Risks of Atrazine Use to Federally Listed Endangered Barton Springs Salamanders (Eurycea sosorum)

Attachment C: Supporting Information for the Scenario Development

August 22, 2006

ATTACHMENT C: Supporting Information for the Scenario Development

INTRODUCTION

EFED initiated an effort to develop a suite of new PRZM/EXAMS scenarios useful for all six chemicals in the Barton Springs endangered species lawsuit including atrazine, simazine, prometon, metolachlor, diazinon, and carbaryl. EFED initiated an evaluation of the potential use sites relevant to all six chemicals for development as possible modeling scenarios. The evaluation consisted of an investigation of geology, hydrogeology, land cover data, use information, soils information, and conversations with local experts knowledgeable in all of the above.

Initial investigation indicated that the geology and hydrogeology are the defining issues surrounding how the action area for each chemical would be defined. As noted in the atrazine assessment, the action area for the development of the Barton Springs Scenarios was comprised of three hydrologic zones (in order of importance) of the Barton Springs Segment of the Edwards Aquifer: 1) the recharge zone which consists of a fractured karstic geology, 2) the contributing zone where surface runoff may flow to the recharge zone, and 3) the transition zone which has a remote potential to contribute to the recharge zone (http://www.edwardsaquifer.net/intro.html). Although the transition zone was considered in this assessment, primary emphasis was given to the recharge zone with secondary emphasis on the contributing zone.

Investigation indicated that areas to the east of the Recharge Zone might not be relevant to the assessment (groundwater flow to the Barton Spring system comes either directly from transport through the Recharge Zone, which occurs generally south to north, or indirectly via the Contributing Zone/Recharge Zone interaction where flow is dominantly west to east). For example, agricultural uses lying east of the Recharge Zone (roughly defined by the Interstate 35 corridor) can be considered outside the area of interest and no scenario need be developed for this use. However, if any of the uses are present west of this area within either Recharge or Contributing Zones, then these scenarios should be developed as described below.

Given these facts it was quickly decided that any new scenarios developed needed to be based on the extent of the potential action area for each chemical. In general, this action area consists of three zones identified above including the Contributing Zone, the Recharge Zone, and the Transition Zone. Primary emphasis for scenario development was placed on use sites (both agricultural and non-agricultural) within the Contributing and Recharge Zones. No scenarios were parameterized based solely on the transition zone. Spatial data containing the Hydrozone boundaries were obtained from the Barton Springs/Edwards Aquifer Conservation district (ftp://www.bseacd.org/from/HCP Shape Files/).

These new scenarios were developed under contract with specific guidelines on how to evaluate the need for a scenario and how to parameterize the scenarios that were developed. The process involved numerous interactions between the contractor and EFED and ultimately all decisions on which scenarios to develop were the responsibility of EFED. If the contractor determined that a particular use site is likely to be outside the area of interest and not likely to contribute to the

exposures in Barton Springs a written description of the steps taken to determine this and rational for the exclusion was documented and is discussed in the sections that follow.

The following sections discuss the various data sources used in this assessment and ultimately provide a rational for the development of each scenario. Note that not all scenarios were used in each assessment but were selected based on specific analysis of each chemical labeled uses and an understanding of which uses are actually present in the action area for each chemical. In the case of atrazine, the scenarios ultimately used in the assessment were one agricultural site (fallow/idle land using the meadow scenario) and three non-agricultural uses including residential, turf and rights-of-way.

SOURCES OF DATA

Land use data

The contractor obtained two land use coverage's from the city of Austin (COA) and the Texas Commission on Environmental Quality (TCEQ). The land use data were important for quantifying the extent of a particular land use and for identifying representative, yet vulnerable soils. The data set from Austin includes land use by tax parcels and was particularly important for the turf (golf courses) and right-of-way scenarios. The TCEQ dataset developed by the USGS (2003) provided agricultural land cover data, including areas representative of meadows and rangelands, and residential areas. Based on a review of the data, residential areas appeared better classified in the USGS (2003) data set; the COA data set tended to include all lots zoned for residential and often included areas well outside of where pesticides would presumably be applied. Abstracts from the metadata of the two land cover data sets are included below.

COA land use data set: "From October 2003 until December 2004, the City of Austin Watershed Protection and Development Review Department (WPDR) and the Transportation Planning and Sustainability Department (TPSD) produced this land use and tax parcel inventory. The extent of the data includes the watersheds of Travis, Hays, Williamson, and Blanco County that drain into Austin city limits. This includes the City of Austin extra-territorial jurisdiction. The layer is used in watershed, land use, and transportation modeling. More specifically, the information will be used to estimate and forecast impervious cover, population and housing density, and land use change. Parcels were created to reflect 2003 tax maps by either updating year 2000 parcel polygons, or converting and attributing lot lines from the City base map or county appraisal district CAD files. After completing parcel polygons, appraisal district land use data was joined to the layer using the parcel identification number. In addition, historical land use data was joined through GIS overlays. We then coded land use by comparing appraisal district data to the historical data where possible. The land use coding system used in year 2000 data was expanded to reflect the needs of both the planning and watershed management disciplines and the availability of new data. Infrared and color aerial photos were used to confirm or make determinations, especially where data was unavailable or questionable. Other GIS layers such as buildings and parks were used in this verification process." (COA 2003)

USGS (TCEQ) land use data set: "This layer delineates the land use/land cover (LULC) polygons for the Edwards Aquifer Project in Texas from the years 1995 and 1996. Attribution of the polygons is based on a modified Anderson classification schema. LULC classification was

done to Level 3 of the classification schema and a new category of Mixed Forest/Shrub was added to better represent the land cover of the area. Fieldwork was performed prior to compilation to gather local data and relate aerial photo images to corresponding ground features. Because of the stunted or lower tree growth common in this region it was difficult at times to differentiate between Forest, Mixed Forest/Shrub, and Shrub. It should be noted that much of the Planted/cultivated land is highly managed pastureland. A detailed description of the schema can be found in the Supplemental Information Section. All the LULC data was collected from color infrared DOQQs and high-resolution (1:40,000-scale) aerial photography. The minimum mapping unit used for delineating a polygon is 5 acres and the minimum polygon width is 125 feet." (USGS 2003)

Soils data

Data for Hays and Travis counties were downloaded from Soil Data Mart (USDA 2006) and clipped to the hydrozones of the BSS AOI (ftp://www.bseacd.org/from/HCP Shape Files/). EFED indicated that scenarios should be parameterized based on representative soils that will yield high-end runoff and sediment values. Specifically, this focused on Hydrological Group C and D soils with high erodibility and slope. Quantitative descriptions of the soil selection process are provided in the metadata for each scenario with additional detail provided in later sections of this report.

Official soil series descriptions (OSD) of the selected soils were used to characterize the soils of interest for the scenarios (Soil Survey Staff 2006a, b). Soil parameters were obtained from USDA Soil Data Mart (USDA 2006).

Additional Data Sources

When exploring the extent of agricultural areas in the AOI, areas of crops grown in Hays and Travis counties were obtained from NASS (USDA 1997, 2002). This was used as a preliminary attempt to understand the types of crops grown in the AOI and their respective magnitudes.

City and County officials and extension agents were contacted to understand and verify correct parameters to represent each of the scenarios that were developed.

In cases where similar PRZM scenarios were available, parameters were reviewed for consistency. Specifically, the BS turf scenario was compared to the PA turf and FL turf scenarios.

For determination of USLEC and Manning's N values, the RUSLE EPA Pesticide project (2000) was used. Existing files were considered according to current USEPA guidance (USEPA 1998). The Barton Springs area is located in Land Resource Region (LRR) I. The San Antonio climate station is located within this LRR and is an appropriate location for which to select appropriate RUSLE data files. Available crops for this climate station include: 1) Range, 2) Pasture, warm season, 3) peanut, Spanish, 4) Sorghum, grain, and 5) Wheat, winter. For scenarios where appropriate files did not exist (i.e. impervious surfaces), appropriate values were selected to represent USLEC and Manning's N values.

Curve numbers were derived based on USDA TR-55: Urban Hydrology for Small Watersheds document (USDA 1986) or from the GLEAMS (USDA 2000) manual when appropriate. Further details are provided in the metadata for each scenario.

CONCEPTUAL MODELS OF DEVELOPED SCENARIOS

Residential

This scenario intended to be used as a surrogate for all urban/suburban home and residential uses in the Barton Springs Segment (BSS) of the Edwards Aquifer. The intention is to couple the edge of field concentrations from this scenario with the edge of field concentrations from the impervious surface scenario for Barton Springs to generate weighted concentrations for areas of varying impervious cover. Crop parameters have been chosen to reflect residential turf areas, primarily lawns, within the BSS.

For this scenario estimates of typical impervious fractions in suburban watersheds were obtained from a City of Austin COA (2002) report for the COA jurisdictional section of the Barton Springs Segment (BSS) and from local runoff studies obtained from the COA. Within the city of Austin Jurisdiction of the Barton Springs Zone approximately 7.5% or 5098 acres consists of impervious surfaces. Within the recharge zone, the city of Austin restricts impervious cover for new development to 15% of the net site area and 20% of the site area in the Barton Creek contributing zone (COA, 2002). However, based on unpublished data obtained from the City of Austin some residential watersheds in the area may be as high as 40% (Rich Robinson, COA, personal communication).

The analysis of land cover information is provided in Figure 1. A conceptual model of this approach is provided in the assessment

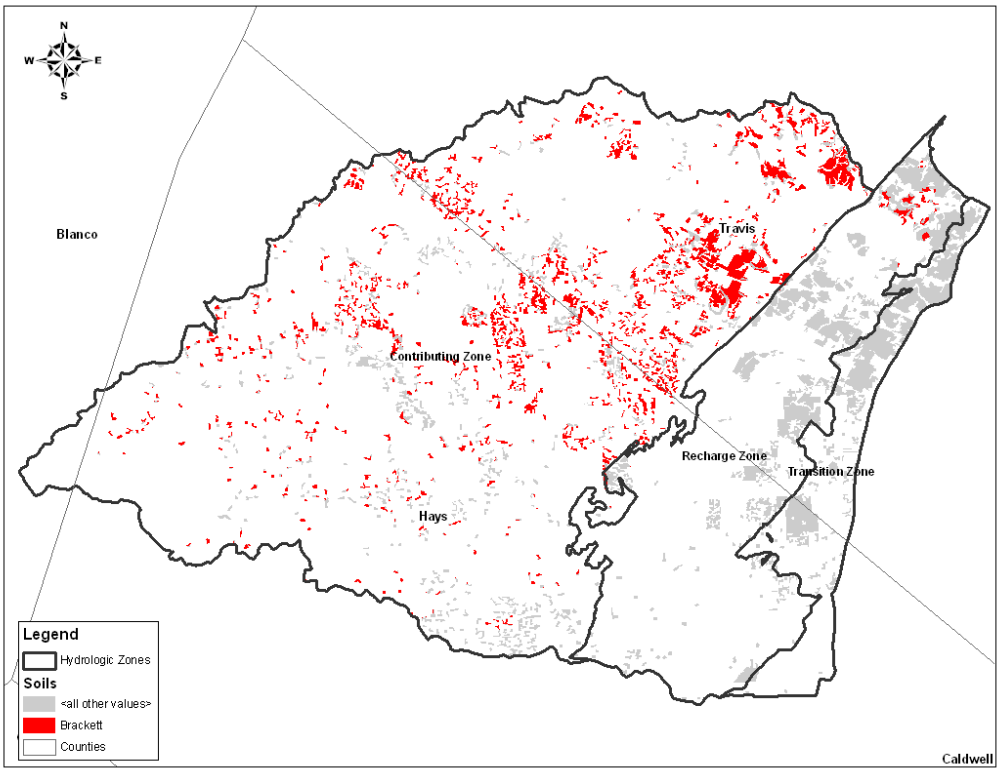

Figure 1. Location of Brackett Soils in single- and multi-family residential areas of the Barton Springs Segment of the Edwards Aquifer, Hays and Travis Counties, Texas.

