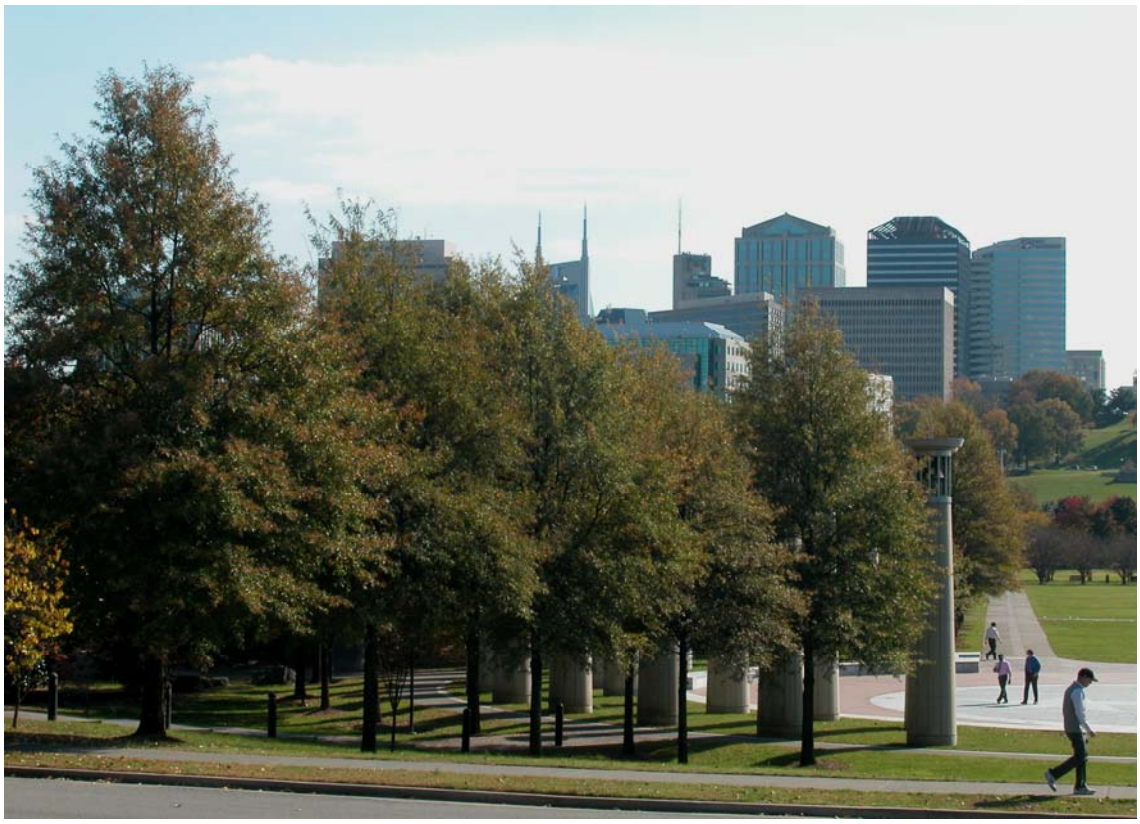
Metropolitan Nashville and Davidson County

April 2010



Prepared for:
Metro Tree Advisory Committee
and Metropolitan Government of
Nashville and Davidson County

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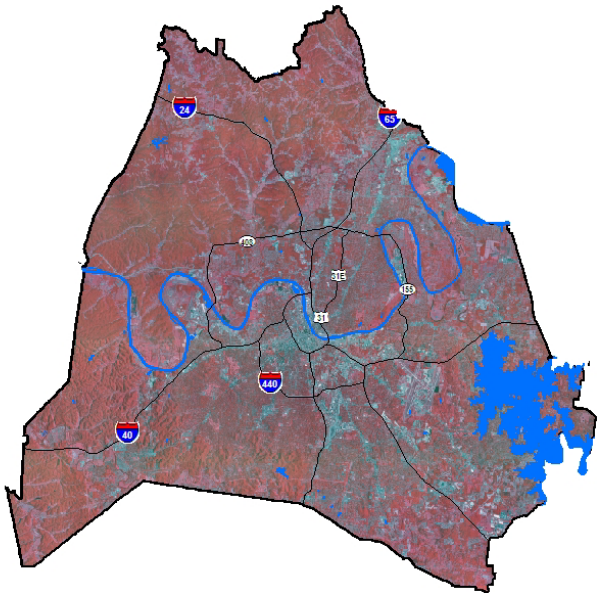
Information Management
AMEC Earth & Environmental

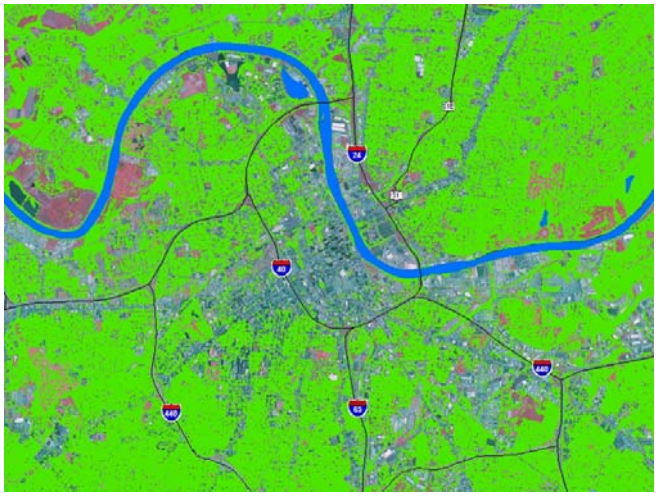
Introduction

Figure 1. Project Area: Davidson County, TN



The objective of this project was to conduct a tree canopy assessment (TCA) within the Metropolitan Government of Nashville and Davidson County, Tennessee ("Metro"). The urban tree canopy (UTC) results will serve as the benchmark from which to measure the success of planning and urban forestry programs and to educate the public about the many benefits of trees. Deliverables included 1-meter resolution multispectral aerial imagery, a GIS-based land cover feature class and raster (impervious surfaces, tree canopy, bare soil, grass, agriculture, and water with a separate layer where trees overhang impervious surfaces), tree canopy height, an accuracy assessment, UTC results at the county-level, by council district, by community sub-area and within land use classes, GeoPDF maps, a "UTC Calculator" spreadsheet and a final PowerPoint presentation. The project covered all of Davidson County, an area of 533 square miles. See Figure 1 above.

Metro Nashville UTC at a Glance



Existing UTC: 47% (157,947 acres)

Possible UTC: 35.3% (118,741 acres)

Existing UTC in Public Rights-of-Way: 15.3% (4,383 acres)

Existing UTC in Public Rights-of-Way: 15.3% (4,383 acres)

Existing UTC Ranges from 4.8% to 66.7% in Community Sub-Areas and from 13.0% to 67% in Council Districts

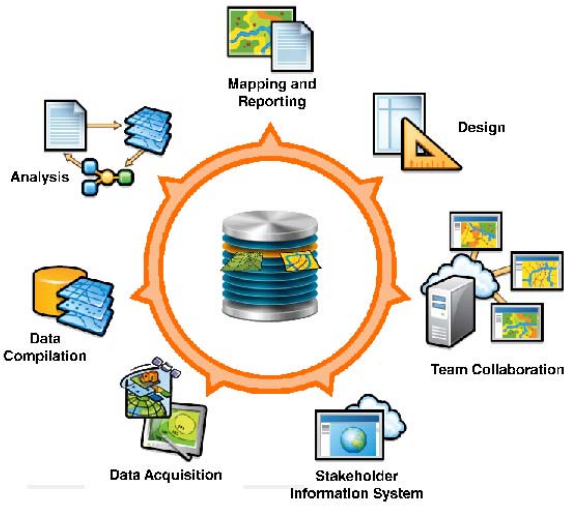
Photo Source: Wikipedia

Key Terms:

GIS – Geographic Information Systems
AOI – Area of Interest, referring to the study or project area
Urban tree canopy (UTC)* – the layer of leaves, branches, and stems of trees that cover the ground when viewed from above using aerial or satellite imagery
Land Cover* – features on the earth mapped from aerial or satellite imagery, such as trees, grass, water, and impervious surfaces
Possible Vegetation UTC * – grass or shrub area that is theoretically available for the establishment of tree canopy.

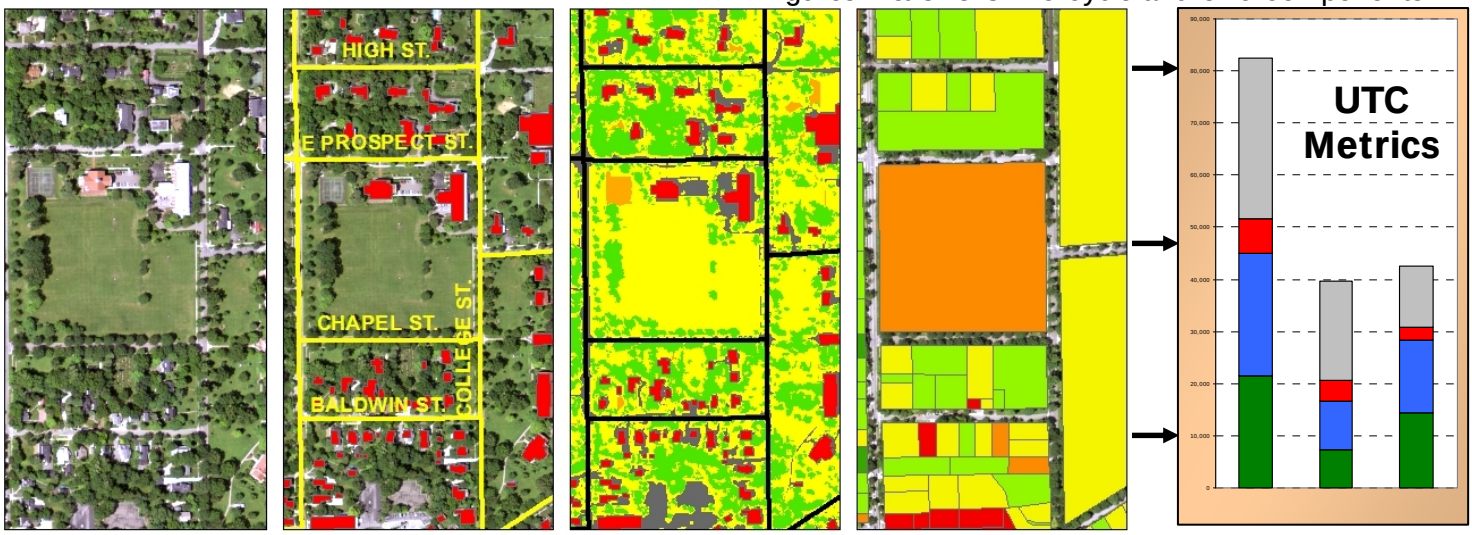
Possible Impervious UTC * – for this project this consisted of parking lots where it is theoretically possible to establish tree canopy
*Source: USDA Forest Service and/or University of Vermont Spatial Analysis Laboratory

The UTC Process: Imagery and Data Requirements



Geographic Information Systems (GIS) and remote sensing technologies offer powerful analysis and decision support tools for managing urban natural resources. All UTC projects have at least 5 main elements in common regarding data inputs and outputs. These are: high-resolution imagery, supporting GIS layers from the community, land cover data, geographic boundaries in which to summarize tree canopy acres and percent cover, and reporting of the results through tables, graphs and maps.

Figures 2 & 3. GIS Life Cycle and UTC Components



For this project, Metro provided AMEC with the following GIS layers: county boundary, parcels and landuse, council districts, community sub-areas, LiDAR, hydrology (lakes, ponds, rivers and streams) and impervious surfaces (buildings, streets, sidewalks, and parking lots). Imagery acquired in the summer of 2008 through the National Agricultural Imagery Program (NAIP) was downloaded and provided 1-meter spatial resolution, 4-band multispectral imagery for the classification of trees and other land cover. LiDAR data (Light Detection & Ranging) was flown in the spring of 2008 and provided accurate elevation data for canopy height information and support of the land cover classification.

