Barton Springs Residential

This scenario is 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. Some estimates of impervious fractions in suburban watersheds of the BSS have been compiled in a City of Austin (COA 2002) report for the COA jurisdictional section of the Barton Springs Zone (BSZ) 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 (City of Austin, 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 However, based on unpublished data obtained from the City of Austin some residential watersheds in the area may be as high as 40% (Rich Robinson, COA, personal communication).

Estimates of impervious fractions for selected residential watersheds in the area of the BSS. Obtained from City of Austin, unpublished data (Rich Robinson, personal communication)

Site Name	Impervious Cover	Drainage Area (acres)	Land Use	Recharge	Latitude	Longitude
Lost Creek Subdivision	0.22	209.9	Single Family Residential	No	30.28	97.84
Rollingwood	0.26	62.9	Single Family Residential	Yes	30.27	97.77
Travis Country Channel	0.37	40.7	Single Family Residential	Yes	30.25	97.82
Travis Country Pipe	0.41	41.6	Single Family Residential	Yes	30.24	97.82

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 (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 residential dwellings are located, accounting for 35% of all soils in residential areas (USDA 2006; USGS 2003). Brackett soils are often undulating (Soil Survey Staff 2006) making them desirable for development due to their scenic nature (Volente 2004). The location of Brackett soils was also cross-checked with aerial photography 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).

The Brackett series represents the 90th percentile of vulnerability in drainage, erodibility, and slope. These soils are loamy, carbonatic, thermic, shallow Typic Haplustepts which

consists of very shallow to shallow soils over bedrock. These well drained and moderately permeable soils formed in residuum over chalky limestone bedrock (USDA 2001). Brackett is a Hydrologic Group C soil which accounts for approximately 47% of residential soils in drainage. Brackett soils have a USLE K factor of 0.37 which includes the 90th percentile of these soils in erodibility (Table 5). Slopes range from 1 to 60 percent (Soil Survey Staff, 2006); however the most typical range for the Brackett series in residential areas is 1-12 percent (USDA 2006; USGS 2003).

Crop parameters have been chosen to reflect residential turf areas, primarily lawns, within the BSS.

The meteorological station selected for this scenario is located in Austin, Texas. This station is the closest available weather station that includes data required for PRZM.

Table 1. PRZM 3.12 Climate and Time Parameters for Barton Springs, TX.

Parameter	Value	Source/Comments
Starting Date	Jan. 1, 1961	Meteorological File from Austin, TX (W13958)
Ending Date	Dec. 31, 1990	Meteorological File from Austin, TX (W13958)
Pan Evaporation Factor (PFAC)	0.69	PRZM Manual Figure 5.1 (EPA 1998).
Snowmelt Factor (SFAC)	0.36	PRZM Manual, Table 5.1 (EPA 1998).
Minimum Depth of Evaporation (ANETD)	25	Mid point of range (20-30), PRZM Manual, Figure 5.2 (EPA 1998).

