1.5 Transfer of Reclaimed Water to Corpus Christi through Choke Canyon Reservoir (L-14)

1.5.1 Description of Option

Previous studies[1] have shown that potential recharge enhancement projects over the Edwards and Carrizo Aquifers in the Nueces River Basin will reduce streamflows in the Nueces and Frio Rivers, which will in turn reduce the firm yield of the Choke Canyon Reservoir and Lake Corpus Christi (CCR/LCC) System. In order to mitigate reductions in the CCR/LCC System yield and to possibly develop additional yield greater than what is needed to replenish impacts of recharge dams, this option considers diverting SAWS reclaimed water and unappropriated water in the San Antonio River from a point near Falls City and transferring it to Choke Canyon Reservoir. This cooperative development of a water supply with the Nueces and Coastal Bend Regions through transfer of water from the South Central Texas Region could be used in exchange for other water supplies under development by the Nueces and Coastal Bend Regions which are closer in proximity to the South Central Region. As shown in Figure 1.5-1, the major facilities needed for this option include a diversion structure in the San Antonio River, surface water intake and pump station, transmission line to Choke Canyon Reservoir, and discharge structure in Choke Canyon Reservoir.

1.5.2 Available Yield

Using the general assumptions outlined in the Introduction, the GSA Model was applied to calculate water availability from the San Antonio River at Falls City for five diversion rates. The water available at Falls City is the sum of unappropriated water diverted under the Consensus Environmental Criteria (Appendix B) and the SAWS reclaimed water delivered via bed and banks subject to channel losses and intervening water rights. Figure 1.5-2 compares average annual diversions for each project at maximum capacity, for the period of record, and for the critical drought. As shown, increases in diversion capacity start to have less of an effect on increases in average annual diversion amounts in excess of that for the 60-inch transmission pipeline. During the critical drought, the increase from the 60-inch pipeline to the 96-inch pipeline, a 156 percent increase in capacity, results in only a 21 percent increase in average

[1] HDR Engineering, Inc., "Edwards Aquifer Recharge Enhancement Project Phase IV-A," Edwards Underground Water District, June 1994.

