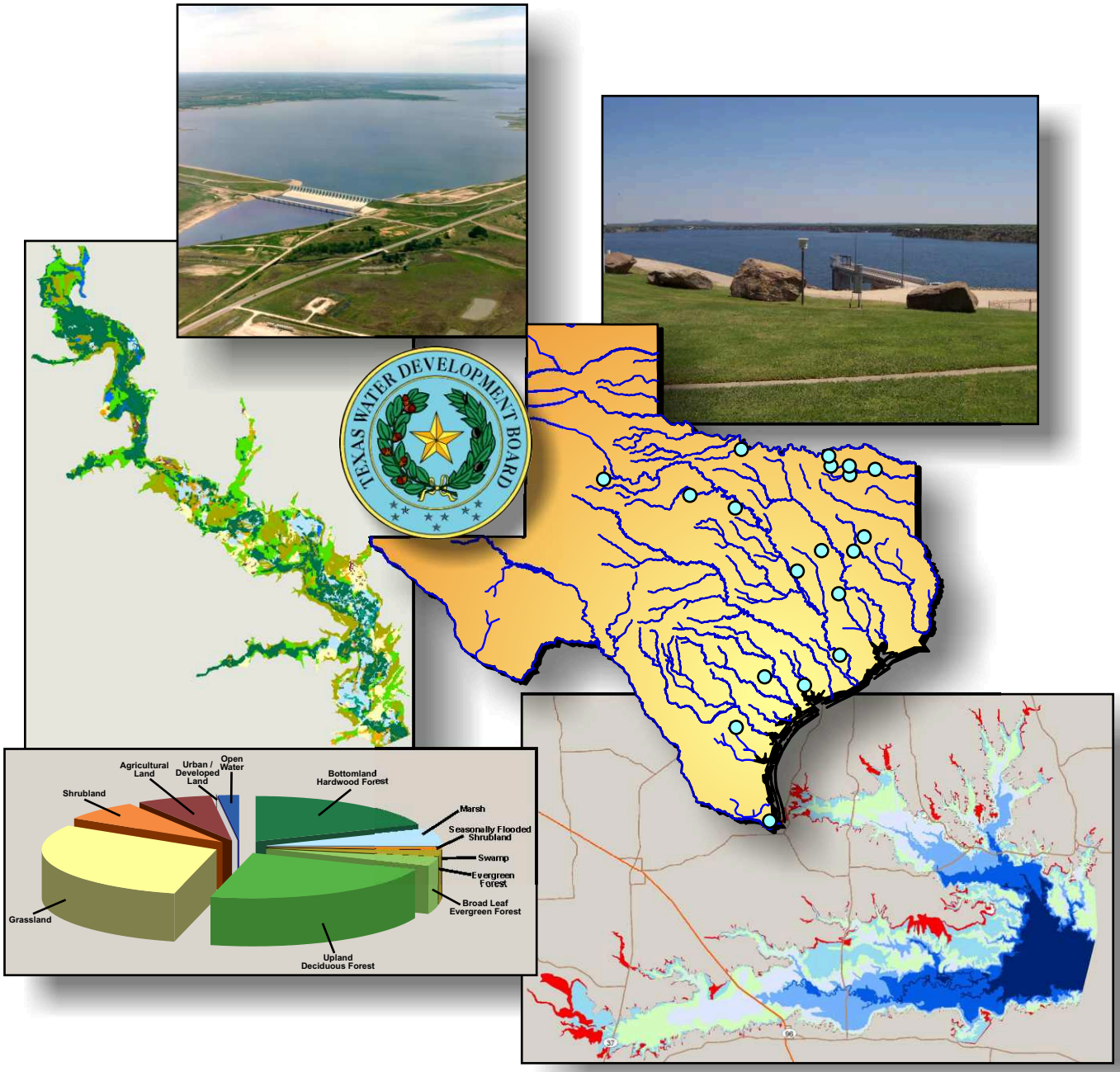
Draft

Reservoir Site Protection Study



December 2006

R.J. Brandes Company
Consulting in Water Resources

HDR | ONE COMPANY Many Solutions℠

FREESE • NICHOLS

Reservoir Site Protection Study
(Draft)

Prepared for:

Prepared by:

HDR Engineering, Inc.
Freese & Nichols, Inc.
R.J. Brandes Company

December 2006

Table of Contents

Section		Page
	Executive Summary	ES-1
1	Introduction	1-1
	1.1 Background	1-1
	1.2 Authorization and Objectives	1-2
2	Reservoir Site Screening Process	2-1
	2.1 Data Compilation and Sources	2-1
	2.2 Matrix Screening Process	2-1
	2.3 Screening Criteria	2-2
	2.3.1 Criteria Identification Process	2-2
	2.3.2 Criteria Discussion and Relative Weighting of Criteria	2-2
	2.4 Matrix Screening Tool Description	2-8
	2.5 Results of Matrix Screening Process	2-9
3	Reservoir Sites Recommended for Protection	3-1
	3.1 Designated Unique Reservoir Sites	3-1
	3.2 Assumptions for Water Supply Modeling	3-1
	3.3 Assumptions for Cost Estimates	3-2
	3.4 Proposed Reservoir Sites Recommended for Protection	3-3
	3.4.1 Bedias Creek Reservoir	3-5
	3.4.2 Brownsville Weir and Reservoir Project	3-19
	3.4.3 Brushy Creek Reservoir	3-33
	3.4.4 Cedar Ridge Reservoir (Breckenridge Reservoir)	3-45
	3.4.5 Cuero II Reservoir (Sandies Creek Reservoir or Lindenau Reservoir)	3-57
	3.4.6 Fastrill Reservoir (Weches Reservoir)	3-69
	3.4.7 Lower Bois d'Arc Creek Reservoir	3-85
	3.4.8 Marvin Nichols Reservoir	3-97
	3.4.9 Nueces Off-Channel Reservoir	3-111
	3.4.10 Palmetto Bend Reservoir — Stage II	3-123
	3.4.11 George Parkhouse I Lake	3-137
	3.4.12 George Parkhouse II Lake	3-151
	3.4.13 Lake Ralph Hall	3-163
	3.4.14 Ringgold Reservoir	3-175
	3.4.15 Tehuacana Reservoir	3-187
	3.4.16 Wilson Hollow Reservoir	3-201