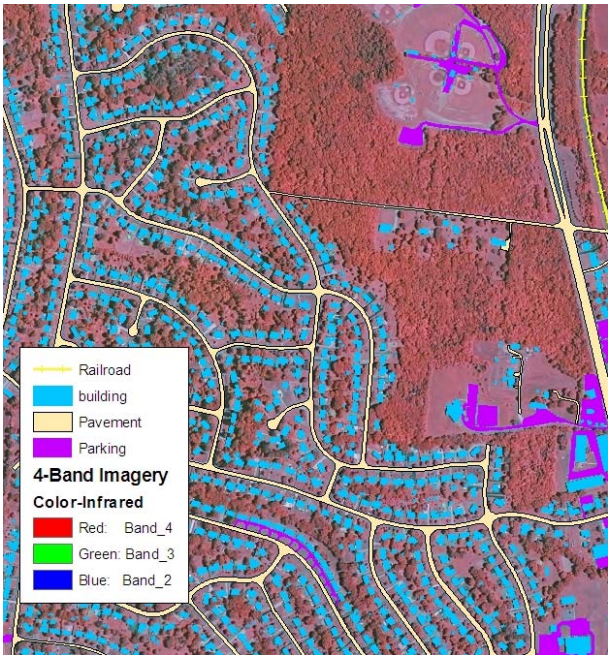


Figure 4. GIS Data Provided by Metro

Land Cover Classification Methodology

AMEC analyzed the multispectral imagery using a technique known as geographic object-based image analysis (GEOBIA) and developed a 6-class land cover dataset that would support the needs of this project and other applications. The land cover was delivered in tiled vector GIS format and as a raster mosaic and included tree canopy, grass/open space, agriculture, impervious surfaces, bare soil, and water. The GEOBIA approach provided a highly accurate, automated and cost-effective method for feature extraction by using algorithms that leverage spectral, spatial, textural, and contextual features in imagery, as well as incorporation of datasets provided by Metro. The classification was refined with a manual quality assurance / quality control (QA/QC) process to finalize the land cover. Finally, a point-based and polygon-based accuracy assessment was performed to meet a 90% Confidence Level at the proposed minimum mapping units. Within each land cover class, point-based accuracy was verified using 27 to 40 randomly sampled points, with an overall land cover classification accuracy of 91.9%. In addition to the point-based classification, tree canopy area was assessed by digitizing 50 random (blind) tree samples. The digitized tree samples were compared to the automated tree canopy polygons resulting in a total of 29.2 and 30.5 acres respectively. Based on this comparison, the polygon-based accuracy equaled 95.8%.

Figures 5-9 on the following pages show examples of the results from the land cover classification, LiDAR, imagery and canopy height analysis. The full accuracy assessment results can be found in the Appendix (see Standard Error Matrix).

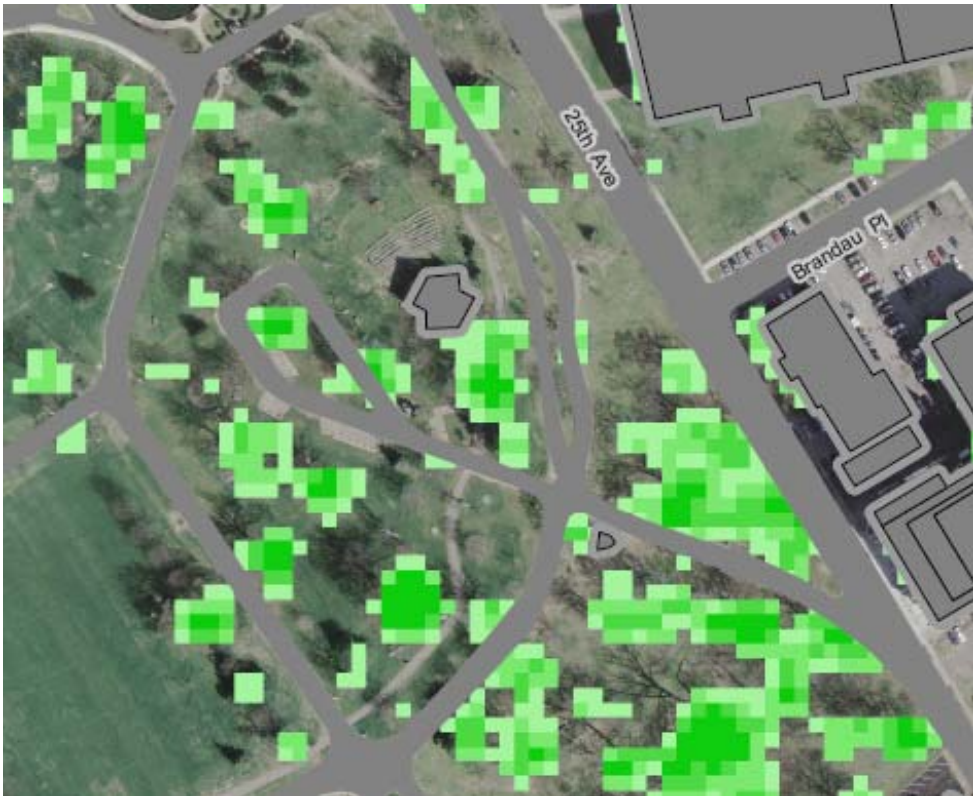
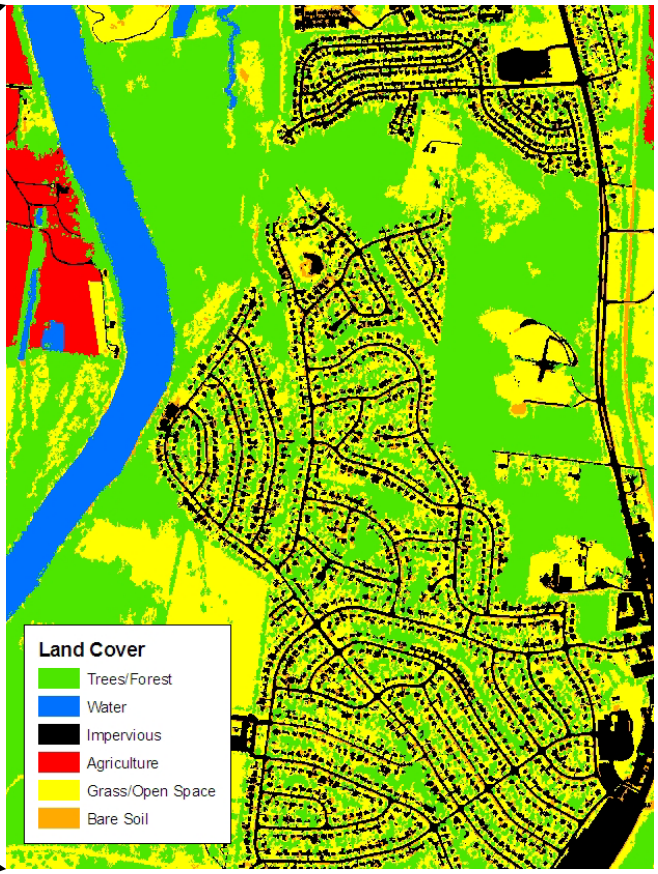
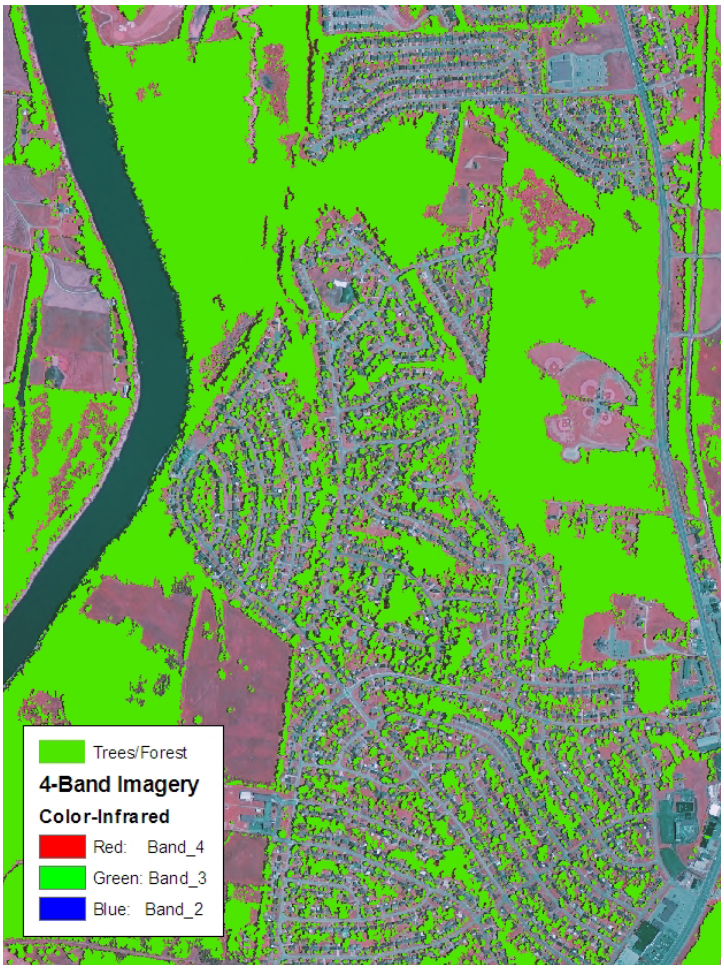


Figure 5. LiDAR-derived tree canopy height with buildings (in gray) excluded.

Figures 6 & 7. True color and color infrared aerial imagery and 6-class land cover data.



