Appendix D

HSPF Model Calibration Procedures for Upstream Contributing Land Segments in the Nueces and Blanco Recharge Basins

Appendix D
HSPF Model Calibration Procedures for Upstream Contributing Land Segments in the Nueces and Blanco Recharge Basins

D.1 Model Calibration of the Nueces Recharge Basin Study Area

The original Nueces Recharge study area represented in EAA's Pilot Recharge Models of the Nueces and Blanco River Basins (HDR, 2002) consisted of upper boundaries at the gauging station on the West Nueces River near Brackettville (USGS# 08190500) and the Nueces River at Laguna (USGS# 08190000). The lower boundary was defined by the gauging station on the Nueces River below Uvalde (USGS# 08192000). The study area was subdivided into land segments and river reaches. The model consisted of two land segments in the contributing zone (LS 101 and LS 102), three land segments in the recharge zone (LS 201- LS 203), and three land segments in the confined zone (LS 301- LS 303) as shown in Section 4C.28 (Figure 4C.28-1). The West Nueces River and Nueces River were simulated in HSPF as seven individual river reaches based upon channel loss surveys from previous studies.[1] There were two reaches for the West Nueces River (Reach 11 and Reach 12) and five reaches for the Nueces River, two upstream of confluence with the West Nueces River (Reach 13 and Reach 14) and three below confluence with the West Nueces (Reach 15- 17).

To more accurately model the recharge basin, the upper model boundaries were extended to the upstream contributing, ungaged headwaters of the West Nueces (LS 401) and upstream contributing, ungaged headwaters of the Nueces Rivers (LS 402) as shown in Section 4C.28 (Figure 4C.28-1). Reach 10 was added as the upstream contributing West Nueces River reach associated with LS 401 and Reach 18 was added for the upstream contributing Nueces River reach associated with LS 402. Table D-1 includes the total area of each land segment and assigned land segment identification number. The length of each reach is listed in Table D-2.

The West Nueces River is subject to high flows during storm events, however based on streamflow data for USGS # 08190500−West Nueces River near Bracketville, 74% of the time there is no flow and 86% of the time flow is less than 10 cfs. Due to these extreme flow values, it was difficult to calibrate the HSPF model to replicate both high and low streamflow gage data. Previous loss studies[1] indicate losses of 286 cfs over the recharge zone, 1.7 miles upstream from

---

[1] USGS, "Streamflow Losses along the Balcones Fault Zone, Nueces River Basin, Texas," Report 83-4368, 1983.

Table D-1. Nueces Recharge Basin Land Segments

Land Segment ID	Description	Area (sq. mi)
401	**Upstream Contributing West Nueces River**	**693.0**
402	**Upstream Contributing Nueces River**	**732.3**
101	West Nueces Contributing	61.4
102	Nueces River Contributing	8.2
201	West Nueces Recharge	141.8
202	Nueces River Recharge	137.4
203	Upper Nueces Recharge	5.2
301	West Nueces Downdip	21.3
302	Nueces River Downdip	40.5
303	Leona Gravels	19.2
	Total	1860.3

Bolded entries indicate updates to the Recharge Model.

Note: Land segment area(s) for LS 101-102, 201-203, and 301-303 obtained from Pilot Recharge Models of Nueces and Blanco River Basins.

Table D-2. Nueces Recharge Basin River Reaches

River Reach ID	Description	Length (miles)
10	**West Nueces River**	**21.3**
11	West Nueces River	12.5
12	West Nueces River	29.5
18	**Nueces River**	**19.1**
13	Nueces River	11.2
14	Nueces River	3.2
15	Nueces River	6.0
16	Nueces River	3.2
17	Nueces River	8.9

Bolded entries indicate updates to the Recharge Model.

Nueces River confluence. Considering the objectives of the evaluations for use in the South Central Texas Regional Water Plan, which are to evaluate potential increase in enhanced recharge due to brush management and weather modification, streamflow greater than approximately 300 cfs would not be available for recharge, and it is therefore not necessary to calibrate to high flow conditions. For example, in this reach of the Nueces River where it traverses the recharge zone, the maximum stream loss, or recharge to the aquifer is 286 cfs.

