Executive Summary

ES.1 Introduction

For more than four decades, the Texas Water Development Board (TWDB) has been responsible for developing and updating the Texas State Water Plan in cooperation with other state agencies and numerous regional, local, and private interests across the State (Figure ES-1). Approximately 100 potential reservoirs have been identified or recommended in the various State Water Plans completed during this period and many more reservoir sites have been considered by state or federal agencies, river authorities, and others. While some of these reservoirs have been constructed, many remain under consideration today as demands for reliable surface water supplies for municipal, industrial, steam-electric power generation, and other purposes continue to grow.

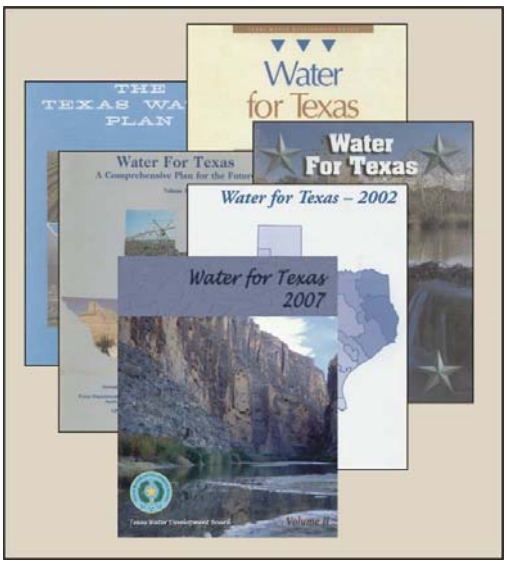

Figure ES-1. State Water Plans

The 2007 State Water Plan recommends the Legislature consider 17 major reservoir sites identified by Regional Water Planning Groups and the TWDB for protection by designation as unique reservoir sites. The Texas Water Code provides that *the legislature may designate a site of unique value for the construction of a reservoir* [Section 16.051(f)(2)] and that *a state agency or political subdivision of the state may not obtain a fee title or an easement that would significantly prevent the construction of a reservoir on a site designated by the legislature under Subsection (f) of this section* [Section 16.051(g)(2)]. Lack of such designation has allowed state, federal, or local governments or private entities to take actions that have significantly impacted the feasibility of constructing reservoirs at some sites. A recent example of such an action is the unilateral establishment of the Neches River National Wildlife Refuge by the U.S. Fish & Wildlife Service on the site of the only new reservoir planned by the City of Dallas in the next 50 years and included in the 2007 State Water Plan.

Perhaps the most certain means of ensuring protection for unique reservoir sites is acquisition of the properties necessary for the reservoir projects, holding such properties in the

public trust, and preventing conversion or uses of the properties for purposes ultimately precluding future reservoir development. Reservoir site acquisition must be considered in the context of compensatory ecological resource protection and preservation for mitigation of valuable ecological resources lost to permanent inundation. Hence, this research project includes land cover classification for reservoir sites potentially included in an acquisition program. Most importantly, this research project includes development and application of technical resources and matrix screening processes necessary to provide recommendations as to the most appropriate reservoir sites for State protection and/or acquisition.

Major tasks accomplished in this research project are listed as follows and summarized in Figure ES-2:

(1) Research and data compilation for about 150 potential reservoir projects;

(2) Adoption of screening criteria and application of a matrix screening process resulting in the selection of 16 reservoir sites for technical evaluation;

(3) Application of geographic information system (GIS) techniques for definition and mapping of reservoir sites including elevation-area-capacity relationships, potential conflicts, and land cover classification;

(4) Assessment of reservoir firm yield available under drought of record conditions subject to senior water rights and provisions for environmental flow needs;

(5) Estimation of costs associated with dams and appurtenant structures, major relocations, and acquisition of reservoir and mitigation lands; and

(6) Recommendation of reservoir sites for protection and/or acquisition.

Although the primary objective of this study is selection of reservoir sites most appropriate for protection, it is understood that such protection as may be afforded by the Legislature is not intended to circumvent the planning and permitting processes through which any major reservoir project must meet the requirements of applicable law prior to implementation. It is further understood that designation of reservoir sites recommended herein as unique, and even acquisition of these sites, does not preclude the planning, permitting, and construction of major reservoirs at alternative sites.