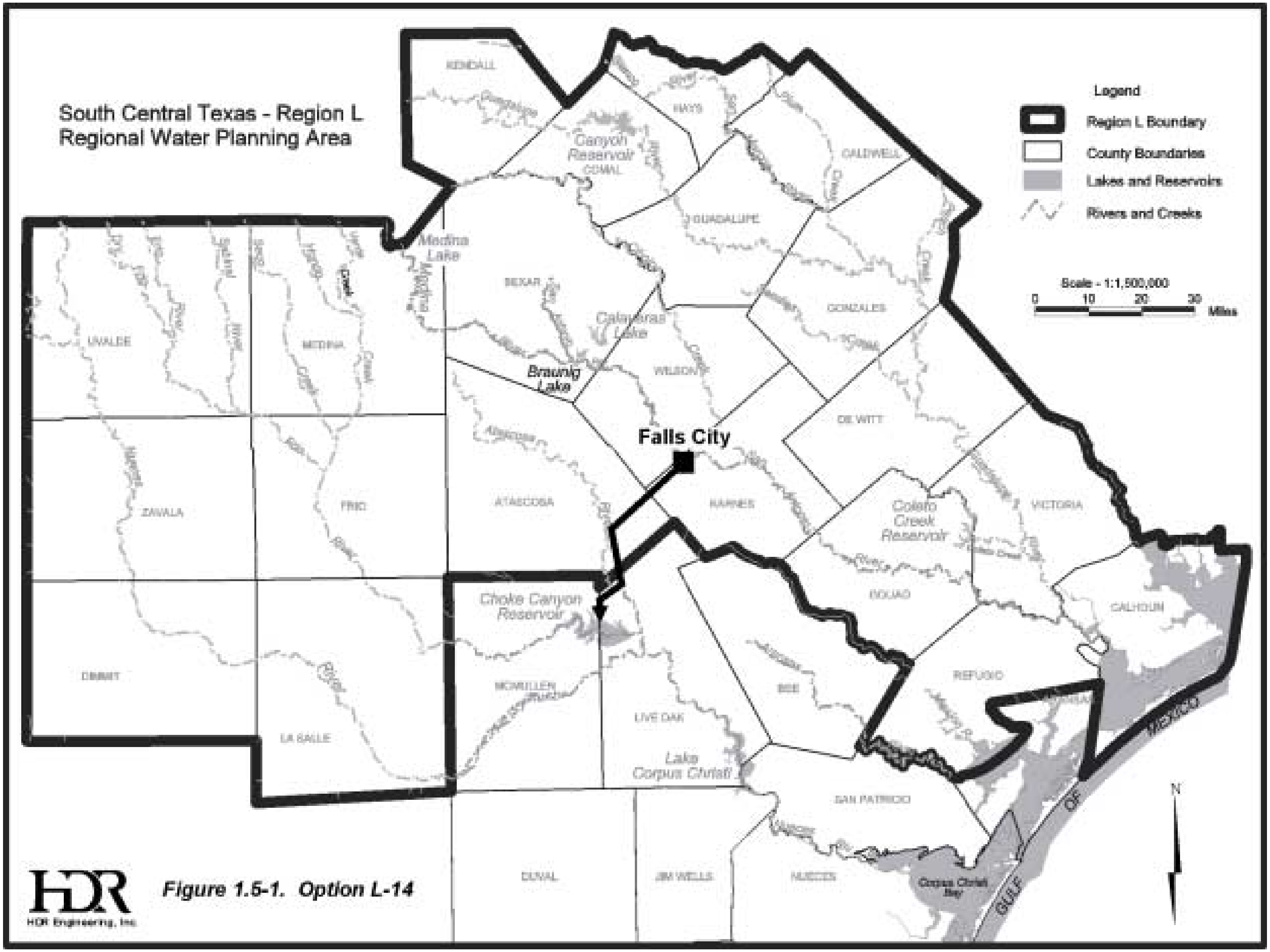


Figure 1.5-1. Option L-14

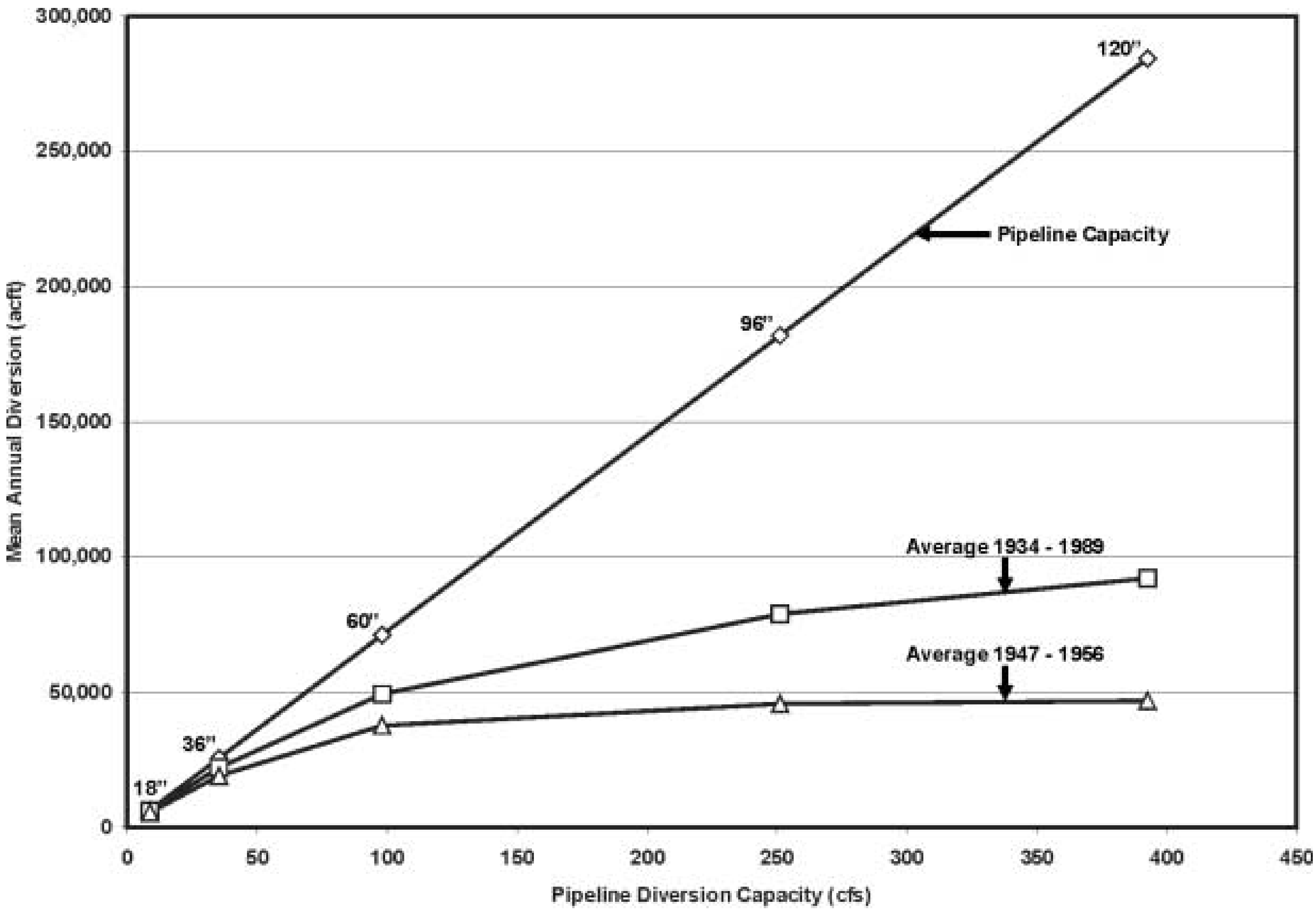


Figure 1.5-2. Water Available for Diversion from San Antonio River at Falls City

annual diversion. Of the average annual diversions, reclaimed water accounts for most of the flow. Reclaimed water makes up almost 100 percent of the flow for the 18-inch and 36-inch pipelines, and contributes to 93 percent, 80 percent, and 69 percent of the pipelines for the 60-inch, 96-inch, and 100-inch diversions, respectively.

