremely important because after a rain event, as pollutants run off impervious cover or are filtered by canopy into the water bodies the water quality results may change which would have allowed the team to create a relationship. We feel that utilizing a GIS system was the best method of analysis for this project. It allowed the team to spatially analyze, create, edit and store the data associated with this project. We highly encourage the education of those with limited to no GIS experience in that it will allow for better scientific research and data collection.

Our recommendations for the next stage of the project would be to first create a stream network. This would allow the analysis of the upstream tributaries and the effect on water quality as it moves through the network. Another recommendation would be to conduct more water quality sampling. Taking samples before and after a rain event would show, if any, the discrepancies that exist in the water quality data. Conducting water quality tests in the remaining reaches not covered in our analysis would allow for the creation of more data that could be compared to our results.

8. Conclusion

Overall the team feels the goals of the project were met. The use of GIS in our analytical process was essential in that it allowed us to successfully calculate percentages for canopy and impervious cover as well as create data for the Urban Forestry Program. It is our belief that with more data, future research will be able to create a relationship between tree canopy and impervious cover and the water quality of the reaches.

9. References

American Forests. 2000.*Trees Help Cities Meet Clean Water Regulations*. American Forests. Alliance for Community Trees, Washington, DC. http://actrees.org/files/Research/treeshelpcities.pdf. Last accessed 24 April 2012.

Delaware Sea Grant College Program 2005. *Delaware NEMO Guide to Natural Resource Based Planning Chapter 2 Impervious Cover*. Delaware NEMO Program, Newark and Lewes, Delaware. http://www.nemo.udel.edu/manual/Chap2Web.pdf. Last accessed 20 April 2012.

E. Gregory McPherson, Klaus I. Scott, et al. – January 2000 "Tree Guidelines for Coastal Southern California Communities" - by the Western Center for Urban Forest Research and Education USDA Forest Service, Pacific Southwest Research Station.

Author Unknown, 2004. Agroforestry "Working Trees for Water Quality" - by The USDA National Agroforestry Center (NAC).

Author Unknown, (No date of publication) (found article online on 2/11/12), "Benefits of Trees" – by The City of San Diego, Urban Forestry - website - http://www.sandiego.gov/street-div/street-div/treebenefits.shtml

Author Unknown, March 1996, "Water Quality Issue Brief" – by the USDA Natural Resources Conservation Service - website - http://www.nrcs,usda.gov/wps/portal/nrcs/detailfull/national/water/quality/?&cid=nrcs143_010881#role

Appendix 1: Metadata

Identification_Information:

Citation:

Citation_Information:

Originator: Creek_300ft_Buff

Publication_Date: April 28, 2012

Publication_Time:

Title: Creek Lines 300ft Buffer

Edition:

Geospatial_Data_Presentation_Form: ArcGIS Shapefiles

Series_Information:

Online_Linkage:

Data_Quality_Information:

Appendix 2: Contribution of Each Team Member

All team members took part in the creation of the project, in editing and made the team effort to assure a final cohesive project; however, all members were solely in charge of specific tasks.

Ashley Zavala: Project Manager, GIS Analyst and Web Master, handled all of the business aspects of the project: communication, and coordination. She created all of the design for the Reports, the ACWQ logo, with Eli, composed the Poster, and created the website which contains all of the contents of the project. She created the "Drainage_Pts" She also created the Metadata that was included in the Final Report. For the Final Report she composed the Literature Review on Canopy Coverage, Limitations of the Project, References, Participation, Appendices 8.1 and 8.2 and compiled appendix 8.3.

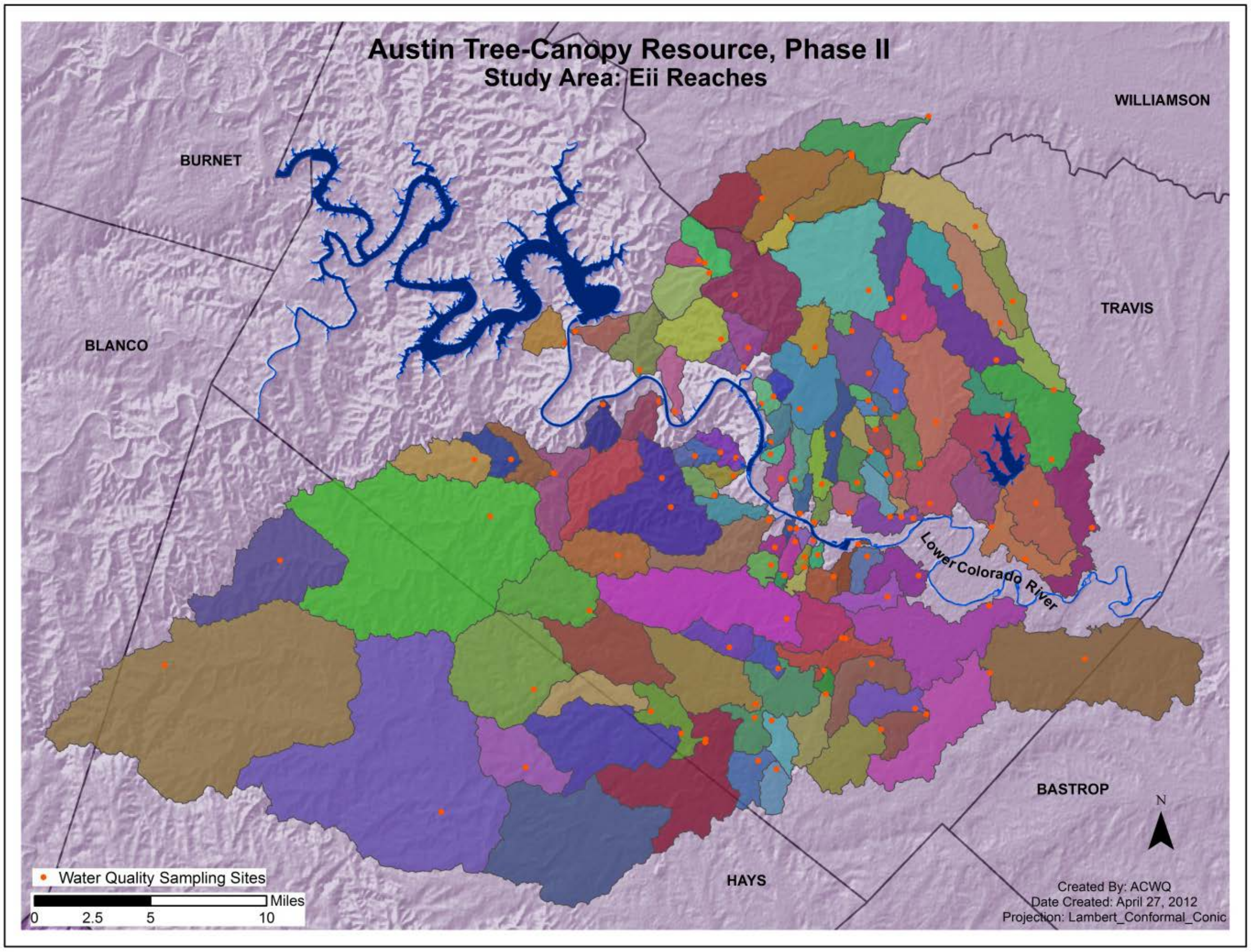
Eli Pruitt: GIS Analyst, Editor, and Interactive Map Creator. He created the Interactive Map utilizing Manifold System 8.0, and acted as our liaison for the GIS technical support team of the Urban Forestry Board. He reported limitations, received data and clarified confusion for our clients and our team. He cleaned up the Water Quality data so that it contained only those sample sites that were at or within a 0.5 mile Euclidean distance of the downstream intersection of the creek line and reach boundary and contained the three water quality parameters of interest: nitrogen, turbidity, and temperature. And, together with Ashley, Eli composed the Poster. For the Final Report he composed the introduction: summary, purpose, and scope; the literature review of Impervious Cover, Implications, and with Lowell created the Results section.

Lowell Hughes: GIS Analyst and Editor, was the person in point of developing the technical aspect of project. He performed all of the tedious tasks of cleaning up a majority of the data used, and developed the models that were necessary for saving time and making our work visually interpretable in flow charts. He clipped most of the data to the necessary layers for final analysis, and organized the Microsoft Excel tables that were used to join to the attribute tables for use by the Urban Forestry Board. For our final report he wrote the Water Quality literature review, data, methodology, final deliverables, and with Eli, wrote the Results section.

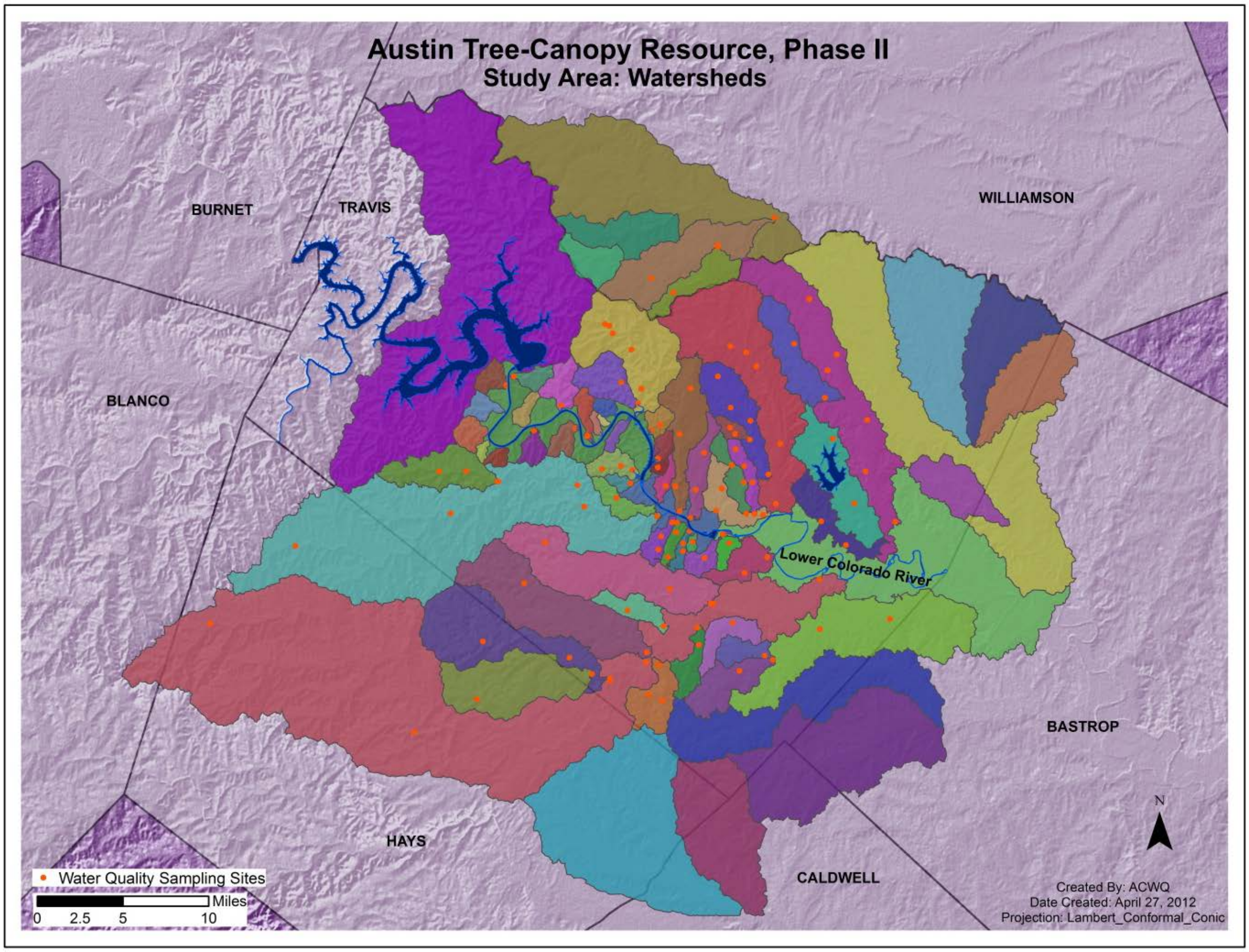
All members located the data needed and created methodology for the work they performed and resulted in the final project, which can be found in the Methodology section of the Final Report. All members took part in the final map making and team effort was the totality of how our project found a successful end.