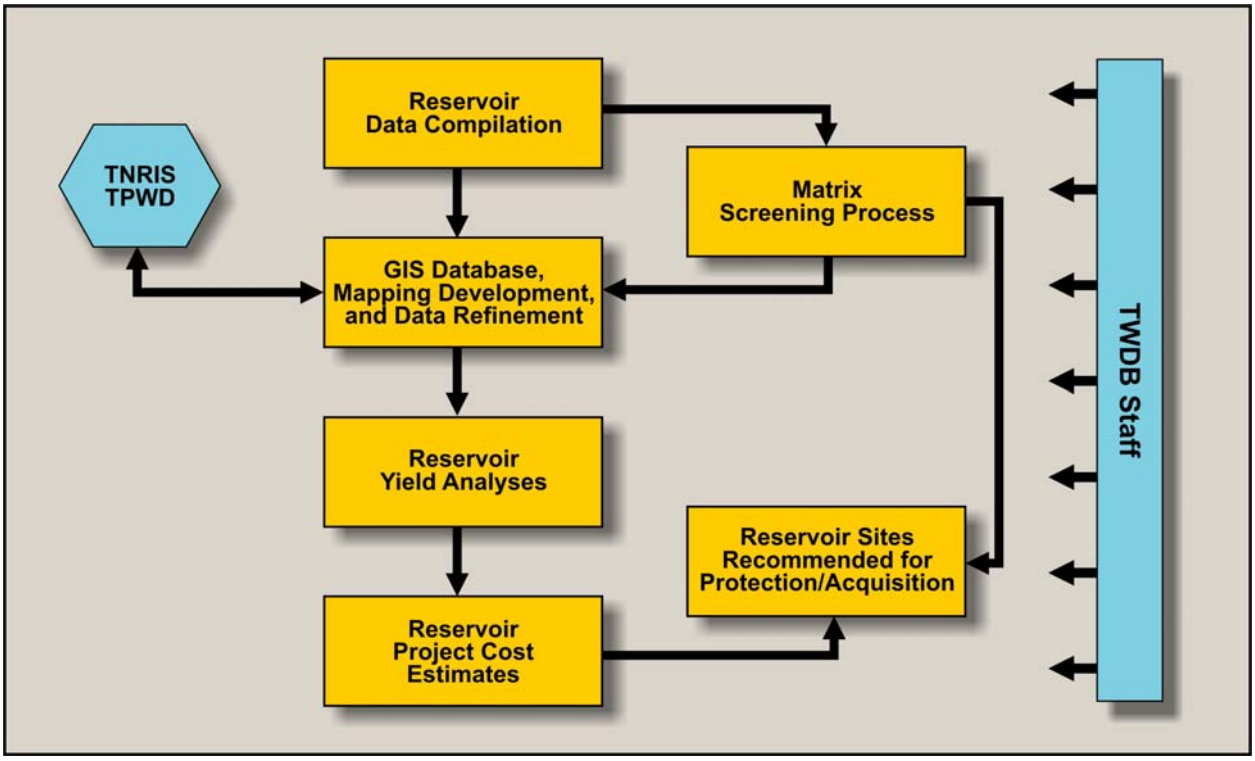

Figure ES-2. Reservoir Site Protection Study Tasks

ES.2 Reservoir Site Screening Process

Research in the course of this study has identified over 220 major reservoir sites in Texas that have been included in State or Regional Water Plans or in significant planning studies by state or federal agencies, river authorities, or water districts interested in water supply development. For the purposes of this study, a major reservoir is defined to be one having a conservation storage capacity of at least 5,000 acft. To date, reservoirs have been constructed at approximately 70 of these sites. For the remaining number of about 150 reservoir sites, consultants have conducted intensive library and archive research to compile key descriptive information including reservoir name, river basin and state water planning region location, firm yield, unit cost of raw water at the reservoir, and surface area at the proposed conservation storage pool level. Figure ES-3 shows the locations of the reservoir sites considered in the matrix screening process.