Impervious

This scenario is intended to be used to mimic hydrology of untreated portions of the Barton Springs Segment (BSS) of the Edwards Aquifer. The intention is to couple the edge of field concentrations from this scenario with the edge of field concentrations from the residential scenario for Barton Springs to generate weighted concentrations for areas of varying impervious cover. Therefore, this scenario relies on a similar soil series as the residential scenario; however the upper horizon has been adjusted to a non-soil nature. As noted above, data indicate that impervious fractions of residential areas in the BSS range from less than 10% (COA 2002) to as high as approximately 40% (Rich Robinson, COA, personal communication). The analysis of land cover information is provided in Figure 2.

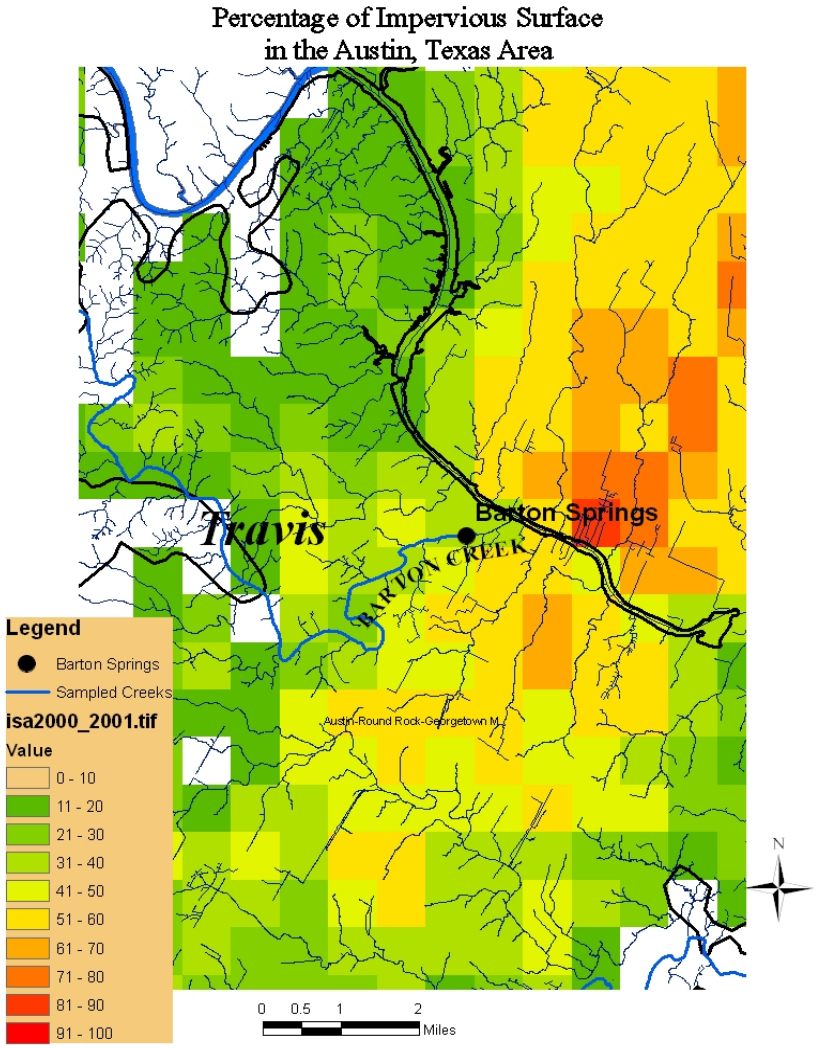

Figure 2. Percentage of Impervious Surfaces near Barton Springs.

Turf

This scenario is intended to represent turf areas (golf courses, parks, sod farms, and recreational fields) in the Barton Springs Segment (BSS) of the Edwards Aquifer. Because golf courses are expected to be the most likely turf areas where pesticides may be applied, much of this scenario has been parameterized to be reflective of golf course turf. NASS data for 1997 and 2002 (USDA 1997, 2002) contained no record of sod harvest in either Hays or Travis counties. Since there are several golf courses located within the BSS (COA 2003), this scenario was parameterized to represent turf on golf courses and may be generally representative of other potential turf areas. Crop parameters are based primarily on bermudagrass (*Cynodon* spp.) since it is a primary turf grass for golf courses and athletic fields. The analysis of land cover information is provided in Figure 3.

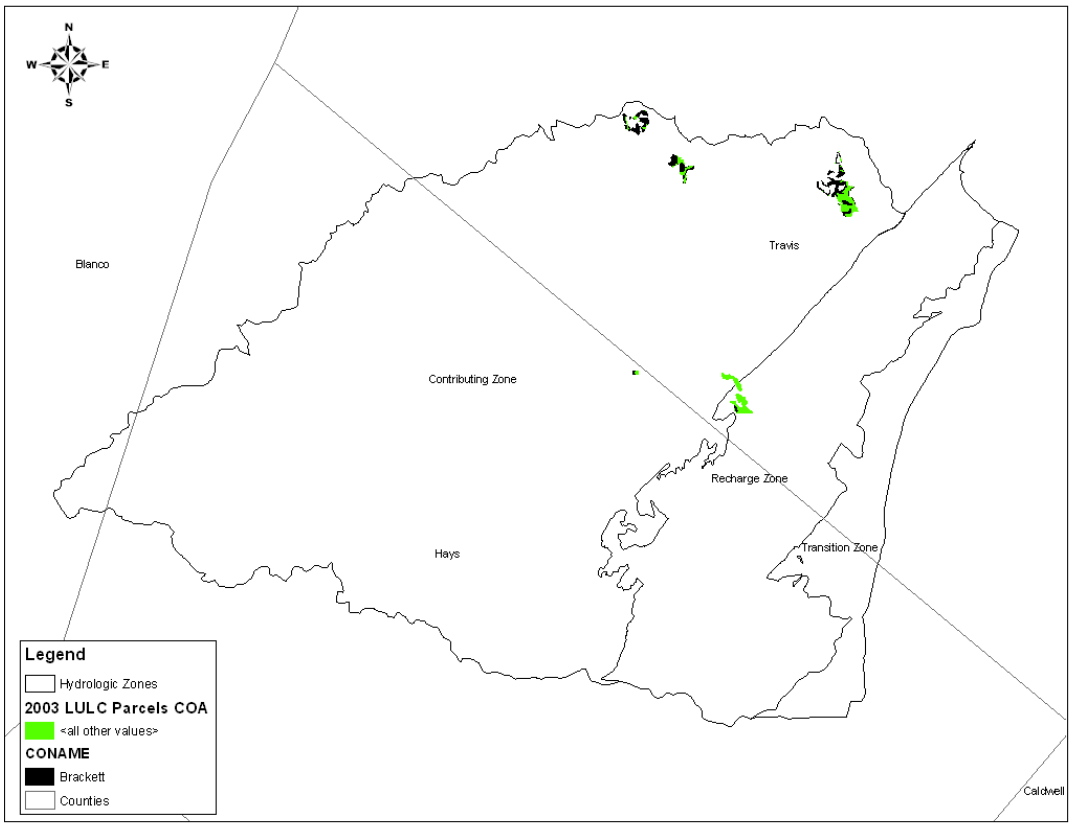

Figure 3. Location of Brackett Soils in golf course areas of the Barton Springs Segment of the Edwards Aquifer, Hays and Travis Counties, Texas.

Right-of-Way

This scenario is intended to represent right-of-way areas including roads, fence lines, power lines, and railroads in the Barton Springs Segment (BSS) of the Edwards Aquifer. Unlike most of EFED existing scenarios, the scenario is conceptually different in that it represents a linear surface that drains into an adjacent water body (drainage ditch). However, for this exercise, EFED assumes that while conceptually different, the scenario is for practicality purposes developed in a similar manner as a standard scenario that assumes a 10-hectare field draining into a 1-hectare static pond.

Crop cover parameters for this scenario were based on typical plants found adjacent to state maintained highway right-of ways. State-maintained highways include farm-to-market (FM) roads, state highways, interstates, and US highways. Bermuda grass is typically found in right-of-way areas in urban areas, while rural areas are dominated by native species such as little bluestem, side-oats grama, and hairy grama (John Mason, Vegetation Management Specialist, Texas DOT, Maintenance Div., personal communication).

The contractor attempted to determine where pesticides may or may not be applied to Right-Of-Ways (including highway/railroad/utility segments). COA was not aware of a source for this information (Nancy McClintock, personal communication). According to Texas Department of Transportation (TX DOT), Vegetation Manager Dennis Markwardt, the TX DOT applies herbicides only (no insecticides) to all of its state roadways. They only apply herbicide to a one-foot wide area along the roadway, not the entire right-of-way. They also limit the use of herbicides within the BSZ to mainly Round-Up, and to a more limited extent, Oust, OutRider and Escort. Occasionally they will need to apply spot treatment to noxious weeds.

According to Travis County Transportation and Natural Resources, Road and Bridge Division Maintenance Manager, Don Ward, Travis County applies herbicide only to their rural roads where there is no curbing gutter. They apply only Round-Up and apply it to a four foot wide area along the roadway approximately two times per year. Scott Lambert provided us with a GIS layer of the Travis County roads where herbicide may be applied. The analysis of land cover information is provided in Figure 4.

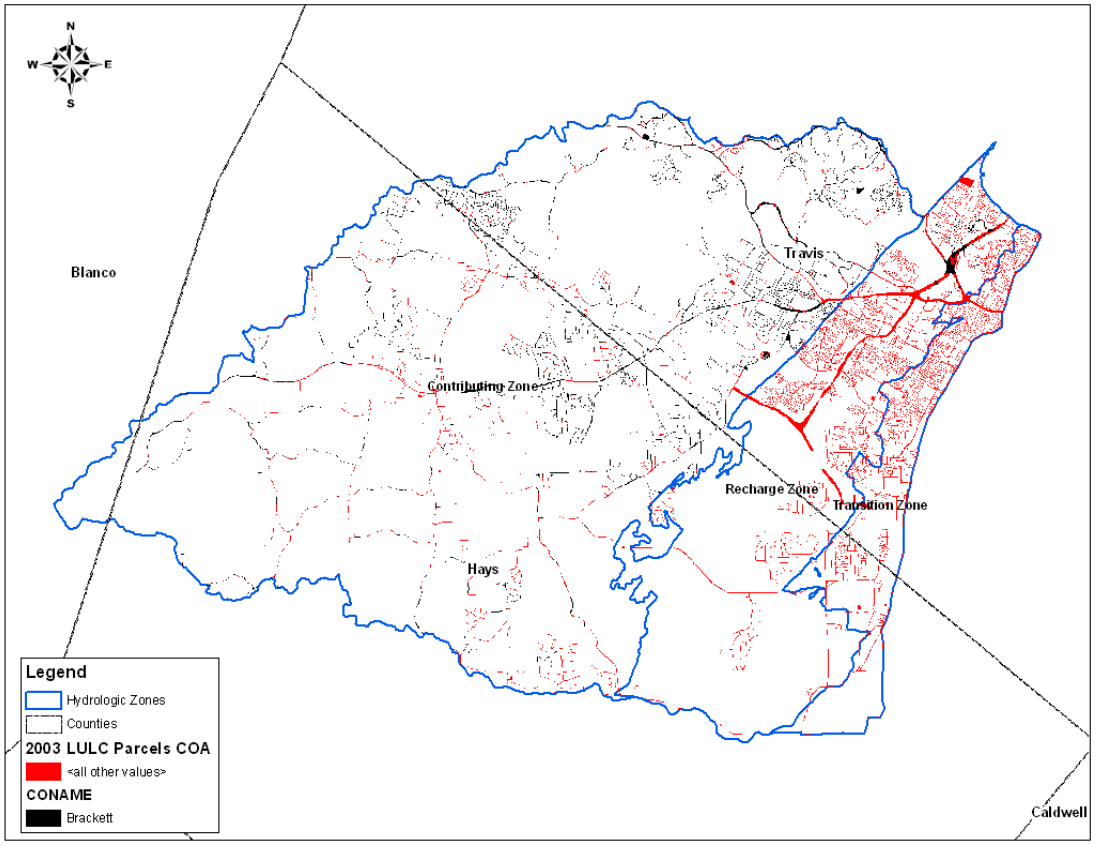

Figure 4. Location of Brackett Soils in right-of-way areas (streets/roads/railroads/utilities) of the Barton Springs Segment of the Edwards Aquifer, Hays and Travis Counties, Texas.