The new upstream land segment (LS 401) on the West Nueces River was calibrated by comparing simulated streamflow from the HSPF model to historical USGS streamflow data at the gauging station on the West Nueces River near Bracketville (USGS # 08190500) (1934-1998). Streamflow calibration was accomplished using daily streamflow frequency distributions to compare HSPF model and historical streamflow data, presented as the percentage of time that streamflow is exceeded. A frequency distribution comparison of simulated to historical streamflow at USGS # 08190500 is shown in Figure D-1. Given that the simulated streamflow and historical (gaged) streamflow curves are almost identical, it is concluded that the HSPF model performs quite well in simulating the frequency of streamflow available for recharge (Figure D-1).

Linear regression of annual flow values was not deemed an appropriate method of calibration, since extreme high flows not replicated by the HSPF model would be absent from average annual flow amounts resulting in poor annual flow correlation between HSPF model and USGS gage data.

The new upstream Nueces River land segment (LS 402) on the Nueces River was calibrated by comparing simulated streamflow from the HSPF model to historical USGS streamflow data at the gauging station on the Nueces River at Laguna (USGS # 08190000) (1934-1998). Streamflow calibration was accomplished using daily streamflow frequency distribution and linear regression of annual flow values to compare model and historical streamflow data. A frequency distribution comparing daily simulated to historical streamflow at USGS # 08190000 is shown in Figure D-2. Given that the simulated streamflow and historical (gaged) streamflow curves are almost identical, it is concluded that the HSPF model performs quite well in simulating the frequency of streamflow available for recharge.

Linear regression is used to measure how closely the simulated streamflows approximate the historical streamflows over the full range of observed annual values. Ideally, the regression equation would have a slope coefficient of 1.0, an intercept of 0.0, and coefficient of determination (r^2) of 1.0 indicating a perfect match between simulated and historical streamflows. Regression analysis was used to compare annual streamflow simulated by the HSPF model to historical annual streamflow at USGS # 08190000-Nueces River at Laguna with

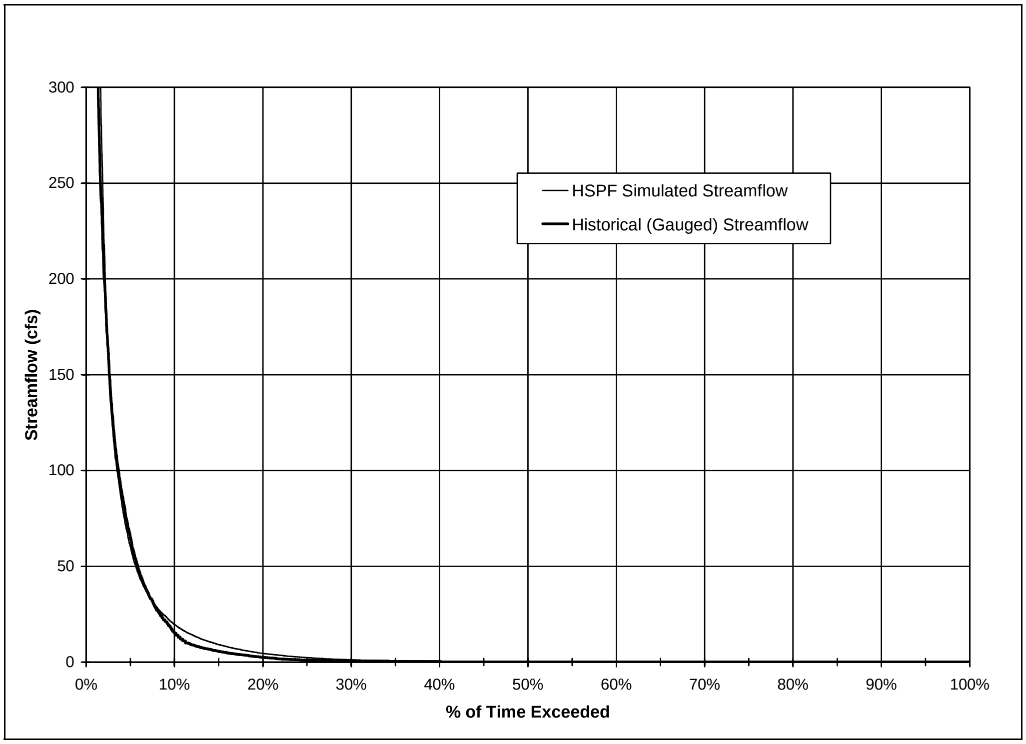

Figure D-1. Streamflow Frequency Distribution of West Nueces River at Bracketville (USGS # 08190500)