Figures 8 & 9. Trees and Impervious land cover data



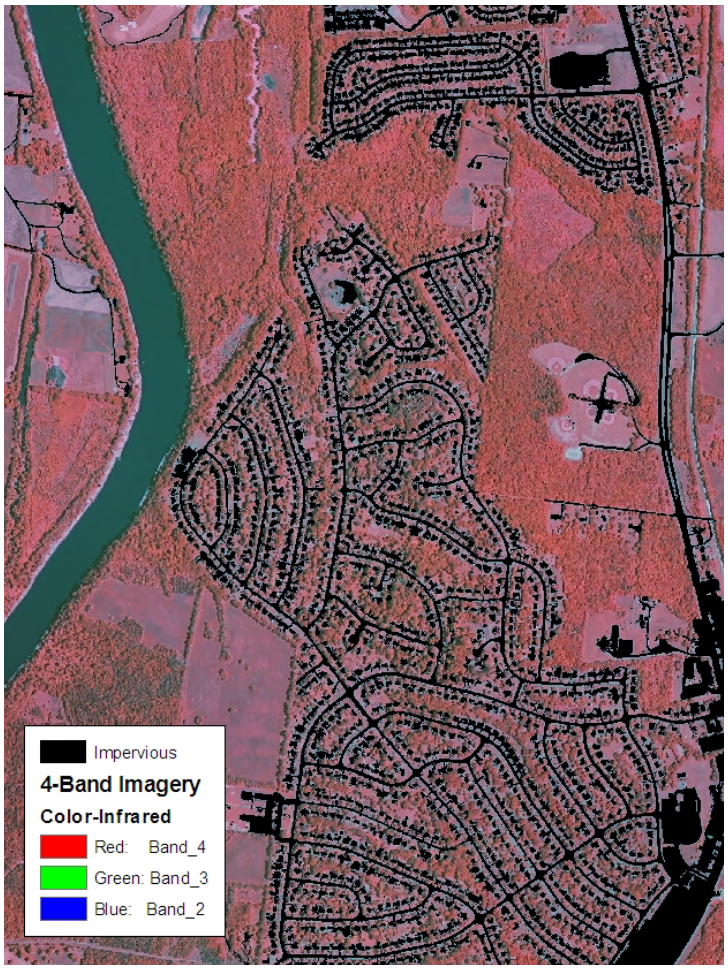
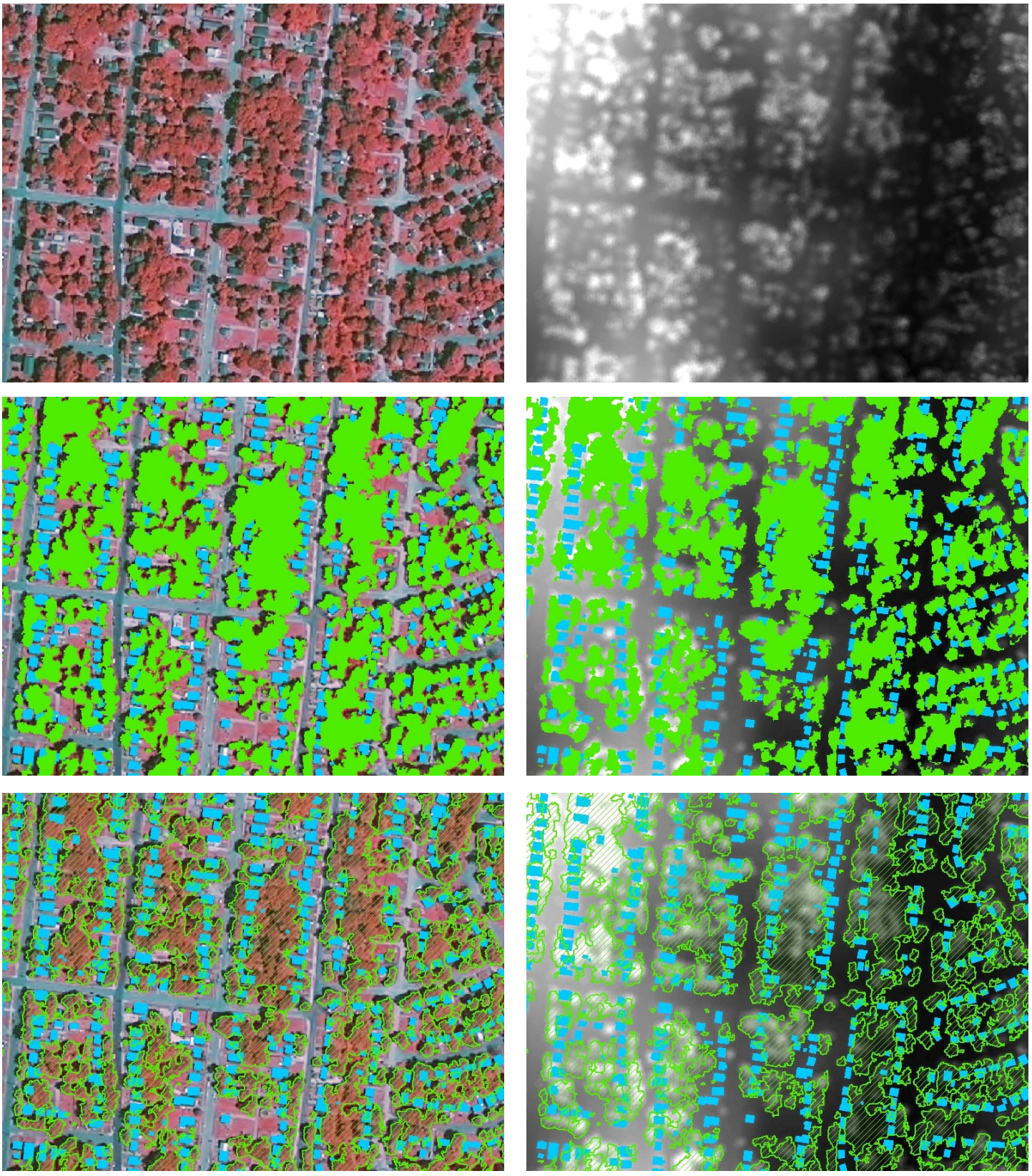


Figure 10. Illustrations representing tree canopy cover mapping using summer 2008 4-band NAIP imagery and spring 2007 LiDAR data. Building footprints provided by Metro are in blue. Note that the 1-meter spatial resolution of the 4-band NAIP imagery provides a clearer depiction of tree canopy cover compared to the 2-meter resolution (2-meter posting) LiDAR data. Tree canopy is in solid green and in a green transparent hatch for visualization aide.



Urban Tree Canopy (UTC) Modeling

Using the land cover classes described in the previous step, AMEC developed a series of geoprocessing models to calculate the area and percent of Existing and Possible UTC in both GIS and Excel format (see Figure 4 below). Existing UTC was defined as all area covered by trees and forest. Possible UTC was split into Possible Impervious UTC and several categories of Possible Vegetation UTC. Generally speaking, Possible UTC is defined as the areas where it is biophysically possible to plant trees, meaning all remaining area after excluding existing trees/forest, buildings, roads and water bodies, leaving primarily grass and open space vegetation as well as certain types of impervious surfaces for canopy establishment such as parking lots and driveways. Portions of this model were developed by the US Forest Service Northern Research Station and the University of Vermont Spatial Analysis Laboratory.

This project extended these protocols several steps further by erasing bare soil found in railroad corridors and then by separating Possible Vegetation UTC into the vegetation that is "possible" in golf courses, overhead power line corridors, agricultural land use and turf grass / meadow / open space. Rather than including these land use / land cover types in one category where it is biophysically possible to establish tree canopy, Metro now has the information to add and subtract from the types of Possible Vegetation UTC that are meaningful for tree canopy goal setting purposes. If golf courses, agricultural lands and power line corridors are unrealistic locations for increasing canopy cover, Metro can simply use the metrics for areas covered by turf grass, meadow and other open space (named Possible UTC Vegetation). Note that agricultural lands were ultimately derived from a landuse attribute within Metro's parcels database rather than through remote sensing means and only represented a small fraction of Possible UTC. From a high level modeling perspective, Figure 11 below illustrates the overall workflow.

Figure 11. UTC GIS modeling workflow

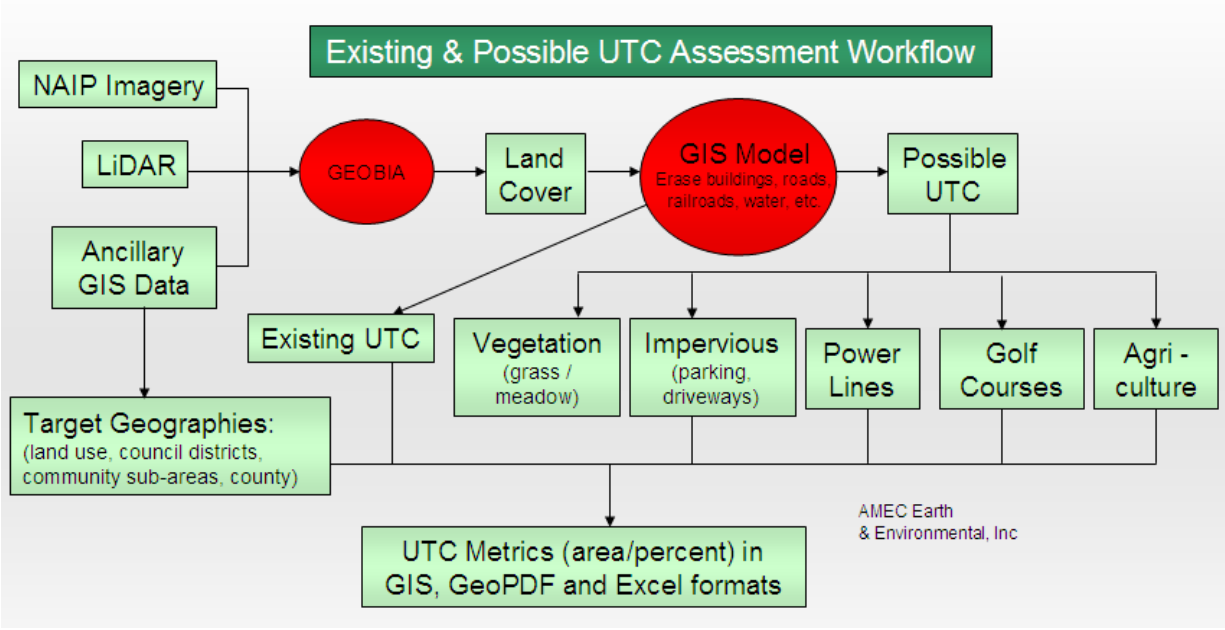
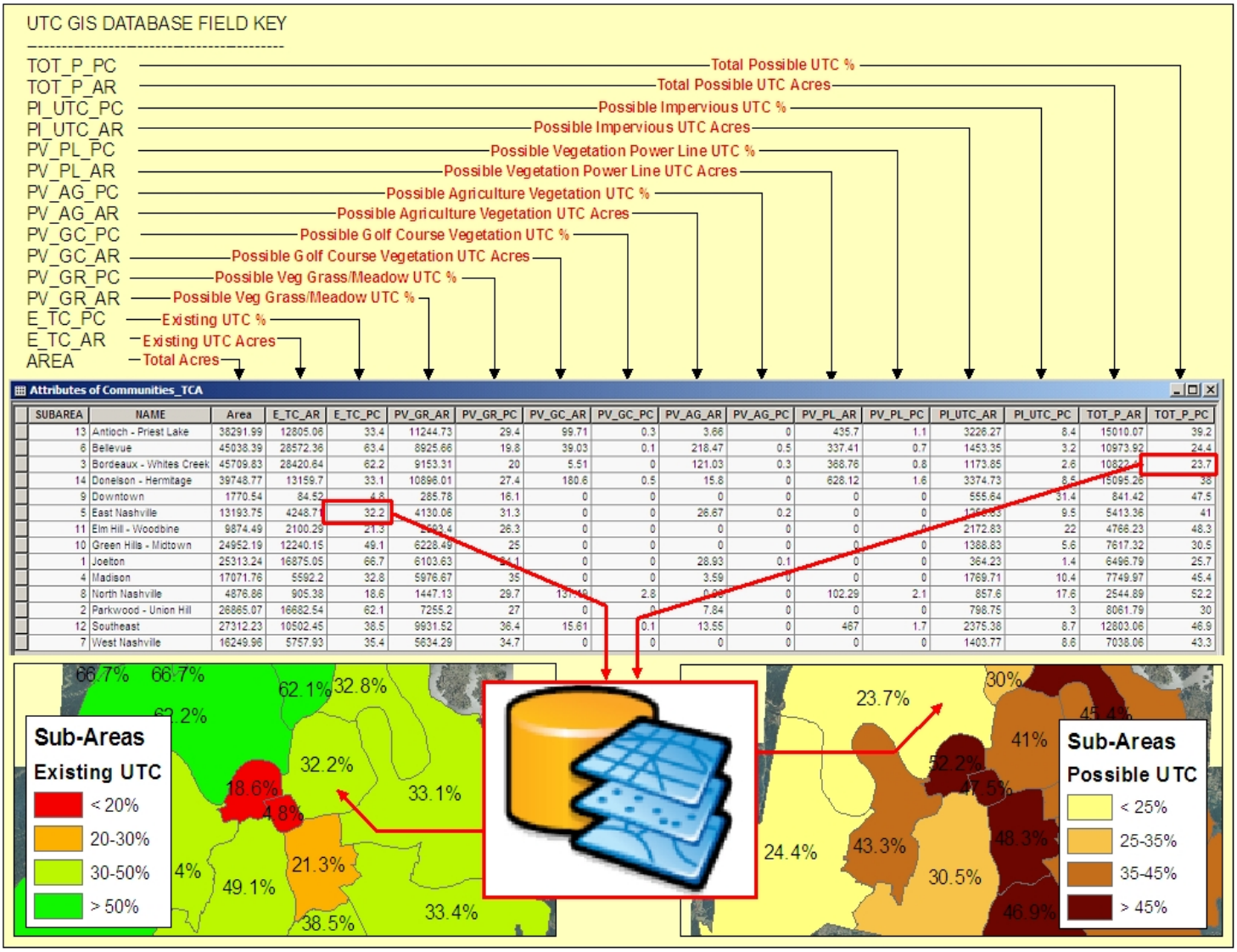


Figure 12. Illustration of UTC database delivered to Metro Nashville. This example shows the GIS attribute table for Community Sub-Areas, a field key for each column heading and how the UTC metrics in the attribute table are tied to the spatial polygons that are used for thematic maps of the UTC results.