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Rangeland/Pastureland

In the BSS, rangeland vegetation is a heterogeneous mixture of trees and grasses. Common tree species include: ash juniper (a nuisance species), oaks, hackberry and elms. Grass species including little blue stem, side oats gramma, Indian grass, switch grass, king ranch bluestem (introduced) and kline grass (introduced) are typical. These areas are composed of approximately 60-65% trees and 30-35% grasses (Perez 2006). Although this land cover contains a significant amount of tree cover, this “crop” was modeled as a field crop rather than an orchard in order to model a more conservative field. The analysis of land cover information is provided in Figure 5.

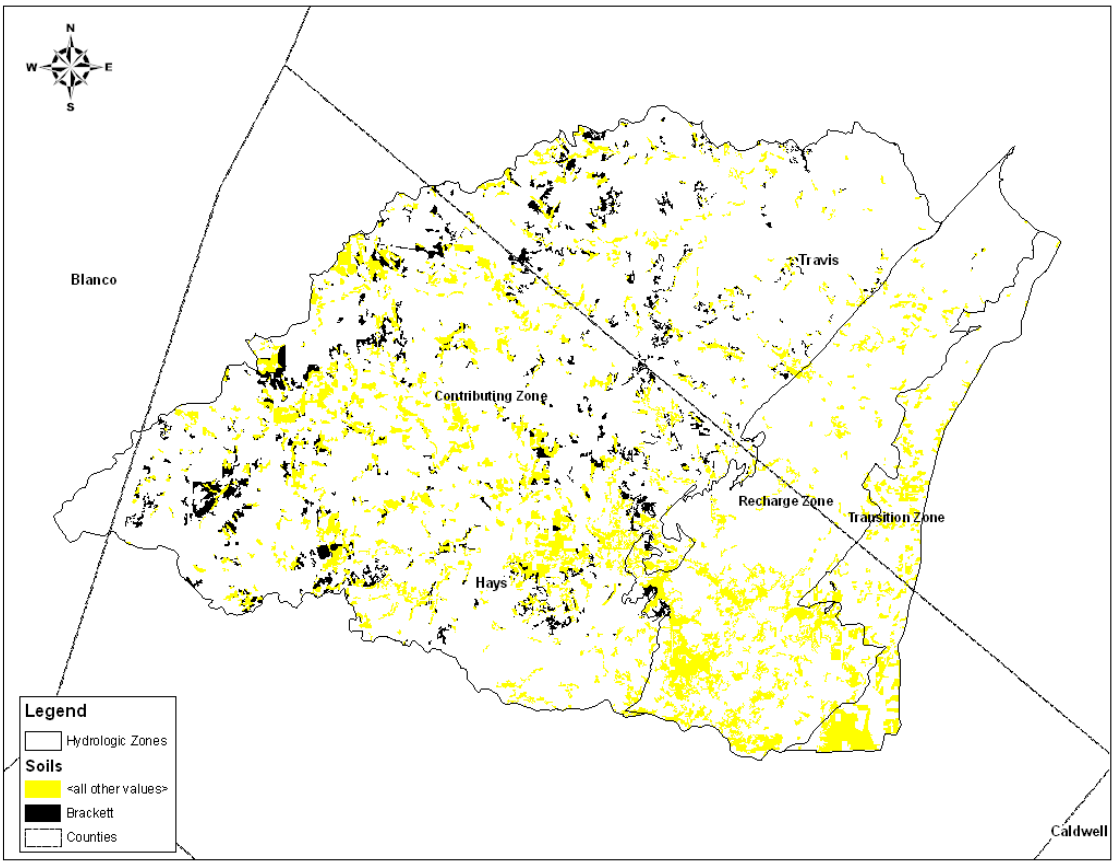

Figure 5. Location of Brackett Soils in natural herbaceous areas of the Barton Springs Segment of the Edwards Aquifer, Hays and Travis Counties, Texas.

Meadow

This scenario is intended to represent a meadow that may include cultivation of herbaceous, non-grass animal feeds (forage, fodder, straw, and hay) (IR4 generalized crop group #18). The USDA census of agriculture (USDA 1997, 2002) indicates that hay of varying types is grown extensively in Travis and Hays Counties (Table 6). Discussions with extension agents in Hays and Travis counties indicated that some cultivation of sorghum hay, and hay grazer, or sweet sorghum does occur in the Barton Springs Segment. Bermuda grass is also planted but is primarily for grazing and not harvested (Perez 2006). Most of this type of crop is for livestock grazing (Davis, 2006). The analysis of land cover information is provided in Figure 6.

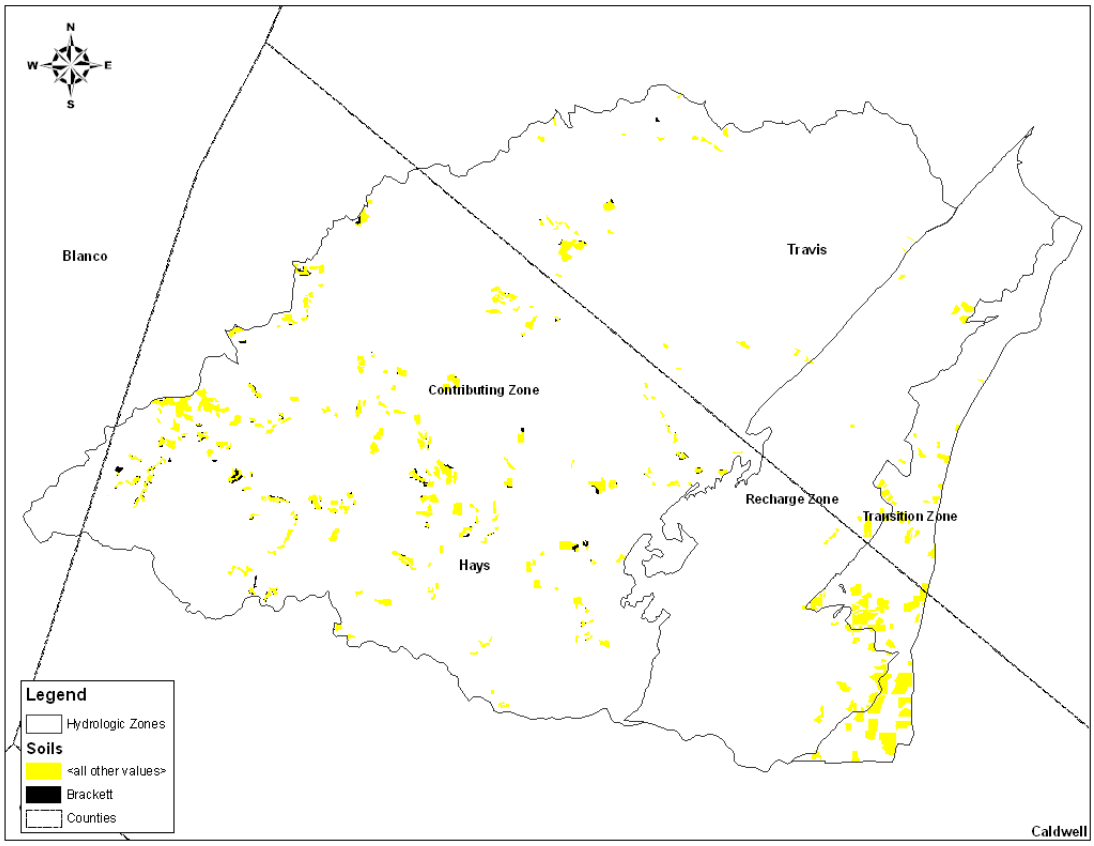

Figure 6. Location of Brackett Soils in planted/cultivated areas of the Barton Springs Segment of the Edwards Aquifer, Hays and Travis Counties, Texas.

Outdoor Nursery

The contractor conducted an investigation of wholesale nurseries in the BSZ using a variety of data sources to determine the extent of nurseries in the BSZ and the potential for *outside* pesticide use. NASS data for 2002 (**Table 1**) indicate that *outside* acreage for reported ornamental crops in all of Hays and Travis Counties is negligible relative to indoor acreage (< 0.1% total indoor and outdoor acreage). The majority of acreage for nursery, greenhouse, floriculture, mushrooms, sod, and vegetable seeds in both years and both counties was grown under glass or other protection. The contractor conducted a refined investigation to determine if this trend was similar in the BSZ.

Initially, nurseries in BSZ were identified through the Texas Nursery and Landscape Association Growers List, "Austin at a Glance Local Business Search", and Google Local Maps. Five potential wholesale nurseries in the BSZ were identified. The contractor confirmed the existence of these nurseries and the potential for other through sources in the City of Austin Watershed Protection and Development Review Board (Kathy Shay, personal communication) and the Ladybird Johnson Wildflower Center (Andrea DeLong-Amaya, personal communication). Both sources confirmed these nurseries and neither source was aware of additional nurseries in the BSZ that would have outdoor wholesale nursery production. The contractor then contacted each

of the five nurseries identified to determine the extent of outside production acreage and the potential for pesticide application. Total outside wholesale nursery production the entire Barton Spring Zone is approximately three acres. Only three of the five nurseries had outdoor wholesale production (Figure 1). Of these three, two had less than 0.5 acres outdoor production. The remaining site, Barton Springs Nursery, has approximately 2.5 acres of outdoor production. The Barton Springs Nursery has a reputation for being "environmentally conscious" (Kathy Shay, personal communication). When the nursery was contacted it indicated that it does use pesticides "when called for".