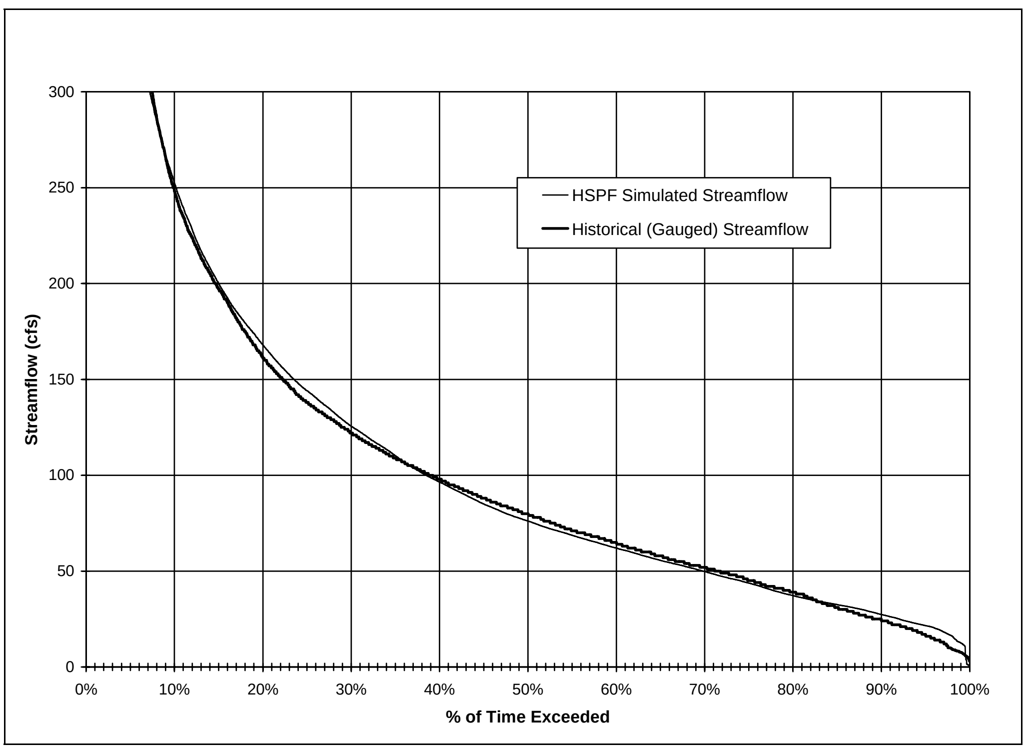

Figure D-2. Streamflow Frequency Distribution of Nueces River at Laguna (USGS # 08190000)

a slope of 0.90 and r^2 value of 0.69 (Figure D-3). The historical annual average streamflow for the Blanco River at Wimberley (1934-1998) was 116,585 acft/yr and the simulated annual average streamflow was estimated at 94,289 acft/yr, a difference of 22,295 acft/yr or about 19 percent. This high percent difference in simulated versus historical annual streamflow is attributable to the HSPF model simulating high flows (>300 cfs) lower than historical gage data. Historical USGS gage data for the Nueces River at Laguna show that streamflow exceeds 300 cfs about 7.5% of the time. Since these high flows would not be able to recharge the Edwards Aquifer in the recharge zone due to recharge limits for the Nueces River[2], it is not essential for the HSPF model to simulate high flows (>300 cfs). The upstream contributing land segments (LS401 and LS402) and corresponding Reaches 10 and 11 were calibrated to USGS gauged data sufficiently to provide reliable estimates of enhanced recharge associated with brush management (Section 4C.28) and weather modification (Section 4C.29).