Table 2. PRZM 3.12 Erosion and Landscape Parameters for Barton Springs – residential.		
Parameter	**Value**	**Source/Comments**
Method to Calculate Erosion (ERFLAG)	4 (MUSS)	Default value.
USLE K Factor (USLEK)	0.37 tons EI^{-1}*	NRCS Soil Data Mart Database for Brackett-Rock outcrop-complex, 1-12% slopes, Travis County, TX. (http://soildatamart.nrcs.usda.gov/).
USLE LS Factor (USLELS)	1.34	Calculated according to Haan and Barfield (1978) equation: $LS = ((\lambda/72.6)^m)((430x^2 + 30x + 0.43)/6.613)$, where λ = slope length, x = SLP/100 and m = constant. In this case, λ = 400 m (default value) and m = 0.5 (EPA 2004).
USLE P Factor (USLEP)	1	No contour plowing is expected (EPA 2004).
Field Area (AFIELD)	10 ha	Default value for standard ecological pond (EPA, 2004).
NRCS Hyetograph (IREG)	4	PRZM Manual, Figure 5.12 (EPA, 1998).
Slope (SLP)	6 %	Brackett-Rock Outcrop-Complex slope range 1-12% (USDA 2006).
Hydraulic Length (HL)	356 m	Default value for standard ecological pond (EPA, 2004)
Irrigation Flag (IRFLAG)	1	Homeowners irrigate year round. Kathy Shay, Water Quality Education Manager, City of Austin Watershed Protection and Development Review Board, (512-974-2446).
Irrigation Type (IRTYP)	3 (sprinkler)	Kathy Shay, City of Austin; and Irrigation Guidance for developing PRZM Scenarios, Table 3; (EPA 2005).
Leaching Factor (FLEACH)	0.1	Irrigation Guidance for developing PRZM Scenario, Table 3; (June 15, 2005).
Fraction of Water Capacity when Irrigation is Applied (PCDEPL)	0.95	Irrigation Guidance for developing PRZM Scenario, Table 3; (EPA 2005). BSS homeowners typically irrigate 3 days/week, regardless of available water capacity.
Maximum Rate at which Irrigation is Applied (RATEAP)	0.032 cm hr^{-1}	Homeowners in the BSS typically apply about twice as much as the recommended ¾ inch of water every five days. RATEAP value is for 1.5 inches per 5 days (0.3 in/day). Karen Stewart, City of Austin Water Conservation Department, (512-974-2978). Irrigation Guidance for developing PRZM Scenario, Table 1; (EPA 2005).
* EI = 100 ft-tons * in/ acre*hr		

Table 3. PRZM 3.12 Crop Parameters for Barton Springs – residential.		
Parameter	**Value**	**Source/Comments**
Initial Crop (INICRP)	1	Default value
Initial Surface Condition (ISCOND)	2	2 = cover crop. Cover crops are typically planted in residential areas to keep lawns green when grass goes dormant (Karen Stewart, Senior Water Conservation Specialist, City of Austin Water Utility, Date: 3/23/06, Phone: 512-974-2978).
Number of Different Crops (NDC)	1	Set to number of crops in simulation. Default value.
Number of Cropping Periods (NCPDS)	30	Set to weather data in meteorological file: Austin, TX (W13958).
Maximum rainfall interception storage of crop (CINTCP)	0.15	Expected to be in the range of highly managed turf (0.10 as cited in PA turf and FL turf scenarios) and non-managed grasses (0.20 as cited in Dunne and Leopold, 1978).
Maximum Active Root Depth (AMXDR)	15 cm	Based on managed turf grasses (Nick Smithamn, Superintendent of Austin Municipal Golf Courses, Date: 3-16-06, Phone: 512-447-2616)
Maximum Canopy Coverage (COVMAX)	100%	Assumes complete turf grass coverage for lawns.
Soil Surface Condition After Harvest (ICNAH)	2	2 = cover crop. Cover crops are typically planted in residential areas to keep lawns green when grass goes dormant (Karen Stewart, Senior Water Conservation Specialist, City of Austin Water Utility, Date: 3/23/06, Phone: 512-974-2978).
Date of Crop Emergence (EMD, EMM, IYREM)	1/1/1961	The average first and last frost dates of the winter season are November 10 and March 10, respectively (Karen Stewart, Senior Water Conservation Specialist, City of Austin Water Utility, Date: 3/23/06, Phone: 512-974-2978). Lawn grass goes dormant after the first frost. This scenario was modeled as year round coverage.
Date of Crop Maturity (MAD, MAM, IYRMAT)	1/2/1961	
Date of Crop Harvest (HAD, HAM, IYRHAR)	31/12/1961	
Maximum Dry Weight (WFMAX)	0.0	Not used in scenario.
Maximum Canopy Height (HTMAX)	7.6 cm	Karen Stewart, City of Austin Water Conservation Department, (512-974-2978).
SCS Curve Number (CN)	83, 83, 83	TR-55 (Table 2-2a). Composite CN for ¼ acre residential lot assuming 38% average impervious area. Assumes year round turf (lawn) coverage with pervious curve number = 74. (USDA, 1986).
Manning's N Value (MNGN)	0.110	San Antonio Hay/Grass (I93HGHGC). Represents cover code 2 for first year hay/grass, moderately dense cover.
USLE C Factor (USLEC)	0.000 – 0.004	San Antonio Hay/Grass (I93HGHGC)