For the purposes of modeling a nursery/ornamental operation in the BSS, one of the nurseries (Barton Springs Nursery) was used to conceptualize a facility that is representative of one located within the BSS. Communications with a staff member were used to parameterize the model. The nursery of interest has indoor and outdoor areas for growing and maintaining plants. Outdoor plants include cacti, annuals, perennials, shrubs, and trees. Outdoor plants are maintained on either weed control mat or on gravel. Plants are kept in pots of various sizes, ranging from 4" to multiple gallons, depending upon the type of plant kept within. Irrigation is carried out daily with either hose or sprinkler systems. Plants are maintained outside year-round, with some becoming dormant in the winter and some remaining green. Spring and fall represent the busiest times for plant production and sales for this nursery (personal communication with nursery employee). Several assumptions were made to parameterize the model. First, it was assumed that the area that would yield the greatest runoff potential would be from a bare surface that would be represented by the walkways between the potted plants. These areas could potentially receive direct applications of pesticides sprayed on potted plants. Therefore, the surface of the soil was conceptualized as being gravel or dirt (area under weed mats). This was an assumption that affected selection of curve numbers, USLE C and Manning's N. Second, it was assumed that pesticide runoff of potted soil would not degrade or adsorb and would therefore, be applied directly to the soil.

The contractor also researched regulations for pesticide runoff from nurseries. Cindy Hooper of the TX Commission on Environmental Quality (TCEQ) Stormwater Team, which regulates the State TPDES for the federal NPDES, stated that the Nursery SIC code is 0181 which is an Agricultural type SIC code. Therefore nurseries are not required to have a TPDES Multi-Sector General Permit. Nancy McClintock, Assistant Director of the City of Austin Watershed Protection and Development Review Board indicated that a recent ordinance requires Integrated Pest Management (IPM) plans for new development; however the plan does not have specific pesticide runoff control requirements. It is important to note that this ordinance applies only to those areas of the BSZ under the jurisdiction of the City of Austin (approximately one-quarter of the BSZ). The analysis of land cover information is provided in Figure 7.

Table 1. NASS 1997/2002 census of agriculture for ornamental production for open areas versus under glass in Hays and Travis Counties, Texas.

	HAYS		TRAVIS	
Crop	**1997 Total Acres**	**2002 Total Acres**	**1997 Total Acres**	**2002 Total Acres**
Nursery, greenhouse, floriculture, aquatic plants, mushrooms, flower seeds, vegetable seeds, sod harvested, total **In open**	x	65	x	111
Nursery, greenhouse, floriculture, aquatic plants, mushrooms, flower seeds, vegetable seeds, sod harvested, total **Under glass (not applicable for modeling)**	x	407,925	x	115,274
Nursery, floriculture, vegetable and flower seed crops, sod harvested, etc., grown in the open, irrigated	26	36	99	106
Floriculture crops – bedding/garden plants, cut flowers and cut florist greens, foliage plants, and potted flowering plants, total , in open	x	14	23	x
Bedding/garden plants, in open	4	x	6	4
Nursery stock, in open	2	27	73	90
Other nursery and greenhouse crops, in open	x	25	x	X

X = data not available, not applicable or withheld

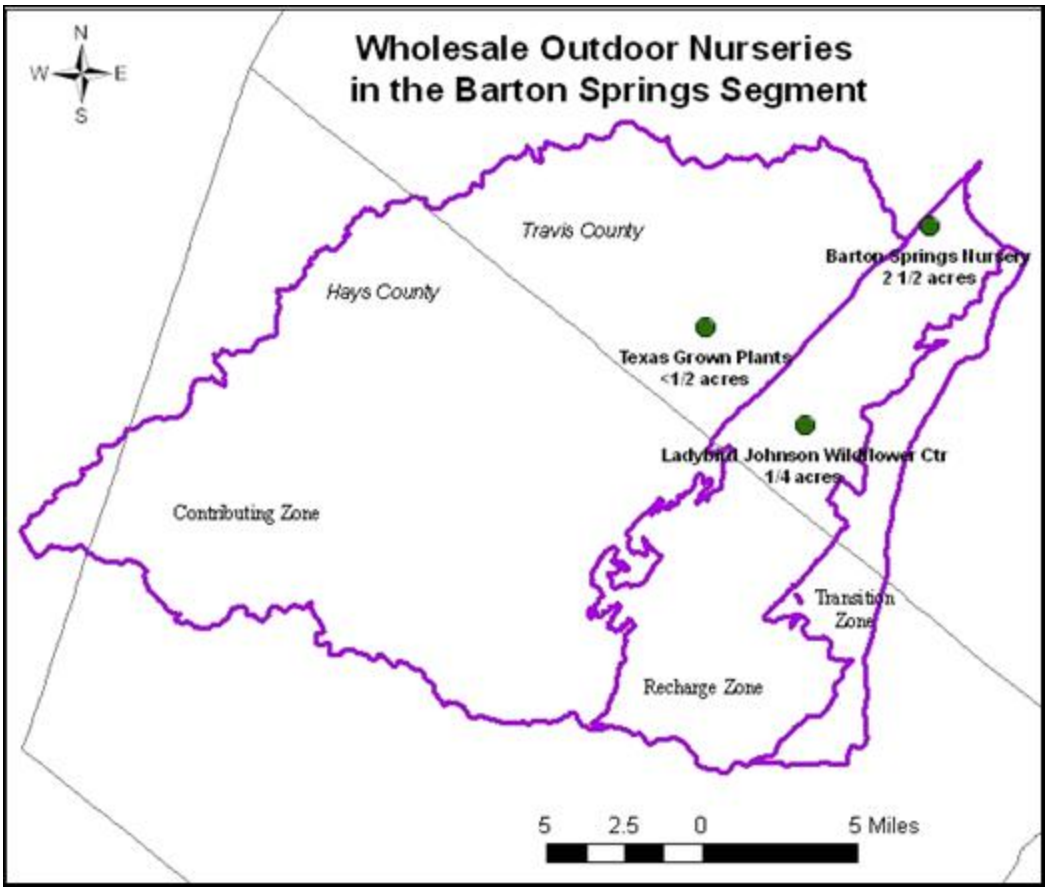

Figure 7. Location of outdoor wholesale nurseries in the Barton Springs Segment of Edwards Aquifer.

LAND USE / LAND COVER ANALYSIS

Percent of each land use was computed for each of the land use / land cover datasets used in scenario development. Table 2 presents the percent of each land use as classified by USGS (2003) for the Barton Springs Segment in Hays and Travis counties, TX. Table 3 presents the percent of each land use as classified by COA (2003). Datasets were spatially "clipped" in ArcGIS to the area of interest as defined in the SOW for this assessment, specifically the Barton Springs Contributing, Recharge, and Transition zones in Hays and Travis Counties, TX.

Table 2. Percent of each land use in the Barton Springs Segment of Hays and Travis Counties, TX computed from USGS (2003) dataset. Based on the table " edw_lulc_BSS_AOI_UTM_SOIL " in the BartonSpringsAOI.mdb geodatabase

Land Use / Land Cover	Area (acres)	%	Related Scenario
Forested	138,670	54.60%	NA
Natural Herbaceous	37,700	14.84%	Rangeland
Single-Family Residential	28,352	11.16%	Residential
Mixed Forest/Shrub	26,068	10.26%	NA
Planted/Cultivated Herbaceous	8,098	3.19%	Meadow
Shrubland	5,989	2.36%	NA
Transportation	2,278	0.90%	NA
Commercial/Light Industry	1,537	0.61%	NA
Mixed Urban	1,339	0.53%	NA
Entertainment and Recreational	1,174	0.46%	NA
Institutional	854	0.34%	NA
Quarries/Strip Mines/Gravel Pits	720	0.28%	NA
Multi-Family Residential	546	0.22%	Residential
Reservoir	141	0.06%	NA
Agricultural Business	113	0.04%	NA
Communications And Utilities	90	0.04%	NA
Planted/Cultivated Woody (Orchards/Vineyards/Groves)	75	0.03%	Orchard
Transitional Bare	65	0.03%	NA
Heavy Industry	64	0.03%	NA
Stream/River	31	0.01%	NA
Bare Rock/Sand	22	0.01%	NA
Emergent Herbaceous Wetlands	20	0.01%	NA
Bare	16	0.01%	NA
Woody Wetland	12	0.00%	NA
Total*	253,974	100.00%	

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Land Use / Land Cover	Area (acres)	%	Related Scenario

* Note: Total area does not match exactly between the COA and USGS data sets due to differences in boundary delineations by each organization. USGS did not include Blanco county and several fringe areas that were included in the COA dataset. Both datasets were clipped to the area of interest as defined in the SOW for this assessment, specifically the Barton Springs Contributing, Recharge, and Transition zones in Hays and Travis Counties, TX.

Table 3. Percent of each land use in the Barton Springs Segment of Hays and Travis Counties, TX computed from COA (2003) dataset. Based on the table "landuse2003_AOI_UTM_SOIL" in the BartonSpringsAOI.mdb geodatabase.

Land Use / Land Cover	Area (acres)	%	Related Scenario
Large-lot Single Family	71,669	28.2%	NA
Undeveloped	59,320	23.3%	NA
Agricultural	38,166	15.0%	NA
Single Family Residential	33,502	13.2%	NA
Preserves	20,020	7.9%	NA
Streets and Roads	10,684	4.2%	Right-of-way
Parks/Greenbelts	6,136	2.4%	NA
Mobile Homes	2,923	1.1%	NA
Commercial	2,353	0.9%	NA
Resource Extraction	1,713	0.7%	NA
Apartment/Condo	1,494	0.6%	NA
Educational	1,184	0.5%	NA
Golf Courses	1,152	0.5%	Turf
Warehousing	1,136	0.4%	NA
Office	792	0.3%	NA
Meeting and Assembly	752	0.3%	NA
Duplexes	505	0.2%	NA
Utilities	249	0.1%	Right-of-way
Three/Fourplex	157	0.1%	NA
Miscellaneous Industrial	154	0.1%	NA
Government Services	114	0.0%	NA
Aviation facilities	59	0.0%	NA
Hospitals	58	0.0%	NA
Water	52	0.0%	NA
Railroad Facilities	45	0.0%	Right-of-way
Cemeteries	39	0.0%	NA

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Land Use / Land Cover	Area (acres)	%	Related Scenario
Retirement Housing	26	0.0%	NA
Manufacturing	22	0.0%	NA
Parking	9	0.0%	NA
Marinas	3	0.0%	NA
Group Quarters	2	0.0%	NA
Semi-institutional Housing	0	0.0%	NA
Total*	254,490	100.0%	

* Note: Total area does not match exactly between the COA and USGS data sets due to differences in boundary delineations by each organization. USGS did not include Blanco county and several fringe areas that were included in the COA dataset. Both datasets were clipped to the area of interest as defined in the SOW for this assessment, specifically the Barton Springs Contributing, Recharge, and Transition zones in Hays and Travis Counties, TX.

CLIMATE AND TIME PARAMETERS

Geographic parameters located in table 1 of the metadata files were determined based on the AOI. The meteorological station selected for the scenarios was located in Austin, Texas (W13958). This station was the closest available weather station that included data required for PRZM. PFAC and ANETD values were determined for the location of the AOI as it corresponded to PRZM manual figures 5.1 and 5.2, respectively (USEPA 1998). It was assumed that snowfall could occur and persist based on meteorological data for Austin, which indicated that from 1971-2001, the average snowfall for the winter season was 0.6 inches (NOAA 2006); therefore, the SFAC value was set to correspond to the value representative of open areas (Table 5.1, USEPA 1998).