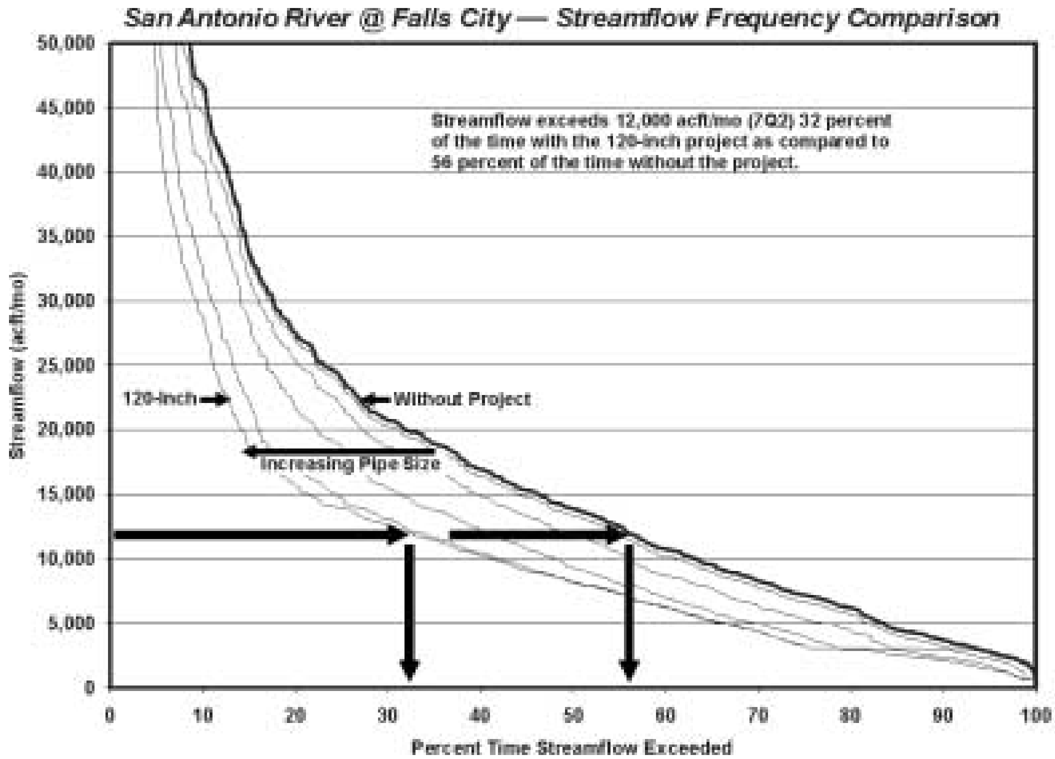
The impacts to streamflow in the San Antonio River at Falls City for the five diversion rates are shown in Figure 1.5-3. The upper plot compares the streamflow frequency with and without the project for each of the diversion rates. As the curves move to the left, the diversion rate increases. At Falls City, TNRCC's published 7Q2 is 197.3 cfs,[2] or approximately 12,000 acft/month. As shown in Figure 1.5-3, streamflow would exceed 12,000 acft/month 32 percent of the time with the 120-inch project, as compared to 56 percent of the time without the project. The 18-inch, 36-inch, 60-inch, and 96-inch projects exceed the 12,000 acft/month 55 percent of the time, 49 percent of the time, 41 percent of the time, and 34 percent of the time, respectively.