Table of Contents (Concluded)

Section			Page
4	Summary and Recommendations		4-1
	4.1	Comparisons of Reservoir Sites Recommended for Protection	4-1
	4.1.1	Recommended to Meet Needs or as a Unique Reservoir Site in the 2007 State Water Plan	4-1
	4.1.2	Firm Yield	4-1
	4.1.3	Unit Cost of Water	4-3
	4.1.4	Special Considerations	4-3
	4.1.5	Ecologically Significant Stream Segments	4-3
	4.1.6	Terrestrial Impacts	4-3
	4.1.7	Water Supply Needs within 50 Miles	4-4
	4.1.8	Least Distance to a Major Demand Center	4-4
	4.1.9	System Operations Opportunity	4-4
	4.1.10	Water Quality Concerns	4-4
	4.1.11	Yield per Unit Surface Area	4-5
	4.2	Reservoir Site Acquisition Program	4-5
	4.3	Recommendations	4-7
	References		R-1

Appendices

A Firm Yield Sensitivity for the Sulphur River Basin Reservoir Sites

B An Assessment of Potential Impacts to Archaeological and Cultural Sites Relating to Reservoir Site Acquisition Development

C Report on The Creation of a Land Cover / Land Use Database for Select Proposed Reservoir Sites in Texas

List of Figures

Figure		Page
1.1-1	State Water Plans	1-1
1.2-1	Reservoir Site Acquisition Study Tasks	1-3
2.3-1	Ecologically Significant River and Stream Segments as Identified by TPWD	2-5
2.3-2	Bottomland Hardwood Preservation Sites as Recommended by USFWS	2-6
2.3-3	Major Water Demand Centers	2-7
2.5-1	Designated and Recommended Unique Reservoir Sites	2-10
3.4.1-1	Location Map of Bedias Creek Reservoir	3-5
3.4.1-2	Elevation-Area-Capacity Relationship for Bedias Creek Reservoir	3-8
3.4.1-3	Inundation Map for Bedias Creek Reservoir	3-9
3.4.1-4	Firm Yield vs. Conservation Storage for Bedias Reservoir	3-11
3.4.1-5	Simulated Storage in Bedias Creek Reservoir	3-11
3.4.1-6	Potential Major Conflicts for Bedias Creek Reservoir	3-13
3.4.1-7	Existing Landcover for Bedias Creek Reservoir	3-18
3.4.2-1	Location Map of Brownsville Weir and Reservoir Project	3-20
3.4.2-2	Elevation-Area-Capacity Relationship for Brownsville Weir and Reservoir	3-22
3.4.2-3	Simulated Storage in Brownsville Weir and Reservoir	3-23
3.4.2-4	Potential Major Conflicts for Brownsville Weir and Reservoir	3-25
3.4.2-5	Existing Landcover for Brownsville Weir and Reservoir	3-31
3.4.3-1	Location Map of Brushy Creek Reservoir	3-33
3.4.3-2	Elevation-Area-Capacity Relationship for Brushy Creek Reservoir	3-35
3.4.3-3	Inundation Map for Brushy Creek Reservoir	3-36
3.4.3-4	Simulated Storage in Brushy Creek Reservoir	3-37

List of Figures (Continued)

Figure		Page
3.4.3-5	Potential Major Conflicts for Brushy Creek Reservoir	3-40
3.4.3-6	Existing Landcover for Brushy Creek Reservoir	3-43
3.4.4-1	Location Map of Cedar Ridge Reservoir	3-45
3.4.4-2	Elevation-Area-Capacity Relationship for Cedar Ridge Reservoir	3-47
3.4.4-3	Inundation Map for Cedar Ridge Reservoir	3-48
3.4.4-4	Firm Yield vs. Conservation Storage for Cedar Ridge Reservoir	3-50
3.4.4-5	Simulated Storage in Cedar Ridge Reservoir	3-51
3.4.4-6	Potential Major Conflicts for Cedar Ridge Reservoir	3-52
3.4.4-7	Existing Landcover for Cedar Ridge Reservoir	3-55
3.4.5-1	Location Map of Cuero II Reservoir	3-57
3.4.5-2	Elevation-Area-Capacity Relationship for Cuero II Reservoir	3-59
3.4.5-3	Inundation Map for Cuero II Reservoir	3-60
3.4.5-4	Firm Yield vs. Conservation Storage for Cuero II Reservoir	3-62
3.4.5-5	Simulated Storage in Cuero II Reservoir	3-63
3.4.5-6	Potential Major Conflicts for Cuero II Reservoir	3-65
3.4.5-7	Existing Landcover for Cuero II Reservoir	3-68
3.4.6-1	Location Map of Fastrill Reservoir	3-69
3.4.6-2	Location Map of Weches Reservoir	3-70
3.4.6-3	Elevation-Area-Capacity Relationship for Fastrill Reservoir	3-72
3.4.6-4	Inundation Map for Fastrill Reservoir	3-73
3.4.6-5	Firm Yield vs. Conservation Storage for Fastrill Reservoir	3-76
3.4.6-6	Simulated Storage in Fastrill Reservoir	3-77
3.4.6-7	Potential Major Conflicts for Fastrill Reservoir	3-78