SUBAREA	NAME	Area	E_TC_AR	E_TC_PC	PV_GR_AR	PV_GR_PC	PV_GC_AR	PV_GC_PC	PV_AG_AR	PV_AG_PC	PV_PL_AR	PV_PL_PC	PI_UTC_AR	PI_UTC_PC	TOT_P_AR	TOT_P_PC
13	Antioch - Priest Lake	38291.99	12805.06	33.4	11244.73	29.4	99.71	0.3	3.66	0	435.7	1.1	3226.27	8.4	15010.07	39.2
6	Bellevue	45038.39	28572.36	63.4	8925.66	19.8	39.03	0.1	218.47	0.5	337.41	0.7	1453.35	3.2	10973.92	24.4
3	Bordeaux - Whites Creek	45709.83	28420.64	62.2	9153.31	20	5.51	0	121.03	0.3	368.76	0.8	1173.85	2.6	10822.4	23.7
14	Donelson - Hermitage	39748.77	13159.7	33.1	10896.01	27.4	180.6	0.5	15.8	0	628.12	1.6	3374.73	8.5	15095.26	38
9	Downtown	1770.54	84.52	4.8	285.78	16.1	0	0	0	0	0	0	555.64	31.4	841.42	47.5
5	East Nashville	13193.75	4248.71	32.2	4130.06	31.3	0	0	26.67	0.2	0	0	1256.83	9.5	5413.36	41
11	Elm Hill - Woodbine	9874.49	2100.29	21.3	2593.4	26.3	0	0	0	0	0	0	2172.83	22	4766.23	48.3
10	Green Hills - Midtown	24952.19	12240.15	49.1	6228.49	25	0	0	0	0	0	0	1388.83	5.6	7617.32	30.5
1	Joelton	25313.24	16875.05	66.7	6103.63	24.1	0	0	28.93	0.1	0	0	364.23	1.4	6496.79	25.7
4	Madison	17071.76	5592.2	32.8	5976.67	35	0	0	3.59	0	0	0	1769.71	10.4	7749.97	45.4
8	North Nashville	4876.86	905.38	18.6	1447.13	29.7	137.19	2.8	0.09	0	102.29	2.1	857.6	17.6	2544.89	52.2
2	Parkwood - Union Hill	26885.07	16682.54	62.1	7255.2	27	0	0	7.84	0	0	0	798.75	3	8061.79	30
12	Southeast	27312.23	10502.45	38.5	9931.52	36.4	15.61	0.1	13.55	0	467	1.7	2375.38	8.7	12803.06	46.9
7	West Nashville	16249.96	5757.93	35.4	5634.29	34.7	0	0	0	0	0	0	1403.77	8.6	7038.06	43.3

Results of the UTC Process

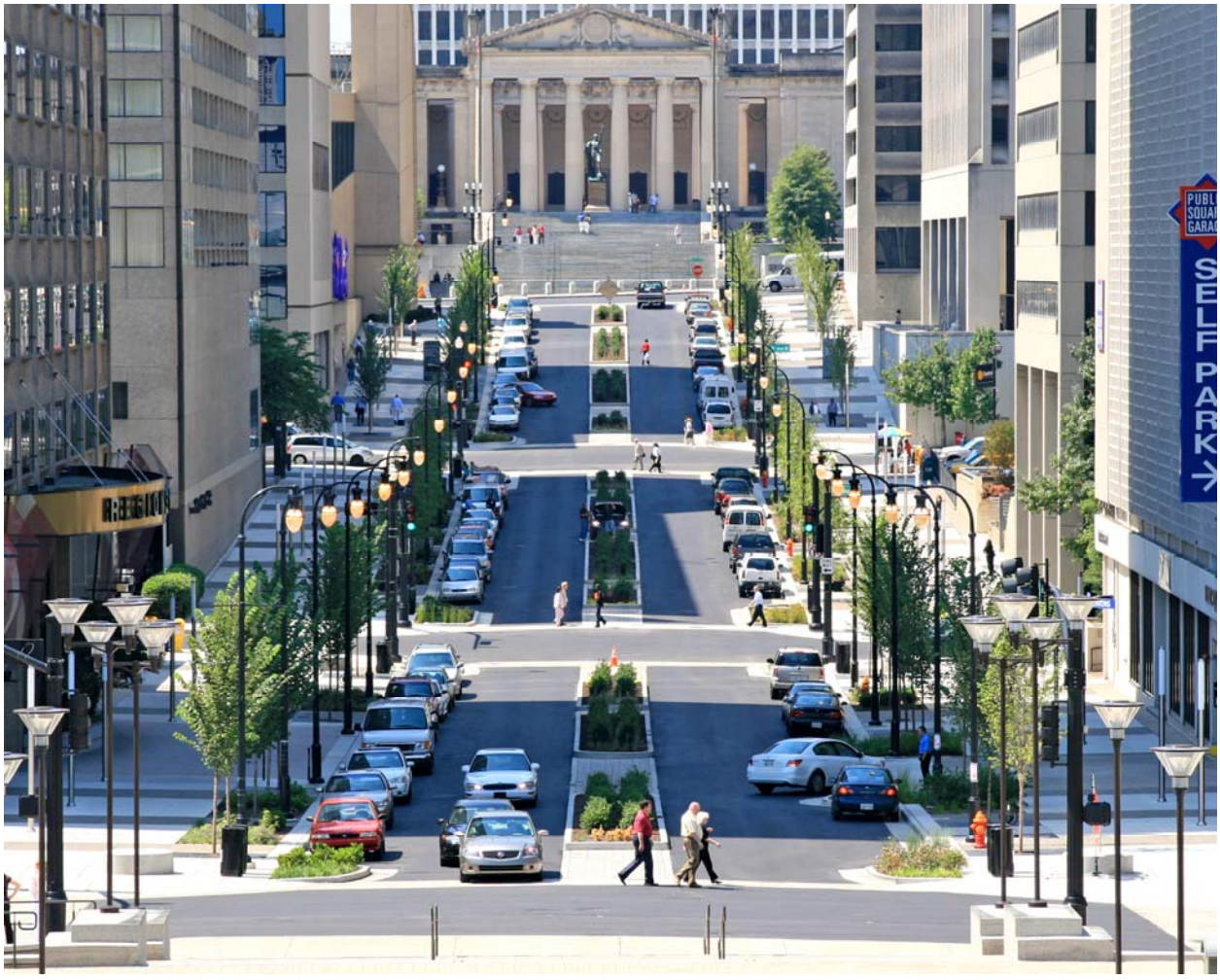
The area and percent of Existing UTC, Possible Vegetation UTC, Possible Impervious UTC, Total Possible UTC and Not Suitable land was calculated for the different geographic boundaries listed above. Existing UTC countywide in Metro Nashville was found to be 47.0% and Total Possible UTC was 35.3%. The sub-categories of Possible UTC that make-up this 35.3% included turf grass/meadow (Possible Vegetation UTC), impervious areas primarily comprised of parking lots (Possible Impervious UTC) and a small percentage from golf course, agriculture and power line corridors. Council districts ranged in Existing UTC from 13-67% and in community sub-areas from roughly 5-67%. For both geographies, Nashville Metro's downtown

business district was the lowest percent Existing UTC (i.e. 13% and 5% respectively).

While vacant and rural landuse types makeup only 47% of Metro Nashville (25% and 22% respectively), this represents 63% of Existing UTC (34% and 29% respectively) countywide. Similarly, while commercial and industrial landuse make-up roughly 8% of Metro Nashville, they only represent 2% of Existing UTC. Public rights-of-way (PROW) makeup 9% of the land area yet only represents 3% of UTC. UTC metrics within PROW were provided for each Council District and found to range from 6.6% to 26.3% with an average of 15.3% throughout Davidson County.

The full results can be accessed through the attribute table of each GIS layer, in the GeoPDF, or through the UTC Spreadsheet delivered as part of the project. Tables 1-4 and Figures 13-22 below provide examples of the results in tabular, graph and map-based format.

Figure 13. Deaderick Street in Downtown Nashville



Overall Metro UTC Results and Landuse Distribution

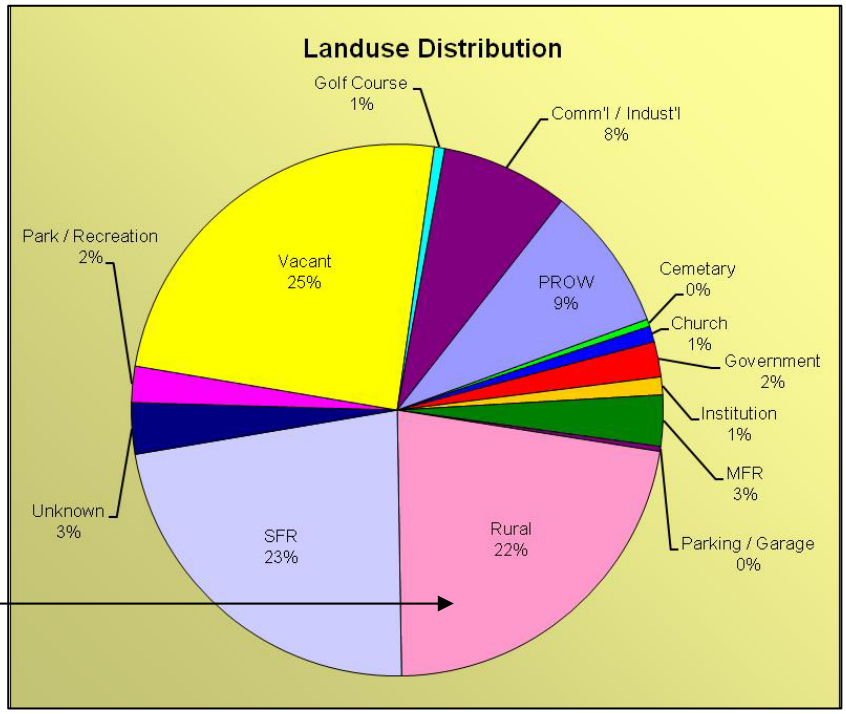


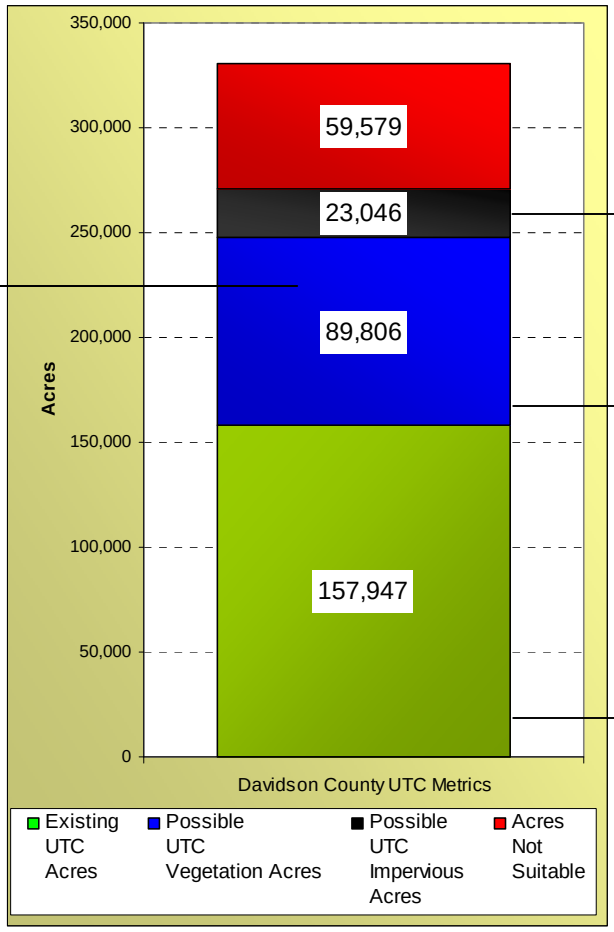
Figure 14. Percent Distribution of Land by General Landuse Types

22% of land within Metro Nashville falls into the "Rural" landuse as designated for this project, which was comprised of rural residential, commercial and industrial landuse.

Table 1. UTC Metrics for Metro Nashville

Total County Area	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Possible UTC Vegetation Acres	Possible UTC Vegetation %	Possible UTC Golf Course Acres	Possible UTC Golf Course %	Possible UTC Agriculture Acres	Possible UTC Agriculture %	Possible UTC Power Line Acres	Possible UTC Power Line %	Possible UTC Impervious Acres	Possible UTC Impervious %	Total Possible UTC Acres	Total Possible UTC %
Metro	336,268	59,579	157,947	47.0	89,806	26.7	924	0.3	440	0.1	4,525	1.3	23,046	6.9	118,741	35.3

Figure 15. Overall Summary of UTC Assessment



Countywide, there are 89,806 acres of "Possible UTC Vegetation".