Apendix 3: Maps

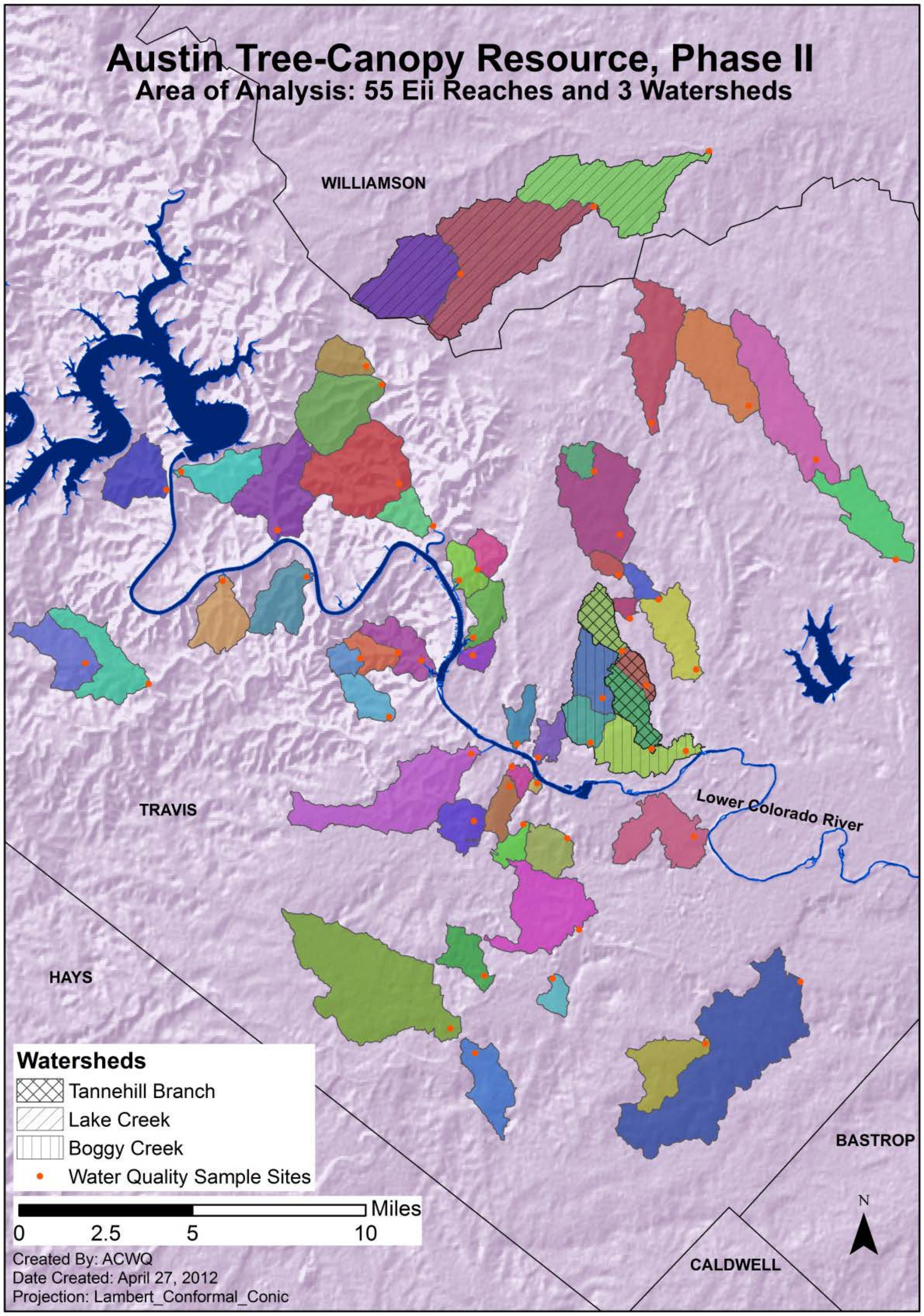
Map 1.1. Study Area: EII Reaches (76 Reaches)



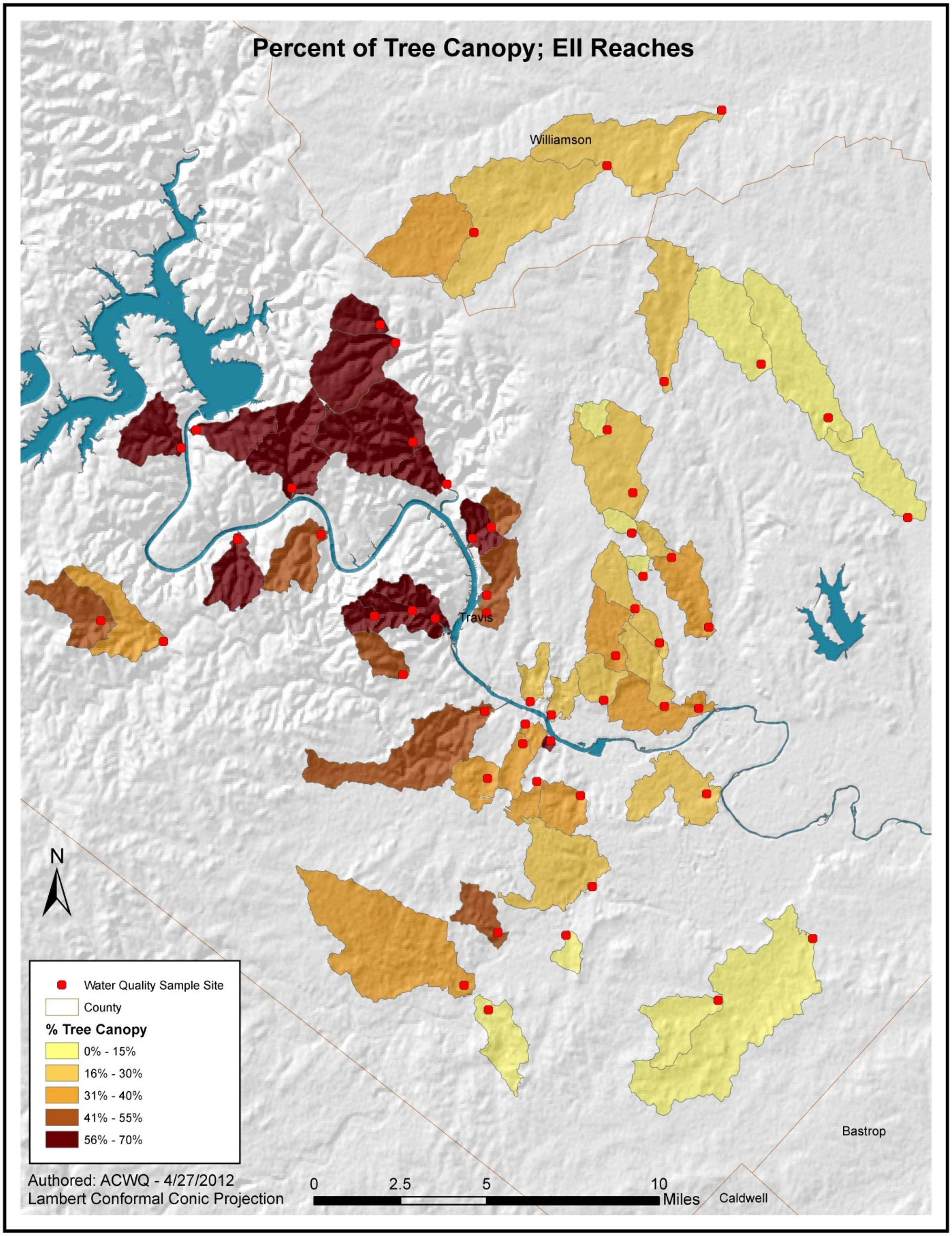
Map 1.2.: Study Area: Watersheds (126 Watersheds)



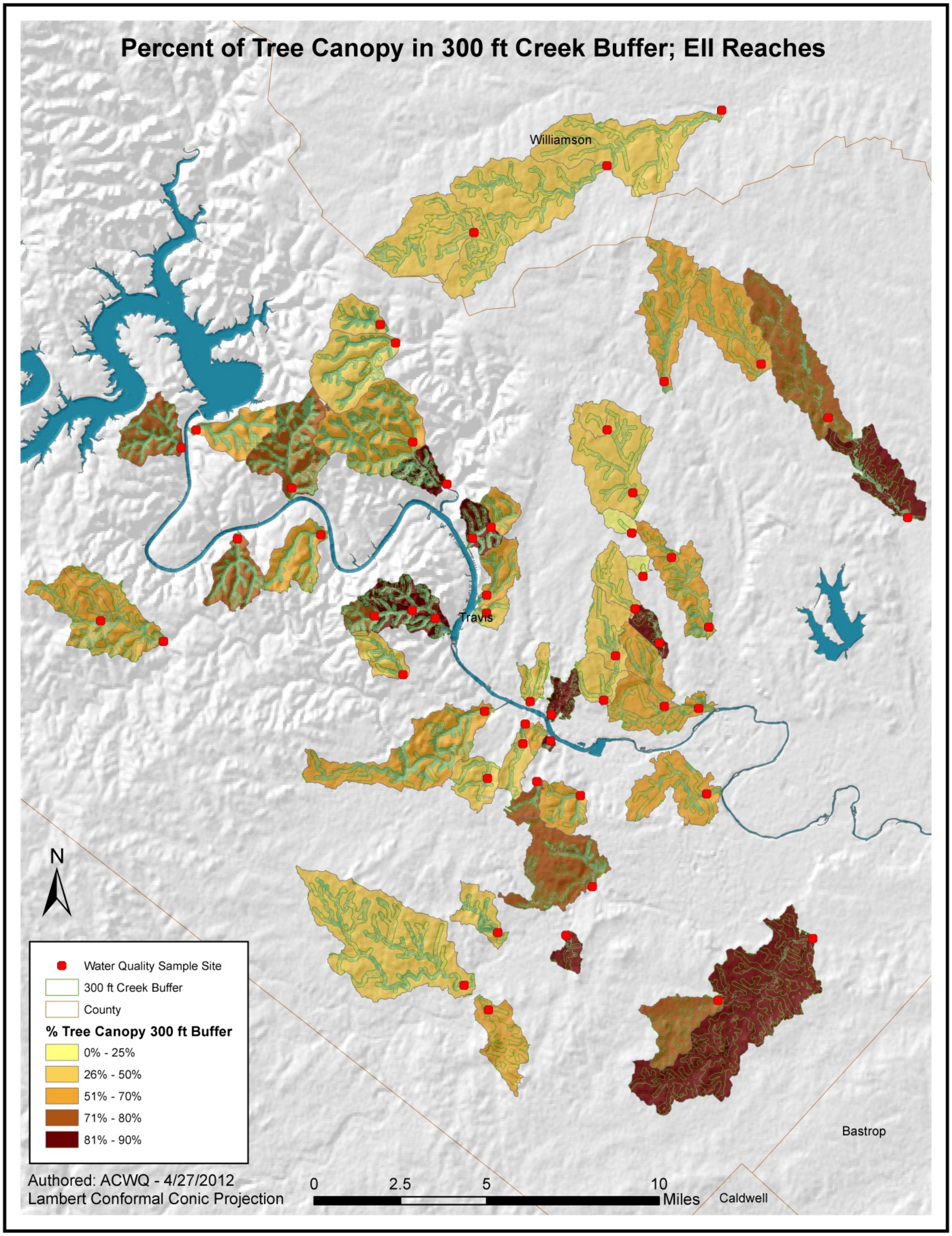
Map 1.3. Area of Analysis: 55 EII Reaches and 3 Watersheds



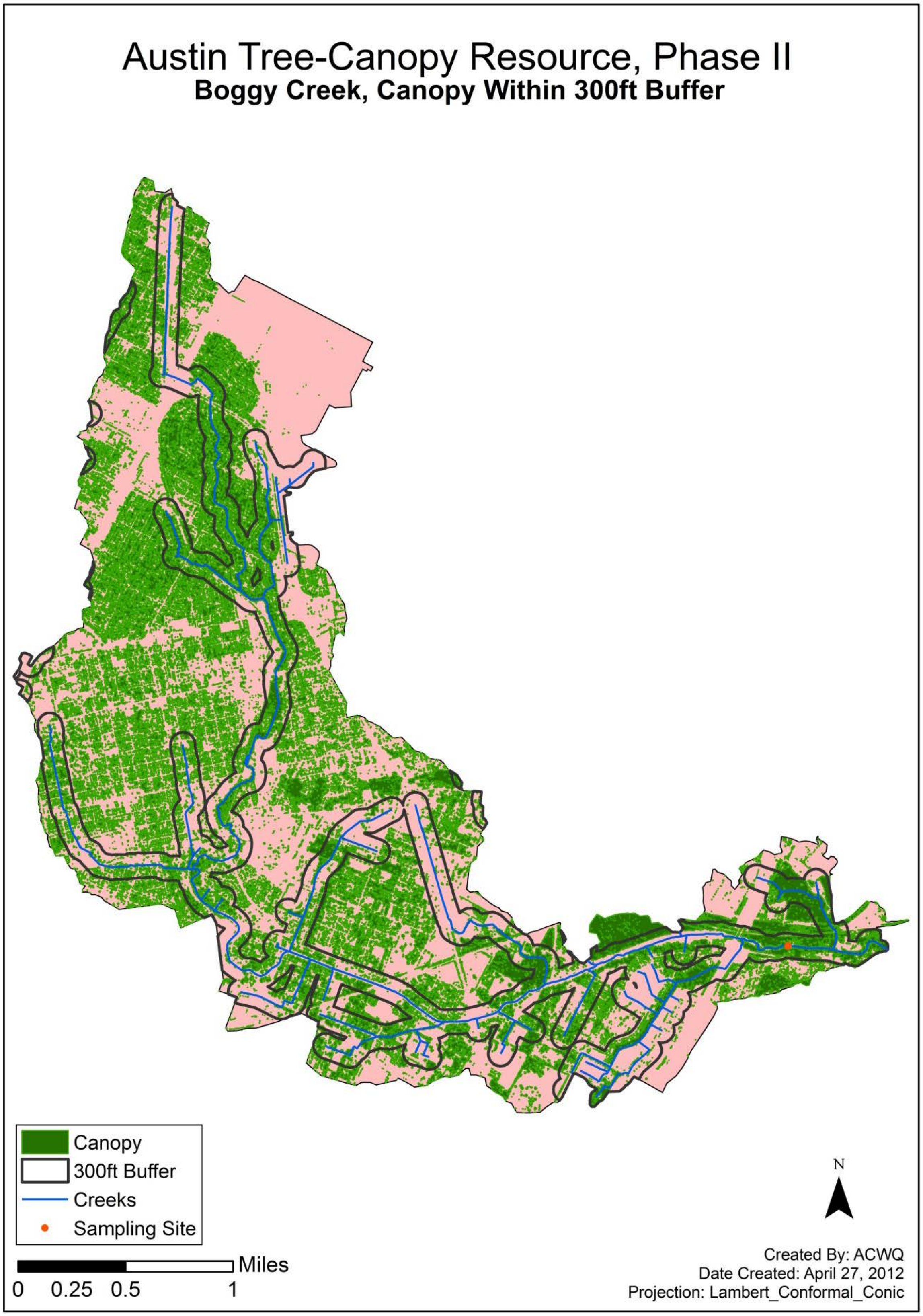
Map2.1. Percent of Tree Canopy; EII Reaches