List of Figures (Continued)

Figure		Page
3.4.6-8	Existing Landcover for Fastrill Reservoir	3-82
3.4.7-1	Location Map for Lower Bois d'Arc Creek Reservoir	3-85
3.4.7-2	Elevation-Area-Capacity Relationship for Lower Bois d'Arc Creek Reservoir	3-87
3.4.7-3	Inundation Map for Lower Bois d'Arc Creek	3-88
3.4.7-4	Firm Yield vs. Conservation Storage for Lower Bois d'Arc Creek Reservoir	3-90
3.4.7-5	Simulated Storage in Lower Bois d'Arc Creek Reservoir	3-91
3.4.7-6	Potential Major Conflicts for Lower Bois d'Arc Creek Reservoir	3-92
3.4.7-7	Existing Landcover for Lower Bois d'Arc Creek Reservoir	3-95
3.4.8-1	Location Map for Marvin Nichols Reservoir (Site IA)	3-97
3.4.8-2	Elevation-Area-Capacity Relationship for Marvin Nichols Reservoir	3-99
3.4.8-3	Inundation Map for Marvin Nichols Reservoir	3-101
3.4.8-4	Firm Yield vs. Conservation Storage for Marvin Nichols Reservoir	3-103
3.4.8-5	Simulated Storage in Marvin Nichols Reservoir	3-104
3.4.8-6	Potential Major Conflicts for Marvin Nichols Reservoir	3-105
3.4.8-7	Existing Landcover for Marvin Nichols Reservoir	3-109
3.4.9-1	Location Map of Nueces Off-Channel Reservoir	3-112
3.4.9-2	Elevation-Area-Capacity Relationship for Nueces Off-Channel Reservoir	3-113
3.4.9-3	Inundation Map for Nueces Off-Channel Reservoir	3-114
3.4.9-4	Firm Yield vs. Conservation Storage for Nueces Off-Channel Reservoir	3-116
3.4.9-5	Simulated Storage in Nueces Off-Channel Reservoir	3-117

List of Figures (Continued)

Figure		Page
3.4.9-6	Simulated System Storage for Lake Corpus Christi, Choke Canyon Reservoir, and Nueces Off-Channel Reservoir	3-118
3.4.9-7	Potential Major Conflicts for Nueces Off-Channel Reservoir	3-119
3.4.9-8	Existing Landcover for Nueces Off-Channel Reservoir	3-122
3.4.10-1	Location Map of Palmetto Bend Reservoir — Stage II	3-124
3.4.10-2	Elevation-Area-Capacity Relationship for Palmetto Bend Reservoir – Stage II	3-126
3.4.10-3	Inundation Map for Palmetto Bend Reservoir – Stage II	3-127
3.4.10-4	Firm Yield vs. Conservation Storage for Palmetto Bend Reservoir – Stage II	3-129
3.4.10-5	Simulated Storage in Palmetto Bend Reservoir – Stage II	3-130
3.4.10-6	Potential Major Conflicts for Palmetto Bend Reservoir – Stage II	3-131
3.4.10-7	Existing Landcover for Palmetto Bend Reservoir – Stage II	3-135
3.4.11-1	Location Map of George Parkhouse I Lake	3-137
3.4.11-2	Elevation-Area-Capacity Relationship for George Parkhouse I Lake	3-139
3.4.11-3	Inundation Map for George Parkhouse I Lake	3-141
3.4.11-4	Firm Yield vs. Conservation Storage for George Parkhouse I Lake	3-143
3.4.11-5	Simulated Storage in George Parkhouse I Lake	3-144
3.4.11-6	Potential Major Conflicts for George Parkhouse I Lake	3-145
3.4.11-7	Existing Landcover for George Parkhouse I Lake	3-149
3.4.12-1	Location Map of George Parkhouse II Lake	3-151
3.4.12-2	Elevation-Area-Capacity Relationship for George Parkhouse II Lake	3-153
3.4.12-3	Inundation Map for George Parkhouse II Lake	3-154
3.4.12-4	Firm Yield vs. Conservation Storage for George Parkhouse II Lake	3-155

List of Figures (Continued)

Figure		Page
3.4.12-5	Simulated Storage in George Parkhouse II Lake	3-157
3.4.12-6	Potential Major Conflicts for George Parkhouse II Lake	3-158
3.4.12-7	Existing Landcover for George Parkhouse II Lake	3-162
3.4.13-1	Location Map of Lake Ralph Hall	3-163
3.4.13-2	Elevation-Area-Capacity Relationship for Lake Ralph Hall	3-165
3.4.13-3	Inundation Map for Lake Ralph Hall	3-166
3.4.13-4	Simulated Storage in Lake Ralph Hall	3-168
3.4.13-5	Potential Major Conflicts for Lake Ralph Hall	3-169
3.4.13-6	Existing Landcover for Lake Ralph Hall	3-173
3.4.14-1	Location Map of Ringgold Reservoir	3-175
3.4.14-2	Elevation-Area-Capacity Relationship for Ringgold Reservoir	3-178
3.4.14-3	Inundation Map for Ringgold Reservoir	3-179
3.4.14-4	Firm Yield vs. Conservation Storage for Ringgold Reservoir	3-181
3.4.14-5	Simulated Storage in Ringgold Reservoir	3-182
3.4.14-6	Potential Major Conflicts for Ringgold Reservoir	3-183
3.4.14-7	Existing Landcover for Ringgold Reservoir	3-186
3.4.15-1	Location Map of Tehuacana Reservoir	3-187
3.4.15-2	Elevation-Area-Capacity Relationship for Tehuacana Reservoirs	3-190
3.4.15-3	Elevation-Area-Capacity Relationship for Tehuacana and Richland Chambers Reservoirs Combined	3-190
3.4.15-4	Inundation Map for Tehuacana Reservoir	3-192
3.4.15-5	System Yield vs. Conservation Storage for Tehuacana and Richland Chambers Reservoirs Combined	3-194
3.4.15-6	Simulated Storage in Tehuacana and Richland Chambers Reservoirs	3-194