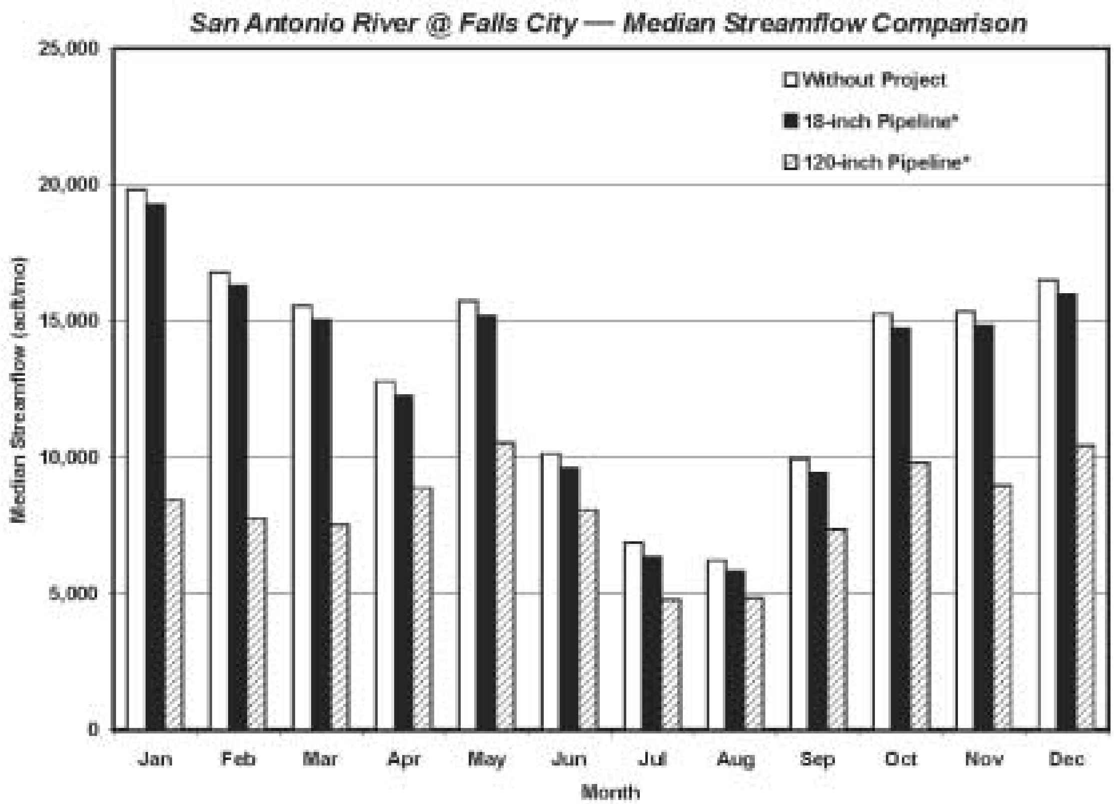
Figure 1.5-3 also shows a comparison of monthly median flows for the largest and smallest projects to the monthly median flows without the project. In August, the month with the lowest median streamflow, monthly median flows over the period are reduced by 7 percent for the 18-inch project and 22 percent for the 120-inch project. As with the 18-inch and 120-inch projects, the median monthly flows for the three other diversion rates decrease as the respective diversion rates increase. Figure 1.5-4 displays similar streamflow comparisons at the Saltwater Barrier. As the size of the project increases, the percent of time streamflow is exceeded decreases. In July, the month with the lowest monthly median flow, median streamflows are reduced by less than 1 percent with the 18-inch project, and 3 percent for the 120-inch project at the Saltwater Barrier.

In order to calculate enhancement of the Corpus Christi Water Supply System yield (including the CCR/LCC System and Lake Texana), the Nueces River Basin Model and the Lower Nueces River Basin and Estuary Model (Nubay) were applied with the following assumptions:

- 1934 to 1989 period of record;
- 2010 sediment conditions;
- Monthly diversions from Falls City summed from daily analysis imported to Choke Canyon Reservoir;

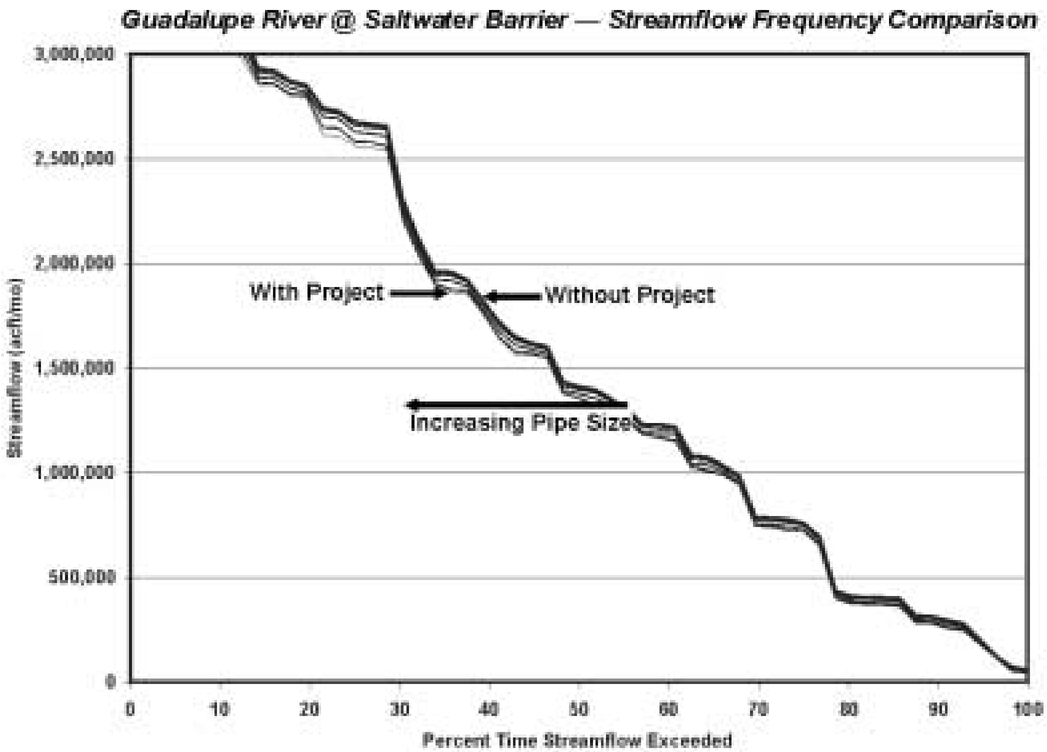
[2] Texas Administrative Code, Chapter 307, Texas Surface Water Quality Standards.