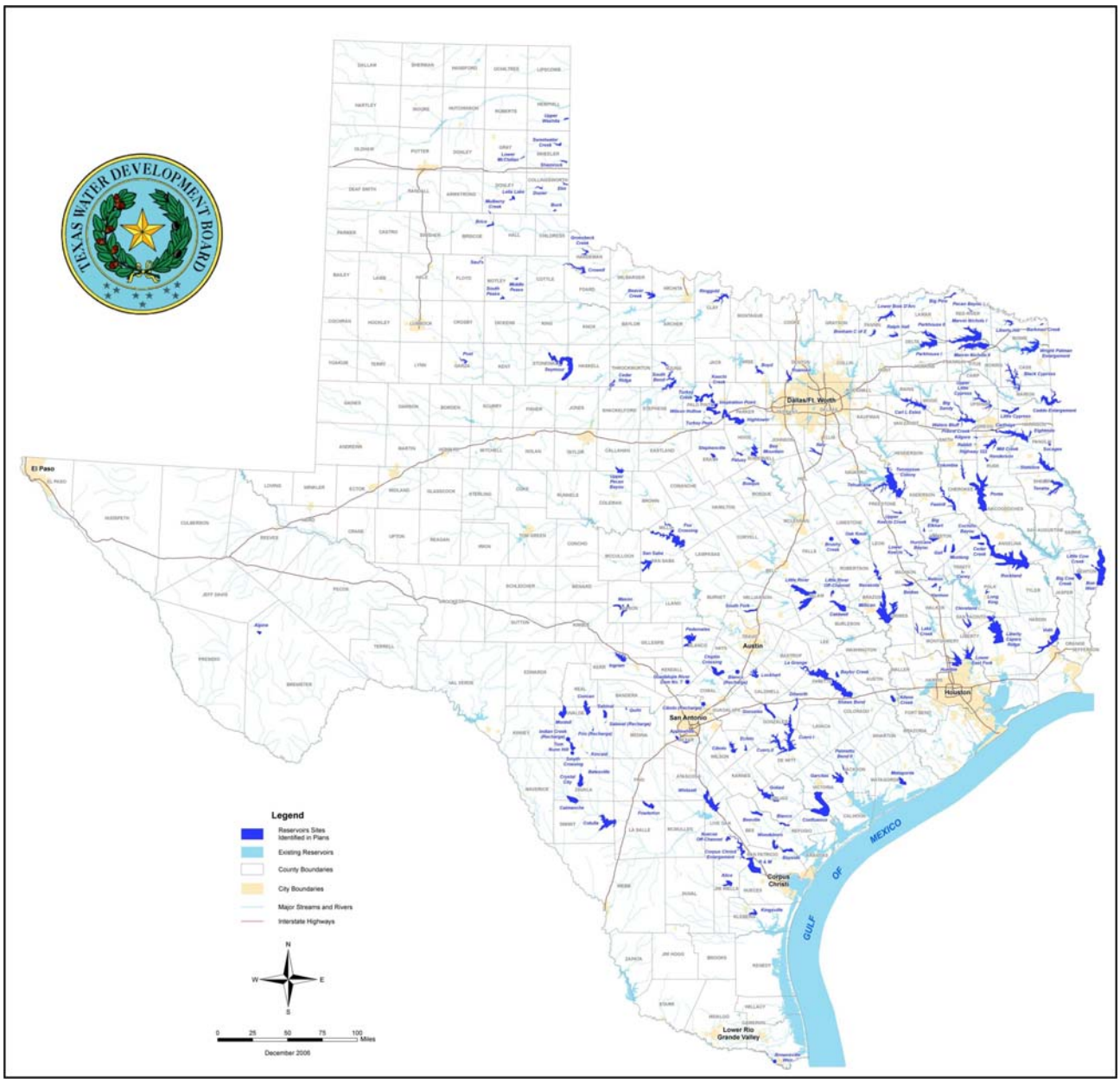

Figure ES-3. Reservoir Sites Identified in Plans

Eleven screening criteria and the relative weightings of these criteria were adopted by TWDB staff and the consultants for the reservoir site screening process. These criteria are listed as follows in the order of relative importance based on an assigned integer weighting from five (most important) to one (least important).