Figure 16. Acres of different types of Possible UTC in Metro Nashville

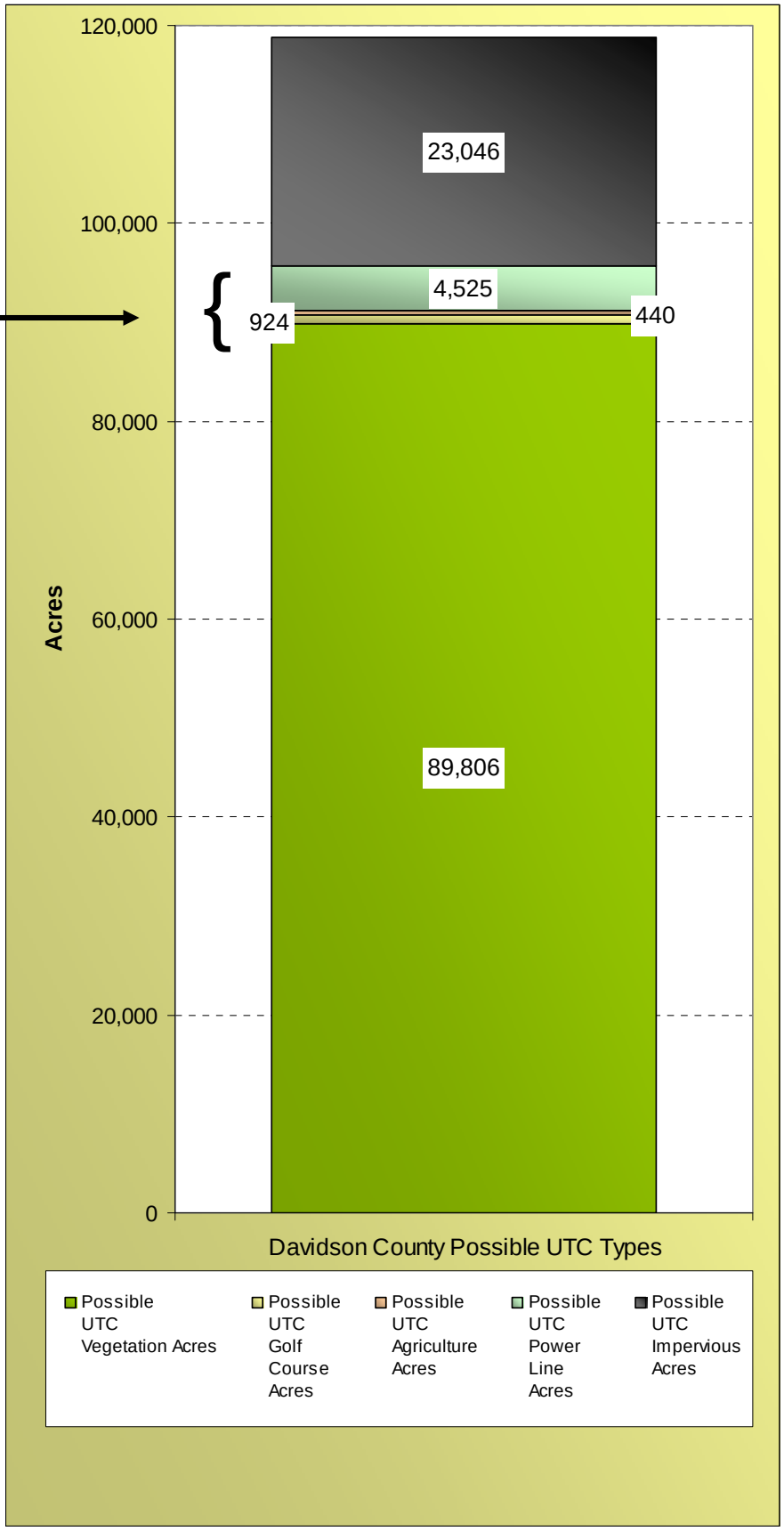


Table 1 on the previous page shows that the Total Possible UTC within Metro Nashville is 35.3% (118,741 acres). This is comprised of grass, meadow and open space, by impervious surfaces that could support tree canopy such as parking lots, and by areas that are biophysically possible to support canopy but less likely to, such as golf courses and agricultural land. By sub-categorizing the area of Possible UTC within agricultural lands, the area within 10-feet on either side of power line corridors and within golf courses, 1.8% (5,889 acres) of Possible UTC can be removed from Total Possible UTC if desired. This would bring the Total Possible UTC down to 33.5% countywide and may reflect a more useful, accurate number for planning and monitoring purposes.

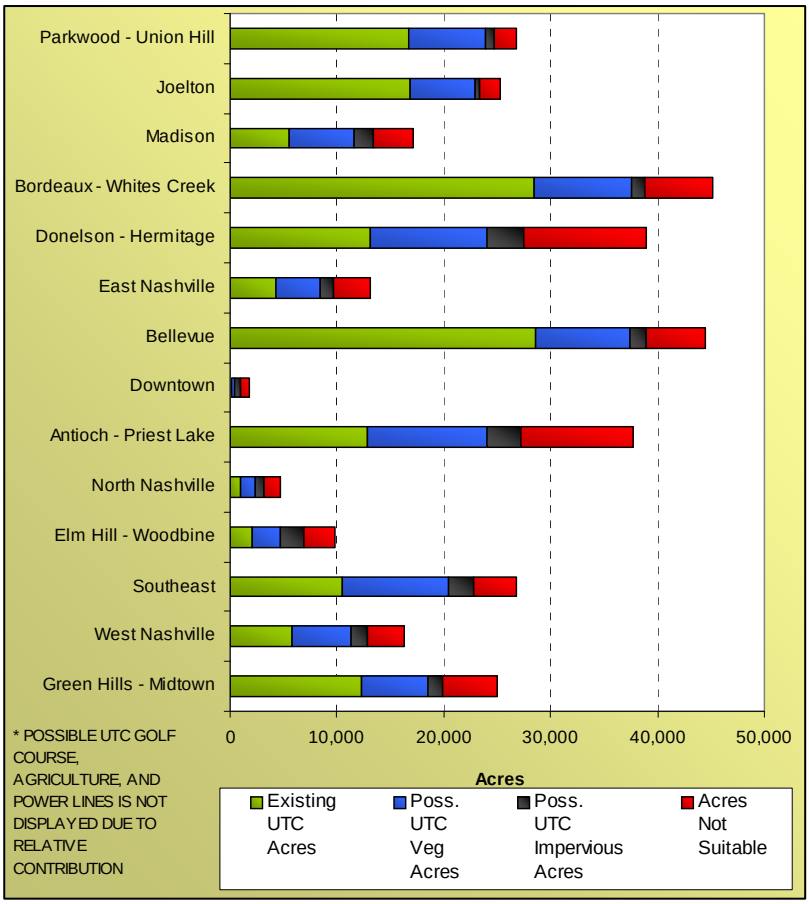
Metro UTC Results by Community Sub-Area

- Existing UTC ranges from 4.8% to 66.7%

Table 2. UTC Metrics in Metro Nashville by Community Sub-Area

Community Name	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Poss. UTC Veg Acres	Poss. UTC Veg %	Poss. UTC Golf Course Acres	Poss. UTC Golf Course %	Poss. UTC Agric. Acres	Poss. UTC Agric.	Poss. UTC Power Line Acres	Poss. UTC Power Line %	Poss. UTC Impervious Acres	Poss. UTC Impervious %	Total Poss. UTC Acres	Total Poss. UTC %
Parkwood - Union Hill	26,865	2,121	16,683	62.1	7,255	27.0	0	0	8	0	0	0	799	3.0	8062	30.0
Joelton	25,313	1,941	16,875	66.7	6,104	24.1	0	0	29	0.1	0	0	364	1.4	6497	25.7
Madison	17,072	3,730	5,592	32.8	5,977	35.0	0	0	4	0	0	0	1,770	10.4	7750	45.4
Bordeaux - Whites Creek	45,710	6,467	28,421	62.2	9,153	20.0	6	0	121	0.3	369	0.8	1,174	2.6	10822	23.7
Donelson - Hermitage	39,749	11,494	13,160	33.1	10,896	27.4	181	0.5	16	0	628	1.6	3,375	8.5	15095	38.0
East Nashville	13,194	3,532	4,249	32.2	4,130	31.3	0	0	27	0.2	0	0	1,257	9.5	5413	41.0
Bellevue	45,038	5,492	28,572	63.4	8,926	19.8	39	0.1	218	0.5	337	0.7	1,453	3.2	10974	24.4
Downtown	1,771	845	85	4.8	286	16.1	0	0	0	0	0	0	556	31.4	841	47.5
Antioch - Priest Lake	38,292	10,477	12,805	33.4	11,245	29.4	100	0.3	4	0	436	1.1	3,226	8.4	15010	39.2
North Nashville	4,877	1,427	905	18.6	1,447	29.7	137	2.8	1	0	102	2.1	858	17.6	2545	52.2
Elm Hill - Woodbine	9,874	3,008	2,100	21.3	2,593	26.3	0	0	0	0	0	0	2,173	22.0	4766	48.3
Southeast	27,312	4,007	10,502	38.5	9,932	36.4	16	0.1	14	0	467	1.7	2,375	8.7	12803	46.9
West Nashville	16,250	3,454	5,758	35.4	5,634	34.7	0	0	0	0	0	0	1,404	8.6	7038	43.3
Green Hills - Midtown	24,952	5,095	12,240	49.1	6,228	25.0	0	0	0	0	0	0	1,389	5.6	7617	30.5

Figure 17. Existing and Possible Vegetation UTC Metrics by Individual Community Sub-Area Boundary