*The 18-inch and 120-inch pipeline represent the minimum and maximum impacts to the monthly median streamflows at Falls City, respectively. The impacts of the other diversion rates lie between the minimums and maximums established by the 18-inch and 120-inch pipeline.

Figure 1.5-3. Transfer of Reclaimed Water, San Antonio River Streamflow Comparisons



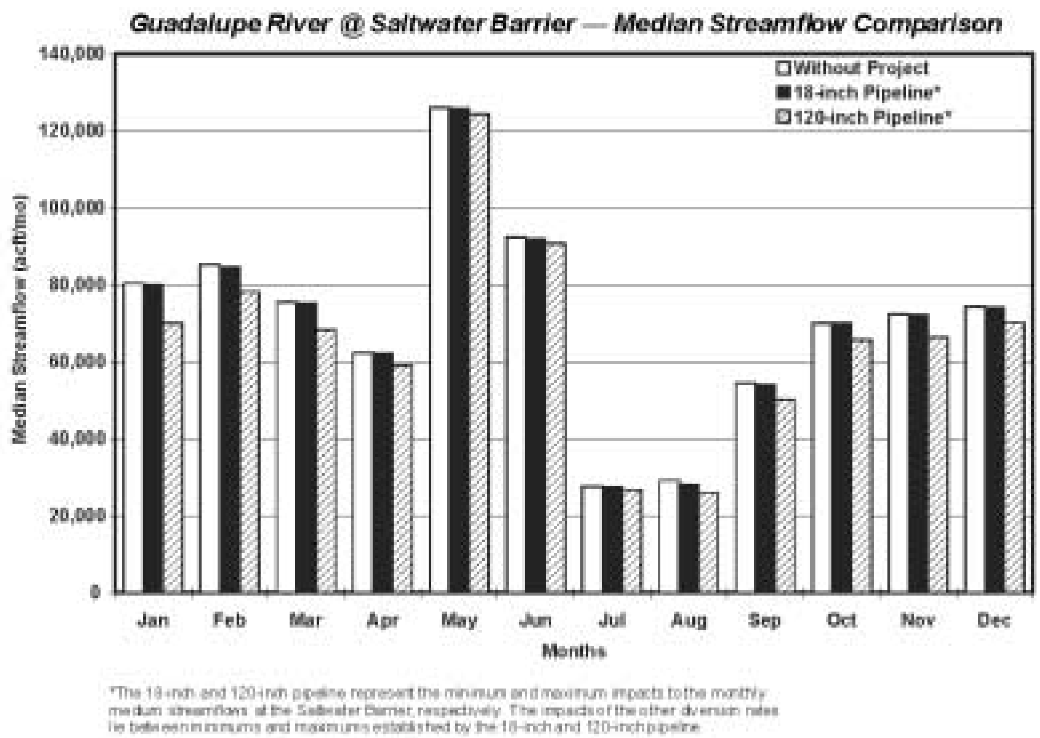


Figure 1.5-4. Transfer of Reclaimed Water, Guadalupe River Streamflow Comparisons

- The City of Corpus Christi's Phase IV[3] (maximum yield) Operations Policy governs the CCR/LCC System operations; and
- Pumpage from Lake Texana of 41,840 acft/yr.

It is important to note that the critical drought for the Nueces River Basin is not included in the 1934 to 1989 simulation limits of the GSA Model. Based on recent updates to the Nueces River Basin and the Nubay Models,[4] the drought of the 1990s is the new critical drought for the Lower Nueces River Basin. The yield of the CCR/LCC System has been reduced by about 2.5 percent (4,000 acft/yr) as a result of the 1990s drought. Since the GSA Model only simulates the 1934 to 1989 period, it is assumed that the incremental change in CCR/LCC System yield from the Falls City imports over the 56-year period is assumed representative of that which would occur by including the 1990s.

Table 1.5-1 displays annual statistics and the Corpus Christi Water Supply System yields for each San Antonio River diversion rate. The potential to mitigate or enhance the yield ranges from 3,000 acft/yr for the 18-inch diameter pipeline to 33,000 acft/yr with a 120-inch diameter pipeline. These estimates of yield are considered a reliable supply based on the period of hydrologic record considered. As shown in Table 1.5-1, the smaller diversions provide less yield, but make more efficient use of their capacities, as seen by the median annual pumpage approaching the potential maximum annual pumpage volume for the smaller pipe diameters. The larger diameter pipes can capture larger events, but, on average, use approximately half their capacity over the 56-year simulation period.