- Recommended Water Management Strategy or Unique Reservoir Site in the 2007 State Water Plan (5)
- Firm Yield (5)
- Unit Cost of Water (4)

- Special Considerations (3)
- Ecologically Significant Stream Segment (3)
- Terrestrial Impacts (2)
- Water Supply Needs within 50 Miles (2)
- Least Distance to a Major Demand Center (2)
- System Operations Opportunity (2)
- Water Quality Concerns (1)
- Yield per Unit Surface Area (1)

The 19 top-ranked sites for protection or acquisition are shown in Figure ES-4 and listed in alphabetical order as follows:

- Allens Creek
- Bedias
- Brownsville Weir
- Brushy Creek
- Cedar Ridge (Breckenridge)
- Columbia (Eastex)
- Cuero II (Sandies Creek, Lindenau)
- Fastrill (Weches)
- Lower Bois d'Arc Creek
- Marvin Nichols IA
- Nueces Off-Channel
- Palmetto Bend – Stage II
- Parkhouse I
- Parkhouse II
- Post
- Ralph Hall
- Ringgold
- Tehuacana
- Wilson Hollow

As indicated in Figure ES-4, three reservoir sites (Allens Creek, Columbia, and Post) have already been designated as unique by the Texas Legislature, 12 are recommended unique reservoir sites in the 2007 State Water Plan, and four are recommended for designation as unique reservoir sites as a result of this study. There are certainly other viable reservoir sites and some of them may be suitable for designation as unique. Study funds, however, were sufficient to update technical information for only the 16 top ranked sites not previously designated as unique.