SOIL SELECTION/PARAMETERIZATION

Soil series were selected for the Barton Springs scenarios based on geospatial analysis and discussions with local experts. Percent of each soil type within a particular LULC of interest in the Barton Springs Segment (BSS) was determined by intersecting the LULC data sets (USGS 2003, COA 2003) with soils data (USDA 2006). Soils were then selected based on various factors, including: extent, representativeness, benchmark soil, and/or high vulnerability of soil to erosion.

The Brackett soil series was selected for six of the seven scenarios, including: residential, impervious, right-of-way, turf, meadow and rangeland/pastureland. The Tarrant soil series was selected for the nursery scenario. Data for these soils was obtained from Soil Data Mart (USDA 2006) for the county with the most extensive amount of the relevant LULC (Table 4). Values for

thickness, bulk density, initial water content, field capacity, and wilting point were taken from soil data mart for the horizons of interest. Organic carbon was determined for each horizon with organic matter data that were adjusted using the relationship % OC = % Organic Matter/1.724 (Doucette 2000). In all scenarios, Soil Data Mart included information for an additional soil horizon. Since this horizon was bedrock, the horizon was not added to the soil profiles.

Table 4. Soil types and county locations of soil data for each of the Barton Springs scenarios.

Scenario	Soil	Soil Confirmed?	County
Meadow	Brackett-Rock Outcrop-Comfort Complex	yes	Hays
Rangeland/Pastureland	Brackett-Rock Outcrop-Comfort Complex	yes	Hays
Residential	Brackett-Rock Outcrop-Complex	yes	Travis
Impervious	Brackett-Rock Outcrop-Complex	yes	Travis
Turf	Brackett-Rock Outcrop-Complex	yes	Travis
Right-of-Way	Brackett-Rock Outcrop-Complex	yes	Travis
Nursery	Tarrant soils and urban land	No*	Travis
* See nursery soil selection information below.			

The Brackett series approximates the 90th percentile of vulnerability, drainage, erodibility, and slope. The relatively low organic matter content is also expected to result in lower microbial activity and thus reduced potential for pesticide degradation. Brackett soils have a USLE K factor of 0.37 which includes the 90th percentile of these soils in erodibility. Brackett is a benchmark soil as well as a Hydrologic Group C. Slopes can range from 1 to 60 percent (Soil Survey Staff, 2006a); however the most typical range for the Brackett series in residential areas is either 1-8 percent (Hays County) or 1-12 percent (Travis County) (USDA 2006).

Tarrant is a Hydrologic Group D soil, with a USLE K factor of 0.32 (USDA 2006). Slopes range from 1 to 8 percent for this series (USDA 1997), but for the portion that overlaps with the nursery, the slope range is 0 to 2 percent. Since all three outdoor nursery operations in the BSS are located within Travis County, soil parameters were obtained soil data mart information pertaining to Travis County (USDA 2006).

Residential and Impervious

Soils were selected based on vulnerability and the extent within single- and multi-family residential areas in BSS. Based on a geospatial analysis of soils (USDA 2006) and land use data (USGS 2003) for residential areas as well as conversations with local soil experts, Brackett soils were chosen to represent residential areas in the BSS. Brackett soils are in Hydrologic Group C, are found in both the contributing and recharge zones of the Edwards Aquifer (Figure 1), and are the most common soil on which residential dwellings are located, accounting for 35% of all soils in residential areas (**Table** 5). Brackett soils are often undulating (Soil Survey Staff 2006a) making them desirable for development due to their scenic nature (Volente 2004). The location of Brackett soils was also cross-checked with aerial photography (TWDB 2004) to ensure that

the soil chosen coincided with residential areas where pesticides would reasonably be applied. A local soil expert also confirmed that Brackett soil is a common soil type in residential areas of the BSS (Perez, 2006). A thatch layer was added to the top of the soil layer according to USEPA guidance on modeling turf, as provided with the SOW.

The impervious scenario is intended to be coupled to the residential scenario to mimic hydrology of untreated portions of the Barton Springs Segment (BSS) of the Edwards Aquifer. The intention is to couple the edge of field concentrations from this scenario with the edge of field concentrations from the residential scenario for Barton Springs to generate weighted concentrations for areas of varying impervious cover. Therefore, this scenario relies on a similar soil series as the residential scenario (Brackett); however the upper horizon has been adjusted to a non-soil nature. This included setting a high curve number, high bulk density, low curve number, and setting organic carbon to zero.

Percent area of soils in each Hydrologic Group within single/multi-family residential land use type (USGS 2003) in Barton Springs Segment of the Edwards Aquifer.

Hydrologic Group	Percent
water/cut & fill /etc.	0.06%
A	0.37%
B	1.35%
C	47.14%
D	51.09%
	100.00%

Table 5. Analysis of Residential Soils Types.

Types of D soils in single- and multi-family residential land use type in the Barton Springs Segment of The Edwards Aquifer (percent of LULC in parenthesis).
Speck stony clay loam 16.9% (8.64%)
Comfort-Rock outcrop complex 12.6% (6.47%)
Real-Comfort-Doss complex 12.0% (6.13%)
Tarrant and Speck soils 8.55% (4.37%)
Tarrant soils and Urban land 7.11% (3.63%)
Tarrant soils 6.09% (3.11%)
Doss silty clay 5.55% (2.83%)
Denton silty clay 3.68% (1.88%)
Urban land and Brackett soils 2.61% (1.33%)
Urban land and Austin soils 2.57% (1.31%)
Crawford clay 2.42% (1.23%)
Urban land, Austin, and Whitewright soils 2.40% (1.23%)
Purves silty clay 2.13% (1.09%)
Krum clay 2.13% (1.09%)
Houston Black soils and Urban land 1.97% (1.01%)
Heiden clay 1.27% (0.65%)

Table 5. Analysis of Residential Soils Types.
Types of D soils in single- and multi-family residential land use type in the Barton Springs Segment of The Edwards Aquifer (percent of LULC in parenthesis).
San Saba soils and Urban land 1.12% (0.57%)
Medlin-Eckrant association 1.07% (0.54%)
Tarpley clay 1.01% (0.51%)
San Saba clay 0.95% (0.49%)
Purves clay 0.90% (0.46%)
Real gravelly loam 0.80% (0.41%)
Tarrant-Rock outcrop complex 0.75% (0.38%)
Speck clay loam 0.65% (0.33%)
Anhalt clay 0.63% (0.32%)
Urban land and Ferris soils 0.58% (0.29%)
Urban land 0.41% (0.21%)
Gruene clay 0.39% (0.20%)
Eckrant-Rock outcrop complex 0.19% (0.09%)
Ferris-Heiden complex 0.17% (0.09%)
Houston Black clay 0.10% (0.05%)
Tinn clay 0.03% (0.01%)
Types of C soils in single- and multi-family residential land use type in the Barton Springs Segment of The Edwards Aquifer (percent of LULC in parenthesis).
Brackett-Rock outcrop (Comfort or Real) complex 73.6% (34.7%)
Rumple-Comfort association 8.22% (3.88%)
Eddy soils and Urban land 4.88% (2.30%)
Volente silty clay loam 4.87% (2.29%)
Eddy gravelly loam 2.15% (1.01%)
Austin silty clay 2.09% (0.98%)
Bolar clay loam 1.26% (0.59%)
Volente soils and Urban land 1.23% (0.58%)
Castephen silty clay loam 0.94% (0.44%)
Austin-Castephen complex 0.42% (0.19%)
Altoga soils and Urban land 0.07% (0.03%)
Altoga silty clay 0.04% (0.02%)
Travis soils and urban land 0.02% (0.01%)
Whitewright clay loam 0.01% (0.00%)
Castephen clay loam 0.00% (0.00%)
Types of B soils in single- and multi-family residential land use type in the Barton Springs Segment of the Edwards Aquifer (percent of LULC in parenthesis).
Sunev clay loam 39.0% (0.52%)
Lewisville silty clay 19.7% (0.26%)
Patrick soils 14.9% (0.20%)
Lewisville soils and Urban land 10.4% (0.14%)
Patrick soils and urban land 6.90% (0.09%)

Table 5. Analysis of Residential Soils Types.
Types of D soils in single- and multi-family residential land use type in the Barton Springs Segment of The Edwards Aquifer (percent of LULC in parenthesis).
Sunev silty clay loam 2.82% (0.03%)
Seawillow clay loam 2.36% (0.03%)
Oakalla soils 2.08% (0.02%)
Hardeman soils and Urban land 0.80% (0.01%)
Oakalla silty clay loam 0.41% (0.00%)
Bergstrom soils and Urban land 0.33% (0.00%)
Boerne fine sandy loam 0.12% (0.00%)
Types of A soils in single- and multi-family residential land use type in the Barton Springs Segment of the Edwards Aquifer (percent of LULC in parenthesis).
Mixed alluvial land 82.4% (0.30%)
Orif soils 15.7% (0.05%)
Gaddy soils and Urban land 1.76% (0.00%)

Turf

Soil parameters were determined using data from Soil Data Mart (USDA 2006) for Travis County and land use data from the City of Austin (COA, 2003). This county data set was used since the majority of golf courses in the AOI reside within Travis County. The specific soil chosen was Brackett-Rock Outcrop-Complex, with 1-12% slopes, which is the most common soil located within golf course areas of BSS (Figure 3). A thatch layer was added to the top of the soil layer according to USEPA guidance on modeling turf, as provided with the SOW. The properties of the thatch layer are consistent with existing turf scenarios: PA turf and FL turf.

The Brackett series was chosen to represent turf areas in the BSS (Table 5) because it is a benchmark soil, is highly representative of golf course areas in the BSS, and it approximates the 90^{th} percentile of vulnerability in drainage, erodibility, and slope. Brackett soils are in Hydrologic Group C soils and are found in both the contributing and recharge zones of the Edwards Aquifer. Bracket soils are the most common soil type found in golf course areas of the BSS (Table 6).

Table 6. Analysis of Golf Course Soil Types.
Types of D soils in golf course land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Tarrant 38.0% (12.5%)
Speck 28.6% (9.45%)
San Saba 19.3% (6.39%)
Crawford 11.4% (3.76%)
Doss 2.52% (0.83%)
Types of C soils in golf course land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Brackett 77.6% (50.5%)
Volente 22.3% (14.5%)
Types of A soils in golf course land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Alluvial land 100% (1.91%)

Right-of-way

Soils were chosen based on co-location with right-of-way areas based on land use coverage developed by the City of Austin (City of Austin 2003). The land use data set include streets, roads, utilities, and railroads, but does not include fence lines. Based on a geospatial analysis of right-of-way land uses (City of Austin 2003) and USDA soils data (USDA 2006), Brackett soils were chosen to represent right-of-way areas in the BSS. Brackett soils are found in both the contributing and recharge zones of the Edwards Aquifer and are the most common soil on which right-of-way areas are located (Figure 4), accounting for 32% of soils in right-of-way areas (Table 7). The soil data for Travis County, Brackett-Rock Outcrop-Complex soil with slopes 1-12% was used to parameterize the soil component of this scenario (USDA 2006).