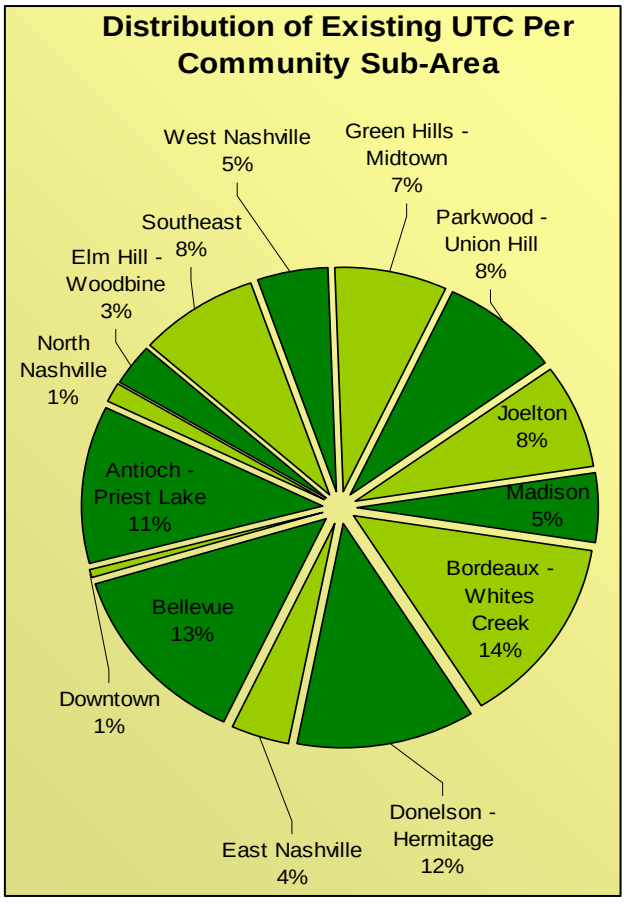
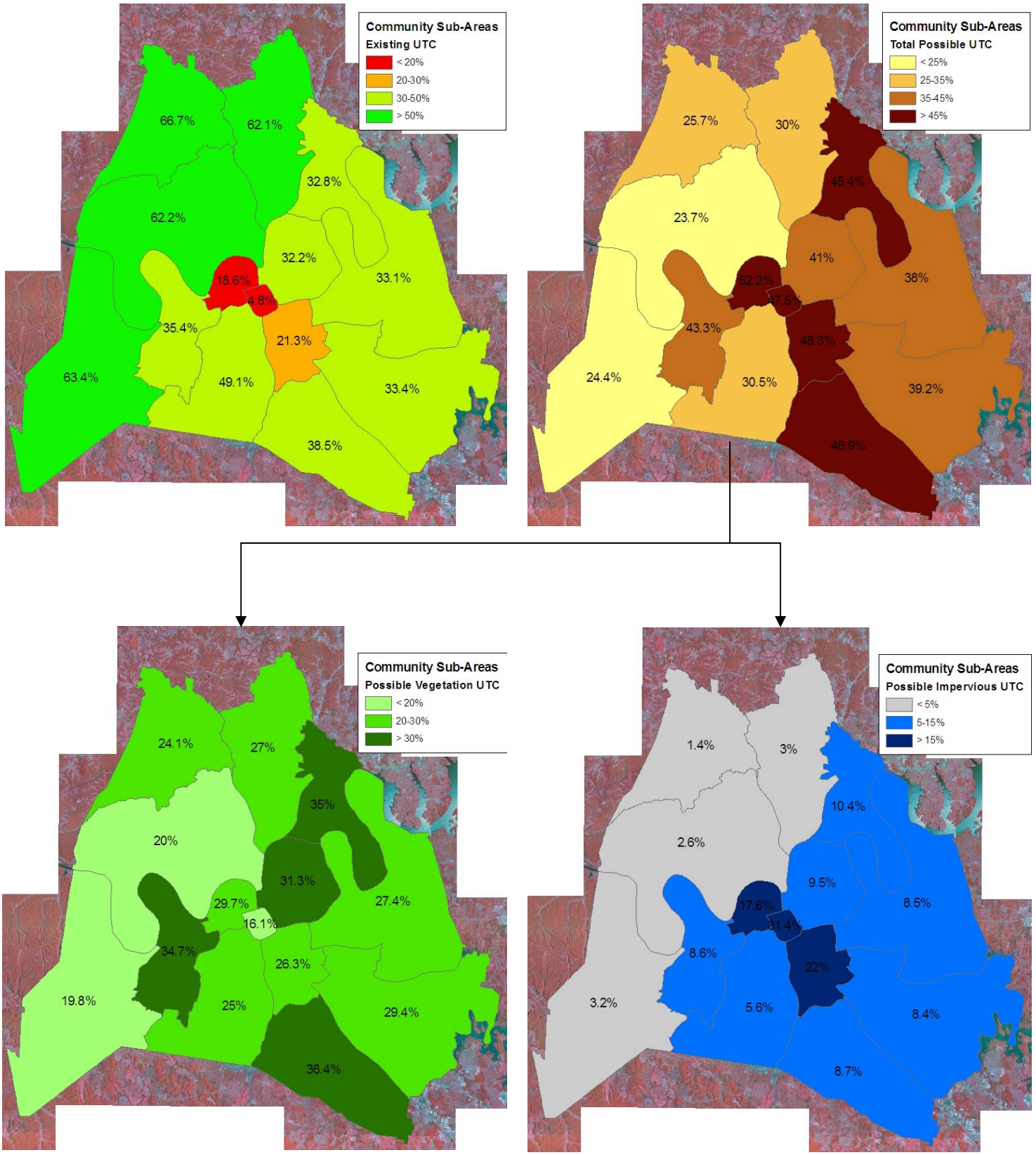


Figure 18. Thematic Maps of Percent Existing and Possible Vegetation UTC Metrics by Community Sub-Area Boundary. The two maps at bottom show Percent Possible UTC for the sub-categories of Possible Vegetation UTC and Possible Impervious UTC.

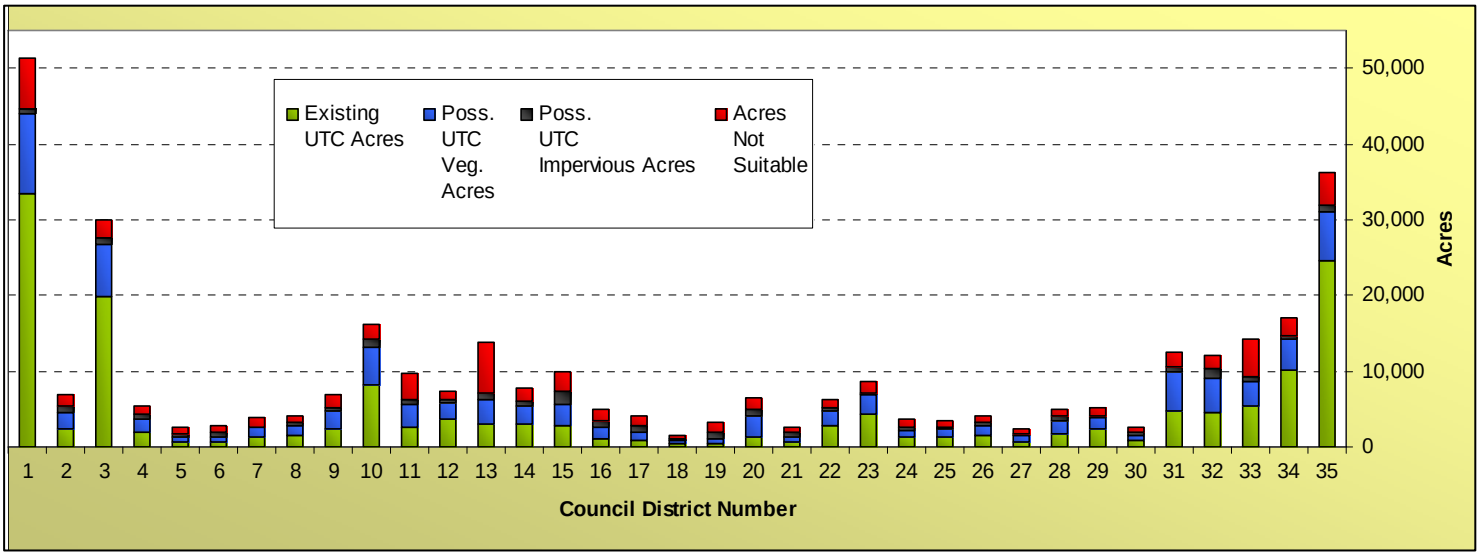


Metro UTC Results by Council District
- Existing UTC ranges from 13% to 67%

Table 3. Existing & Possible UTC Metrics by Council District

Council Districts	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Poss. UTC Veg. Acres	Poss. UTC Veg. %	Poss. UTC Golf Course Acres	Poss. UTC Golf Course %	Poss. UTC Agric. Acres	Poss. UTC Agric. %	Poss. UTC Power Line Acres	Poss. UTC Power Line %	Poss. UTC Impervious Acres	Poss. UTC Impervious %	Total Poss. UTC Acres	Total Poss. UTC %
1	51,821	6,597	33,415	64.5	10,550	20.4	6	0	140	0.3	325	0.6	789	1.5	11809	22.8
2	6,917	1,498	2,277	32.9	2,354	34.0	0	0	0	0	0	0	788	11.4	3142	45.4
3	30,052	2,390	19,861	66.1	6,956	23.1	0	0	17	0.1	0	0	828	2.8	7801	26.0
4	5,323	1,046	2,040	38.3	1,699	31.9	0	0	0	0	0	0	539	10.1	2237	42.0
5	2,510	758	588	23.4	754	30.1	0	0	0	0	0	0	409	16.3	1163	46.4
6	2,848	1,010	592	20.8	782	27.5	0	0	0	0	0	0	463	16.3	1245	43.7
7	3,833	1,133	1,375	35.9	1,117	29.1	0	0	27	0.7	0	0	182	4.7	1325	34.6
8	4,020	851	1,510	37.6	1,323	32.9	0	0	0	0	0	0	336	8.4	1659	41.3
9	6,898	1,634	2,273	33.0	2,562	37.1	0	0	3	0.1	0	0	425	6.2	2991	43.4
10	16,080	1,831	8,122	50.5	5,024	31.2	0	0	1	0	0	0	1,102	6.9	6127	38.1
11	9,920	3,399	2,493	25.1	3,167	31.9	33	0.3	3	0	160	1.6	664	6.7	4027	40.6
12	7,472	1,085	3,574	47.8	2,242	30.0	10	0.1	2	0	109	1.5	449	6.0	2813	37.6
13	13,712	6,577	3,119	22.7	3,175	23.2	0	0	0	0	0	0	841	6.1	4016	29.3
14	7,746	1,702	2,964	38.3	2,398	31.0	0	0	3	0	0	0	678	8.7	3079	39.8
15	10,318	2,634	2,821	27.3	2,683	26.0	137	1.3	7	0.1	204	2.0	1,832	17.8	4863	47.1
16	5,057	1,621	1,100	21.8	1,391	27.5	0	0	0	0	0	0	945	18.7	2336	46.2
17	4,098	1,253	848	20.7	1,122	27.4	0	0	0	0	0	0	875	21.4	1997	48.7
18	1,559	550	424	27.2	364	23.4	0	0	0	0	0	0	220	14.1	584	37.5
19	3,288	1,378	427	13.0	717	21.8	0	0	0	0	0	0	765	23.3	1482	45.1
20	6,375	1,437	1,324	20.8	2,767	43.4	0	0	0	0	0	0	848	13.3	3614	56.7
21	2,780	772	548	19.7	826	29.7	83	3.0	1	0	57	2.1	492	17.7	1460	52.5
22	6,302	1,113	2,836	45.0	1,811	28.7	0	0	2	0	0	0	540	8.6	2353	37.3
23	8,533	1,435	4,218	49.4	2,590	30.3	0	0	0	0	0	0	290	3.4	2880	33.8
24	3,641	1,031	1,306	35.9	858	23.6	0	0	0	0	0	0	446	12.3	1304	35.8
25	3,542	964	1,319	37.2	1,018	28.8	0	0	0	0	0	0	241	6.8	1259	35.5
26	4,009	868	1,429	35.6	1,285	32.0	0	0	0	0	0	0	428	10.7	1713	42.7
27	2,284	510	728	31.9	728	31.9	0	0	0	0	0	0	318	13.9	1046	45.8
28	4,987	986	1,810	36.3	1,552	31.1	0	0	0	0	0	0	640	12.8	2192	44.0
29	5,086	916	2,346	46.1	1,506	29.6	0	0	0	0	0	0	318	6.2	1824	35.9
30	2,488	572	874	35.1	741	29.8	0	0	0	0	0	0	302	12.1	1043	41.9
31	12,548	1,887	4,811	38.3	5,069	40.4	0	0	12	0.1	0	0	770	6.1	5851	46.6
32	12,320	1,697	4,532	36.8	4,581	37.2	16	0.1	2	0	166	1.3	1,328	10.8	6092	49.4
33	14,136	4,943	5,378	38.0	3,302	23.4	0	0	3	0	0	0	509	3.6	3815	27.0
34	17,022	2,396	10,045	59.0	4,250	25.0	0	0	0	0	0	0	331	1.9	4581	26.9
35	36,747	4,369	24,622	67.0	6,543	17.8	39	0.1	217	0.6	222	0.6	735	2.0	7756	21.1