Table 4. PRZM 3.12 "Brackett-Rock Outcrop-Complex" Soil Parameters for Barton Springs, TX - residential.		
Parameter	**Value**	**Source/Comments**
Total Soil Depth (CORED)	48 cm	Brackett-Rock outcrop-complex, 1-12% slopes, Travis County, TX. NRCS Soil Data Mart Database (http://soildatamart.nrcs.usda.gov/).
Number of Horizons (NHORIZ)	4	According to an extension agent (Cris Perez), residential areas reside on a variety of soils. Brackett is a common soil type of residential areas in the BSS.
Horizon Thickness (THKNS)	2 cm (HORIZN =1) 10 cm (HORIZN =2) 5 cm (HORIZN =3) 31 cm (HORIZN =4)	Top horizon split in two and thatch layer added as HORIZN 1. Soil parameters of HORIZN 1 according to EPA guidance on development of turf scenario, which is appropriate for modeling residential lawns.
Bulk Density (BD)	0.37 g/cm3 (HORIZN = 1) 1.4 g/cm3 (HORIZN =2) 1.4 g/cm3 (HORIZN =3) 1.43 g/cm3 (HORIZN =4)	
Initial Water Content (THETO)	0.47 cm3/cm3 (HORIZN =1) 0.28 cm3/cm3 (HORIZN =2) 0.28 cm3/cm3 (HORIZN =3) 0.252 cm3/cm3 (HORIZN =4)	Additional data were listed for a 5th HORIZN. However, these were not included in this soil profile since the 5th HORIZN is composed of bedrock.
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 5 cm (HORIZN = 2) 5 cm (HORIZN = 3) 1 cm (HORIZN = 4)	PRZM Scenario Guidance (2004).
Field Capacity (THEFC)	0.47 cm3/cm3 (HORIZN =1) 0.28 cm3/cm3 (HORIZN =2) 0.28 cm3/cm3 (HORIZN =3) 0.252 cm3/cm3 (HORIZN =4)	
Wilting Point (THEWP)	0.27 cm3/cm3 (HORIZN =1) 0.164 cm3/cm3 (HORIZN =2) 0.164 cm3/cm3 (HORIZN =3) 0.145 cm3/cm3 (HORIZN =4)	
Organic Carbon Content (OC)	7.5 % (HORIZN = 1) 1.16 % (HORIZN =2) 1.16 % (HORIZN =3) 0.73 % (HORIZN =4)	Adjusted using the relationship % OC = % Organic Matter/1.724 (Doucette 2000).