1.5.3 Environmental Issues

Option L-14 diverts San Antonio River flow at Falls City via a transmission line running southwest around the City of Campbellton and then south to Choke Canyon Reservoir. Proposed facilities include a diversion structure in the San Antonio River near Falls City and an estimated 40-mile transmission line to Choke Canyon Reservoir. This option is entirely within the South Texas Plains Ecoregion and the corresponding South Texas Plain vegetational area.[5,6]

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[3] City of Corpus Christi Code of Ordinances, Chapter 55, Utilities, Article XII, Water Conservation, Section 55-156, Water Conservation and Drought Contingency Plan.
[4] HDR Engineering, Inc., "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, Texas, 1999.
[5] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1) pp. 118-125, 1987.
[6] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.

Table 1.5-1.
Diversions at Falls City and Yield Increases
to the Corpus Christi Water Supply System

Pipe Size (inches)	*Maximum Potential Pumpage (acft/yr)*	*Maximum Pumpage (acft/yr)*	*Average Pumpage (acft/yr)*	*Median Pumpage (acft/yr)*	*CCR/LCC Firm Yield (acft/yr)*	*Incremental Change in Yield (acft/yr)*	*Yield Increase (acft/yr)*
18	6,372	6,372	5,936	6,247	249,305	3,028	3,028
36	25,585	25,562	22,019	22,439	258,753	9,448	12,476
60	71,072	69,318	49,215	49,391	270,180	11,427	23,903
96	181,955	154,843	78,802	73,251	279,030	8,850	32,753
120	284,302	215,267	92,100	79,263	279,030	0	32,753

The South Texas Plains is dissected by streams flowing into the Rio Grande River and the Gulf of Mexico. Soils in this area range from clays to sandy loams, and vary in reaction from very basic to slightly acid. This wide range of soil types is responsible for great differences in soil drainage and moisture holding capacities within the region.[7,8] Wetlands in the project area consist of riverine habitats of the Atascosa and the San Antonio Rivers, their tributaries, and associated palustrine habitats, typically wetlands along the river basins.[9]

The transmission line corridor is within a wide band of mesquite-blackbrush brushlands and mesquite-granjeno woods surrounded by cropland. Construction would impact an estimated 710 acres of right-of-way, and maintenance activities would permanently affect about 240 acres for the 60-inch project, which yields the least cost per unit volume of water. Mesquite-blackbrush brushlands are the main vegetational community (70 percent) in the proposed project corridor. The brushlands are dominated by honey mesquite, blackbrush, and other thornbrush species, including lotebush, ceniza, whitebrush, agarito, granjeno, yucca, Texas pricklypear, bluewood, and desert yaupon. The herbaceous layer is a mixture of purple three-awn, pink pappusgrass, hairy tridens, hairy grama, coldenia, and dogweed.[10] The mesquite-granjeno woods occupy a central band between the brushland corridor that is more typical of the South Texas Plains of Kleberg and Jim Wells Counties. This dense wood is characterized by honey mesquite,

[7] Ibid.
[8] McMahan, C.A., Frye, R.G., and Brown, K.L., "The Vegetation Types of Texas," Texas Parks and Wildlife Department, Austin, Texas, 1984.
[9] Ibid.
[10] McMahan, C.A., et al., Op. Cit., 1984.

granjeno, retama, bluewood, woollybucket bumelia, catclaw, tasajillo, lotebush, whitebrush, and desert yaupon. The woods are about 30 percent of the total area within the corridor. The brushland and the relatively dense woods provide the best wildlife habitat for endemic species, such as the regionally important and protected jaguarundi, ocelot, and Texas tortoise. An estimated 240 vertebrate species utilize this habitat type, including 5 amphibians, 45 reptiles, 150 birds, and 41 mammals.[11]

Depending on the transmission line alignment, construction impact may be minimized or avoided by locating in less-sensitive cropland and cattle-grazed upland brushland whenever possible. Construction impacts across rivers and streams should be minimized. Although water quality and biota of the Nueces and San Antonio Rivers are similar, an analysis of potential effects arising from water quality differences or from the introduction of organisms not native to the Nueces River Basin should be conducted.

Although the Natural Heritage Program does not report any endangered or threatened species directly along the proposed pipeline corridor, some have been reported in the vicinity. Many of these appear to be dependent on thornbrush and woods habitat, such as the Jaguarundi, Ocelot, Texas Tortoise, Indigo Snake, Reticulated Collared Lizard, Texas Scarlet Snake, and Texas Horned Lizard. The Texas Garter Snake, Black-spotted Newt, Sheep Frog, and Lesser Rio Grande Siren may be present in wetland habitats. Mapped vascular plants that are of concern in the area and in close contact to the pipeline are the Silvery Wild-mercury, Drummond Rushpea, and Crown Coreopsis. Table 1.5-2 accounts for species mapped or in the vicinity of Atascosa, Karnes, and McMullen Counties. Surveys for protected species or other biological resources of restricted distribution, or other importance, would be conducted within the proposed construction corridor where potential habitat is present.

Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL 96-515), and the Archaeological and Historic Preservation Act (PL 93-291). All areas to be disturbed during construction would be surveyed by qualified professionals for the presence of significant cultural resources. Additional measures to mitigate impacts may be required by the presence of significant cultural deposits that cannot be avoided.

[11] Blair, W. Frank, "The Biotic Provinces of Texas," Texas Journal of Science, Vol. 2, No. 1: pp. 93-112, 1950.