Table 7. Analysis of Right-of-way Soil Types.
Types of D soils in right-of-way (streets/roads/utilities/railroads) land use type in the Barton Springs Segment of Edwards Aquifer (percent of AOI in parenthesis).
Speck stony clay loam 23.5% (12.8%)
Tarrant and Speck soils 10.2% (5.54%)
Tarrant soils 7.05% (3.83%)
Real-Comfort-Doss complex 6.85% (3.72%)
Crawford clay 6.85% (3.72%)
Comfort-Rock outcrop complex 6.50% (3.53%)
Tarrant soils and Urban land 5.75% (3.12%)
Doss silty clay 4.07% (2.21%)
Denton silty clay 3.55% (1.93%)
Urban land and Austin soils 2.28% (1.23%)
San Saba clay 2.24% (1.21%)
Krum clay 2.22% (1.20%)
Heiden clay 2.08% (1.13%)
Purves silty clay 1.83% (0.99%)
Urban land Austin and Whitewright soils 1.59% (0.86%)
Houston Black soils and Urban land 1.54% (0.83%)
San Saba soils and Urban land 1.53% (0.83%)
Urban land and Brackett soils 1.38% (0.75%)
Urban land 1.18% (0.64%)
Tarpley clay 1.01% (0.55%)
Gruene clay 0.96% (0.52%)
Purves clay 0.84% (0.45%)
Medlin-Eckrant association 0.80% (0.43%)
Tarrant-Rock outcrop complex 0.77% (0.41%)
Speck clay loam 0.66% (0.36%)
Ferris-Heiden complex 0.59% (0.32%)
Anhalt clay 0.42% (0.23%)
Branyon clay 0.41% (0.22%)
Real gravelly loam 0.36% (0.19%)
Houston Black clay 0.32% (0.17%)
Urban land and Ferris soils 0.23% (0.12%)
Eckrant-Rock outcrop complex 0.15% (0.08%)
Tinn clay 0.07% (0.03%)
Types of C soils in right-of-way (streets/roads/utilities/railroads) land use type in the Barton Springs Segment of Edwards Aquifer (percent of AOI in parenthesis).
Brackett-Rock outcrop (Comfort or Real) complex 73.8% (32.2%)
Rumple-Comfort association 7.41% (3.23%)
Volente silty clay loam 6.52% (2.84%)

Table 7. Analysis of Right-of-way Soil Types.
Eddy soils and Urban land 3.14% (1.37%)
Austin silty clay 2.56% (1.11%)
Bolar clay loam 1.95% (0.85%)
Eddy gravelly loam 1.68% (0.73%)
Castephen silty clay loam 1.06% (0.46%)
Volente soils and Urban land 0.89% (0.39%)
Austin-Castephen complex 0.60% (0.26%)
Castephen clay loam 0.18% (0.07%)
Travis soils and urban land 0.05% (0.02%)
Altoga soils and Urban land 0.03% (0.01%)
Whitewright clay loam 0.03% (0.01%)
Altoga silty clay 0.01% (0.00%)
Types of B soils in right-of-way (streets/roads/utilities/railroads) land use type in the Barton Springs Segment of Edwards Aquifer (percent of AOI in parenthesis).
Sunev clay loam 40.7% (0.60%)
Lewisville silty clay 21.5% (0.32%)
Patrick soils 10.9% (0.16%)
Lewisville soils and Urban land 5.63% (0.08%)
Hardeman soils and Urban land 5.36% (0.07%)
Patrick soils and urban land 4.93% (0.07%)
Oakalla silty clay loam 3.01% (0.04%)
Oakalla soils 2.92% (0.04%)
Bergstrom soils and Urban land 2.64% (0.03%)
Sunev silty clay loam 1.43% (0.02%)
Seawillow clay loam 0.77% (0.01%)
Types of A soils in right-of-way (streets/roads/utilities/railroads) land use type in the Barton Springs Segment of Edwards Aquifer (percent of AOI in parenthesis).
Mixed alluvial land 80.3% (0.46%)
Orif soils 19.2% (0.11%)
Gaddy soils and Urban land 0.30% (0.00%)

Rangeland/pastureland

Rangeland and pastureland were identified based on the natural herbaceous land cover classification in the BSS (USGS 2003). Based on the analysis of land use and soils data, Brackett soils were chosen to represent rangelands and pasturelands in the BSS (Table 5). Brackett soils are found in both the contributing and recharge zones of the Edwards Aquifer and are the most common soil on which rangeland is located (**Table** 8). This soil type was confirmed by an extension agent (Perez, 2006).

Percent area of soils in each Hydrologic Group within the natural herbaceous land use type (USGS 2003) in Barton Springs Segment of Edwards Aquifer.	
Hydrologic Group	**Percent**
water/cut & fill /etc.	0.25%
A	0.68%
B	6.67%
C	49.95%
D	42.45%
	100.00%

Table 8. Analysis of Rangeland Soil Types.
Types of D soils in natural herbaceous land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Doss silty clay 25.1% (10.6%)
Real-Comfort-Doss complex 15.4% (6.54%)
Comfort-Rock outcrop complex 10.3% (4.40%)
Krum clay 6.58% (2.79%)
Tarpley clay 4.83% (2.04%)
Denton silty clay 4.74% (2.01%)
Purves clay 4.44% (1.88%)
Speck stony clay loam 3.14% (1.33%)
Crawford clay 2.86% (1.21%)
Houston Black clay 2.43% (1.03%)
Anhalt clay 2.22% (0.94%)
Gruene clay 2.14% (0.90%)
Tarrant soils 2.12% (0.89%)
Krum clay 1.99% (0.84%)
Purves silty clay 1.59% (0.67%)
Tarrant and Speck soils 1.51% (0.64%)
San Saba clay 1.10% (0.46%)
Branyon clay 0.98% (0.41%)
Heiden clay 0.87% (0.37%)

Table 8. Analysis of Rangeland Soil Types.
Denton silty clay 0.68% (0.28%)
Tinn clay 0.62% (0.26%)
Heiden clay 0.54% (0.22%)
Speck clay loam 0.43% (0.18%)
Real gravelly loam 0.39% (0.16%)
Eckrant-Rock outcrop complex 0.35% (0.15%)
Heiden clay 0.33% (0.14%)
Medlin-Eckrant association 0.32% (0.13%)
Denton silty clay 0.27% (0.11%)
Medlin-Eckrant association 0.27% (0.11%)
Krum clay 0.24% (0.10%)
Urban land and Austin soils 0.21% (0.09%)
Crawford clay 0.18% (0.07%)
Heiden clay 0.10% (0.04%)
Houston Black clay 0.10% (0.04%)
Tarrant soils and Urban land 0.08% (0.03%)
San Saba soils and Urban land 0.07% (0.03%)
Urban land, Austin and Whitewright soils 0.06% (0.02%)
Urban land 0.03% (0.01%)
Tarrant-Rock outcrop complex 0.02% (0.01%)
Branyon clay 0.02% (0.00%)
Houston Black clay 0.00% (0.00%)
Houston Black soils and Urban land 0.00% (0.00%)
Ferris-Heiden complex 0.00% (0.00%)
Tarrant soils and Urban land 0.00% (0.00%)
Tarrant soils and Urban land 1.48% (6.31%)
Types of C soils in natural herbaceous land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Brackett-Rock outcrop (Comfort or Real) complex 82.9% (22.7%)
Rumple-Comfort association 57.7% (15.8%)
Bolar clay loam 15.4% (4.24%)
Volente silty clay loam 14.3% (3.93%)
Austin-Castephen complex 4.78% (1.31%)
Austin silty clay 1.73% (0.47%)
Austin-Castephen complex 1.63% (0.44%)
Volente silty clay loam 1.44% (0.39%)
Castephen silty clay loam 1.27% (0.34%)
Castephen silty clay loam 0.40% (0.11%)
Altoga silty clay 0.33% (0.09%)
Castephen clay loam 0.33% (0.09%)
Austin silty clay 0.26% (0.07%)

Table 8. Analysis of Rangeland Soil Types.
Altoga silty clay 0.11% (0.03%)
Eddy gravelly loam 0.08% (0.02%)
Eddy gravelly loam 0.03% (0.00%)
Eddy soils and Urban land 0.02% (0.00%)
Travis soils and urban land 0.00% (0.00%)
Types of B soils in natural herbaceous land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Sunev clay loam 54.1% (3.62%)
Lewisville silty clay 25.0% (1.67%)
Seawillow clay loam 3.10% (0.20%)
Boerne fine sandy loam 2.89% (0.19%)
Seawillow clay loam 2.49% (0.16%)
Lewisville silty clay 2.26% (0.15%)
Oakalla silty clay loam 2.05% (0.13%)
Sunev silty clay loam 2.05% (0.13%)
Lewisville silty clay 1.49% (0.09%)
Oakalla soils 1.27% (0.08%)
Patrick soils 1.21% (0.08%)
Lewisville silty clay 1.16% (0.07%)
Patrick soils 0.43% (0.02%)
Oakalla soils 0.17% (0.01%)
Patrick soils and urban land 0.12% (0.00%)
Hardeman soils and Urban land 0.06% (0.00%)
Lewisville soils and Urban land 0.04% (0.00%)
Types of A soils in natural herbaceous land use type in the Barton Springs Segment of Edwards Aquifer (percent of LULC in parenthesis).
Mixed alluvial land 76.3% (0.52%)
Orif soils 23.6% (0.16%)
Gaddy soils and Urban land 0.02% (0.00%)

Meadow

Soils were selected based on the extent within herbaceous planted areas in BSS and the potential to yield high-end runoff and erosion. Based on a geospatial analysis of soils (USDA 2006) and land use data (USGS 2003) for herbaceous planted areas as well as conversations with local soil experts, Brackett soils were chosen to represent meadow areas in the BSS (Table 5). Location of the Brackett soils was also cross-checked with aerial photography (TWDB 2004) to ensure that the soil chosen coincided with herbaceous planted areas where pesticides would reasonably be applied. A local soil expert also confirmed that Brackett soils are extensive soil types of meadows in the BSS (Perez 2006). Brackett soils while not the most extensive soil in this land use; it is the second most extensive *benchmark soil* in the herbaceous planted land use. One

benchmark soil is more extensive (Denton), however Brackett was chosen over this soil since Brackett soils have a higher erodibility potential. Data from Hays County were selected since the majority of this LULC is located in this county.

Planted/Cultivated herbaceous land use type in USGS (2003) data set	
Hydrologic Group	**Percent**
water	0.03%
A	0.15%
B	16.27%
C	17.76%
D	65.79%
	100.00%

Table 9. Analysis of Meadow Soil Types.
Types of D soils in herbaceous planted land use type in the Barton Springs Segment of Edwards Aquifer (percent in LULC in parenthesis).
Doss silty clay 28.2% (18.5%)
Krum clay 21.4% (14.0%)
Denton silty clay 7.91% (5.20%)
Heiden clay 6.61% (4.35%)
Houston Black clay 5.84% (3.84%)
Tarpley clay 4.05% (2.66%)
Anhalt clay 3.73% (2.45%)
Purves clay 3.64% (2.39%)
Crawford clay 3.48% (2.29%)
Gruene clay 3.10% (2.04%)
Branyon clay 2.24% (1.47%)
Purves silty clay 2.19% (1.44%)
Speck clay loam 1.95% (1.28%)
Real-Comfort-Doss complex 1.94% (1.28%)
San Saba clay 1.28% (0.84%)
Comfort-Rock outcrop complex 0.84% (0.55%)
Medlin-Eckrant association 0.59% (0.39%)
Real gravelly loam 0.22% (0.14%)
Speck stony clay loam 0.20% (0.13%)
Tarrant and Speck soils 0.13% (0.09%)
Tinn clay 0.12% (0.08%)
Tarrant soils 0.10% (0.07%)
Urban land and Austin soils 0.07% (0.04%)
Urban land, Austin, and Whitewright soils 0.02% (0.01%)
Eckrant-Rock outcrop complex 0.00% (0.00%)
Types of C soils in herbaceous planted land use type in the Barton Springs Segment of Edwards Aquifer (percent in LULC in parenthesis).

