Spatial Analysis of Stream Buffer Setbacks for the Texas Hill Country

Background

The Texas Hill Country Alliance (HCA) is a non-profit group working to develop a strategic and responsible regional growth plan that reflects their expertise and ideas of land stewardship. A major focus for HCA has been their involvement in creating the *Regional Water Quality Protection Plan for the Barton Springs Segment of the Edwards Aquifer and Its Contributing Zone**. This plan (RWQPP) is a comprehensive guide for the "protection of surface and ground water, outlining model ordinances and suggested development rules." HCA is currently analyzing the feasibility of RWQPP implementation across the Texas Hill Country as part of a comprehensive sustainable growth plan.

*Resource:

Naismith Engineering, Inc. 2005. *Regional Water Quality Protection Plan for the Barton Springs Segment of the Edwards Aquifer and Its Contributing Zone*. Regional Water Quality Planning Office Dripping Springs, TX. http://www.waterqualityplan.org/index.php?BODY=finaldraft (last accessed 16 Feb 2009).

Objective

PAKK's objective was to employ GIS capabilities for illustration and measurement of land area identified by stream buffer guidelines expressed in the RWQPP. The cartographic output provided by PAKK, in addition to data and analysis results, will be utilized by HCA and future GIS analysis teams in continuing to gather and aggregate stakeholder input that will prepare them to embark on a full build-out landuse map. The goal of our project was to construct general overview maps. This executive overview was intended to provide the approximate land area identified by the RWQPP stream setback buffer zone when applied at its greatest extent. The particular guideline PAKK followed stated that a 300 ft. buffer on each side of the centerline of the stream (or 600 ft. wide) be applied in relation to a contributing area of greater than 640 acres. The overview maps will also assist HCA in facilitating discussions of the many criteria to consider in urban and rural growth planning. The geographic scope, in regard to the stream buffer analysis and land area calculations, was a 17 county area of the central region of Texas called the Hill Country.

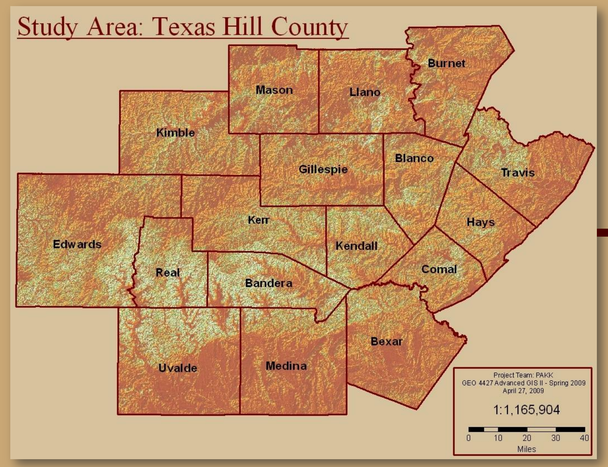
Methods

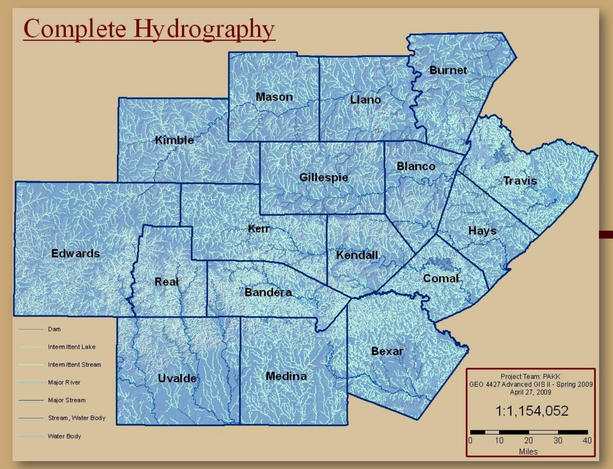
PAKK created a GIS model to streamline and standardize output for analysis in relation to stream buffer creation and land area calculations. Several test runs of the model were executed and adjustments made as needed to ensure the most accurate results possible. In conjunction with the model runs, test maps were produced, which provided a preliminary sample of how the cartographic output would be illustrated.