Table 1.5-2.
Important Species* Having Habitat or Known to Occur in Counties Potentially Affected by Option[1]
Transfer of Reclaimed Water to Corpus Christi through Choke Canyon Reservoir (L-14)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Agency USFWS[2]	TPWD[2]	TOES[3,4]	Potential Occurrence in County
American Peregrine Falcon	*Falco peregrinus anatum*	Open country; cliffs	E	E	E	Nesting/Migrant
Arctic Peregrine Falcon	*Falco peregtinus tundrius*	Open country; cliffs	E	T	E	Nesting/Migrant
Audubon's Oriole	*Icterus antillarum athalassos*	South Texas; Mesquite and evergreen woodlands	C2		NL	Nesting/Migrant
Black-spotted Newt	*Notophthalmus meridionalis*	Wet or temporally wet arroyos, canals, ditches, shallow depressions; aestivates underground during dry periods		T	E	Resident
Cave Myotis Bat	*Myotis velifer*	Colonial & cave dwelling; hibernates in limestone caves of Edwards Plateau			NL	Resident
Crown Coreopsis	*Coreopsis nuecemsis*				NL	Resident
Drummond Rushpea	*Caesalpinia drummondii*				NL	Resident
Elmendorf's Onion	*Allium elmendorfii*	Endemic; deep sands derived from Queen City and similar Eocene formations			WL	Resident
Henslow's Sparrow	*Ammodramus henslowii*	Weedy fields or cut over areas; bare ground for running and walking			NL	Nesting/Migrant
Indigo Snake	*Drymarchon corais erebennus*	Grass prairies and sand hills; usually thornbush woodland and mesquite savannah of coastal plain		T	WL	Resident
Interior Least Tern	*Sterna antillarum athalassos*	Inland river sandbars for nesting and shallow water for foraging	E	E	E	Nesting/Migrant
Jaguarundi	*Felis yagouaroudi*	South Texas thick brushlands, favors areas near water	E	E	E	Resident
Keeled Earless Lizard	*Holbrookia propinqua*	Coastal dunes, Barrier islands and sandy areas			NL	Resident
Maculated Manfreda Skipper	*Stallingsia maculosus*	Usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk				Resident
Ocelot	*Felis pardalis*	Dense chaparral thickets; mesquite-thorn scrubland and live oak mottes; avoids open areas; primarily extreme south Texas	E	E	E	Resident
Parks' Jointweed	*Polygonella parksii*	South Texas Plains; subherbaceous annual in deep loose sands, spring-summer			WL	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	Catholic; Wooded, brushy areas and tallgrass prairies			NL	Resident
Reticulate Collared Lizard	*Crotaphytus reticulatus*	Endemic grass prairies of South Texas Plains; usually thornbush, mesquite-blackbrush		T	T	Resident
Sandhill Woolywhite	*Hymenopappus carrizoanus*	Endemic; Open areas in deep sands derived from Carrizo and similar Eocene formations			NL	Resident
Sheep Frog	*Hypopachus variolosus*	Wet areas of the Rio Grande Valley, lower South Texas Plains, Southern Coastal Prairie and marshes		T	T	Resident
Silvery Wild-Mercury	*Argythamnia argyraea*	South Texas Plains, perennial herb, also in Kinney, LaSalle and Maverick Counties			WL	Resident

Table 1.5-2 (continued)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Agency USFWS[2]	Listing Agency TPWD[2]	Listing Agency TOES[3,4]	Potential Occurrence in County
Siren, Lesser, Rio Grande	*Siren intermedia texana*	Wet or temporally wet areas such as arroyos, canals, ditches and shallow depressions; requires moisture to remain	C2	E	E	Resident
South Texas Rushpea	*Caesalpinia phyllanthoides*	Thorn shrublands or grasslands on shallow sandy to clayey soils			WL	Resident
Spot-tailed Earless Lizard	*Holbrookia lacerata*	Oak-juniper woodlands and mesquite-prickly pear			NL	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	Varied, especially wet areas; bottomlands and pastures			NL	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands		T	T	Resident
Texas Scarlet Snake	*Cemophora coccinea lineri*	Mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September			WL	Resident
Texas Tortoise	*Gopherus berlandieri*	Open brush with grass understory; open grass and bare ground avoided; occupies shallow depressions at base of bush or cactus, undergound burrows, under objects; active March-Nov		T	T	Resident
White-faced Ibis	*Plegadis chihi*	Varied, prefers freshwater marshes, sloughs and irrigated rice fields; Nests in low trees		T	T	Nesting/Migrant
Whooping Crane	*Grus americana*	Potential migrant	E	E	E	Migrant
Yellowshow	*Amoreuxia wrightii*	Thorn shrublands on clayey calcareous soils; shortgrass grasslands along southern edge of Edwards Plateau			WL	Resident

[1] Texas Parks and Wildlife Department. Unpublished 1999. September 1999, Data and map files of the Natural Heritage Program, Resource Protection Division, Austin, Texas.
[2] Texas Organization for Endangered Species (TOES). 1995. Endangered, threatened, and watch list of Texas vertebrates. TOES Publication 10. Austin, Texas. 22 pp.
[3] Texas Organization for Endangered Species (TOES). 1993. Endangered, threatened, and watch list of Texas plants. TOES Publication 9. Austin, Texas. 32 pp.
[4] Texas Organization for Endangered Species (TOES). 1988. Invertebrates of Special Concern. TOES Publication 7. Austin, Texas. 17 pp.