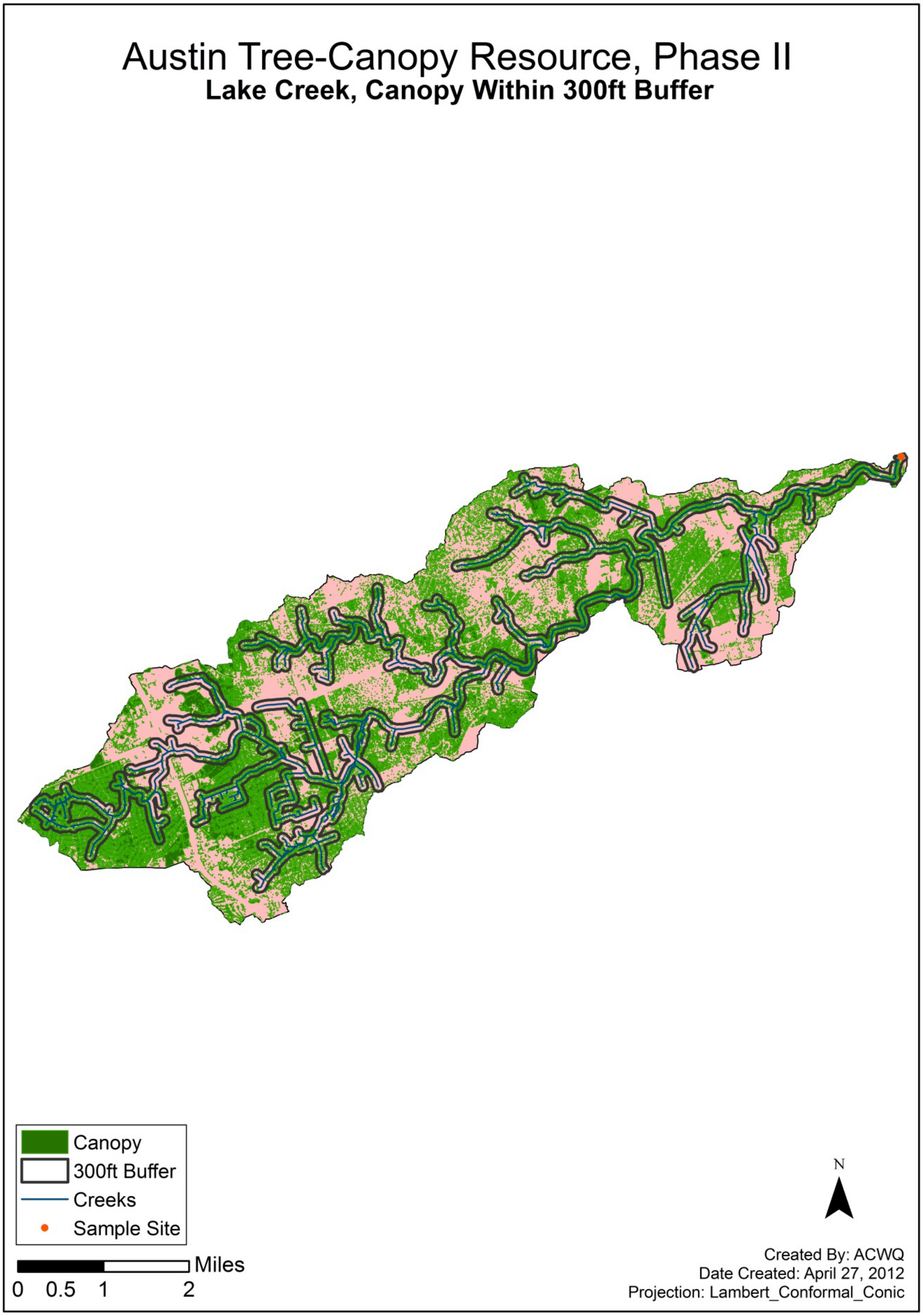
Map 2.2. Percent of Tree Canopy in 300 ft Creek Buffer; EII Reaches



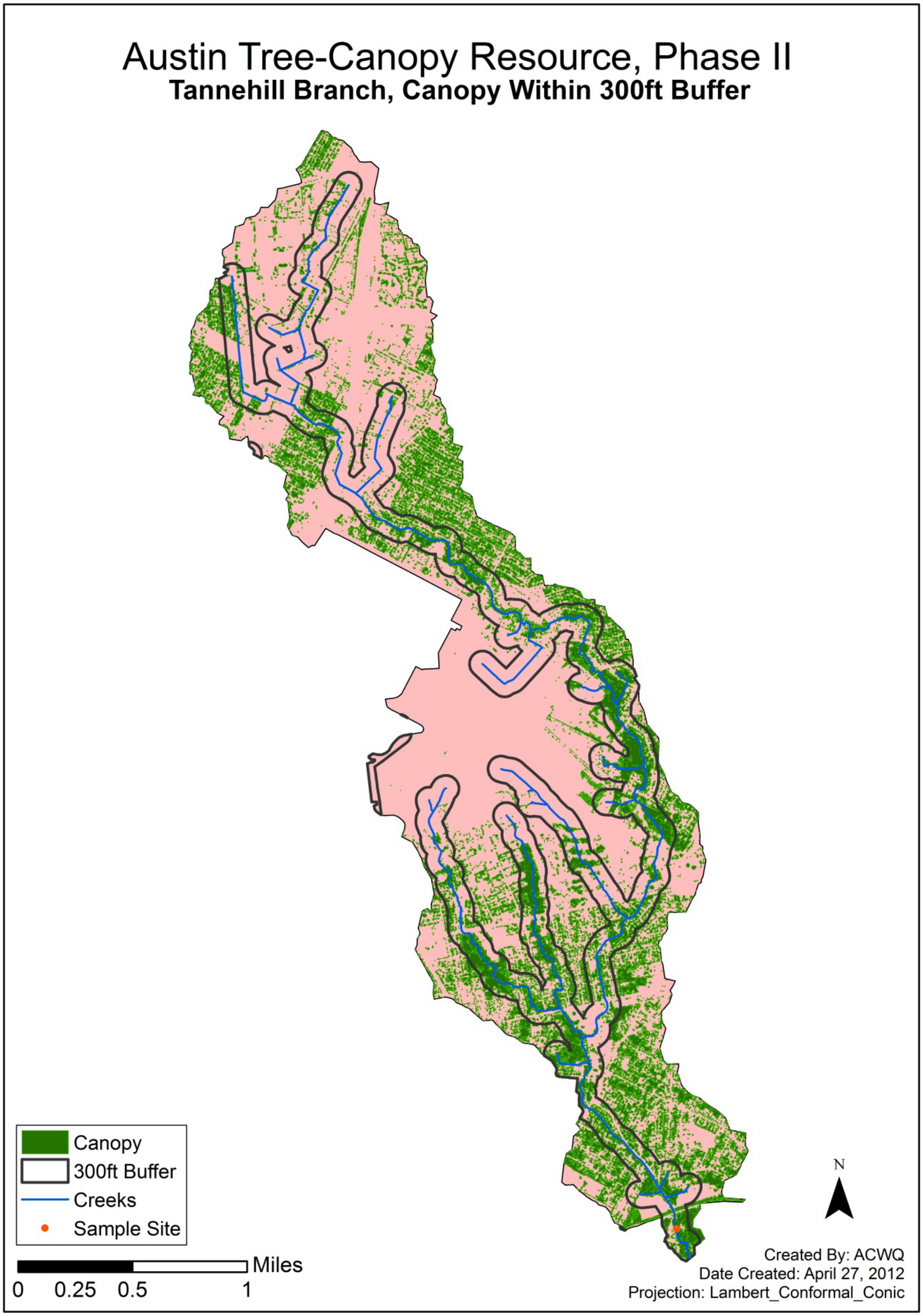
Map 2.3. Tree Canopy in Boggy Creek and 300 ft Creek Buffer



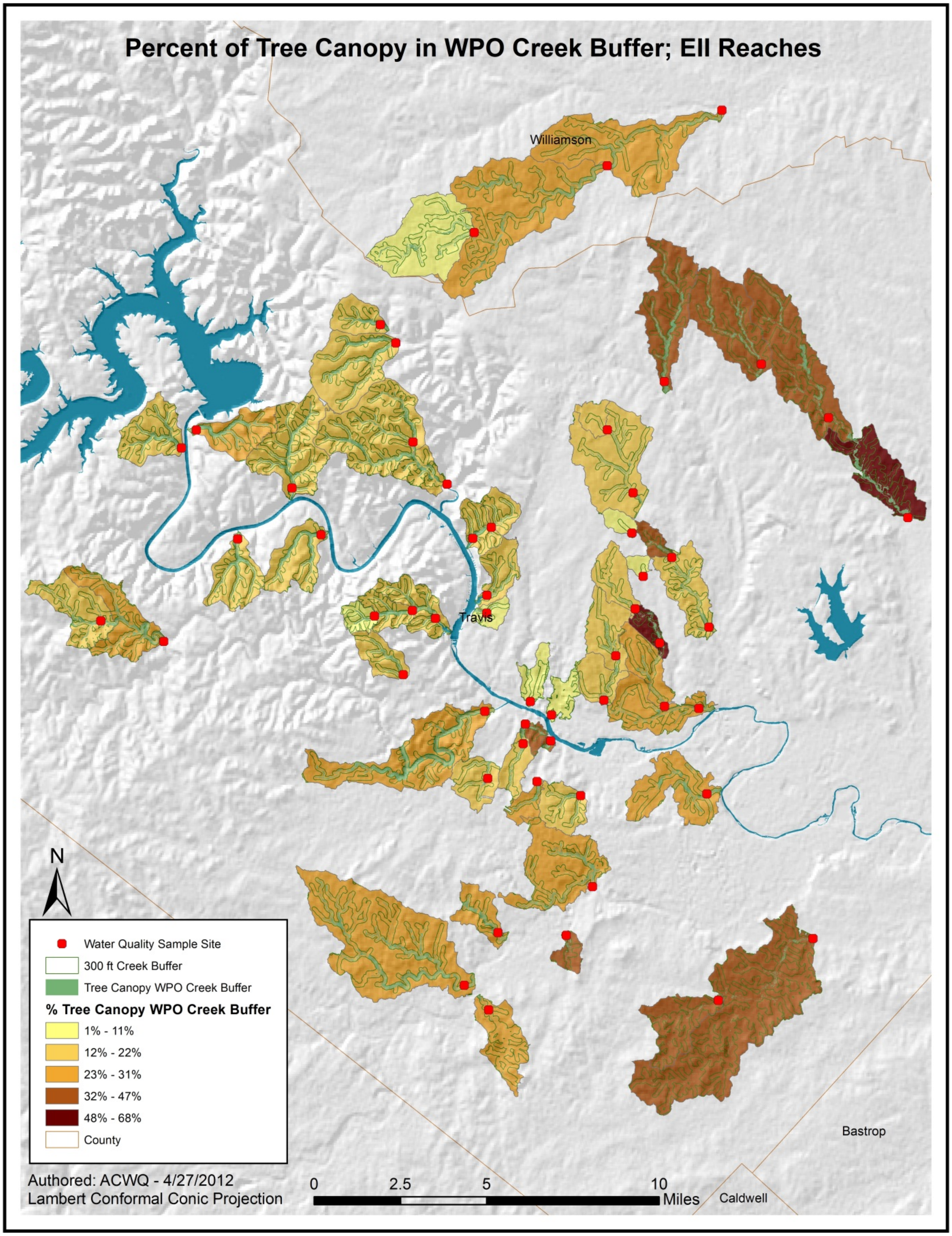
Map 2.4. Tree Canopy in Lake Creek and 300 ft Creek Buffer