Table 5. Soils co-located with single- and multi-family residential areas in the Barton Spring Segment based on USDA 2006 soils data and USGS 2003 land use data.										
Soil	**Total Acreage**	**% Area**	**Drainage Class**	**KF**	**Slope**	**pH**	**OM (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**
Brackett	10,044	34.8%	C	0.37	1 - 12	8	2	34	38	28
Tarrant	3,322	11.5%	D	0.32	5 - 18	8	5	22	28	50
Speck	2,594	9.0%	D	0.32	1 - 3	7	2	34	37	30
Real	1,891	6.6%	D	0.28	1 - 8	8	6	36	34	31
Comfort	1,869	6.5%	D	0.32	1 - 8	8	6	28	29	43
Urban land	1,269	4.4%	D	0.00	0 - 6	0	0	0	0	0
Rumple	1,120	3.9%	C	0.32	1 - 8	7	2	34	37	30
Eddy	959	3.3%	C	0.32	1 - 3	8	1	38	36	26
Volente	832	2.9%	C	0.32	1 - 8	8	3	7	54	39
Doss	819	2.8%	D	0.32	1 - 5	8	2	7	49	44
Denton	544	1.9%	D	0.32	1 - 3	8	3	6	48	46
Purves	448	1.6%	D	0.32	1 - 5	8	3	23	29	48
Crawford	357	1.2%	D	0.32	0 - 1	7	2	22	28	50
Austin	343	1.2%	C	0.32	1 - 3	8	3	7	48	45
Krum	315	1.1%	D	0.32	0 - 1	8	2	26	29	45
Houston Black	308	1.1%	D	0.32	1 - 3	8	3	17	28	55
San Saba	307	1.1%	D	0.32	1 - 2	8	3	18	29	53
Heiden	188	0.7%	D	0.32	1 - 3	8	3	22	28	50
Bolar	173	0.6%	C	0.32	1 - 3	8	2	34	37	30
Sunev	163	0.6%	B	0.32	0 - 1	8	2	18	52	30
Medlin	159	0.5%	D	0.32	1 - 8	8	2	22	28	50
Tarpley	149	0.5%	D	0.32	1 - 3	7	3	30	30	40
Castephen	130	0.4%	C	0.32	3 - 5	8	2	34	32	34
Lewisville	117	0.4%	B	0.32	0 - 1	8	2	8	51	41
Anhalt	94	0.3%	D	0.32	1 - 3	7	3	26	29	45
Alluvial land	87	0.3%	A	0.15	0 - 1	8	1	90	0	5
Patrick	85	0.3%	B	0.32	2 - 5	8	2	28	29	43
Gruene	59	0.2%	D	0.28	1 - 5	8	2	28	29	43
Eckrant	28	0.1%	D	0.32	8 - 40	8	7	22	28	50
Ferris	26	0.1%	D	0.32	8 - 20	8	1	18	29	53
Orif	17	0.1%	A	0.28	0 - 1	8	2	82	9	9
Altoga	16	0.1%	C	0.32	3 - 6	8	1	7	48	45
Oakalla	10	0.0%	B	0.32	0 - 1	8	4	18	48	34
Seawillow	9	0.0%	B	0.32	1 - 3	8	1	35	34	31
Tinn	6	0.0%	D	0.32	0 - 1	8	3	22	28	50
Travis	3	0.0%	C	0.24	1 - 8	7	1	66	19	15
Hardeman	3	0.0%	B	0.24	3 - 12	8	1	66	20	14
Whitewright	2	0.0%	C	0.32	1 - 5	8	1	31	33	37
Gaddy	2	0.0%	A	0.17	0 - 1	8	0	84	7	10
Bergstrom	1	0.0%	B	0.32	0 - 2	8	2	7	62	31
Boerne	0	0.0%	B	0.28	1 - 3	8	1	65	20	16

Uncertainties

It should be noted that the BSS is presently, and expected to continue to be under heavy development pressure (City of Austin, 2002). Although every attempt was made to select representative soils in residential areas that would also yield high end runoff and erosion rates based on the best available data, it is possible that not all soils in residential areas have been considered due to new development since the publication of the USGS land cover data set (USGS 2003) which is generally representative of land cover in 1996.

Curve Number – Uses a high end percent impervious area in TR-55 (USDA 1986) based on unpublished data from COA (Rich Robinson, Personal Communication). However, within the city of Austin Jurisdiction of the Barton Springs Zone data suggest that impervious area may be as low as 7.5% (or 5098 Acres). 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).

Irrigation parameters: During the dry summer months, BSS homeowners use about 12 inches of water per month which is double the usage of other homeowners that time of year (Stewart, 2006). RATEAP would therefore be slightly higher during very dry periods: 12 in/mo ≈ 0.4 in/day = 0.042 cm/hr. Homeowners apply less water in the winter months. Actual data for the available water capacity that would trigger irrigation (PCDEPL) is not available for residential uses. BSS homeowners typically irrigate 3 days/week, regardless of available water capacity (Stewart, 2006). PCDEPL was set to 0.95 in order to trigger irrigation every day at the daily average irrigation rate.

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