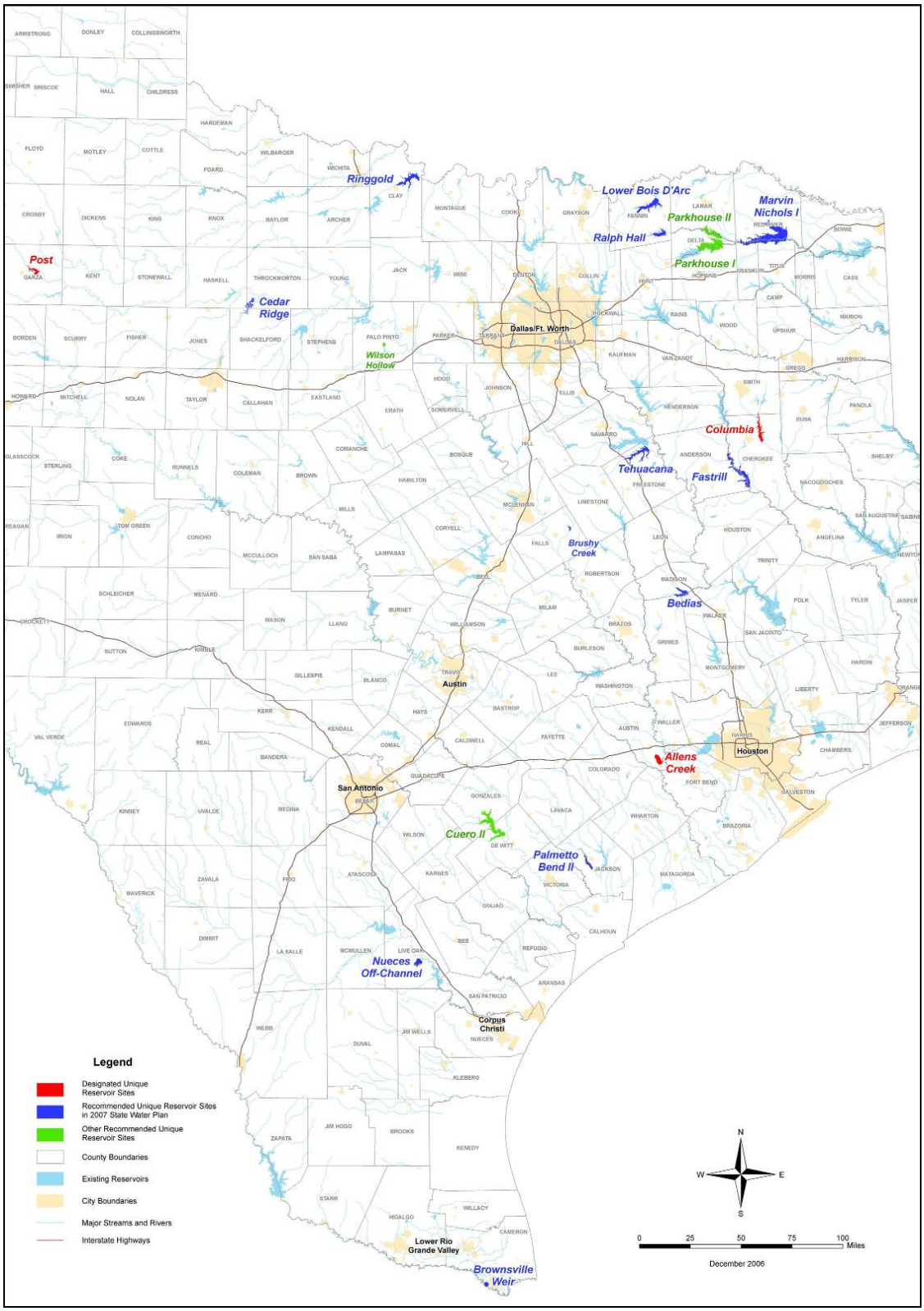

Figure ES-4. Designated and Recommended Unique Reservoir Sites

ES.3 Reservoir Sites Recommended for Protection

Technical evaluations including project description, firm yield computation, cost estimation, and assessment of environmental consideration have been performed for each of the 16 reservoir sites recommended for protection and/or acquisition. Key information from these technical evaluations is summarized in Table ES-1. Observations and comparisons of these 16 reservoir sites are presented in the following paragraphs in the order of relative importance for the screening process that was applied to about 150 sites.

ES.3.1 Recommended Water Management Strategy or Unique Reservoir Site in the 2007 State Water Plan

All of the reservoir sites recommended for protection, with the exceptions of Cuero II (Sandies Creek, Lindenau), George Parkhouse I, and George Parkhouse II, are recommended water management strategies and/or are recommended for designation as unique reservoir sites in the 2007 State Water Plan. The Parkhouse I and II Reservoirs are identified as alternative water management strategies for several major water suppliers in the 2006 Region C Water Plan. The Cuero II reservoir site is not explicitly mentioned in the 2006 Region L Water Plan, though it might be considered Additional Storage which is referenced therein as a water management strategy in need of further study and funding prior to implementation.

ES.3.2 Firm Yield

The largest firm yield or dependable supply during a drought of record (602,000 acft/yr) can be provided by the Marvin Nichols IA reservoir site. Depending upon the ultimate development of other sites recommended for protection in the Sulphur River Basin (e.g., Parkhouse I, Parkhouse II, and/or Ralph Hall) and their priorities relative to Marvin Nichols IA, the firm yield of Marvin Nichols IA could be as low as 460,800 acft/yr (Appendix A). The Brushy Creek reservoir site provides the least firm yield (1,380 acft/yr) among the sites recommended for protection, however, it is the recommended water supply strategy for the City of Marlin.

Table ES-1.
Comparison of Reservoir Sites Recommended for Protection

Reservoir Site	River Basin	Region	Recommended Water Management Strategy or Unique Reservoir Site (2007 SWP)	Firm Yield (acft/yr)	Unit Cost of Water - Raw @ Reservoir ($/acft/yr)	Special Considerations (Permitted)	Ecologically Significant Stream Segment (# Criteria)	Terrestrial Impacts, Bottomland Hardwood Preservation (Priority)	2060 Water Supply Needs within 50 miles (acft/yr)	Least Distance to Major Demand Center (miles)	System Operations Opportunity	Water Quality Concerns (Treatment)	Yield / Surface Area
Bedias	Trinity	G & H	Yes	75,430	$232	No	No Impact	Just Upstream (6)	284,552	85	Yes	No	7.5
Brownsville Weir	Rio Grande	M	Yes	20,643	$181	Yes	Inundating (4)	No Impact	223,489	29	Yes	No	34.4
Brushy Creek	Brazos	G	Yes	1,380	$484	Yes	No Impact	No Impact	246,820	83	No	No	2.0
Cedar Ridge	Brazos	G	Yes	36,891	$230	No	No Impact	No Impact	17,240	146	Yes	No	6.0
Cuero II	Guadalupe	L	No	71,437	$501	No	No Impact	No Impact	346,140	71	Yes	No	2.7
Fastrill	Neches	I	Yes	134,038	$152	No	Inundating (3)	Inundating (1)	136,476	127	Yes	No	5.4
Lower Bois D'Arc	Red	C	Yes	126,280	$140	No	Inundating (3)	Inundating (4)	728,028	80	Yes	No	7.6
Marvin Nichols IA	Sulphur	D	Yes	602,000	$61	No	Indirect (2)	Inundating (1)	103,879	124	Yes	No	8.9
Nueces Off-Channel	Nueces	N	Yes	39,935	$432	No	No Impact	No Impact	159,640	56	Yes	No	7.5
Palmetto Bend II	Lavaca	P	Yes	22,964	$515	Yes	Indirect (2)	No Impact	79,857	93	Yes	No	5.0
Parkhouse I	Sulphur	D	No	122,000	$174	No	No Impact	Upstream (1)	561,591	93	Yes	No	4.2
Parkhouse II	Sulphur	D	No	144,300	$107	No	No Impact	Upstream (1)	473,850	94	Yes	No	10.0
Ralph Hall	Sulphur	C	Yes	32,940	$430	No	No Impact	No Impact	419,136	72	Yes	No	4.3
Ringgold	Red	B	Yes	32,800	$273	No	No Impact	No Impact	313,933	96	Yes	No	2.2
Tehuacana	Trinity	C	Yes	41,900	$320	No	Indirect (3)	Just Upstream (5)	890,895	79	Yes	No	2.8
Wilson Hollow	Brazos	G	Yes	5,873	$920	No	No Impact	No Impact	511,124	79	Yes	No	17.6