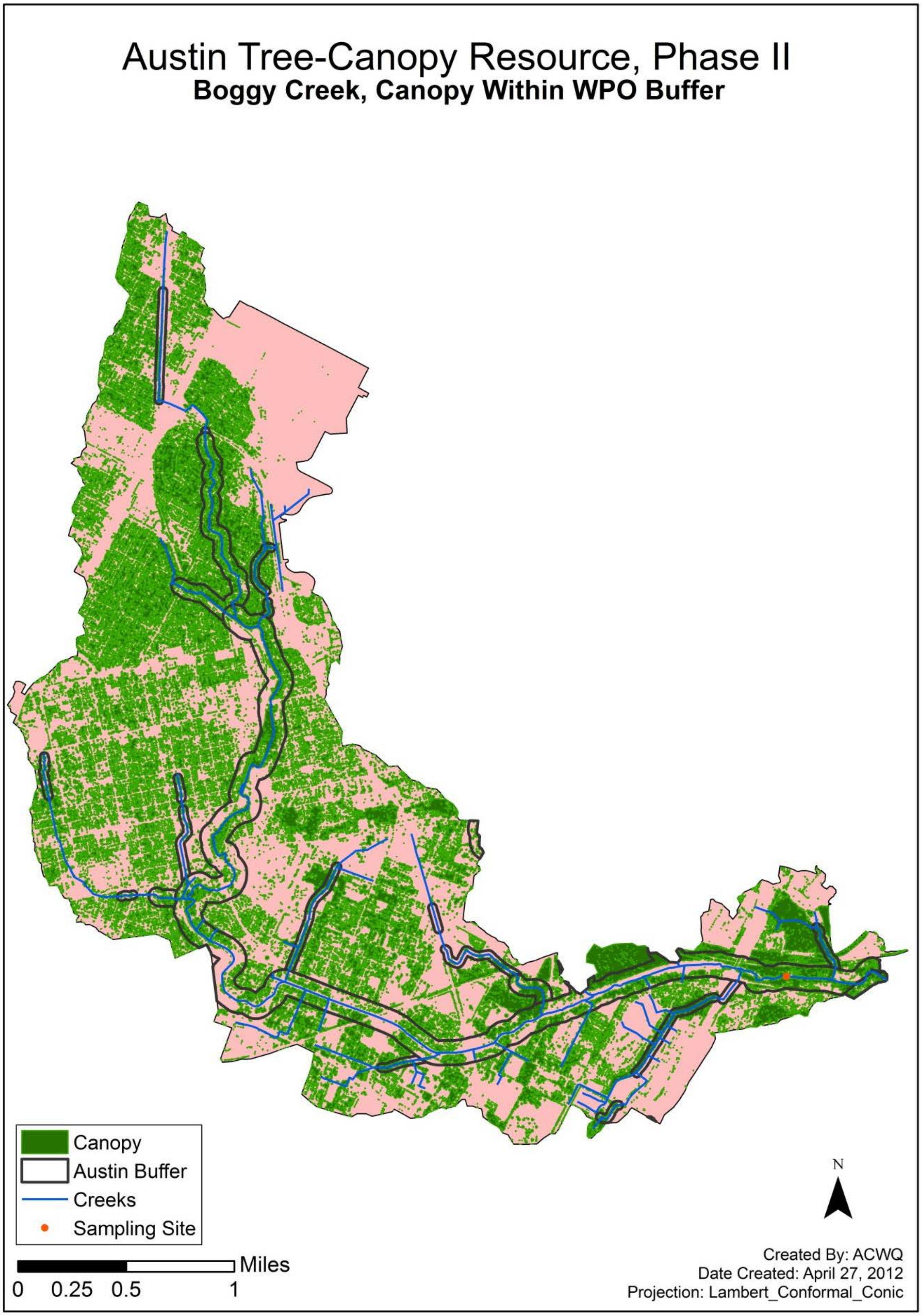
Map 2.5. Tree Canopy in Tannehill Branch and 300ft Creek Buffer



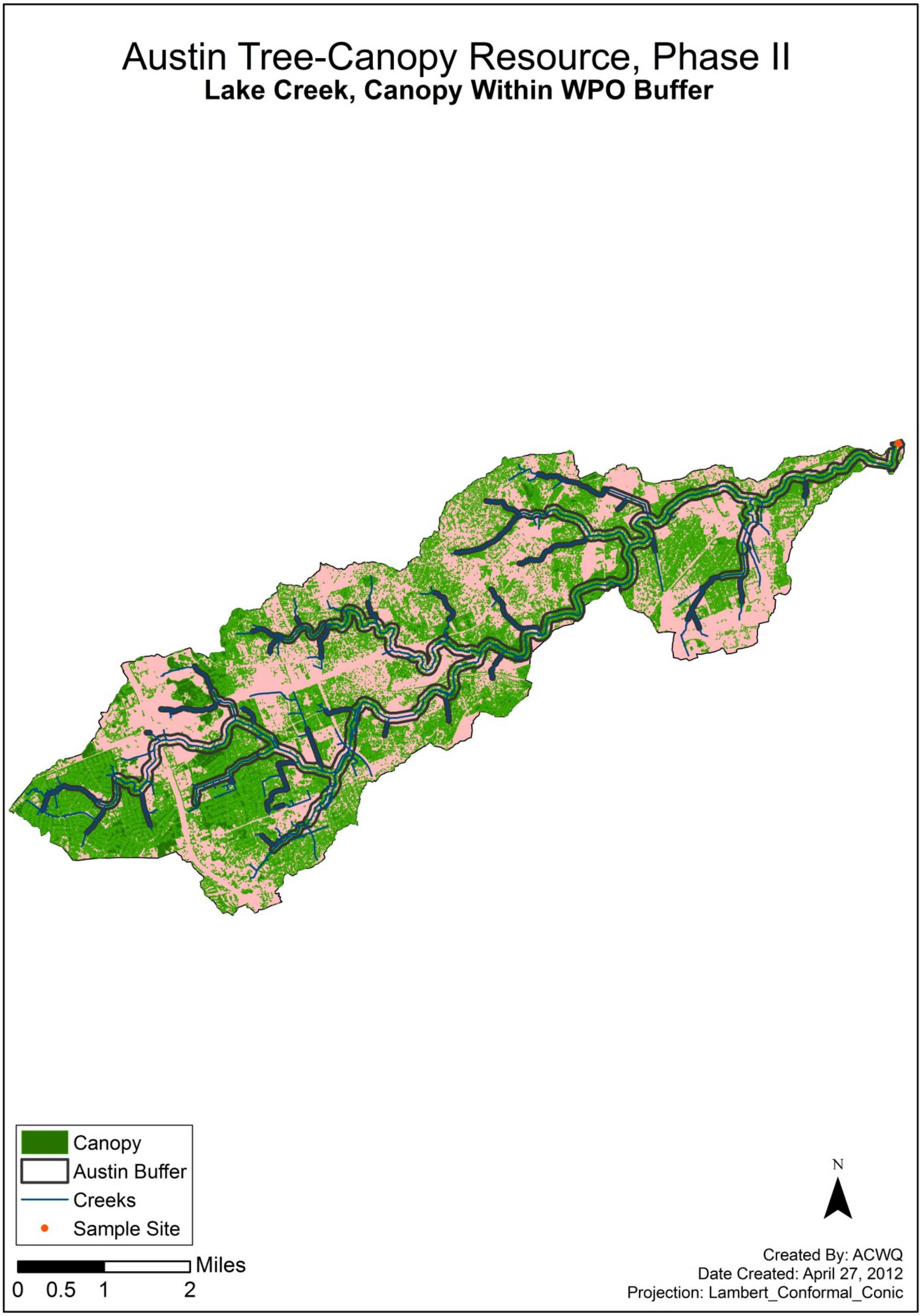
Map 2.6. Percent of Tree Canopy in WPO Creek Buffer; EII Reaches



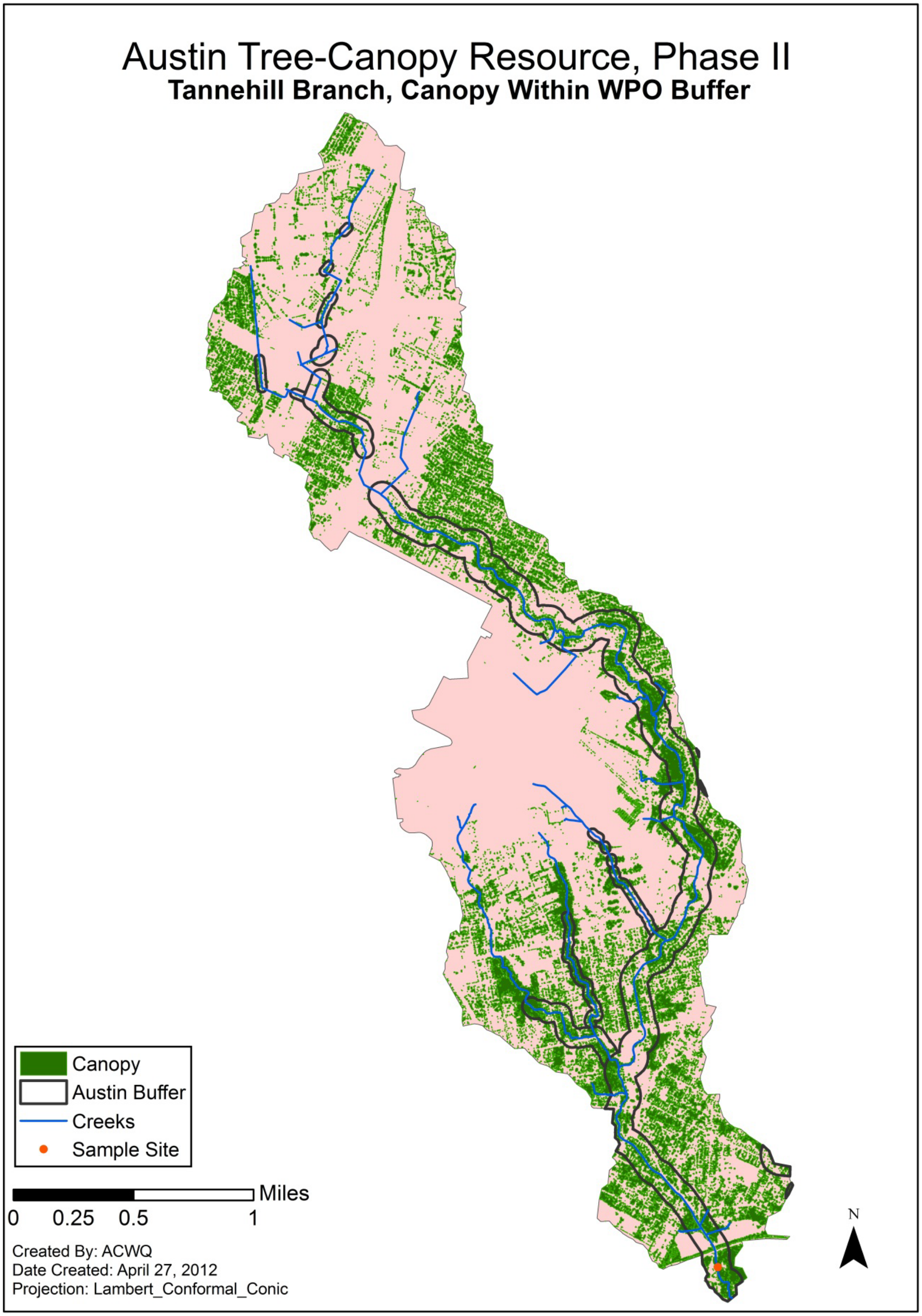
Map 2.7. Tree Canopy in Boggy Creek and WPO Creek Buffer