List of Figures (Concluded)

Figure		Page
3.4.15-7	Potential Major Conflicts for Tehuacana Reservoir	3-196
3.4.15-8	Existing Landcover for Tehuacana Reservoir	3-199
3.4.16-1	Location Map of Wilson Hollow Reservoir	3-201
3.4.16-2	Elevation-Area-Capacity Relationship for Wilson Hollow Reservoir	3-203
3.4.16-3	Inundation Map for Wilson Hollow Reservoir	3-204
3.4.16-4	Firm Yield vs. Conservation Storage for Wilson Hollow Reservoir	3-206
3.4.16-5	Simulated Storage in Wilson Hollow Reservoir	3-207
3.4.16-6	Simulated System Storage for Lake Palo Pinto and Wilson Hollow Reservoirs	3-208
3.4.16-7	Potential Major Conflicts for Wilson Hollow Reservoir	3-209
3.4.16-8	Existing Landcover for Wilson Hollow Reservoir	3-212
4.2-1	Landcover Classification for 16 Reservoir Sites	4-7

List of Tables

Table		Page
3.4.1-1	Elevation-Area-Capacity Relationship for Bedias Creek Reservoir	3-7
3.4.1-2	Consensus Criteria for Environmental Flow Needs for Bedias Creek Reservoir	3-8
3.4.1-3	Firm Yield vs. Conservation Storage for Bedias Creek Reservoir	3-10
3.4.1-4	List of Potential Conflicts for Bedias Creek Reservoir	3-12
3.4.1-5	Cost Estimate — Bedias Creek Reservoir @ Elevation 210 ft-msl	3-14
3.4.1-6	Acreage and Percent Landcover for Bedias Creek Reservoir	3-17
3.4.2-1	Elevation-Area-Capacity Relationship for Brownsville Weir Reservoir	3-22
3.4.2-2	Cost Estimate — Brownsville Weir @ Elevation 26 ft-msl	3-26
3.4.2-3	Acreage and Percent Landcover for Brownsville Weir and Reservoir	3-30
3.4.3-1	Elevation-Area-Capacity Relationship for Brushy Creek Reservoir	3-35
3.4.3-2	List of Potential Conflicts for Brushy Creek Reservoir	3-38
3.4.3-3	Acreage and Percent Landcover for Brushy Creek Reservoir	3-39
3.4.3-4	Cost Estimate — Brushy Creek Reservoir Elevation @ 380.5 ft-msl	3-41
3.4.4-1	Elevation-Area-Capacity Relationship for Cedar Ridge Reservoir	3-46
3.4.4-2	Consensus Criteria for Environmental Flow Needs for Cedar Ridge Reservoir	3-48
3.4.4-3	Firm Yield vs. Conservation Storage for Cedar Ridge Reservoir	3-50
3.4.4-4	Cost Estimate — Cedar Ridge Reservoir @ Elevation 1,430 ft-msl	3-53
3.4.4-5	Acreage and Percent Landcover for Cedar Ridge Reservoir	3-54
3.4.5-1	Elevation-Area-Capacity Relationship for Cuero II Reservoir	3-58
3.4.5-2	Consensus Criteria for Environmental Flow Needs for Cuero II Reservoir	3-61
3.4.5-3	Consensus Criteria for Environmental Flow Needs for Guadalupe River Diversions	3-61
3.4.5-4	Firm Yield vs. Conservation Storage for Cuero II Reservoir	3-62

List of Tables (Continued)

Table		Page
3.4.5-5	Cost Estimate — Cuero II @ Elevation 232 ft-msl	3-66
3.4.5-6	Acreage and Percent Landcover for Cuero II Reservoir	3-67
3.4.6-1	Elevation-Area-Capacity Relationship for Fastrill Reservoir	3-71
3.4.6-2	Consensus Criteria for Environmental Flow Needs for Fastrill Reservoir	3-74
3.4.6-3	Firm Yield vs. Conservation Storage for Fastrill Reservoir	3-76
3.4.6-4	Cost Estimate — Fastrill Reservoir @ Elevation 274 ft-msl	3-79
3.4.6-5	Acreage and Percent Landcover for Fastrill Reservoir	3-83
3.4.7-1	Elevation-Area-Capacity Relationship for Lower Bois d'Arc Creek Reservoir	3-87
3.4.7-2	Consensus Criteria for Environmental Flow Needs for Lower Bois d'Arc Creek Reservoir	3-89
3.4.7-3	Firm Yield vs. Conservation Storage for Lower Bois d'Arc Creek Reservoir	3-90
3.4.7-4	List of Potential Conflicts for Lower Bois d'Arc Creek Reservoir	3-91
3.4.7-5	Cost Estimate — Lower Bois d'Arc Creek Reservoir @ Elevation 534 ft-msl	3-94
3.4.7-6	Acreage and Percent Landcover for Lower Bois d'Arc Creek Reservoir	3-96
3.4.8-1	Elevation-Area-Capacity Relationship for Marvin Nichols Reservoir	3-99
3.4.8-2	Consensus Criteria for Environmental Flow Needs for Marvin Nichols Reservoir	3-100
3.4.8-3	Firm Yield vs. Conservation Storage for Marvin Nichols Reservoir	3-103
3.4.8-4	List of Potential Conflicts for Marvin Nichols Reservoir	3-105
3.4.8-5	Cost Estimate — Marvin Nichols Reservoir @ Elevation 328 ft-msl	3-107
3.4.8-6	Acreage and Percent Landcover for Marvin Nichols Reservoir	3-108