[2] U.S. Geological Survey, "Streamflow Losses Along the Balcones Fault Zone, Nueces River Basin, Texas", December 1983

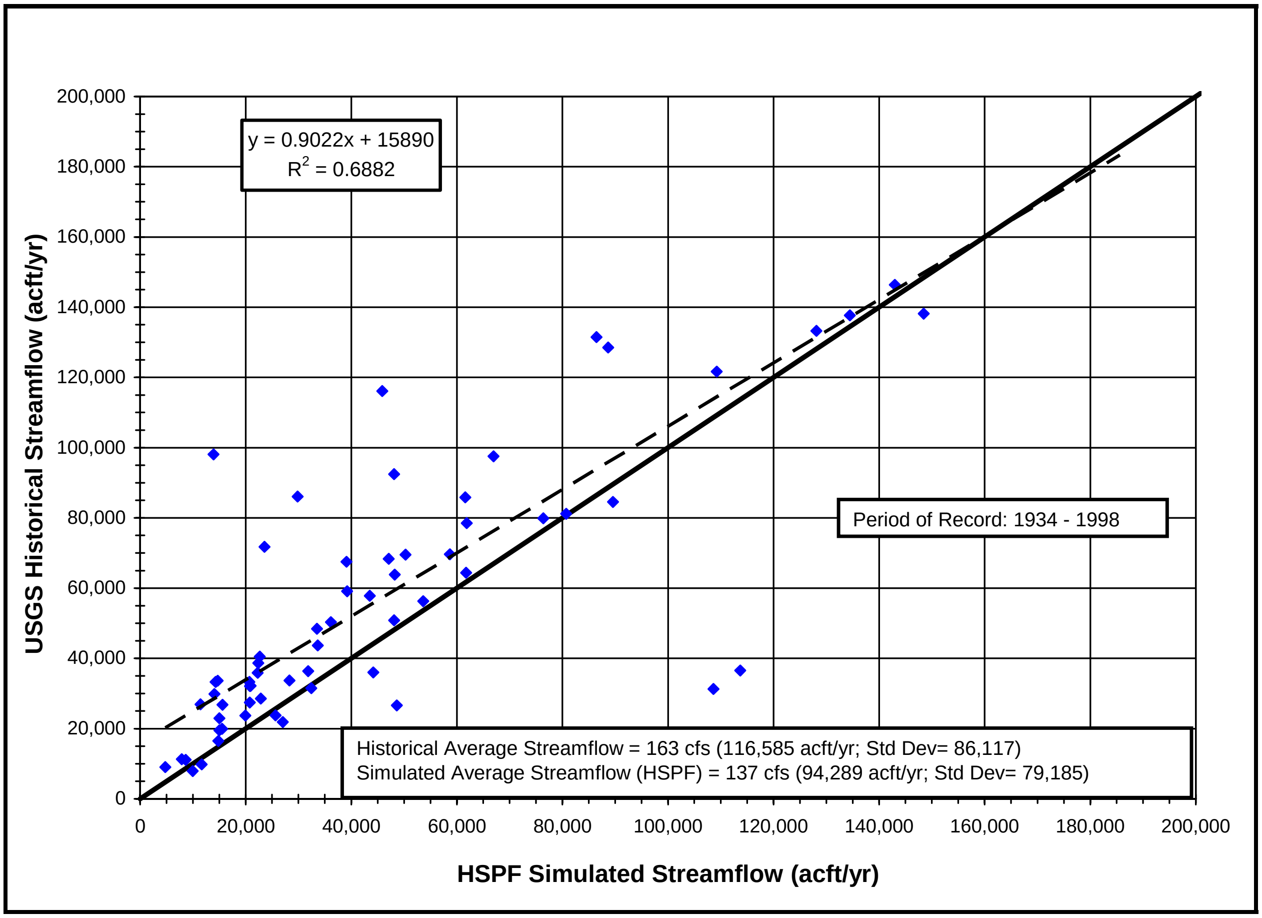

Figure D-3. Nueces River at Laguna- Annual Streamflow Comparison (1934-1998)

D.2 Model Calibration of the Blanco Recharge Basin Study Area

The original Blanco Recharge study area represented in EAA's Pilot Recharge Models of the Nueces and Blanco River Basins (HDR, 2002) consisted of an upper boundary at the gauging station on the Blanco River at Wimberley (USGS # 08171000) and a lower boundary defined by the gauging station on the Blanco River near Kyle (USGS# 08171300). The study area was subdivided into land segments and river reaches. The model consisted of one land segment in the contributing zone (LS 101), four land segments in the recharge zone (LS 201- LS 204), and two land segments in the confined zone (LS 301- LS 302) as shown in Section 4C.28 (Figure 4C.28-2). The Blanco River was subdivided into several river reach segments, based upon channel loss surveys conducted by the Texas Board of Water Engineers.[3] There was one reach segment over the contributing zone (Reach 11) and five over the recharge zone (Reach 12-

[3] Texas Board of Water Engineers, "Channel Gain and Loss Investigations of Texas Streams (1918-1958), 1960.