ES.3.3 Unit Cost of Water

The Marvin Nichols IA site provides firm raw water supply at the reservoir for the least unit cost among the reservoir sites recommended for protection. Even with potential reductions in firm yield due to prior development of upstream reservoirs, Marvin Nichols IA would still have the least unit cost for additional firm water supply. The greatest unit cost is associated with the Wilson Hollow site which is an off-channel reservoir including pumping and transmission facilities to move water from Lake Palo Pinto. It is important to remember that costs reported in this study include neither transmission from the source reservoir to the ultimate user nor treatment to drinking water standards.

ES.3.4 Special Considerations

Permits have been issued by the Texas Commission on Environmental Quality (TCEQ) or a predecessor regulatory agency for reservoirs at the Brownsville Weir, Brushy Creek, and Palmetto Bend II sites. A water rights application is pending at TCEQ for the Ralph Hall site and water rights applications are in various stages of preparation for the Cedar Ridge, Fastrill, Lower Bois d'Arc Creek, and Wilson Hollow sites.

ES.3.5 Ecologically Significant Stream Segments

Six of the 16 reservoir sites recommended for protection are expected to have some effect upon stream segments identified as ecologically significant by the Texas Parks & Wildlife Department (TPWD). The Brownsville Weir, Fastrill, and Lower Bois d'Arc Creek sites would affect recommended segments by inundation, while the Marvin Nichols IA, Palmetto Bend II, and Tehuacana sites could have indirect effects upon recommended segments as a result of changes in flow regime below the reservoirs.

ES.3.6 Terrestrial Impacts

Seven of the 16 reservoir sites recommended for protection are expected to have some effect upon prioritized bottomland hardwood preservation sites identified by the USFWS. The Fastrill, Lower Bois d'Arc Creek, and Marvin Nichols IA sites would affect such bottomland hardwood preservation sites by inundation, while the Bedias and Tehuacana sites would be located immediately upstream of potential preservation sites. Although the Parkhouse I and Parkhouse II sites would be located some distance upstream of a prioritized bottomland

hardwood preservation site, detailed hydrological and biological studies would likely be required to assess potential reservoir impacts. Development of reservoir projects at all 16 of the sites recommended for protection in this study would significantly affect only two of 14 Priority 1 bottomland hardwood preservation sites in Texas. Since publication of the prioritized bottomland hardwood preservation sites by USFWS in 1985, no major reservoirs have been constructed that consequentially affect any of the 14 Priority 1 sites.

ES.3.7 Water Supply Needs within 50 Miles

The Lower Bois d'Arc Creek, Parkhouse I, Parkhouse II, Ralph Hall, Tehuacana, and Wilson Hollow reservoir sites have the greatest projected needs for additional water supply at year 2060 for counties within (or partially within) a 50-mile radius of the sites. The Cedar Ridge and Palmetto Bend II sites have the least projected needs for potential users geographically proximate to the reservoir sites. It is noted, however, that projected needs near the Cedar Ridge site could be underestimated because existing reservoirs serving users in the area are in the midst of a drought more severe than that experienced in the 1950s.

ES.3.8 Least Distance to a Major Demand Center

Among the 16 reservoir sites recommended for protection, the Brownsville Weir and Nueces Off-Channel reservoir sites are the closest to some of the largest current population centers in Texas, while the Cedar Ridge, Fastrill, and Marvin Nichols IA sites are the most distant.