List of Tables (Continued)

Table		Page
3.4.9-1	Elevation-Area-Capacity Relationship for Nueces Off-Channel Reservoir.	3-113
3.4.9-2	Firm Yield vs. Conservation Storage for Nueces Off-Channel Reservoir ...	3-116
3.4.9-3	Cost Estimate — Nueces Off-Channel Reservoir @ Elevation 275 ft-msl	3-120
3.4.9-4	Acreage and Percent Landcover for Nueces Off-Channel Reservoir.....	3-121
3.4.10-1	Elevation-Area-Capacity Relationship for Palmetto Bend Reservoir – Stage II	3-125
3.4.10-2	Consensus Criteria for Environmental Flow Needs for Palmetto Bend Reservoir – Stage II	3-128
3.4.10-3	Firm Yield vs. Conservation Storage for Palmetto Bend Reservoir – Stage II	3-129
3.4.10-4	Cost Estimate — Palmetto Bend Reservoir – Stage II @ Elevation 44 ft-msl	3-132
3.4.10-5	Acreage and Percent Landcover for Palmetto Bend Reservoir – Stage II	3-134
3.4.11-1	Elevation-Area-Capacity Relationship for George Parkhouse I Lake	3-139
3.4.11-2	Consensus Criteria for Environmental Flow Needs for George Parkhouse I Lake	3-140
3.4.11-3	Firm Yield vs. Conservation Storage for George Parkhouse I Lake.....	3-142
3.4.11-4	List of Potential Conflicts for George Parkhouse I Lake	3-145
3.4.11-5	Cost Estimate — George Parkhouse I Lake @ Elevation 401 ft-msl	3-147
3.4.11-6	Acreage and Percent Landcover for George Parkhouse I Lake	3-148
3.4.12-1	Elevation-Area-Capacity Relationship for George Parkhouse II Lake	3-153
3.4.12-2	Consensus Criteria for Environmental Flow Needs for George Parkhouse II Lake	3-154
3.4.12-3	Firm Yield vs. Conservation Storage for George Parkhouse II Lake	3-155
3.4.12-4	List of Potential Conflicts for George Parkhouse II Lake.....	3-157

List of Tables (Continued)

Table		Page
3.4.12-5	Cost Estimate — George Parkhouse II Lake @ Elevation 410 ft-msl	3-160
3.4.12-6	Acreage and Percent Landcover for George Parkhouse II Lake	3-161
3.4.13-1	Elevation-Area-Capacity Relationship for Lake Ralph Hall	3-165
3.4.13-2	Lyons Criteria for Environmental Flow Needs for Lake Ralph Hall	3-167
3.4.13-3	List of Potential Conflicts for Lake Ralph Hall	3-169
3.4.13-4	Cost Estimate — Lake Ralph Hall @ Elevation 551 ft-msl	3-171
3.4.13-5	Acreage and Percent Landcover for Lake Ralph Hall	3-172
3.4.14-1	Elevation-Area-Capacity Relationship for Ringgold Reservoir	3-177
3.4.14-2	Consensus Criteria for Environmental Flow Needs for Ringgold Reservoir	3-179
3.4.14-3	Firm Yield vs. Conservation Storage for Ringgold Reservoir	3-180
3.4.14-4	List of Potential Conflicts for Ringgold Reservoir	3-182
3.4.14-5	Cost Estimate — Ringgold Reservoir @ Elevation 844 ft-msl	3-185
3.4.14-6	Acreage and Percent Landcover for Ringgold Reservoir	3-184
3.4.15-1	Elevation-Area-Capacity Relationship for Tehuacana Reservoir	3-189
3.4.15-2	Elevation-Area-Capacity Relationship for Tehuacana and Richland Chambers Reservoirs Combined	3-189
3.4.15-3	Consensus Criteria for Environmental Flow Needs for Tehuacana and Richland Chambers Reservoirs Combined	3-191
3.4.15-4	Firm Yield vs. Conservation Storage for Tehuacana and Richland Chambers Reservoirs Combined	3-193
3.4.15-5	List of Potential Conflicts for Tehuacana Reservoir	3-195
3.4.15-6	Cost Estimate — Tehuacana Reservoir @ Elevation 315 ft-msl	3-197
3.4.15-7	Acreage and Percent Landcover for Tehuacana Reservoir	3-200
3.4.16-1	Elevation-Area-Capacity Relationship for Wilson Hollow Reservoir	3-203

List of Tables (Concluded)

Table		Page
3.4.16-2	Firm Yield vs. Conservation Storage for Wilson Hollow Reservoir	3-206
3.4.16-3	Cost Estimate — Wilson Hollow Reservoir @ Elevation 1,077 ft-msl	3-210
3.4.16-4	Acreage and Percent Landcover for Wilson Hollow Reservoir	3-211
4.1-1	Comparison of Reservoir Sites Recommended for Protection.....	4-2
4.2-1	Reservoir Site Acquisition Program.....	4-6

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.