Reach 16). Flood retardation structures over the ungaged land segments and channel losses for Sink, York, and Purgatory Creeks, which serve to enhance Edwards Aquifer recharge, were also modeled using HSPF.

To more accurately model the Blanco Recharge Basin, the upper boundary was extended to the upstream, contributing, ungauged headwaters of the Blanco River above USGS Gage 08171000-Blanco River at Wimberley by adding one land segment (LS 401) and associated Reach 10. Table D-3 includes the total area of each land segment and assigned land segment identification number. The length of each reach is listed in Table D-4.

The new upstream land segment (LS 401) was calibrated by comparing simulated streamflow from the HSPF model to historical USGS streamflow data at the gauging station on the Blanco River at Wimberley (USGS # 08171000) (1934-1998). Streamflow calibration was accomplished using daily streamflow frequency distribution and linear regression of annual flow values to compare model and historical streamflow data.

A daily streamflow frequency distribution was used to compare daily HSPF simulated streamflows to USGS historical streamflows during high and low flow conditions and presents data as a percentage of time that streamflow is exceeded. A frequency distribution comparing simulated to historical streamflow at USGS # 08171000 is shown in Figure D-4. As in the case for the Nueces Recharge Basin (Figure D-1), it is concluded that the HSPF model clearly performs quite well in simulating the frequency of occurrence of streamflows less than 500 cfs.

Table D-3. Blanco Recharge Basin Land Segments

Land Segment ID	Description	Area (sq. mi)
401	**Upstream Contributing**	**355.1**
101	Gauged Contributing	24.6
201	Gauged Recharge	28.3
202	Sink Creek Recharge	46.3
203	Purgatory Creek Recharge	35.0
204	York Creek Recharge	21.2
301	Gauged Confined	4.4
302	Ungaged Confined	11.5
	Total	526.4

Bolded entries indicate updates to the Recharge Model.

Note: Land segment area(s) for LS 101-102, 201-203, and 301-303 obtained from Pilot Recharge Models of Nueces and Blanco River Basins.

Table D-4. Blanco Recharge Basin River Reaches

River Reach ID	Description	Length (miles)
10	**Blanco River**	**60.3**
11	Blanco River	5.2
12	Blanco River	6.5
13	Blanco River	1.5
14	Blanco River	0.5
15	Blanco River	3.2
16	Blanco River	2.2

Bolded entries indicate updates to the Recharge Model.

Linear regression is used to measure how closely the simulated streamflows approximate the historical streamflows over the full range of observed annual values. Ideally, the regression equation would have a slope coefficient of 1.0, an intercept of 0.0, and coefficient of determination (r^2) of 1.0 indicating a perfect match between simulated and historical streamflows. Regression analysis was used to compare annual HSPF simulated streamflow to historical annual streamflow at USGS # 08171000-Blanco River at Wimberley with a slope of

0.94 and r^2 value of 0.75 (Figure D-5). The historical annual average streamflow for the Blanco River at Wimberley (1934-1998) is 102,784 acft/yr and the simulated annual average streamflow is 92,481 acft/yr, a difference of 10,302 acft/yr or about 10 percent.