ES.3.9 System Operations Opportunity

Each of the 16 reservoir sites recommended for protection, with the exception of Brushy Creek, presents some opportunity for enhancement of firm yield through system operations with one or more existing reservoirs or alternative water supply sources.

ES.3.10 Water Quality Concerns

None of the 16 reservoir sites recommended for protection exhibit water quality characteristics expected to significantly affect costs of treatment to drinking water standards.

ES.3.11 Yield per Unit Surface Area

The Brownsville Weir and Wilson Hollow reservoir sites, though relatively small, are the most efficient in terms of firm yield per unit of inundated surface area.

ES.4 Reservoir Site Acquisition Program

Sixteen (16) reservoir sites are recommended for protection through legislative designation as being of unique value for the construction of a reservoir. Beyond such designation, the Texas Legislature could choose to create a reservoir site acquisition program in order to exercise greater control over federal, state, or local government actions that would significantly impact the feasibility of future reservoir construction for water supply purposes. Table ES-2 summarizes the conservation, or normal, pool areas for the 16 reservoir sites evaluated in detail in this study, as well as the estimated costs for acquisition in 2005 dollars. Land for Brushy Creek Reservoir has been purchased by the City of Marlin and purchase of land for Brownsville Reservoir is not expected to be necessary because the land to be inundated is managed and controlled by the International Boundary and Water Commission. As shown in Table ES-2, acquisition of the remaining 14 sites up to the conservation storage level would entail purchase of about 244,000 acres at an estimated capital cost of about $428,000,000 for land only. This capital cost equates to an annual cost of about $28,400,000 assuming a 40-year debt service period and an annual interest rate of 6 percent.

A reservoir site acquisition program should include sites that the Legislature has already designated as being of unique value for the construction of a reservoir. These designated sites are: Allens Creek on Allens Creek near the confluence with the Brazos River in Austin County; Columbia on Mud Creek, a tributary of the Angelina River, in Cherokee and Smith Counties; and Post on the north fork of the Double Mountain Fork of the Brazos River in Garza County. As land for Allens Creek has already been purchased, only Columbia and Post need be included in a reservoir site acquisition program. Addition of the Columbia and Post sites (up to conservation storage level) would bring the reservoir site acquisition program to a total of about 256,500 acres at an estimated capital cost of about $447,000,000 (Table ES-2) and an annual cost of about $29,700,000.

Consideration may also be given to protection and/or acquisition of five additional sites recommended for designation as unique reservoir sites in the 2007 State Water Plan, but not technically evaluated in this study. These sites are: Lake 07 and Lake 08 on the North Fork of

the Double Mountain Fork of the Brazos River in Lubbock County; and Little River Reservoir and Little River Off-Channel on, or adjacent to, the Little River, a tributary of the Brazos River in Milam County.

Table ES-2.
Reservoir Site Acquisition Program

Reservoir	*Conservation Pool Elevation (ft-msl)*	*Conservation Pool Area (acres)*	*Land Unit Cost[1] ($/ac)*	*Conservation Pool Land Cost[1] ($)*
Bedias	210	10,000	$3,288	$32,880,000
Brownsville Weir	26	600 / 0[2]	$0[2]	$0[2]
Brushy Creek	380.5	697 / 0[3]	$0[3]	$0[3]
Cedar Ridge	1430	6,190	$850	$5,261,500
Cuero II	232	28,154	$3,100	$87,277,400
Fastrill	274	24,948	$1,825	$45,530,100
Lower Bois d'Arc	534	16,526	$2,675	$44,207,050
Marvin Nichols IA	328	67,392	$1,201	$80,937,792
Nueces Off-Channel	275.3	5,294	$1,450	$7,676,300
Palmetto Bend II	44	4,564	$1,627	$7,425,628
Parkhouse I	401	28,855	$1,201	$34,654,855
Parkhouse II	410	14,387	$1,201	$17,278,787
Ralph Hall	551	7,605	$2,675	$20,343,375
Ringgold	844	14,980	$850	$12,733,000
Tehuacana	315	14,938	$2,009	$30,010,442
Wilson Hollow	1077	333	$4,250	$1,415,250
Total		**244,166**		**$427,631,479**
Columbia[4]	315	10,000	$1,825	$18,250,000
Post[4]	2,420	2,283	$566	$1,292,278
Grand Total		**256,449**		**$447,173,657**

[1]Land costs in 2005 dollars.