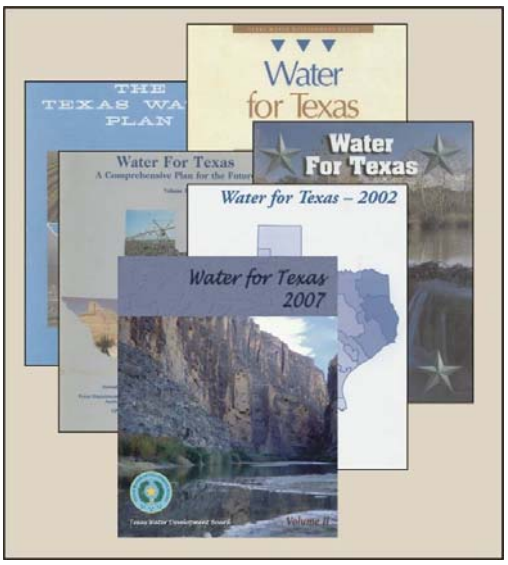


Figure ES-1. State Water Plans

In the 2007 State Water Plan, the TWDB has recommended that the Legislature consider 17 major reservoir sites identified by Regional Water Planning Groups 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.

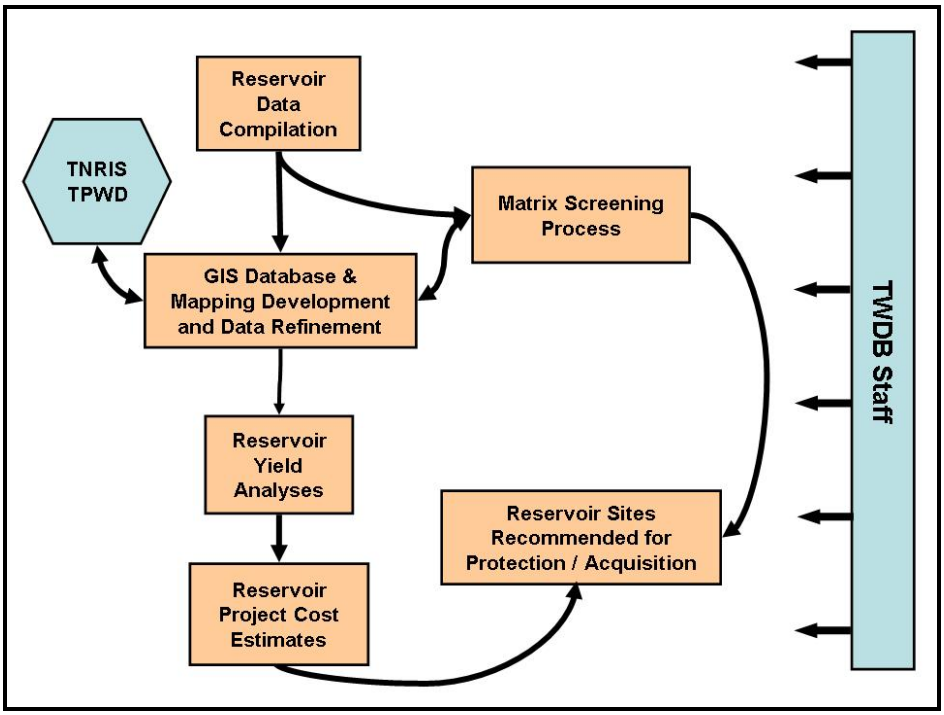


Figure ES-2. Reservoir Site Acquisition Study Tasks

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.