Figure 19. Acres of Existing, Possible and Not-Suitable UTC by Council District



Metro UTC Results within Landuse Types

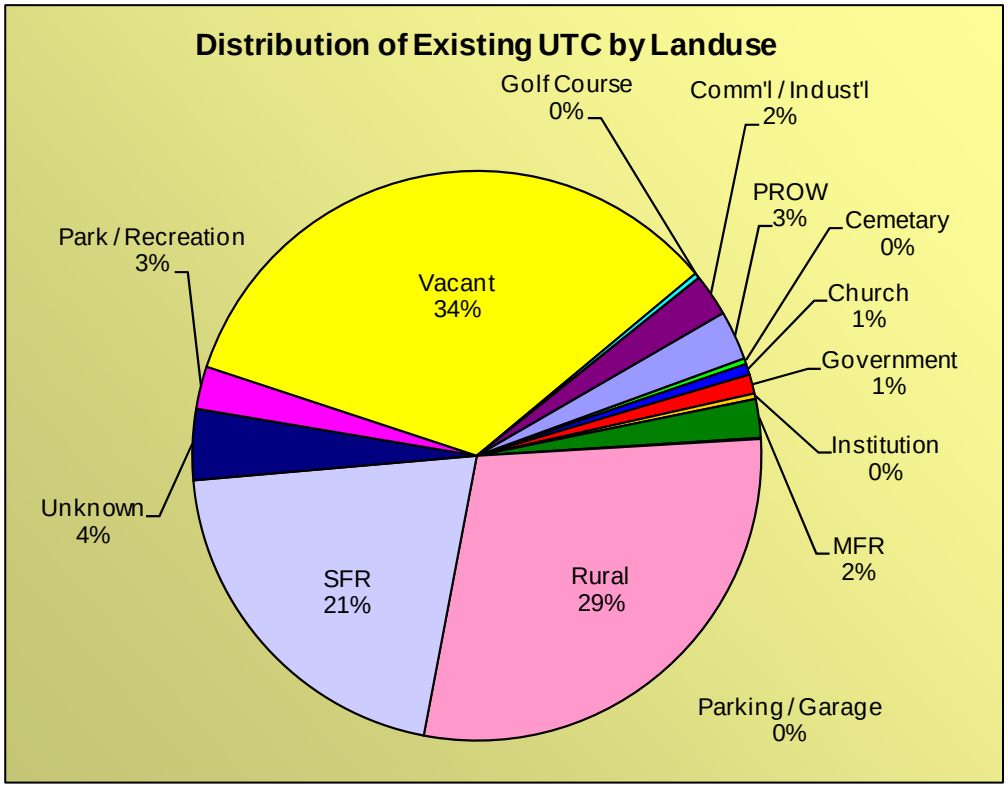
- Set canopy cover goals with landuse types

Table 4. Existing and Possible UTC Metrics Within Each General Landuse Category

Community Name	Total Acres	Acres Not Suitable	Existing UTC Acres	Existing UTC %	Poss. UTC Veg. Acres	Poss. UTC Veg. %	Poss. UTC Agric. Acres	Poss. UTC Agric. %	Poss. UTC Power Line Acres	Poss. UTC Power Line %	Poss. UTC Impervious Acres	Poss. UTC Impervious %	Total Poss. UTC Acres	Total Poss. UTC %
Cemetary	1,451	83	519	35.8	798	55.0	0	0	9	0.6	42	2.9	849	58.5
Church	3,128	347	976	31.2	1,034	33.1	0	0	47	1.5	724	23.1	1,804	57.7
Government	6,880	831	1,712	24.9	3,627	52.7	0	0	111	1.6	600	8.7	4,338	63.0
Institution	3,497	708	497	14.2	1,581	45.2	0	0	50	1.4	661	18.9	2,292	65.5
MFR	10,015	1,538	3,438	34.3	3,159	31.5	0	0	217	2.2	1,663	16.6	5,039	50.3
Parking / Garage	960	85	106	11.0	180	18.7	0	0	11	1.1	579	60.3	769	80.1
Rural	71,753	8,880	45,446	63.3	16,014	22.3	284	0.4	394	0.5	735	1.0	17,427	24.3
SFR	72,846	8,374	32,418	44.5	27,027	37.1	0	0	1080	1.5	3,947	5.4	32,053	44.0
Unknown	10,070	858	6,320	62.8	2,295	22.8	0	0	87	0.9	510	5.1	2,892	28.7
Park / Recreation	7,079	902	3,800	53.7	1,982	28.0	0	0	49	0.7	346	4.9	2,377	33.6
Vacant	79,231	14,171	53,236	67.2	10,119	12.8	0	0	354	0.4	1,351	1.7	11,824	14.9
Golf Course	2,065	595	475	23.0	924	44.7	0	0	8	0.4	62	3.0	994	48.1
Comm'l / Indust'l	24,881	5,301	3,776	15.2	6,645	26.7	0	0	304	1.2	8,857	35.6	15,805	63.5
PROW	28,560	13,018	4,383	15.3	6,381	22.3	0	0	1816	6.4	2,962	10.4	11,159	39.1

* Commercial and industrial parcels have a countywide average Existing UTC of 15.2% and 26.7% Possible Vegetation UTC

- 34% of Metro's tree canopy is in Vacant landuse ("Vacant" is comprised of vacant residential, commercial and industrial)
- 21% of Metro's tree canopy is in Single Family Residential (SFR) landuse
- 29% of Metro's tree canopy is in Rural landuse
- 3% of Metro's tree canopy is in Public Right-of-Way (PROW)



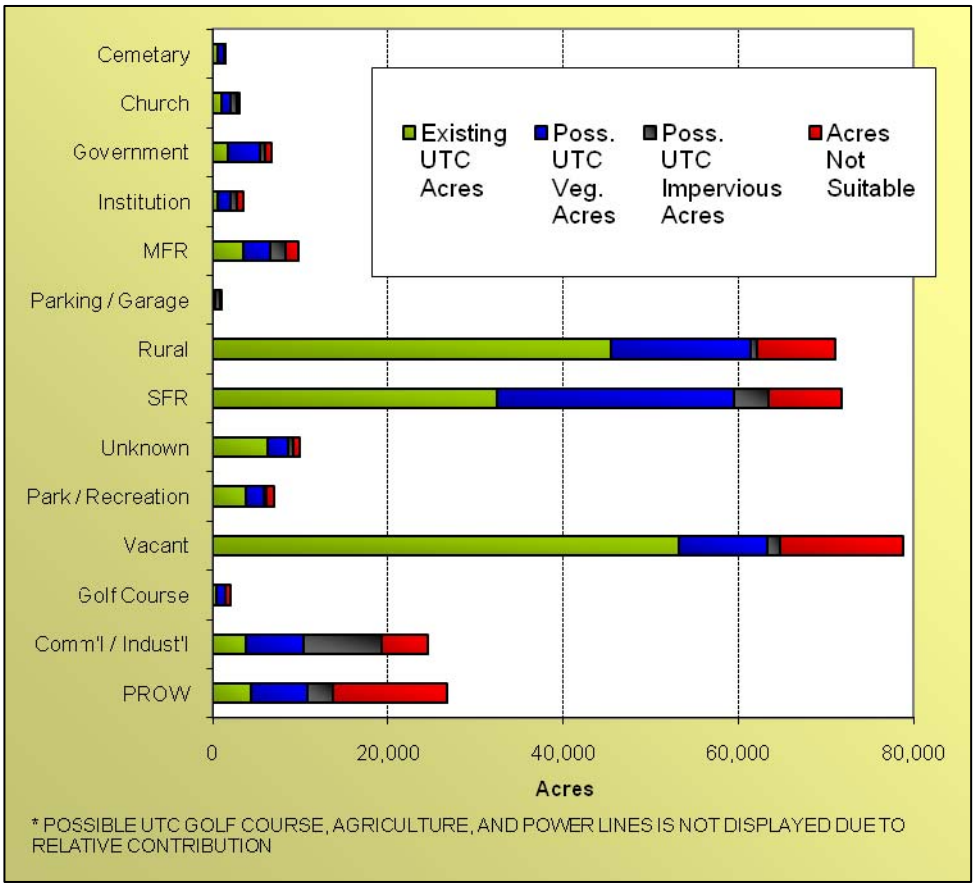


Figure 20. Acres of Existing UTC, Possible Vegetation UTC, Possible Impervious UTC and Not Suitable by General Landuse Type

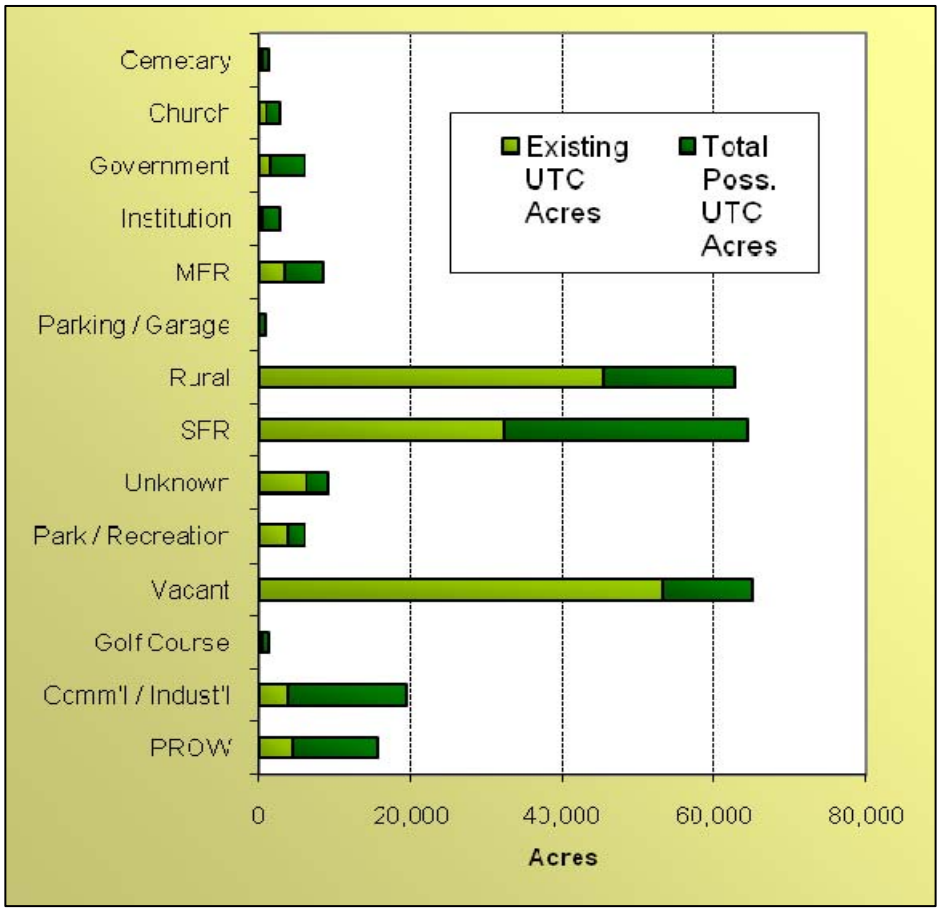
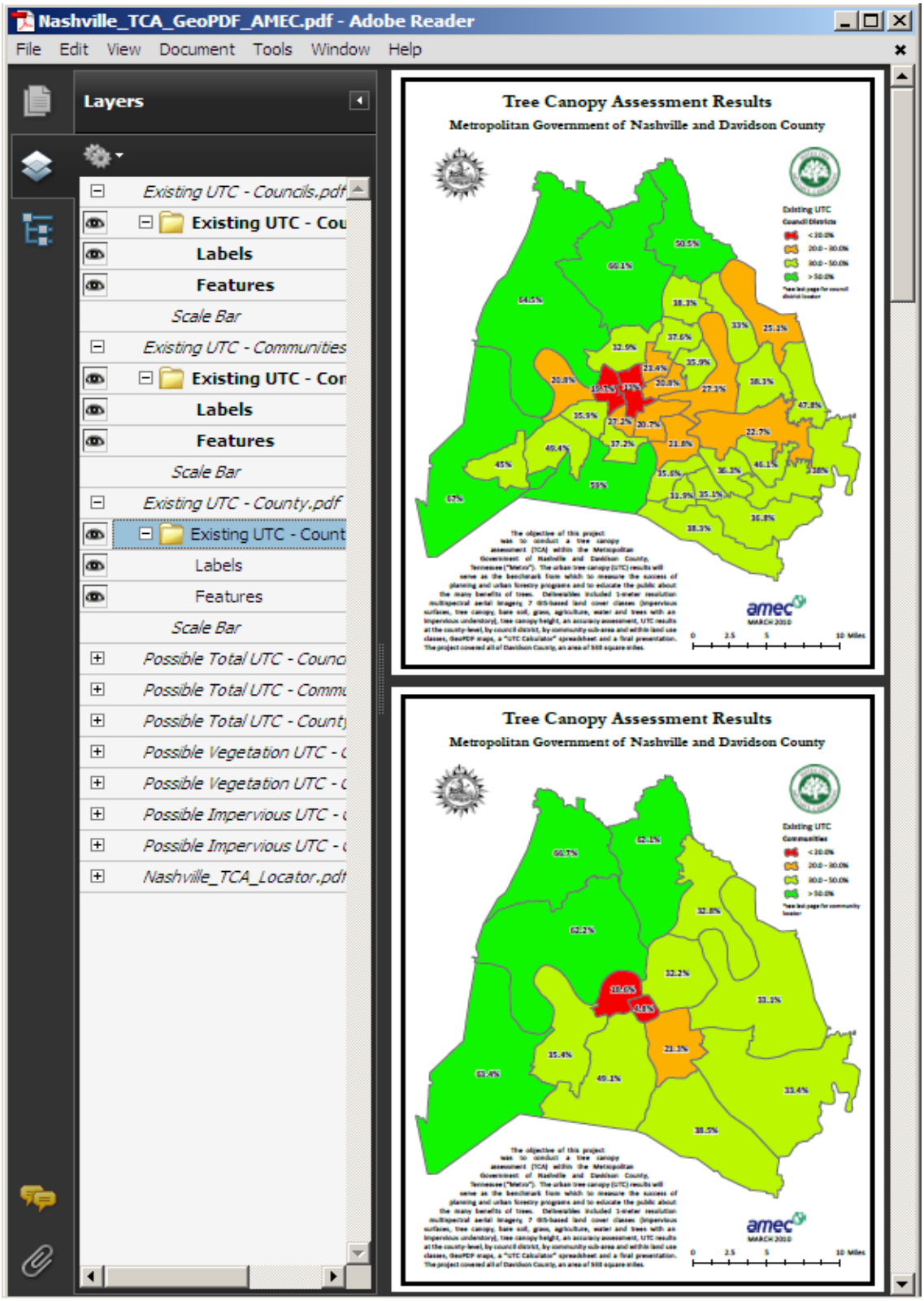