Table 9. Analysis of Meadow Soil Types.
Brackett-Rock outcrop (Comfort or Real) complex 25.5% (4.54%)
Bolar clay loam 23.8% (4.24%)
Austin-Castephen complex 23.6% (4.20%)
Volente silty clay loam 13.4% (2.38%)
Rumple-Comfort association 6.66% (1.18%)
Castephen clay loam 3.84% (0.68%)
Austin silty clay 1.91% (0.33%)
Castephen silty clay loam 0.93% (0.16%)
Eddy soils and Urban land 0.12% (0.02%)
Volente soils and Urban land 0.03% (0.00%)
Eddy gravelly loam 0.03% (0.00%)
Types of B soils in herbaceous planted land use type in the Barton Springs Segment of Edwards Aquifer (percent in LULC in parenthesis).
Sunev clay loam 55.6% (9.06%)
Lewisville silty clay 30.1% (3.98%)
Seawillow clay loam 16.7% (2.22%)
Sunev silty clay loam 3.89% (0.51%)
Oakalla silty clay loam 1.97% (0.26%)
Boerne fine sandy loam 0.66% (0.08%)
Patrick soils 0.66% (0.08%)
Oakalla soils 0.51% (0.06%)
Types of A soils in herbaceous planted land use type in the Barton Springs Segment of Edwards Aquifer (percent in LULC in parenthesis).
Orif soils 81.1% (0.12%)
Mixed alluvial land 18.8% (0.02%)

Outdoor nursery

The soil selected for the nursery scenario was selected based on the overlap between the nursery of interest (Barton Springs Nursery) and soil extents (USDA 2006). Aerial photography (TWDB 2004) was used to identify the location of the nursery operation and the locations of the outdoor areas of production (**Error! Reference source not found.**). Only one soil type overlapped with the nursery operation: Tarrant soils and urban land. Therefore, it was determined that this soil type was a representative soil that an outdoor nursery operation in the BSS would reside upon. Since all three outdoor nursery operations in the BSS are located within Travis County, soil parameters were obtained soil data mart information pertaining to Travis County (USDA 2006).

CONTACTS

Botto, Robert
GIS Specialist
Watershed Protection and Development Review Board
512-974-2187

Davis, Bryan
Texas Cooperative Extension
Phone: 512-393-2120

DeLong-Amaya, Andrea
Ladybird Johnson Wildflower Center
5112-292-4200 x122

Garcia, Eddie
NRCS - Soil Conservationist
Phone: 512-459-1623 x3

Hooper, Cynthia
Non-Point Source Team
Texas Commission on Environmental Quality
512-239-4524

Lambert, Scott
Travis County Highway Department
512-854-9317

Markwardt, Dennis
Vegetation Management Specialist
Texas DOT, Maintenance Div.
Phone: 512-832-7380

Mason, John
Vegetation Management Specialist
Texas DOT, Maintenance Div.
Phone: 512-832-7380

McClintock, Nancy
Assistant Director
Watershed Protection and Development Review Board
512-974-2652

Perez, Cresencio (Cris)
NRCS - District Conservationist
Phone: 512-392-4050 x3)

Robinson, Rich
Stormwater Quality Monitoring Program
Watershed Protection and Development Review Dept.
City of Austin, Texas
Phone: 512-974-2394
Fax: 512-974-2846

Shay, Kathy
Water Quality Education Manager
City of Austin Watershed Protection and Development Review Board
Phone: 512-974-2446

Smithamn, Nick
Superintendent of Austin Municipal Golf Courses
Phone: 512-447-2616

Stewart, Karen
Senior Water Conservation Specialist
City of Austin Water Utility
Phone: 512-974-2978

Ward, Don
Travis County Highway Department
512-854-9317

Windhager, Steve
Ladybird Johnson Wildflower Center
5112-292-4200 x122

REFERENCES

City of Austin (COA). 2003. Unpublished Land Use Data. http://www.ci.austin.tx.us/landuse/. Accessed 15 February 2005.

City of Austin Land Use data 2003 (ftp://coageoid01.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html)

City of Austin. 2002. Barton Springs Zone Scientific Inventory. City of Austin Watershed Protection Department. Environmental Resources Management Division. Available on-line at http://www.cityofaustin.org/.

Dunne, T., and L. Leopold. 1978. Water in Environmental Planning. W.H. Freeman an Company, New York. 818 pp.

Martinez, R. 2006. NRCS officer for Travis County. Personal Communication, March 22, 2006.

NOAA. 2006. National Weather Service Forecast Office. Climatological data for Austin, Texas. data. http://www.weather.gov/climate/xmacis.php?wfo=ewx

Smithamn, N. Superintendent, City of Austin Municipal Golf Courses. Personal Communication, March 16, 2006.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2006b. Official Soil Series Description [Online WWW] for Tarrant Series. Available URL: " http://ortho.ftw.nrcs.usda.gov/osd/dat/T/TARRANT.html" [Accessed 6 March 2006].

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2006a. Official Soil Series Description [Online WWW] for Brackett Series. Available URL: "http://ortho.ftw.nrcs.usda.gov/osd/dat/B/BRACKETT.html" [Accessed 6 March 2006].

Stewart, K. Senior Water Conservation Specialist, City of Austin Water Utility. Personal Communication, March 23, 2006.

Texas Water Development Board (TWDB), Texas Natural Resource Information System (http://www.tnris.state.tx.us/digital.htm). 2004. 1-Meter Aerial Photography for Travis and Hays Counties. Accessed March 3, 2006.

USDA Soil Conservation Service. 1986. Urban Hydrology for Small Watersheds. Technical Release 55, 2nd edition, June 1986.

USDA. 1997. 1997 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service. Accessed March 2006. Online at: http://www.nass.usda.gov/index.asp.

USDA. 2002. 2002 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service. Accessed March 2006. Online at: http://www.nass.usda.gov/index.asp.

USDA. 2006. Soil Survey Areas of Hays Counties, Texas. U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), Soil Data Mart. March 1, 2005. Online at: http://soildatamart.nrcs.usda.gov.

USDA. 2000. Knisel, W.G., and Davis, F.M., 2000, GLEAMS: Groundwater Loading Effects of Agricultural Management Systems, Version 3.0: Agricultural Research Service, U.S. Department of Agriculture, Publication No. SEWRL-WGK/FMD-050199, 191 p.

USEPA. 1998. Carsel, R.F., J.C. Imhoff, P.R. Hummel, J.M. Cheplick, and A.S. Donigian, Jr. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

USEPA. 2004. Pesticide Root Zone Model (PRZM) Field and Orchard Crop Scenarios: Guidance for Selecting Field Crop and Orchard Scenario Input Parameters. November 15, 2001; Revisions July 2004.

USEPA. 2005. Irrigation Guidance for developing PRZM Scenario. June 15, 2005.

USGS, National Mapping Division, Rocky Mountain Mapping Center. 2003. Edwards Aquifer Land Use / Land Cover. Denver, Colorado. Accessed online at http://www.tceq.state.tx.us/gis/lulc.html

Volente, Village of. 2004. Comprehensive Plan, village of Volente, Texas. Draft Report.

RESEARCH AND DOCUMENTATION FOR AGRICULTURAL SCENARIOS EVALUATED FOR THE BARTON SPRINGS SALAMANDER ASSESSMENT

Overview

This appendix is intended to supplement the summary report submitted by the contractor under technical direction (TD) No. 3 (GSA Contract No. GS-00F-0019L, Order Number. EP06H000149). The SOW for TD3 indicated that seven optional scenarios may be required, depending on the existence of potential uses in the Barton Springs Segment. The scenarios included:

1. Forestry;
2. Row crops (Table 2-2b of USDA TR55);
3. Small grains (Table 2-2b of USDA TR55);
4. Close seeded legumes (Table 2-2b of USDA TR55);
5. Woods-grass combination (orchard or tree farm) (Table 2-2c of USDA TR55);
6. Meadow (Table 2-2c of USDA TR55); and
7. Cotton

For the seven optional generic scenarios, the contractor conducted preliminary background research on each of the suggested uses to determine the presence of the use site in the area of interest the level of significance of the use. The contractor provided an interim deliverable report documenting the preliminary research on 6 March 2006. The Agency directed the contractor to proceed based on the recommendations, but to also further investigate the need for the orchard scenario. The Agency indicated if the contractor can confirm these are in the contributing zone but not the recharge zone then document as such and do not develop these scenarios. If the crop is possibly in the recharge zone then the scenario may need to developed, even with a limited acreage. The contractor determined that the one (1) orchard located in the recharge zone based on land use (USGS 2003) is no longer active; the land has been converted to a Lowes home center.

According to GIS land use coverage from the Texas Commission on Environmental Quality and the City of Austin, agricultural land uses do exist extensively throughout the in the Barton Springs Recharge and Contributing Zones (hereafter referred to as the AOI or “Area of Interest”), However, most of this agricultural land is used for range land, livestock grazing, and pasture, according to the extension agents from Hays and Travis Counties. All extension agents indicated the prevailing trend of agricultural and range land being broken up and converted to residential and commercial development.

Eddie Garcia from Travis County indicated that there are no crops commercially grown and harvested in the AOI of Travis County. There may be some grazing but usually it’s not even enough pasture so that supplemental food must be purchased for the livestock. There is forested/wooded land but no forestry operations for planting and harvesting. The Nature Conservancy owns 4600 acres in the AOI and is managing it as a natural area. There are no agricultural producers registered with the Farm Service Agency (FSA) in the Barton Springs AOI.

Scenario Background Research

1. **Forestry**

NASS data indicates that a small amount of Christmas trees are grown in Travis County (Table 10), however the extension agents from Travis and Hays Counties indicated that these crops are not grown the AOI. There is some cedar and juniper removal. These are considered pests and are removed and not sold (Perez 2006). There is a chemical that can be used for removing cedar, but no one uses it in the BSS; most people cut nuisance trees down (Davis 2006). Based on the information from local extension agents, this use was deemed outside the area of interest and was not developed

Table 10. NASS 1997/2002 census of agriculture for Christmas trees in Hays and Travis Counties, Texas (USDA 1997, 2002).

	HAYS		TRAVIS	
Crop	1997 Acres in Production	2002 Acres in Production	1997 Acres in Production	2002 Acres in Production
Cut Christmas trees	X	X	X	9

X = data not available, not applicable or withheld

2. **Row Crops**

NASS data indicates that a small amount of vegetable crops are the only row crops that are grown in Travis and Hays Counties (Table 11), however the extension agents from Travis and Hays Counties indicated that these crops are not grown the AOI commercially, only in residential gardens. There is one certified organic farm near Wimberly but not within the AOI (Perez 2006). The only vegetables are in home gardens (Davis 2006). Based on the information from local extension agents, this use was deemed outside the area of interest and was not developed

Table 11. NASS 1997/2002 census of agriculture for vegetable crops in Hays and Travis Counties, Texas (USDA 1997, 2002).