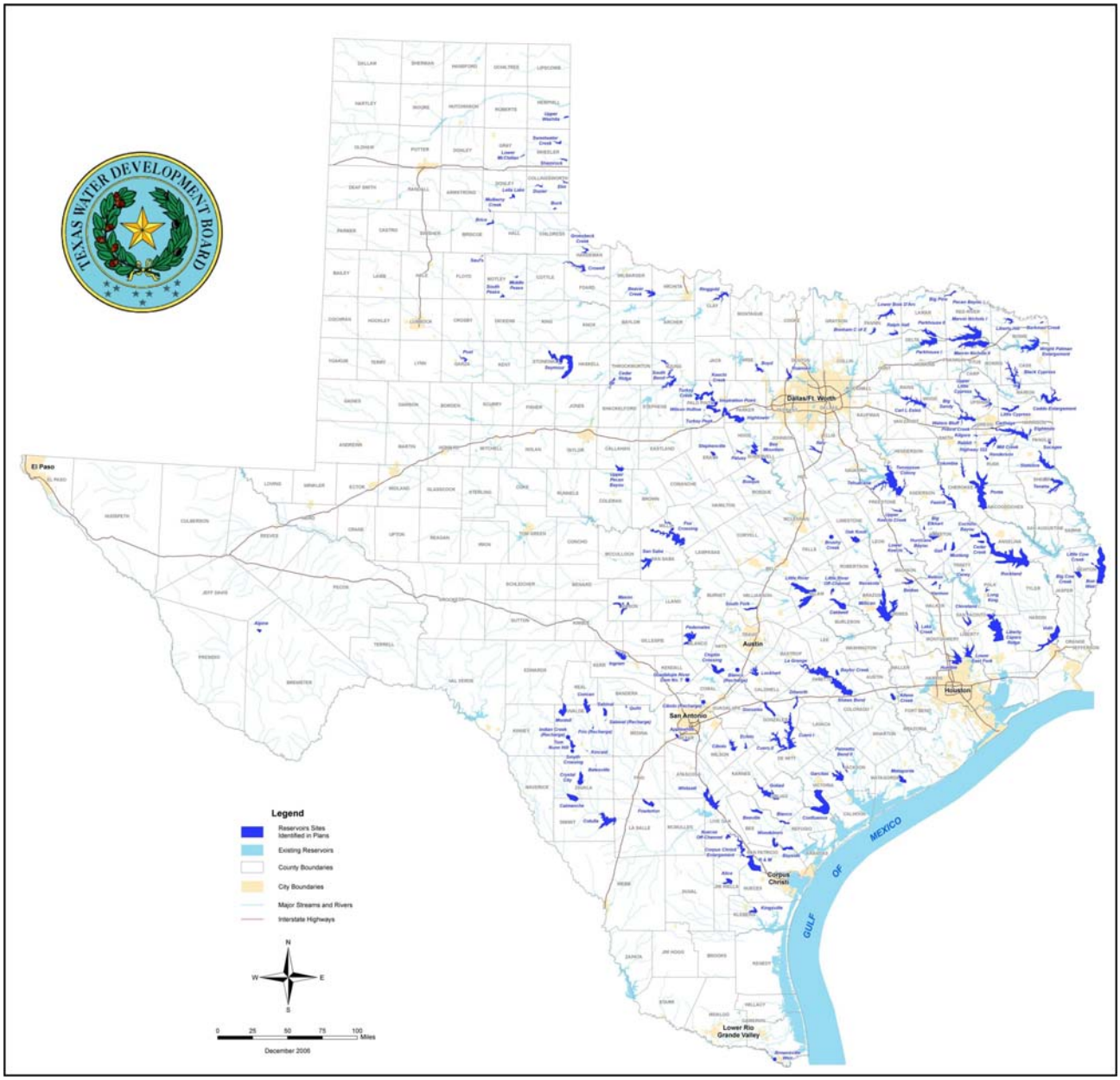


Figure ES-3. Reservoir Sites Identified in Plans

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 to Meet Needs or as a 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.