E = Endangered T = Threatened 3C = No Longer a Candidate for Protection C2 = Candidate Category
C1 = Candidate Category, Substantial Information WL Potentially Endangered/Threatened Blank = Rare, but no regulatory listing status

1.5.4 Engineering and Costing

The major cost elements for this option include the San Antonio River diversion structure, water intake and pump station(s), transmission line to Choke Canyon Reservoir, and the discharge structure into the reservoir. Table 1.5-3 summarizes the capital and O&M cost for each of the five diversion rates. The optimum diversion rate on a dollar per acft of system yield increase basis is the 60-inch diameter project. However, for recharge enhancement mitigation, the pipe that delivers the necessary mitigation volume for the respective recharge enhancement program could be used and included as a part of the costs for those options (Options L-17, L-18, and/or SCTN-7).

Table 1.5-3.
Cost Estimate for Transfer of Reclaimed Water to Corpus Christi through Choke Canyon Reservoir (L-14)
(Second Quarter 1999 Prices)

Item	*18-inch Project*	*36-inch Project*	*60-inch Project*	*96-inch Project*	*120-inch Project*
Capital Costs					
Intake Structure	$2,303,000	$3,513,000	$4,140,000	$4,783,000	$5,194,000
Outlet Structure	23,625	94,675	263,375	673,200	1,053,250
Intake Pump Station	1,240,658	4,027,790	5,748,717	7,783,618	9,319,853
Transmission Pump Stations	1,868,869	0	0	0	0
Transmission Pipeline (40 miles)	19,209000	28,666,000	42,833,000	81,355,000	123,261,000
Total Capital Costs	**$24,645,152**	**$36,301,465**	**$52,985,092**	**$94,594,818**	**$138,828,103**
Engineering, Contingencies, and Legal Costs	$7,393,000	$10,890,000	$15,896,000	$28,378,000	$41,648,000
Environmental & Archaeology Studies, Mitigation, and Permitting	990,000	987,000	987,000	987,000	987,000
Land Acquisition and Surveying	1,382,000	1,376,000	1,834,000	1,834,000	1,834,000
Interest During Construction[1]	2,753,000	3,965,000	5,737,000	10,064,000	14,664,000
Total Project Cost	**$37,163,152**	**$53,519,465**	**$77,439,092**	**$135,857,818**	**$197,961,103**
Annual Costs					
Debt Service (6 percent for 30 years)	$2,700,000	$3,888,000	$5,626,000	$9,870,000	$14,382,000
Intake, Pipeline, Pump Station Operation and Maintenance	210,000	358,000	540,000	954,000	1,416,000
Pumping Energy Costs[2]	510,000	776,000	934,000	1,506,000	1,748,000
Total Annual Cost	**$3,420,000**	**$5,022,000**	**$7,100,000**	**$12,330,000**	**$17,546,000**
Available Project Yield (acft/yr)[3]	3,028	12,476	23,903	32,753	32,753
Total Annual Cost of Water ($ per acft)	$1,130	$403	$297	$376	$536
Total Annual Cost of Water ($ per 1,000 gallons)	$3.47	$1.24	$0.91	$1.16	$1.64

[1] Based on 6 percent interest and 4 percent reinvestment over a 2-year term.

[2] Pumping energy costs based upon $0.06 per kWh.

[3] Increase in firm yield of Corpus Christi Water Supply System.

1.5.5 Implementation Issues

Since this option involves delivering SAWS reclaimed water via the San Antonio River, a bed-and-banks permit from the TNRCC may be required to transfer the water from the wastewater plants to the point of diversion near Falls City. Implementation of this diversion of reclaimed water from the San Antonio River could directly affect the feasibility of other water supply options under consideration, including L-11, L-20, S-14D, S-15Da, S-15Db, S-15Dc, S-15Ea, S-15Eb, S-16C, SCTN-14b, SCTN-16a, SCTN-16b, and/or SCTN-16c.

Requirements Specific to Pipelines

1. Necessary permits:
   a. TNRCC Interbasin Transfer permit.
   b. USCE Sections 10 and 404 dredge and fill permits for stream crossings.
   c. GLO Sand and Gravel Removal permits.
   d. Coastal Coordination Council review.
   e. TPWD Sand, Gravel and Marl permit for river crossings.
2. Right-of-way and easement acquisition.
3. Crossings:
   a. Highways and railroads
   b. Creeks and rivers
   c. Other utilities

If the Regional Water Planning Group decides to move forward with further consideration of this water supply option, studies will need to include water quality compatibility studies of the co-mingled water in Choke Canyon Reservoir.