	HAYS		TRAVIS	
Crop	1997 Harvested Acres	2002 Harvested Acres	1997 Harvested Acres	2002 Harvested Acres
Land Used For Vegetables	13	11	19	17
Vegetables Harvested For Sale	24	39	52	37
Turnips	X	1	X	X
Herbs, Fresh Cut	10	4	X	X
Carrots	1	X	X	X
Dry Onions	X	1	X	2
Peppers, Bell	X	X	X	1
Peppers, Chile (All Peppers - Excluding Bell)	X	X	X	3

Table 11. NASS 1997/2002 census of agriculture for vegetable crops in Hays and Travis Counties, Texas (USDA 1997, 2002).				
	HAYS		TRAVIS	
Crop	1997 Harvested Acres	2002 Harvested Acres	1997 Harvested Acres	2002 Harvested Acres
Tomatoes	2	4	2	9
Okra	X	3	1	3
Cantaloups	1	3	X	2
Watermelons	1	X	X	1
Cucumbers And Pickles	1	X	X	X
Squash	1	3	X	X
Beets	X	X	X	2

X = data not available, not applicable or withheld

3. Small Grains

NASS data indicate that corn, oats, sorghum, and wheat are grown extensively in Travis and Hays Counties (Table 12). According to Soil Data Mart, there are numerous soils in the BSS that are suitable for growing corn, grain sorghum, and wheat; however, Hays and Travis County extension agents from Travis and Hays Counties indicated that small grain crops are not cultivated in the BSS. In cases where small grains are planted such as winter wheat or oats they are used exclusively for harvesting from small plots from 5 to 15 acres (Davis 2006). All other grain crops like corn, sorghum, wheat, oats and milo are grown East of I-35 in the Blackland Prairie region (Perez 2006). Based on the information from local extension agents, this use was deemed outside the area of interest and was not developed

Table 12. NASS 1997/2002 census of agriculture for grain crops in Hays and Travis Counties, Texas (USDA 1997, 2002).				
	HAYS		TRAVIS	
Crop	1997 Harvested Acres	2002 Harvested Acres	1997 Harvested Acres	2002 Harvested Acres
Corn For Grain	5915	3084	12139	12378
Oats For Grain	836	X	215	206
Sorghum For Grain	5406	1435	21298	14684
Wheat For Grain, All	4674	3527	4849	3320
Winter Wheat For Grain	X	3527	X	3320
Sweet Corn	1	1	X	3

X = data not available, not applicable or withheld

4. Close-seeded legumes

NASS data indicates that a small amount of close-seeded legumes are grown in Travis and Hays Counties (Table 13), however the extension agents from Travis and Hays Counties indicated that these crops are not grown in the AOI (Perez 2006; Davis 2006). Based on the limited extent of legumes in Hays and Travis counties and information from local extension agents, this use was deemed outside the area of interest and was not developed

Table 13. NASS 1997/2002 census of agriculture for legumes in Hays and Travis Counties, Texas (USDA 1997, 2002).

	HAYS		TRAVIS	
Crop	1997 Harvested Acres	2002 Harvested Acres	1997 Harvested Acres	2002 Harvested Acres
Peas, Green Southern (Cowpeas) - Blackeyed, Crowder, Etc.	X	1	X	X
Snap Beans	X	4	X	1

X = data not available, not applicable or withheld

5. Orchard or Tree Farms

NASS data indicates that orchard crops are grown in Travis and Hays Counties (Table 14); however the extension agent from Travis County indicated that there are no orchards in the BSS. The extension agent from Hays County indicated that there is one location in the BSS where orchard crops are grown: the orchard at the Barsana Dham-Isdl Temple (on FM1826) where they grow persimmons, peaches, pecans, etc. These are grown for Pick-Your-Own and they use low toxicity IPM (Integrated Pest Management) practices there (Davis 2006). All orchard crops like peaches and pecans are not in the AOI but near the San Marcos and Blanco Rivers (Perez 2006). EFED reviewed the initial recommendation and directed the contractor to further investigate the need for the orchard scenario. The Agency indicated that if there is minimal acreage in the recharge zone (e.g., nurseries) that could contribute to exposures, then the scenario may be developed. Based on USGS (2003) land use data, the contractor identified one (1) orchard located in the recharge zone (Figure 15). Conversations with personnel in the city of Austin GIS department indicated the orchard is no longer active and has been rezoned for a Lowes® home center (COA, personal communication). Based on this information it was deemed that this orchard will not contribute to potential exposures in the BSS and therefore has not been developed.

Table 14. NASS 1997/2002 census of agriculture for orchard crops in Hays and Travis Counties, Texas (USDA 1997, 2002).				
	HAYS		TRAVIS	
Crop	1997 Total Acres	2002 Total Acres	1997 Total Acres	2002 Total Acres
Land In Orchards	260	290	1394	1793
Apples	X	10	X	X
Pears, All	X	9	X	7
Apricots	X	16	X	X
Peaches, All	X	76	X	22
Plums And Prunes	X	6	X	X
Pecans	X	143	X	1720
Grapes	X	31	X	38

X = data not available, not applicable or withheld

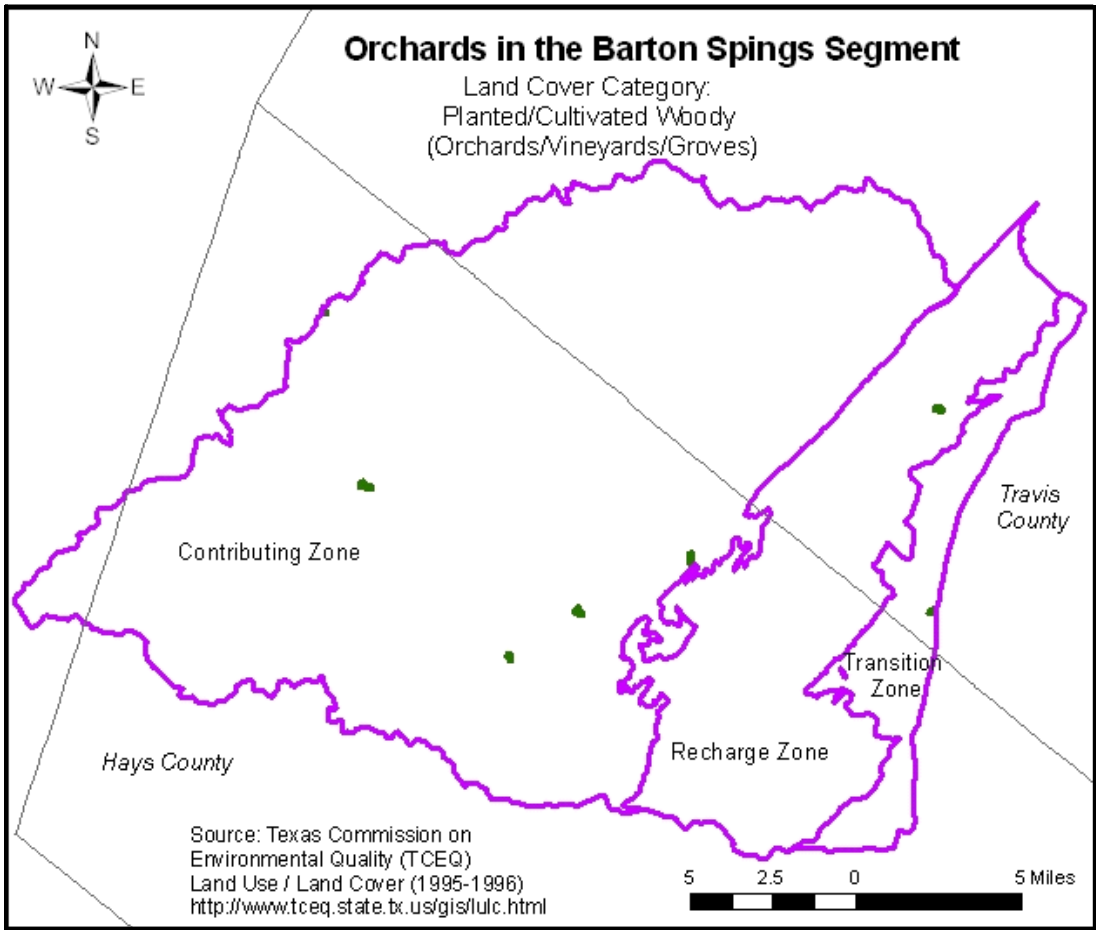

Figure 15. Location of woody planted areas in the BSS segment based on land use data. Local contacts indicated orchards are not present or not active in the BSS. See description for more information.

6. Meadow

NASS Data indicates that hay of varying types is grown extensively in Travis and Hays Counties (Table 15). According to Soil Data Mart, there are a number of soils in the BSS that are suitable for growing improved bermudagrass. In addition, extension agents indicated that some hay crops are cultivated in the BSS. There is some cultivation of sorghum hay, and hay grazer, or sweet sorghum in the BSS. There is also some bermuda grass planted but this is permanent for grazing and not harvested (Perez 2006). Most of this type of crop is for livestock grazing (Davis 2006). Based on this information, this scenario was developed.

Table 15. NASS 1997/2002 census of agriculture for hay crops in Hays and Travis Counties, Texas (USDA 1997, 2002).

	HAYS		TRAVIS	
Crop	**1997 Harvested Acres**	**2002 Harvested Acres**	**1997 Harvested Acres**	**2002 Harvested Acres**
Hay - All Hay Including Alfalfa, Other Tame, Small Grain, And Wild	X	7657	X	20471
All Haylage, Grass Silage, And Greenchop	140	229	769	357
Forage - Land Used For All Hay And All Haylage, Grass Silage, And Greenchop	X	7855	X	20367
Other Haylage, Grass Silage, And Greenchop	X	229	X	357
Other Tame Hay	8287	5358	14020	16737
Small Grain Hay	600	X	943	2219
Wild Hay	840	1228	X	1411
Alfalfa Hay	65	X	X	104

X = data not available, not applicable or withheld

7. Cotton

NASS data indicates that cotton is grown in Travis County (Table 16). According to Soil Data Mart, there are many soils in the AOI that are suitable for growing cotton. However, the extension agents from Travis and Hays Counties indicated that this crop is not grown in the AOI. All cotton is grown East of I-35 (Perez 2006 and Davis 2006). Based on the information from local extension agents, this use was deemed outside the area of interest and was not developed.

Table 16. NASS 1997/2002 census of agriculture for cotton in Hays and Travis Counties, Texas (USDA 1997, 2002).				
	HAYS		TRAVIS	
Crop	1997 Harvested Acres	2002 Harvested Acres	1997 Harvested Acres	2002 Harvested Acres
Cotton, All	X	X	5661	2151
Upland Cotton	X	X	X	2151

X = data not available, not applicable or withheld

References

City of Austin (COA). 2003. Unpublished Land Use Data. http://www.ci.austin.tx.us/landuse/. Accessed 15 February 2005.

USDA. 1997. 1997 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service. Accessed March 2006. Online at: http://www.nass.usda.gov/index.asp.

USDA. 2002. 2002 Census of Agriculture. U.S. Department of Agriculture, National Agricultural Statistics Service. Accessed March 2006. Online at: http://www.nass.usda.gov/index.asp.

USGS, National Mapping Division, Rocky Mountain Mapping Center. 2003. Edwards Aquifer Land Use / Land Cover. Denver, Colorado.

Contacts

Davis, Bryan
Texas Cooperative Extension (Hays County)
County Extension Agent
Agriculture and Natural Resources
512-393-2120
by-davis@tamu.edu

Garcia, Eddie
NRCS - Soil Conservationist (Travis County)
512-459-1623 x3
Eddie.Garcia@tx.usda.gov

Perez, Cresencio (Cris)
NRCS - District Conservationist (Hays County)
512-392-4050 x3
cresencio.perez@tx.usda.gov