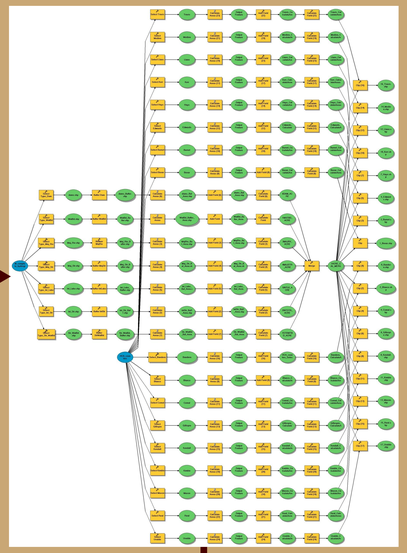
In the process of preparing the complete hydrography data layer for use in our GIS model, we encountered a few challenges. The hydrography layer was not consistent in its portrayal of water features. The water features were digitized into multiple line segments to represent one feature. No topology was defined in the hydrography data, hence no network connectivity between segments exists. That is, one stream could consist of multiple segments (e.g., West Bear Creek has eight segments), but when displayed in a GIS, appear as a continuous line feature. Another related issue was that some hydrography features were illustrated as single lines (e.g., intermittent streams) but others were depicted with double lines (e.g., the Colorado River). Time constraints and lack of data topology precluded extremely precise application of the stream buffer guideline.

In order to address these concerns, PAKK created separate layers for each of the seven feature types in the original hydrography data layer. This enabled us to determine to what extent these issues existed within the data. The intermittent stream features consisted of only single line segments. This layer represented over 80% of all water feature types. The water bodies, stream water bodies, major streams, dams, and intermittent lake feature types consisted of mixed single and double line representations; one major river is represented with double lines.

Buffers were produced for each representative line of the hydrography. These buffered areas were dissolved in order to create a single polygon for each of the seven types of hydrography for which areas were calculated. For features made up of single line segments, the line functioned as the stream centerline and the 300 ft. buffer was applied to each side for a total width of 600 ft. For the few features that were represented by double lines, the 300 ft. buffer was applied to each of the lines, resulting in a somewhat wider buffer with the inclusion of water area in the buffer. When the data layers were displayed at a county-wide scale, the inconsistencies were not conspicuous; however, the acreage calculations were slightly skewed toward a larger amount. It is our opinion that this skewed amount was negligible. The buffers were then merged back into one layer for calculations, which was one example of how utilizing a model assisted us.





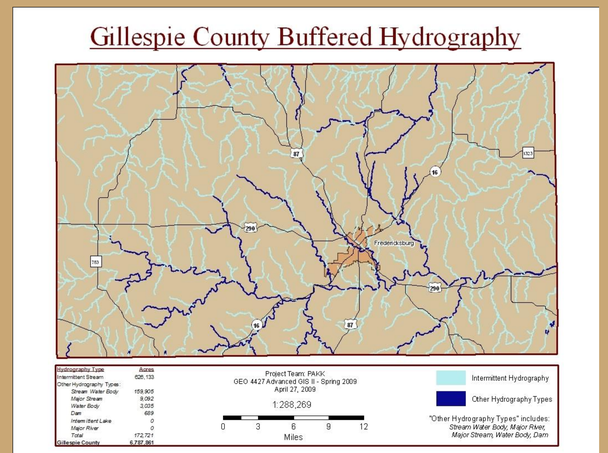


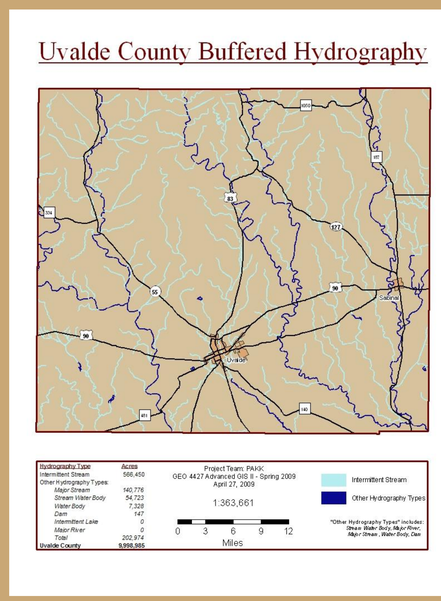
Model Explanation

The numerous repetitive steps required for this project necessitated the creation and utilization of a GIS model as a primary analysis tool.

Model's Functional Steps:

- Select and create layer for each of the 7 hydrography types.
- Apply 91.44m (300 ft) buffer to each line segment
- Dissolve each type to create individual polygons and calculate their areas
- Select, clip, and calculate acreage for each of the 17 Hill Country counties
- Clip the complete buffered hydrography to each county
- Formula for conversion of calculated area: **(square meter) x (.00247105) = Acre**





Results

PAKK produced general overview maps for each of the 17 Hill County counties. Three of the maps, Gillespie, Uvalde and Llano Counties, have been included here as representative examples of the final cartographic products. In addition to the maps, PAKK calculated land area for counties and stream setback buffers.