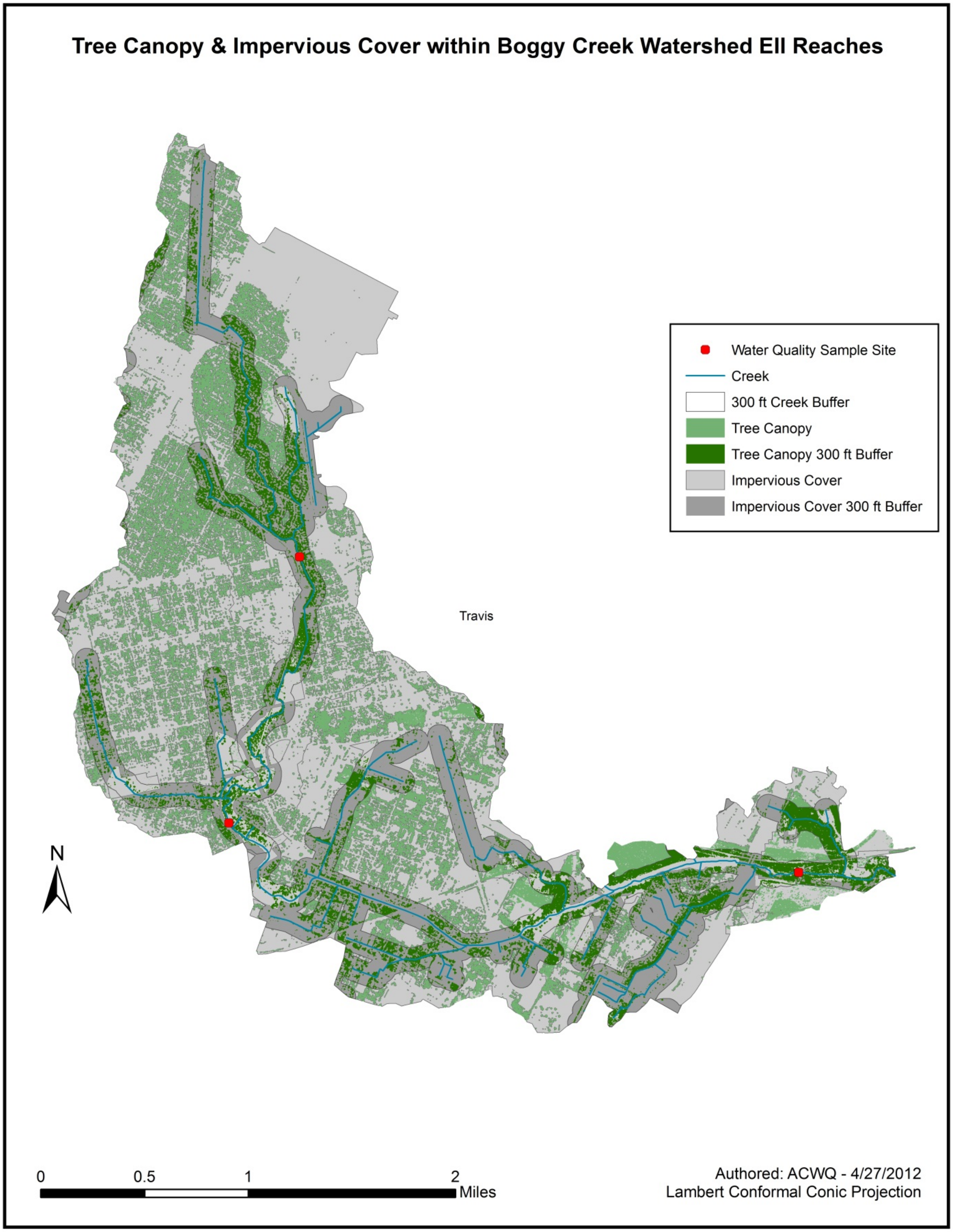
Map 2.8. Tree Canopy in Lake Creek and WPO Creek Buffer



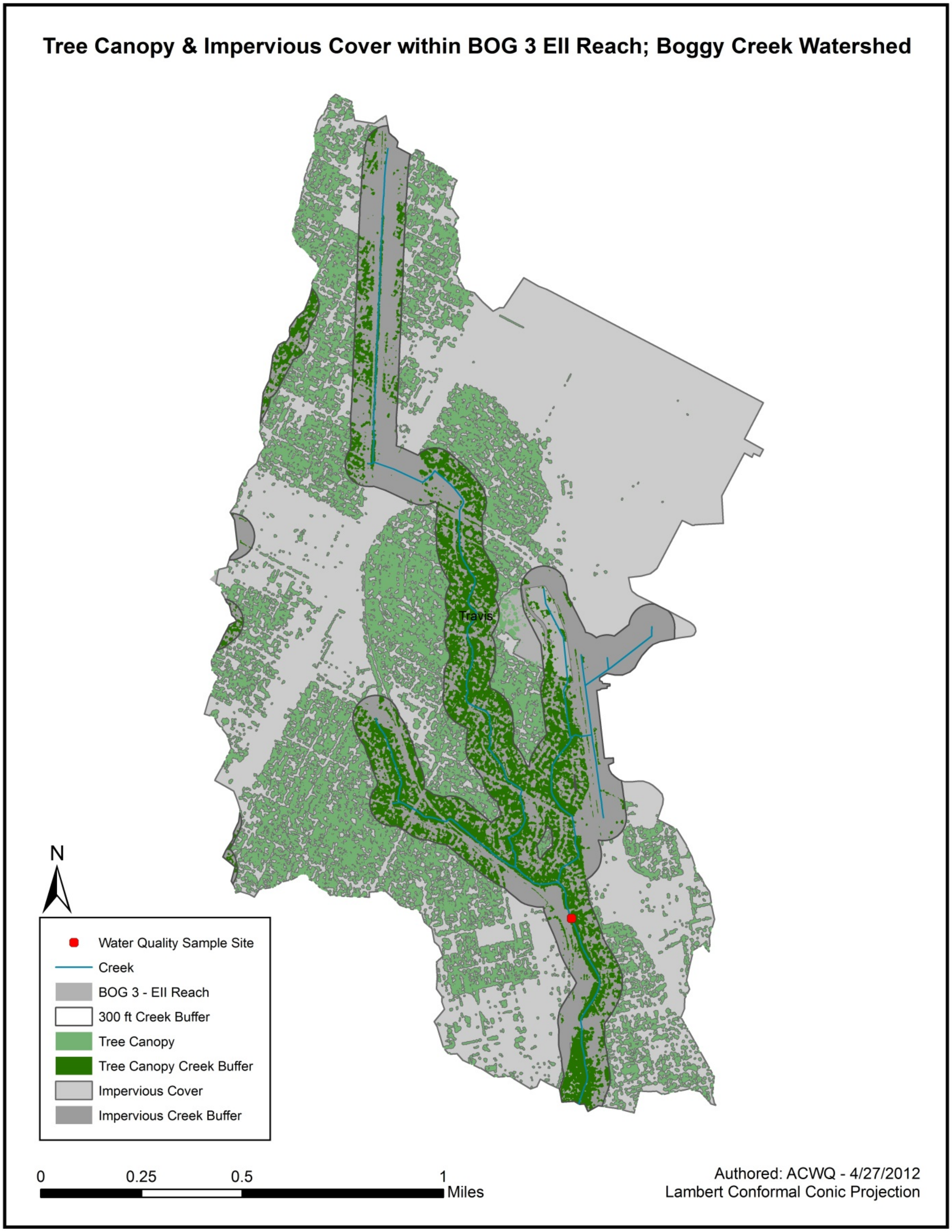
Map 2.9. Tree Canopy in Tannehill Branch and WPO Buffer



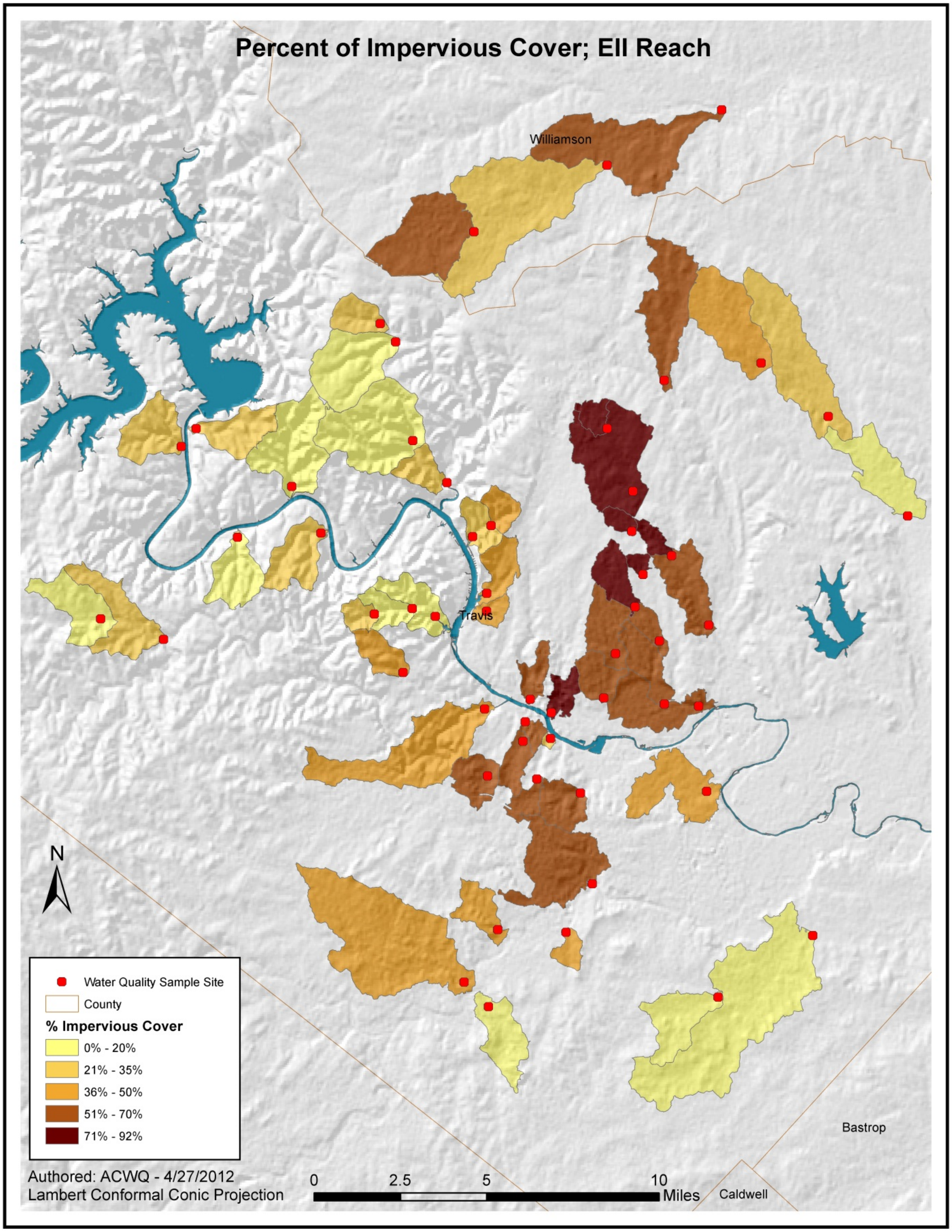
Map 2.10. Tree Canopy and Impervious Cover within Boggy Creek Watershed EII Reaches



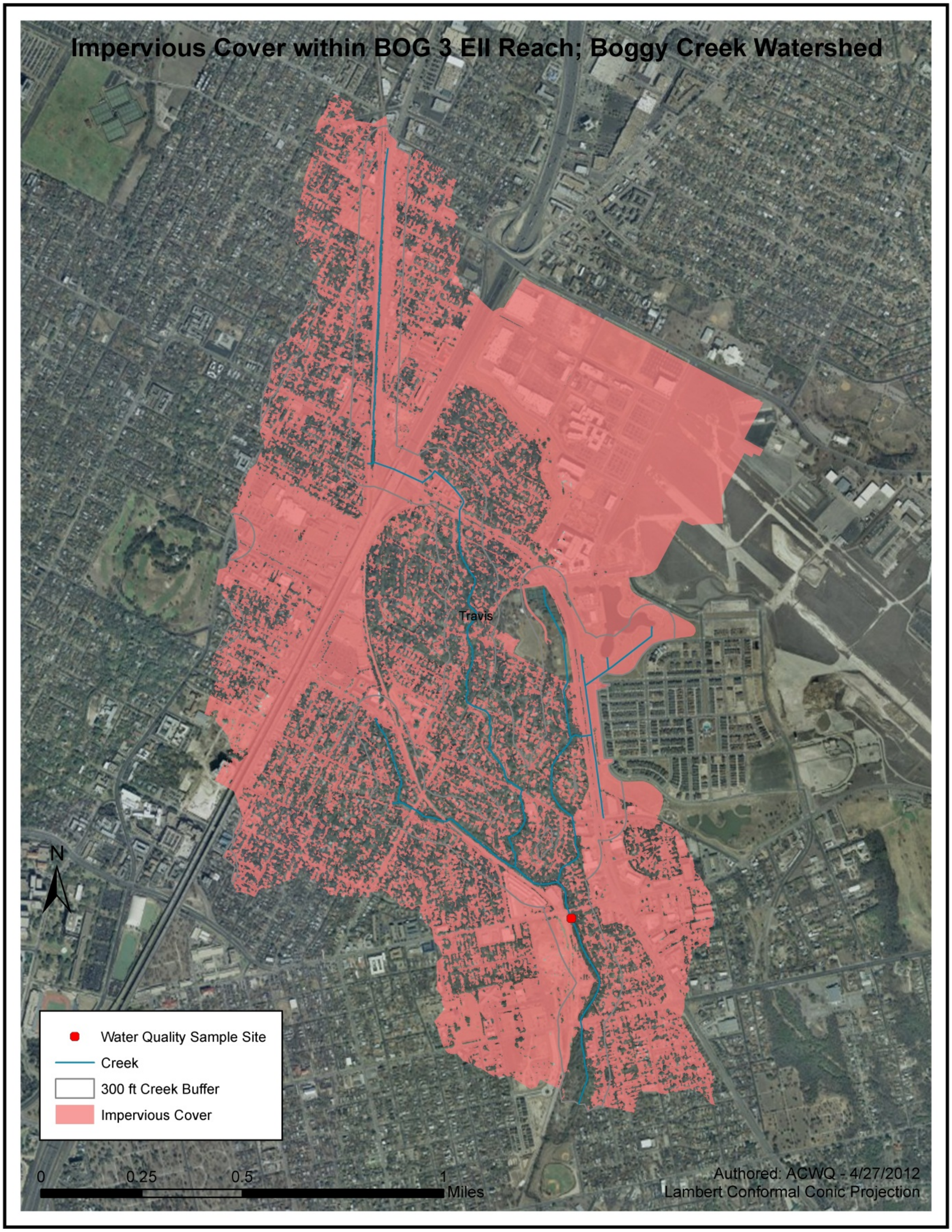
Map 2.11. Tree Canopy and Impervious Cover within BOG 3 EII Reach; Boggy Creek Watershed