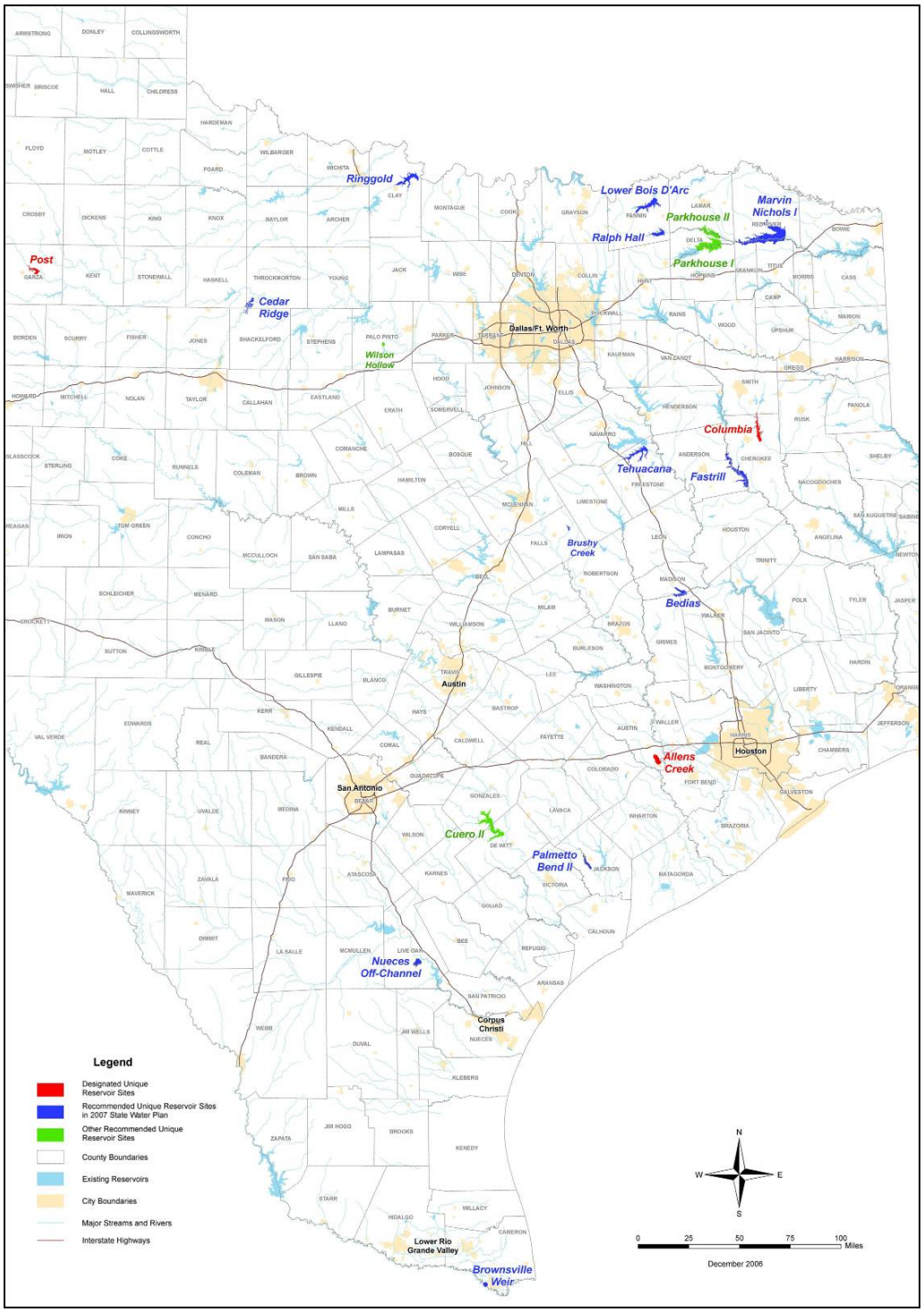


Figure ES-4. Designated and Recommended Unique Reservoir Sites

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 to Meet Needs or as a 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 to meet projected water needs 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 to Meet Needs (2006 RWP) 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	$228	No	No Impact	Just Upstream (6)	284,552	85	Yes	No	7.5
Brownsville Weir	Rio Grande	M	Yes	20,643	$182	Yes	Inundating (4)	No Impact	223,489	29	Yes	No	34.4
Brushy Creek	Brazos	G	Yes	1,380	$455	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	$425	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	$330	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	$294	No	Indirect (3)	Just Upstream (5)	890,895	79	Yes	No	2.8
Wilson Hollow	Brazos	G	Yes	7,556	$715	No	No Impact	No Impact	511,124	79	Yes	No	22.7

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 recommended for designation 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 $413,000,000 for land only. This capital cost equates to an annual cost of about $27,400,000 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.

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; Little River Reservoir and Little River Off-Channel on, or adjacent to, the Little River, a tributary of the Brazos River in

Milam County; and Muenster Reservoir on Brushy Elm Creek, a tributary of the Elm Fork of the Trinity River in Cooke 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	$3,088	$30,876,000
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	$1,111	$5,881,634
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	$1,201	$9,133,605
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
Totals		**244,166**		**$412,623,043**

[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.

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.

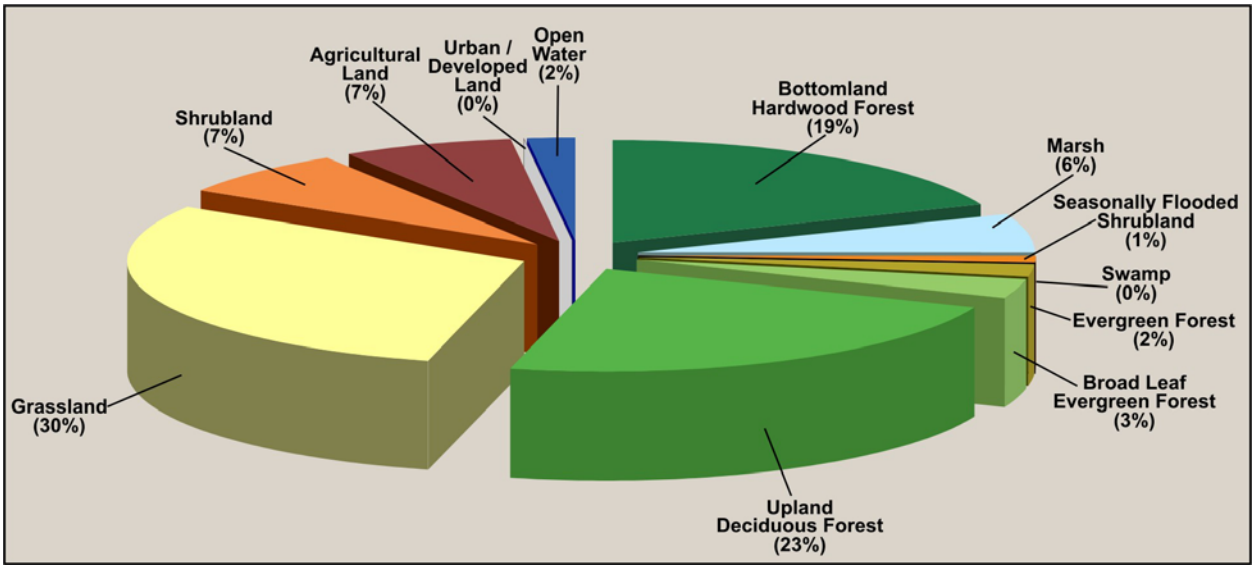


Figure ES-5. Landcover Classification for 16 Reservoir Sites

4.3 Recommendations

- Legislatively designate the 16 reservoir sites recommended in this study as unique.
- Investigate the feasibility and funding mechanisms for a reservoir site acquisition program including at least the 16 sites recommended herein for which land has yet to be acquired. Evaluate opportunities for revenue generation during debt service period (e.g., timber harvest, eco-tourism, etc.).

- Conduct more detailed studies to define total acquisition lands including flood pools and land required for project facilities.
- Consider multiple objectives for acquisition including potential use as mitigation lands for alternative reservoir projects should a reservoir at the unique site ultimately prove infeasible.
- Develop a reservoir site acquisition plan outlining specific measures to be taken over a designated timeframe, including state and local sponsor responsibilities.
- Consider further investigation (including updated landcover assessments) and potential acquisition of bottomland hardwood preservation sites for mitigation of habitat losses associated with future reservoir development.
- Consider expansion of Section 16.051(g)(2) of the Texas Water Code to include municipalities, water suppliers, utilities, transit authorities, and/or other public entities thereby preventing such entities from obtaining land or easements effectively preventing the construction of a reservoir at a site designated as unique by the Legislature.