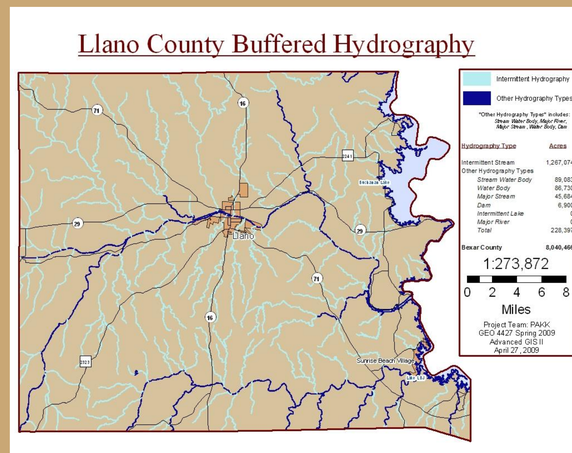
Results of the land area calculations performed are provided in the table below. The first column lists each of the Hill County counties in alphabetical order with the second column containing the total county area. The third through ninth columns provide the buffered area in acres for each of the seven types of hydrography features. The last column gives the total buffered area per county, which may be considered incongruous for well-planned sustainable development.

	County Area (Acres)	Stream Water Body (Acre)	Intermittent Stream (Acre)	Intermittent Lake (Acre)	Major River (Acre)	Major Stream (Acre)	Dam (Acre)	Water Body (Acre)	Complete Hydrography (Acre)
Bandera	5,101,079	92,697	744,012	0	0	26,625	2,423	44,890	910,647
Bexar	8,040,466	89,083	1,267,074	0	0	45,684	6,900	86,730	1,495,471
Blanco	4,564,994	50,739	433,135	0	0	62,501	137	36	546,548
Burnet	6,526,667	118,786	619,879	0	1,304	8,611	2,013	122,142	872,734
Comal	3,678,186	56,454	639,772	0	0	40,787	1,384	6,390	744,788
Edwards	13,566,468	19,692	1,159,041	0	0	12,491	0	0	1,191,223
Gillespie	6,787,861	159,905	626,133	0	0	9,092	689	3,035	798,855
Hays	4,340,657	58,064	575,116	0	0	49,252	2,757	12,422	697,611
Kendall	4,239,714	57,231	412,104	1,487	0	40,359	1,378	5,675	518,234
Kerr	7,081,019	88,752	928,300	0	0	33,534	1,834	9,300	1,061,721
Kimble	7,994,578	6,823	681,490	0	0	45,364	0	913	734,590
Llano	6,180,573	79,985	484,671	0	0	26,329	89	87,617	678,691
Mason	5,970,617	27,319	540,130	0	0	32,762	0	0	600,211
Medina	8,550,764	40,772	1,000,527	0	0	21,811	1,256	38,410	1,102,776
Real	4,476,585	22,385	376,707	0	0	21,644	0	0	420,736
Travis	6,556,080	147,337	1,219,365	0	30,651	18,752	2,527	140,079	1,558,711
Uvalde	9,998,985	54,723	566,450	0	0	140,776	147	7,328	769,424
Buffered Hydrography Total/ Type	113,655,291	1,170,747	12,273,907	1,487	31,955	636,374	23,536	564,968	14,702,973

Conclusion

The maps produced have identified areas of land sensitive to development that may aid in municipality implementation of stream setback buffer guidelines set forth in the RWQPP. Many municipal areas are in close proximity to streams and rivers, so the analysis is needed not only as a starting point for a plan, but also to educate communities regarding their sensitive locations. In the future, full-scale zoning and potential growth maps will supplement the buffer analyses and be utilized for zoning areas of more specificity, such as residential, commercial, and industrial development.

PAKK hopes that our cartographic results have offered HCA an opportunity to spatially view sensitive areas that can be protected during the projected population booms in the next 30-60 years. The final product of the project will assist HCA, other concerned citizens, and local advocacy groups in the future delineation and implementation of the RWQPP. The realization of such a plan in conjunction with other regulatory forces will serve to smooth the progress of a rapidly growing area in the protection and utilization of limited natural resources, particularly water.



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GEO 4427
Spring 2009
Advanced GIS II

PAKK

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