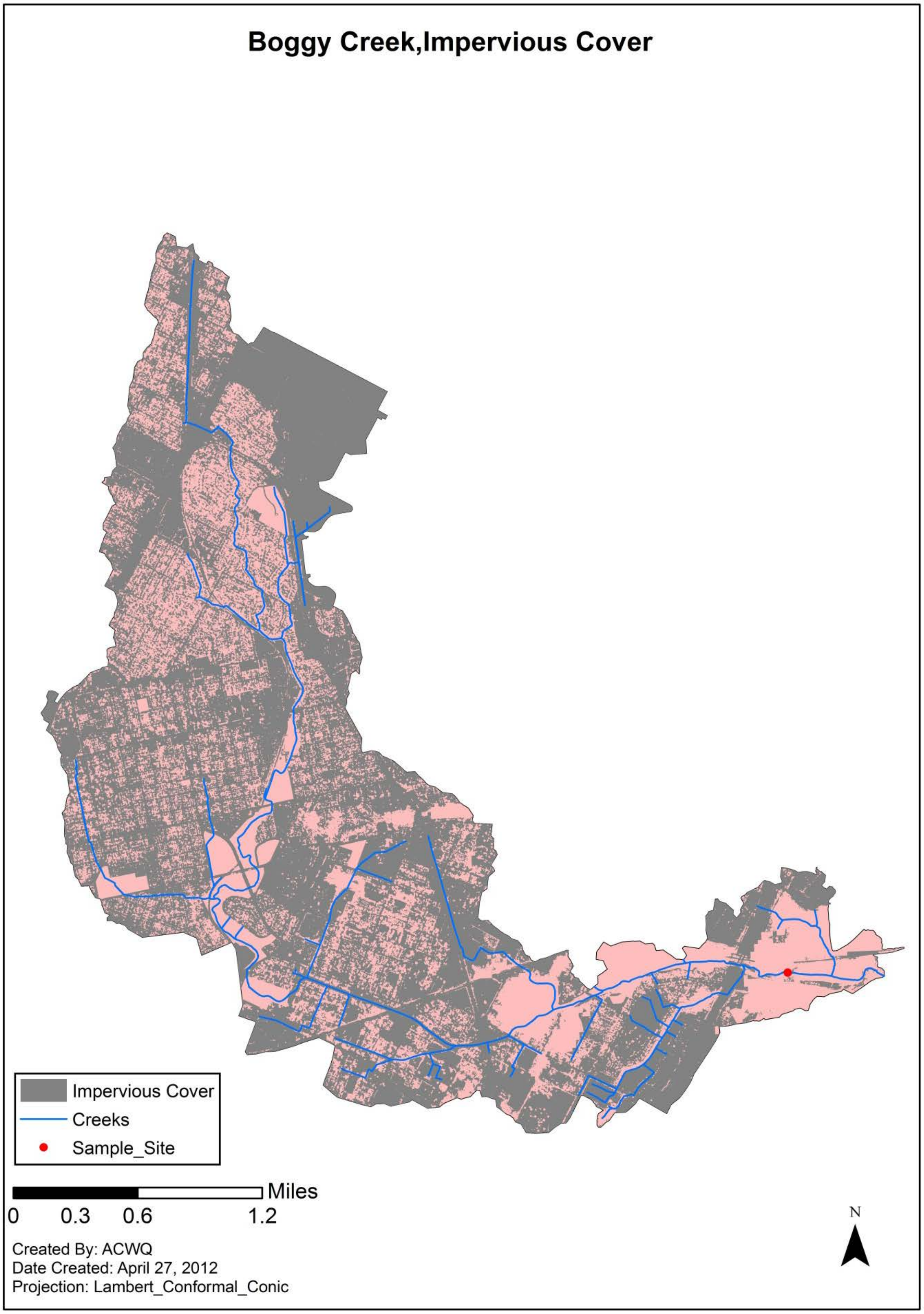
Map 3.1. Percent of Impervious Cover; EII Reaches



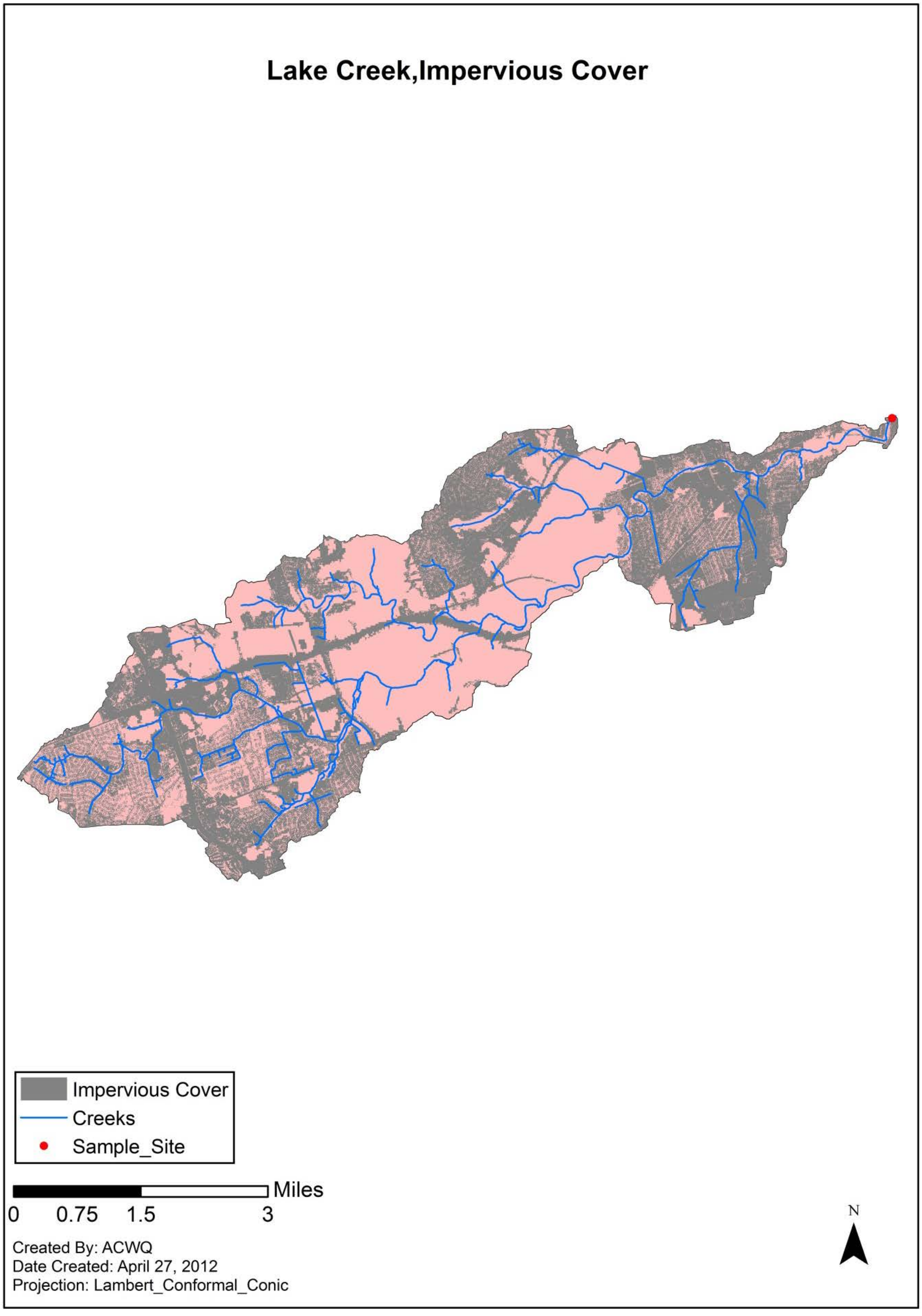
Map 3.2. Impervious Cover within BOG 3 EII Reach; Boggy Creek Watershed



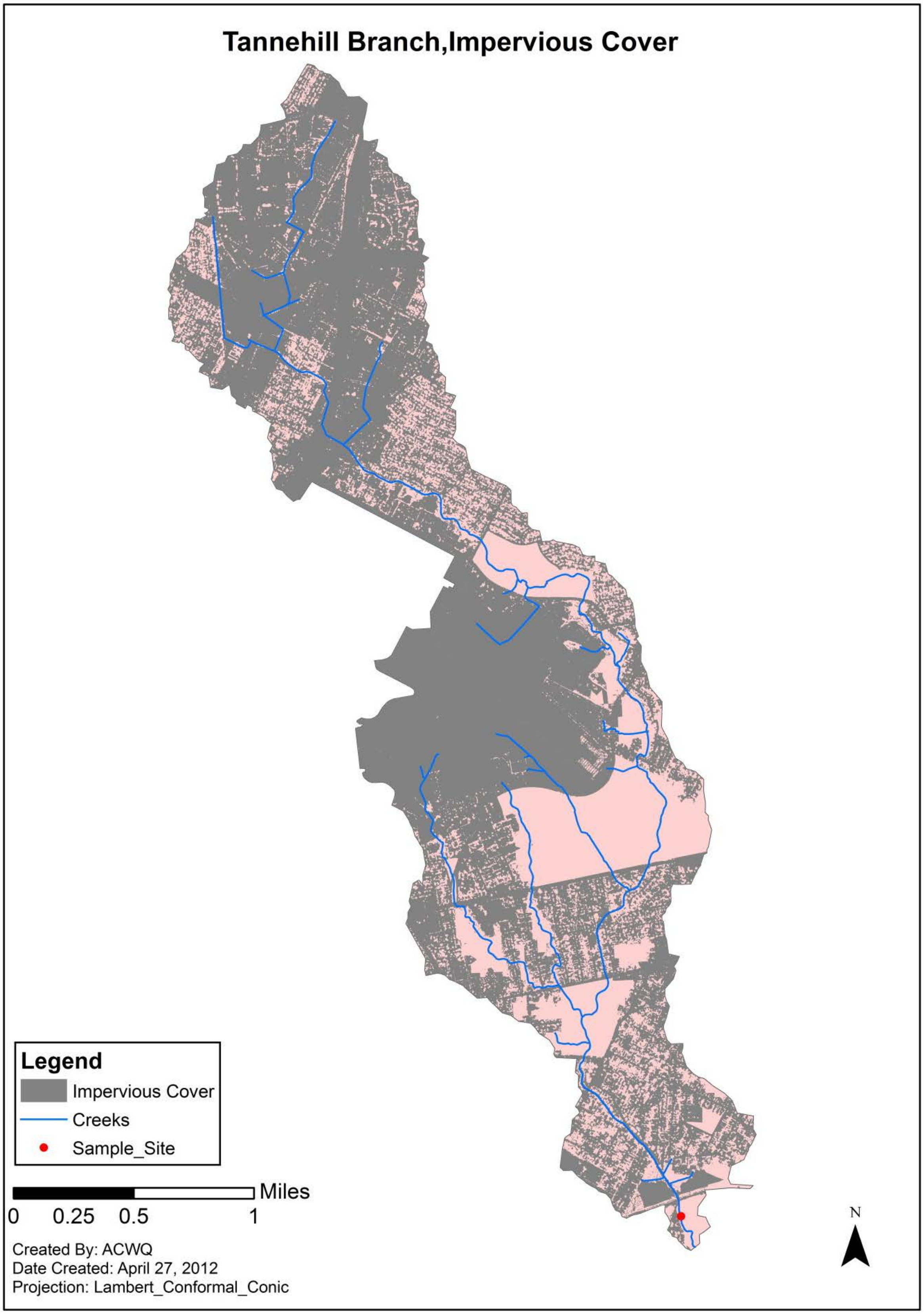
Map 3.3. Impervious Cover in Boggy Creek Watershed