Figure 21. Acres of Existing and Total Possible UTC by General Land Use Type

Figure 22. Screenshot of the GeoPDF document, or map-based PDF, delivered to Metro that enables non-GIS users the ability to view UTC results at different scales, specifically the County, Community Sub-Areas and Council Districts, by turning each layer on and off in the PDF and clicking on an object (polygon boundary) to identify its full GIS attributes. Note that the imagery used in the land cover analysis is included as a background layer but is not visible here.



Conclusions & Recommendations

With 47% Existing UTC, Metro Nashville has average or above-average tree canopy cover compared with other metropolitan and suburban areas in the United States (see "UTC Comparison" chart in the Appendix). With this robust canopy cover, goals and objectives should focus on preserving tree canopy where it is high to maintain the ecological benefits it provides and improving or enhancing tree canopy in specific areas of the county where it is low but there is significant Possible UTC. Public/private partnerships that promote the importance of tree planting, species selection, pruning and the enforcement or strengthening of existing tree-related ordinances will result in maintained or increased UTC. These results and data products should be used by Metro Nashville and other stakeholders involved in green infrastructure development as a starting point for more detailed environmental studies, comprehensive planning, GIS analyses, targeted urban forestry implementation and continuing outreach and education programs.

The following represent opportunities for increasing tree canopy in Metro Nashville:

- Parking lots represent a major portion of most urban and suburban landscapes. In Metro Nashville, landuse categorized as "parking lot / garage" represents 960 acres however this excludes most parking lot area found within commercial and industrial properties. Regardless, this landuse has 11% Existing UTC, 18.7% Possible Vegetation UTC and 60.3% Possible Impervious UTC, implying there are significant opportunities to increase UTC over impervious surfaces even without replacing significant portions of parking lots with trees. Benefits would include a decrease in the urban heat island effect, improved infiltration, stormwater runoff mitigation, improved water quality, and improved aesthetics.
- Sorting the UTC spreadsheet by Existing UTC % and Total Possible UTC % quickly identifies council districts and community sub-areas with low Existing UTC and high Possible UTC. This provides a starting point for targeting increases in UTC at scales that are meaningful for planning and management.
- All landuse categories include significant opportunity for increasing tree canopy, however the greatest disparity may be within Commercial and Industrial properties which average only 15.2% Existing UTC but have 26.7% Possible Vegetation UTC and an additional 35.6% Possible Impervious UTC. Second to this, single family residential (SFR) property has an average 44.5% Existing UTC but 37.1% Possible Vegetation UTC, and public involvement is often the most cost-effective means to promote awareness and increase UTC.
- Metro Nashville's "Downtown" community sub-area has 4.5% Existing UTC but 16.1% Possible Vegetation UTC and an additional 31.4% Possible Impervious UTC, which is primarily comprised of paved parking lots. Tree canopy improvements could be targeted in tangent with green infrastructure initiatives to mitigate combined sewer overflows.

Other recommendations:

- An urban forest "report card" assessment could rate other criteria and indicators that are important to Metro's sustainability, including species diversity, condition, funding sources, policy, and increased public support and involvement.
- Possible UTC represents a very broad analysis while moving towards what is truly "Potential" UTC could be done using results from this project. GIS modeling rules could be developed to budget for the number and location of potential planting sites at the parcel-level and within the Public right-of-way to maintain or reach particular canopy cover goals, which could then be included in and implemented through an urban forest management plan. Individual tree planting sites could be ranked through GIS modeling and economic / environmental overlays to maximize where dollars are spent on tree planting and maintenance.
- This urban tree canopy assessment should be performed again in 5 to 8 years to monitor development and effectiveness of incentive or other programs, codes and ordinances.
- This dataset can now be data inputs for models to calculate benefits such as air quality, carbon storage & sequestration and energy savings. Metro could consider using the tree canopy assessment to conduct an U.S. Forest Service i-Tree Eco (aka, UFORE) project or a CITYgreen analysis. To address watershed health and function, more specific field and GIS-based assessments could be conducted utilizing the land cover data generated through this project to identify opportunities that provide the greatest benefit for the investment made. This could be done using the U.S. Forest Service i-Tree Hydro model or the U.S. EPA's new SMWW-5 LID and/or SUSTAIN models.

There are several benefits of UTC projects, including low cost, rapid turnaround, integration with existing GIS resources and resulting datasets that meet multiple agency and department needs. A UTC project will never replace the more detailed information collected through a traditional street tree inventory as specific species are not identified and no attempt is made to qualify the existing canopy in terms of its sustainable and diverse species. Nonetheless, it is an effective method for establishing canopy cover goals, estimating overall ecosystem services, and assessing the urban forest with results that are easily communicated with project stakeholders and the community at large.

Acknowledgements & Additional Information

Metro would like to sincerely thank the following organizations for their funding support: State of Tennessee Department of Agriculture Division of Forestry Grant, Metro Planning Department, Metro Public Works, and Metro Water Services. Additionally, this project was supported by Metro Beautification and Environment Commission, Metro Codes Department and Metro Parks and Recreation.

About AMEC Earth & Environmental, Inc.

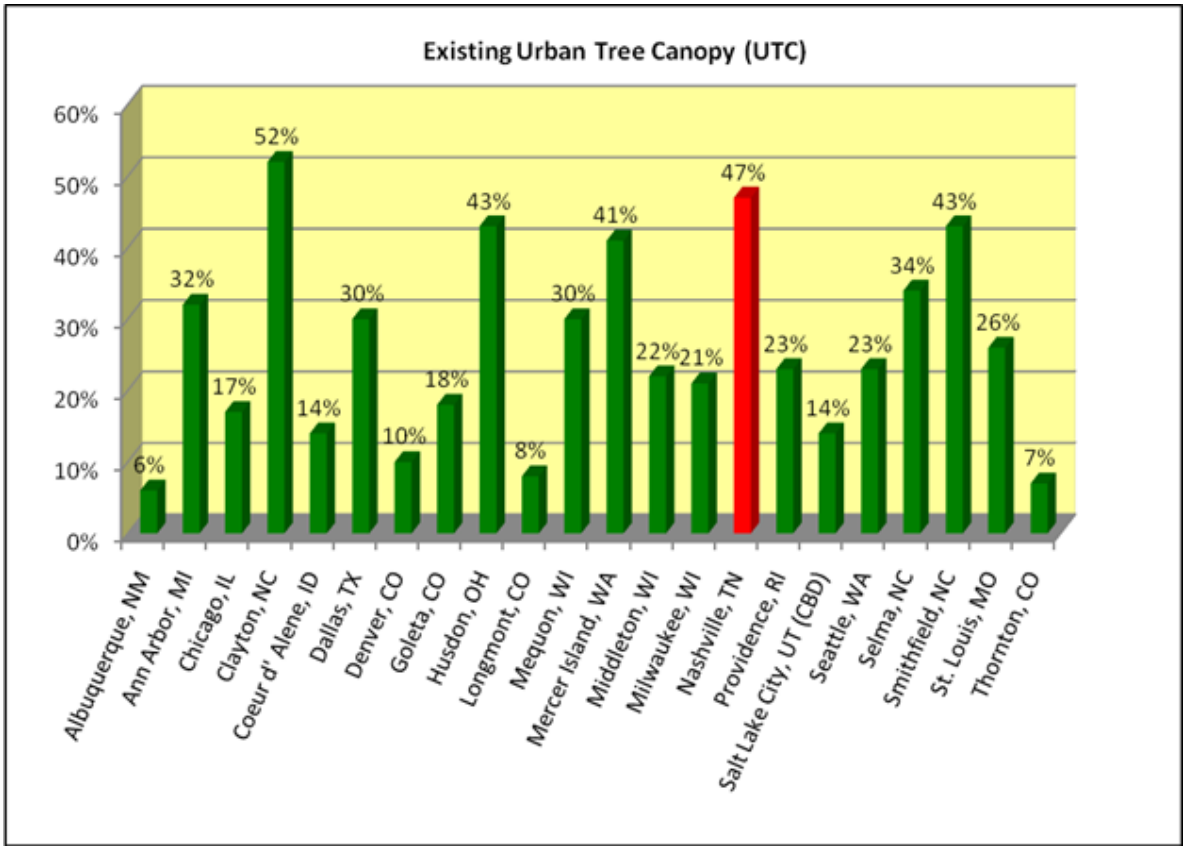
AMEC Earth & Environmental (AMEC) is a leading full-service environmental engineering and construction/remediation services firm in North America, providing environmental and geotechnical engineering and scientific consulting services. AMEC is a focused supplier of high-value consultancy, engineering, and project management services to the world's energy, power and process industries. We are one of the world's leading environmental and engineering consulting organizations. Our full service capabilities cover a wide range of disciplines, including environmental engineering and science, geotechnical engineering, water resources, materials testing and engineering, surveying, information management (GIS, remote sensing, database/application development) and program/project management.

About Magnolia River Services, Inc.

Magnolia River Services, Inc. (MRS), a certified Woman-owned Small Business, is a solutions-based company that specializes in Energy Management Solutions, Geospatial Solutions, and Infrastructure Solutions. MRS provides multi-tiered solutions to private firms along with local, state, and federal government. The company's professional solutions are designed to exceed customer expectations through premium customer service provided by sincere personal attention and careful consideration of the needs of its clients. MRS is an ESRI Business Partner with advanced experience in Remote Senisng & GIS including system management, geodatabase development/integration, GPS data collection, documentation/training, custom tools, and enterprise GIS.

APPENDIX

Comparing Existing UTC in Nashville, TN to that of other U.S. Communities



Accuracy Assessment – Standard Error Matrix

Point Accuracy Matrix		**Reference Data**				
Classification	Impervious	Soil	Tree Canopy	Vegetation	Water	*Total Row*
Impervious	37	1	1	1	0	40
Soil	2	23	0	2	0	27
Tree Canopy	1	0	26	0	0	27
Vegetation	1	0	2	37	0	40
Water	2	0	0	0	25	27
Total Column	43	24	29	40	25	**161**

Accuracy Report	Reference Totals	Classified Totals	Number Correct	Producer's Accuracy	User's Accuracy
Impervious	43	40	37	86.0%	92.5%
Soil	24	27	23	95.8%	85.2%
Tree Canopy	29	27	26	89.7%	96.3%
Vegetation	40	40	37	92.5%	92.5%
Water	25	27	25	100.0%	92.6%
Totals	161	161	148	Omission Offset	Commission Offset

Overall Point Accuracy	
Impervious	92.5%
Soil	85.2%
Tree Canopy	96.3%
Vegetation	92.5%
Water	92.6%
Total Accuracy	***91.9%***

Overall Tree Canopy Area Accuracy	
Digitized Tree Canopy Acres	29.243
Derived Tree Canopy Acres	30.5309
Tree Canopy Accuracy	95.8%

UTC Metrics per Council District Focusing on the Public Rights-of-Way (PROW)