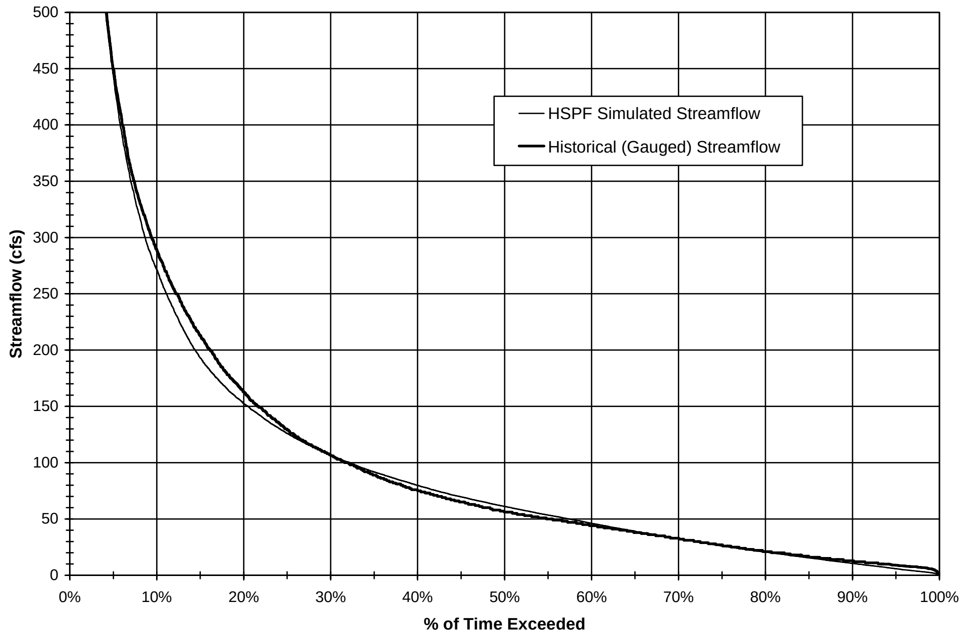

Figure D-4 Blanco River at Wimberley Frequency Distribution (Average Daily Flow, 1934-1998)

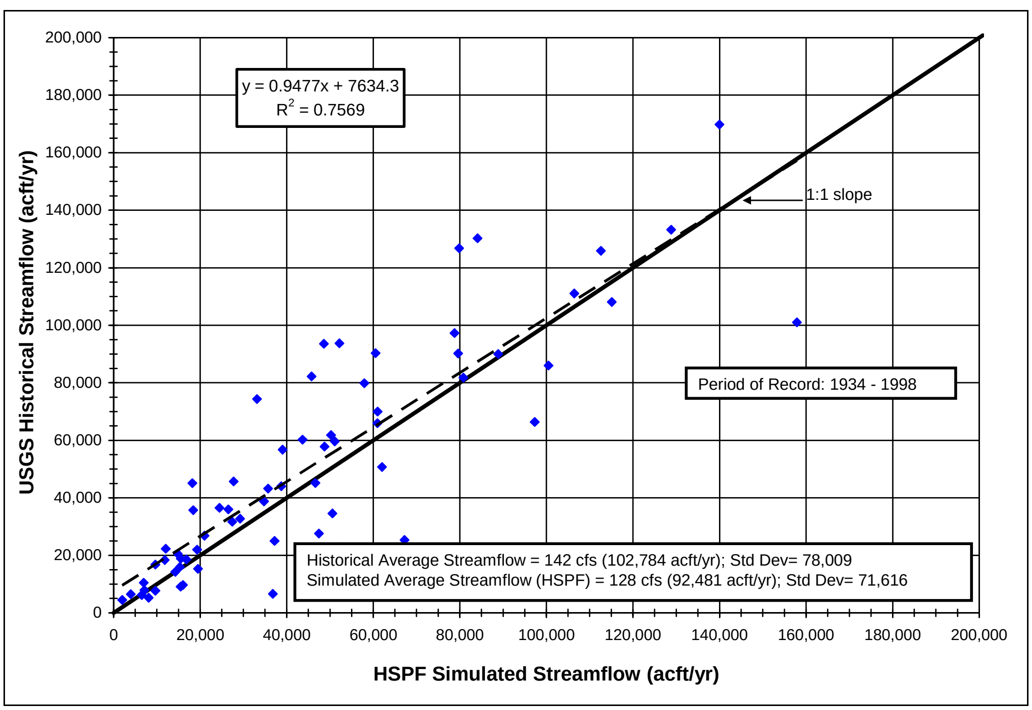

Figure D-5 Blanco River at Wimberley- Annual Streamflow Comparison (1934-1998)

(This page intentionally left blank.)