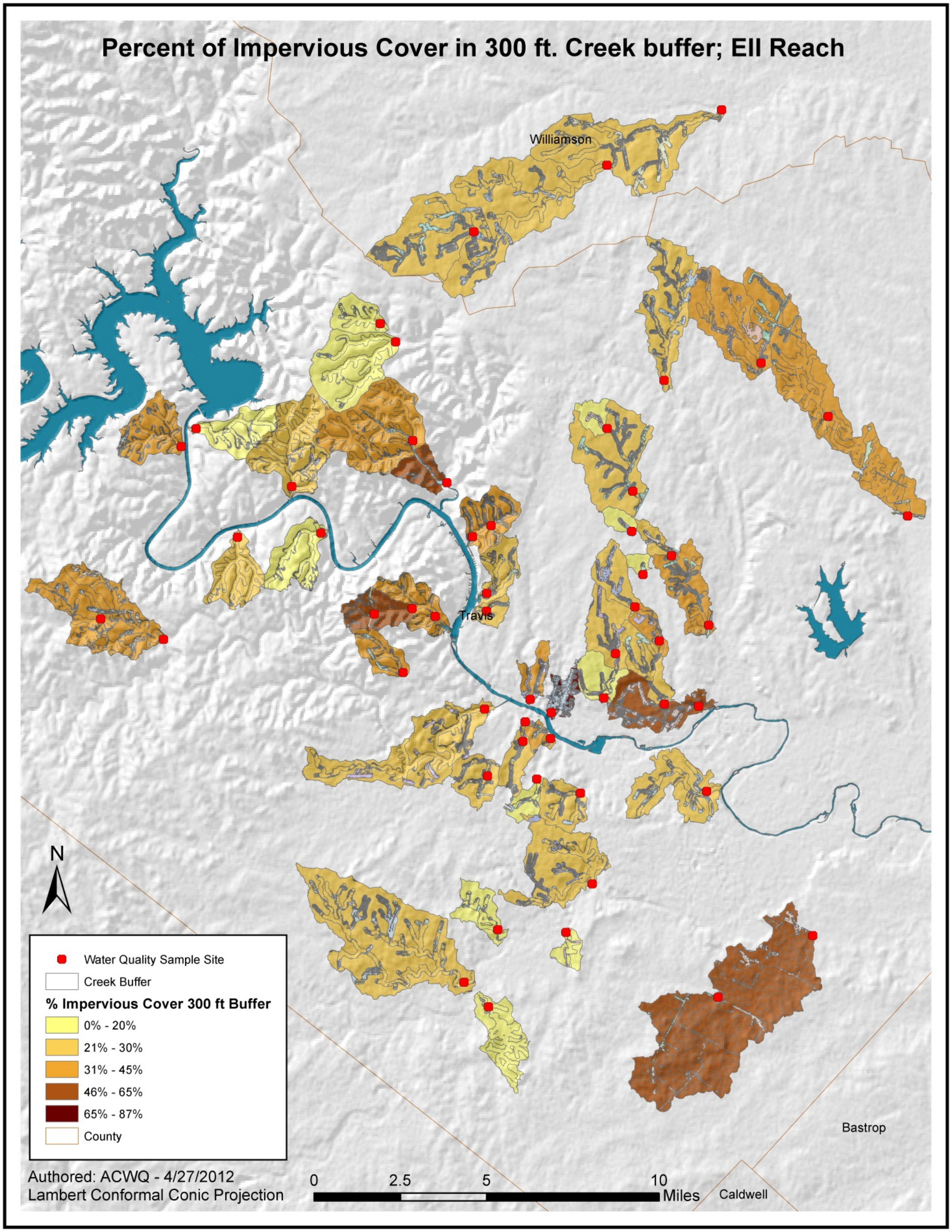
Map 3.4. Impervious Cover in Lake Creek Watershed



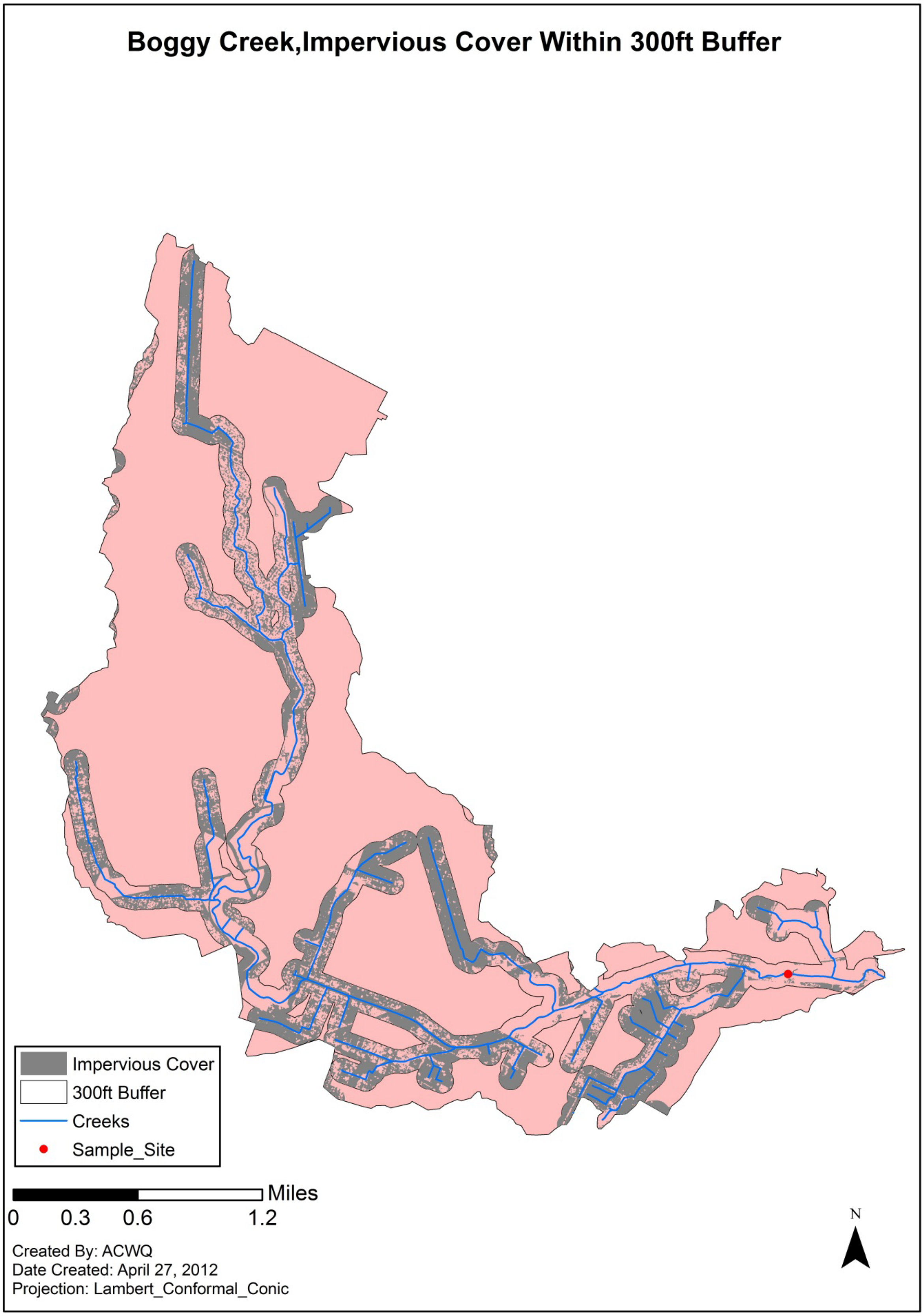
Map 3.5. Impervious Cover in Tannehill Branch Watershed



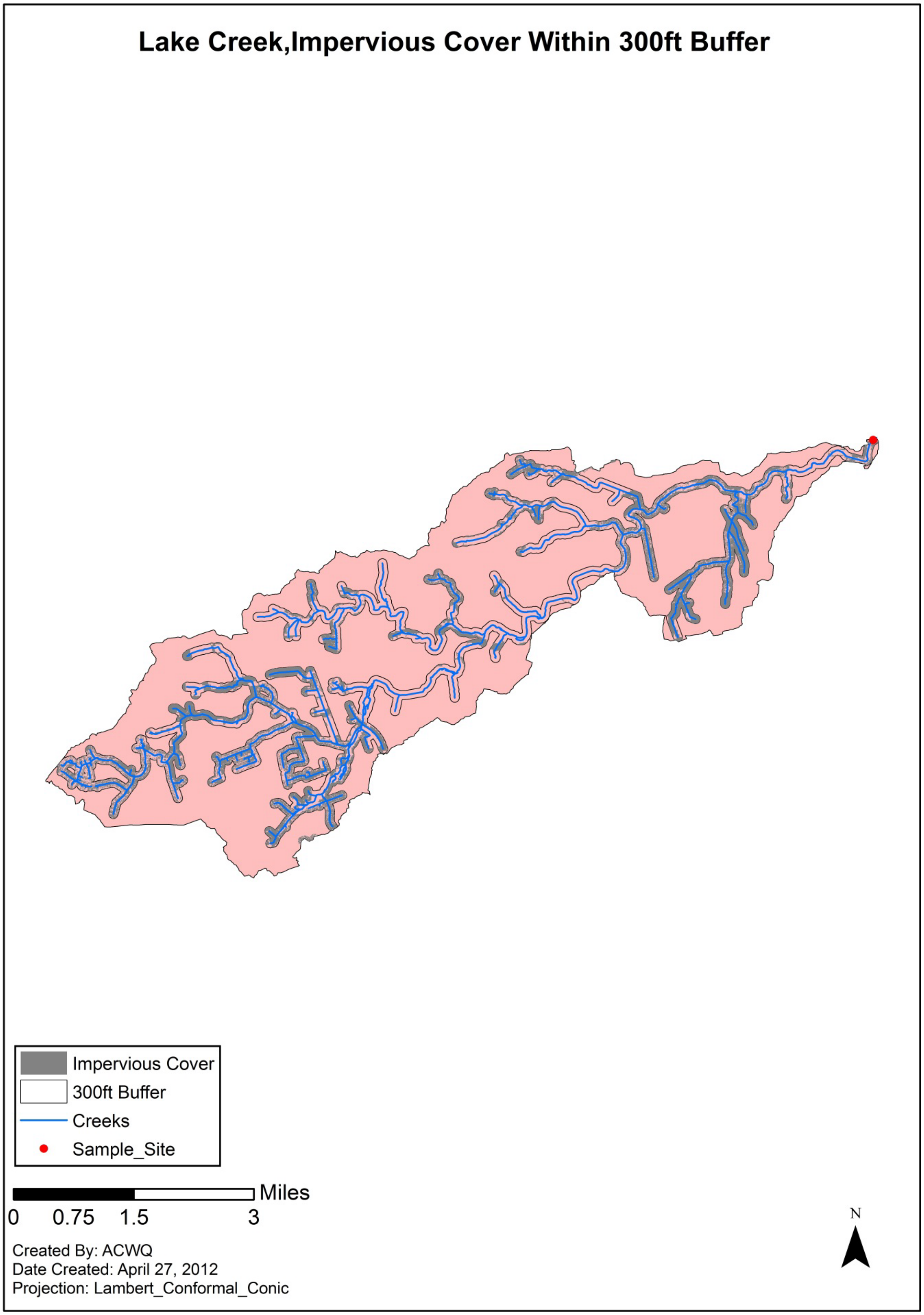
Map 3.5. Percent of Impervious Cover in 300 ft. Creek Buffer; EII Reach



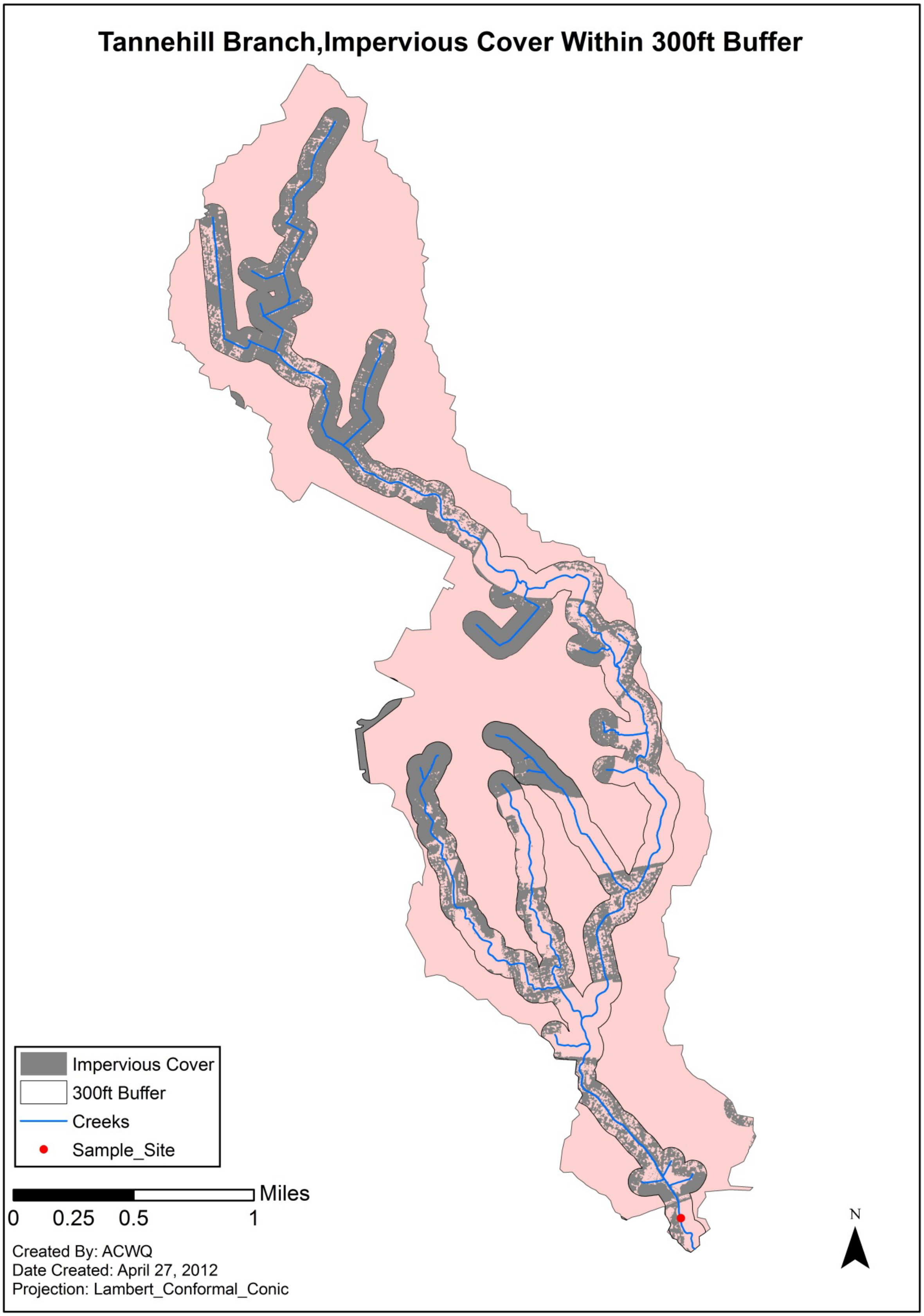
Map 3.6. Boggy Creek, Impervious Cover in 300 ft. Buffer