[2]All of the inundated area associated with the Brownsville Reservoir lies within the channel portion of the Rio Grande and is managed and controlled by the United States and Mexican Sections of the International Boundary and Water Commission for flood protection purposes; therefore, it is anticipated that purchase of this land will not be necessary.

[3]All of the land to be inundated by Brushy Creek Reservoir has been purchased by the City of Marlin.

[4]Texas Legislature has designated this site as being of unique value for the construction of a reservoir.

Additional acreage for project facilities and above the conservation storage level up to the 100-year or standard project flood level is usually purchased around the perimeter of a reservoir. Comprehensive hydrologic and hydraulic studies that define these flood levels, however, are typically a part of final design and have not been undertaken for most of the 18 reservoir sites recommended for protection and/or acquisition. Implementation of a reservoir site acquisition program will also necessarily entail substantial additional costs for title research, negotiations, land surveying, and legal proceedings.

As an important part of this reservoir site acquisition study, TPWD performed land cover classifications for each of the 16 reservoir sites selected for technical evaluation. Figure ES-5 summarizes landcover classification by percentage for the potential acquisition program lands including all 16 reservoir sites technically evaluated herein up to their conservation storage levels. As shown in Figure ES-5, the predominant landcovers are Grassland (30 percent) and Upland Deciduous Forest (23 percent). Approximately 19 percent of the acquisition program lands are classified as Bottomland Hardwood Forest with more than 75 percent of such forests located in the Marvin Nichols IA and Parkhouse I reservoir sites. Only about 7 percent of the acquisition program lands are classified as Agricultural Land.

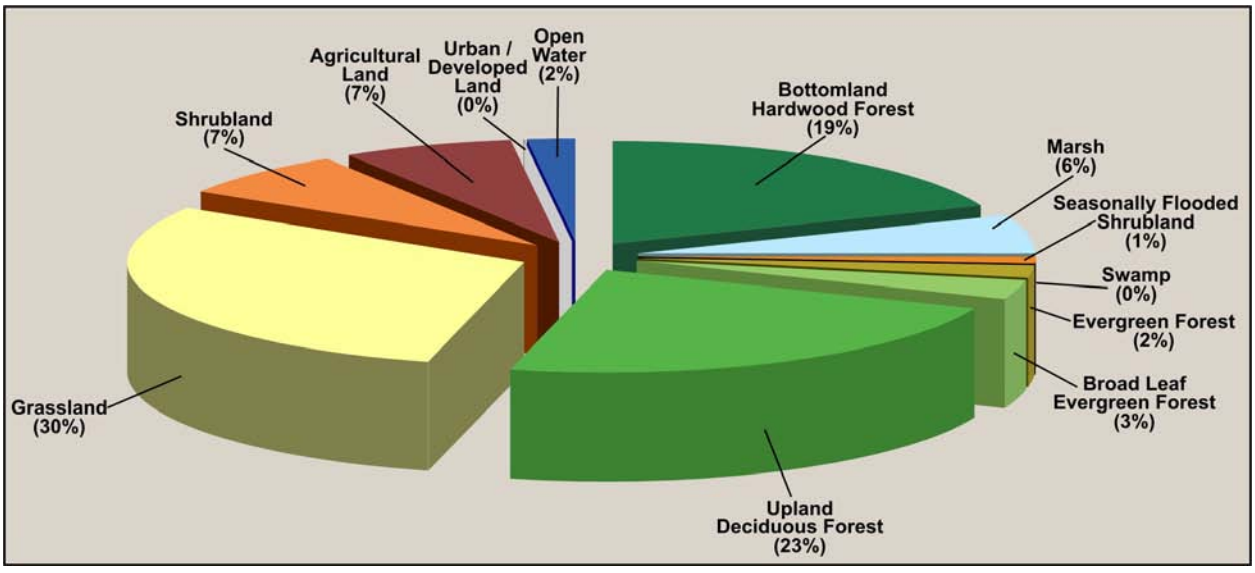

Figure ES-5. Landcover Classification for 16 Reservoir Sites

ES.5 Recommendations

- Legislatively designate the 16 reservoir sites technically evaluated and recommended in this study as unique.

- Conduct more detailed studies to define total lands for protection including reservoir flood pools and land required for project facilities.

- Consider further investigation (including updated landcover assessments) and potential protection of bottomland hardwood preservation sites for mitigation of habitat losses associated with future reservoir development.