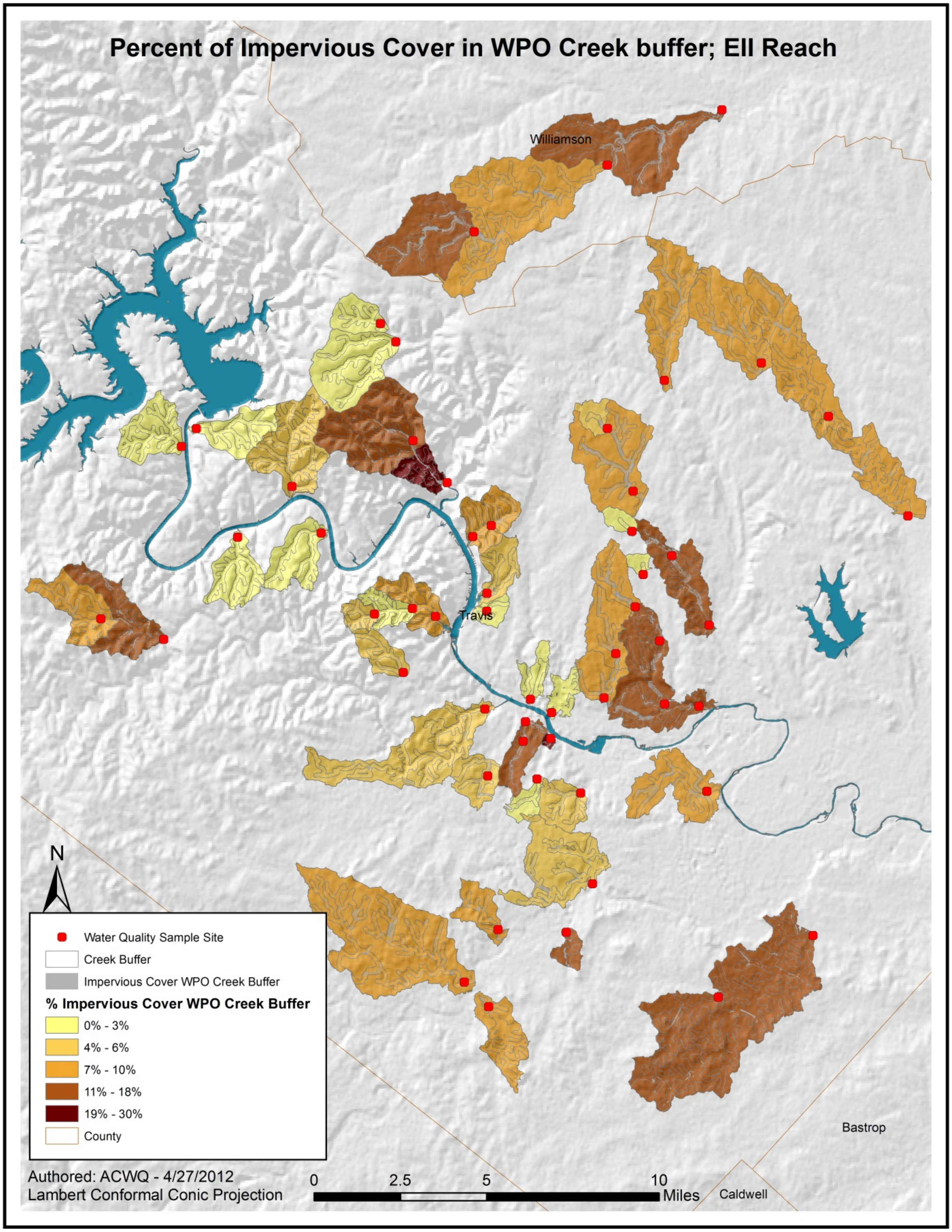
Map 3.7. Lake Creek, Impervious Cover in 300 ft. Buffer



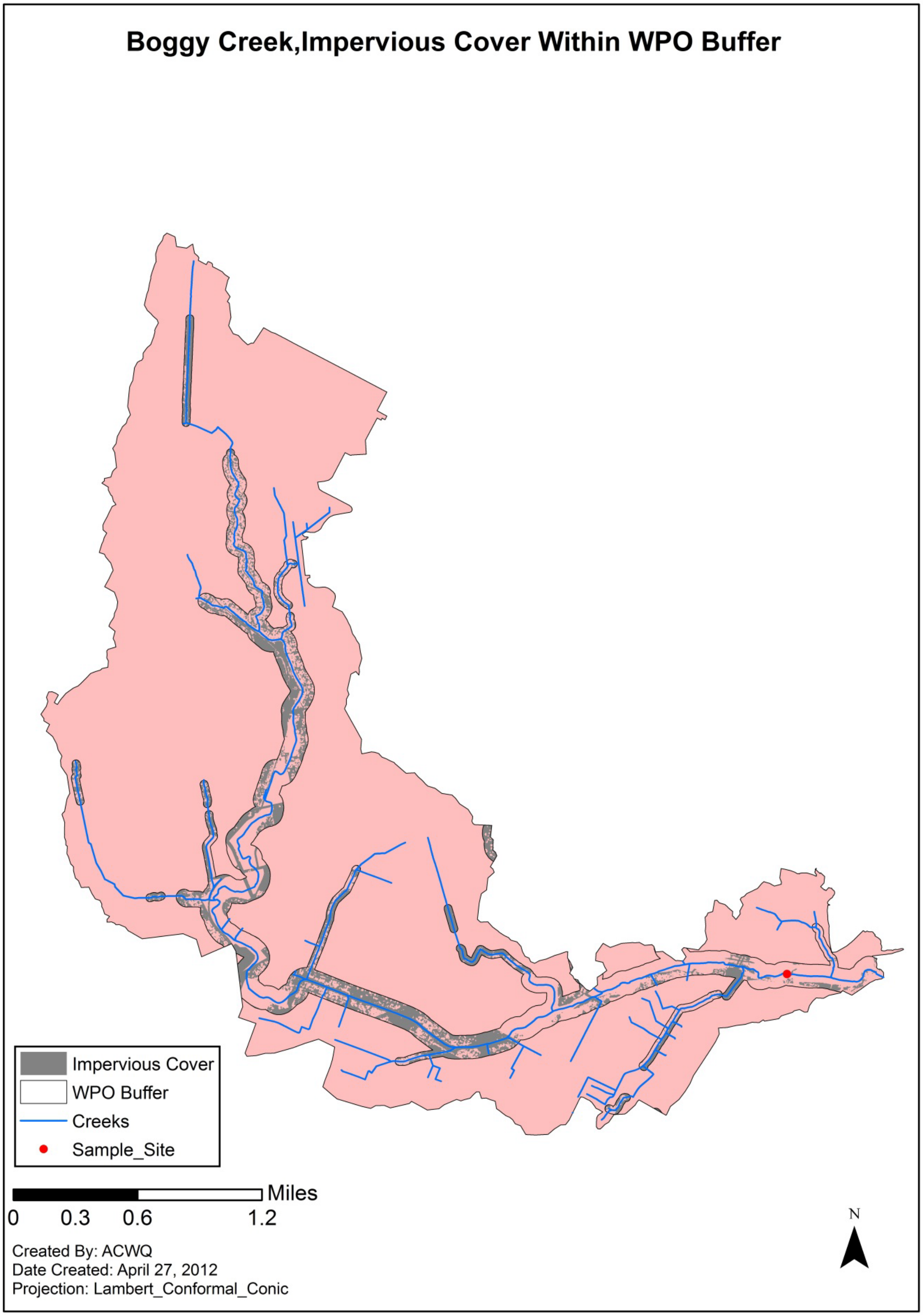
Map 3.8. Tannehill Branch, Impervious Cover in 300 ft. Buffer



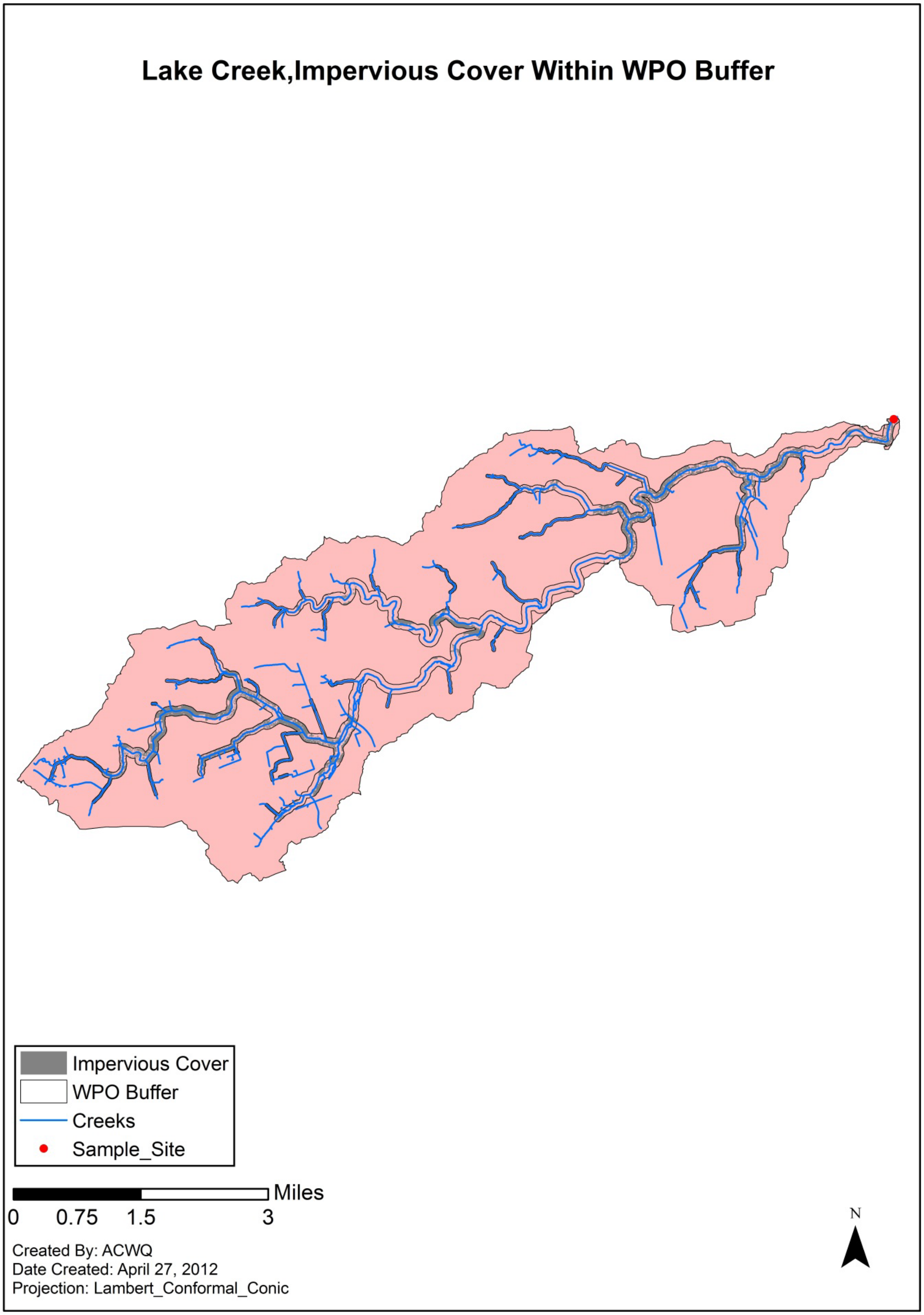
Map 3.9. Percent of Impervious Cover in WPO Buffer; EII Reach



Map 3.10. Boggy Creek, Impervious Cover Within WPO Buffer



Map 3.11. Lake Creek, Impervious Cover Within WPO Buffer



Map 3.12. Tannehill Branch, Impervious Cover Within WPO Buffer